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PREY HAIR AND BONE RECOVERY IN ERMINE SCATS

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Abstract: We examined the relationship of hair (y_1) and bone (y_2) weight to body weight (x) in meadow voles (*Microtus pennsylvanicus*). The regressions were linear in both cases: $y_1 = 0.1541 + 0.0195x$ ($r^2 = 0.84$), $y_2 = 0.3776 + 0.0402x$ ($r^2 = 0.89$). These equations were used to estimate hair and bone consumed when ermine (*Mustela erminea*) were fed meadow voles. Apparent digestibilities of these components were −5 and 60%, respectively, and did not differ ($P < 0.05$) between male and female ermine. These values are substantially lower than those previously reported for hair and bone digestibility in other predators. Such variability must be explained if scat analysis data is to be used to reconstruct diets in carnivores.

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Scat analysis techniques, used to determine the diet of carnivores, rely on identifying and quantitating undigested components of prey (e.g., hair and bone) appearing in feces. Estimating how many prey items of a particular species are represented by a collection of fecal fragments is difficult (Putman 1984). Selective consumption of prey parts (e.g., hair and skeleton) and differential digestion of these components may induce errors in the estimation of prey consumed. Several workers have attempted to account for these sources of error by developing correction factors relating fecal composition to prey consumed for specific predators and prey items (Lockie 1959, Frank 1979, Liberg 1982). Others (Meriwether and Johnson 1980, Johnson and Aldred 1982) have measured the digestibility of carcass hair and bone as it differs among prey and predator species. Substantial disappearance of hair and bone has been reported during controlled recovery trials with prey species fed to coyotes (*Canis latrans*) (Meriwether and Johnson 1980) and bobcats (*Felis rufus*) (Johnson and Aldred 1982). However, different and sometimes unclear methodologies make comparisons among these experiments difficult. From our gross observation of ermine scats we could not agree that ingested hair and bone were destroyed to the extent reported by Meriwether and Johnson (1980) and Johnson and Aldred (1982). Our study was designed to quantify digestibility of hair and bone when ermine were fed meadow voles and to investigate reasons for the variability of previous digestibility estimates.

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METHODS

We fed 10 individually caged ermine (5 M and 5 F) meadow voles their preferred prey species (Hamilton 1933, Aldous and Manweiler 1942, Simms 1979). All voles used in the study were trapped in the spring in southern Ontario. To estimate the intake of vole hair and skeletons in the feeding trial, we determined the relationship between vole body weight and hair and skeleton weight. Twenty voles ranging from 15 to 51 g were killed and skinned, and the hides were soaked in distilled water for 48 hours at room temperature to loosen the hair. The hair was then removed by gentle scraping, oven-dried at 105 C, and weighed for each carcass. The hair-free skin and the carcasses were freeze-dried to determine overall dry matter content. We determined skeletal weights by cleaning the carcasses in a dermestid beetle (*Dermestes* spp.) colony and oven-drying the skeletons at 105 C. The relationships between body weight and measured hair and skeletal components were determined by linear regression.

Twenty-eight voles from the same population as those used to generate the regression equations were weighed, killed, and ground in a food grinder (Hobart Mfg. Inc., Ont., Canada) with a 2-mm plate to mix the hair and bone thoroughly with the rest of the carcass. This was done to ensure proportional ingestion of hair and bone. Hair and bone content of the carcass mixture was determined from the regression equations for each of these components against individual carcass weights. Six samples of the mixture were weighed prior to drying for approximately 96 hours in a commercial freeze-dryer (Virtis Co., Gardiner, N.Y.), then re-weighed immediately upon removal. Percent

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dry matter was calculated at 100 × (dry wt/fresh wt).

We fed weighed amounts of the vole carcass mixture in excess of daily requirements to ermine in a 3-day digestibility trial. The ermine were fasted 8 hours before the start of the trial to empty the gastrointestinal tract, and overnight at the end of the trial to ensure total recovery of feces. During the trial, we recorded food consumption and collected, freeze-dried, and weighed the feces and refused food daily. Total intake of hair and skeleton was calculated from the dry feed intake and the calculated hair and bone content of the feed.

To isolate hair and bone from feces, lipid was first removed from the dried fecal sample for each animal by soxhlet extraction (Horwitz 1980: 135). The fat-free samples were repeatedly boiled with distilled water and washed through a 180-μm sieve until the extraction water was clear and only hair and skeleton remained. Hair and skeleton were separated by flotation and filtration, oven-dried at 105 C, and the dry weights recorded.

Because some hair might be lost during this separation process, the method was tested using 6 preweighed samples of clean, dry, domestic rabbit hair. In addition, 6 samples of rabbit hair were used to test an alternative method of fecal hair and bone separation described by Johnson and Aldred (1982), who put feces in nylon bags, washed and dried them in an automatic clothes washer and dryer, then hand separated and weighed the hair and bone. Our test used 25-μm mesh nylon, the tightest weave available commercially.

Digestibility of the skeleton was calculated by comparing the total weight recovered with the estimated consumption for each animal; however, digestibility estimates for the vole hair were confounded by the presence of variable amounts of ermine hair (ingested while grooming) in the fecal samples. To correct for this, we examined 5 random subsamples of the fecal hair collected from each ermine using a 40× microscope and counted the number of vole and ermine hairs in each field of view. Prey hair digestibility was then calculated after using the appropriate correction value for each animal. Because ermine are sexually dimorphic (Banfield 1974:321), we compared values for hair and skeleton digestibility by males and females using Student's t-test.

RESULTS

The vole carcass mixture was 33.9% dry matter. Body weight and hair weight (g) were linearly related and described by the equation $y_1 = 0.1541 + 0.0195x$ ($r^2 = 0.84$). The equivalent equation relating weight of carcass and skeleton was $y_2 = 0.3776 + 0.0402x$ ($r^2 = 0.89$). The mean body weight of the voles used to prepare the carcass mixture was 28.3 g; therefore, the hair and skeletal components of the mixture were 2.5 and 5.4% of fresh weight, respectively.

A mean of 2.8% of the hair sample was lost when the sieving method of fecal analysis used in this study was tested using rabbit hair. This was less ($P = 0.0001$) than the 21.6% lost by the alternate method (Johnson and Aldred 1982) using an automatic washer and dryer. The sieving method had lower variability ($S^2 = 0.0001$) than the alternate method ($S^2 = 0.001$).

The mean proportion of ermine hair in the scats was 31% of the total hair recovered (range = 18–48%). The higher values represented animals that were beginning to moult.

Mean prey hair digestibility was -3 ± 8 (SE) and -6 ± 6% for male and female ermine, respectively. The means were not different ($P > 0.05$) and the combined mean was -5 ± 5%. These slightly negative digestibility values for hair were not different from zero ($P > 0.05$), implying that essentially all prey hair ingested was recovered in the feces. Skeleton was 58 ± 6% digestible by male ermine and 62 ± 4% by females. Again, digestibility did not differ between the sexes ($P > 0.05$); the combined mean was 60 ± 4%.

DISCUSSION

Digestibility values obtained in this study differ from previously published data. Skeleton was 99% digestible when bobcats consumed gray squirrels (*Sciurus carolinensis*) and eastern cottontails (*Sylvilagus floridanus*), and hair was 93 and 88% digestible, respectively (Johnson and Aldred 1982). Meriwether and Johnson (1980) reported mean digestibilities of 91% for skeleton and 55% for hair of several prey items fed to coyotes. Such variability is important and must be considered when interpreting the results of laboratory recovery trials or when converting components recovered in field-collected scats to estimates of prey consumed.

Grinding prey into a mash eliminated a source

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of error common in this type of feeding trial. Many predators selectively avoid consumption of hair when feeding on intact prey carcasses especially when the prey is large relative to the predator; e.g., weasels feeding on mice (Chapman and Feldhamer 1982), cougars (*Felis concolor*) feeding on mule deer (*Odocoileus hemionus*) (Ackerman et al. 1984), and tigers (*Panthera tigris*) feeding on rabbits (Veselovsky 1967). In a preliminary trial with ermine fed laboratory mice, 19% of the estimated prey hair was left uneaten. Similarly, some skeletal parts (e.g., skull and feet) may not be consumed. Unless prevented or carefully measured, selective consumption would markedly alter the apparent digestibility of these carcass components. In previous studies where whole animals have been used as food, it is not clear how or if this problem has been dealt with (Johnson and Hansen 1979, Meriwether and Johnson 1980, Johnson and Aldred 1982). This may account for some of the variability of digestibility estimates in the literature. We recognize that grinding prey into a mash does not simulate natural conditions and that selectivity of consumption must eventually be addressed, but it does eliminate selectivity as a source of error and allow digestibility to be studied as a single parameter. We do not believe that grinding materially altered the digestibility of hair. Vole's hairs examined with a microscope were intact. Bone digestibility was substantially lower in our study than in others using intact prey (Meriwether and Johnson 1980, Johnson and Aldred 1982). If grinding increases digestibility by reducing particle size, our values would have been higher than previously reported.

Hair of predators in feces has not been recognized as a potential problem in previous digestibility studies. We found variable and sometimes large amounts of predator hair in ermine feces (range = 18–48%), indicating that appropriate correction values should be used to accurately estimate digestibility of prey hair.

Both prey and predator species used in feeding trials may affect the digestibility of hair and bone. This possibility is supported by differential recovery of indigestible residues from various prey species fed to coyotes (Weaver and Hoffman 1979) and tawny owls (*Strix aluco*) (Lowe 1980). Bone is broken down during digestion in the acidic gastric region of a predator's digestive tract; the extent to which this occurs has been related to differences in gastric acidity among species of raptors (Duke et al. 1975). Factors influencing the breakdown of ingested prey hair are less obvious. Different mammals have hair of different length, thickness, and macrostructure, which may affect the hair's ability to be broken down by digestive enzymes. Leprince et al. (1980) reported that feathers ingested by raptors could not be recognized because of the action of pepsin. This degradation was a result of the hydrolysis of protein acting as a cement for the keratin component of the feathers. Keratin is a highly resistant molecule requiring a keratinase (found in few microorganisms) or a specific reducing enzymatic system with proteases (found only in insects) for digestion to occur (Leprince et al. 1980). Because hair is similar in composition to feathers, the degradation of hair in the carnivore stomach may render hair unrecognizable and unrecoverable from feces. Thus, the difference in hair recovery between our study and previous reports for coyotes and bobcats (Meriwether and Johnson 1980, Johnson and Aldred 1982) may reflect differences in digestibility of this prey component between predator species, possibly because of differences in gastric acidity or retention time.

The completeness of prey hair recovery in our study supports the suggestion by Liberg (1982) that prey hair identification provides a good basis for diet reconstruction. The use of skeletal material may be less valid, given the lower recovery of this component. It does not seem appropriate, however, to extrapolate digestibility values among predators and perhaps among prey items unless digestibility values have been shown to be equivalent using controlled laboratory trials. To validate laboratory trials however, it is necessary to standardize the methodology, including measurement of avoided portions of prey items and a carefully controlled method of fecal analysis. Relationships between scat contents and prey ingested for a range of predators and prey species can only be determined under these rigorous conditions.

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PANTHER HABITAT USE IN SOUTHERN FLORIDA

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Abstract: We captured 6 Florida panthers (*Felis concolor coryi*) in southern Florida and radiolocated them 1,630 times from February 1981 through August 1983. Mean home area for 4 males and 2 females was 435 ± 231 (SE) km² and 202 ± 141 km², respectively. Mixed swamp forests and hammock forests were used more than expected based on the availability of these habitats within the panthers' home areas. Based on the availability of mixed swamp forests and hammock forests, we estimate that south Florida can support 30–40 panthers. The major factor limiting the panther population in south Florida appears to be availability of suitable habitat.

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In October 1976 the Florida Game and Fresh Water Fish Commission (GFC) initiated a study of the Florida panther to determine if a viable population of panthers remained in Florida. At least 1 population was located in the Fakahatchee Strand–Big Cypress Swamp–Everglades National Park region of southern Florida (Belden 1978). Our objective was to identify habitat necessary for the continued survival of the population of panthers in southern Florida.

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