Highlights

► Several fallow deer from Middle Pleistocene Level B of Tabun Cave (Israel) exhibited pathologies

► The proximal phalanges showed lesions on their axial surfaces

► The bone erosion is a localized osteitis caused by contagious bacterial infection

MIDDLE PLEISTOCENE FOOT INFECTION IN DAMA MESOPOTAMICA

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Abstract

Tabun is one of the most important Palaeolithic sites in the near East, with levels dating from the Lower through to the Upper Palaeolithic. The faunal collection from Tabun Cave (Israel) was recovered by Dorothy Garrod during her archaeological excavations carried out during the 1920-30s in Mount Carmel. Since then this collection has been housed at The Natural History Museum, London. In this brief communication, a pathology observed in phalanges of fallow deer (*Dama mesopotamica*) from Level B is reported. The pathology consists of bone erosion on the cortex of the axial surface of the proximal phalanges, most likely as a result of a localized osteitis produced by an infection, initially on the hoof, and later on the phalanges and even metapodials. These pathologies were probably caused by bacterial infection, possibly linked to environmental and climatic conditions at the site, which affected their growth and spread.

Keywords

Fallow deer. Phalanx. Osteitis. Footrot.

1. Introduction

Tabun contains evidence of human hunting from the late Lower Palaeolithic to modern times (Stiner et al., 2010), and is one of the most important Middle Palaeolithic sites in the near East (Shea, 2003). The faunal collection from Tabun Cave (Israel) was recovered by Dorothy Garrod during her archaeological excavations carried out during the 1920-30s in Mount Carmel (Garrod and Bate, 1937). Dorothea Bate (1937) was first to identify the macromammal assemblage through the whole stratigraphic sequence. In the 1980s, Garrard (1981) reviewed the previous palaeontological work and, more recently, Marín-Arroyo (2013a, 2013b) undertook a taphonomic analysis of the Mousterian levels. Through the study of bone modifications, several identical lesions were observed in fallow deer remains, specifically in the proximal phalanges. The particular pathologies reported here are uncommon within the archaeological record but interesting enough to understand their cause among several artiodactyl species. Currently, this collection is curated at the Department of Earth Sciences at the Natural History Museum, London.

2. Results

Fallow deer is the most common taxon found in level B of Tabun Cave, with all anatomical elements represented within the deposit and dated to between 130-70 kyr (MIS 5). During the taphonomic study of the large mammals carried out by Marín-Arroyo (2013a, 2013b), some particularly deep cortical bone erosions were observed with the naked eye on the axial surfaces of several proximal phalanges and later were examined with a binocular microscope. It was notable through microscopy that these erosions were not caused anthropogenically, but were the result of a pathology. From a NISP of 97 elements, 15% of fused proximal phalanges showed these alterations (n=15). In the phalanges, the individual bone erosion was always located on the cortex of the axial surface of the proximal phalanges, just distal to the fusion line of the proximal epiphysis (Figure 1). The diameter of these erosions was, on average, 4-5 mm in width and 2-3 mm depth (Figure 2). On one phalanx only, an exostosis was identified affecting the complete bone (Figure 3). Unfortunately, it was not possible to discriminate the sex of the animals and whether or not phalanges belonged to fore or hind feet.

The appearance of the cortical bone erosion on the axial surface of the proximal epiphysis could be a localized osteitis, probably as a result of contagious bacterial infection, which usually starts on the hoof. Currently this infection, known as footrot, is caused by the microbial activity of two bacteria, *Fusobacterium necrophorum* and *Dichelobacter nodusus* (Ginn et al., 2007). The former is regularly present in soil and manure, and the latter, when present, is the bacterium which causes the problem. Unfortunately, it has not been possible to prove whether or not these bacteria were those involved in the infection during MIS 5, the period when the cave deposit accumulated. Nevertheless, specific environmental conditions such as warmth and moisture are important factors in this disease, as the hooves become soft and it makes them susceptible to colonisation by the bacteria responsible in the development of footrot. In the same way, rocky soils also increase the likelihood of infection, due to the risk of trauma to the hoof.

Although the infection grows within the hoof, it spreads via the soft tissues to the surface of the phalanges where the infection then spreads along the bone surface on the metacarpals in severe cases. When the climatic and geological conditions described above exist, the activity of *F. necrophorum* proliferates affecting the interdigital dermis, causing soft tissue inflammation and osteoclast-mediated erosion of the surface of metacarpal bones in severe cases (Fernández et al., 1996; Thompson, 2007),

In the case of Tabun B, the pattern of bone surface erosion is compatible with one caused by a localized bacterial periostitis and one that has also involved the insertion of the collateral ligament on the axial surface of the proximal phalanx. Avulsion of the insertion of this ligament would have induced the formation of the enthesophyte observed at this location in the proximal phalanx of these specimens.

3. Conclusions and discussion

Currently, footrot is often found among species of the order Artiodactyla, such as cervids and bovids, when particular climatic and landscape conditions are present; it has also been reported in pigs (Ginn et al., 2007). During a large part of MIS 5, the Levant region had a warm climate with high humidity (Bar-Matthews et al 2003; Marín-Arroyo 2013a: Figure 5), which at times would have allowed the hooves of fallow deer to soften, permitting microorganism activity with subsequent infection in the interdigital spaces, and later spreading to the bone. Additionally, the topographic relief of the grassland feeding locations and of the area surrounding Mount Carmel would have facilitated the occurrence of injuries within the hoof. Today, footrot is a devastating disease, initially affecting the hooves, with lameness as the first visible signal within the herds. When the infection increases, necroses appear in the soft tissues, causing lesions in the ligaments and later in the adjacent bones (phalanges and metapodials). These lesions exacerbate the lameness of the animal which reduces their survivorship and ability to search for food, making them more susceptible to predators or natural traps, as was the case with Tabun B (Marín-Arroyo, 2013a, 2013b)

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Figure captions

Figure 1. Proximal phalanges of fallow deer from Tabun B. The pathology is observed in the cortex of the axial surface of the proximal phalanges. Photo courtesy of the NHM, London.

Figure 2. The image shows a close view of the osteitis on the proximal part of the axial surface of the phalanx. Scale shows millimeters. Photo courtesy of the NHM, London.

Figure 3. Proximal phalanx with exostosis on the whole bone. From left to right: medial, lateral, cranial and caudal views. Photo courtesy of the NHM, London.

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Figure 3. Proximal phalanx of fallow deer from Tabun B with new bone formation across the entire shaft. From left to right: medial, lateral, cranial and caudal views. Photo courtesy of the NHM, London.