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THE TAXONOMIC STATUS OF WILD CANIS (CANIDAE) IN THE SOUTH CENTRAL UNITED STATES

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ABSTRACT. The relationship based on skull morphology of populations known as *Canis latrans* and *C. niger* in Arkansas, Louisiana, Oklahoma and Texas is considered. Available evidence indicates that *C. niger* has become extinct except in isolated areas of Louisiana. Elsewhere, *C. latrans* has replaced *C. niger* as a primary predator. Probable previous hybridization between *C. latrans* and *C. niger* is discussed.

INTRODUCTION

Two species of wild canines, red wolves, (*Canis niger*) and coyotes (*C. latrans*) have been reported in recent years from Arkansas (Sealander, 1956), Louisiana (Lowery, 1943), eastern Oklahoma (Blair, 1939; McCarley, 1952) and eastern Texas (McCarley, 1959). Both species, as presently defined, show a considerable amount of geographic variation and morphological overlap of both skeletal and pelage characteristics. Considerable confusion exists in species identification in areas where both may occur. This paper is an analysis of the relationship that currently exists between coyotes and red wolves in the south central United States (Arkansas, Louisiana, Oklahoma and Texas) based largely on skull morphology.

The study of variation in red wolves by Young and Goldman (1944), resulted in the naming of three subspecies of red wolves, largely on the basis of size. The largest of the subspecies, *Canis n. niger* (Bartram) has a geographic range in the southeastern United States east of the Mississippi River. This form is now presumed to be extinct and, because its range is beyond the confines of the present study, will not be considered further. The smallest of the red wolf populations was assigned to the subspecies *C. n. rufus* Audubon and Bachman with a geographic range in central Texas, central Oklahoma and northwestern Arkansas. A form described as *C. n. gregoryi* Goldman has been characterized as intermediate in size between *niger* and *rufus* and has a geographic range between that of *niger* and *rufus*, i.e., the area eastward from eastern Oklahoma and Texas to the Mississippi River and thence northward into Illinois and Indiana. Thus a west to east cline of increase in size is apparent.

Only one recognized form of coyote (*Canis latrans frustror* Woodhouse) has been recorded from the geographic area under consideration (Young and Jackson, 1951; Hall and Kelson, 1959). This, the largest of the coyote forms, has a range generally sympatric with *C. n. rufus* and overlaps the range of *C. n. gregoryi* near the eastern borders of Oklahoma and Texas.

The two species under consideration are morphologically quite similar and have been distinguished largely on the basis of size. This similarity of size is particularly true of *Canis n. rufus* and *C. l. frustror*. Young and Goldman (1944) stated the problem well: "There appear to be no . . . dependable characters distinguishing in all cases small specimens of *rufus* from large ones of the coyote." At various times workers in canid taxonomy have proposed characters or combinations of characters of reputed value in separating the two forms, e.g., skull size (Young and Goldman, 1944), size of canines and spacing of premolars (Young and Jackson, 1951), index of ratio of palatal width and upper molar tooth row (Howard, 1949), and hind foot length (Hall and Kelson, 1959). All of these criteria were tested using skulls and/or specimens of animals previously identified as one species or the other. With the exception of overall skull size, all these criteria produced results so inconsistent that they had little value in distinguishing *C. n. rufus* and *C. latrans frustror*.

The problem of separating *C. l. frustror* from *C. n. rufus* is further complicated by the situation regarding the holotypes. The holotype of *frustror* is a young male (about four months old) and includes the skin only. No type specimen has been designated for *rufus* although Goldman (1937) restricted the name to canid populations occurring 15 miles west of Austin, Texas.

METHODS

One hundred and seventeen adult skulls of recent origin (since approximately 1948) were examined and measured. The following measurements were made of each skull: (1) greatest length of skull, (2) condylobasal length, (3) zygomatic breadth, (4) squamosal constriction, (5) width of rostrum, (6) interorbital breadth, (7) length of maxillary tooth row, (8) upper carnassial length, (9) lower carnassial length, (10) space between 2nd and 3rd upper premolars, and (11) space between 2nd and 3rd lower premolars.

In addition to the skulls mentioned above, 17 skulls of *C. n. rufus* and 8 skulls of *C. n. gregoryi* that were used by Goldman (Young and Goldman, 1944) for his monograph of the species were examined, re-

measured, and used for subjective comparisons. Two hundred and twenty-one additional skulls and/or carcasses of coyotes were examined, but not measured. Examination of the latter specimens was possible because of the practice of trappers and other predator control workers of hanging the carcasses of killed animals on fence posts by the sides of highways throughout eastern Oklahoma and Texas. When these carcasses were noted they were usually examined on the spot, and unless there was some individual, or some skull, of which the species identity was in doubt, the carcasses were left as found. This selectivity biased the data derived from the 117 measured skulls in favor of the larger skulls.

DATA

Analysis of all measurements showed that there was a gradation in size from the smallest to the largest skulls of presumed specimens of *niger* and *latrans*. On the basis of size, the largest skulls were assignable to *C. n. gregoryi*. The smallest skulls were obviously assignable to *C. latrans frustror*. A considerable number of skulls, however, were intermediate in size and not easily assignable to either species. Identification of these intermediate sized skulls constituted the main problem of this study. The majority of the skulls examined were of unknown sex. Consequently, it was necessary to treat both sexes together with full recognition that males generally exceeded females in size in both species. For convenience, and to have an adequate series in each case to analyze statistically, skulls from several different localities were grouped together. Due consideration in those groupings was given not only to geographic distribution, but also to ecologic distribution mainly on the basis of biotic districts.

Figures 1 and 2 represent an approach (Hubbs and Hubbs, 1953) to the problem of distinguishing red wolves and coyotes using skull length and zygomatic breadth as indicators of size. The measurements used for *Canis n. gregoryi* and *C. n. rufus* were taken from the measurements of Young and Goldman (1944) unless otherwise noted. It can be seen that there was a marked similarity in relationship for both characters for each of the populations from different areas. (The majority of the skulls from Atoka County, Oklahoma, had broken zygomata and were not included in Figure 2.) The pattern exhibited in Figures 1 and 2 was also true of all other cranial features studied. Because skull length and zygomatic breadth were the best indicators of size, comparison of these two characters was deemed the most significant for distinguishing coyotes and wolves.

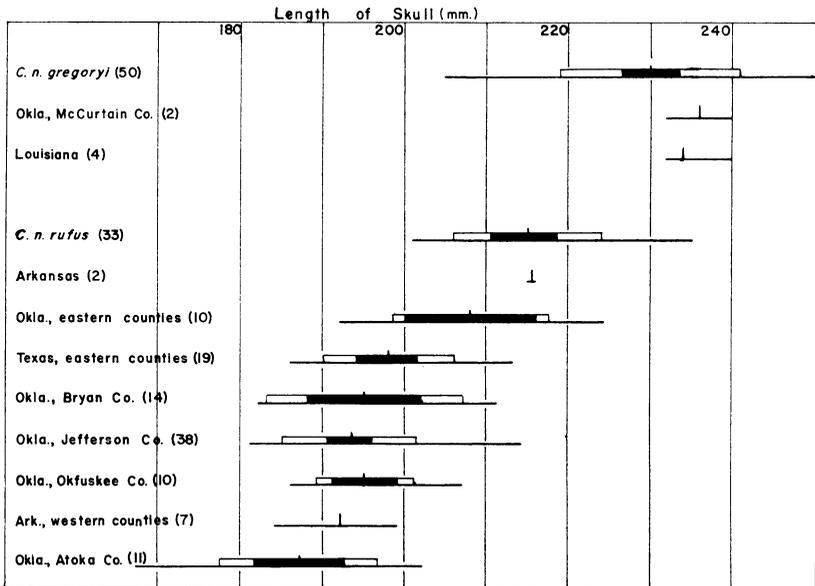


Fig. 1. Variation of total length of skull of populations of wild *Canis* from the southeastern United States. For each locality the range of variation is shown by a heavy horizontal line: the mean by a small narrow vertical line. The blackened part of each bar comprises two standard errors of the mean on either side of the mean and indicate reliability. One-half of each black bar plus the white bar at either end outline one standard deviation on either side of mean (Hubbs and Hubbs, 1953).

There was a statistical difference (a difference exceeding two standard errors of the means of two samples was considered to indicate a difference of statistical reliability) in skull length and zygomatic breadth between skulls identified as *C. n. gregoryi* and all other populations identified as *C. n. rufus* and *C. l. frustror*, at least as the *C. niger* populations existed from about 1900 to 1925, which was the inclusive dates on most of the skulls utilized by Goldman and used in this study to establish the range of variation for each subspecies of red wolf.

Using the criteria of skull length and zygomatic breadth, one badly broken and four complete skulls from LaSalle, Madison, and Terrebonne Parishes, Louisiana (L.S.U. Museum of Zoology) collected from 1935 to 1957, and two skulls from McCurtain County, Oklahoma, (Univ. of Ark., Dept. of Zoology) collected in 1936, were referable to *C. n. gregoryi* (Figures 1 and 2). Using the same criteria, two skulls from Arkansas (Stone County, 1936; and locality unknown, 1949), (Univ. of Ark., Dept. of Zoology), were referable to *C. n. rufus* (Figures 1 and 2).

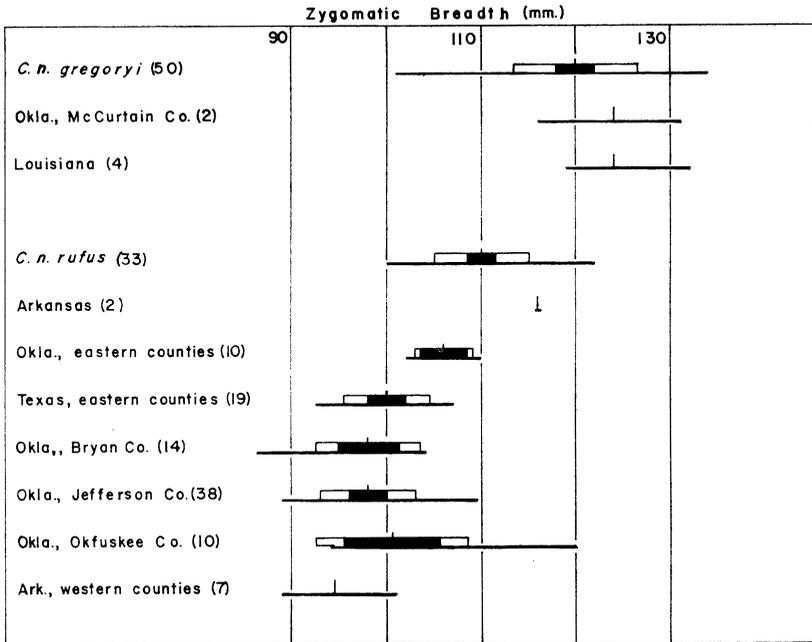


Fig. 2. Variation of zygomatic breadth of skulls of population samples of *Canis* from the southeastern United States. For explanation see Figure 1.

All skulls from eastern Texas, southern and central Oklahoma and western Arkansas (other than the two mentioned above) were referable to *C. latrans frustror*, using the same criteria as that given above. (The Bryan and Jefferson County samples may be considered as most typical of *C. latrans frustror*.)

Skulls from the eastern counties of Oklahoma (Choctaw, McCurtain, Pushmataha, and Latimer counties) collected since 1949 were, on the average, larger than skulls collected elsewhere and assigned to *C. latrans* on the basis of descriptions of Young and Jackson (1951). The mean length and mean breadth of zygomata, however, were not significantly different (Figures 1 and 2) from the means of skulls of *C. n. rufus* (so identified by Goldman) from Texas and Oklahoma. In general, however, these recent Oklahoma skulls were smaller and of less massive bone structure than the 17 skulls of *C. n. rufus* (collected from 1900 to 1925) used for comparative material. The eastern Oklahoma skulls were intermediate in size between typical *C. l. frustror* and *C. n. rufus*. A subjective comparison of the largest of these eastern Oklahoma skulls with a series of seven near topotypes of *C. n. rufus* (used by Goldman for the description of *rufus*) revealed that none of the

eastern Oklahoma skulls has massive enough bone structure or other combinations of characters that would justify assigning them to *C. niger*. This was emphatically true when the sex of the animal from which the skull came was considered. Known skulls of males from eastern Oklahoma overlapped in size only the female skulls of *rufus*. On the basis of these observations, it was apparent that none of the eastern Oklahoma skulls was assignable to *C. niger*.

On the basis of the evidence presented in Figures 1 and 2, all of the wild *Canis* currently occurring in Arkansas (except the two skulls assigned to *C. n. rufus*), Oklahoma and Texas are referable to *C. latrans frustror*. Admittedly, the available evidence which discounts current reports of red wolves from these areas is of a negative nature, but it seems likely that if animals large enough to be considered red wolves currently existed in these areas, at least some recent specimens would have been available.

The situation in Louisiana is apparently somewhat different. On the basis of actual specimens, *C. niger* has been collected as recently as 1956 and 1957 from Terrebonne and Madison Parishes, respectively. Apparently the species is presently (1961) extant in some of the alluvial swamps of eastern and southern Louisiana.

DISCUSSION

The question that should be discussed is: what happened to the population of animals known as *Canis niger* which, prior to 1935, apparently were present in the south central United States in considerable numbers and apparently are not now present, at least in the abundance of former years? The difficulty of suitably answering this question is that it is impossible to regress in time, and the apparent extirpation of the population known as *Canis niger* was not well documented either by reports or by specimens.

One possible answer is based on the premise that the population known as *C. n. rufus* was a valid taxon and could be considered a red wolf and not a large race of the coyote. It is interesting to note in older faunal accounts such as Bailey's (1905) publication that coyotes were not recorded from the eastern wooded part of Texas, but red wolves [*Canis frustror* = *Canis niger*] were present and fairly common. Lowery (1943) noted that red wolves were decreasing in Louisiana and did not list coyotes as part of the Louisiana fauna at that time. The time of apparent decrease of red wolves in the geographic area under consideration, particularly in eastern Texas and Oklahoma, coincided with intensive lumbering and agricultural practices. It is known that

coyote populations in these areas have increased in recent years, now being found in areas where they were not recorded 40–45 years ago, but where red wolves were recorded (Bailey, 1905; McCarley, 1959, for example). It could be suggested that red wolves were not able to adapt to the man-wrought environmental changes associated with intensive farming and lumbering operations, and gradually disappeared. Coyotes, on the other hand, have apparently been able to utilize the changing habitat and have ecologically replaced red wolves as primary predators.

A second possible answer is based on the premise that *Canis niger rufus* was not a valid taxon, but represented the result of natural hybridization between *Canis latrans* and *Canis niger gregoryi*. Young and Goldman (1944) and Young and Jackson (1951) both suggested the possibility of such hybridization between coyotes and wolves.

Support for this hypothesis is available from several sources. A series of eight skulls from the vicinity of Llano, Texas, assembled and examined by Goldman were re-examined in the present study. At least two of these skulls (U.S.N.M. Nos. 224185 and 228069) were indistinguishable from the majority of larger presumed coyote skulls from eastern Oklahoma. It is known that coyotes and dogs may cross and produce fertile offspring (see particularly Gier, 1957, for comments on this and additional supporting citations). McCarley (1959) reported the occurrence of two sibling dog-coyote natural hybrids from eastern Texas. Because of the close relationship of *Canis familiaris*, *Canis latrans*, and *Canis niger*, coyote-red wolf hybridization was entirely within the realm of probability, particularly if the environmental changes mentioned earlier resulted in a closer contact between the two species, i.e., a breakdown of reproductive isolation.

Examination of Figures 1 and 2 show that from a morphological standpoint the population sample of *C. n. rufus*, as it existed prior to 1925, was morphologically distinct from *C. n. gregoryi* at least in the non-overlap of standard errors of means. This same population sample of *C. n. rufus* was not, however, statistically different on the basis of skull size (Figures 1 and 2) from present population samples from eastern Oklahoma which have characteristics within the range described for *C. latrans frustror* (Young and Jackson, 1951). In addition there is a fairly regular cline of increase in size from west to east of these present-day canid populations in Oklahoma and Texas.

It seems plausible to hypothesize that sometime in the past (prior to 1900) interspecific hybridization between coyotes and red wolves (probably *C. n. gregoryi*), occurred. This hybridization probably occurred first in central Oklahoma and Texas as Goldman suggested, pro-

ducing a hybrid population described as *C. niger rufus*. As the coyote populations continued to expand eastward, hybridization increased, gradually swamping out the red wolf populations as the previously effective isolation mechanisms (geographic, ecological?) broke down. The population sample of recent *Canis* with the largest skull dimensions came from the eastern counties of Oklahoma, presumably the last portion of Oklahoma to be extensively influenced by the activities of man. The skulls from eastern Oklahoma were, on the average, larger than typical coyotes, yet considerably smaller than *C. n. gregoryi*. This suggests that the populations of *Canis* in eastern Oklahoma may presently be of hybrid character. It may also be of significance to note that as far as is known, no coyotes occur in Louisiana in contact with the apparent extant populations of red wolves, (Geo. H. Lowery, Jr., personal communication, 1961.)

SUMMARY

Samples of skulls of wild *Canis* populations from Arkansas, Louisiana, Oklahoma and Texas were examined, measured and analyzed in an attempt to distinguish skulls of coyotes (*Canis latrans*) from skulls of red wolves (*Canis niger*). It was found that, in general, size of skull was the most reliable character for separating the two species. On the basis of total length of skull and zygomatic breadth, the following conclusions were reached: At present (1961), *Canis niger* is extant only in a few places in eastern and southern Louisiana. All current population samples of *Canis* in Arkansas, Oklahoma, and Texas that were examined were referable to *Canis latrans frustror* on the basis of skull size. It was hypothesized that the apparent extirpation of red wolves in these latter states was the result of (1) non-adaptability of red wolves to changing environmental conditions, including competition with coyote populations, and (2) probable hybridization between coyotes and red wolves, resulting in the blending of red wolf and coyote characters into a form known as *Canis niger rufus*. It was suggested that *C. niger rufus* was not a valid taxonomic entity, but rather a population of natural hybrids between *C. latrans* and *C. niger gregoryi*.

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