CHAPTER 12

Descriptive Genetics of Cichlid Fishes

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1. Introduction

The evolutionary biology of cichlids is unusual principally because of the extensive adaptive radiations that have occurred in many endemic complexes (Futuyma, 1979). Within the major lakes of East Africa (Fryer and Iles, 1972) and smaller lacustrine systems in both Old and New Worlds (Taylor and Minckley, 1966; Trewavas et al., 1972; Barlow, 1976; Taylor and Miller, 1982), endemic species display dramatic morphological and ecological adaptations. Prodigious numbers of endemic species occur in Lake Malawi \((N = 500+;\) McKay and MacKenzie, 1982; McKay, personal communication), Lake Tanganyika \((N = 150+;\) Bailey and Stewart, 1977), and Lake Victoria \((N = 300+;\) Van Oijen et al., 1981). The apparent youth of many species in some of these systems presents at least two fundamental evolutionary questions: first, what mechanisms control divergence in ecology and functional morphology? and second, how do new species arise? While substantial insights have been made in the areas of functional anatomy and ecology by Barel et al. (1977), Greenwood (1981), Liem (1980), McKay (1980), and their coworkers, the basic questions of trophic divergence and speciation have remained controversial (Sage and Selander, 1975; McKay, 1980; Kornfield et al., 1982; McKay et al., 1983; Trewavas, 1982; Dominey, 1984; Greenwood, 1984).

The Cichlidae is a monophyletic group (Stiassny, 1981) of approximately 1200 species distributed over the entire African continent and much
of Central and South America. Additional endemic elements occur in India, Madagascar, and Sri Lanka. A tentative phylogeny has been presented by Chichoki (1976). Intentional introductions, principally of Old World tilapine species, have occurred globally. It is difficult to geologically date the separation of Old and New World faunas, since the ancestral species may have been euryhaline (Darlington, 1957) and thus capable of dispersal after Gondwanian fragmentation. Regardless, considerable evolutionary divergence has occurred both within and between these two major groups. With a few significant exceptions, diversification has primarily occurred in rivers in the New World and in lakes in the Old World. The general biology of many species is reviewed by Fryer and Iles (1972), Wohlfarth and Hulata (1981), and Pullin and Lowe-McConnell (1982).

The taxonomy of cichlids has recently undergone substantial revision. Generic allocations of tilapias and their allies are treated by Trewavas (1982, 1983); haplochromines have received extensive review by Greenwood (1979b, 1980, 1981). Additions to the fauna of Lake Tanganyika have been summarized by Bailey and Stewart (1977) and Liem (1981). Future changes in the taxonomy of African cichlids can be anticipated. Major changes have not occurred in New World systems, but a comprehensive treatment of certain elements, particularly the speciose genus Cichlasoma, has been warranted for some time. To stimulate thought on the evolutionary biology of cichlids, genetic characterization of the family is presented in the sections that follow. The pertinent literature is reviewed with the incorporation of additional new information. General statements about genomic evolution within the Cichlidae can be made. However, the absence of genetic information about inheritance and phenotypic plasticity, as well as gene flow and population structure, constrain the construction of models of adaptive radiation. Clearly, new genetic studies are needed. A general consideration of speciation and diversification in the family will appear elsewhere.

2. Genome Size

Quantitative estimates of nuclear DNA can be used to index major genomic modifications among related taxa. Given a sensitive assay, polyploidy or substantial deletions or duplications of genetic material can be detected. Within teleost families, haploid DNA content (C value) is generally conservative and does not reflect fine-scale genetic changes; homogeneous C values may be associated with significant karyotypic heterogeneity and vice versa (Park and Kang, 1976). While measurement variations associated with some assay techniques can significantly affect