

DISTRIBUTION AND TAXONOMIC AFFINITIES OF MULE DEER, *ODOCOILEUS HEMIONUS*, FROM ANZA-BORREGO DESERT STATE PARK, CALIFORNIA ¹

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The distribution and taxonomic status of mule deer, *Odocoileus hemionus*, from Anza-Borrego Desert State Park, California and vicinity are re-evaluated using cranial morphometrics and field observations. Evidence is presented suggesting deer from this broad, arid region are intergrades between southern mule deer and burro deer. The distribution of these intergrades is delineated with respect to the ranges of southern mule deer and burro deer. The possible origin of this population is discussed in an evolutionary context, and those factors which may contribute to intergradation between burro deer and southern mule deer are explored.

INTRODUCTION

The distribution and taxonomy of the subspecies of mule deer, *Odocoileus hemionus*, in California have been detailed by numerous authors (Hall 1927; Grinell 1933; Sheldon 1933; Dixon 1934; Cowan 1936, 1956; Longhurst, Leopold, and Dasmann 1952; Hall and Kelson 1959; Hoffmeister 1962; and Dasmann 1965). Their range maps show either a conspicuous absence of deer from a broad, arid corridor in eastern San Diego and western Imperial counties, or suggest that southern mule deer, *O. h. fuliginatus*, inhabit this region. Within this area lies Anza-Borrego Desert State Park, encompassing over 200,000 ha and spanning portions of San Diego, Riverside, and Imperial counties. Coastal and montane areas west of this region are inhabited by southern mule deer, whereas burro deer, *O. h. eremicus*, occupy desert regions to the east. Hoffmeister (1962) synonymized *eremicus* with *crooki*, but his rationale for this was not compelling; thus we retain Cowan's (1936, 1956) designation of *eremicus* for burro deer. Burro deer are distinguished from southern mule deer by their larger body size, ears, and rump patch, and by the darker pelage and black dorsal stripe of southern mule deer (Hall 1927, McLean 1930, Longhurst and Chattin 1941, and Cowan 1956). Cowan (1936, 1956) and Longhurst and Chattin (1941) provide additional characteristics which allow differentiation between these subspecies.

While conducting surveys of springs in the State Park and its vicinity, we observed numerous deer that did not conform to morphological descriptions of southern mule deer or burro deer provided by Cowan (1936, 1956) and Longhurst and Chattin (1941). The purpose of this paper is to provide information

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on the distribution of these desert deer and to comment on their probable taxonomic affinities.

METHODS

Four skulls of adult male deer from the State Park were examined. One skull (ABDSP 662-I-143) was recovered from Chuckwalla Wash, San Diego County. The other skulls (ABDSP 662-X-56, 662-X-57, and 662-X-71) were found within the Park, but more precise locality data were unavailable. Cranial measurements were recorded in the manner described by Cowan (1936).

Locality data, written physical descriptions, and photographs of deer observed by the authors were collected from June 1976 through August 1979. Additionally, we made field observations of southern mule deer in the Cuyamaca Mountains of San Diego County and burro deer in eastern Imperial County to compare with deer seen in the State Park.

RESULTS

Deer distinct in appearance from southern mule deer and burro deer were observed at 13 localities in and around the State Park (Figure 1). These deer possessed ears, rump patches, and bodies that appeared intermediate in size between the smaller southern mule deer and larger burro deer. The pelage was lighter than the sooty-colored coats of southern mule deer, and the antlers were wide and diverging like those of burro deer (Longhurst and Chattin 1941:3), but the antlers of State Park deer appeared smaller in overall size.

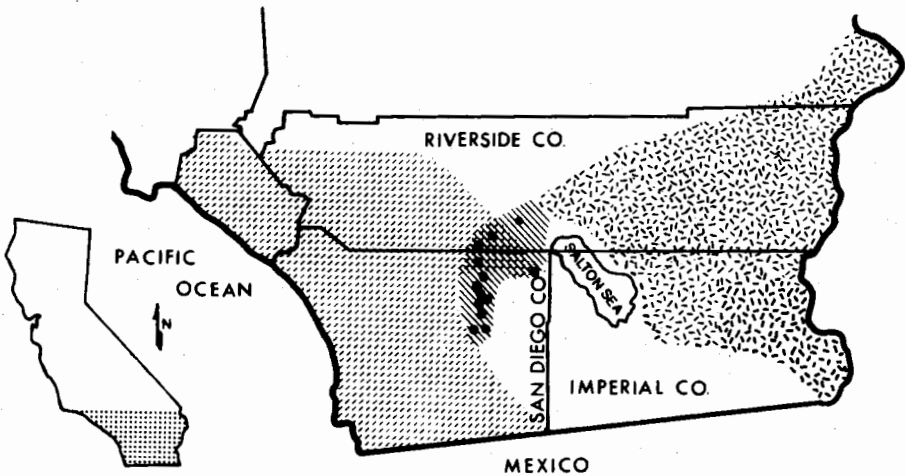


FIGURE 1. Probable zone of intergradation (continuous diagonal lines) between the published ranges of southern mule deer (broken diagonal lines) and burro deer (hatching). Dots indicate sightings of mule deer from Anza-Borrego Desert State Park, California.

Those characteristics that Cowan (1936) suggested were the most diagnostic for differentiating subspecies of mule deer were used to compare deer skulls from the State Park with those of southern mule deer and burro deer. Cranial measurements of skulls from the Park (Table 1) fell between those for southern mule deer and burro deer in eight of ten cranial characteristics (Figure 2). A Friedman two-way analysis of variance (Siegel 1956) showed this pattern to be highly significant ($\chi^2 = 15.7, P < 0.001, 2 \text{ d.f.}$).

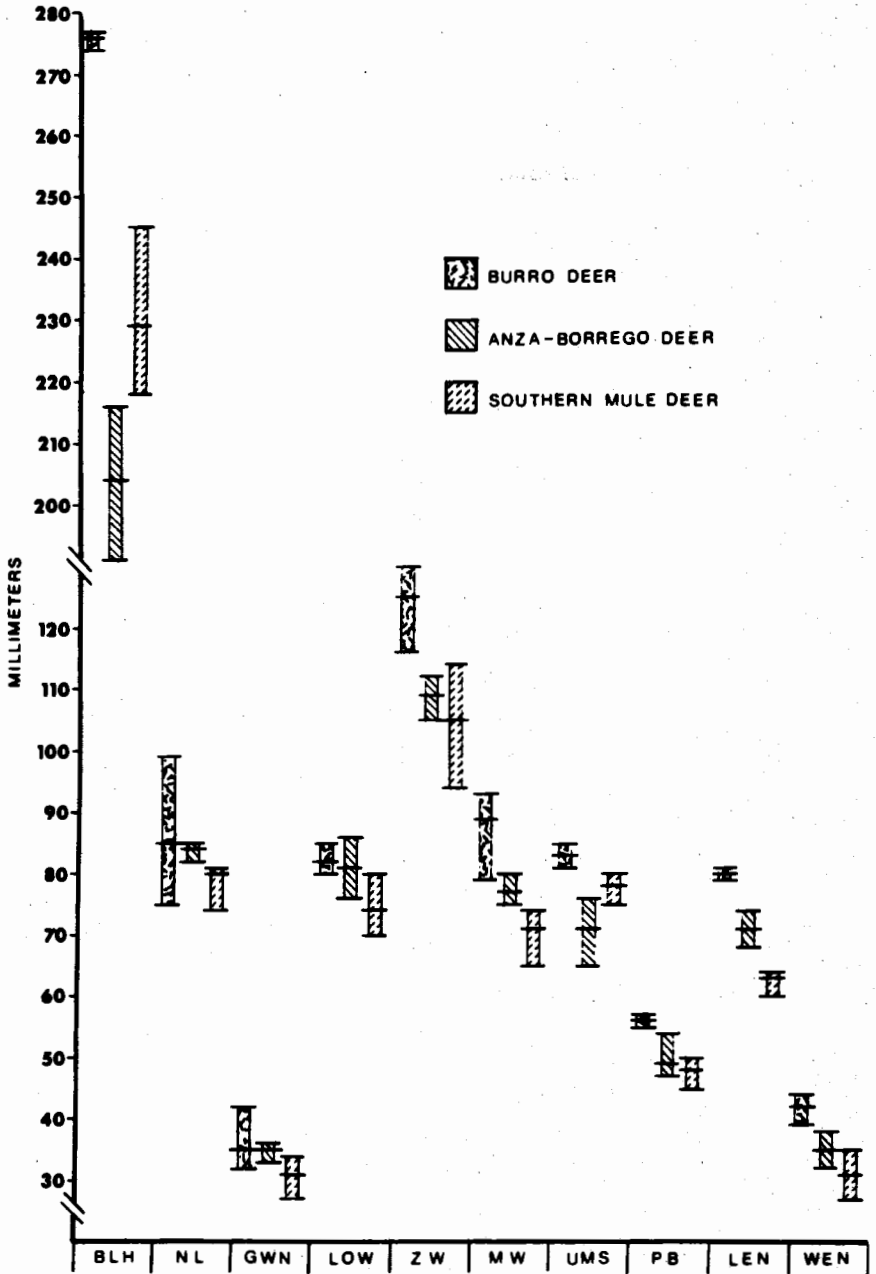


FIGURE 2. Comparisons of means and ranges for selected measurements for mule deer from Anza-Borrego Desert State Park, burro deer, and southern mule deer. Data for southern mule deer and burro deer are from Cowan (1936). BLH = Basilar length of Hensel; NL = Nasal length; GWN = Greatest width of nasals; LOW = Least orbital width; ZW = Zygomatic width; MW = Mastoid width; PB = Palatal breadth; WEN = Width external nares; LEN = Length external nares; UMS = Length of upper molar series.

Ninety ratios between paired combinations of 10 cranial measurements also were considered. Forty-seven percent of skull measurement ratios from the Park were closer to those of southern mule deer, 47% were closer to burro deer, and 6% were midway between the two subspecies.

TABLE 1. Skull Measurements of Adult (2 yrs +) Male Deer from Anza-Borrego Desert State Park, California

MEASUREMENT (mm)	MEAN	SD	RANGE	N
Basilar length of hensenl	204	10.3	191-216	3
Nasal length.....	84	1.6	82-85	2
Greatest width of nasals	35	1.3	33-36	3
Least width of nasals	24	1.6	22-26	3
Least orbital width	81	3.8	76-86	4
Zygomatic width.....	109	2.6	105-112	4
Mastoid width.....	77	2.1	75-80	4
Maxillary width	84	2.9	81-88	3
Palatal breadth	49	3.3	47-54	3
Post-palatal width.....	29	1.0	28-30	2
Width external nares	35	2.5	32-38	3
Elevation of rostrum.....	50	1.6	48-51	2
Length of external nares	71	2.5	68-74	3
Upper molar series.....	71	4.5	65-76	3

DISCUSSION

Qualitative differences in the appearance of deer in the field, intermediate cranial measurements, and medial ratios derived from these measures suggest that deer from Anza-Borrego Desert State Park and vicinity cannot be assigned confidently to either *O. h. fuliginatus* or *O. h. eremicus*. Subspeciation in the corridor between the ranges of southern mule deer and burro deer would require substantial barriers to gene flow and habitats dissimilar enough for natural selection to favor the evolution of differing morphological adaptations; no evidence for these exist. Moreover, the overlap in the ranges of many skull measurements (Figure 2) suggests much of the variation is clinal, and that total genetic isolation did not occur. The most tenable hypothesis is that deer from the region of the State Park are intergrades between southern mule deer and burro deer.

Cowan (1936) speculated that burro deer and southern mule deer may interbreed in eastern San Diego County; however, he offered no evidence to substantiate this contention and failed to indicate the areas on his range map. Longhurst and Chattin (1941) suggested the possibility of intergradation between *eremicus* and other subspecies of deer along zones of contact, but they did not elaborate on the locations of these areas. Similarly, Hoffmeister (1962) noted that *crooki* (= *eremicus*) interbred with *fuliginatus*, but his range map clearly shows their distributions as noncontiguous. Hall and Kelson (1959) closed the gap between the distribution of burro deer and southern mule deer but provided no rationale for depicting the ranges of these subspecies as being contiguous. Finally, Cowan (1936) suggested that the Santa Rosa Mountains, at the Riverside-San Diego county line, were occupied by southern mule deer. Hall's (1927) range maps, however, indicate that burrow deer inhabit the southern terminus of that range, which is within the Park. Field observations suggest that some deer from the southern Santa Rosa Mountains are similar in appearance to others we encoun-

tered in the vicinity of the State Park, and we hypothesize that these deer may be intergrades, also.

The area of intergradation between southern mule deer and burro deer is extensive (Figure 1), and depicting their ranges as contiguous over so large an area is biologically unrealistic. Thus, we suggest that future range maps of mule deer subspecies show the area defined in Figure 1 as a zone of probable southern mule deer-burro deer intergradation. Obviously, the data presented in Figure 1 are incomplete, because we have limited information for western Imperial County. We hope, however, that this paper will stimulate further investigations into the distribution and taxonomic status of deer from the deserts of southern California.

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