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INTRAPOPULATIONAL MORPHOLOGICAL VARIATION AS A PREDICTOR OF FEEDING BEHAVIOR IN DEERMICE

Richard A. Smartt
University of Texas

Cliff A. Lemen
University of Nebraska-Lincoln, clemen2@unl.edu

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Within populations of animals that have determinate growth, all fully grown adults, even of one sex, are not identical. Both genetic and environmental factors are responsible for this variation. In recent years the importance of this variation has received much attention (Mayr 1963; Van Valen 1965; Fretwell 1969; Soulé and Stewart 1970; Rothstein 1973). The important question asked has been, What effect does this morphological variation have on niche width and the ecology of a population? Implicit in many of these works is the concept that differences in the morphologies of population members can result in differences in their niches. This kind of variation is called *adaptive variation* and the general concept is known as the *niche variation hypothesis*.

A considerable alteration of the classical view of a population is necessary if adaptive variation is important. The competitive interaction term, alpha, from the Lotka-Volterra equation is no longer unity between population members. Different phenotypes may occupy very different niches and so compete at a lower level than they would with similar phenotypes. Such competition could cause natural selection to increase the variation within a population by selecting for those phenotypes which occupy niches at the periphery of the populational niche. In populations with adaptive variation the total populational niche is made up by differences among phenotypes in their niche use. By adding or removing peripheral phenotypes the populational niche can be enlarged or reduced. Do patterns such as those suggested above exist in natural populations? It is impossible to assess without the quantification of adaptive variation. It is surprising, for this reason, that so little evidence has been presented to test such morphological-ecological relationships within populations.

Most available information comes from studies of animals with indeterminate growth. It is obvious that very small individuals of a species with indeterminate growth will use food resources different from those used by very large individuals of the species. The difference has to do with a simple age-size relationship. The size differences, often of several orders of magnitude, do not necessarily represent genetic differences. Variation within species of animals with determinate growth presents a different situation. Within a relatively short period of time (a few months for the *Peromyscus* species we worked with) these animals reach full size. Adult morphological variation in these populations can be easily quantified.

The purpose of our research was to answer the basic question fundamental to further development of hypotheses on variation: Do differences in the adult morphology of individuals within a population generate predictable differences in their ecologies? To our knowledge the only case in which natural populations of animals with determinate growth have been shown to vary ecologically with morphological variation is in wintering fringillid birds (Fretwell 1969). However, in this study problems exist in defining real populations in groups of wintering migratory birds. (For a discussion of these and other problems, see Banks 1970.)

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TABLE 1

RESULTS OF CANONICAL CORRELATION ANALYSIS RELATING MORPHOLOGICAL VARIATION TO ECOLOGICAL VARIATION (DIFFERENCES IN FOOD HABITS)

Species	Canonical Correlation	χ^2	*N*	df	Significance
P. boylii	.684	138.687	97	88	.000
P. truei	.502	147.544	202	104	.003

NOTE.—No attempt was made to interpret the canonical variates in this analysis.

To examine the relationship between morphology and ecology at the intrapopulational level we studied populations of two different species of deermice (*Peromyscus*). The brush mouse (*Peromyscus boylii*) and the pinyon mouse (*Peromyscus truei*) were taken from the Cerrillos Hills of central New Mexico throughout 1974. The following morphological measurements were recorded for each mouse caught: total length, tail length, hind foot length, and ear length. Average coefficient of variation for these populations of *P. boylii* and *P. truei* is 5.96 and 5.10, respectively. Stomach contents were analyzed and quantified for each mouse caught (Smartt 1978). Juveniles and subadults were eliminated from the analysis using pelage and cranial criteria; thus variation present in the data reflects adult morphological variation. Sexes were not analyzed separately because sexual morphological dimorphism was shown statistically to be unimportant in these populations.

In order to relate ecological parameters (food habits) and the morphological measurements of each animal, canonical correlations (Nie et al. 1975) were run using the above two groups of variables (i.e., food habits and morphological measurements) from each population (*P. boylii* and *P. truei*). The canonical correlation, in this study, defines statistically the tendency for individuals to occupy similar positions relative to one another in morphological and ecological space. This would be the tendency for those animals which are similar morphologically to also have similar food habits. Table 1 shows the results of this analysis. Within both of two different populations of deermice the relationship between morphology and food habits is significant. Thus, in two separate cases presented here differences in feeding behavior among population members can be correlated with morphological differences within each population.

Our next question concerned the functional relationship between ecological and morphological variables. To investigate this relationship within each of the two populations we grouped food items used by the mice into three categories: food associated with trees, associated with brush, and from ground forbs. The data were partitioned in this way because of the tendency for some *Peromyscus* species to select microhabitat vertically. The two sets of variables (morphological and grouped ecological) were analyzed for two populations. The results of this analysis are shown in table 2. Again a strong relationship exists between the two sets of variables. Within the population of *P. boylii* the most important variables in determining the relationship between foraging area and morphology were body

TABLE 2

Results of Canonical Correlation Analysis Relating Morphological Variation to Variation in Foraging Habitat
(Canonical variates are given to show possible functional relationships between variables)

Species	Canonical Correlation	χ^2	N	df	Significance
P. boylii	.512	35.60	97	12	.000

Canonical variates

First set (morphological)		Second set (grouped ecological)	
Body	1.657	Tree	−.612
Tail	−1.673	Brush	−.805
Foot	−.049	Ground	.165
Ear	.228		

Species	Canonical Correlation	χ^2	N	df	Significance
P. truei	.278	20.32	202	12	.060

Canonical variates

First set (morphological)		Second set (grouped ecological)	
Body	.518	Tree	.868
Tail	−.547	Brush	.389
Foot	.648	Ground	−.239
Ear	.525		

length, tail length, and brush microhabitat (table 2). In this population tail length appears to be related to climbing ability among population members. Individuals with relatively shorter tails in relation to total body length tend to avoid foraging in trees and brush. It has long been known that tail length is related to climbing ability among geographically variable populations and among species of deermice (Horner 1954). It is now evident that tail length is also related to degree of arboreality within a population of deermice.

The relationship between morphology and foraging area in the population of *P. truei* is determined by all morphological variables and tree microhabitat. Individuals with a tendency to use more food items from trees had larger feet (table 2). Foot length has also been shown to be an important factor in determining arboreality among species of *Peromyscus* (Horner 1954). Here it is important in determining climbing ability within a population.

Variation among population members can be related to differential foraging behavior and ability among population members. These data, then, support the concept of adaptive variation. Examination of the functional relationship between morphological and ecological variability shows that morphological characters important in predicting an individual's foraging behavior within a population of *Peromyscus* are the same ones others have found important in determining among species differences.

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RICHARD A. SMARTT

DEPARTMENT OF BIOLOGICAL SCIENCES
UNIVERSITY OF TEXAS
EL PASO, TEXAS 79968

CLIFF LEMEN

FIELD MUSEUM OF NATURAL HISTORY
CHICAGO, ILLINOIS 60605

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