

# **Description of pathological conditions in the skeleton of an adult male brown bear *Ursus arctos* from the Cantabrian range of mountains (Reserva Nacional de Caza de Riaño, León)**

Patologías óseas en un esqueleto de Oso pardo macho adulto de la Cordillera Cantábrica (Reserva Nacional de Caza de Riaño, León)

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## **ABSTRACT**

**In this paper we describe with detail the pathological conditions found on the skeleton of an adult male brown bear from the Cantabrian Mountains. This specimen shows a great number of pathologies, some of infectious origin and others of traumatic origin, as well as pathologies such as caries. We discuss the possible aetiology of the lesions, development and consequences, as well as how they did affect the living animal and its survival opportunities.**

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## INTRODUCTION

Bears are generally big-sized animals and have few natural enemies. A wound bear therefore has good chances of recovering from trauma or disease without being meanwhile attacked. The lack of natural enemies also implies that many of these animals can reach advanced ages, favouring the quantitative as well as qualitative increase in pathological conditions.

The literature dealing with skeletal diseases in the extinct cave bears is very rich. This is due to the very many fossils of this species recovered in caves throughout Europe, many of them displaying spectacular pathological conditions. On the other hand, the literature dealing with skeletal conditions on present day brown bears is much more scarce, as these animals do not use limestone caves as intensively as cave bears did, and therefore their remains are, more frequently than not, lost.

When thinking on the ecological implications of cave bear skeletal conditions, we can only use as comparison our present knowledge of its extant counterpart, the brown bear or other temperate modern bears, in order to make inferences. It is therefore important to create a log of information on present day bear pathologies.

In this paper we describe in detail the pathological conditions found in the skeleton of a present-day brown bear *Ursus arctos* from the Cantabrian range of mountains in N. Spain. This specimen is kept in the Centro de Recuperación de Animales Silvestres (Valladolid), and was found dead at the Reserva Nacional de Caza de Riaño

(León). It has a very great number of relevant pathological conditions, some of traumatic origin, some of infectious origin, throughout the skeleton, chiefly affecting the functioning of the vertebral spine, pelvis and limb elements as described.

## DESCRIPTION OF THE PATHOLOGIES

This is the complete skeleton of a present day brown bear, an adult male with a cementum age of  $20 \pm 2$  years (J. Seijas, pers. comm), and therefore a very old bear by modern Cantabrian Mountains standards. The skeletal remains of this specimen show grave lesions, that have affected to its locomotion and general quality of life. Below we describe all the alterations observed in each one of the skeletal elements. Almost all of them suffer from anomalous conditions, in greater or smaller degree.

### Mandible

- Lost *post-mortem*. Right M2, left M3, right P1 and right and left I1.
- Lost *intra-vitam*. Left I2. Advanced alveolar resorption.
  - Alveolar resorption affecting the external bone wall of right M3 and left M2
  - The enamel of the crown of the cheek teeth is completely worn, and secondary dentine protects the pulp cavity
    - Caries: Affecting distally the right M2 and M3, and also to the left M2
    - *Intra-vitam* breakage of the canine

teeth, probably in events related with sexual competition. The stumps appear very rounded. The pulp cavity is exposed.

- The temporo-mandibular joint shows eburneation.

### **Maxilar**

- *Post-mortem* loss of right P3, left P1 and left I1.

- *Intra-vitam* loss: Right I1. The alveolus has been resorbed and there is a fistulae discharging towards the nasal bone between I1 and I2.

- Resorption of the external wall of the alveoli affecting right M2.

- Right M2: loss of occlusal enamel and caries

- Agnesia right P1

- Fistulae at the root of right M1, discharges towards bucal

- Right canine has an *intra-vitam* breakage of the cusp and resorption of the external wall of the alveolus as well as some signs of periodontal pathology.

- There are also some lesions with bone resorption in the palate.

- The enamel in all molars has been entirely worn down exposing the pulp cavity, which appears protected by secondary dentine.

### **Cervical vertebrae**

Around the articular surface of the atlas there is a complete circle of osteophytes. The axis is in a comparatively good condition. The next five cervical vertebrae also show osteophytes and exostoses along the antero-distal edge.

### **Dorsal vertebrae**

These vertebrae (14) are affected in varying degrees by eburneation of the articular surfaces, rings of osteophytes along the edges and exostoses. These exostoses acquire great size from the 6<sup>th</sup> vertebra downwards, affecting the anterior surface. Vertebrae 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> are fused through great exostoses and calcifications in its anterior area. The body of vertebra 9 is greatly disfigured. The anterior exostoses and articular osteophytes appear through till the last vertebra, very modified also with de-calcification and anomalous disorganised new bone production. It appears also fused to the first lumbar vertebra.

### **Lumbar vertebrae**

The first lumbar vertebra appears almost entirely fused with the last dorsal vertebra. Exostoses and disorganised bone formation affect the 1<sup>st</sup> and the 2<sup>nd</sup> lumbar vertebrae. The three last ones have also exostoses, although of smaller size.

### **Tail vertebrae**

The three first ones show abundant great sized exostoses (21x12x4 mm.). Las three last ones do not show lesions.

### **Scapula**

The right scapula shows an osteochondroma, eburneation that exposes the spongy bone tissue and osteophytes in the

articular surfaces. It also has an *intra-vitam* rip on the blade, that appears healed without infectious processes and without production of new bone.

### **Humerus**

The right humerus has an eburnation in the inner proximal articular surface. It shows also a great circular exostose (11 mm. diameter) in the middle of the articular surface and circle of osteophytes along its inner edge. Distally the humerus shows great wear of the joint and pseudo-articular surfaces produced by the intense pathologies affecting radius and ulna, explained below.

The left humerus shows in the proximal articulation eburnation and osteophytes. Probably to compensate the great lesions in the right side, the muscular insertion appears very developed. The distal articulation has a circle of osteophytes, not so developed. The diaphysis of the left humerus is notoriously wider and stronger than that of the right arm. As we will see, the left arm is the only healthy limb this animal had.

### **Radius and ulnae**

The right radius and ulnae appear crushed or with multiple fractures affecting both bones. These are old fractures with formation of new bone tissue, that fuses both bones. They appear very distorted and their functionality must have been very limited. This lesion affects the totality of both bones and plays also a role in the deformations suffered by the proximal and distal joints and by adjacent bones.

The edges of the distal articulation in the left radius show an incipient circle of osteophytes. The left ulna shows osteophytes surrounding the distal articulation.

### **Carpal and metacarpal bones**

The carpal bones of the right hand show an intense wear and eburnation of the articular surfaces, leading to the general loss of bone mass and to the formation of rows of osteophytes. The metacarpal bones have similar pathologies. The 1<sup>st</sup> has distally a healed fracture, a fistulae and osteophytes. The second one seems to have also a healed fracture, as well as anomalous bone production on the diaphysis and exostoses, that extend to the remaining metacarpal bones. The 4<sup>th</sup> metacarpal has exostoses in proximal.

The carpal bones of the left arm are bigger and have great osteophytes, that affect also the metacarpal bones. The 1<sup>st</sup> left metacarpal shows crushing, exostoses, osteophytes around articular surfaces and pseudo-arthritis in mid diaphysis. The remaining metacarpal bones are affected by osteophytes in varying degrees at the joints and exostoses at the diaphysis..

### **Falanges**

The articular surfaces in the right hand falanges are circled by osteophytes, have exostoses in the diaphysis, eburnations and arthritic deformations. The 3<sup>rd</sup> falange of the 2<sup>nd</sup> finger is distally anomalous. The 3<sup>rd</sup> finger has two falanges fused in an anomalous position. The 5<sup>th</sup> finger has an amputation in the first falange, with new

bone growth over the stump. The fingers of the left hand have similar alterations.

### **Innominate**

Luxation of the left innominate, that has then formed a secondary sub-articulation with great proliferation of newly formed bone that grows disorganised suggesting an infectious. The right side appears relatively healthy, and the innominate keeps its general symmetry.

### **Femur**

The right femur head has eburnation with wear discovering spongy bone tissue. Distally, osteophytes in the articulation with the tibia. The diaphysis show in posterior a great development of lobular exostoses, probably result of the ossification of the muscle insertions. Tibia and fibulae show amputation of the distal third.

The left femur shows bone degeneration and resorption and loss of bone mass and shape at the femur head, possibly due to an infectious process associated to the great lesions in the innominate, described above as luxation. Dorsally the diaphysis shows new bone in formation.

### **Rotulae**

Both rotulae have osteophytes around the articular surfaces.

### **Tibiae and fibulae**

The right tibia shows amputation of the distal third, with bone formation as lobular exostoses in the stump area. It has

also exostoses in the diaphysis, in the muscle insertion area and in the articulation with the fibula. The right fibula shows also amputation of the distal third and anomalous bone production covering its whole surface.

The left tibia has osteophytes around the proximal articulation, exostoses and alterations in the articulation with the fibula. The left fibula shows pseudo-arthrosis in the diaphysis. Distally, the head has a healed fracture with new bone formation forming lobes.

### **Calcaneum, astragalus and tarsal (left)**

Both show eburnation and bone formation, osteophytes around articular surfaces and exostoses affect these bones.

### **Metatarsal and falanges (left)**

The five are kept, and they show the following alterations: anomalous bone formation as lines of osteophytes, exostoses, decalcifications, eburnations, syndesmophytes, fistulas and infectious osteomyelitis. The falanges have similar arthritic alterations in lesser degree.

### **Ribs**

The 14 right ones have osteophytes and deformations in the proximal area. Eburnation, osteophytes, arthrosis and healed fractures are also present. As for the 14 left ribs, 4 have osteophytes and deformations in the articulation with the vertebrae. One has a healed fracture with anomalous bone formation.

**Penis bone**

Healed fracture

**CLASSIFICATION OF THE PATHOLOGIES: TRAUMA VERSUS INFECTIONS**

The lesions described have two origins: traumas or infections. Both can be related, when the soft tissues get an infection and transmit it to the bones through the blood.

***Traumatic pathologies***

These affect to the front right limb and to the bones in both legs. The right scapula has a breakage which is a direct trauma. Although there is no bone formation in this wound, this trauma could have affected to soft tissues around the scapula. An infectious process started then, and manifests itself in the vertebral spine.

The right forearm shows alterations consistent with several traumatic lesions –crushing or multiple fractures- affecting the whole of radius and ulnae. Healed fractures can be seen that affect to both diaphysis, now fused and shortened.

The right leg has a traumatic amputation of part of the tibia and fibula. This amputation does not appear to have been infected. Doubtless it has affected the ability to move of this animal, that in its movements had to rely strongly in the left leg and arm. The left leg shows a double fracture of the fibula. The proximal fracture never re-fused and there is a pseudoarthrosis. The bones of hands and legs have lesions which are consistent with

infections, and are not an age triggered degeneration.

As for the healed baculum fracture, this is a relatively frequent lesion produced in the heat of mating, and is of no consequence for bears.

Therefore, and summarising, the main traumatic lesions suffered by this specimen were:

- a) Ripping of the right scapula with osteolysis
- b) Polytraumatic "catastrophic member" right forearm.
- c) Traumatic amputation of right tibia and fibula, with a well healed stump, affecting the ability to move.
- d) Double fracture of the left fibulae with pseudoarthrosis of the most proximal fracture.

***Infectious pathologies***

There is an infectious process affecting sectors of the vertebral spine, producing the fusion of some vertebrae and the almost complete disintegration of others. While the affected ones are very much altered, the ones out of the affected zones appear normal and healthy.

The anomalies concentrate in two spots: there is a great decalcification and complete fusion of the 7<sup>th</sup> and the 8<sup>th</sup> through great exostoses that affect also the 9<sup>th</sup> with a great distortion of the body. The second area with important alterations goes from the 12<sup>th</sup> dorsal vertebrae to the 1<sup>st</sup> lumbar, that appears greatly distorted.

The infectious process can be detected also in the left innominate and proximal femur. It could be therefore a septic arth-

ritis, infectious process that has produced a proliferation of bone in the left innominate as well as a very important resorption in the femur head. This process has closed the major sciatic scooping.

The symmetry between the right and left side of the pelvis, the lack of disorganisation or disharmony in the general structure, and the conservation of all the skeletal elements suggests that this is not a healed fracture of the innominate, with an open wound and an infectious component, but that the infection arrived here from a focus placed in other lesion in the body, through the blood stream.

### **POSSIBLE AETIOLOGY OF THESE PATHOLOGIES**

The particular disposition of the infectious lesions reminds of the developmental mechanism of tuberculosis in human being. In men, Pott's disease lodges itself in the 12<sup>th</sup> dorsal vertebrae, inserted in the hideosoas muscle, responsible for the upward movement of the thigh. The infection gets into this muscle, from which it spreads to its distal insertion point, in the lesser trochanter of the femur, entering from underneath the left innominate, and producing the infection and subsequent alterations in this bone.

This similarity with how this disease develops in human beings suggested NEIBURGER (1984) his interpretation of the pathologies observed in a specimen of extinct fossil bear (*Arctodus simus*). Other workers dismissed this diagnosis (ROTSCHILD, 1988; ROTSCHILD & TURNBULL, 1987), because of the lack of new bone formation in tuberculosis as

opposed to the exuberant formation of new bone in Neiburger's specimen. After finding treponema antigens in a sample from this bear, they proposed alternatively that it was treponematosi or syphilis what was causing these lesions. Neiburger however answered that the formation of new reactive bone is not incompatible with tuberculosis (NEIBURGER & TURNBULL, 1990). The fact that the scientific magazine Nature echoed twice this debate, is a reflect of the interest aroused by the origins of a disease as syphilis.

In a subsequent paper, ROTHSCHILD *et al.* (1993) analyse bear collections of every genus in several museums, and they diagnose them with spondiloarthropaty. They consider first rheumatoid arthritis, but dismiss it because of the lack of reactive tissue; then consider tuberculosis and dismiss it because of the distinct appearance of the new bone. There is only then left arthritis, be it psoriatic or be reactive. The first has not been documented in bears, and therefore the only option left is reactive arthritis of sexual transmission. Although the argument till here is interesting, then the authors put this into relation with baculum fractures, which leaves us short of an entirely satisfactory answer to this problem.

A biomedical analysis of a sample from the Riaño bear with this orientation will doubtless yield data relevant in this context. Antigen as well as DNA studies will allow to determine whether this specimen has been affected by any of these two diseases.

In the meantime, the great abundance of grave traumatic lesions in the Riaño bear, that compromise the functional sta-

bility of the animal, can suffice to explain the sequence of later lesions. For example, if this animal lost a leg to a poacher's leash, as it does happen to bears in the area, will later be more liable to falling down, and generally be more liable to further damage.

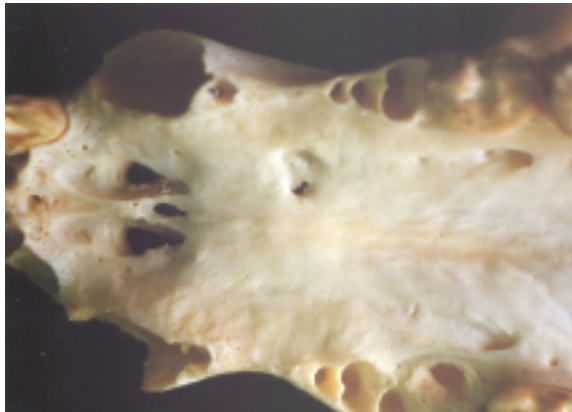
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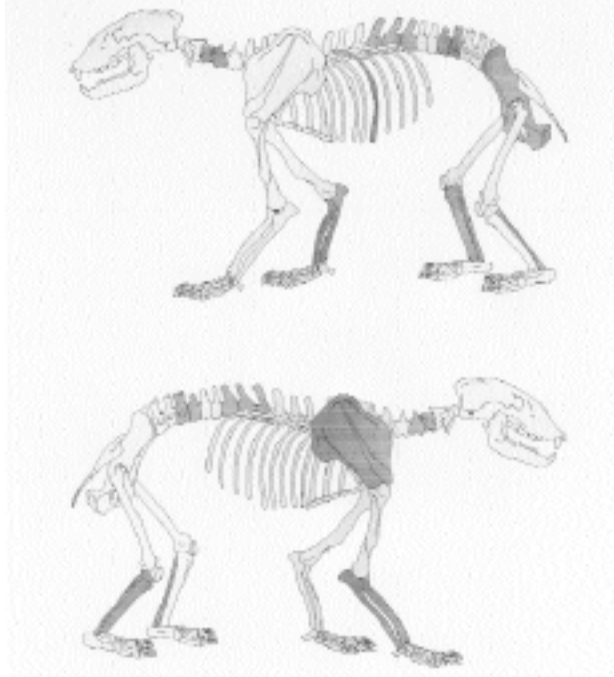


**Figure 1. Caries.**



**Figure 2. Fistulization towards nasal.**





**Figure 3. Diagram of the skeleton showing all the areas affected by pathologies in this specimen.**



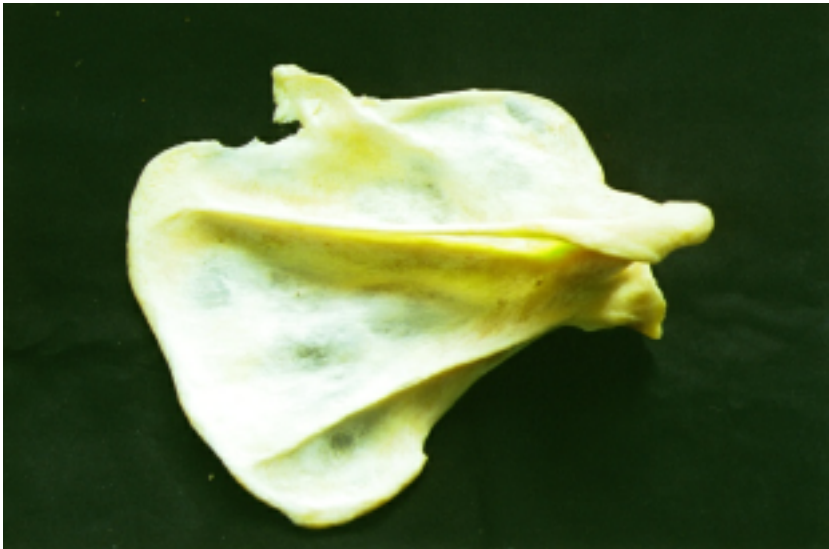
**Figure 4. Cervical vertebrae with osteophytes and exostoses.**



**Figure 5. Dorsal vertebrae intensely altered.**



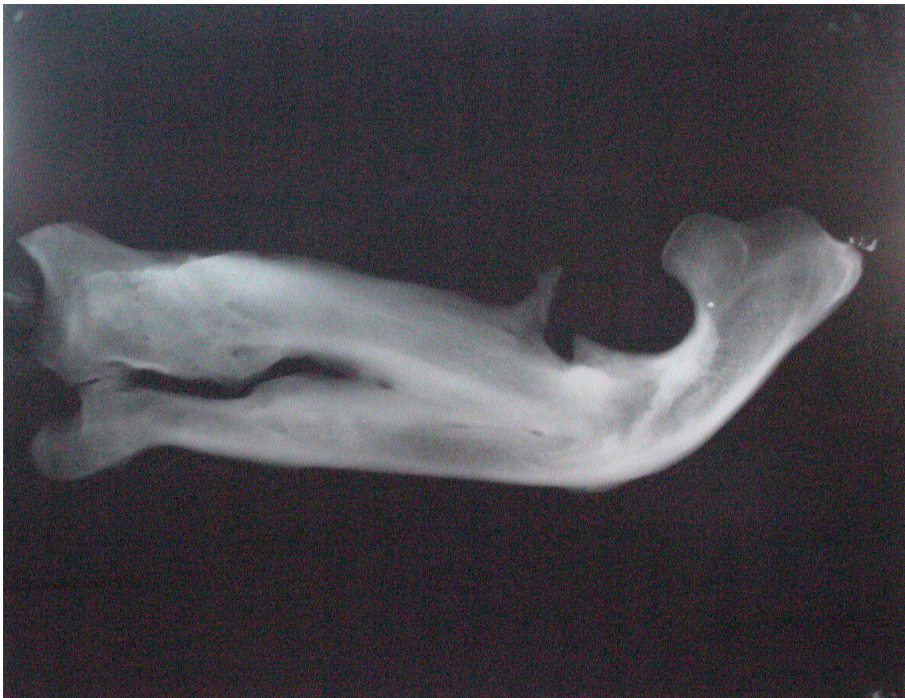
**Figure 6. Dorsal vertebrae with pathologies. Radiograph.**



**Figure 7. Rip in the right scapula.**



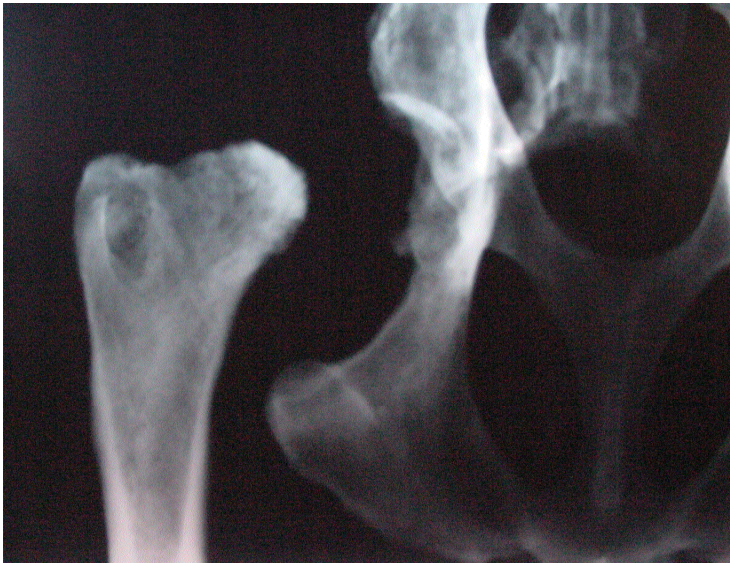
**Figure 8. Right radius and ulnae, wich together form a 'catastrophic limb'.**



**Figure 9. Right radius and ulnae. Radiograph.**



**Figure 10. Left area of the innominate bone, articulation with the femur head.**



**Figure 11. Radiograph of the innominate: great new bone formation in the innominate, and bone resorption in the femur head.**

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