

THE FRACTAL DIMENSION: MEASURING BEHAVIORAL COMPLEXITY AND ITS IMPLICATIONS FOR EVALUATING THE HEALTH OF PRIMATES IN THE WILD

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Parasitism and other stresses are ubiquitous in nature but their effects on individual animals are difficult to ascertain in the absence of clear symptoms. Fractal analysis of behavior presents a novel quantitative and non-invasive approach to measuring behavior and health. Such analyses have shown that stressed, e.g. sick or parasitized, animals under experimental and wild conditions exhibit reduced complexity in their temporal patterns of behavior; their behavior exhibits greater periodicity and predictability. Complexity, in this sense, represents an evolutionary adaptation to the inherently variable conditions in an animal's natural environment. We employed Detrended Fluctuation Analysis (DFA) to examine the fractal dimension, i.e. degree of temporal complexity, of foraging and locomotion behavior in wild Japanese macaques (*Macaca fuscata yakui*) inhabiting Yakushima Island. AJJM observed all sexually mature individuals (≥ 5 years; $N=28$) of Umi group between October 2007 and August 2008, and collected two fecal samples per month from each individual to assess their state of gastrointestinal helminth parasitism. Our mixed model analyses suggest that a number of life history and ecological variables affect the fractal dimension of these behaviors. For example, Young adults and females exhibited greater complexity than older individuals and males, respectively. Fractal dimension was lowest during the mating season (fall), when stress levels are high, and reproductively active females (mating, pregnant, periparturient) consistently displayed lower fractal dimensions than other females throughout the year. The effects of parasitism were less clear, but our data indicate reductions in complexity with infection, particularly among aged individuals. We discuss our results in terms of fundamental differences in behavior and the ability of individuals to maintain complexity under physiological stress.

Keywords: behavioral complexity, health, parasitic stress, Japanese macaque