

HEALED MASSIVE PELVIC FRACTURE IN A SMILODON FROM RANCHO LA BREA, CALIFORNIA

Stewart SHERMIS*

RESUME

L'Auteur décrit le bassin d'un *Smilodon californicus* (le *Machairodus* américain), provenant d'un dépôt d'asphalte de Rancho La Brea, Californie. L'animal a subi un violent traumatisme alors qu'il n'était pas encore complètement adulte. Ceci a entraîné au niveau des os coxaux, des fractures multiples accompagnées de dislocation et plaies importantes du tissu mou. A la longue les blessures ont guéri laissant comme séquelles : déformation irréversible et incapacité. La survie de cet animal impotent ne peut s'expliquer que par son appartenance à un groupe organisé, qui le pris en charge pendant tout le reste de sa vie.

INTRODUCTION

It stands to reason that serious trauma in prey animals would seldom be represented either in the current natural condition or the fossil record: any reduction of total efficiency usually means a swift demise. Predatory animals, on the other hand, are more apt to survive trauma as they are at the top or close to the top of the food chain and thus under less stress of survival. And while fossil evidence of incapacitation in the form of healed fractures in predatory animals may be plentiful and occasionally impressive by its extent, the injuries are seldom life-threatening in and of themselves; they would usually become lethal to the extent that they prevent an animal from obtaining sustenance. Trauma to the pelvis to be described, however, is of such a magnitude that explanations of survival must necessarily involve social/behavioral mechanisms and these strongly suggest intraspecific altruism.

That *Smilodon* was subject to the stress of trauma has been documented previously (Moody, 1930 a & b; Merriam and Stock, 1932) (cf. note). In the literature it was observed that intraspecific combat led to death (Shermis, in press) and that this combat must have presented some difficulty in normal predatory hunting given the occasional traumatic avulsion of a saber (Shermis, in press). A fully articulated pelvis designated LACMHC 9854, located in the George C. Page Museum at Rancho La Brea along with a femur, LACMHC 6963, constitute the subject of this report.

The femur was found in the same pit as was the pelvis and matches the side, degree of traumatization, healing response and configuration of the reorganized acetabulum. It was, however, found at a different level and some 9 meters away. But given the instability of the asphalt matrix, especially in this pit, this is not a strong objection to considering these elements to be from the same individual.

INITIAL INJURY

When initially traumatized, LACMHC 9854 was a subadult, the exact age indeterminate (Tejada-Flores and Shaw, 1982). The subadult status is predicated upon the triradiate suture of the acetabulum not having fused the ilium and pubis to the ischium. It was at this point in time when this felid received a massive blow directed at the right trochanter. It is all but useless to attempt to reconstruct the exact nature of this force though from the degree and format of injury it was likely a crushing blow by a large mammal.

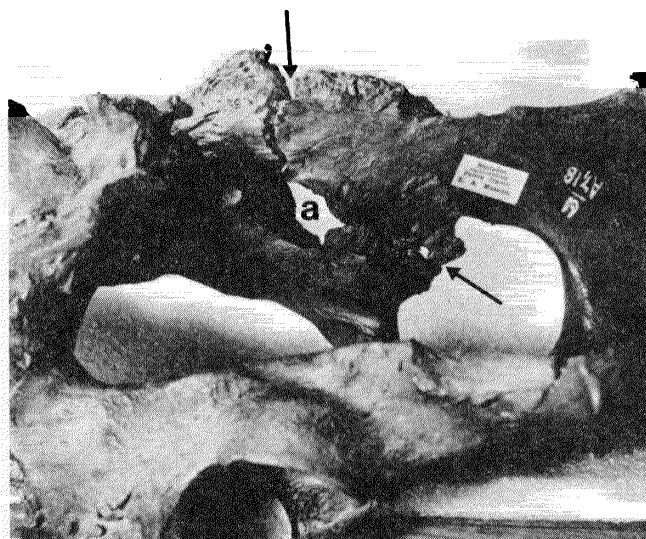


FIGURE 1 — Medial view of right acetabulum. Arrows indicate two patent fracture lines. "a" refers to medial portion of socket destroyed in initial injury. Left normal socket is below.

* California State University, Long Beach, 1250 Bellflower Boulevard, Long Beach, California, 90840, U.S.A.

The force was such that multiple pelvic injuries occurred simultaneously. The capital epiphysis of the right femur was thrust medially with such force that it fractured the acetabular socket causing the most medial portion to fragment away, Fig. 1, 2 and 3. The ischial portion was avulsed from the iliac and pubic portions causing permanent non-union and dislocation. Medial acetabular protrusion amounted to 31 mm. The trauma also dislocated the pubic bone

and raised the ischial bone above its fellow by almost 20 mm. Both ilia became separated from the sacrum which was fractured and, given the size of a vertebral osteophyte extending superiorly, Fig. 4, it would appear that several lumbar vertebrae were traumatized also. The inferior margin of the left ilium from the crest to the inferior iliac point was either fractured or the muscles adherent were very severely traumatized.

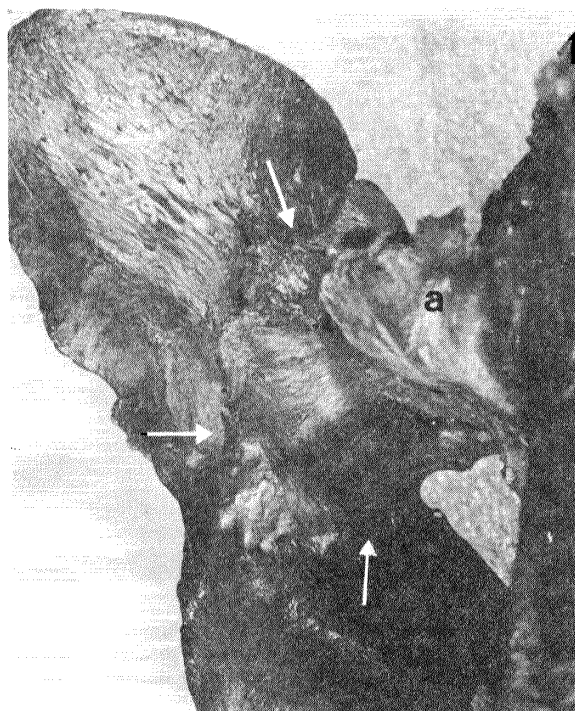
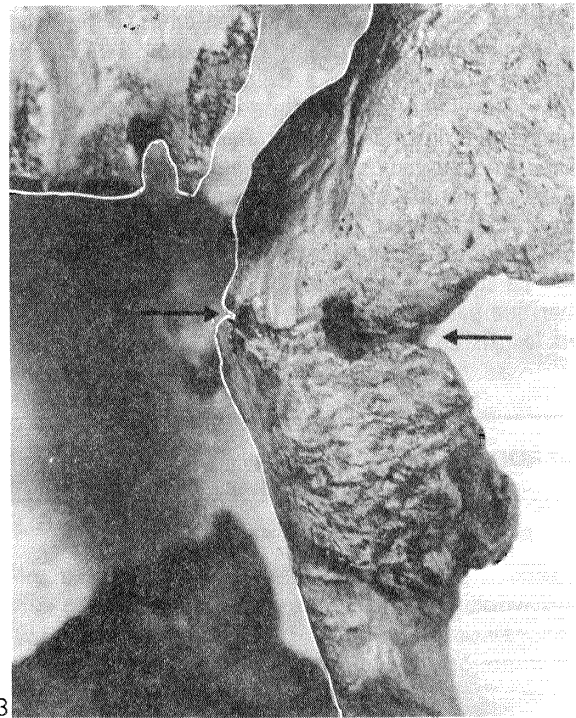
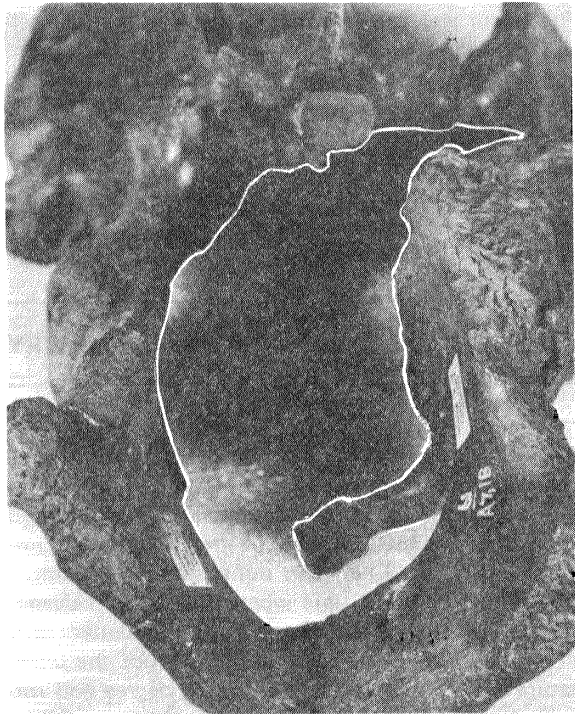
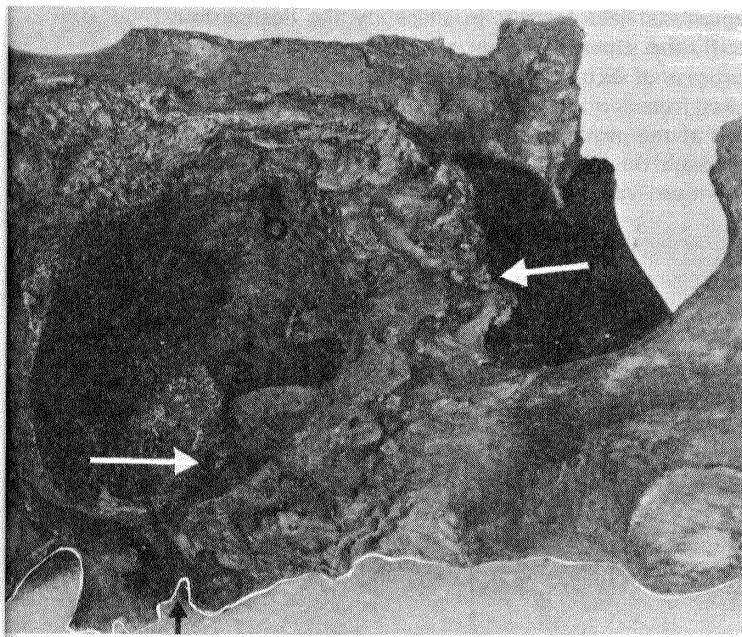


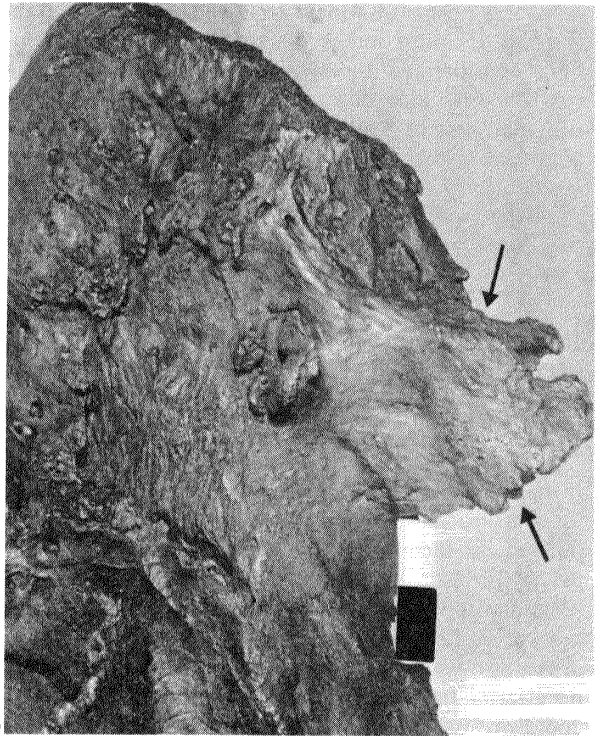
FIGURE 2 – Posterior view of pelvic basin. Intact structure is to the left. Amount of acetabular protrusion into basin is approximately 31 mm.

FIGURE 3 – Close-up of posterior view of right acetabulum. Arrows indicate patent fracture through socket which is united only at the ischial portion of the symphysis.

FIGURE 4 – Right sacroiliac joint. Arrows indicate reparative callus tissue where bones separated at joint. "a" represents a large lumbo-sacral osteophyte usually indicating a stressed vertebra.

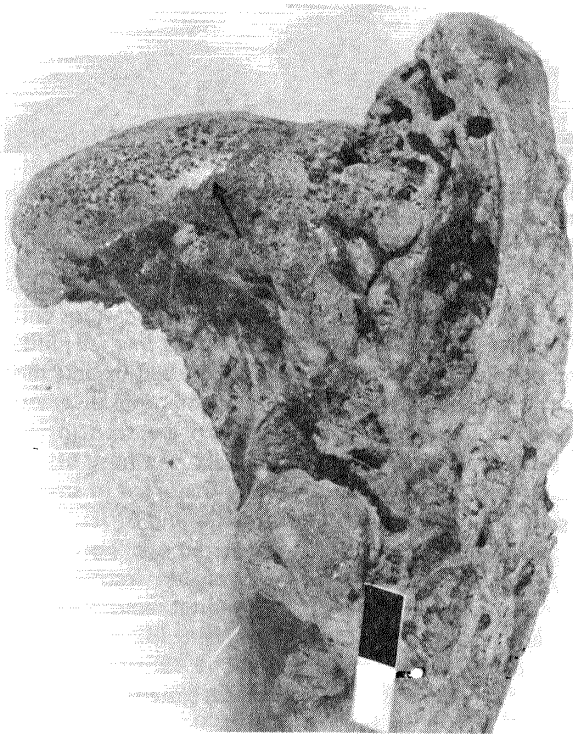


5



6

FIGURE 5 — Right acetabular fossa. Arrows indicate fractures through socket. "a" represents portion destroyed at initial injury and "b" is vacated original articular surface. Note oval shape and reparative bone tissue in the circumacetabular region which normally houses the periarticular ligament cuff.



7

FIGURE 6 — Right femur. Head is about 15 mm inferior to normal position. Normally globular, the capital epiphysis is distorted because of regressive and progressive remodeling as a concomitant to osteoarthritis. Signs of this disease include subchondral pitting and eburnation (arrow). Metaphysis of femur matches appearance of circumacetabular area. Bar is 2 cm.

FIGURE 7 — Left ilium. Arrows indicate a large traumatic exostosis on anterior margin of ilium. Note the cortical outgrowths as a result of myositis ossificans traumatica covering almost the entire medial surface. Bar is 2 cm.

As part of hip socket destruction, the right femur was dislocated from its normal position in the acetabulum. This is readily discernable from the distorted appearance of the unused original joint surface, Fig. 5. The head, however, was maintained in the vicinity of the acetabulum, likely at about the superior labrum, the periarticular cuff having been severely traumatized.

Soft tissue damage was proportional to hard tissue destruction. Much of the damaged and undamaged bone tissue is covered with lesions of extensive myositis ossificans traumatica attesting to very large amounts of extravasated blood pooled in the pelvic

region along with scar tissue formation reflecting badly damaged muscle tissue. These are seen on the metaphysis of the right femur, Fig. 6, right and left ilia, Fig. 7, and superacetabular surfaces, Fig. 5. These ectopic bony growths can be recognized as raised masses of irregular bone extending from the cortical surface and assuming a variety of shapes often resembling exaggerated rugosities. Given the normal appearance of the left acetabulum, it would appear that the left femur was either not affected or only slightly so.

The physical picture, then, at the initial stage of trau-

ma was a powerful impact followed by multiple fractures, dislocation and severe soft tissue damage including considerable blood extravasation. Post-trauma survival was likely due to the contained character of the injury with neither profound shock, nor any appreciable loss of blood or significant injury to vital tissue. There is nothing to suggest that there was any significant nerve damage ; subsequent healing is entirely consistent with an intact nervous system.

INITIAL BEHAVIORAL RESPONSE

Initially, the extent of incapacitation in terms of locomotion was close to total. Given the primary propulsion by the hind legs, the bilateral hard and soft pelvic tissue damage would have allowed for only the most limited of crawling, assuming that this represented the full extent of injuries. Whatever food and protection were obtained by the injured animal must necessarily have been provided by others directly. It could not have been simply a matter of another felid having downed a prey and allowing the injured subadult to share in the kill. This must have been an instance whereby food was brought back from the kill site and given to the traumatized subadult directly. With one hind limb virtually flail and the other with severely traumatized muscle tissue the likely picture was hardly otherwise.

This would not be a novel social behavioral response. Schaller (1972) observes an instance when a lioness, having been bitten on her flank, was provided with food by the rest of the pride for a period of nine months. And while Schaller (1972) observes a single instance of an unsuccessful attempt of a mother to provision a young cub, it is difficult to know if this traumatised subadult fell into the category of a cub. Schaller notes that lions have great recuperative powers even in the face of severe wounds : the present example only suggests that this endowment goes back to the Upper Pleistocene and strongly suggests if not confirms the fact *Smilodon californicus* was a pride-dwelling animal.

CHRONIC DEFORMATION AND BEHAVIOR RESPONSE

Subsequent healing followed hard on the path set by the pattern of initial injury. Most noticeable were the developments in and about the right hip socket. Owing to the fact that the head of the femur came to rest close to the superior margin of the acetabulum, it was in this region that most of the adaptive changes in locomotion took place. To accomodate the capital

epiphysis held loosely in place by the ligamentous cuff, the superior margin of the socket began a long process of extension increasing the depth of the socket from a norm of 22 mm to about 64 mm measured at the most superior surface, Fig. 8. The fracture through the triradial suture never having healed, there are two fracture lines transecting the joint, Fig. 1.

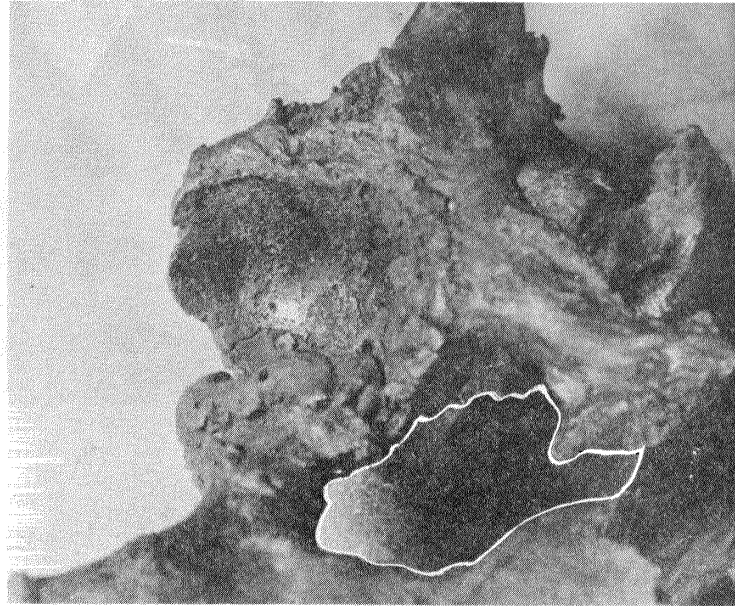


FIGURE 8 — Inferior view of right acetabulum. Lateral aspect of superior surface is highly eburnated. Note also the characteristic pitted surface.

It is a commonplace that unreduced dislocations will eventuate in degenerative osteoarthritis in that joint. Precisely this can be seen in both the femur and the circumacetabular region, including the progressive and regressive remodeling changes which are seen in the more exacerbated cases. For its part, the head of the femur is both lower and severely distorted in shape, Fig. 6. Whether this inferior positioning of the head is solely the result of regressive remodeling is unknown. Other factors may be involved : fracture dislocation of the neck of the capital epiphysis or perhaps a slipped capital epiphysis. In any event, the weight-bearing surface is about 15 mm inferior to where it would be in a normal specimen.

The head of the femur shows all the standard signs of chronic degenerative osteoarthritis. The largest part of the weight-bearing surface shows the pitting characteristic of subchondral cystification and the superior/lateral margin exhibits eburnation, Fig. 8. The femoral eburnation corresponds to the large area of eburnation on the superior surface of the socket. As the entire portion of the femur superior to the lesser trochanter is heavily encrusted with exuberant periosteal growth, much of it the reaction to the initial injury, it is impossible to know if this represents the only reactive bone. It is not improbable that some of the finer lacy reactive bone currently obscured with some of the tar matrix is a local reactive process resulting from septic arthritis.

In addition to the degenerative osteoarthritic changes in the socket, the distortion of shape is quite profound. A normal acetabulum is about 50 mm in diameter and about 25 mm in depth. In this traumatized specimen, the acetabular cavity is approximately oval measuring 55 mm in the shortest diameter (superior-inferior) and 70 mm in the other (anterior-posterior) with the greatest depth measuring 64 mm, Fig. 5.

From the appearance of the remnants of the pubic symphysis, it is clear that the superior portion was fractured. No union between the superior portions ever took place, in part, because the two innominate bones are displaced, the one being 13 mm more caudal than the other. The symphyseal surface of the right superior ramus of the pubic bone is such as to suggest a pseudoarthrosis: mushroomed and highly irregular, Fig. 9. Given the offset of the innominates, it is well within the bounds of possibility that the lumbar portion of the spine was slightly scoliotic during life. The left superior articulating facet of the first sacral vertebra shows marked osteoarthritic degeneration strongly suggesting a stressed, malpositioned local structure further suggesting scoliosis.

The left innominate exhibits less functional disturbance. The healing callus and the surface distortion on the ilium indicates gluteal muscles of significantly reduced efficiency. The left ilium is more laterally rotated than the right, even more so with the ectopic bone projection of 36 mm, Fig. 7.

In sum, the list of chronic diseases includes but is not limited to dysraphism, muscle and bone non-symmetry, dysplastic hip joint, osteoarthritis, possible scoliosis and muscle atrophy.

CHRONIC BEHAVIORAL RESPONSE

Function and behavior were likely closely mirrored to hard and soft tissue destruction. It is most likely that this specimen walked with a profound limp in the right hind leg. Furthermore, the left hind limb was likely not as strong as the norm given the considerable soft tissue destruction. The right femur was sharply curtailed in the amount of movement allowed in all directions, especially rotation and adduction. The stressed lumbar spine only added to the restrictions. Saltatory movements were likely out of the question given these limitations as was running. The animal was most likely restricted to slow, painful walking.

Destruction of this magnitude is seldom encountered outside of the human community where the mantel

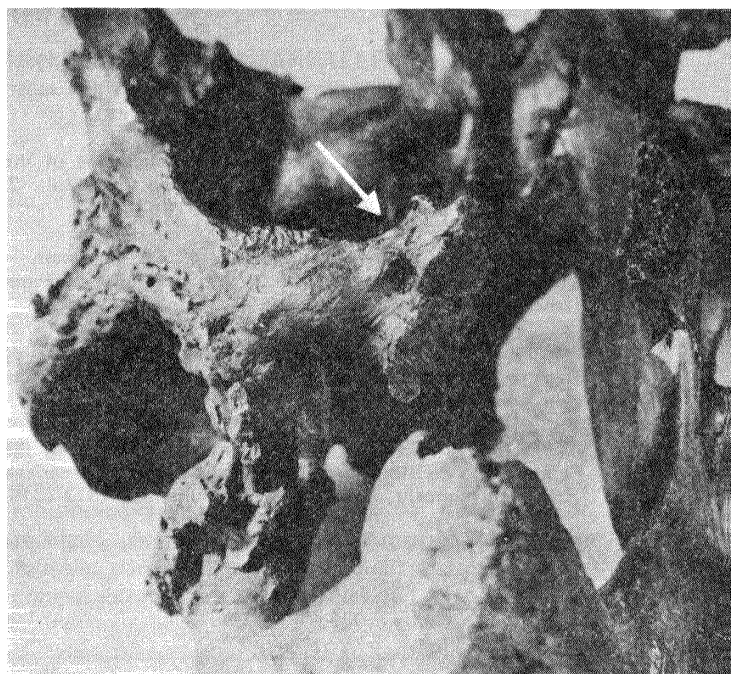


FIGURE 9 – Inferior view of right superior ramus of pubic bone. Arrow indicates expanded portion with a healed, irregular, mushroomed surface suggesting pseudoarthrosis. Note overhanging, enlarged superior surface of right acetabulum.

of culture with its emphasis on caring, sharing and reciprocity serves to insulate the individual from extinction at the hands of calamity. Such gross, lifelong physical distortion as seen in this specimen from Rancho La Brea must be a rare event at any age in the history of the felids. No analogue is provided by Schaller (1972) in his definitive study of the African lion, though he does mention two aged females who were too weak to hunt and were provisioned by the kills of the other pride members.

I would suspect that this would be an instance in kind. Given the profound restrictions on normal hunting, this animal was very likely sustained with food and protection by the other pride members for the entirety of its life. Pride-dwelling social organization has been suggested or hinted at before (Gonyea, 1976 Akersten, in prep.): this is the first time, however, that there is strong indirect evidence for its having been the case. This is yet another small example of paleopathology, a discipline generally neglected by paleontologists, illuminating paleoethology.

I should like to extend my appreciation to the staff at the George C. Page Museum and especially to George Jefferson and Richard Reynolds for their suggestions and critique of this paper.

Note : In 1972, P. Morel, R. Perrot and R. Ballesio (Lyon France) studied the right humerus of a french machairodus (*Homo-therium crenatideus*) showing an exostosis on the shaft : The radiography strongly suggested a traumatic etiology.

REFERENCES

- AKERSTEN (W.A.) (in prep.). — Of dragons and saber-tooths : canine function in *Smilodon*., (manuscript).
- GONYEA (W.I.), 1976. — Behavioral implications of the sabre-toothed felid morphology. *Paleobiology*, Vol. 2, pp. 332-342.
- FLORES-TEJADA (A.E.) and SHAW (C.A.) (in press). — Tooth Replacement and Skull Growth in *Smilodon* From Rancho La Brea.
- MERRIAM (J.C.) and STOCK (C.), 1932. — The Felidae of Rancho La Brea. *Carnegie Institute of Washington, Publication*, 4 pp. 1-231.
- MOODY (R.), 1930. — Hypertrophy in the Sacrum of the Sabre-tooth, Pleistocene of Southern California. *American Journal of Surgery*, Vol. VII, N° 6, June, pp. 1313-1315.
- MOODY (R.), 1930. — The Phenomenon of Sacralization in the Pleistocene Sabre-tooth. *American Journal of Surgery*, Vol. X, N° 3, December, pp. 587-589.
- MOREL (P.), PERROT (R.) et BALLESSIO (R.), 1972. — Les proliférations osseuses en paléopathologie : 1 - Les exostoses isolées : à propos de l'humérus d'un machairodus découvert à Senèze (Haute-Loire, France). *Cahiers médicaux lyonnais*, Vol. 48, N° 32, pp. 3647-3659.
- SCHALLER (G.B.), 1972. — *The Serengeti Lion ; a Study of Predator-Prey Relations*. The University of Chicago Press, Chicago, pp. 430.
- SHERMIS (S.) (in press). — *Smilodon californicus* Intraspecific Combat. *Bulletin of the Southern California Academy of Science*.
- SHERMIS (S.) (in press). — Canine Fracture Avulsion in *Smilodon californicus*. *Bulletin of the Southern California Academy of Science*.