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BODY SIZE AND CONDITION OF COYOTES IN SOUTHERN TEXAS

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ABSTRACT: Body size and condition of coyotes (*Canis latrans*) from a high-density population in Webb County, Texas (USA) were analyzed for age, sex and seasonal differences during 1980 to 1986. Mean body mass was progressively greater for juvenile, yearling and adult coyotes. Males were heavier and longer than females in each age class. Indices of intraperitoneal fat deposits were similar between sexes. Juveniles continued growth from fall to spring. Adults and yearlings both lost intraperitoneal fat overwinter. Mean body mass of adults decreased overwinter but mass of yearlings did not differ significantly between fall and spring. Territorial and transient female coyotes did not differ in mean body mass, length or indices of subcutaneous fat deposits.

Key words: Body condition, body length, body mass, *Canis latrans*, coyote, fat indices.

INTRODUCTION

Body condition of mammals is commonly measured by the amount of fat deposition (Riney, 1955; Hanks, 1981), which represents energy reserves, with the assumption that relative levels of fat reflect nutritional status. Whole body mass and various fat deposits are used as indices of body condition based on the assumption that they are related to total body fat. Analyses of the relationship between food abundance and body condition of canids in northern latitudes indicate that condition declines overwinter (Lindstrom, 1983; Todd and Keith, 1983). However, seasonal variation in body condition of carnivores in southern regions of North America is poorly quantified.

Coyote (*Canis latrans*) populations in southern Texas (USA) sustain the highest densities (0.9–2.7/km^2) reported (Knowlton, 1972; Andelt, 1985; Knowlton et al., 1986). High coyote densities in the region are associated with a broad food base as evidenced by dietary studies which show that coyotes feed on a variety of native fruit and insects during the lengthy warm season and shift to mammalian prey during the cool season (Knowlton, 1964; Brown, 1977; Andelt et al., 1987). The primary objective of this study was to describe age, sex and seasonal differences in body mass, length and fat deposits of coyotes from a high-density population in southern Texas.

Social organization is typically well defined in coyote populations (Camenzind, 1978; Bekoff, 1982; Andelt, 1985) but the behavioral and physical differences between territorial and transient (nonterritorial) individuals are not readily identifiable. Although Knight (1978) found that relative body mass often influenced social relationships of captive coyote littermates, she concluded that greater mass per se was insufficient for individuals to consistently attain dominance. Measurable variables related to the territorial status of individuals may be useful for describing the social structure of coyote populations. In this study, we also compared body mass and length and fat indices of a sample of territorial and transient female coyotes.

MATERIALS AND METHODS

Coyotes were collected for ecological studies on 10 different sites in Webb County, Texas (USA; 27°20′ to 28°00′N, 99°00′ to 99°40′W) within 70 km north and east of Laredo. The sites ranged from 40 to 80 km^2, were separated from each other by ≥8 km and were not resampled within 4 yr. Two additional study areas (52 and 55 km^2), located 30 and 60 km northwest of Laredo, were used to study spacing patterns of female coyotes for classification of their territorial status (Windberg and Knowlton, 1988).

Habitats on all study areas are comparable and representative of the South Texas Plains vegetational area (Gould, 1975). Topography, soils, vegetation, climate, and land use for the study area were described by Windberg et al. (1985).

Samples of coyotes were captured using foothold traps each fall (October–November) and spring (March–April) during six annual periods (fall 1980 to spring 1986). Tranquilizer tabs containing 500 mg of propiopromazine hydrochloride (Diamond Laboratories, Des Moines, Iowa 50318, USA) were affixed to traps (Balser, 1965) to reduce injury and trauma associated with capture. Trapped coyotes were sacrificed by gunshot within 24 hours after capture. Whole body mass was recorded to the nearest 0.2 kg for each coyote immediately after death. Body length was measured along the dorsal surface from the nose to the base (first vertebrae) of the tail. As an approximate index of fat deposits, the relative amount of intraperitoneal fat (IPF) was rated visually using a scale of 0 (none) to 3 (abundant), as follows: 0, no fat obvious in peritoneal cavity; 1, <10% of kidney covered with perinephric fat and small deposits of mesenteric fat on mesentaries of gastrointestinal tract; 2, 10 to 50% of kidney with fat and moderate deposits of mesenteric fat; 3, >50% of kidney with fat and abundant deposits of mesenteric fat.

During February and March of 1984 and 1985, female coyotes were captured and released for classification of territorial status based on the distribution of radio-telemetry locations (Windberg and Knowlton, 1988). The deposit of subcutaneous fat in those coyotes was indexed by measurement of skinfold thickness using tri-ceps Harpenden skinfold calipers (British Indicators Ltd., St. Albans, Herts, England). Skinfold thickness reflected nutrition levels of captive coyotes (Whittemore, 1984). We used a mean of five skinfold measurements (mm) taken in the region between the scapulae after removal of hair (Whittemore, 1984).

Coyote age was estimated by relative pulp cavity size determined from radiographs of canine teeth (F. F. Knowlton and S. L. Whittemore, unpubl. data) and enumeration of cementum layers in microscopic sections of canine or premolar teeth (Linhart and Knowlton, 1967). Coyotes were classed as juveniles (0.5 to 1.0 yr), yearlings (1.5 to 2.0 yr), and adults (≥2.5 yr).

Body mass and length were analyzed by 2-factor (sex and season) randomized block analyses of variance (ANOVA) for each of the three age classes using the SAS General Linear Model procedure (SAS, 1985). The IPF indices were categorical variables analyzed by Chi-square contingency tables but reported as means to simplify description of results. Mean mass, length and skinfold thickness of territorial versus transient female coyotes were compared for each age class using 2-sample t-tests.

All coyotes with advanced infections of sarcoptic mange (Mange Class III) were excluded from the analyses, because this disease adversely affects body condition (Pence et al., 1983). Females in the latter half of gestation (>30 days) also were excluded from the data because of the effects of variable fetal mass on total body mass.

RESULTS

Body mass and length

Mean body mass was progressively greater ($P < 0.01$) for juvenile, yearling and adult age classes (Table 1). Males were heavier and longer than females in each age class ($P < 0.01$). Adult males were 17% heavier ($\bar{x} = 11.0$ kg versus 9.4 kg, $n =$ 145, 109) and 5% longer ($\bar{x} = 86.4$ cm versus 82.1 cm, $n = 145, 109$) than adult females. There was greater variability in mean body mass ($CV = 10.2$–17.8%) than mean body length ($CV = 3.2$–5.6%) for all age, sex and season categories.

Population samples at half-year intervals indicated a general trend for continued growth in body mass and length to the adult age class (≥2.5 yr) (Table 1). Seasonal changes in body mass were notable among coyotes ≥1.5 yr of age (Table 1). Juveniles increased in mean body mass ($P < 0.01$) and length ($P < 0.01$) from fall (0.5 yr) to spring (1.0 yr). Mean body length did not differ between seasons among either yearlings ($P = 0.54$) or adults ($P = 0.80$). No difference ($P = 0.75$) in mean body mass of yearlings was detected between fall and the subsequent spring. Mean body mass of adults was less ($P = 0.04$) in spring than the preceding fall.

No differences in either mean body mass or length were detected ($P \geq 0.10$) between territorial and transient female coyotes of the three age classes (Table 2).

Indices of fat deposits

Differences in indices of intraperitoneal fat (IPF) deposits were not evident ($P \geq 0.09$) between sexes in any age class (Table 1). In fall, the relative frequency of IPF

TABLE 1. Sex-specific mean body mass, length and indices of intraperitoneal fat (IPF) for six age classes of coyotes, Webb County, Texas, 1980 to 1986.

Age (years)	Sex	n	Body mass (kg) $\bar{x}$	Body mass (kg) SE	Body length (cm) $\bar{x}$	Body length (cm) SE	IPF index[a] $\bar{x}$	IPF index[a] SE
Juvenile (0.5)	M	38	7.6	0.2	79.4	0.6	1.1	0.1
	F	40	6.5	0.2	75.6	0.7	0.9	0.1
Juvenile (1.0)	M	32	9.1	0.2	83.8	0.8	1.4	0.2
	F	50	8.0	0.1	81.0	0.5	1.0	0.1
Yearling (1.5)	M	19	10.8	0.3	85.7	0.8	2.0	0.2
	F	22	8.9	0.2	80.9	0.5	1.6	0.2
Yearling (2.0)	M	35	10.0	0.2	84.3	0.5	1.0	0.2
	F	32	8.6	0.2	81.3	0.5	1.2	0.2
Adult (≥2.5)[b]	M	69	11.4	0.2	86.8	0.4	2.0	0.1
	F	66	9.6	0.1	81.9	0.4	1.8	0.1
Adult (≥3.0)[c]	M	76	10.6	0.1	86.0	0.4	1.3	0.1
	F	43	9.1	0.1	82.4	0.4	1.1	0.1

[a] Rated visually by scale of 0 (none) to 3 (abundant).
[b] All adults in fall.
[c] All adults in spring.

indices indicated significantly less ($P < 0.01$) fat deposition in juveniles than either yearlings or adults, which had similar ($P = 0.54$) frequencies of IPF. IPF decreased from fall to spring in both yearlings ($P < 0.01$) and adults ($P < 0.01$). IPF indices of juveniles did not differ significantly between fall and spring ($P = 0.24$). As a result, differences in the frequency of IPF indices among the age classes were not obvious ($P = 0.07$) in spring (Table 1).

No differences in mean skinfold thickness were detected between territorial and transient adult ($P = 0.28$) or yearling ($P = 0.47$) females (Table 2). Skinfold thickness was greater in transient than territorial juveniles ($P < 0.01$).

DISCUSSION

Sexual dimorphism in body mass is well documented for coyotes. Bekoff (1982) provided nine estimates for mean body mass of coyotes from various localities where adult males averaged 16% heavier than females, which was similar (17%) to this study in Webb County, Texas.

Some early reports failed to recognize differences in body mass among age classes of coyotes (Young and Jackson, 1951; Gier, 1968) but subsequent studies distinguished

TABLE 2. Mean body mass, length and skinfold thickness of territorial and transient female coyotes, Webb County, Texas, February–March 1984 and 1985.

Age (years) Social class	Body mass (kg) $\bar{x}$	Body mass (kg) SE	Body mass (kg) n	Body length (cm) $\bar{x}$	Body length (cm) SE	Body length (cm) n	Skinfold (cm) $\bar{x}$	Skinfold (cm) SE	Skinfold (cm) n
Juvenile (0.9)									
Territorial	8.1	0.3	3	80.5	2.2	3	2.4	0.0	2
Transient	8.3	0.3	8	78.7	0.8	8	3.2	0.1	6
Yearling (1.9)									
Territorial	10.1	0.5	6	79.8	2.0	6	2.7	0.2	2
Transient	9.5	0.2	17	82.4	0.6	17	3.0	0.2	8
Adult (≥2.9)									
Territorial	10.4	0.2	17	83.1	0.8	17	3.4	0.2	12
Transient	10.8	0.4	8	84.1	1.5	8	2.9	0.4	5

between mass of adults and juveniles (Meinzer and Guthery, 1980; Sterling, 1982). Mean body mass of juvenile, yearling and adult coyotes in our southern Texas population was nearly identical to mass estimates reported for similar age classes in northwestern Texas (Meinzer and Guthery, 1980).

Although juvenile coyotes had less IPF than yearlings and adults in fall, they continued growth in body length and mass and maintained similar IPF deposits overwinter. Todd and Keith (1983) also found less fat in juveniles than adult coyotes during winter in Alberta.

A decline in body condition of adults from fall to spring was documented by decreases in both body mass and indices of IPF. Among yearlings, a decline in condition overwinter was measured by a decrease in IPF but not body mass. Significant depletion of fat deposits without loss of mass suggests that fat indices may be more sensitive indicators of body condition than body mass in coyotes. However, fat indices derived from precise measurements of the fat deposits most responsive to nutritional changes would be required for the most accurate assessment of body condition of coyotes. In ungulates, the progressive sequence of fat deposition is (1) bone marrow, (2) perinephric, (3) mesenteric and (4) subcutaneous fat (Riney, 1955; Hanks, 1981). Assuming that fat deposition in carnivores is similar to ungulates, measurement of the mass of perinephric fat (Riney, 1955; Smith, 1970; Hanks, 1981) may be a precise and practical method for assessing body condition of coyotes and other carnivores.

The greatest body mass and IPF deposits, observed among adults and yearlings in fall in this coyote population, may be attributable to a diet of predominantly native fruit during the warm season (Knowlton, 1964; Brown, 1977; Andelt et al., 1987) as suggested by Lindstrom (1983) for foxes (*Vulpes vulpes*). Kruuk and Parish (1983) reported that seasonal fluctuation in body mass occurred independent of food supply in badgers (*Meles meles*) and suggested that differences in seasonal metabolic rates may have been the factor. We suspect that differential metabolic rates were associated with seasonal changes in condition because the energy demands of coyotes foraging for fruit during the warm season were probably less than for hunting mammalian prey during the cool season in southern Texas. Increased metabolic rates, and perhaps decreased foraging activity, associated with breeding activities in late-winter may have been another factor that contributed to the decline in body condition overwinter. The effect of breeding activities on overwinter decline in condition may have been reflected in differentially greater loss of body mass by adults compared with yearlings because a high proportion of yearlings did not reproduce in this high-density population (Knowlton et al., 1986; L. A. Windberg, unpubl. data). We assumed that seasonal differences in temperature had no effect on metabolic rates because Pekins and Mautz (1990) concluded that thermoregulation was probably not a major energy expenditure for coyotes.

We found no differences in body size (length), mass or fat deposits among territorial and transient females, except for a difference in fat indices of juveniles which could be an artifact of small samples. Hence the attributes that enable some coyotes to acquire and maintain territories may not be related to physical dimensions or body condition. Conversely, territorial status apparently had no effect on the opportunity to acquire adequate energy reserves in this high-density coyote population.

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