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Differences between northern and southern female coyotes

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Abstract.—The coyote (*Canis latrans*) has a wide distribution range, spanning boreal forests from the north of the continent to tropical environments in Central America, showing great adaptation and plasticity. Bergmann's rule states that individuals inhabiting colder climates are larger than those in warmer climates. It is suggested that in carnivore species, litter size is influenced by allometric constraints such as maternal body size. The aim of this study is to analyze the relations using correlation between female coyote mass, latitude, and litter size. Using data compiled from the literature, I carried out statistical analyses to correlate female body size, litter size, and latitude for coyotes across their distribution range. The results indicated a soft significant correlation between female body size and latitude, confirming Bergmann's rule. However, no significant correlation was found between litter size and latitude or between litter size and female body size; litter size in coyotes remains roughly uniform across their distribution range.

Resumen.—El coyote (*Canis latrans*) tiene un amplio rango de distribución, que abarca desde bosques boreales en el norte del continente hasta ambientes tropicales en Centroamérica, mostrando una gran adaptación y plasticidad. La regla de Bergmann establece que los individuos en climas más fríos son más grandes que los que habitan en los climas más cálidos. Se sugiere que en las especies el tamaño de la camada está influenciada por restricciones alométricas como el tamaño del cuerpo materno. El objetivo de este estudio es analizar la relación entre el peso de las hembras de coyote, la latitud y el tamaño de la camada. Utilizando datos recopilados de la literatura, llevé a cabo análisis estadísticos para correlacionar el tamaño del cuerpo de la hembra de coyote con el tamaño de la camada y la latitud en su rango de distribución. Los resultados indicaron una correlación ligeramente significativa entre el tamaño del cuerpo de las hembras y la latitud, lo que confirma la regla de Bergmann. Sin embargo, no se encontró una correlación significativa entre el tamaño de la camada y la latitud o el tamaño de la camada y el tamaño del cuerpo de las hembras. Ya que, se encontró que el tamaño de la camada en los coyotes es similar a lo largo de todo su rango de distribución.

The distribution range of a species is related to climate as well as geographic position (latitude, longitude, and elevation; Townsend Peterson et al. 2011). The species that are widespread stand out due to their adaptations to different environments and the relative ease with which they can colonize new ones. One of these adaptations is shown by a correlation between body size and temperature, a relationship known as Bergmann's rule. The relationship has been documented in multiple mammal species, with individuals from arctic and temperate regions (higher latitudes) being larger than those from equatorial regions (Bergmann 1847, Meiri and Dayan 2003, Blackburn and Hawkins 2004, Rodríguez et al. 2008).

The coyote (*Canis latrans*) is an ideal case study to test these correlations because of its continuous distribution from Alaska through Central America (Bekoff 1977, Hidalgo-Mihart et al. 2004). The expansion of the coyote's range at the north and east in North America has been associated with body size (Thurber and Peterson 1991). Nowadays, its range is advancing southward; if the coyote reaches northern South America, there are possible routes that could facilitate a rapid spread through the entire continent (Hody et al. 2019, Monroy-Vilchis et al. 2020). This wide distribution reflects the coyote's high genetic plasticity and ability to occupy various habitats, and it is associated with land use and vegetation cover changes (Gompper 2002). Female coyotes have 8 mammary glands (Hildebrand 1952), which represents the theoretical maximum number of pups per litter that could be adequately fed (Stockley and Parker

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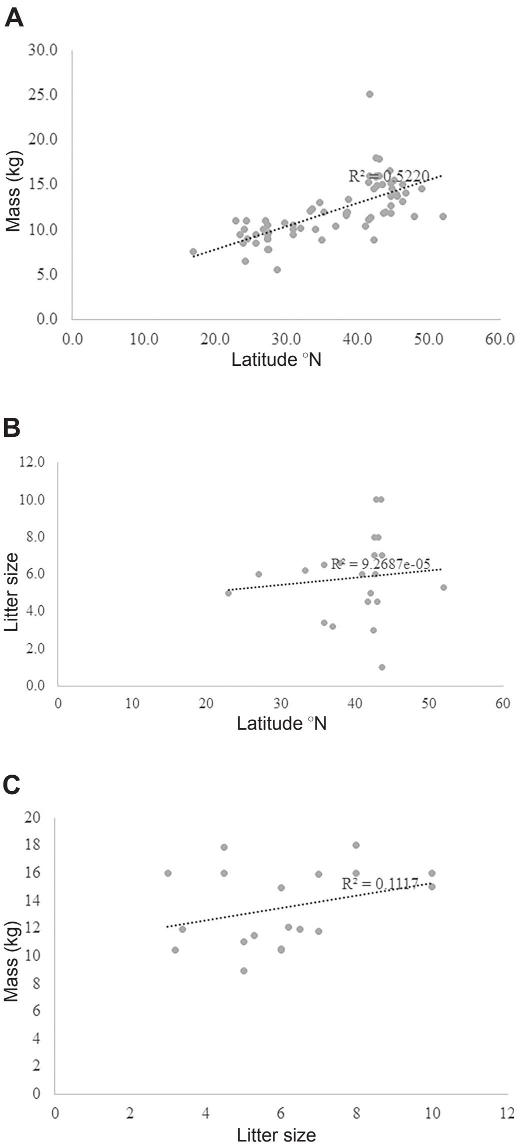

Fig. 1. Graphics for linear regression models. ***A,*** Female coyote body mass (kg) versus latitude (°N). ***B,*** Litter size (number of pups) versus latitude (°N). ***C,*** Female coyote body mass (kg) versus litter size (number of pups).

2002). Females are monoestrous, and the timing of their reproductive cycle varies across the distribution range, with no specific breeding season (Hamlett 1938, Bekoff 1977). Studying coyotes can help our understanding of the relationship between latitude, maternal size, and litter size, since data on carnivore species suggest that reproductive characteristics, such as litter size, are bounded by allometric constraints (e.g., maternal body size). The aim of this study is to analyze the correlation between female coyote mass, latitude, and litter size. The hypotheses I tested are as follows: (1) female coyotes from higher latitudes are larger in mass than those from lower latitudes; (2) heavier female coyotes have larger litter sizes; and (3) female coyotes from higher latitudes have larger litter sizes.

I compiled data on the average mass of wild female coyotes and litter size across their range through a comprehensive search of literature, the Global Biodiversity Information Facility database (GBIF 2020), and the Mammal Collection from the Centro de Investigaciones Biológicas del Noroeste, S.C. (CIBNOR). Because the usable records were limited in number, I did not restrict the data set to a specific time frame. Additionally, for each record, location was georeferenced in Google Earth Pro (https://www.google.com/intl/es-419/earth/).

To test the correlations, I used Pearson's correlation coefficient that is a coefficient of determination (R^2) with simple linear regression (Amat 2016) in the program R (R Development Core Team 2021). I examined all paired combinations of the 3 variables (female body mass, litter size, and latitude), using a significance level of $\alpha = 0.05$.

The results showed a soft (not strong) significant correlation between female body size and latitude ($r = 0.7225$, $t = 8.6178$, $P < 1.658 \times 10^{-12}$, $R^2 = 0.5220$), with the largest females occurring in higher latitudes and the smaller ones in lower regions, supporting Bergmann's rule and confirming the first hypothesis (Fig. 1A, Table 1). However, litter size was not correlated with latitude ($r = 0.0096$, $t = 0.0419$, $P < 0.967$, $R^2 = 9.2687 \times 10^{-5}$; Fig. 1B, Table 2); the most variation in litter size was observed between latitudes of 40 and 50 °N. Female body size was also not correlated with litter size ($r = 0.3343$, $t = 1.4627$, $P < 0.1618$, $R^2 = 0.1117$; Fig. 1C). The range-wide average litter size recorded so far is 5.7 pups (range 1–9; Hamlett 1938). Canids are known to have heavy litters relative to the mother's body mass (approximately 14.4% of the mother's mass; Oftedal and Gittleman 1989). In 90.5% of cases, litter size was smaller or equal to 8 (the number of mammary glands in female coyotes), but in 9.5% of the cases litter size was larger than 8. In these cases, perhaps the mortality index in the pups is higher because the

TABLE 1. Latitude and average mass of female coyotes (*Canis latrans*) across the species' North American range.

Latitude (°N)	Mass (kg)	Locality	Reference
52.0	11.5	Jasper National Park, Alberta, Canada	Bowen 1982
49.0	14.5	Ontario, Canada	Kolenosky 1971
48.0	11.5	N Minnesota, USA	Berg and Chesness 1978
46.8	14.1	SE Québec, Canada	Poullé et al. 1995
46.3	13.1	E New Brunswick, Canada	Dumond and Villard 2000
46.3	15.0	Prince Edward Island, Canada	Parker 1995
45.5	13.7	Somerset, Maine, USA	Richens and Hugie 1974
45.4	14.0	United Counties of Leeds and Grenville, Ontario, Canada	Garvey and Patterson 2014
45.2	15.5	Calais, Maine, USA	Harrison 1986
44.9	14.5	Orono, Maine, USA	Hilton 1976
44.8	11.8	Yellowstone National Park, Wyoming, USA	Crabtree and Sheldon 1999
44.7	15.2	Nova Scotia, Canada	Moore and Millar 1986
44.7	12.6	Nova Scotia, Canada	Sabean 1993
44.7	13.7	Nova Scotia, Canada	Parker 1995
44.5	16.6	Champlain Valley Region, Vermont, USA	Person 1988
44.0	11.9	Adirondacks, New York, USA	Brundige 1993
43.66	11.8	Boylston, New York, USA	GBIF 2020
43.53	15.0	Redfield, New York, USA	GBIF 2020
43.12	16.0	Cato Township, New York, USA	GBIF 2020
43.0	17.9	New Hampshire, USA	Silver and Silver 1969
42.91	16.0	Lafayette, New York, USA	GBIF 2020
42.72	15.0	Sempronius, New York, USA	GBIF 2020
42.65	18.1	Homer, New York, USA	GBIF 2020
42.65	15.9	Homer, New York, USA	GBIF 2020
42.57	16.0	Cortlandville, New York, USA	GBIF 2020
42.4	14.5	West Massachusetts, USA	Lorenz 1978
42.3	8.9	Idaho, USA	Barnum et al. 1979
41.9	11.4	Iowa, USA	Andrews and Boggess 1978
41.7	16.0	Barnstable, Cape Cod, Massachusetts, USA	Way 2000
41.7	25.1	Barnstable, Cape Cod, Massachusetts, USA	Way and Proietto 2005
41.6	11.1	Kenai, Arkansas, USA	Thurber and Peterson 1991
41.6	15.3	Rhode Island, USA	Brown et al. 1993
41.1	10.4	North Coast, California, USA	Neale et al. 1998
38.7	13.4	West Virginia, USA	Houben and Mason 2004
38.6	11.9	West Virginia, USA	Wykle 1999
38.5	11.6	Kansas, USA	Gipson and Kamler 2002
38.5	11.8	Kansas, USA	Gier 1968
37.0	10.4	California, USA	Hawthorne 1971
35.3	11.9	Oklahoma, USA	Young and Jackson 1951
35.1	8.8	Anderson Mesa, Arizona, USA	Witham 1977
34.8	13.0	Arkansas, USA	Gipson 1978
34.2	10.1	New Mexico, USA	Young and Jackson 1951
33.7	12.3	B.F. Grant Wildlife Management Area, Georgia, USA	Gates et al. 2014
33.4	12.1	Cedar Creek Wildlife Management Area, Georgia, USA	Gates et al. 2014
32.0	10.2	Tucson, Arizona, USA	Grinder and Krausman 2001
31.0	9.5	New Mexico, USA	Windberg et al. 1997
31.0	10.5	Texas, USA	Young and Jackson 1951
31.0	10.0	Sierra San Pedro Mártir, Baja California, México	Mammal Museum CIBNOR 2021
29.8	10.7	San Luis Gonzaga, Baja California, México	Mammal Museum CIBNOR 2021
28.7	5.5	Misión San Borja, Baja California, México	Mammal Museum CIBNOR 2021
27.5	7.8	Vizcaíno Biosphere Reserve, Baja California Sur, México	Mammal Museum CIBNOR 2021
27.5	9.7	Vizcaíno Biosphere Reserve, Baja California Sur, México	Mammal Museum CIBNOR 2021
27.4	9.0	Corral de Berrendos, Baja California Sur, México	Mammal Museum CIBNOR 2021
27.4	7.8	Corral de Berrendos, Baja California Sur, México	Mammal Museum CIBNOR 2021
27.4	9.5	Corral de Berrendos, Baja California Sur, México	Mammal Museum CIBNOR 2021
27.4	9.0	Corral de Berrendos, Baja California Sur, México	Mammal Museum CIBNOR 2021
27.4	10.5	Corral de Berrendos, Baja California Sur, México	Mammal Museum CIBNOR 2021

TABLE 1. Continued.

Latitude (°N)	Mass (kg)	Locality	Reference
27.4	9.0	Corral de Berrendos, Baja California Sur, México	Mammal Museum CIBNOR 2021
27.1	11.0	15 km E Bahía Asunción, Baja California Sur, México	Mammal Museum CIBNOR 2021
26.8	10.0	50 km S, 28 km W San Ignacio, Baja California Sur, México	Mammal Museum CIBNOR 2021
25.7	9.5	San Jorge, Baja California Sur, México	Mammal Museum CIBNOR 2021
25.7	8.5	San Jorge, Baja California Sur, México	Mammal Museum CIBNOR 2021
24.7	9.0	Isla Magdalena, Baja California Sur, México	Mammal Museum CIBNOR 2021
24.5	11.0	Isla Magdalena, Baja California Sur, México	Mammal Museum CIBNOR 2021
24.3	6.5	Km 76 carretera Transpeninsular, Baja California Sur, México	Mammal Museum CIBNOR 2021
24.1	10.0	El Comitán, Baja California Sur, México	Mammal Museum CIBNOR 2021
23.9	8.5	San Pedro, Baja California Sur, México	Mammal Museum CIBNOR 2021
23.5	9.5	Santiago, Baja California Sur, México	Mammal Museum CIBNOR 2021
23.0	11.0	La Michilía Biosphere Reserve, Durango, México	Servín 2000
17.0	7.5	Santa Catarina Ixtepeji, Oaxaca, México	Monroy-Gamboa 2007

TABLE 2. Latitude, average litter size per female coyote, and season when data were collected across the species' North American range. N/D = no data.

Latitude (°N)	Litter size	Season	Locality	Reference
52.00	5.3	N/D	Alberta, Canada	Nellis and Keith 1976
43.66	7.0	Winter	Boylston, New York, USA	GBIF 2020
43.66	1.0	Winter	Boylston, New York, USA	GBIF 2020
43.53	10.0	Winter	Redfield, New York, USA	GBIF 2020
43.12	8.0	Winter	Cato Township, New York, USA	GBIF 2020
43.00	4.5	N/D	National Elk Refuge, Jackson, Wyoming, USA	Camenzind 1978
42.91	10.0	Autumn	Lafayette, New York, USA	GBIF 2020
42.72	6.0	Autumn	Sempronius, New York, USA	GBIF 2020
42.65	8.0	Winter	Homer, New York, USA	GBIF 2020
42.65	7.0	Winter	Homer, New York, USA	GBIF 2020
42.57	3.0	Spring	Cortlandville, New York, USA	GBIF 2020
42.10	5.0	Spring	Greater Chicago Metropolitan Area, Illinois, USA	Hennessy et al. 2012
41.70	4.5	Spring	Barnstable Cape Cod, Massachusetts, USA	Way et al. 2001
38.03	6.6	Spring	Sierra Nevada, California, USA	Sacks 2005
41.00	6.0	N/D	Iowa, USA	Andrews and Boggess 1978
37.00	3.2	N/D	SE Colorado, USA	Gese et al. 1989
35.90	3.4	N/D	Gibson and Carroll Counties, Tennessee, USA	Stephenson and Kennedy 1993
35.90	6.5	N/D	Tennessee, USA	Kennedy et al. 1990
33.30	6.2	N/D	Barnwell, Allendale, South Carolina, USA	Kilgo et al. 2017
27.00	6.0	N/D	Webb County, Texas, USA	Knowlton et al. 1999
23.00	5.0	Summer	La Michilía Biosphere Reserve, Durango, México	Servín 2000

pups do not obtain enough maternal milk. The findings of Asdell (1964), that an average of 6.23 embryos were produced across a sample of 1370 cases, strengthen the previous statement.

Hypotheses 2 and 3 were rejected at this geographic scale. No significant correlation was found between litter size and female body size or between litter size and latitude, although smaller females apparently had smaller litter sizes. There is a high possibility that significant correlations might emerge with the incorporation of more data.

The great genetic plasticity that allows coyotes to occur in a wide variety of habitats and climates does not seem to affect reproductive aspects. Litter size data from the same latitude were recorded at different seasons of the year, which implies seasonally different available food and prey (Table 2). Thus, variations in litter size might rather be related to food availability in different environments (Gier 1975, Gompper 2002). Potential prey and carrion that coyotes feed on in temperate regions are (or come from) larger animals than found in the tropics (Bekoff and Wells 1980). The results of the present study indicated that there is not a significant correlation of latitude with litter size, so my results imply that having larger available prey does not translate into more pups. Breeding female coyotes need about 900 g of additional food per day, compared to nonbreeding females (Gier 1975). Another important variable is that the predator control programs in the USA showed little success, because in the long term, coyote populations increased instead of decreased; the response of female coyotes to predator control was to produce larger litter sizes (Knowlton 1972, Gompper 2002). So, there are exogenous factors (e.g., predator control programs, land use and vegetation cover change, quality and availability of food and prey) and endogenous factors (e.g., genetic information, hybridization) that influence litter size in coyotes apart from the environment (climate) and the mother's size (McNab 1989, Thurber and Peterson 1991).

In terms of ecosystem conservation and management, the litter size of coyotes does not vary significantly across their distribution range or with female body size.

Because coyotes are expanding their distribution range, adequate strategies should be promoted to improve ecological monitoring of coyote colonization in South America in order to describe the changes that occur in those animal communities and ecosystems. This monitoring would provide important information that, at present, is poorly known.

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LITERATURE CITED

AMAT, R.J. 2016. Correlación lineal y regresión lineal simple. https://www.cienciadedatos.net/documentos/24_correlacion_y_regresion_lineal

ANDREWS, R.D., AND E.K. BOGGESS. 1978. Ecology of coyotes. Pages 251–268 *in* M. Bekoff, editor, Coyotes: biology, behavior and management. Academic Press, New York, NY.

ASDELL, S.A. 1964. Patterns of mammalian reproduction. Cornell University Press, Ithaca, NY.

BARNUM, D.A., J.S. GREEN, AND J.T. FLINDERS. 1979. Nutritional levels and growth rates of hand-reared coyote pups. Journal of Mammalogy 60:820–823.

BEKOFF, M. 1977. *Canis latrans*. Mammalian Species 79:1–9.

BEKOFF, M., AND M.C. WELLS. 1980. The social ecology of coyotes. Scientific American 242:130–148.

BERG, W.E., AND R.A. CHESNESS. 1978. Ecology of coyotes in northern Minnesota. Pages 229–247 *in* M. Bekoff, editor, Coyotes: biology, behavior and management. Academic Press, New York, NY.

BERGMANN, C. 1847. Über die Verhältnisse der Wärmeökonomie der Thiere zu ihrer Grösse. Gottinger Studien, Germany.

BLACKBURN, T.M., AND B.A. HAWKINS. 2004. Bergmann's rule and the mammal fauna of northern North America. Ecography 27:715–724.

BOWEN, W.D. 1982. Home range and spatial organization of coyotes in Jasper National Park, Alberta. Journal of Wildlife Management 46:201–216.

BROWN, J.H., P.A. MARQUET, AND M.D. TAPER. 1993. Evolution of body size: consequences of an energetic definition of fitness. American Naturalist 142:573–584.

BRUNDIGE, G.C. 1993. Predation ecology of eastern coyote, *Canis latrans* var., in the Adirondacks, New York. Doctoral dissertation, State University of New York, Syracuse, NY.

CAMENZIND, F.J. 1978. Behavioral ecology of coyotes on the National Elk Refuge, Jackson, Wyoming. Pages 267–296 *in* M. Bekoff, editor, Coyotes: biology, behavior and management. Academic Press, New York, NY.

CRABTREE, R.L., AND J.W. SHELDON. 1999. The ecological role of coyotes on Yellowstone's Northern Range. Yellowstone Science 7:15–24.

DUMOND, M., AND M.A. VILLARD. 2000. Demography and body condition of coyotes (*Canis latrans*) in eastern New Brunswick. Canadian Journal of Zoology 78:399–406.

GARVEY, M.E., AND B.R. PATTERSON. 2014. Evaluation of cable restraints to live-capture coyotes (*Canis latrans*) in southern Ontario, Canada. Canadian Wildlife Biology and Management 3:22–29.

GATES, M., R.W. GERHOLD, R.P. WILKES, W.D. GULSBY, L. MAESTAS, A. ROSYPAL, K.V. MILLER, AND D.L.

MILLER. 2014. Parasitology, virology, and serology of free-ranging coyotes (*Canis latrans*) from central Georgia, USA. Journal of Wildlife Diseases 50:896–901.

GESE, E.M., O.J. RONGSTAD, AND W.R. MYTTON. 1989. Population dynamics of coyotes in southeastern Colorado. Journal of Wildlife Management 53:174–181.

GIER, H.T. 1968. Coyotes in Kansas. Kansas State College Agriculture Experimental Station Bulletin No. 393. Kansas State University of Agriculture and Applied Science, Agricultural Experiment Station, Manhattan, KS. 118 pp.

GIER, H.T. 1975. Ecology and social behavior of the coyote. Pages 247–262 *in* M.V. Fox, editor, The wild canids. Van Nostrand Reinhold, New York, NY.

GIPSON, P.S. 1978. Coyotes and related *Canis* in southeastern United States with a comment on Mexican and Central American *Canis*. Pages 199–208 *in* M. Bekoff, editor, Coyotes: biology, behavior and management, Academic Press, New York, NY.

GIPSON, P.S., AND J.F. KAMLER. 2002. Bobcat killed by a coyote. Southwestern Naturalist 47:511–513.

[GBIF] GLOBAL BIODIVERSITY INFORMATION FACILITY. 2020. GBIF occurrence download. https://doi.org/10.15468/dl.29xcub

GOMPPER, M.E. 2002. The ecology of northeast coyotes. Current knowledge and priorities for future research. WCS Working Paper 17. Wildlife Conservation Society, Bronx, NY.

GRINDER, M., AND P.R. KRAUSMAN. 2001. Morbidity-mortality factors and survival of an urban coyote population in Arizona. Journal of Wildlife Diseases 37:312–317.

HAMLETT, G.W.D. 1938. The reproductive cycle of the coyote. Technical Bulletins of the USDA–ERS No. 616. U.S. Department of Agriculture, Washington, DC. 12 pp.

HARRISON, D.J. 1986. Coyotes in the northeast. Appalachia 182:30–39.

HAWTHORNE, V.M. 1971. Coyote movements in Sagehen Creek Basin, northeastern California. California Fish and Game 57:154–161.

HENNESSY, C.A., J. DUBACH, AND S.D. GEHRT. 2012. Long-term pair bonding and genetic evidence of monogamy among urban coyotes (*Canis latrans*). Journal of Mammalogy 93:732–742.

HIDALGO-MIHART, M.G., L. CANTÚ-SALAZAR, A. GONZÁLEZ-ROMERO, AND C.A. LÓPEZ-GONZÁLEZ. 2004. Historical and present distribution of coyote (*Canis latrans*) in Mexico and Central America. Journal of Biogeography 31:2025–2038.

HILDEBRAND, M. 1952. The integument in Canidae. Journal of Mammalogy 33:419–428.

HILTON, H. 1976. The physical characteristics, taxonomic status, and food habits of the eastern coyote in Maine. Master's thesis, University of Maine, Orono, ME.

HODY, A.W., R. MORENO, N.F.V. MEYER, K. PACIFICI, AND R. KAYS. 2019. Canid collision—expanding populations of coyotes (*Canis latans*) and crab-eating foxes (*Cerdocyon thous*) meet up in Panama. Journal of Mammalogy 100:1819–1830.

HOUBEN, J.M., AND J.R. MASON. 2004. Weight and age of coyotes captured in Virginia, USA. Pages 75–76 *in* R.M. Timm and W.P. Gorenzel, editors, Proceedings of the 21st Vertebrate Pest Conference. University of California, Davis, CA. https://digitalcommons.unl.edu/icwdm_usdanwrc/365

KENNEDY, M.L., J.G. BABB, R.M. LEE, AND C. LYEDARD. 1990. Average litter size of the coyote in Tennessee. Journal of the Tennessee Academy of Science 65:61–62.

KILGO, J.C., C.E. SHAW, M. VUKOVICH, M.J. CONROY, AND C. RUTH. 2017. Reproductive characteristics of a coyote population before and during exploitation. Journal of Wildlife Management 81:1386–1393.

KNOWLTON, F.F. 1972. Preliminary interpretations of coyote population mechanics with some management implications. Journal of Wildlife Management 36: 369–382.

KNOWLTON, F.F., E.M. GESE, AND M.M. JAEGER. 1999. Coyote depredation control: an interface between biology and management. Journal of Range Management 52:398–412.

KOLENOSKY, G.B. 1971. Hybridization between wolf and coyote. Journal of Mammalogy 52:446–449.

LORENZ, J.R. 1978. Physical characteristics, movement, and population estimate of the eastern coyote in New England. Master's thesis, University of Massachussets, Amherst, MA.

MAMMAL MUSEUM CIBNOR. 2021. Data from specimens of *Canis latrans*. Centro de Investigaciones Biológicas del Noroeste, S.C., México.

MCNAB, B.K. 1989. Basal rate of metabolism, body size, and food habits in the order Carnivora. Pages 335–354 *in* J.L. Gittleman, editor, Carnivore behavior, ecology, and evolution. Cornell University Press, New York, NY.

MEIRI, S., AND T. DAYAN. 2003. On the validity of Bergmann's rule. Journal of Biogeography 30:331–351.

MONROY-GAMBOA, A.G. 2007. Ámbito hogareño y uso de hábitat del coyote (*Canis latrans cagottis*) en un área comunal protegida de la Sierra Madre de Oaxaca, México. Master's thesis, CIIDIR-Oaxaca-IPN, Oaxaca, México.

MONROY-VILCHIS, O., J.F. GONZÁLEZ-MAYA, Á. BALBUENA-SERRANO, F. ELVIR, M.M. ZARCO-GONZÁLEZ, AND C. RODRÍGUEZ-SOTO. 2020. Coyote (*Canis latrans*) in South America: potential routes of colonization. Integrative Zoology 15:471–481.

MOORE, G.C., AND J.S. MILLAR. 1986. Food habits and average weights of a fall winter sample of eastern coyotes, *Canis latrans*. Canadian Field-Naturalist 100:105–106.

NEALE, J.C.C., B.N. SACKS, M.M. JAEGER, AND D.R. MCCULLOUGH. 1998. A comparison of bobcat and coyote predation on lambs in north-coastal California. Journal of Wildlife Management 62:700–706.

NELLIS, C.H., AND L.B. KEITH. 1976. Population dynamics of coyotes in central Alberta, 1964–1968. Journal of Wildlife Management 40:389–399.

OFTEDAL, O.T., AND J.L. GITTLEMAN. 1989. Patterns of energy output during reproduction of carnivores. Pages 355–378 *in* J.L. Gittleman, editors, Carnivore behavior, ecology, and evolution. Cornell University Press, Ithaca, NY.

PARKER, G.R. 1995. Eastern coyote: the story of its success. Nimbus Publishing, Halifax, NS.

PERSON, D.K. 1988. Home range, activity, habitat use, and food habits of eastern coyotes in the Champlain Valley Region of Vermont. Master's thesis, University of Vermont, Burlington, VT.

POULLÉ, M.L., M. CRÊTE, AND J. HUOT. 1995. Seasonal variation in body mass and composition of eastern coyotes. Canadian Journal of Zoology 73:1625–1633.

R DEVELOPMENT CORE TEAM. 2021. R: a language and environment for statistical computing 4.0.4. R Foundation for Statistical Computing. https://www.r-project.com

RICHENS, V.B., AND R.D. HUGIE. 1974. Distribution, taxonomic status, and characteristics of coyotes in Maine. Journal of Wildlife Management 38:447–454.

RODRÍGUEZ, M.A., M.A. OLALLA-TÁRRAGA, AND B.A. HAWKINS. 2008. Bergmann's rule and the geography of mammal body size in the western hemisphere. Global Ecology and Biogeography 17:274–283.

SABEAN, B. 1993. Coyote carcass collections. Nova Scotia Trappers Newsletter 29:10.

SACKS, B.N. 2005. Reproduction and body condition of California coyotes (*Canis latrans*). Journal of Mammalogy 86:1036–1041.

SERVÍN, J. 2000. Ecología conductual del coyote en el sureste de Durango. Doctoral dissertation, Universidad Nacional Autónoma de México, Ciudad de México, Mexico.

SILVER, H., AND W.T. SILVER. 1969. Growth and behavior of the coyote-like canid of northern New England with observations on canid hybrids. Wildlife Monographs 17:1–41.

STEPHENSON, S.W., AND M.L. KENNEDY. 1993. Demography of a coyote population in western Tennessee. Journal of the Tennessee Academy of Science 68: 122–124.

STOCKLEY, P., AND G.A. PARKER. 2002. Life history consequences of mammal sibling rivalry. Proceedings of the National Academy of Sciences of the United States of America 99:12932–12937.

THURBER, J.M., AND R.O. PETERSON. 1991. Changes in body size associated with range expansion in the coyote (*Canis latrans*). Journal of Mammalogy 72: 750–755.

TOWNSEND PETERSON, A., J. SOBERÓN, R.G. PEARSON, R.P. ANDERSON, E. MARTÍNEZ-MEYER, M. NAKAMURA, AND M. BASTOS-ARAÚJO. 2011. Ecological niches and geographic distributions (MPB-49). Princeton University Press, Princeton, NJ.

WAY, J.G. 2000. Ecology of Cape Cod coyotes (*Canis latrans* var.). Master's thesis, University of Connecticut, Storrs, CT.

WAY, J.G., P.J. AUGER, I.M. ORTEGA, AND E.S. STRAUSS. 2001. Eastern coyote denning behavior in an anthropogenic environment. Northeast Wildlife 56:18–30.

WAY, J.G., AND R.L. PROIETTO. 2005. Record size female coyote, *Canis latrans*. Canadian Field-Naturalist 119: 139–140.

WINDBERG, L.A., S.M. EBBERT, AND B.T. KELLY. 1997. Population characteristics of coyotes (*Canis latrans*) in the northern Chihuahuan Desert of New Mexico. American Midland Naturalist 138:197–207.

WITHAM, J.H. 1977. Movement and spacing patterns of female coyotes near Anderson Mesa, Arizona. Master's thesis, Northern Arizona University, Flagstaff, AZ.

WYKLE, J. 1999. The status of the coyote *Canis latrans* in West Virginia. Master's thesis, Marshall University, Huntington, WV.

YOUNG, S.P., AND H.H.T. JACKSON. 1951. The clever coyote. Stackpole Company, Harrisburg, PA.

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