Aberrant Sagittae in Black Sea Bass Occur Frequently in Isolated Areas

MARK R. COLLINS and H. SCOTT MEISTER
South Carolina Department of Natural Resources
Marine Resources Research Institute
P.O. Box 12559
Charleston, SC 29422-2559 USA

ABSTRACT

Black sea bass, *Centropristis striata*, were collected during 1991 - 1995 at randomly selected reef sites throughout the South Atlantic Bight (SAB) and were aged by two readers using whole sagittae. At the conclusion of the ageing study, perusal of the data suggested a clumped distribution of specimens marked as unreadable (i.e., aberrant). Sample sites located within ± 0° 0.4' lat./long. or less of each other, and which were sampled in at least three of the five years, were labelled "areas of aberrancy". Three such areas were identified, and all were off South Carolina in depths of 26 - 44 m. Total ocurrence of aberrant otoliths in the areas of aberrancy (38 of 135 specimens; 28.1%) was significantly greater (X^2: $p < 0.001$) than in the rest of the SAB (158 of 1,786; 8.8%). Although only 7.6% of black sea bass were collected in the areas of aberrancy, 19.4% of all aberrant otoliths encountered were from these areas. Further, occurrence in each of the three areas was significantly greater than in the rest of the SAB (X^2: $p < 0.001$ for all). Lengths of fish from the three areas suggested that individuals of ages one through at least four had aberrant otoliths. The reason why aberrant otoliths occurred with unusually high frequency in small, isolated areas is not apparent. If the cause is an unusual combination of physical conditions in the three areas, further study may assist in our understanding of calcium metabolism and variation in fish growth. On the other hand, if otolith aberrancy is a heritable trait, the dispersion pattern of affected fish could be used to examine stock structure and recruitment.

KEY WORDS: Aberrant, black sea bass, *Centropristis striata*, otoliths

INTRODUCTION

In fish ageing studies based on interpreting marks on hard parts, percent readability is a commonly reported statistic that describes the proportion of otoliths to which the reader(s) could assign an age. Percent readability is quite high in most studies of otoliths (with the exception of certain groups such as deepwater serranids), and unreadable otoliths often appear obviously abnormal or aberrant (M.R. Collins, pers. observ.). Types of aberrancies and their geographic and temporal distributions are rarely presented in published studies. Here we report unusually high frequencies of occurrence of aberrant otoliths from

specific reef locations.

METHODS

An ageing study of black sea bass, *Centropristis striata*, was conducted as part of an update of the stock assessment provided by Vaughan *et al.* (1995). The fish were collected (primarily with traps) during 1991-1995 at randomly selected sites (343-606 sites/yr) in known reef habitat throughout the South Atlantic Bight (SAB; Cape Hatteras, NC to Cape Canaveral, FL) during an annual, fishery-independent reef fish stock assessment survey. Up to 50 fish in each 25 mm size class from 100 to 400 mm total length (TL), and all fish >400 mm TL, were randomly selected for ageing from the samples of black sea bass collected each year. Whole sagittae were placed in water and examined under a dissecting microscope by two readers. Specimens were eliminated from further consideration by being labelled aberrant by either reader. Both otoliths were available for most fish, and if one was readable the specimen was not labelled aberrant. At the conclusion of the ageing study, perusal of the data suggested a clumped distribution among collection numbers of specimens labelled aberrant. Locations of these collections were determined; clusters of collections located within $\pm$ 0° 0.4' lat./long. or less of each other, and which were sampled in at least three of the five years, were labelled "areas of aberrancy".

RESULTS AND DISCUSSION

Three areas of aberrancy were identified: one at a depth of 26 m off Georgetown, SC, one in 33-35 m off Capers Island, SC, and one in 44 m off Pritchard Island, SC (Table 1). Two of the areas were sampled in three years (1992 - 1994) and one was sampled in four years (1992 - 1995). Because none of the areas were sampled in 1991, data from that year were deleted from analyses. Total ocurrence of aberrant otoliths in the areas of aberrancy (38 of 135 specimens; 28.1%) was significantly greater (X^2: $p < 0.001$) than in the rest of the SAB (158 of 1,786; 8.8%). Although only 7.6% of the specimens came from the areas of aberrancy, 19.4% of all aberrant otoliths encountered over the four year period were from these areas. Further, occurrence in each of the three areas was significantly greater than in the rest of the SAB (X^2: $p < 0.001$ for all). Pooled occurrence by year in the three areas was also significantly greater than in the rest of the SAB for 1992 and 1993 (X^2: $p < 0.001$), but not for 1994. A similar comparison for 1995 could not be made because the small sample size (11 fish) from the areas of aberrancy produced an expected value that was unacceptably small for the Chi-square test.

Examination of length frequencies of fish from the areas of aberrancy showed no difference in size distribution between those with aberrant and normal otoliths. It also indicated that the high percentage of aberrant otoliths was not

due to a single aberrant year class; rather, fish of ages one through at least four were probably involved.

Table 1. Percentage of black sea bass sagittae considered aberrant (sample size in parentheses) for three locations and for the rest of the South Atlantic Bight over a 4-year period. Area 1 is in the vicinity of 33°16.8'N/78°25.9'W (depth = 26 m), area 2 is in the vicinity of 32°20.2'N/79°12.7'W (depth = 44 m), and area 3 is in the vicinity of 32°47.6'N/78°46.9'W (depth = 33-35 m).

	Areas of Aberrancy				
Year	**Area 1**	**Area 2**	**Area 3**	**Total**	**SAB**
1992	42.9 (14)	62.5 (8)	14.3 (7)	41.4 (29)	10.0 (459)
1993	33.3 (3)	23.8 (21)	39.1 (23)	31.9 (47)	11.9 (411)
1994	0.0 (5)	21.1 (19)	20.8 (24)	18.8 (48)	10.6 (377)
1995	18.2 (11)			18.2 (11)	4.3 (539)
Total	27.3 (33)	29.2 (48)	27.8 (54)	28.1 (135)	8.8 (1,786)

Black sea bass otoliths exhibited several patterns of aberrancy. The most common pattern consisted of unusually thick and mostly opaque sagittae with few or no discernible marks. A less common pattern of aberrancy was partial or total translucency of a large portion of the sagitta, with the affected part having an irregular crystalline appearance. Otoliths fitting the latter description, but not the former, have been reported from several species, and numerous causes of the aberrancy have been proposed (Mugiya, 1972; Gauldie, 1986; David *et al.*, 1994). Strong *et al.* (1986) divided the continental shelf off Nova Scotia into three areas and found that in pollock, *Pollachius virens*, the frequency of the latter aberrancy differed among areas (2.6% - 4.6%). However, smaller areas of high occurrence of aberrancy were not reported. Wenner *et al.* (1986), in a thorough study of the life history of black sea bass, unfortunately did not report the percent readability or comment on aberrant otoliths.

Two ageing studies of the same species often result in substantially different percent readabilities. This may be attributed to differences in the skill (or willingness to guess at ages) of the readers, although Collins *et al.* (1989) and Beamish (1979) reported differences in appearance and readability of otoliths at the population level. Small, seemingly isolated areas of aberrancy such as those described here have apparently not been reported previously. Black sea bass have

planktonic eggs and larvae but are relatively sedentary as adults (Collins *et al.*, in press; Parker, 1990), so a group of fish with aberrant otoliths that were recruited to a reef area might persist for years. However, length frequencies indicated that the high percentage of aberrancies was present in several year classes.

Of the several explanations previously postulated for otolith aberrancy, two seem most applicable to this case. One is that some physical attribute(s) of the areas of aberrancy (e.g., frequent but geographically isolated cold water intrusions) interrupt proper otolith formation after fish are recruited to the area (i.e., settle out of the plankton). Available hydrographic data are inadequate to determine whether this situation exists. The other explanation is that otolith aberrancy is a heritable trait, and that the areas of aberrancy regularly draw recruits from a genetically distinct group of spawners in which the trait is significantly more common than in the rest of the SAB. The case for this explanation is weak, however, as many of the fish spawned within the areas of aberrancy and recruited elsewhere should also possess the trait. We suggest that future fish ageing studies include examination of the geographic distribution of unreadable otoliths, as determining the cause of aberrancies might provide information on recruitment mechanisms and the structure of populations and, as suggested by Mugiya (1972), could have a bearing on research into the polymorphic formation of calcium carbonate.

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LITERATURE CITED

Beamish, R. J. 1979. Differences in the age of Pacific hake (Merluccius productus) using whhole otoliths and sections of otoliths. *J. Fish. Res. Board Can.* **36**:141 - 151.

Collins, M. R., D. J. Schmidt, C. W. Waltz, and J. L. Pickney. 1989. Age and growth of king mackerel, *Scomberomorus cavalla*, from the Atlantic coast of the United States. *Fish. Bull.* **8**:49 - 61.

Collins, M. R., S. B. Van Sant, and G. R. Sedberry. Age validation, movements, and growth rates of tagged gag (*Mycteroperca microlepis*), black sea bass (*Centropristis striata*), and red porgy (*Pagrus pagrus*). Pages 161 - 165 in: F. Arreguin-Sanchez, J. L. Munro, M. C. Balgos and D. Pauly (eds.) *Biology, Fisheries and Culture of Tropical Groupers and Snappers.* ICLARM Conf. Proc. 48. In press.

David, A. W., C. B. Grimes, and J. J. Isely. 1994. Vaterite sagittal otoliths in hatchery-reared juvenile red drums. *Prog. Fish-Cult.* **56**:301-303.

Gauldie, R. W. 1986. Vaterite otoliths from chinook salmon (*Oncorhynchus tshawytscha*). *N. Z. J. Mar. Freshwat. Res.* **20**:209 - 217.

Mugiya, Y. 1972. On aberrant sagittas of teleostean fishes. *Jap. J. of Ichth.* **19**:11 - 14.

Parker, R. O., Jr. 1990. Tagging studies and diver observations of fish populations on live-bottom reefs of the U.S. southeastern coast. *Bull. Mar. Sci.* **46**:749 - 760.

Strong, M. B., J. D. Neilson, and J. J. Hunt. 1986. Aberrant crystallization of pollock (*Pollachius virens*) otoliths. *Can. J. Fish. Aquat. Sci.*

43:1457 - 1463.

Vaughan, D. S., M. R. Collins, and D. J. Schmidt. 1995. Population characteristics of the black sea bass *Centropristis striata* from the southeastern U.S. *Bull. Mar. Sci.* **56**:250 - 267.