Genetic Polymorphism of Urine Deoxyribonuclease I Isomerases of Subterranean Mole Rats, *Spalax ehrenbergi* Superspecies, in Israel: Ecogeographical Patterns and Correlates

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Genetic polymorphism of urine deoxyribonuclease I (DNase I) of mole rats was analyzed by isoelectric focusing in a thin-layer polyacrylamide gel (IEF-PAGE). One hundred and three subterranean mole rats, comprising 13 populations belonging to the four chromosomal species (2n = 52, 54, 58, 60) of the actively speciating *Spalax ehrenbergi* superspecies in Israel, were tested. The following results were indicated. (i) *Spalax* DNase I consisted of 6–12 major isozymes. (ii) Four phenotypes (numbers in parentheses) were 1 (92), 1–2 (5), 1–3 (4), and 2 (1). The decreasing order of genetic diversity, $H_e$, in the four species was 0.37, 0.13, 0.10, and 0.0 for 2n = 58, 52, 54, and 60, respectively. (iii) Spearman rank correlations and multiple regression analyses indicated associations of allele frequencies and genetic diversity with climatic and vegetation factors. We concluded that (a) climatic selection, either directly or indirectly through plant (i.e., food resources) diversity, plays an important role in DNase genetic differentiation and (b) no gene flow and introgression occur between the recent derivative of speciation (2n = 60) and its ancestor (2n = 58), suggesting the operation of reproductive isolation between both species despite natural hybridization.

KEY WORDS: deoxyribonuclease (DNase); isozymes; genetic polymorphism; natural selection; *Spalax ehrenbergi*; subterranean mammals.

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INTRODUCTION

Nucleic acids ingested by animals undergo hydrolysis in the intestine by nucleases secreted by the pancreas. Deoxyribonuclease I (DNase I) is a 3' enzyme, specifically hydrolyzing the ester linkage between the 3' carbon and the phosphoric group. DNase I of bovine pancreas, an endonuclease, catalyzes hydrolysis of some of the α, or β, linkages of DNA to yield oligonucleotides containing, on average, about four nucleotide residues (Moore, 1981).

Two distinct types of DNase were identified in humans, in serum and urine. One of them, DNase I, has been purified to an electrophoretically homogeneous state from urine (Ito et al., 1984). DNase I from bovine pancreas consists of at least four to six isozymes which are separable by phosphocellulose chromatography and isoelectric focusing in thin polyacrylamide gels [IEF-PAGE; see references given by Yasuda et al. (1989)]. The genetic aspects of DNase in humans became known by the development of two analytical methods of DNase isozymes, one involving a combination of IEF-PAGE separation and immunological detection and the other a combination of IEF-PAGE separation and enzymological detection (Yasuda et al., 1989). We have studied geographical patterns of DNase I of subterranean mole rats by the second method.

Subterranean mole rats of the Spalax ehrenbergi superspecies in Israel represent an active case of ecological speciation and adaptive radiation. The superspecies comprises four chromosomal sibling species (2n = 52, 54, 58, and 60), not yet named formally, displaying progressive stages of late chromosomal speciation (Nevo, 1985). Their adaptive radiation in Israel from the Early Pleistocene to recent times is closely associated with distinct climatic diversity in both the Mediterranean and the steppic climatic regimes: 2n = 52 radiated in the cool-humid Upper Galilee Mountains; 2n = 54 in the cool-semidry Golan Heights; 2n = 58 in the warm-humid Lower Galilee Mountains, Central Yizreel, and Coastal Plains; and finally, 2n = 60 in the warm-dry mountains of Samaria, Judea, northern Negev, and the southern part of the Jordan Valley and Coastal Plain (Fig. 1). The adaptation associated with speciation that occurred in the four climatic regimes exhibits genetical, physiological, ecological, morphological, and behavioral strategies (reviewed by Nevo 1979, 1982, 1985, 1986a,b, 1988a, 1989, 1990a,b).

Our objective in the present study was to explore potential polymorphisms of DNase I, across the range of the S. ehrenbergi superspecies in Israel, and assess their ecogeographical patterns and correlates.

MATERIALS AND METHODS

Animal Samples

We tested deoxyribonuclease I (DNase I) polymorphism in laboratory urine samples of 103 individuals of the four chromosomal species of the Spalax