A Possible Case of Coccidioidomycosis from the Los Muertos Site, Tempe, Arizona

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ABSTRACT Coccidioidomycosis is a fungal disease endemic to southwestern North America and parts of Central and South America. Coccidioidomycosis frequently disseminates to the human skeleton and produces mostly lytic skeletal lesions. However, this disease is infrequently described within archaeological populations. As a result, it is important to report potential cases in order to improve current understanding of the appearance and distribution of lesions resulting from coccidioidomycosis in archaeological specimens. This study describes skeletal lesions in an adult male recovered from the Los Muertos site, Tempe, Arizona (AD 500–1450). These lesions are present on the inferior border of the left scapular spine, the medial portion of the left first metacarpal head, and the medial portion of the right first metatarsal. The lesions are predominantly lytic with sclerotic and, in some cases, healed cortical bone distributed around their margins. Evidence of skeletal healing is recorded within the destructive focus of one lesion. Geographical information on pathogen endemism, overall lesion distribution, and agricultural-era Hohokom behaviour suggest that coccidioidomycosis is the most likely diagnostic option for these lesions. Mounting evidence for possible infections in the palaeopathological literature, combined with high frequencies of nutritional stress levels in endemic regions, suggests that coccidioidomycosis contributed at least moderately to morbidity in the American Southwest. Copyright © 2006 John Wiley & Sons, Ltd.

Key words: coccidioidomycosis; differential diagnosis; Los Muertos; palaeopathology; mycotic disease; American Southwest

Introduction

Coccidioidomycosis is a non-communicable disease caused when individuals inhale the spores of Coccidioides immitis (Drutz & Catanzaro, 1971). Coccidioides immitis is a dimorphic fungus endemic to hot and dry desert climates, including the southwestern United States, northern Mexico, and parts of Central and South America. The spores of Coccidioides immitis exist approximately 20 cm below the desert floor as mycelia, which partition into arthrospores subsequent to exiting the soil (Richardson & Warnock, 1997: 172). Seasonal desert rainfall catalyses mycelial proliferation, while successive hot-dry summer periods create a hospitable environment for arthrospore production. Numerous agents are then responsible for dispersing the pathogenic arthrospores over large distances.

Illness produced by coccidioidomycosis ranges from mild ‘pneumonia like’ symptoms to acutely fatal dissemination beyond the lungs in chronic cases (Drutz & Catanzaro, 1971). Dissemination occurs in less than 1% of all coccidioidomycosis cases (Aufderheide & Rodríguez-Martín, 1998: 215). Bone involvement occurs in more than 30% of all disseminated cases (Carter,
Many incidences of pre-antibiotic disseminated cases of coccidioidomycosis can be found in the clinical literature (Bowman, 1919; Taylor, 1923; Cummins et al., 1929; Evans & Ball, 1929; Carter, 1931, 1934). These cases included ulcerations of the skin, organ granulomas, and considerable bone destruction. Destructive bone lesions are most frequently reported to involve the tibia, clavicle, radius, ulna, fibula and vertebrae (Carter, 1931, 1934; Schwartzmann, 1957; Dykes et al., 1957; Dalinka & Greendyke, 1971; Dalinka et al., 1971). In contrast to diseases with similar osseous manifestations such as tuberculosis and metastatic cancer, coccidioidomycosis is reported to produce a significant number of extra-vertebral skeletal lesions affecting soft tissue attachment sites of bone and bone extremities among clinical populations (Temple, 2003). Bone extremities refer to extreme distal, medial and lateral bone planes. Vertebral lesions typically involve singular vertebra. The term singular refers to lesions recorded on non-coalescent vertebrae. For example, lesions on the 8th and 12th thoracic vertebrae occur on singular or isolated elements, while lesions on the 7th and 8th thoracic vertebrae involve coalescent structures.

A number of palaeopathological studies have suggested coccidioidomycosis as a possible specific diagnosis for lesions in archaeological skeletal remains. For example, Poswall (1976) and Tudor (1985) suggested coccidioidomycosis as a specific diagnosis among individuals recovered from prehistoric California and southern Arizona. In addition, 12 possible cases of coccidioidomycosis from the Cardinal site, San Joaquin Valley, California have been described (Hoffman, 1987). Van Gerven & Sheridan (1994) also briefly described an individual recovered from the Pueblo Grande site in central Arizona with lesions similar to those produced by coccidioidomycosis, using appearance and overall distribution as diagnostic criteria. Similar lesions attributed to coccidioidomycosis were also observed in an individual recovered from a site near Taos, New Mexico (Schillaci, 1999).

*Coccidioides immitis* spores have been recognised histologically in an ancient Sinagua male aged approximately 40–65 years recovered from the Nuvakwewetaqa site in northern Arizona. They are described as reticular networks of 20–80 μm and spore-like forms of 5–12 μm diameter (Harrison et al., 1991: 436), which are consistent with the morphology and size of *C. immitis* spherules (see Chaplan et al., 1980: 50; Frey et al., 1980).

Two other possible cases of coccidioidomycosis were described by Ortner (2003: 332–4). These cases are from Meridia, Mexico (AD 1920) and Los Muertos, Tempe, Arizona (AD 500–1450). Lesions in both cases match the clinical description of coccidioidomycosis with one discrepancy, specifically the presence of contiguous vertebral lesions on the individual from Meridia, Mexico (see Carter, 1931; Dalinka and Greendyke, 1971; Temple, 2003).

Another individual with destructive vertebral lesions similar to those produced by coccidioidomycosis from Los Muertos was described by Matthews et al. (1893: 171). Merbs (1985a: 138) reviewed these descriptions and concluded that the lesions were due to either coccidioidomycosis or tuberculosis. An analysis of the individual by Tudor (1985) concluded that the lesions were the result of coccidioidomycosis (Fink & Komatsu, 2001: 27). This case was not located by this study, possibly due to repatriation.

Beyond the hominin subfamily, lesions attributed to coccidioidomycosis are reported in the skeletons of chimpanzees from the Phoenix Zoo (Long & Merbs, 1981) and in domesticated dogs from modern veterinary contexts (Fink, 1985). The goals of the Long & Merbs (1985) and Fink (1985) studies were to understand the distribution of coccidioidomycosis in the human skeleton by using a close phylogenetic analogue, and whether coccidioidomycosis was present among prehistoric populations by recognising such infections among domesticated dogs.

The purpose of this paper is to describe a possible case of coccidioidomycosis in an individual recovered from the Los Muertos archaeological site. It is important that possible coccidioidomycosis cases are thoroughly described due to their infrequency within the palaeopathological literature. Such reports improve current understanding of lesions that are specific to a causative agent within an archaeological context (see Ortner, 1991, 1992, 1994; Lovell, 2000).
Materials and methods

The mostly complete skeletal remains of 56 individuals from the Los Muertos archaeological site (Figure 1), Tempe, Arizona, were examined in an attempt to find lesions similar to those produced by coccidioidomycosis. This skeletal material is curated by the National Museum of Natural History, Washington, DC. Los Muertos was occupied by the Hohokom culture and dates from approximately AD 500 to AD 1550 (Haury, 1945: 43). Abandonment occurred for currently unknown reasons, although disease and other factors related to European contact are the most likely possibilities (Fish et al., 1994: 163).

The Los Muertos skeletal material was chosen because it was located within a region that is endemic to coccidioidomycosis, and various behaviours among the population placed it at risk for infection. Palaeoenvironmental analysis of central Arizona suggests that arid conditions were present as early as AD 750, with suitable climates for dry farming occurring around AD 1100 and major environmental desiccation around AD 1350 (Masse, 1991: 215). These environments are capable of supporting Coccioides immitis and coincide with the Los Muertos site occupation. Irrigation canals used to support agricultural products are present at Los Muertos, with significant construction efforts taking place around AD 1150 (Gregory, 1991; Neitzel, 1991: 196–7). Digging irrigation canals would have placed individuals in direct contact with the habitat of Coccioides immitis and disturbed the soil enough to disperse these pathogenic arthropores.

Age and sex of each individual were determined according to standard bioarchaeological protocols (i.e. Buikstra & Ubelaker, 1994). Sex in adults was determined from pelvis and skull morphology. Sex was not assessed among juveniles. Adult age was evaluated by pubic symphyysis and auricular surface morphology as well as medial clavicular and sacral body fusion. Age in

Figure 1. North American distribution of coccidioidomycosis. The approximate location of Los Muertos is indicated with a black dot. (Adapted from Pappagianis, 1980, Plenum Publishing Corporation).
subadults was determined by dental development, eruption, long bone lengths, and epiphyseal union.

Each bone was then examined macroscopically for abnormalities. All lesions were recorded onto an anatomically-specific diagram that coded for lesion morphology (see Buikstra & Ubelaker, 1994: Attachments 3a–4b). Microscopic, radiographic and CT analyses were performed on individuals with macroscopically visible skeletal abnormalities in an attempt to reveal additional lesions. Post-mortem damage and pathological changes were differentiated using a magnifying lens and dissecting microscope. Ante-mortem disease processes were identified by the presence of bone production around destructive margins in varying stages, ranging from macroscopically apparent to that which could not be viewed without the assistance of a low-powered dissecting microscope or radiograph.

Results

One male aged between 45 and 60 years from the Los Muertos site has lytic lesions which require a careful differential diagnosis (NMNH 239224). The skeleton is mostly complete. All except two cervical vertebrae (C3–C6 region), eight carpals, 16 manual phalanges and 17 pedal phalanges are missing from the assemblage. The catalogue number and lack of vertebrae confirm that this skeleton is different from another individual with lytic vertebral lesions reported from Los Muertos (Matthews et al., 1893; Tudor, 1985). Three destructive lesions are macroscopically visible on the left scapular spine, medial portion of the left first metacarpal head and medial portion of the right first metatarsal head. Radiographic and CT analyses failed to reveal additional lesions.

The first lesion is a small well-defined lytic process on the inferior border of the left scapular spine (Figure 2). Moderate reactive bone is macroscopically and radiographically visible around the lesion margins (Figure 3). An additional well-defined and circumscribed destructive process is present on the medial side of the left first metacarpal head (Figure 4). This lesion, however, lacks observable reactive bone around its margins. Finally, a small circular lesion is present on the medial portion of the right first metatarsal head (Figure 5). The lesion is well-defined and displays some bone formation within its destructive focus (Figures 5 and 6). Bone formation recorded within the destructive focus of the right first metatarsal suggests the disease process was active at the time of death and this lesion formed earlier than the other two lytic processes (Ortner & Putschar, 1981: 38–39; Ortner, 1994: 75). Dense bony margins recorded around the lytic foci on the scapular spine (Figures 2 and 3) and healing within the lytic process on the metatarsal (Figure 5) suggest that the infection responsible for the lesions described here was relatively chronic (Ortner, 2003: 51–2).
Poor vertebral representation would normally hinder the diagnostic process, especially when attempting to match lesions with diseases that often involve vertebral elements; in this case, however, extra-vertebral lesion distribution combined with endemic data provide sufficient evidence for diagnostic comparisons. The lesions recorded on the adult male from Los Muertos could be attributed to blastomycosis, coccidiodomycosis, cryptococcosis, metastatic cancer, or tuberculosis.

Differential diagnosis

Metastatic cancer

One diagnostic option that should be considered for these lesions is metastatic cancer. Lesions
resulting from metastatic cancer appear radiographically as both singular and multiple lytic foci with little evidence of marginal reaction (Carter, 1931). Studies of dry bone specimens also find that destructive lesions attributed to metastatic cancer lack well-defined margins or macroscopic evidence of bony repair (Merbs, 1985b; Rothschild et al., 1998), with similar observations reported among human skeletal remains from archaeological sites (Manchester, 1983; Grupe, 1988; Šefčaková et al., 2001; Smith, 2002). The frequency of studies reporting irregular lesion margins and a lack of marginal reactions associated with cancer metastases are suggestive of an acute disease process.

Radiological studies find that the skull, pelvis, femur and vertebrae are the skeletal elements most frequently involved in disseminated cases of metastatic carcinoma (Copeland, 1931; Ortner & Putschar, 1981; Ortner, 2003). This pattern is also reported in dry-bone studies of pathological specimens (Merbs, 1985b; Rothschild et al., 1998) and in human skeletal remains from archaeological contexts (Manchester, 1983; Suzuki, 1989; Smith, 2002).

The lesions described in the adult male from Los Muertos contrast with those associated with metastatic cancer. The lesions described here, for example, show some evidence of bone production around lesion margins. This suggests that the lesions recorded in the adult male from Los Muertos were caused by a more chronic process than those associated with various cancer metastases. The anatomical distribution of lesions associated with metastatic cancer also differs significantly from those reported in the adult male from Los Muertos.

Tuberculosis

Tuberculosis is another diagnostic option for these lesions. Tuberculosis often results in destructive and inflammatory lesions at many extra-vertebral locations. Lytic lesions associated with tuberculosis often have smooth margins and considerable bone deposition around or near destructive foci (Resnick & Niwayama, 1995a). Tibial periostitis is frequently associated with tuberculosis infection; it is, however, worth noting that exuberant periosteal reactions at other locations are reported in many descriptions of tuberculosis (Ortner & Putschar, 1981). Periosteal inflammation is also reported on the pleural surfaces of ribs in dry bone and archaeologically documented cases of tuberculosis (Baker, 1999; Santos & Roberts, 2001). These skeletal manifestations are consistent with a chronic disease process.

Lytic lesions associated with extra-vertebral tuberculosis have been reported on the skull,
sacroiliac joint, knee joint and elbow joint (Steinbock, 1976; Ortner, 2003: 228). Similar anatomical distribution has also been reported in archaeological human skeletal remains where tuberculosis was found to be the most likely diagnostic option (Buikstra & Cook, 1981; Kelley & Eisenberg, 1987; Powell, 1990; Stodder, 1994). Tuberculous dactylitis involves the metacarpals and manual phalanges. Tuberculous dactylitis is rarely found in individuals over ten years of age and often shows evidence of exuberant bone production around the margins of destructive foci (Ortner & Putschar, 1981: 156; Resnick & Niwayama, 1995a: 2142).

Skeletal lesions associated with tuberculosis are dissimilar to those described in the adult male from Los Muertos. The lesions observed in the Los Muertos male are indicative of an infection that is slightly more acute in nature than tuberculosis—exuberant bone production around or near lesion margins is absent, as is periosteal inflammation of the long bones and ribs. Additionally, the overall lesion distribution does not match the anatomical patterning of lesions associated with tuberculosis. For example, lesions associated with tuberculosis rarely involve the hands or feet of adults; skeletal evidence of tuberculosis infection is also infrequently observed on the scapula.

Mycotic infection

Blastomycosis, coccidioidomycosis and cryptococcosis, three air-dispersed fungal diseases, frequently spread to bone hematogenously. Lesions produced by these conditions frequently occur on the scapula, vertebrae, ribs, hands, tibia, fibula and feet (Carter, 1934; Collins, 1950; Gehweiler et al., 1970; Resnick & Niwayama, 1995a). Additionally, lesions associated with blastomycosis, coccidioidomycosis and cryptococcosis all produce well-defined lytic lesions (Colonna & Glucker, 1944; Collins, 1950; Dalinka et al., 1971; Ortner & Putschar, 1981). Consequently, these conditions are impossible to separate solely by dry bone analysis.

However, the organisms that cause blastomycosis, coccidioidomycosis and cryptococcosis are adapted to different environments. Blastomyces dermatitidis, for example, grows in cool moist environments such as those found in the Mississippi River Valley as well as the Midwestern and eastern US in general (Chick, 1971). Cryptococcus neoformans is often found in organic-rich soils dissimilar to the southwestern desert (Salfelder, 1971). Furthermore, descriptions of blastomycosis and cryptococcosis infections originating in the American Southwest are absent from the clinical literature. In contrast, Coccidioides immitis is endemic to the American Southwest and is habituated to hot and dry soil. Seasonal rainfall causes rapid reproduction of C. immitis arthrospores which are dispersed when soil is disturbed. Inhalation of these spores causes frequent infections among populations living within endemic regions (see Schwarz & Furcolow, 1955; Drutz & Catanzaro, 1971).

Lesions resulting from coccidioidomycosis are radiologically described as lytic foci with well-defined margins (Carter, 1934; Dalinka et al., 1971; Resnick & Niwayama, 1995a: 2563–76). The anatomical distribution of lesions associated with coccidioidomycosis is random and involves many bones. One dry bone study of blastomycosis that included a discussion about coccidioidomycosis found lytic foci distributed on the cervical and lumbar vertebrae, ribs, scapula and cranium (Hershkovitz et al., 1998). Descriptions of coccidioidomycosis infections in archaeological material report lesion distribution patterns with varying degrees of similarity to radiological and dry bone studies (Hoffman, 1987; Harrison et al., 1991; Van Gerven & Sheridan, 1994; Schillaci, 1999). Diagnosing coccidioidomycosis in human skeletal material based solely on the presence of destructive lesions on specific skeletal elements is, therefore, imprudent (see Temple, 2003). In fact, one archaeological case that included histological descriptions of possible C. immitis spores is still considered tentative (Merbs, 1992).

A review of 74 extra-vertebral lesions reported in a radiological study of coccidioidomycosis (Carter, 1931), where infection was confirmed with coccidioidal skin tests, found that the lesions significantly involved bony soft-tissue attachment sites: $\chi^2 = 8.99$, df = 2, $P < 0.05$ (Temple, 2003). A single clinical study was used to collect these data because studies of skeletal lesions associated...
with coccidioidomycosis do not offer this type of anatomically specific data. Many other radiological and dry bone studies of mycotic infection do, however, describe a preference for osseous soft-tissue attachment sites or cancellous-rich regions of bone (Evans & Ball, 1929; Carter, 1931; Dalinka et al., 1971; Hershkovitz et al., 1998). Descriptions of possible coccidioidomycosis infections in human skeletal remains from archaeological sites support these findings (see Hoffman, 1987; Harrison et al., 1991; Van Gerven & Sheridan, 1994; Schillaci, 1999). In addition, this protocol successfully differentiated lesions associated with possible mycotic infection and those from probable tuberculosis in human skeletal recovered from the Hawikku, Heshotauthla and Los Muertos archaeological sites (Temple, 2003).

The vasculature of bone provides one possible explanation for the distribution of lesions observed in clinical and dry bone studies of coccidioidomycosis. Osseous soft-tissue attachment sites of tubular and irregular bones have complex vascular networks because they contain a significant amount of cancellous bone and attachment sites for nearby soft tissues. Cancellous bone has numerous arterial and venous networks which provide nutrients to the bony cortex and produce blood (Resnick & Niwayama, 1995b: 2328–30). In addition, connections formed between cortical capillaries and periosteal plexuses are often derived from adjacent soft tissues. Cancellous bone has numerous arterial and venous networks which provide nutrients to the bony cortex and produce blood (Resnick & Niwayama, 1995b: 2328–30). In addition, connections formed between cortical capillaries and periosteal plexuses are often derived from adjacent soft tissues. During the early phase of chronic infections or acute disease processes, blood oxygen tension in these regions can increase and stimulate osteoclast activity (Ortner, 2003: 35). Abnormal proliferations of osteoclast cells are then responsible for bone destruction. These lesions generally begin in highly vascularised cancellous bone networks and spread outward, resulting first in the destruction of cancellous bone, then the periosteum.

The adult male from Los Muertos has one lesion recorded on the inferior border of the scapular spine. This lesion is located at the attachment site for m. deltoideus (Abrahams et al., 1998). The lesion on the lateral portion of the distal left first metacarpal is located at or near the insertion site for m. opponens pollicus, while the lesion affecting the medial portion of the distal left first metatarsal occurs within close proximity to attachment sites for m. flexor hallucis brevis and m. adductor hallucis (Stone & Stone, 2000).

The appearance and distribution of the lesions observed on the adult male from Los Muertos are consistent with mycotic infection. Disseminated mycoses are chronic systemic infections. The presence of destructive lesions with well-defined margins that lack extensive bone proliferation is consistent with a disease process that was more acute than tuberculosis and more chronic than various cancer metastases. This process does, however, match those reported among clinically observed mycotic diseases (Drutz & Catanzaro, 1971; Resnick & Niwayama, 1995a). The lesions reported here also show a clear preference for bony soft-tissue attachment sites which further argues for the presence of mycotic infection in this adult male. Los Muertos is located in the same ecological zone as Coccidioides immitis. Mycotic organisms such as Blastomyces dermatitidis and Cryptococcus neoformans are not found within a reasonable proximity of the Los Muertos site. Coccidioidomycosis is, therefore, considered the most likely diagnostic option for the lesions observed in the adult male from Los Muertos.

Discussion

Los Muertos is located in a region endemic to coccidioidomycosis with, many infections often resulting from contact with disturbed soil (Schwarz & Furcolow, 1955; Huntington, 1971; Drutz & Catanzaro, 1971). Thus, frequent soil contact among prehistoric Hohokom populations provides further evidence in support of a coccidioidomycosis diagnosis. Extensive irrigation canal networks pioneered by the Hohokom are found in the Salt River area. These canals date as early as AD 500 and began in the region of the Gila and Salt River systems (Doyel, 1984: 35). Irrigation canals acted as sources of water for corn, cotton, beans and squash cultivation for many Native southwestern populations (Huckleberry, 1992).

Irrigation canals are present at Los Muertos, with major construction occurring around AD 1150 (Neitzel, 1991; Gregory, 1991). Canal depth at Los Muertos easily impinged on the...
environment of *Coccidioides immitis*, which is measured at approximately 20 cm below the surface. Furthermore, coccidioidomycosis outbreaks are frequently reported as a consequence of soil disturbance by modern occupations including construction and archaeological excavations (Huntington, 1971; Drutz & Catanzaro, 1971; Fink & Komatsu, 2001). Accidental soil disruption by adults and children are also reported to facilitate infection by dispersing large amounts *Coccidioides immitis* spores into the surrounding environment (Schwarz & Furcolow, 1955). It is therefore likely that frequent soil disruption caused by irrigation canal engineering at Los Muertos facilitated coccidioidomycosis infection by dispersing *C. immitis* spherules into the surrounding environment.

Lesions associated with coccidioidomycosis are infrequently described in the palaeopathological literature because *C. immitis* rarely disseminates beyond the primary point of infection (Drutz & Catanzaro, 1971). The small sample used by this study also presents a challenge because it is impossible to estimate, from one isolated case, the frequency of coccidioidomycosis infections at Los Muertos. As a result, it is not possible to explain the impact of this disease on the Los Muertos or other regional populations. It is, however, possible to conclude that two reported cases (this study, and Tudor, 1985) of coccidioidomycosis within the Los Muertos sample suggests that it was probably present in many other individuals, given the infrequency with which mycotic infections disseminate. Alternatively, it is possible that coccidioidomycosis infection was rare among the Los Muertos population, and that these lesions represent two chronic and isolated cases.

Reports of coccidioidomycosis among modern populations do provide some indication of the environmental circumstances under which infection may have occurred among prehistoric populations. Longitudinal studies of modern populations found that American Indians living within the most endemic regions of Arizona accounted for 11% of the total number of deaths due to coccidioidomycosis, with a mean annual incidence of 7.9 cases per 100,000 people (Sievers, 1977: 66–8). Forty-five percent of the total number of American Indians that experienced disseminated coccidioidomycosis had additional conditions associated with immunosuppression, such as malignant neoplasms, diabetes and severe malnutrition. Skeletal indicators of nutritional stress are reported with high frequency from many archaeological sites in the American Southwest (Walker, 1985; Martin et al., 1991; Stodder, 1994; Ortner et al., 2001). It is, therefore, quite possible that coccidioidomycosis infections were present among many prehistoric and historic southwestern populations. This possibility is supported by descriptions of probable coccidioidomycosis infections from archaeological sites with elevated frequencies of nutritional stress indicators (see Matthews et al., 1891; Hoffman, 1987; Harrison et al., 1991; Van Gerven & Sheridan, 1994; Schillaci, 1999).

**Conclusion**

The most likely diagnostic option for the lesions described in this paper is coccidioidomycosis. Overall lesion appearance and distribution in the adult male from Los Muertos differs from conditions such as metastatic cancer and tuberculosis. These lesions are consistent with a chronic systemic infection and similar to those produced by mycotic diseases. The involvement of soft-tissue attachment sites further supports mycotic infection as the most likely diagnostic option for these lesions. Blastomycosis and cryptococcosis have similar osseous manifestations to the lesions described within this individual, they are, however, absent from the arid environments found in the southwestern US.

In contrast, *Coccidioides immitis* is present in the American Southwest, and palaeoenvironmental studies suggest that an environment capable of sustaining these arthrospores was present in southwestern America as early as AD 750, which dates to the occupation of Los Muertos. Further evidence supporting this conclusion is the presence of irrigation canals at Los Muertos. Soil disruption caused by irrigation canal construction may have facilitated infection among the Los Muertos inhabitants by placing individuals in direct contact with *Coccidioides immitis*. The small sample size precludes this study from making estimates about infection frequencies at Los
Muertos. However, increasing reports of mycotic infections in human skeletal remains from several archaeological sites in Arizona and New Mexico, combined with the presence of high nutritional stress levels among these populations, suggests that coccidioidomycosis may have contributed to morbidity in the American Southwest.

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