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## Estimation of Fat from Femur Marrow of Oregon Black-Tailed Deer<sup>1</sup>

### Abstract

Femur marrow samples from 27 Oregon black-tailed deer (*Odocoileus hemionus columbianus*) were analyzed for percentage content of fat, water, and residue. Percentage of fat was significantly inversely correlated to percentage of water ( $r^2=0.98$ ,  $d.f.=25$ ). Evidently an accurate measure of fat content can be extrapolated by accurately measuring water content.

Measurement of fat concentration in the femur marrow of an ungulate can indicate the state of the animal's energy reserves. Ether extraction of fat by traditional methodology is time consuming, and other, less accurate methods of deducing fat content of marrow have been devised (Cheatum, 1949; Greer, 1968). Verme and Holland (1973) developed a rapid reagent-dry assay method, but estimates of femur fat concentrations derived from their rapid method and the more laborious ether extraction methods were dissimilar.

Bischoff (1954) indicated that most of the dry weight of femur marrow from both mule deer (*O. b. hemionus*) and black-tailed deer was fat. Neiland (1970) demonstrated that the weight of dried femur marrow in caribou (*Rangifer tarandus*) was nearly equal to the weight of the fat in the marrow. He postulated that the marrow in deer and caribou was essentially a three-component system comprised principally of water and fat, and that as fat is deposited within the marrow, water is driven off. Likewise, as fat is used during nutritionally stressful periods, resulting space in the marrow is filled by water, presumably because replacement by water would have the lowest metabolic cost to the animal.

This study was designed to determine whether the relationship between amounts of water and fat in femur marrows of black-tailed deer was sufficiently precise to enable prediction of fat content from accurate measurements of water content. Deer were collected with permission of the Oregon Department of Fish and Wildlife. K. R. Hall and T. P. Kistner aided in collection of deer, and J. Early aided in laboratory analyses.

### Methods

Femurs were obtained from the carcasses of 27 black-tailed deer (4 fawns, 8 yearlings, 15 adults) collected by shooting between 31 August 1976 and 23 February 1977 and frozen until analysis. Deer were collected from three distinct areas: 1) The Alsea Ranger District, Siuslaw National Forest, in the Coast Range ( $n=13$ ); 2) The William L. Finley National Wildlife Refuge in the Willamette Valley ( $n=9$ ); and 3) The Willamette National Forest in the Oregon Cascades ( $n=5$ ).

<sup>1</sup>Oregon State University, Agricultural Experiment Station Technical Report No. 4601.

The approximate center third of each femur was cut out with a lapidary saw, and the marrow removed. Marrow samples were weighed to the nearest hundredth of a gram, and dried in a forced-air drying oven at 60°C for 2-3 days, or until weight loss ceased. The samples were then weighed to extrapolate water loss. Each sample was then placed in a soxhlet extraction thimble and the fat extracted with a 2:1 solution of chloroform and methanol (Bloor's reagent) for 24 hours. The remaining residue was weighed after drying, and the amount of extracted fat was calculated.

### Results and Discussion

Fat concentration ranged from 12 to 92 percent, and water concentration from 7 to 74 percent (Figure 1). Percentage of fat was significantly inversely correlated to percentage of water ( $r=0.99$ ,  $P<0.01$ ,  $d.f.=25$ ).

Amount of residue ranged from 1 to 20 percent, and was significantly inversely correlated to percentage of fat ( $r=0.86$ ,  $P<0.01$ ,  $d.f.=25$ ). Although Neiland (1970) found a similar relationship in caribou femurs, caribou appear to have a considerably

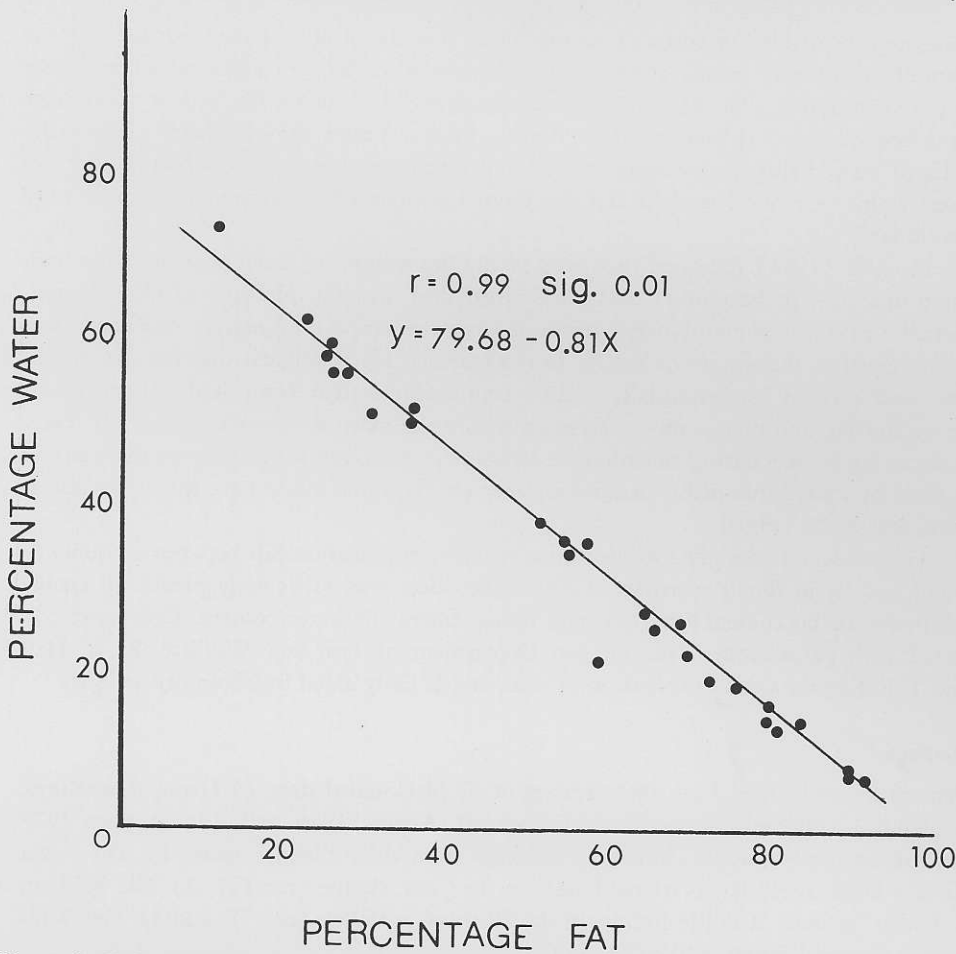


Figure 1. Relationship between percentage fat and percentage water in femur marrows from Oregon black-tailed deer.

narrower range of residue content (2-6 percent vs. 1-20 percent) than black-tailed deer.

The strong relationship between fat and water concentration indicated that for black-tailed deer, an accurate prediction of concentration of fat content in the femur could be made by accurately measuring water content. This hypothesis was suggested by Verme and Holland (1973), who worked with estimation of femur marrow fat in white-tailed deer (*O. virginianus*). For their estimations they assumed that the white-tails had a similar range of residue in the marrow as did caribou. If white-tails are at all similar to the black-tails examined in this study, however, their assumption may be incorrect. In fact, Verme and Holland (1973) obtained higher values for fat concentration with their reagent-dry method than with ether extraction, and proposed among other possibilities that white-tailed deer marrow might contain proportionately more residue than was found in caribou.

If the relationship between percentage of fat and percentage of water is as highly correlated for other ungulates as it is for Oregon black-tails, only a small number of femurs would be required to predict fat content accurately in the marrow by measuring water content of the marrow.

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