

Expression of LDH-C Isozyme among Lizard Taxa: Evolutionary Implications for the Vertebrate Lactate Dehydrogenase Gene Family

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Chien-Hsien Kuo, San Kao, Ching-Feng Weng and Sin-Che Lee (1999) Expression of LDH-C isozyme among lizard taxa: evolutionary implications for the vertebrate lactate dehydrogenase gene family. *Zoological Studies* 38(3): 344-349. In order to more completely understand the complete basis for the multiple LDH isozymes in lizards, seven species of Taiwanese lizards belonging to 4 families and 7 genera were sampled. Starch gel electrophoretic patterns of lizard LDH isozymes from brain, eye, heart, liver, muscle, and testis were analyzed. Like all other vertebrates, lizards possess the 2 fundamental LDH loci—A and B. A 3rd locus, LDH-C, was detected only in testes of *Hemidactylus frenatus*, *Eumeces elegans*, and *Mabuya longicaudata*. This testis-specific product, designated according to tissue-specific expression exhibited, a faster anodal migration than did the other LDH isozymes. These findings suggest that the testis-specific LDH isozyme was derived from ancestor amniote LDH-A.

Key words: Lizard, Lactate dehydrogenase, Evolution, Amniote.

Isozymes are multiple molecular forms of enzymes (Markert and Möller 1959). Their biological significance and function have proved to be very important in research on biochemical and genetic mechanisms during the development and evolution of vertebrates (Markert 1983). The L-lactate dehydrogenase (LDH, EC 1.1.1.27) isozyme system is one of the most extensively studied models used to investigate the origin and evolution of isozymes and regulation of multigene families (Holmes 1972, Markert et al. 1975, Li 1990). Of the 2 isozymes present in almost all vertebrate species examined, the LDH-A isozyme is better known for pyruvate reduction in anaerobic tissues (muscle), whereas LDH-B is better for L-lactate oxidation in aerobic tissues (heart and brain) (Holbrook et al. 1975, Markert et al. 1975). An additional locus encoding an isozyme with more variable kinetic properties (LDH-C) is expressed in a variety of tissues in vertebrates. In lower teleost fish (Acipenseriformes, Amiiformes, Anguilliformes, etc.), the 3rd LDH has a generalized tissue distribution, but in advanced teleost fish (Salmoniformes, Myctophiformes, Per-

ciformes, etc.), it is found either in liver (e.g., cod) or in the eye (e.g., salmon) (Almeida-Val and Val 1993). In mammals and columbid birds, a 3rd LDH isozyme is expressed in mature testes (Matson 1989, Wheat and Goldberg 1983). However, only the LDH-A and LDH-B isozymes are present in other birds (Matson 1989). Surprisingly, there were no reports related to the 3rd LDH in reptiles (Mannen et al. 1997). The major group of amniotes diverged from a common ancestor during a short period about 250-300 Mya (Laurin and Reisz 1995). The classical phylogenetic relationships among the amniotes based on paleontological and morphological evidence (Carroll 1987) have recently been judged using 18S and 28S rRNA genes and protein sequences (Hedges et al. 1990, Eemisse and Kluge 1993). Nevertheless, evolutionary relationships among these LDH isozymes of vertebrates have not been completely resolved.

Here, we report on the expression of LDH-C isozyme in testes of some Taiwanese lizard species. We also discuss the evolution of vertebrate LDH isozymes.

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