JOURNAL OF
WILDLIFE DISEASES

Survival of the Less-fit: A Least Shrew (Mammalia, Soricidae, *Cryptotis parvus*) Survives a Separated Leg Fracture in the Wild

Neal Woodman[1,2] [1]US Geological Survey Patuxent Wildlife Research Center, National Museum of Natural History, Smithsonian Institution, Washington, DC 20013-7012, USA; [2]Corresponding author (email: woodmann@si.edu)

DOI: 10.7589/2012-08-218

Journal of Wildlife Diseases, 49(3), 2013, pp. 735–737

Survival of the Less-fit: A Least Shrew (Mammalia, Soricidae, *Cryptotis parvus*) Survives a Separated Leg Fracture in the Wild

Neal Woodman[1,2] [1]US Geological Survey Patuxent Wildlife Research Center, National Museum of Natural History, Smithsonian Institution, Washington, DC 20013-7012, USA; [2]Corresponding author (email: woodmann@si.edu)

ABSTRACT: X-rays of the deformed femur of a least shrew (*Cryptotis parvus*) revealed an ossified callus enclosing a greatly displaced, spiral fracture. Based on models of fracture healing, this shrew lived for at least 28 days postfracture. Survival of major fractures in the wild may not be uncommon.

A specimen of a least shrew (Mammalia: Soricidae: *Cryptotis parvus parvus*) in the mammal collection of the US National Museum of Natural History (USNM 569835), Washington, DC, possesses a malformed left femur paired with a more typical right femur (Fig. 1). The left femur is about 16% shorter (head to medial condyle=6.5 mm) than the right femur (7.8 mm), and the shaft appears as an irregularly inflated mass of bone up to four times the diaphysis diameter of the right. The distal end is twisted and offset horizontally, vertically, and laterally from its natural position relative to the proximal end. Although the resulting shorter left leg is unlikely to have been much in use, no obvious differences in external morphology or bone thickness are evident between left and right tibiae or pelves.

To determine the extent and nature of bony growth surrounding the left femur, I obtained digital x-rays of both femurs using a Kevex X-Ray source (Kevex X-Ray, Inc., Palo Alto, California, USA) and Varian Image Viewing and Acquisition software (version 2.0; Varian Medical Systems, Waltham, Massachusetts, USA). The images (Fig. 2) reveal that the diaphysis of the left femur sustained a broadly separated spiral fracture. The two sections of the diaphysis have slid past, and are angled away from, each other. No parts of the two are in direct contact, and no secondary bony bridge connects them. There is no evidence of an internal callus. Surrounding nearly the entire diaphysis is a large, relatively thin-walled external callus, the bony margin of which represents a greatly enlarged external wall of a double cortex similar to that described by Isaksson et al. (2009). The callus contains abundant trabecular bone, which probably provided structural support in the absence of bridging and healing of the diaphysis.

Experiments investigating fracture repair in laboratory mouse models indicate that fractures in small mammals can heal relatively rapidly (Manigrasso and O'Connor, 2004; Isaksson et al., 2009). External callus forms by 7 days and reaches peak volume 10–21 days postfracture. By 21 days, bone remodeling begins, the fracture is first bridged, and callus volume decreases. At 28 days, external callus is completely ossified. Callus is smaller, but still present, at 42 days (Manigrasso and O'Connor, 2004). Isaksson et al. (2009) described formation of a "double cortex" of lamellar bone bounding the external callus in mice at 21–28 days that was attributed to the constant bending moment on rodent limbs as a result of their flex-legged stance, which is similar to that in shrews. Most woven bone between the two cortices is resorbed after 28 days, and the cortices merge after 42 days as the bone remodels (Isaksson et al., 2009). Based on the timing of fracture healing, formation of double cortex, and resorption of woven bone in mouse models, the least shrew probably died at least 28 days after breaking its leg.

Specimen USNM 569835 is an adult female found dead on 3 January 2004 by Robert M. Timm near a bird feeding station on a back lawn bordering replanted

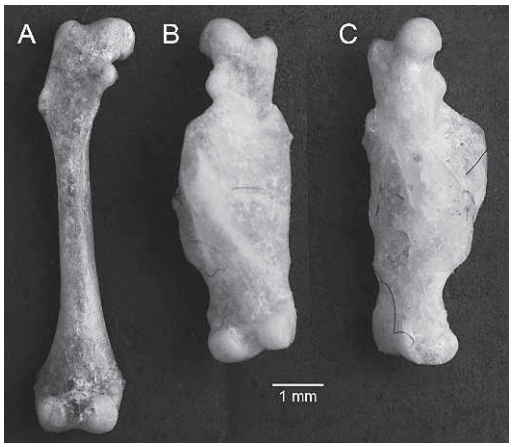

FIGURE 1. Photographs of right and left femurs of a least shrew, *Cryptotis parvus*: (A) posterior view of uninjured right femur; (B) oblique posterior view of fractured left femur showing extensive hard callus formation; (C) oblique anterior view of fractured left femur.

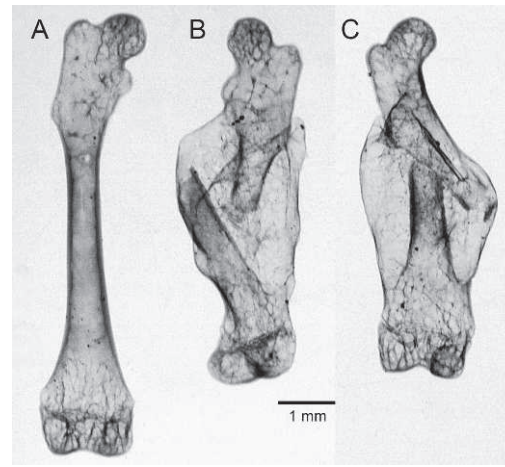

FIGURE 2. Inverted x-ray images of right and left femurs of a least shrew, *Cryptotis parvus*: (A) posterior view of uninjured right femur; (B) oblique posterior view of fractured left femur showing the separated nature of the fracture and extensive external callus formation; (C) oblique anterior view of fractured left femur.

tall-grass prairie ca. 8 km north of Lawrence, Douglas County, Kansas (39°03′N, 95°14′W). During winter months, least shrews were regularly observed feeding on seeds near this feeder, and about one dead individual per month was discovered (R. M. Timm, unpubl.). Measurements of the specimen are near the mean in condylobasal length of the skull (15.6 mm) for Kansas least shrews (15.5±0.4 mm, range=14.8–16.2 mm, n=32); large (65 mm) in external head-and-body length (60±4 mm, 46–68 mm, n=89); and about average (4.3 g) in weight (4.9±0.9 g, 2.5–7.3 g, n=77). Based on dental wear, the shrew was an old animal, about tooth-wear stage 4 (estimated 12–16 mo; Rudd, 1955): Upper incisors and unicuspids are worn beyond the pigment and are flat; occlusal surfaces of premolars and molars are mostly flattened with small hillocks. Mean and modal longevities for 189 captive least shrews were 8 and 5.5 mo, respectively; only 11 animals survived 18 mo, and one survived 31 mo (Mock and Conaway, 1976). A maximum age of 14 mo for USNM 569835 is likely.

Despite the injury, which almost certainly left it with a severely damaged hind leg, the shrew did not appear to have fared poorly. Temperate-zone shrews typically weigh less during winter than summer (Churchfield, 1990), so this individual's near-average weight suggests that obtaining sufficient food was not difficult, probably because of abundant seeds available at the feeder. Weather in late December 2003 through 3 January 2004 was mild. There was no snow cover or precipitation for the previous 18 days, and temperatures were above normal, with daily maxima above freezing and daily minima below freezing on only 11 days (USNDC, 2004–2005). It is likely the shrew died of natural causes unrelated to its fracture and represents part of the natural annual mortality for which shrews are known (Churchfield, 1990). Its survival with a broken leg in the wild contradicts the beliefs that shrews are delicate creatures easily frightened to death (Crowcroft, 1957) and that limb fractures are generally fatal for adult wild animals (Bulstrode et al., 1986).

Anecdotal accounts of individual wild mammals surviving limb fractures (e.g., Glander, 1930; Gilbert and Hill, 1956) and even amputations (Barkalow, 1956) abound. In a study of porcupines (*Erethizon dorsatum*), raccoons (*Procyon lotor*), and woodchucks (*Marmota monax*), the incidence of healed fractures was 7–35% (Roze et al., 1990). Few studies, however, report the incidence of fractures in specific populations of smaller terrestrial mammals. Hamar (1970) noted only 56 healing fractures or abnormalities among four rodent species from a collection of 15,000 owl pellets, suggesting a low occurrence in these wild populations. In a systematic study of wild European water voles (*Arvicola terrestris*), Ventura and Götzens (2005) reported 47 (8%) healing postcranial fractures among 564 individuals. Of these, 11 (2%) were femur fractures. While it is impossible to gauge rates of mortality from fractures based on such studies, bone repair in small mammals is relatively rapid, and healthy populations of mammals can include substantial numbers of individual survivors of limb fractures.

I thank Robert M. Timm for his generous donation of the specimen reported in this paper and for providing additional details regarding its discovery. Sandra Raredon, USNM Division of Fishes, provided assistance with digital x-ray procedures. Sandy Feinstein, Robert M. Timm, and two anonymous reviewers provided valuable comments on previous drafts of this paper. Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the US government.

LITERATURE CITED

Barkalow FS Jr. 1956. A handicapped flying squirrel, *Glaucomys volans*. *J Mamm* 37:122–123.

Bulstrode C, King J, Robert B. 1986. What happens to wild animals with broken bones? *Lancet* 327:29–31.

Churchfield S. 1990. The natural history of shrews. Comstock Publishing Associates, Ithaca, New York, 178 pp.

Crowcroft WP. 1957. *The life of the shrew*. Max Reinhardt, London, UK, 166 pp.

Gilbert PF, Hill RR. 1956. Healing of the fractured leg bone of an elk. *J Mamm* 37:129.

Glander FF. 1930. Fractured leg not fatal to rabbit. *J of Mamm* 11:240.

Hamar M. 1970. Knochenbrüche und Anomalien am Skelett von Nagetieren aus Raubvogelgewöllen. *Säugetierk Mitteil* 18:115–117.

Isaksson H, Gröngröft I, Wilson W, van Donkelaar CC, van Rietbergen B, Tami A, Huiskes R, Ito K. 2009. Remodeling of fracture callus in mice is consistent with mechanical loading and bone remodeling theory. *J Orthop Res* 27:664–672.

Manigrasso MB, O'Connor JP. 2004. Characterization of a closed femur fracture model in mice. *J Orthop Trauma* 18:687–695.

Mock OB, Conaway CH. 1976. Reproduction of the least shrew (*Cryptotis parva*) in captivity. In: *The laboratory animal in the study of reproduction*, Antikatzides T, Erichsen S, Spiegel A, editors. Gustav Fischer Verlag, Stuttgart, Germany, pp. 59–74.

Roze U, Locke DC, Vatakis N. 1990. Antibiotic properties of porcupine quills. *J Chemical Ecology* 16:725–734.

Rudd RL. 1955. Age, sex, and weight comparisons in three species of shrews. *J Mamm* 36:323–339.

United States National Climatic Data Center, National Oceanic and Atmospheric Administration (USNCDC). 2004–2005. *Local climatological data. Topeka, Kansas. December 2004, January 2005*, http://www7.ncdc.noaa.gov/IPS/lcd/lcd.html. Accessed 25 July 2012.

Ventura J, Götzens V. 2005. Prevalence of anomalies in the appendicular skeleton of a fossorial rodent population. *J Wildl Dis* 41:728–734.

Submitted for publication 27 August 2012.
Accepted 19 November 2012.