

Preliminary Observations on the Sexual Development of Hogfish, *Lachnolaimus maximus* (Pisces: Labridae)

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ABSTRACT

Hogfish are the largest and most valuable wrasse species in Florida's waters. Recreational and commercial fishers combined caught an annual average of 400,000 pounds of hogfish during the last 12 years. Declining landings and catch rates, together with rapidly increasing prices per pound, suggest that problems may persist for hogfish populations despite fishery regulations enacted in 1994. Hogfish are hermaphroditic (protogynous) and there is concern that the minimum size limit of 12 inches may be too small to allow females to change to males in heavily fished areas. We are currently reviewing data from the Florida Marine Fisheries Information System, the Marine Recreational Fishery Statistics Survey, and special collections of hogfish. Fish were collected with spears, trawls, and traps. Otoliths were removed for age determination and gonads were fixed for characterization of reproductive biology. Here, we present our methods of reproductive staging through the use of histological preparations. We also present preliminary results on the associations between morphometric and pigmentation characters and reproductive development, and we compare the sizes at first maturity and sexual transformation of fish collected in the northeastern Gulf of Mexico with those of fish from the Florida Keys.

KEY WORDS: Hermaphroditism, protogyny, sexual dichromatism

INTRODUCTION

Hogfish life-history research has been conducted in the Florida Keys (Davis, 1976), Puerto Rico (Colin 1982), and Cuba (Claro et al. 1989). However, the pattern of sexual development of hogfish has received only limited treatment, particularly in comparison to other wrasse species. Wrasses (Labridae) and the related parrotfishes (Scaridae) have complex and diverse mating systems, patterns

of sex change, and sexual dichromatism (Robertson and Warner 1978, Warner and Robertson 1978). In many of these species, for example, size at sexual transformation can be explained by adaptive processes of sexual selection.

The purpose of this study is to describe the sexual development of hogfish in a manner comparable to previous studies of the sexual development of other wrasses (e.g., Warner and Robertson 1978). While such information is of interest to evolutionary ecologists, the results are of more than theoretical value. Hogfish are the largest Caribbean wrasse (Randall 1968), and they are harvested as a foodfish throughout Florida's coastal waters, particularly in regions with reef habitats, such as the Florida Keys or the Gulf of Mexico Middle Ground. Both recreational and commercial fishers use spears and hook-and-line gear to capture hogfish. This species is known for remaining in the vicinity of diver activity, a behavior that makes hogfish particularly vulnerable to spearfishing. Because anecdotal information for the Florida Keys indicates that average hogfish size has decreased in recent years (DeMaria 1996), this study will also examine if life-history parameters such as size at maturity have changed relative to previous reports of hogfish life history.

Hogfish are known to be protogynous hermaphrodites, but previous studies had emphasized macroscopic or population-level sexual characteristics, which can occasionally be misleading (Sadovy and Shapiro 1987). In this study, we are examining microscopic characters from histological preparations of gonad tissue. We are specifically interested in sexual characteristics of hogfish such as size at first maturity and size at sexual transformation, and in evidence for monandric versus diandric protogyny. Diandry refers to a pattern in which both primary and secondary males are present in a population, whereas monandry refers to a pattern in which all males in a population have transformed from a female stage.

Histological preparations were made from a portion of tissue excised from the mid-dorsal area of the gonad. Tissue samples were embedded in glycol methacrylate, sectioned along the transverse plane, and stained with PAS/iron-hematoxylin and counterstained with metanil yellow (Quintero-Hunter et al. 1991). Our staging scheme for gonad development was adopted from the system developed by Moe (1969) for the protogynous hermaphrodite *Epinephelus morio* (Serranidae). This system was adapted for a labrid, the protogynous hermaphrodite *Semicossyphus pulcher*, by Warner (1975). Warner had chosen to lump two male classes, but we find it useful to use all ten classes established by Moe (1969). Details of our microscopic criteria will be published elsewhere. We also measured several morphological characters, particularly those relating to head shape, and pigment characters to identify sex-specific allometry and sexual dichromatism. Preliminary results reported here are based on approximately 750 hogfish, about half of our anticipated final sample size.

Proceedings of the 52nd Gulf and Caribbean Fisheries Institute

Our preliminary observations of histological preparations indicate that hogfish are monandric (i.e., all fish begin as females and all males are secondary). We are still assessing evidence for whether sex change by this species is strictly postmaturational (i.e., sexual transition occurs after a functional female stage). We have confirmed several pigment patterns that are characteristic of the terminal male phase: a mask covering the snout, a caudal fin band, and a dash behind the pectoral fin. Sexual dichromatism in hogfish is particularly useful for field identification of sexes; it can be and has been used to observe hogfish harem formation and reproductive behavior (Colin 1982). We can also confirm that dramatic changes in snout morphology are associated with transformation into the terminal phase.

Because fishing pressure on hogfish has increased in the Florida Keys since the 1970s (Bohnsack et al. 1994), hogfish size at maturity could theoretically change over time in response to this fishing pressure. This research question will affect management of this species, but we do not have a final result here because the samples we have examined to date represent an uneven mix of fish sizes, months of collections, and collection localities. Based on our preliminary results, sexual transformation begins at a size (300 mm FL) similar to that reported by Davis (1976) for hogfish collected in the middle Florida Keys during 1973 - 1974. In contrast to this preliminary finding, Cowen (1990) observed that in heavily fished areas, sexual transformation occurred in smaller-than-normal sheephead, *Semicossyphus pulcher*, a temperate labrid. His results were consistent with and offered further insight into both the size-advantage model of Ghiselin (1969) and the sex-ratio model of Shapiro and Lubbock (1980). We are also interested in examining whether sex ratios for hogfish have changed in response to fishing pressure. For example, we plan to examine whether increases in fishing effort have caused harem structure to shift to smaller males and if it has, whether these males are controlling smaller and fewer females. Our final conclusions about the significance of sexual patterns in hogfish will be reported after we have reviewed all the gonadal material available to us.

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