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AVIAN OSTEOPATHOLOGY AND ITS EVALUATION

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ABSTRACT: Pathological evidence in skeletal remains from archaeological sites is to be found in bird remains as well as mammals. However, avian osteopathology may well have been neglected in the past, and there seems to be a need to call attention to the range of pathology which might turn up in bird bones. Survival of disease evidence may be particularly likely in captive and domestic birds. The author reviews the major categories of disease which may result in bone changes in birds, where possible giving archaeological examples. Congenital abnormality, bone pathology resulting from environmental stresses, joint diseases, neoplasms, and a range of infections, are considered in turn. It was concluded from the known archaeological cases of bird bone pathology, together with the more recent veterinary descriptions of other bone pathology, that there are certainly prospects for further discoveries and research in this field of avian zooarchaeology.

KEYWORDS: BIRD BONES, OSTEOPATHOLOGY, CONGENITAL ABNORMALITY, TRAUMA, ENVIRONMENTAL STRESS, NEOPLASMS, ARTHROPATHIES, INFECTIONS

RESUMEN: Las aves, al igual que los mamíferos, presentan evidencias de patologías óseas en los restos que de las mismas se recuperan en yacimientos arqueológicos. A pesar de ello, ha existido hasta ahora un cierto desinterés en este tipo de fenómenos por lo que resulta necesario hacer una llamada de advertencia para el futuro de esta disciplina. Las pruebas de enfermedades son particularmente frecuentes en aves domésticas y de jaula. El trabajo describe las principales categorías de enfermedades susceptibles de provocar cambios en los huesos de aves, mostrando, en los casos que ello resulta posible, pruebas de naturaleza ornitoarqueológica. Las anormalidades congénitas, las patologías óseas resultado de situaciones ambientales de stress, las enfermedades articulares, los neoplasmas y las infecciones son descritas secuencialmente. Con los casos detectados en yacimientos arqueológicos, junto con descripciones veterinarias más recientes de otros tipos de patologías óseas, parece evidente la existencia de un amplio campo de investigación dentro de esta rama de la ornitoarqueología.

PALABRAS CLAVE: HUESO, AVES, OSTEOPATOLOGIA, ANORMALIDAD CONGENITA, TRAUMA, STRESS AMBIENTAL, NEOPLASMA, ARTROPATIA, INFECCIONES

INTRODUCTION

It seems pertinent at this first ICAZ meeting on Avian zooarchaeology to consider what evidence of disease can be found in bird remains, and how relevant the study of this kind of information is for archaeological interpretation. It may be that some aspects of disease have no relevance for archaeology at all, and clearly there is a constant need for an appraisal of the evidence being collected. Survival in wild birds, long enough for disease to leave a skeletal marker is usually considered a rare thing (Parmalee, 1977). Captive and domestic birds are considered more likely to show pathology (Gilbert, Martin & Savage, 1985). What I plan to do here is briefly review the range of bird pathology which seems to me to have significance for us, and consider where appropriate a number of archaeological examples.

CONGENITAL ABNORMALITY

In the scheme shown in Table 1, I have greatly condensed the range of diseases and pathology which can be found in some if not most bird species. Group A are the congenital defects, some having a genetic basis and others probably not. There are a number which leave skeletal changes,

(A)Genetic/congenital malformation
1)Polydactyly, brachydactyly
2)Spondylolithesis
3)Chondrodystrophy, dyschondroplasia
4)Cerebral hernia
5)Rumpless
6)Dwarfism

(B)Environmentally influenced conditions
1)Anaemia
2)Vitamen deficiency, rickets
3)Trave element deficiency, zinc, manganese

(C)Trauma
1)Fractures, joint stress
2)"Cannibalism"

(D)Arthropathies
1)Gout
2)Osteoarthritis (?traumatic)
3)Infectious arthritis

(E)Neoplasms
Benign and malignant (Uncommon)

(F)Infections
1)Avian leucosis. Possible limb paralysis
2)Avian osteopetrosis
3)Most high mortality infections without skeletal involvement.
Some (salmonellosis, avian tuberculosis, psittacosis) are zoonoses.

(G)External parasites
Scaly leg (mites) - can be severe, with secondary infection.

TABLE 1 - Bird pathology of potential archaeological significance.

some of which may have archaeological relevance. Conditions such as polydactyly (Figure 1.J) and brachydactyly (extra or reduced digits) are only likely to be identified in fairly complete bird burials. Columella was aware of polydactyly, and says they made the best breeds - good evidence perhaps of actual selection for "abnormality" in the past. The so-called "fifth toe" is now widely known in domestic fowls and has become a breed characteristic in Dorkings, Houdans, Silkies and others. Examples of such abnormality would certainly help to establish a history for these varieties. "Kinky back" (spondylolisthesis), the subluxation or downward rotation of the 4th thoracic vertebral body (Pattison, 1986; Duff, 1990), is well known in modern poultry husbandry, and its common occurrence in an ancient sample might be used to indicate that particular domestic fowl stocks were small inbred groups. Chondrodystrophy, with leg weakness, short, thick and often misshapen bones, and dyschondroplasia (with bowing of the proximal tibiotarsus), might in certain circumstances again say something about inbreeding, as they may well have a genetic basis (Pierson & Hester, 1982). At times, abnormality may have become established as a pleiotropic effect, secondary to the selection of some primary variable. This was the case with cerebral hernia, which is associated with head feather cresting, caused by an incompletely dominant gene (Hutt, 1949). Although further studies are needed on the degree of cranial variation occurring in cerebral hernia -especially in mild form, nevertheless it has been clearly demonstrated in a Roman fowl from south-west England (Brothwell, 1979). It should be noted that a form of cresting also occurs in ducks, and can again result in skull modification with herniation.

A few centuries ago, Aldrovandus was aware of another skeletally modifying congenital defect known as "rumpless". In this condition, 2 sacro-caudal vertebrae are missing, as well as the pygostyle and caudal vertebrae (Stevens, 1991) (Figure 1, K,L). Today it is known to have genetic and environmentally-induced forms, but both produce modifications in the synsacral area. Although I have seen synsacral abnormality in archaeological material, this particular condition has not come to my attention as yet.

Other congenital conditions which could conceivably occur in archaeological material include sex-linked dwarfism (Zlochevskaya & Penionzhkevich (1973), abnormal tibio-metatarsal joints, supernumerary ribs, "crooked neck", "crooked keel" and kyphoscoliosis (Somes, 1990). It seems unlikely that severe conditions, such as "wingless" would have survived to become mature birds.

Lastly, it should perhaps be mentioned that spurs in *Gallus* females might be considered to be a congenital anomaly. As a result of breeding studies, the spurs seem more likely to have a genetic basis than an environmental one (Tandon & Iyer, 1954).

DISEASE AND ENVIRONMENT

Environmentally influenced diseases (group B, Table 1), include a number of different conditions which can leave their mark on bones, and might be used to indicate poor animal husbandry, or at least environmental stress (Hungerford, 1969). Anaemia and zinc deficiency can result in defective growth. Perosis, another deficiency condition, usually indicating a lack of manganese or B vitamins, but at times other imbalances, leads to slipped tendons, joint involvement and eventual bowing of long bones. Severely restricted rearing conditions could have resulted in bone thinning and fragility, somewhat like the so-called "Cage fatigue" of modern broiler fowls. Similarly, under extreme feeding conditions, severe stunting, or rickets in the young and osteomalacia in the older bird, may have commonly developed, as in recent domestic and captive birds (Hamerton, 1933; Horrox, 1989). Where growth alone is retarded (Dickerson & Mc Cance, 1964) without obvious shape abnormality, it may not be easy to distinguish from normal small body size. It is thus clearly important to be alert to the possibility of environmental stress of this kind. Archaeologically, bowed long bones have been noted, which might be indicative of rickets. Coy (1981) for instance, notes two Saxon fowls which displayed curved tibia shafts. A bent sternum from medieval Nantwich, in Britain has also been linked to a deficiency condition (Baker, 1986).

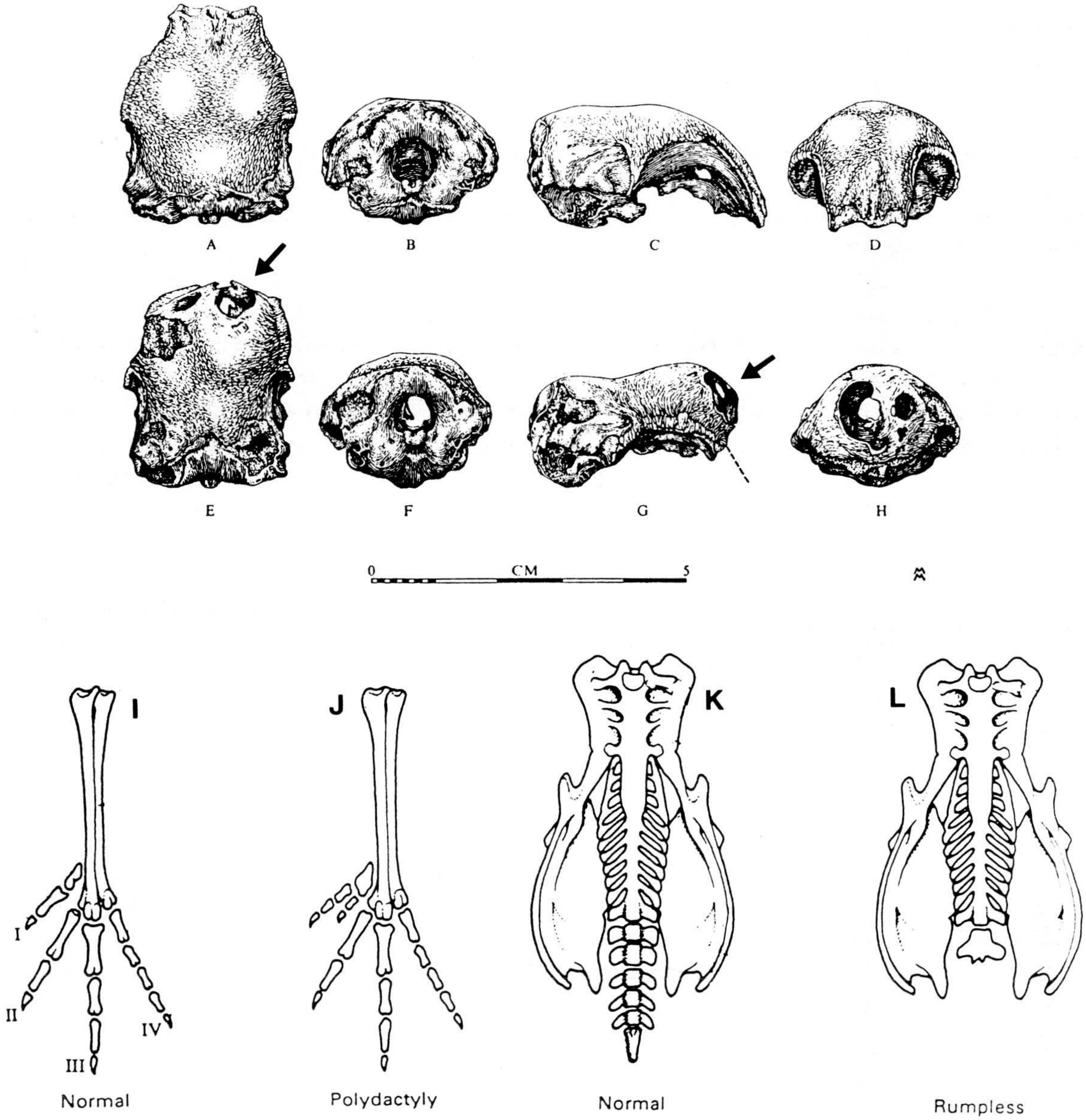

FIGURE 1 - A - H. Calvaria of two Roman fowls, comparing top (A,E), posterior (B,F), lateral (C,G) and front (D,H) views of a normal form (A-D) and an abnormal (E-H) form displaying cerebral hernia. From Brothwell (1979). **I - J.** Diagrams of a normal and polydactylous foot. **K - L.** Diagrams of the pelvis and posterior vertebrae in normal and rumpless fowls. I - L after Stevens (1990).

TRAUMA

Trauma (group C) can obviously occur throughout the life of a bird, and may not be the result of human activity at all. Boev (1986) found that half the abnormalities found in a sample of 127 heron skeletons, were indicative of trauma. Although for most of the time, damage to bones can be recognised for what they are, there may be questionable cases. In particular, can we always distinguish bones cut and used culturally (Ubelaker & Wedel, 1975) from butchery marks or cuts received at the kill or capture? In Birkhead's (1973) study of deformed Corvid skulls, for instance where 8% were abnormal in a sample of 186, he did not find it easy to distinguish congenital abnormality from old healed wounds. At the other extreme, though rarely, the nature of the trauma - arrow or whatever - may still be very much in evidence (Schutz, 1969).

Excluding injury received in the wild, birds are most likely to display evidence of trauma as a result of hunting, catching, keeping or handling. In large enough samples, trauma may thus reflect on human behaviour. A good example of this is surely the study by Hargrave (1970) of Mexican macaws from sites in Arizona. Of the 145 skeletons studied, 20 cases (that is 13%) displayed healed trauma (Figure 2B), in particular of the sternum and humerus. These birds were of ritual value, and I would like to suggest on the new evidence of turquoise trade between Arizona and New Mexico with Mexico, that stone went in a southerly direction and macaws were transported north. Trundling the birds over long distances would surely explain not only these clear instances of trauma, but also what appear to be stress arthropathies in 8 of the birds as well.

An unusual form of trauma in long legged waders, resulting in the partial loss of a limb has been described by Dobney (1993). Constriction of blood supply and eventual loss of a foot appears to have occurred as a result of the accidental tight binding of the leg by wool (Figure 4), picked up in pastures.

Another form of trauma, which should be mentioned even though I know of no convincing archaeological case as yet, is normally termed "cannibalism". Fifty years ago it was not uncommon in poorly managed, and often restricted, poultry runs to have widespread aggressive pecking. Flesh, feathers and eggs could all come under attack, and with secondary infection, bone may well have been involved at times. The cause of pecking is believed to be multifactorial, with housing, group size and strain differences all being contributive factors (Duncan & Hughes, 1973). In 1200 Peruvian fowls, a Third World sample studied specifically for cause of death, mortality from various causes affected 137, of which 37% (lower left total) in figure were the result of cannibalism (Ploog, pers comm.). Clearly we should therefore look for any evidence of this behaviour in ancient samples.

JOINT DISEASES

In comparison with humans and other mammals the arthropathies (joint diseases) of birds may not have such a complex story to tell. Of the three major divisions of joint disease, gout in fowls and turkeys is not uncommon, but may not be skeletal and has not been identified in archaeological material to my knowledge. As in other species, the urates at the joints are unlikely to survive, but it is possible that erosive changes at the legs and feet might occur. Articular gout can have a genetic background, but high protein diets can also be a predisposing factor (Pierson & Hester, 1982).

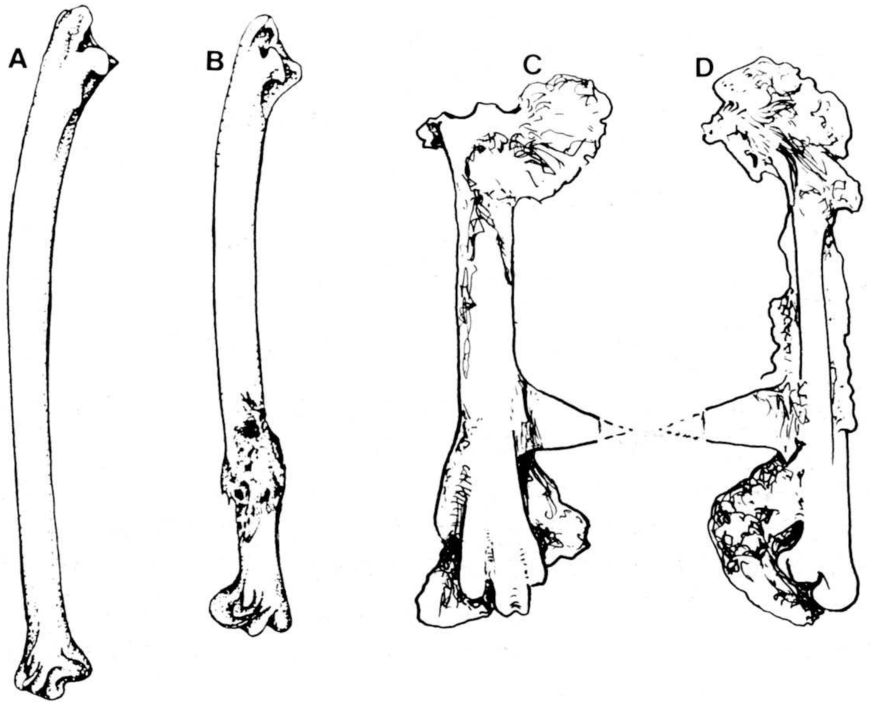

FIGURE 2 - A and B. Right ulnae from archaeological macaws, one being normal and the other displaying a healing shaft fracture. After Hargrave (1970). C and D. Chicken bones from Bristol Castle, displaying age-related new bone formation of unknown aetiolgy. Adapted from Baker and Brothwell (1980).

Viral and bacterial forms of arthritis can result in lameness, and should be identifiable as minor inflammatory change or even osteomyelitis. Probably the tibiometatarsal area is most frequently involved. Bumble foot is the bird equivalent of foul in the foot of cattle, and could leave its mark. Marginal lipping and eburnation (joint polishing), suggestive of an osteoarthritis, certainly appears in archaeological material, but as yet its occurrence has not been associated with age, trauma or joint stress as in mammals. Osteochondrosis, a disturbance of endochondral ossification (Duff, 1990) can produce various lesions.

NEOPLASMS

Tumours (group E) can certainly affect the skeleton, but uncommonly. They are more likely to occur in domesticated than wild species (Keymer, 1958). There are benign and malignant forms, the latter being able to produce destructive changes which can sometimes mimic post-mortem decay. In a detailed study of 586 tumours in gallinaceous birds (Conceicao, 1965), it was found that 45% were benign and the rest were malignant, so destructive lesions or extra bone can be expected. However, even when identified, their archaeological - as opposed to veterinary - value may be

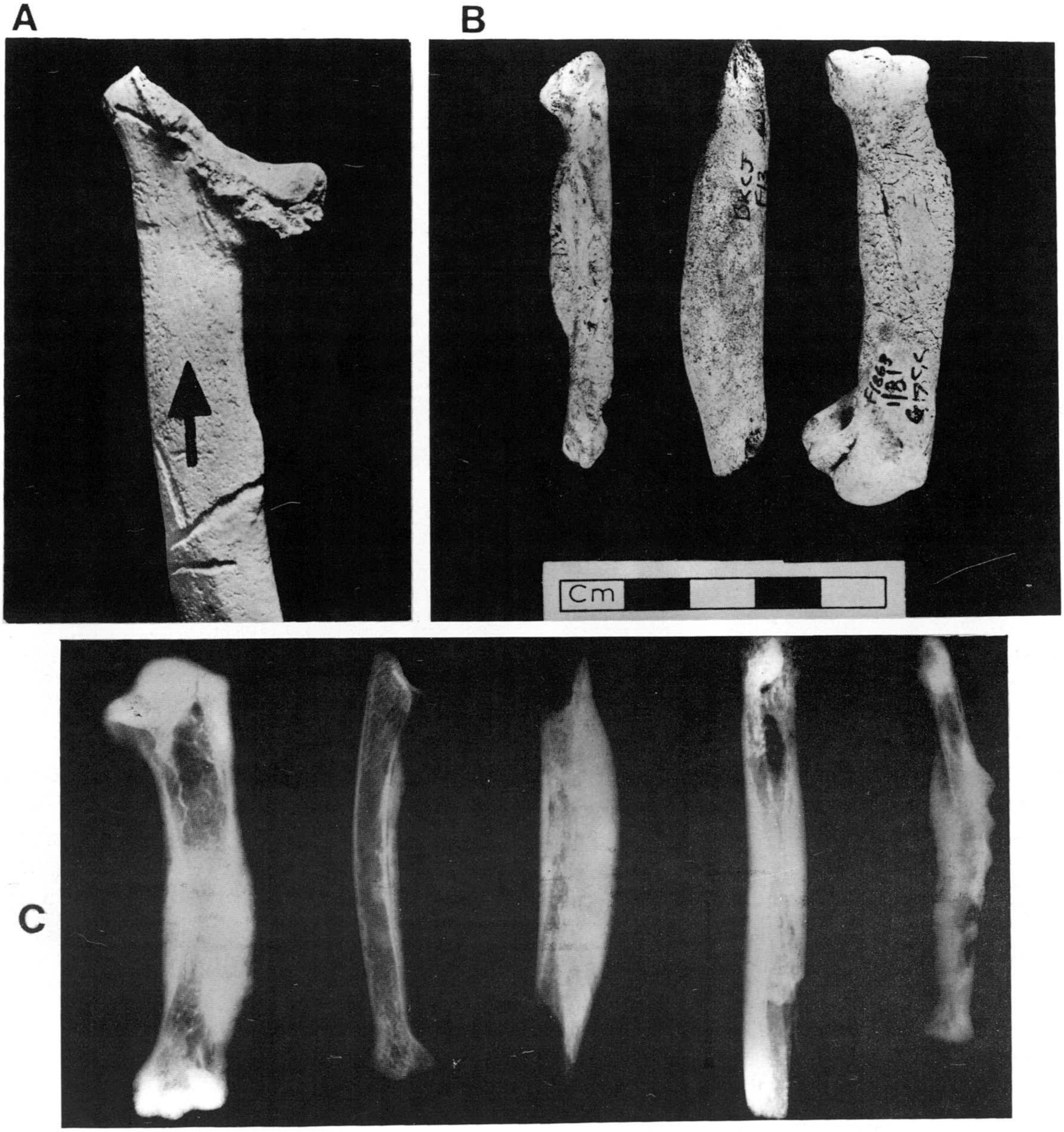

FIGURE 3 - A. Part of a Roman scapula from Uley, displaying marginal "lipping" indicative of arthropathic changes. B. An ulna, humerus and tibiotarsus shaft from Roman Colchester, displaying dense new bone indicative of osteopetrosis. C. X-ray detail of five long bones from Roman Colchester, displaying varying degrees of additional bone development indicative of osteopetrosis. Note that the new bone extends into the interior of shafts.

limited. It is worth noting here that pseudo-tumours in the form of multiple exostoses and extra bone on the legs have been found by Harcourt (1971) and others in archaeological bone (Figure 2, C.D.). The aetiology is uncertain, but appears to be linked to age changes in old fowls. We need to know more about this pathology.

INFECTIONS

Infectious disease (group F) is a major category in the study of bird health. Unfortunately, fowl typhoid, fowl cholera, hepatitis and numerous other conditions do not leave skeletal markers. Some infections are of course zoonoses, and for instance the outbreak of psittacosis in the Faroes in 1930 (Rasmussen, 1938) resulted in deaths in the human inhabitants who had plucked and dressed fulmar petrels as food. The transmission of tuberculosis is a more complex phenomenon, with little

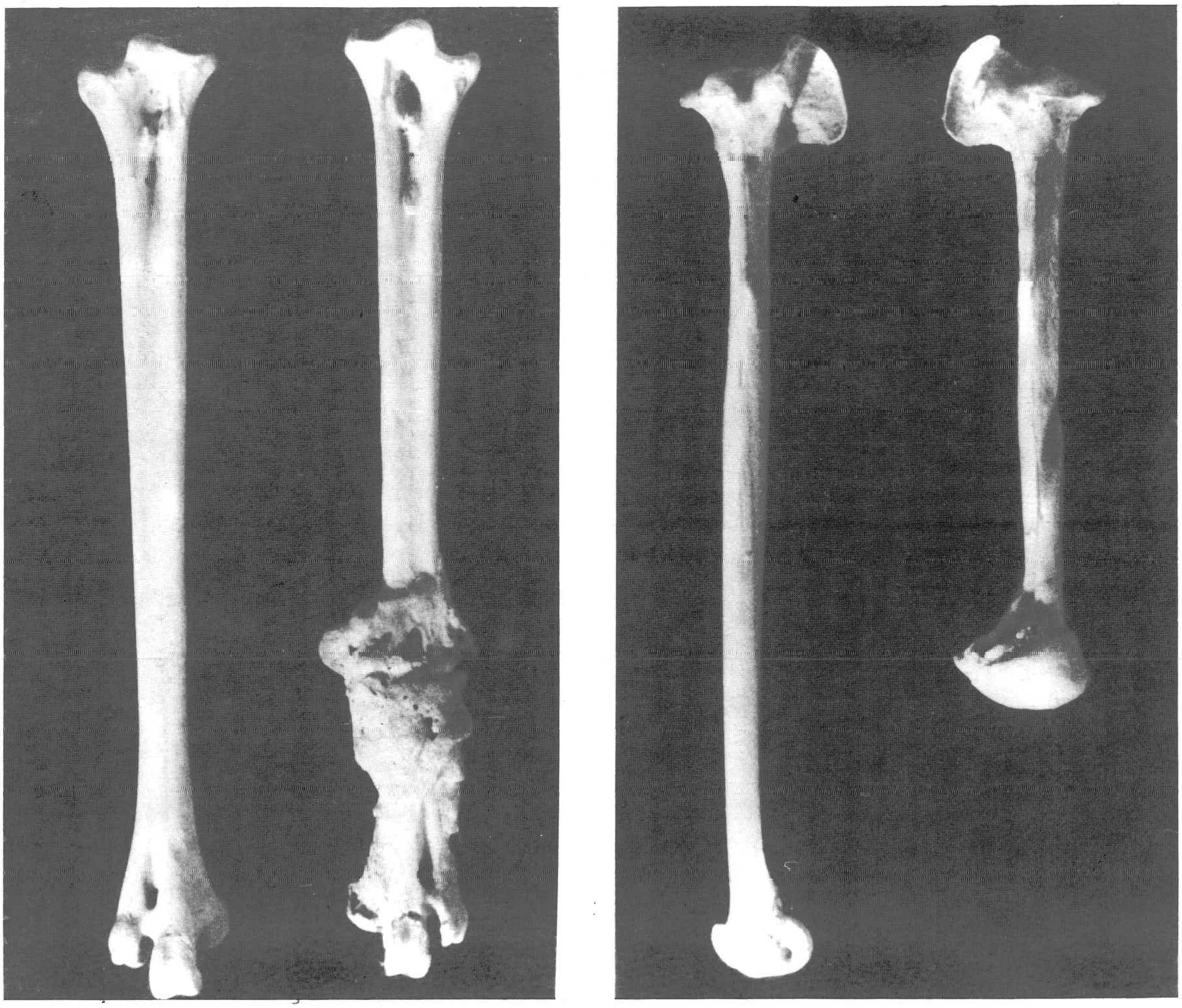

FIGURE 4 - Unusual results of trauma in long legged waders, following constriction of the soft tissue by sheeps' wool. Photographs courtesy of Keith Dobney.

detailed information on skeletal changes in avian tuberculosis. Captive birds can certainly be seriously affected by tuberculosis, and this disease was a primary cause of death in 641 seaducks studied by the Wildfowl Trust (Hillgarth & Kear, 1979). Avian tuberculosis can occasionally be passed to humans, and indeed birds can be carriers for other forms of tuberculosis. For instance, some time ago it was found that on farms in one area where pigs had tuberculosis, about 14% of the sparrows in the vicinity were also affected with the same mycobacteria (Plum, 1942).

The most interesting of all the infections, because it leaves its very characteristic mark on bones and can reach epidemic proportions, is avian osteopetrosis. It is caused by a virus which stimulates the proliferation of osteoblasts and massive swelling in the long bones of chickens (Boyde, Bames, Billaman & Mechanic, 1978). Anaemia may develop in advanced cases as a result of the occlusion of the marrow cavities (Payne, 1990). In view of the swollen dense long bones in this condition, it has been identified in archaeological material from a number of sites (Baker & Brothwell, 1980; Luff & Brothwell, 1992). At the site of Velsen, in Holland, about one percent of the domestic fowl displayed the condition (Prummel, 1987). If this was searched for systematically in *Gallus* samples and reported on in all dated cases, then it should be possible to build up an epidemiological history of this virus disease, at least since Roman time. There is also some evidence from British sites that it was more of a health threat in some flocks, and again we need more precise information on numbers of bones affected in earlier samples, which bones, and the degree of development of the osteopetrosis. It was certainly far more of a health hazard in Roman Colchester in East Anglia, for instance, than it was in Roman Uley, in the West Country.

Finally a very brief comment on external parasites (Table 1, group G). There may be a time in the future when mites and other less perishable external parasites are commonly identified on archaeological sites. Indeed, the bed bug has been identified, and it is possible that it may have adapted to humans in Roman times (Busvine, 1976), having first associated with domesticated pigeons and doves (*Cimex columbarius* is very similar to the human bed bug). Similarly, feather mites (Analgesidae have been found on Dutch archaeological feathers (Schelvis, 1992). But to return to bones; scaly leg, caused by another genus of mite (*Cnemidocoptes mutans*) can become very common where flock hygiene is poor. Infestation is mainly in domestic poultry, but can be found in other kept birds. The lower legs and feet may become severely affected, and the swollen crusty scabs may become infected secondarily, leading to periostitis. So even mites may potentially leave their mark at a skeletal level!

This has of necessity been a brief survey of the potential in avian palaeopathology. Certain lines of evidence already seen in archaeological material, suggest that prospects for further research are promising. There is also a need to clarify exactly which bird diseases may leave their mark on bones (and relatively how often). I hope by calling your attention to this area of comparative palaeopathology, that it may lead to further disease identifications and descriptions in future avian zooarchaeology.

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