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SEXUAL DIMORPHISM WITHIN CANINE DIMENSIONS OF *DIDELPHIS VIRGINIANA*

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ABSTRACT

Sexual dimorphism in canine size was analyzed from a sample of the Baldwin County, Georgia population of *Didelphis virginiana* (Virginia opossum). Where possible 6 measurements were obtained from 59 (47 males, 12 females) individuals collected as roadkill. Although range overlap exists for all measurements, males were found to be significantly larger for upper and lower canine length, width and height. The observed sexual dimorphism agrees with previously published analyses of cranial and post-cranial sexual dimorphism in this species and is likely related to intrasexual aggression between males during mating season.

Key words: Sexual dimorphism, *Didelphis virginiana*, canines, Virginia opossum

INTRODUCTION

Sexual dimorphism within osteological dimensions is prominent throughout both extant and extinct populations. In most mammalian lineages, there appears to be some degree of sexual dimorphism (1), much of which is observable in cranial dimensions. Within human populations, skeletal variation has been studied extensively because of the importance of being able to determine the sex of archeological remains (2). This ability to determine sex is also of great importance in paleoecological studies of prehistoric taxa.

Intraspecific variation within osteological proportions can occur for a wide variety of reasons. In populations where "female-choice" is the primary mode of sexual selection, males typically exhibit larger dimensions as a result of competitive interactions with other males. Other groups show variation in relation to display behaviors. This concept has been known and comprehensively studied since its proposal by Darwin (3, 4). Males that possess a "better fit" adaptation in relation to mating will reproduce more frequently and supply the next generation with a greater proportion of their genotype. This practice is especially prominent in mammalian lineages, as in many species of ungulates. Loison *et al.* (5) found that sexual dimorphism is especially

pronounced within the Bovidae and Cervidae families, both of which exhibit male-male competitive interactions.

Didelphis virginiana (Virginia opossum) is a species found in large populations in the eastern and extreme western portions of the United States. With this prevalence, the species is readily available for scientific analyses; however, few studies have analyzed its osteological variation, and more specifically sexual dimorphism. Tague (6) determined that males were significantly larger for 14 of 16 pelvic and 8 non-pelvic dimensions. Patterson and Mead (7) found that males were significantly larger for 8 cranial and 5 post-cranial measurements. Coues (8) provided a detailed study of the osteology and myology of *Didelphis virginiana*, however, only noted that the male canines appeared to be much larger than those of females. Gardner (11) presented a detailed study of *Didelphis virginiana* and after analyzing 64 random museum specimens from across the country, suggested that sex could be determined with a high degree of certainty based upon canine dimensions and age class. However, in many paleontological and ecological instances, determination of age class is virtually impossible due to the isolated nature of the material. The present study analyzes the degree of sexual variation within the canine dimensions of *Didelphis virginiana* independent of adult age class, proposes a standardized measurement technique, and provides baseline data for the use in additional comparative studies.

MATERIALS AND METHODS

During the winter months (January-March) of 2002 and 2004, 59 (47 males and 12 females) specimens of *Didelphis virginiana* were collected as road-kill in Baldwin County, Georgia. These individuals were sexed, weighed and tagged at the time of collection, and were later skeletonized by Dermestid beetles. All samples were determined to be of mature age (10+ months) based upon the parameters suggested by Gardner (9). All specimens are housed in the Georgia College and State University Recent Mammal Collection.

Where possible, length, width and height measurements were obtained for upper and lower canines of each specimen using Chicago Brand digital calipers accurate to within 0.01 millimeters. However, owing to the nature of death on roadways, many of the individuals had damaged dentition. The upper and lower left canines were measured when possible. In cases where left canines were broken or absent, those on the right side were measured. Upper and lower length (UL, LL) and width (UW, LW) were obtained at the bone level on either the maxilla or the dentary. Lengths were measured from the most anterior portion of the canine to the most posterior. Widths were obtained by measuring from the center of the lingual surface to the center of the labial surface. We measured upper and lower crown heights (UCH, LCH) from the labial margin of the canine alveolus to the apex of the crown. For each dimension, a sample mean, range, standard deviation, and standard error were calculated. Student's t-test was used to determine the significance

of the difference between male and female mean values. Crown height was plotted against length and width for both upper and lower canines.

RESULTS

Summary statistics of the upper and lower canine dimensions (Table I) show range overlap; however, males are significantly larger ($P < 0.001$) for each measurement. The mean values show the greatest difference between males and females for both the upper and lower crown heights. Upper and lower canine lengths in relation to crown heights are presented in Figures 1A and 1B. Upper and lower canine widths in relation to crown heights are presented in Figures 2A and 2B. In each figure, the overlap between large females and small males in clearly evident.

Table I. Upper and lower canine dimensions for the study sample of *Didelphis virginiana* from Baldwin County, Georgia. All measurements are in millimeters. UL = upper canine length, UW = upper canine width, UCH = upper canine crown height, LL = lower canine length, LW = lower canine width, LCH = lower canine crown height.

Dimension	Sex	Mean	N	Range	SD	SE	*P*
UL	M F	7.39 5.85	35 6	5.14-9.81 5.51-6.46	1.01 0.37	0.17 0.15	<0.001
UW	M F	4.30 3.20	36 6	3.07-5.43 3.05-3.38	0.57 0.13	0.10 0.05	<0.001
UCH	M F	15.57 11.31	32 4	9.16-20.85 10.22-12.39	2.41 0.93	0.43 0.47	<0.001
LL	M F	7.72 6/02	40 7	6.23-9.54 5.36-6.86	0.83 0.49	0.13 0.19	<0.001
LW	M F	3.83 3.02	39 7	3.09-4.82 2.70-3.47	0.37 0.26	0.06 0.10	<0.001
LCH	M F	10.14 7.63	34 6	7.93-12.49 6.14–8.83	1.14 0.97	0.20 0.40	<0.001

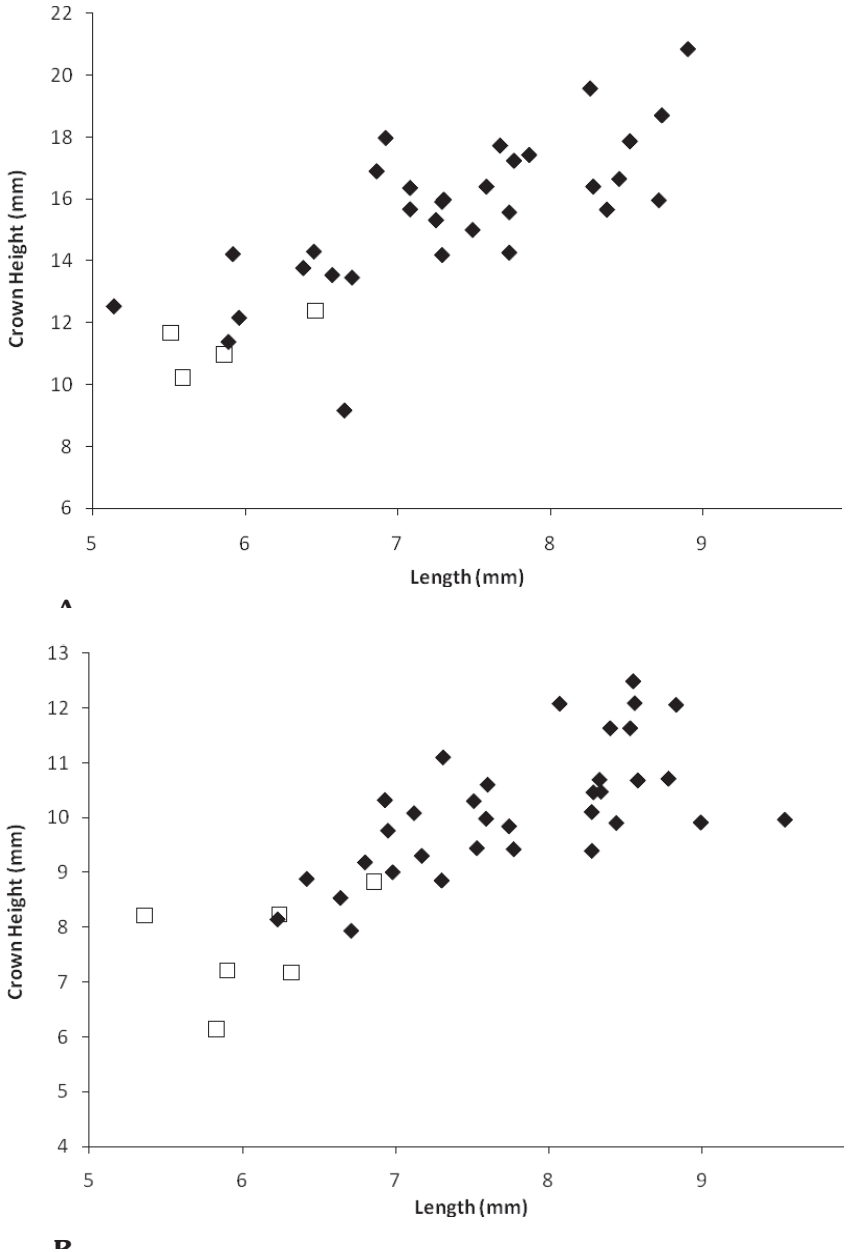
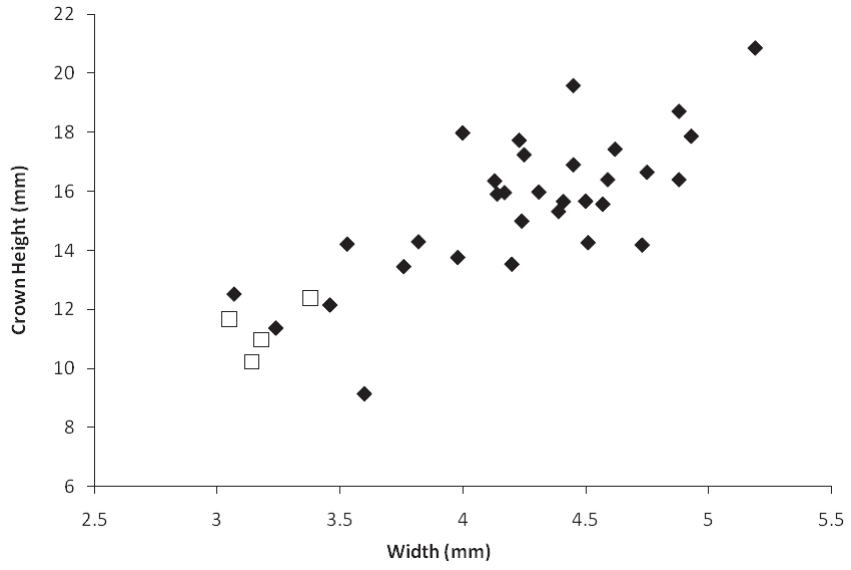
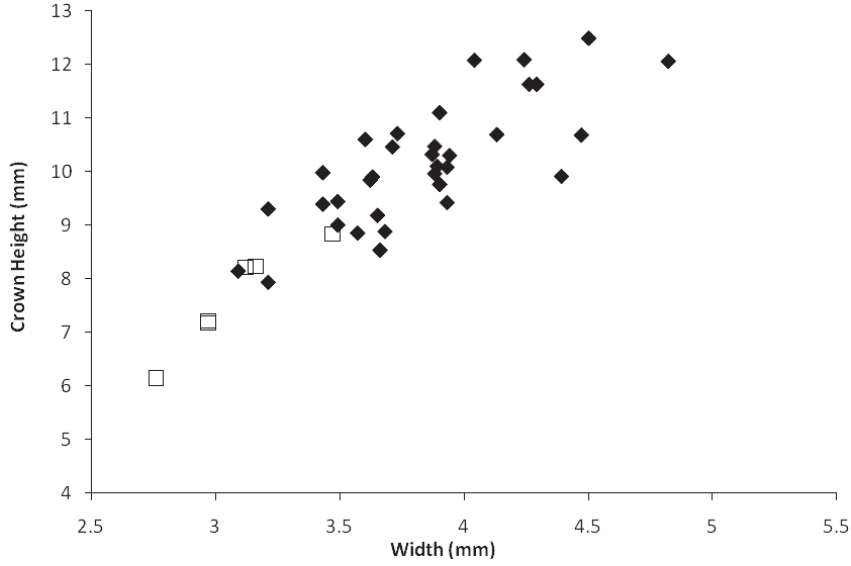


Figure 1. Scatter-plots of A) upper canine lengths (UL) in relation to upper canine crown heights (UCH) and B) lower canine lengths (LL) in relation to lower crown heights (LCH) for the study sample of *Didelphis virginiana* from Baldwin County, Georgia. Males are represented with solid diamonds; females are represented with open squares.



A



B

Figure 2. Scatter-plots of A) upper canine widths (UW) in relation to upper crown heights (UCH) and B) lower canine widths (LW) in relation to lower crown heights (LCH) for the study sample of *Didelphis virginiana* from Baldwin County, Georgia. Males are represented with solid diamonds; females are represented with open squares.

DISCUSSION

This analysis indicates that males within the Baldwin County population of *Didelphis virginiana* exhibit significantly ($P < 0.001$) larger upper canine lengths, upper canine widths, upper canine crown heights, lower canine lengths, lower canine widths, and lower canine crown heights. Gardner (11) and McManus (12) reported that males engage in combative interactions, especially during mating season. This suggests that the sexually dimorphic nature of canines is likely the result of selection pressures associated with mate selection. Increased canine dimensions in relation to larger cranial proportions (7) would also amplify the likelihood of survival in aggressive interactions.

The Baldwin County sample of *Didelphis virginiana* is composed of 47 males and 12 females, suggesting that males are more highly active during the period of collection (January-March) (11, 13). Golley (14) found that mating season in Georgia peaked in February. Males range widely in search of mates, and thus increase their likelihood of being killed on roadways. This larger proportion of males would suggest a degree of sampling bias, however, the post cranial measurements for this sample (7) were consistent with those of Gardner's (9) much larger sample. The slight variation between the two populations could be accounted for by age class designation or museum sampling bias.

Although multiple studies (8, 10) have noted the sexually dimorphic nature of the canines within the Virginia opossum, none have analyzed them in a method independent of adult age class. Gardner (11) found little overlap in male and female dimensions of the same age class, and concluded that sex could be determined based upon length and width measurements. Within Gardner's age class 4, no overlap existed between male and female length dimensions, and within his age class 5 there was no height overlap. However, there was height overlap in age class 4 and length overlap in age class 5 making this sexing technique inaccurate without first knowing the age class.

As with most mammalian species, age determination in *Didelphis virginiana* is primarily based upon eruption and wear of the molars. In many biological circumstances, age class is nearly impossible to determine due to the fragmentary nature of the material, but the information provided by sex ratios is vital to understanding the dynamics of a population. This study supports Gardner's (11) findings, in that age class must be determined in order to positively identify the sex based on canine dimensions. However, with the information provided in this study, biologists can predict sex with a high probability of certainty in instances where age determination is not possible, but canine proportions are obtainable.

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