COLORATION IN AFRICAN CICHLIDS: DIVERSITY AND CONSTRAINTS IN LAKE MALAWI ENDEMS

by

DOUGLAS M. McELROY1, IRV KORNFIELD and JON EVERETT

(Department of Zoology and Migratory Fish Research Institute, University of Maine, Orono, Maine 04469)

ABSTRACT

Male breeding coloration is an obvious and often diagnostic character for species identification among mbuna, the rock-dwelling haplochromine fishes of Lake Malawi. Colour diversification has figured prominently in most models of cichlid speciation, though considerations of colour diversity have been limited. We describe coloration for common species of mbuna by digital colour acquisition techniques and use these data to characterize coloration of the fauna.

The range of colour diversity in the mbuna is great; however, patterns of diversity appear somewhat limited. A number of taxa are similar in coloration, and several areas of available colour space are under-represented relative to random expectations. Colour diversification does not appear to be phylogenetically constrained, at least within species complexes. However, weakly significant associations between coloration and ecological characteristics exist. We discuss our results in terms of potential forces acting to influence mbuna coloration, such as phylogenetic or developmental constraints and natural or sexual selection.

KEYWORDS: Cichlid, coloration, speciation, natural selection, sexual selection.

"On the northeast coast of [Lake] Nyassa, we chanced upon an extraordinary fish. The animal, which resembled the fish of Mbamba Bay, was entirely purple in colour, with the exception of three orange spots on the trailing fin. As this was the only specimen obtained, we could not know if it is indigenous or merely a local sport."

Col. Graham McK. Willigs
Rhodesia Survey, 1889

INTRODUCTION

The cichlid fish faunas of the East African great lakes have interested evolutionary biologists for over one hundred years. In addition to the tremendous morphological diversity developed within these fishes over short evolutionary time spans, members of these endemic faunas possess bright and often diagnostic coloration, which is intensified and prominently displayed during social interaction.

1 To whom correspondence should be addressed
The mbuna, rock-dwelling haplochromine cichlids of Lake Malawi, are of particular interest with respect to coloration. The mbuna form an assemblage of over 200 species in ten genera (TREWAVAS, 1935; RIBBINK et al., 1983, REINTHAL, 1990), that exhibit marked colour differentiation. Suitable rocky habitats for the highly stenotopic mbuna are often distributed patchily; most isolated localities support unique communities (RIBBINK, 1986) often composed in part by endemic colour variants. Not only is coloration often the best character for species level identification at any locality (RIBBINK et al., 1983), but it is the basis for marked geographic variation within species.

Because coloration is such a striking (and consistent) character in species identification, investigators have implicated colour differentiation in most models of cichlid diversification. FRYER & ILES (1972) stressed the role of coloration as a behavioural signal involved in species recognition. GREENWOOD (1965), pointing to the rapid colour differentiation (in < 5000 yr.) shown by the fishes of Lake Nabugabo relative to their presumptive parental species in Lake Victoria, suggested that colour differences may be critical to the formation and maintenance of reproductive isolation. Coloration has been implicated in isolation among sympatric members of the Pseudotropheus zebra species complex (HOLZBERG, 1978; MARSH et al., 1981) and RIBBINK et al. (1983) emphasized colour differences when categorizing allopatric populations of uncertain taxonomic rank. Finally, DOMINEY (1984) suggested that differences in coloration may drive sexual selection through intermale competition or female choice.

A critical component to evaluation of these ideas is the accurate description of coloration. Unfortunately, because considerations of colour diversity have generally been without a common point of reference, hypotheses positing a role for coloration in community structuring and speciation have remained largely untestable. Herein we report results of digital colour analysis establishing a data base for cichlid colour diversity. We examine 30 species of rock-dwelling cichlids (mbuna) from Lake Malawi. These data are applied to an initial evaluation of the association between coloration and ecological characteristics. We discuss our findings with respect to current models of cichlid evolution involving natural and sexual selection.

MATERIALS AND METHODS

To quantify coloration, we adopted the Tektronix HLS (hue, light, saturation) colour model, based on the Oswald colour system (Oswald, 1931) which defines colour on a human perceptual level. Colour space is continuous, such that a range of non-spectral magenta