

Effects of Vitamin C Deficiency on Body Shape and Skull Osteology in *Geophagus brasiliensis*: Implications for Interpretations of Morphological Plasticity

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Morphological plasticity in fish and other vertebrates is usually attributed to the bone and muscle remodelling that results from exposure to different environmental regimes requiring different kinematic responses, such as feeding on different diets. I examined the extent of morphological plasticity that could be induced by feeding *Geophagus brasiliensis*, fish known to respond via plasticity to different foods, diets identical in consistency, but which differed in the amount of vitamin C they contained. Vitamin C is crucial to proper bone and connective tissue development, and there are numerous qualitative reports of deformation related to vitamin C deficiency. In this experiment, fish fed the vitamin C deficient diet differed in caudal peduncle measurements and had shorter snout and oral jaw measurements than fish fed the vitamin C sufficient diet. These results suggest that both nutritional differences between diets and mechanics of feeding on different diets in different ways can induce morphological plasticity.

THERE are a growing number of reports of phenotypic plasticity of jaw, skull, and body shape in vertebrates (Collins and Cheek, 1983; Witte, 1984; Wimberger, 1991). Those that involve trophic morphology usually infer that differences in the way that an organism captures or processes prey lead to the induced morphological differences. A heretofore unexplored alternative explanation for the morphological differences is that differences in nutrition between diets lead to morphological

differences. In this paper, I examine the effect of vitamin C deficiency on jaw, skull, and body shape in *Geophagus brasiliensis*, a species known to be morphologically plastic when fed different diets (Wimberger, 1991, 1992), to determine whether the morphological differences were due to feeding behavior or nutritional effects.

Differences in both body shape and jaw and skull morphology were previously induced in two species of the cichlid genus *Geophagus* by feeding juveniles either chironomid larvae or