September 1970

PHYSIOLOGICAL INTERPRETATIONS OF MORPHOLOGICAL VARIATION IN THE RED-WINGED BLACKBIRD

Dennis M. Power
Royal Ontario Museum, Toronto, Ontario

PHYSIOLOGICAL INTERPRETATIONS OF MORPHOLOGICAL VARIATION IN THE RED-WINGED BLACKBIRD

Dennis M. Power
Royal Ontario Museum
Toronto, Ontario

A number of widespread species vary morphologically throughout their range. Ultimately such geographic variation appears to be adaptive and represents local evolutionary responses to the pressures of natural selection. Detailed knowledge of size, shape and color variation in species such as the Red-winged Blackbird *(Agelaius phoeniceus)* may eventually allow the identification of breeding localities of autumn and winter flocks simply from morphological evidence. Knowledge of variation in behavioral and physiological parameters also will be useful in assessing the effect of various control devices.

The present study stems from an attempt to elucidate the adaptive significance of geographic variation of redwings in the Great Plains states of the U.S. and the Prairie Provinces of Canada. Two characters are considered here, the surface/volume ratio of the bill and wing length as measured from the bend of the wing to the tip of the longest primary feather. Character means were calculated for a maximum of 54 localities throughout the study area. All represent breeding season samples, and both males and females are treated.

In order to assess the relationship between character variation and multiple environmental factors, a multiple regression model is used. Independent variables are locality values for longitude, latitude, altitude, mean breeding season temperature, April minimum temperature, July maximum temperature, July wet-bulb temperature, and breeding season precipitation. The partial regression coefficients in a multiple regression analysis allow us to examine the relationship between character variation and a particular independent variable while variation accounted for by all other independent variables is held constant. In this way, we can correct for correlations among independent variables. Although a number of statistically significant partial correlation coefficients were found, only those for which both males and females showed a similar relationship and for which a physiological interpretation is suggested will be discussed.

For bill surface/volume ratio there is a significant, positive coefficient with April minimum temperature. Thus, surface/volume ratio is less in colder regions and greater in warmer ones. This is in accordance with variation as predicted by Allen's ecogeographic rule and suggests that there may be a significant, although admittedly small, amount of heat lost from the vascular bony structure of the bill across the surface. A reduced surface/volume ratio in colder areas may be advantageous in reducing heat flow from the bill and may thereby increase thermoregulatory efficiency. This may explain only a part of the geographic variation in bill size and shape. Other

factors, most likely related to diet and feeding behavior, are also expected to be a part of the selective pressure on the bill.

For wing length there is a significant, negative partial regression coefficient with July wet-bulb temperature. Thus, where combined temperature and humidity are greatest during the hottest time of the year, wing length is less. Likewise, in cooler, more arid regions wing length is greater. It is known that mean wing length is highly correlated with mean body weight, for those few localities for which weights were available, so the relationship with wet-bulb temperature may be more cogently viewed in terms of body size. We therefore observe that birds are smallest in regions where wet-bulb temperature is highest during the hottest time of the year, and are largest in relatively cool, dry areas. This has also been observed for Hairy and Downy Woodpeckers, the Blue Jay, Carolina Chickadee, White-breasted Nuthatch, Eastern Meadowlark, and certain vireos.

Size increases in arid regions may facilitate conservation of metabolic water, while size decreases in humid regions may facilitate heat dissipation. In the latter case, a smaller endotherm by virtue of a relatively greater surface/volume ratio, higher respiratory and metabolic rates, and, perhaps, relative to size, greater respiratory surfaces for evaporative cooling, by behavioral means such as rest and seeking shade may be able to recover from hyperthermy or a heat load more rapidly and with less expenditure of energy than a larger endotherm in the same situation.

One final point should also be made. Multiple regression analysis is best used for predicting the value of a dependent variable (e.g., character) given values for multiple independent variables (e.g., environmental factors). We could theoretically use the geographic and climatic factors treated here to predict variation for localities within the boundaries of the study area. And, if some of these factors are operative in the same way outside of the study area, then we should be able to use values outside the study area in a predictive way. I therefore attempted to predict the mean values for characters in a number of spots west of the Rocky Mountains by obtaining locality values of the independent variables and using the regression coefficients from my study area in central North America. In all cases outside the study area the predicted means were a poor match for the actual, observed means. This suggests that in a widely distributed species, such as the redwing, selection factors and the degree of their evolutionary impact may vary from region to region and from one ecological setting to the next.

QUESTION AND COMMENTS

M. GILTZ: I would like to ask you how you took the samples. Did you take them all at the same season, and did you eliminate migrant birds?

D. POWER: The samples were restricted to the breeding season. The collecting was initiated after spring migration had stopped and the birds were settled on the breeding grounds. I stopped collecting when the birds started leaving the nest or flocking, so they represent breeding season samples. Some of the samples were taken by me to fill in missing areas, but mostly they came from existing museum specimens.

T. QUAY: Can the natural selection keep up with the rate of change and the food availability here under agricultural conditions? The birds we have now have been adapting over the last few thousand years, but changes in agricultural practices have been going on at even a greater pace in the last fifteen years.

D. POWERS: This brings up the whole area of why birds are successful in different areas and why birds are successful colonizers. Those which were brought over seemed to adapt to foods that they didn't have available to them before. The only way I can answer that question is by guessing, and I would suggest that simply the red-winged blackbird is adaptable to the extent that it can pretty well take what changes we have been making on the land. It certainly seems to have taken to man's habitation and has increased its numbers, I gather, as a result of agricultural practices. So using this weak evidence, I can only suggest that it is perhaps a highly adaptive species. Other species are restricted to forest types and perhaps very narrow niches, if I can use that word. For example, if you were to remove one of their dominant food items, perhaps they would completely die off in local regions. So it relates, I guess, to the degree of adaptability that is more or less species-specific.

WILLIAM JACKSON: Now I think we all recognize the red-wing is one of the most adaptable kinds of pests we have. That is why we are here. If they weren't adaptable, like the rats and like man, many of us would be out of jobs.