Part III - Parasite Findings in Archeological Remains: a paleogeographic view

23. The Findings in Asia

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The Findings in Asia

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This chapter discusses the importance of paleoparasitology studies in Asia and the need for data to expand our understanding of the paths trod by human hosts and the traces left by their specific parasites. Such traces can be recovered in places where human migrants passed during the thousands of years that preceded the peopling of the Americas (Araújo et al., 2008).

Paleoparasitology has a long history in Asia. It may not be as old as the studies on Ancient Egypt or the European and American traditions, but it emerged with expert researchers. Although rarely cited by Western scholars, Chen (1956) published one of the first articles on parasites in archaeological remains from Asia, describing *Clonorchis sinensis* eggs in coprolites from a corpse dated to the Ming dynasty, buried in 1513 on the outskirts of Guangzhou.

Another Chinese researcher, Ou Wei (1973), published the autopsy findings from a Chinese mummy dated to 2100 BP, belonging to the Han dynasty (206 BC to 220 AD). Based on the archaeological analyses, the individual was the widow of the Marquis of Tai. The study is highly detailed, with tissues examined under both light microscopy and transmission electron microscopy. The woman had a severe coronary lesion, and various parts of her corpse presented atherosclerotic alterations. The hepatic duct was blocked by a gallstone, and since there were no signs of lesion causes by extended bedridden time, Wei (1973) concluded that the woman had died of a heart attack caused by biliary colic.

Radiological examination showed a calcified TB lesion. Wei (1973) reported finding eggs from whipworms (*Trichuris trichiura*) and pinworms (*Enterobius vermicularis*) in intestinal content and *Schistosoma* eggs (without identifying the species) in the liver. Hall (1974) and later Freedman & Proust (1978) cited the autopsy in this same mummy, confirming the presence of the parasites described by Ou Wei (1973) in the gut and liver and the pulmonary lesions from tuberculosis.

According to Han et al. (2003), eggs of *Clonorchis sinensis*, *Ascaris lumbricoides*, *Trichuris trichiura*, *Enterobius vermicularis*, and *Schistosoma japonicum* were found in mummified bodies corresponding to the Han and Chu dynasties in China (Chen & Hung, 1981; Wei et al., 1981; Hu, 1984; Yang et al., 1984; Su, 1987; Wu, Guan & Zhou, 1996), dating as far back as 2,100 years.

Witenberg (1961) described *Trichuris trichiura* eggs and cysts of *Entamoeba coli*, *Entamoeba histolytica*, *Giardia lamblia*, and *Chilomastix mesnili* in coprolites excavated in an area close to the Dead Sea and dated to 1800 BP. The article reports the first protozoan find in ancient material but lacks a precise description of the techniques used or photographs of the parasites. However, the precise identification of each protozoan, differentiating the amoebic cysts, and of *Chilomastix mesnili* cysts, leads one to assume an accurate diagnosis and adequate use of staining techniques (although not described). Still, it is extremely difficult to find protozoa in coprolites, so alternative diagnostic techniques should always be used.

None of the articles subsequently published in paleoparasitology managed to show the presence of protozoan cysts, except in extremely rare cases (Le Bailly et al., 2008). This makes the report by Witenberg (1961) one of the most exceptional findings in paleoparasitology due to the diversity of protozoan species (although the study can be criticized for lack of precise methodological description and photographic documentation).

A fascinating article by Dubinina (1972) reports the presence of *Alfortia edentatus* eggs in horse coprolites dated to the Pleistocene in Russia.

Liangbiao & Tao (1981) showed *Opisthorchis* sp. and *Clonorchis sinensis* eggs in detail using electron microscopy. The eggs were found in a mummified body in China. Cheng (1984) comments on this and other finds in Chinese mummified bodies. In one of them, the Marchioness of Tai, described previously, Cheng (1984) confirms death from myocardial infarction following coronary occlusion.

In another mummified body belonging to the Han dynasty and examined 2,142 years after the individual's death, various intestinal helminth eggs were found, such as tapeworm, whipworm, and *Clonorchis sinensis*. Cheng (1984) makes a curious comment on the presence of *Schistosoma japonicum*. According to him, the parasite's name is inappropriate, since it already parasitized the Chinese long before Japan even emerged as a country. The autopsy results also showed that although this individual also presented severe arterial lesions, the causes of death were diffuse peritonitis due to a perforated gastric ulcer complicated by septic shock and disseminated intravascular coagulation.

Mikhailov, Kuznetsov & Zhdanov (1984) describe the necropsy of a mammoth found in Siberia and dated to 10,000 BP. Examination of the animal's intestinal content under scanning electron microscopy showed spherical particles identified as viral particles, but despite the authors' attempts, they were unable to isolate the organism in cell culture.

Zias & Mumcuoglu (1991) report finding a calcified hydatid cyst when examining a funeral chamber culturally associated with the Roman period from the first century AD. The findings were two hollow, calcified structures measuring some 2.5 cm in diameter. Based on comparison with descriptions by other authors (Møller-Christensen, 1971; Wells & Dallas, 1976), they made the diagnosis of hydatid cysts resulting from infection with *Echinococcus granulosus*. They call the attention of parasitologists and archaeologists to this finding, potentially overlooked by specialists due to the structures' great similarity to common pebbles.

HersHKovitz et al. (1992) describe a lesion in a partially preserved corpse as a possible case of maduromycosis. The lesion is characterized by mycelial nodules formed by grains of bacteria or fungi that cause vesicles and abscesses with chronic swelling mainly in the feet and hands. The skeleton was found in Bet Gruvin, Israel, and dated to 1500 BP. According to the authors, the lesions were consistent with maduromycosis, possibly from infection with *Nocardia caviae*. Due to its rarity in the region, they conclude that the case was not autochthonous. However this diagnosis can raise doubts, since some mycologists prefer to use the maduromycosis for cases caused by fungi, or eumycetomas, while cases involving actinomycetes as the etiological agents are referred to simply as mycetomas.

Morimoto (1993) describes a study performed in Buddhist mummies in Japan, remarking that the preservation of organic material is unusual in such a humid region as that in which the mummies were found (Saishoji Temple, Teradomari, Niigata Prefecture). However, the three types of mummification reported by Vreeland Jr. & Cockburn (1980) – natural, intentionally natural, and artificial – can be found in the Japanese Buddhist mummies.

Mitchell (1993) studied the occurrence of leprosy in Israel during the Crusades in the 12th and 13th centuries, presenting the case of King Baldwin IV, who died in 1185 AD (Anno Domini). He discusses the theories on the entry of *Mycobacterium leprae* infection in the Middle East and its names in antiquity: what was referred to as leprosy in King Baldwin's time could have been either Hansen disease itself or endemic syphilis, since the physicians of the time did not distinguish one from the other, or either of them from other skin lesions.

The author also says that King Baldwin's disease may have been a treponematoses and not Hansen disease, as discussed previously by other authors when referring to the antiquity of syphilis (Baker & Armelagos, 1988). The evolution of his disease was described by his preceptor, William of Tyre, who refers numbness in the young boy's hands. After he was crowned, Baldwin could barely remain standing, had lost his sight, and his hands and feet were covered with ulcers. The king died young, at just 24.

However, Mitchell (1993) rules out syphilis in King Baldwin's case, for various reasons. First, Baldwin was treated by one of the most highly respected Egyptian physicians of the time, who did not prescribe any of the remedies indicated for syphilis or for other skin diseases, which could have improved his condition. Second, the distribution of his lesions, affecting the extremities and face, is characteristic of leprosy, not syphilis. Finally, the nature of the lesions suggests leprosy much more than endemic syphilis. Although both produce skin ulcers, the lepromatous form of leprosy is associated with numbness and loss of extremities, which does not occur with syphilis.

Mitchell (1993) discusses the theory that the tuberculoid form of leprosy developed gradually, only emerging after several centuries. He comments on descriptions of the disease in skeletons and mummies, where the distribution pattern of the lesions resembles that described in King Baldwin, concluding that his case was lepromatous leprosy, as expected in his time.

Rao, Vasulu & Rector Babu (1996) describe a possible case of treponematoses in India, dated to the Megalithic period.

Tayles (1996) studies factors that could lead to bone lesions characteristic of anemia in prehistoric Southeast Asia. He examined skeletons dated to 4000 BP found on the coast of Thailand, with evidence of severe anemia, and concluded that hemoglobinopathies could have produced the lesions found in this prehistoric population. This could mean that both malaria and the resulting genetic response by the human host had a long and profound influence on the life of peoples in Southeast Asia.

Mitchell & Stern (2000) describe eggs from *Trichuris trichiura*, *Ascaris lumbricoides*, and *Diphyllbothrium latum* found in latrines in a Crusade hospital in what is now Israel. The hospital was used by both Crusaders and sick pilgrims, but the latrines were destroyed and never used again after the assault by Muslim troops in 1291. The final commentary is fascinating, highlighting that *Diphyllbothrium latum*, transmitted to the human host by eating raw or poorly cooked fish, is not endemic to the Middle East but to countries of northern Europe. The period ranged from the 13th to the 15th century.

Han et al. (2003) describe a series of parasites in material of human origin in Korea, including eggs of *Trichuris trichiura*, *Ascaris lumbricoides*, and *Clonorchis sinensis*, among other unidentified parasites. The age varied from 668 to 935 AD, corresponding to the Shilla dynasty, but one site dated to 2000-1000 BC, corresponding to the Bronze Age,

material dated from 100 BC to 650 AD, corresponding to the Shilla, Koguryo, and Paekje reigns, and material dated from 1400 to 1900 AD, representing the Chosen dynasty. The authors report an interesting history of paleoparasitology in Korea, little known in the West. The first studies were done in 1997 in organic sediments excavated from a swampy terrain and dated to circa 100 BC, yielding *Ascaris* sp. and *Trichuris* sp. eggs. The material is stored at the Kwangju National Museum. Finally, the authors refer to infection with *Ascaris lumbricoides*, *Clonorchis sinensis*, and *Trichuris trichiura* in both Korea and China for at least 2,300 years.

Matsui, Kanehara & Kanera (2003) tell the history of paleoparasitology in Japan, especially dedicated to the study of latrine sediments and coprolites. The studies began with the return of Akira Matsui from England, where he learned paleoparasitological techniques from Andrew Jones at the University of York. The initial work was difficult, since residues from excavations were not kept, particularly the content of latrines and other waste found in archaeological sites, discarded from the objects before the latter were exhibited. However, Akira Matsui was called in to participate in the excavations at the Fujiwara Palace in the late 1980s, where he managed to collect samples from cesspits and latrines and took them for testing by other specialists. The dates corresponding to the excavations ranged from 600 to 710 AD. Parasite finds included *Ascaris lumbricoides*, *Trichuris trichiura*, *Metagonimus yokogawai*, *Clonorchis sinensis*, and *Taenia* eggs, indicating the eating habits of the time, especially referring to parasites transmitted by ingesting uncooked fish. The authors comment on the introduction of *A. lumbricoides* in Japan, coinciding with the introduction of rice-growing by the Chinese.

Donoghue et al. (2004) describe the history of tuberculosis with the use of molecular biology techniques, recovering genetic material from the bacillus in archaeological remains. They refer particularly to the Middle East, but review material from the entire planet. They use the term “paleomicrobiology”, a new discipline, to refer to the study of bacteria in archaeological material. However, if one adopts the broader definition of parasite (Ferreira & Araújo, 2005) as we do in this book, the terms “paleoparasitology” and “paleomicrobiology” mean the same thing. Donoghue et al. (2004) discuss the results obtained with molecular biology techniques and the limitations for the recovery of genetic material from parasites in archaeological remains. They comment on the origin of infection with *Mycobacterium tuberculosis*, ruling out the hypothesis that it was associated with the domestication of bovines some 10 to 15 thousand years ago. Their studies conclude that the modern strains of *Mycobacterium tuberculosis* emerged some 15 to 20 thousand years ago, before spreading throughout the globe. The authors highlight the need for more studies, especially in archaeological material from long-distance maritime voyages.

Seo et al. (2007) describe parasite findings in the mummified body of a Korean child from the 15th century, considered the medieval period, which includes the 10th to the 19th centuries, corresponding to the Joseon dynasty. The search for intestinal helminths was conducted in coprolites removed from the rectum with the use of an endoscope and rehydrated with the conventional method using trisodium phosphate aqueous solution. The results showed *Trichuris trichiura*, *Ascaris lumbricoides*, and *Clonorchis sinensis* eggs, while the first species called attention because it was far more numerous than the other two.

Paleoparasitology in Asia particularly relevant to paleoparasitological data in the Americas, since the theories and knowledge on the prehistoric peopling of the New World show close links between populations of Asian origin and those that gave rise to the various American population groups. Paleoparasitology has made a relevant contribution to studies of prehistoric migrations to the Americas, as discussed several times in other chapters of this book. Sorenson & Johannessen (2004, 2009) collect evidence of transoceanic contacts with an emphasis on transportation of plant species, but also considering intestinal parasites (Araújo, Ferreira & Confalonieri, 1981). They refer to species of helminths, bacteria, viruses, fungi, and what they call micropredators. They also show

the sharing of at least six different animal parasite species between Asia and the Americas, providing purported evidence of intentional maritime voyages from one continent to the other.

However, the evidence obtained from plant species outnumbers all the other forms of evidence. The authors quote Stephan Jay Gould (1994) when he states, “A species will arise in a single place and time.” Sorenson & Johannessen (2004) comment that when a species is found in the Americas before the arrival of Columbus in 1492 and early 16th-century navigators, as well as in other parts of the world like Oceania, Asia, Europa, or Africa, this requires an explanation. They rule out (as implausible) the possibility of species having been carried by the wind or other natural mechanisms. They list 98 species of plants which they consider decisive evidence of organisms that existed in both the Western and Eastern hemispheres before Columbus’ first voyage.

The evidence comes from macrofossils, pollen, phytoliths, and DNA, showing the presence, on both continents, of plant species in locations other than their places of origin. They also use information from ancient texts and artistic depictions than can be defined reliably down to the species level.

One of the issues explored by Montenegro, Avis & Weaver (2007) is the introduction of sweet potato (*Ipomoea batatas*), originally from South America and probably domesticated around 4,000 years ago, into Polynesia, possibly by accidental voyages. In this case the direction would have been the reverse, from the Americas to Asia, which could also have led to the circulation of parasites. These seafaring voyages have been reconstructed with modeling and simulations, in keeping with the probabilities of shorter voyages, more feasible for the sailors’ survival.

The relations between Asian and American peoples in the past remain to be elucidated, and many attempts have been made. Montenegro et al. (2006a) recreate transoceanic voyages and estimate the fastest times from one continent to the other, whether across the Pacific or the Atlantic. This reconstitution is still under way. Studies in bioarchaeology, especially with the contribution by paleoparasitology, combined with other sciences such as paleoclimatic modeling (Montenegro et al., 2006b), are one of the surest ways to obtain a realistic picture of the past.

Much remains to be explored in paleoparasitology on the Asian continent, as the path for prehistoric migrations to the Americas. Human groups left Asia with their parasites. Many parasites were able to cross the cold, icy Bering Bridge, at least 15,000 years ago.

However, other parasites died along the way because they were unable to maintain their life cycle in the harsh climate between Siberia and Alaska (Araújo et al., 2008). This issue alone has been extensively explored but still sparks the curiosity of various researchers, including parasitologists, archaeologists, bioanthropologists, and others. Yet other scenarios remain to be elucidated, including the introduction of parasites from the continent to the islands, as discussed by Matsui, Kanehara & Kanehara (2003). and the changes in parasitism found in archaeological sites in Korea (Shin et al., 2009a). In addition, new techniques in electron microscopy and the resulting morphological detail allow identifying food remains and parasite species with increasing precision (Shin et al., 2009b).

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