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AN ESTERASE PHENOTYPE CORRELATED WITH DISPERSAL IN *MICROTUS*

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Abstract.-- A strong correlation was discovered between an esterase isozyme phenotype and prairie voles, *Microtus ochrogaster*, that had dispersed across extensive areas of unsuitable habitat. This indicates there may be a genetic component associated with dispersal in the prairie vole.

Lidicker (1962) postulated that emigration might be a means by which a population could be regulated below its carrying capacity. He stated that there "is the possibility that a tendency to emigrate may be selected for in a given species and eventually come to play a primary role, even if an uncommon or occasional role in population regulation." Howard (1960) proposed two types of dispersers: ecological and innate. Ecological dispersers would be affected by population pressures; their dispersal would be density dependent. Innate dispersers, however, would disperse without regard to population density. Howard suggested that both ecological and innate dispersers were genetically based.

The present study was initiated to determine if a genetic difference, at the level of the enzyme phenotype, exists between dispersing and non-dispersing individuals of the prairie vole, *Microtus ochrogaster*. Starch gel electrophoresis of enzymes was used as a means of identifying genetic markers associated with dispersal.

Myers and Krebs (1971) and Tamarin and Krebs (1969) have examined various isozyme differences in vole populations through electrophoretic techniques. Our study emphasized identification of an enzyme marker associated with dispersal. We were not attempting to correlate such enzyme occurrence with phase of the population cycle. A disperser as defined in this study is an animal which has had to cross unsuitable habitat and not simply reoccupy a contiguous suitable habitat depopulated by trapping. We employed starch gel electrophoresis because it provides a sensitive resolution of enzyme variants. An esterase system was investigated since such systems display high levels of polymorphism and therefore are ideal for studying population variation within a species.

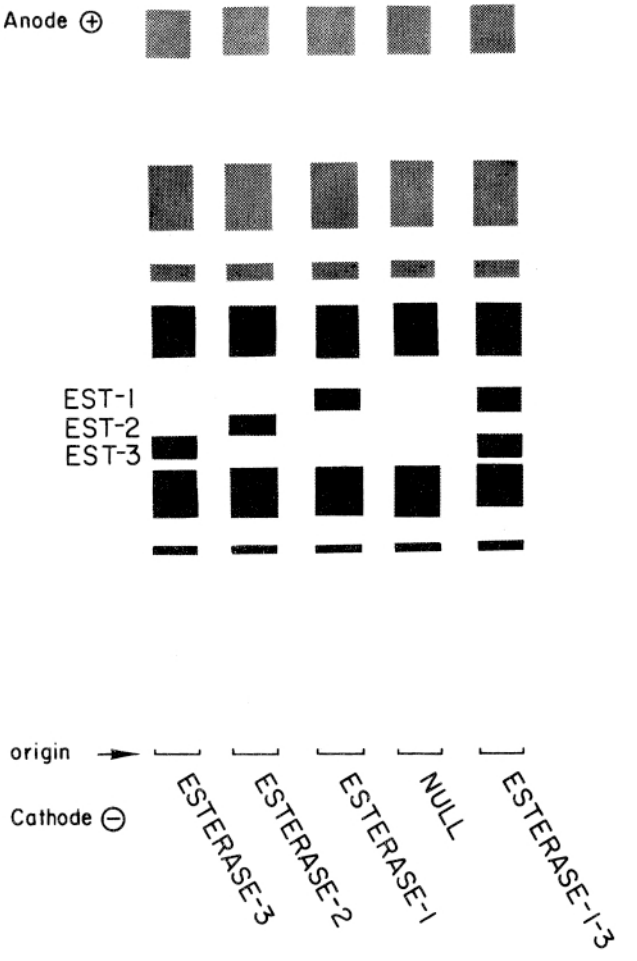

Figure 1. Esterase isozyme phenotypes observed in the Microtus ochrogaster populations studied. The esterase phenotypic designations below the zymogram refer specifically to the presence and absence of the three esterase isozymes indicated to the left as EST-1, EST-2, and EST-3.

Dispersers were obtained by first removing all resident M. ochrogaster from two isolated grassy fencerows 1.5 km S Urbana, Illinois. The voles that dispersed into these fencerows during a period of one month were live-trapped for study. These strips

of grass, approximately 2 m wide, are capable of supporting a limited number of voles. Cultivated fields, unsuitable vole habitat, extended for at least 1/2 km on all sides of the fencerows. Any dispersing individual would have had to travel at least this distance over unsuitable terrain. The fencerows were cleared of their resident populations in mid-March by first live-trapping. The fencerows were then snap-trapped for seven days; no voles were caught during the snap-trapping. We, therefore, assumed all residents had been removed; prior experience with fencerow trapping indicated all individuals should have been caught in that time.

The animals classified as dispersers were live-trapped in April, a month after the initial depopulation. This period of time was chosen to provide time for immigration, but not time for recruitment by reproduction of the early arrivals. The non-dispersal group was comprised of the 14 animals trapped in the fencerows in March plus 33 individuals sampled in a large population (8.5 ha area; 19 voles/ha) located more than 10 km from the fencerow area studied. The source of the dispersers was not located; they apparently came from patches of habitat at least 1 km from the fencerows. The spatial pattern of vole habitats was such that it was highly unlikely the "dispersers" came from one source.

Different esterase isozyme phenotypes were observed in the vole populations after starch gel electrophoresis. Blood samples were collected in heparinized capillary tubes from the cavernous sinus (Semeonoff and Robertson, 1968). The blood was then centrifuged at 15,000 g for 30 minutes at 4°C. The supernatant was subjected to electrophoresis on vertical starch gels. A discontinuous buffer system (EDTA-Borate-Tris) was employed (Boyer, et al., 1963). Electrophoresis was carried out at 4°C, at 7V/cm, for 20-28 hours. The gels were cut in half and stained for esterase activity according to Shaw and Prasad (1970).

The esterase bands are shown schematically in the zymogram shown in Figure 1. Five phenotypes were observed and scored.

A significantly ($X^2 = 12.20$; $<.05$) higher proportion of the dispersers possessed the EST-1 phenotype (Table 1). In addition, only 11 of 88 M. ochrogaster from a laboratory (established two years earlier with 25-30 individuals from two separate wild populations; one in the vicinity of the fencerows in this study) tested possessed the EST-1 phenotype.

The exact molecular and genetic bases of these esterase phenotypes has not yet been elucidated. However, the discrete nature of the electrophoretic mobility differences suggests a simple Mendelian basis, probably several alleles at one esterase locus. Laboratory reared M. ochrogaster did not undergo a change in their isozyme phenotypes over the life span of the individuals studied. Furthermore, there was no significant correlation between sex and esterase phenotype ($X^2 = 2.93$, df, 3).

Table 1.-- Frequency of esterase phenotypes in dispersing and non-dispersing Microtus ochrogaster. Dispersers were obtained from immigrators into isolated habitats from which the residents had been removed.

Esterase Phenotype	Dispersers	Non-dispersers
Esterase - 1	11	19 (5)*
Esterase - 2	1	8 (6)
Esterase - 3	0	7 (0)
Esterase - 1-3	0	4 (0)
Null	0	9 (3)
Total	12	47 (14)

*Numbers in parentheses indicate individuals resident in the isolated habitats at the time of the removal trapping.

Because the dispersal group possessed predominately the EST-1 phenotype in contrast to the control group, there does appear to be a genetic component which is associated with dispersal in this species. At the present time it is not known what relationship the possession of the EST-1 enzyme has to dispersal in M. ochrogaster. Since relatively few dispersers were obtained in this study, the results are susceptible to the usual small sample biases. In addition, environmental or behavioral factors other than dispersal could be the selective factor, if any, involved in the high proportion of the EST-1 phenotype in dispersers. Much larger samples and more extensive analysis of possible selective factors would be necessary to establish the true correlation between the EST-1 phenotype and dispersal of this species.

If the EST-1 phenotype is associated with dispersal, it is improbable that this study has fortuitously found the "dispersal gene" or even an enzyme locus on the same chromosome with a main genetic determinant of dispersal behavior. There could be an epistatic interaction of the EST-1 allele and genetic components on separate chromosomes which are involved in dispersal behavior.

Regardless of the unanswered questions concerning the significance of the data presented here, the strong correlation between an esterase isozyme phenotype and the tendency to disperse is highly suggestive and certainly warrants future study.

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