DELINEATION OF TILEFISH, *LOPHOLATILUS CHAMAELEONTICEPS*, STOCKS ALONG THE UNITED STATES EAST COAST AND IN THE GULF OF MEXICO

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ABSTRACT

Tilefish, *Lopholatilus chamaeleonticeps*, are an important commercial species in the Mid-Atlantic Bight and the focus of developing fisheries in the South Atlantic Bight and the Gulf of Mexico. Attempts were made to delineate stocks over this range by analyzing for variation in morphology (28 meristic and morphometric characters) and electrophoretic migration of eye, liver, and muscle proteins. Morphological and electrophoretic data (liver isocitrate dehydrogenase and liver esterase) consistently supported a separate Mid-Atlantic Bight stock. Electrophoretic data suggested that South Atlantic Bight and Gulf of Mexico samples belonged to a separate, single stock. This was not consistently supported by the more variable morphometric characters. It was suggested that Mid-Atlantic Bight populations be treated as a separate stock and, as a working hypothesis, that South Atlantic and Gulf of Mexico populations be considered as a second stock.

Tilefish, *Lopholatilus chamaeleonticeps*, are distributed from southern Nova Scotia (Leim 1960; Markle et al. 1980) south to off Surinam, South America, (Wolf and Rathjen 1974) and throughout the Gulf of Mexico (Bigelow and Schroeder 1947; Hoese and Moore 1977) but exclusive of the Caribbean Sea (Dooley 1978). The tilefish is the basis for a valuable bottom longline fishery in the Mid-Atlantic Bight (Grimes et al. 1980), and this fishery is developing elsewhere along the east coast of the United States and in the Gulf of Mexico. This paper investigates tilefish populations to determine if separate stocks can be identified over this range.

There are several reasons to suspect that distinct stocks of tilefish may occur. Tilefish probably have a restricted habitat. They are reported from rather narrow temperature ranges (9°-14°C) at the edge of the continental shelf along the east coast (Goode 1884; Rathburn 1895; Bigelow and Schroeder 1953) and in the Gulf of Mexico (Nelson and Carpenter 1968; Wolf and Rathjen 1974). Also, preliminary tagging studies (Grimes et al. in press) suggested that individual tilefish moved <2 km in over 1 yr. These observations are supported by submersible observations which suggest that tilefish are resident in temporally stable burrows of their own construction (Able et al. 1982). In the Mid-Atlantic Bight, tilefish are caught the year-round which also suggests that these may be resident populations. In addition, the prevailing current patterns, temperature regimes, and species distribution patterns along the east coast suggest that important faunal boundaries may exist at Cape Hatteras and around the Florida peninsula (see Briggs 1974 for discussion). This study reports on morphological and electrophoretic characteristics of tilefish from the U.S. east coast and the Gulf of Mexico. The distribution of the characters were used to test the null hypothesis that there are no differences among these populations.

MATERIALS AND METHODS

Tilefish samples were obtained from commercial fishermen or collected by hook and line on exploratory fishing cruises (National Marine Fisheries Service RV *Oregon II*) during 1978 and 1979 (Fig. 1) (Katz 1982). Information on physical conditions at collection were unavailable, but temperature is known to be relatively constant throughout the range (see above). Fish were transported fresh, on ice, or frozen, depending on distance of collection from the laboratory.

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Manuscript accepted July 1982.
FISHERY BULLETIN: VOL. 81, NO. 1, 1983.

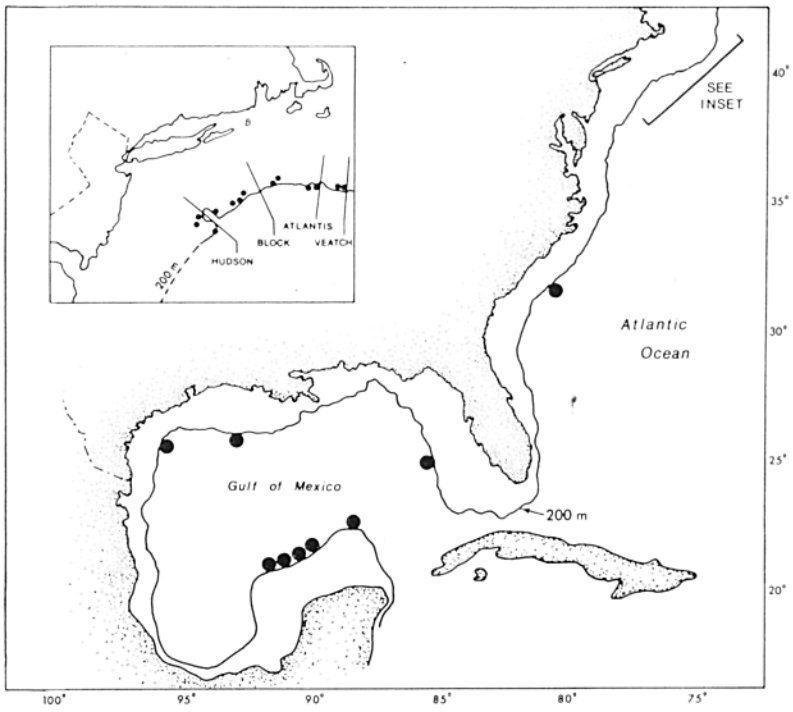

FIGURE 1.—Sample locations for tilefish along the U.S. east coast and the Gulf of Mexico. Submarine canyons are identified in the inset.

Electrophoresis

Eye, liver, and muscle tissues were removed from individual fish and frozen as soon as possible. Vertical starch gel electrophoresis was used to detect protein variation. Initially only tissues of fish from the most distant collection localities (Hudson Canyon and off Texas) were screened for 28 enzymes to maximize the chance of finding polymorphic enzymes. Of the 28 enzymes screened during the initial electrophoresis, several were scorable; however, most appeared monomorphic (malate dehydrogenase, lactate dehydrogenase, xanthine dehydrogenase, creatin kinase, adenylate kinase, peptidase, alcohol dehydrogenase, malic enzyme, 6-phosphogluconate dehydrogenase, and glyceraldehyde 3-phosphate dehydrogenase) and only two [liver isocitrate dehydrogenase (IDH) and liver esterase (EST)] were polymorphic. Liver tissues from all collections were then run for both IDH and EST with an amine citrate buffer (pH 6.0) (Clayton and Tretiak 1972) for 17 h at 140 V and 40°C, and allelic frequencies were determined for all populations. Allelic frequencies were compared with their Hardy-Weinberg expectations by a chi-square test (Spiess 1977). We evaluated differences between sample locations, by chi-square contingency tests of electromorph distribution between sample locations. This test does not assume Hardy-Weinberg equilibrium and compares n samples with k classes to determine whether the individual k classes are in the same relative proportion throughout the n samples.

Length (age)-related differences in genotype distribution were tested (chi-square) on the largest sample with a wide range of sizes ($n=40$, west side of Hudson Canyon). Fish were divided into two size classes (<550 mm fork length and >550 mm) based on the approximate size at sexual maturity.

Morphology

Seven meristic (number of dorsal fin spines and rays, anal fin spines and rays, pectoral fin rays, upper and lower gill rakers on the first arch) and 21 morphometric (fork, standard, total, pectoral fin, pelvic fin, upper jaw, snout, adipose flap, barbel, snout to vent, snout to anal origin, snout to dorsal origin, snout to incurrent nostril, lengths; orbit diameter, interorbital width, head width, height of first, second, and third dorsal fin spines, caudal peduncle depth, and suborbital depth) characters were counted or measured following Hubbs and Lagler (1967),

with two exceptions: Barbel length was measured from its posterior tip to the junction with the lower lip, and the suborbital depth was measured from the lower margin of the infraorbitals to the junction of the articular and interopercular bones. Morphometric characters were measured to the nearest millimeter with dividers and a tape measure. These characters were chosen on the basis of a preliminary study of two specimens of tilefish by Bigelow and Schroeder (1947) and a systematic study of the Branchiostegidae by Dooley (1978).

Morphological data was determined from fish of dissimilar lengths (Fig. 2), so we used analysis of covariance to remove the size effects as suggested by Atchley et al. (1976). A linear relationship to standard length (SL) was determined for most morphological characters with the exception of adipose flap length where an additional coefficient of standard length squared was included in the model because of allometry. For the final size-corrected comparisons between sample locations we used sample location least square means for each morphological character (Barr et al. 1976). Least square means are estimates of arithmetic means that would be predicted had samples with the same size composition been obtainable from each sampling location.

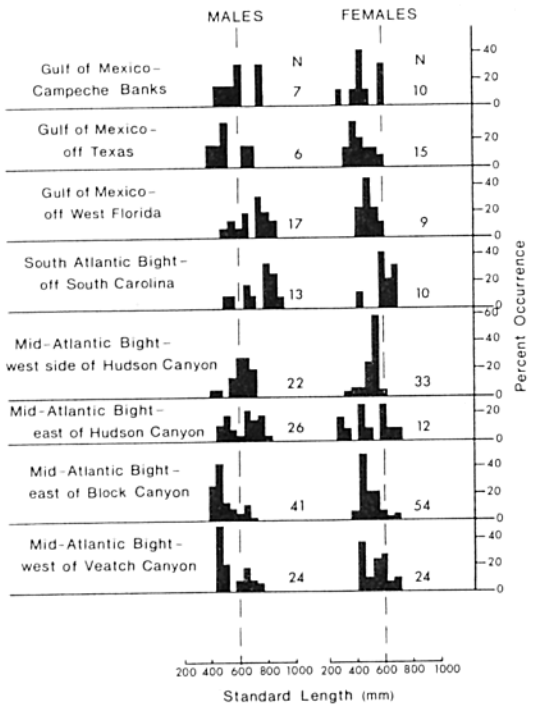

FIGURE 2.—Length-frequency histograms of tilefish samples used to conduct the morphological analysis. See Figure 1 for approximate locations.

We conducted analysis of covariance on each morphological character to test for differences between sampling locations. Sex, sample location, and all interactions were initially included in the covariance model, but all nonsignificant ($P<0.01$) interactions were removed from the final model. The difference between sample location least square means for each morphological character for each sex was tested by comparison with the west Hudson Canyon sample using a t test. Significant differences were determined conservatively, using a high significance level ($P<0.001$), because the possibility of finding differences increases with the number of tests run.

To further test for differences between sample locations we used discriminant function analysis (Jolicoeur 1959; Seal 1964) to determine the level of distinctness of fish from each location. The discriminant function was computed using both raw and size-corrected data for males and females separately, because the analysis of covariance indicated sexual dimorphism. Only linearly related morphological characters were used in the raw discriminant function (Seal 1964). Size correction of morphological characters was accomplished using the average value of standard length ($\overline{SL}$) of all samples, and linear and quadratic regression coefficients (B_1, B_2) obtained from covariance analysis for each morphological character according to the following formula:

$$\text{corrected} = \text{raw} - B_1 (\text{SL}-\overline{\text{SL}}) - B_2 (\text{SL}-\overline{\text{SL}})^2.$$

This correction removed size effects by displacing each morphological observation towards the average, while allowing sample location and interaction effects to remain.

RESULTS

Electrophoretic Data

The genetic basis of protein variation in tilefish was implied from the electrophoretic banding patterns. IDH showed a dimeric pattern (heterozygote was three banded) with medium, slow, and fast bands. The rare fast form occurred only as a heterozygote in 10 out of 226 fish in the Mid-Atlantic Bight samples; therefore it has been left out of the statistical analysis. The EST

locus exhibited a monomeric pattern (heterozygote was two banded) with fast and slow bands. Our interpretation of the dimeric and monomeric nature of these enzymes is consistent with past studies of their molecular structure (Manwell and Baker 1970). Distribution of EST and IDH electromorphs was not significantly different than expected from Hardy-Weinberg equilibrium (Tables 1, 2), which is additional support for a single-locus, two-allele genetic model. However, it should be noted that the chi-square test is not very sensitive at small sample sizes (<200) (Fairbairn and Roff 1980).

There was no significant difference in genotype distribution as a function of length (age) for both enzymes (EST $\chi^2 = 1.16$, $P>0.6$, $n = 20$; IDH $\chi^2 = 2.93$, $P>0.2$, $n = 20$) in the sample examined (west side of Hudson Canyon).

There were distinct patterns of variation among the populations sampled (Fig. 3). Chi-square contingency tests revealed no significant differences in genotype distribution within the Mid-Atlantic Bight or southern sampling locations (South Carolina, west Florida, Texas, and Campeche) (within Mid-Atlantic Bight EST $\chi^2_{5,3} = 8.77$, $0.25<P<0.5$; IDH $\chi^2_{5,3} = 9.45$, $0.25<P<0.5$: within southern locations EST $\chi^2_{4,3} = 4.12$, $0.5<P<0.75$; IDH $\chi^2_{3,3} = 7.34$, $0.1<P<0.25$). However, differences in genotype distributions between Mid-Atlantic Bight and southern samples were highly significant (EST $\chi^2_{9,3} = 45.01$, $P<0.001$; IDH $\chi^2_{8,3} = 111.76$, $P<0.001$).

Morphological Data

Gill raker numbers were the only meristic characters that were significantly different among samples. All gill raker counts (upper, lower, and total) for males and females from the Mid-Atlantic Bight samples were not significantly different from the west Hudson Canyon sample (Tables 3, 4). However, total gill rakers,

TABLE 1.—Comparison between observed genotypes and Hardy-Weinberg expectations (in parentheses) at the liver esterase locus for all tilefish sampling locations. See Figure 3 for sample sizes.

Sampling locations	A/A	A/B	B/B	χ^2
Gulf of Mexico				
Campeche Banks	4(4.51)	9(7.97)	3(3.52)	0.25 ns[2]
Off Texas	4(4.29)	11(10.40)	6(6.31)	0.06 ns
Off West Florida	9(6.78)	9(11.41)	7(4.80)	3.44 ns
South Atlantic Bight-				
off South Carolina	6(5.26)	10(11.48)	7(6.27)	0.10 ns
Mid-Atlantic Bight				
Hudson Canyon	46(45.24)	35(36.42)	8(7.33)	0.13 ns
Niche[1]	25(26.40)	22(19.13)	2(3.47)	1.13 ns
Block Canyon	45(44.27)	32(33.42)	7(6.31)	0.15 ns
Atlantis Canyon	34(36.24)	43(38.52)	8(10.23)	1.15 ns
Veatch Canyon	30(31.21)	19(16.59)	1(2.21)	1.06 ns
	χ^2 (0.05) = 3.84			

[1]Niche = name applied by fishermen to area about 50 km east of Hudson Canyon.
[2]ns = not significant.

TABLE 2.—Comparison between observed genotypes and Hardy-Weinberg expectations (in parentheses) at the liver isocitrate dehydrogenase locus for all tilefish sampling locations. See Figure 3 for sample sizes.

Sampling locations	A/A	A/B	B/B	χ^2
Gulf of Mexico				
Campeche Banks	1(0.39)	3(2.11)	12(11.40)	0.11 ns[2]
Off Texas	0(1.19)	10(7.62)	11(12.19)	2.05 ns
Off West Florida		no data, enzyme denatured		
South Atlantic Bight-				
off South Carolina	0(0.27)	5(4.47)	18(18.26)	0.12 ns
Mid-Atlantic Bight				
Hudson Canyon	29(31.65)	39(36.71)	8(10.64)	1.02 ns
Niche[1]	6(8.05)	12(9.91)	1(3.05)	3.59 ns
Block Canyon	37(34.42)	31(36.11)	12(9.47)	2.19 ns
Atlantis Canyon	14(14.77)	20(18.46)	5(5.77)	0.27 ns
Veatch Canyon	12(14.89)	25(19.23)	3(5.89)	3.71 ns
	χ^2 (0.05) = 3.84			

[1]Niche = name applied by fishermen to area about 50 km east of Hudson Canyon.
[2]ns = not significant.

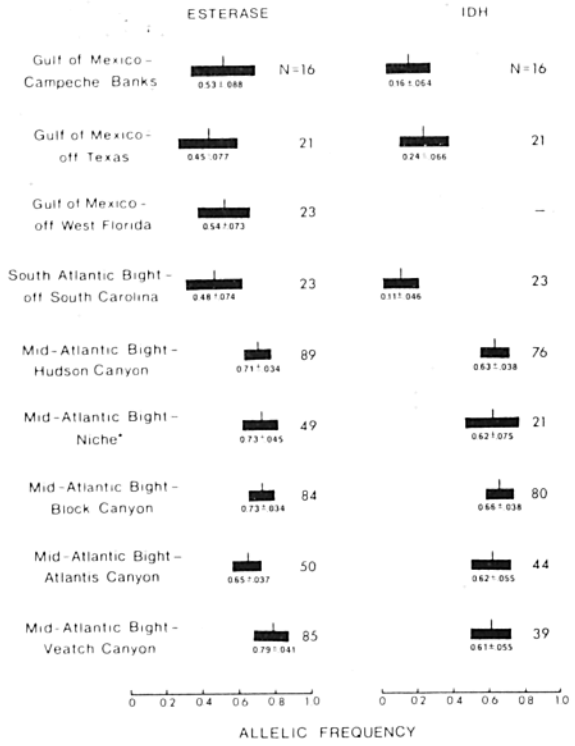

FIGURE 3.—Allelic frequencies of esterase and isocitrate dehydrogenase (IDH) for tilefish samples collected along the U.S. east coast and the Gulf of Mexico. Mean allelic frequency indicated by vertical line and bands represents 95% confidence intervals. Allelic frequency and standard error below bands. "Niche" = fisherman name of area approximately 50 km east of Hudson Canyon.

and less consistently the upper and lower gill raker number, differed significantly for the males and females from South Carolina and Gulf of Mexico samples (Tables 3, 4). These differences were not size related because there was no significant difference between fish size and gill raker number ($R^2 = 0.22$, $n = 328$).

Sexual dimorphism was apparent for several morphometric characters (Table 5); therefore all comparisons among morphometric characters were made separately for each sex.

Separate comparisons of male and female morphometric characters indicated that there were no significant differences among all of the east coast samples (Mid-Atlantic Bight and South Carolina—Tables 3, 4). The Gulf of Mexico samples, however, differed from the west Hudson Canyon site for most comparisons. In 16 of the 20 comparisons for males and 18 of the 20 for females the samples were significantly different (Tables 3, 4).

TABLE 3.—Comparison of size adjusted morphological characters (least squares means in mm) for male tilefish from sample locations by covariance analysis. Independent variable is standard length. Sample from west of Hudson Canyon is the basis for comparison. ** = $P<0.01$, *** = $P<0.001$.

Sampling locations	Pectoral fin length	Inter-orbital width	Orbit diam-eter	Caudal peduncle depth	Head length	Adipose flap length	Barbel length	2d dorsal spine length	1st dorsal spine length	No. of gill rakers		
										Upper	Lower	Total
Gulf of Mexico-Campeche Banks	141.0***	44.4	42.2***	44.4***	181.5***	16.1***	12.0	44.7***	32.0***	8.58	15.40**	23.97**
Gulf of Mexico-off Texas	140.5***	39.8***	39.8***	45.4	173.5***	10.5***	—	—	—	—	—	—
Gulf of Mexico-off west Florida	137.7***	42.9***	38.6	42.3	172.6***	19.5***	9.1***	49.6	38.1***	8.83**	15.23**	24.05**
South Atlantic Bight-off South Carolina	118.6	46.3	36.2	47.6	164.8	33.4	—	—	—	—	—	23.68**
Mid-Atlantic Bight-west of Hudson Canyon	126.7	46.6	32.8	49.6	164.5	37.7	16.1	52.0	42.0	8.11	14.65	22.76
Mid-Atlantic Bight-east of Hudson Canyon	127.4	47.3	35.7	47.6	165.0	39.6	16.0	49.9	40.1	8.53	14.74	23.26
Mid-Atlantic Bight-east of Block Canyon	125.0	44.9	34.9	47.0	166.6	44.9	16.4	51.5	39.2	8.24	14.54	22.79
Mid-Atlantic Bight-west of Veatch Canyon	126.9	44.7	34.9	47.8	166.4	40.6	17.2	50.0	39.5	8.33	14.75	23.09
R^2	0.91	0.93	0.82	0.91	0.98	0.83	0.48	0.77	0.74	0.11	0.15	0.22

TABLE 4.—Comparison of size adjusted morphological characters (least squares means in mm) for female tilefish from sample locations by covariance analysis. Independent variable is standard length. Sample from west of Hudson Canyon is the basis for comparison. ** = $P<0.01$, *** = $P<0.001$.

Sampling locations	Pectoral fin length	Inter-orbital width	Orbit diam-eter	Caudal peduncle depth	Head length	Adipose flap length	Barbel length	2d dorsal spine length	1st dorsal spine length	No. of gill rakers		
										Upper	Lower	Total
Gulf of Mexico–Campeche Banks	130.8	36.3***	39.2***	43.3***	172.6***	19.5***	10.5	43.6***	32.3***	8.59	15.23	23.83**
Gulf of Mexico–off Texas	138.5***	39.4***	42.9***	42.4***	170.7***	14.7***	—	—	—	—	—	—
Gulf of Mexico–off west Florida	133.2***	41.0***	41.7***	38.6***	172.1***	14.5***	5.8***	45.4***	34.2***	9.00***	15.12	24.14**
South Atlantic Bight–off South Carolina	123.9	42.6	36.8	47.0	165.4	21.0	—	—	—	—	—	24.07**
Mid-Atlantic Bight–west of Hudson Canyon	125.0	45.5	34.1	49.1	165.6	31.9	15.3	50.8	39.7	8.35	14.72	23.08
Mid-Atlantic Bight–east of Hudson Canyon	124.2	45.6	35.2	46.9	167.0	29.9	14.4	49.3	38.2	8.41	14.85	23.28
Mid-Atlantic Bight–east of Block Canyon	125.1	43.5	35.8	45.5	166.1	31.5	15.1	49.6	39.0	8.38	14.63	23.03
Mid-Atlantic Bight–west of Veatch Canyon	125.4	43.7	35.2	46.1	165.9	31.1	14.7	50.0	39.0	8.29	14.71	23.00
R^2	0.91	0.93	0.82	0.91	0.98	0.83	0.48	0.77	0.74	0.11	0.15	0.22

The nature of the variation in the morphometric characters examined varied between sexes and locations (Tables 3, 4). For several characters the least square mean values appeared to vary clinally. This was most evident for male adipose flap height and orbit diameter as seen in plots of raw data (Figs. 4, 5), female interorbital width and male head length. The values for other characters showed less consistent patterns and in some cases could be interpreted to suggest two distinct groups with the South Carolina samples most similar to Mid-Atlantic Bight groups (Tables 3, 4). This was most obvious for male pectoral fin length and female pectoral fin length, caudal peduncle depth, and head length. Clinal variation was also suggested by the increasing number of significantly different morphological characters with increasing geographic distance between compared samples.

The discriminant function analysis was conducted with both raw and size-corrected data. In each case the results were virtually identical with two exceptions (males, east Hudson Canyon - 60% correct classification with size corrected vs. 23% raw data, and Campeche - 86% correct classification vs. 43% raw data). We believe neither of these significantly affects the overall interpretation of the results, and we report the raw data results here (Tables 6, 7).

The discriminant function analysis suggests a similar clinal pattern of variation for both males and females (Tables 6, 7). There was generally low differentiation within the Mid-Atlantic Bight samples, and where misidentification occurred it was to other Mid-Atlantic Bight or South Carolina samples and infrequently to west Florida and the Gulf of Mexico off Texas. Gulf of Mexico samples naturally had higher percentage correct classification (sample locations were more widely separated geographically) and incorrect classifications were usually to other Gulf of Mexico samples. Classifications for South Carolina samples had a high correct classification, and where misclassification occurred it was to both Mid-Atlantic Bight and Gulf of Mexico locations.

DISCUSSION

For purposes of interpreting the significance in allelic frequencies observed for IDH and EST we are assuming that the genetic variation observed is neutral (Allendorf and Phelps 1981; Ihssen et al. 1981). Thus, based on the patterns

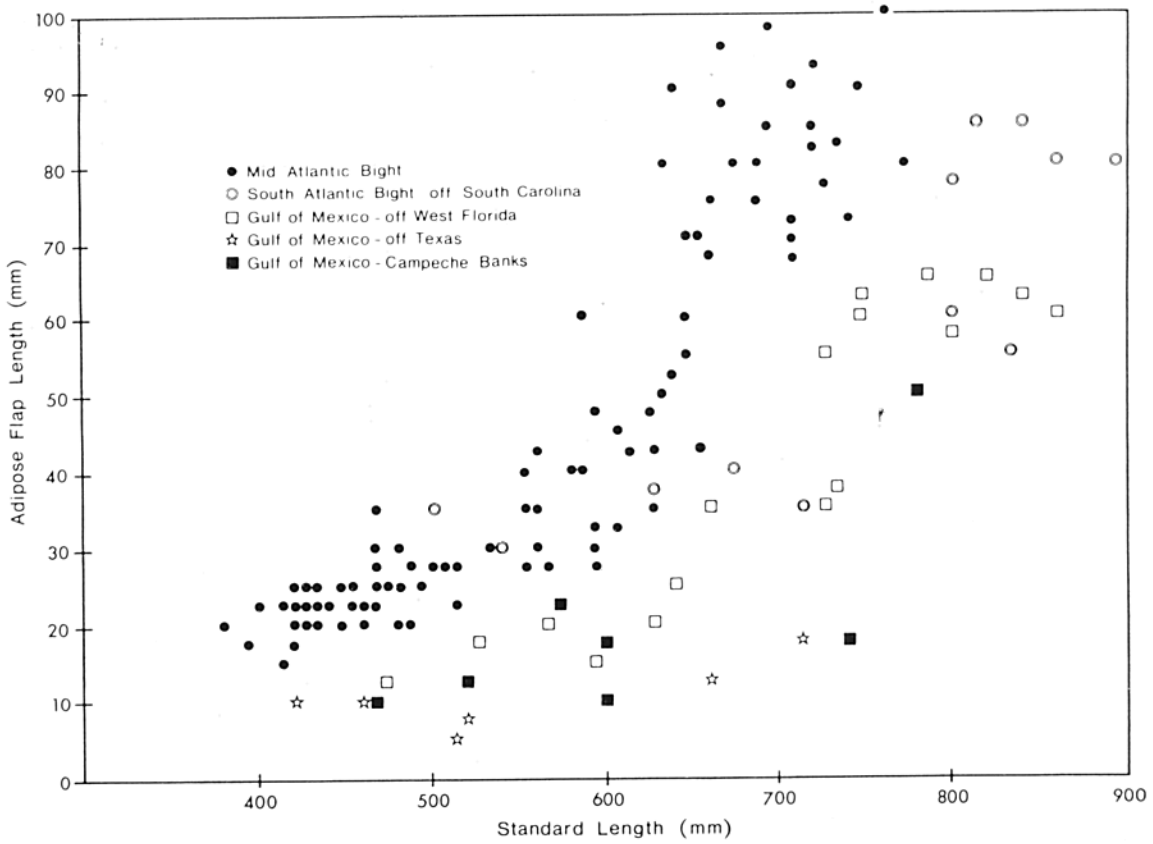

FIGURE 4.—Adipose flap length plotted against standard length for male tilefish from the U.S. east coast and the Gulf of Mexico.

TABLE 5.—Comparison of size adjusted morphological characters (least squares means in mm) for male and female tilefish by covariance analysis. Independent variable is standard length. ** = $P<0.01$.

	Inter-orbital width	3d dorsal spine length	2d dorsal spine length	1st dorsal spine length	Snout to anal origin length	Caudal peduncle depth	Barbel length	Snout to nostril length	Adipose flap length
Males	44.6**	56.6**	49.6	38.5	323.7	46.5**	14.4	47.4	30.3**
Females	42.2	54.7	48.3	37.1	328.3	44.9	12.6	46.2	24.3
R^2	0.93	0.87	0.77	0.74	0.97	0.91	0.48	0.91	0.83

observed (Fig. 3), we reject the null hypothesis and suggest that there are at least two distinct groups in the samples examined, a Mid-Atlantic Bight group and a second group composed of samples from South Carolina and the Gulf of Mexico. This is supported by concordance in the patterns of variation for both EST and IDH (Fig. 3).

The morphological data consistently support the concept of a single group of fish in the Mid-Atlantic Bight but varies for other areas. Both meristic and morphometric data for both sexes in the Mid-Atlantic Bight show little significant variation (Tables 3, 4, 6, 7), suggesting that these are freely interbreeding populations. The Gulf of Mexico samples appear completely distinct from Mid-Atlantic Bight samples by the same analysis. The morphological analyses of the South Carolina samples were contradictory with the electrophoretic results. The comparisons of least squares mean values for morphometric characters for the South Carolina samples to the Mid-Atlantic Bight samples (Tables 3, 4) consistently indicated no significant differences. However, the South Carolina samples differed significantly in total gill raker number as did the Gulf of

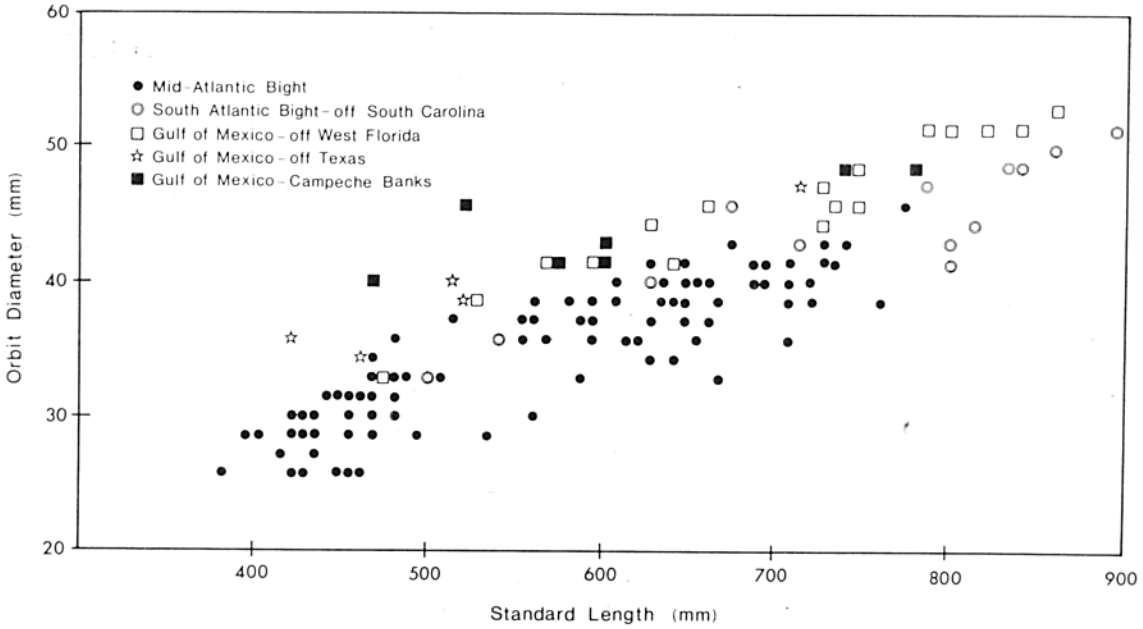

FIGURE 5.—Orbit diameter plotted against standard length for male tilefish from the U.S. east coast and the Gulf of Mexico.

TABLE 6.—Percent male tilefish classified to sample locations by discriminant function analysis.

From sample locations	To sample locations: Gulf of Mexico-Campeche Banks	Gulf of Mexico-off Texas	Gulf of Mexico-off west Florida	South Atlantic Bight-off South Carolina	Mid-Atlantic Bight-west of Hudson Canyon	Mid-Atlantic Bight-east of Hudson Canyon	Mid-Atlantic Bight-east of Block Canyon	Mid-Atlantic Bight-west of Veatch Canyon	N
Gulf of Mexico-Campeche Banks	43	14	43						7
Gulf of Mexico-off Texas	17	83							6
Gulf of Mexico-off west Florida	18	12	70						17
South Atlantic Bight-off South Carolina			9	75		8	8		12
Mid-Atlantic Bight-west of Hudson Canyon				9	55	18	9	9	22
Mid-Atlantic Bight-east of Hudson Canyon			4	15	23	23	19	16	26
Mid-Atlantic Bight-east of Block Canyon		2		5	7	5	54	27	41
Mid-Atlantic Bight-west of Veatch Canyon			12	4	4	17	50	13	24

TABLE 7.—Percent female tilefish classified to sample locations by discriminant function analysis.

From sample locations	To sample locations: Gulf of Mexico-Campeche Banks	Gulf of Mexico-off Texas	Gulf of Mexico-off west Florida	South Atlantic Bight-off South Carolina	Mid-Atlantic Bight-west of Hudson Canyon	Mid-Atlantic Bight-east of Hudson Canyon	Mid-Atlantic Bight-east of Block Canyon	Mid-Atlantic Bight-west of Veatch Canyon	N
Gulf of Mexico-Campeche Banks	20	20	50			10			10
Gulf of Mexico-off Texas		87	13						15
Gulf of Mexico-off west Florida		22	78						9
South Atlantic Bight-off South Carolina			10	70		10	10		10
Mid-Atlantic Bight-west of Hudson Canyon			3	6	45	3	33	9	33
Mid-Atlantic Bight-east of Hudson Canyon				17	17	33	33		12
Mid-Atlantic Bight-east of Block Canyon	2		4	11	6	3	67	9	54
Mid-Atlantic Bight-west of Veatch Canyon			4	17	8	5	33	33	24

Mexico populations. In the discriminant function analysis South Carolina samples of both sexes classified correctly a high percentage of the time but misclassification occurred to both Mid-Atlantic Bight and Gulf of Mexico samples. The variability in the pattern of morphological characters can be accounted for by clinal variation in these characters, or, less likely, by two distinct groups that are only weakly differentiated. The interpretation of the morphological data may also be hampered by the small samples for more southern populations and the great distances between them.

Other life history data for tilefish in the Mid-

Atlantic Bight are in accord with the concept of a separate stock. As we have previously mentioned, they are resident because they are taken year-round in the fishery (Grimes et al. 1980), apparently move short distances in the course of a year (Grimes et al. in press), and construct temporally stable burrows that may be occupied for the life of a fish (Able et al. 1982). In addition, they are known to reproduce in the Mid-Atlantic Bight because gonads show seasonal patterns of development and decline (Idelberger et al. 1981) and eggs and larvae have been collected (Fahay and Berrien 1981).

The prevailing current patterns and hydrographic regimes over the study area are consistent with our delineation of the stocks. While there is a southwesterly drift of shelf water within the Mid-Atlantic Bight (Miller 1952; Bumpus 1973) that would provide mixing of eggs and larvae, it is unlikely that egg or larval transport occurs between the Mid-Atlantic and South Atlantic Bights. The Gulf Stream turns eastward at Cape Hatteras so that its axis is located 250 km east of the shelf break in the Mid-Atlantic Bight (Emery and Uchupi 1972). This difference in Gulf Stream effects produces distinct northern and southern continental shelf water masses (Stefansson et al. 1971; Emery and Uchupi 1972). Thus it is unlikely that egg and larval transport between these two areas would commonly occur, although Cox and Wiebe (1979) have suggested that anticyclonic eddies could provide a mechanism for transporting oceanic larvae across the Gulf Stream to Mid-Atlantic Bight waters.

Prevailing current systems in the southern United States may provide the means for larval mixing between the Gulf of Mexico and the South Atlantic Bight as suggested by the similarities in allelic frequencies for samples from these two areas. The Gulf of Mexico Loop Current (Maul 1977) provides a means for tilefish larvae to be transported out of the Gulf of Mexico and into the South Atlantic Bight as it joins the Florida Current and eventually forms the Gulf Stream.

In addition to prevailing currents, periodic mass mortality may have contributed to the differences between distinct stocks. Following their discovery by a cod fisherman off southern New England in 1879, tilefish experienced a mass mortality in 1882 (a few billion fish reported floating at the surface; Bumpus 1898) probably caused by a sudden temporary intrusion of cold water (McLellan et al. 1953; Hachey 1955). This mortality may have resulted in a "founder effect" phenomenon and thus be responsible for stock differences we have noted.

In summary, we believe that the available data suggest that Mid-Atlantic Bight tilefish populations represent one unit stock and that South Atlantic Bight and Gulf of Mexico populations be considered another stock, at least as a working hypothesis. However, the wide geographic separation of the latter two areas may necessitate managing them as two stocks. Because the electrophoretic results suggest that gene flow may occur between Gulf of Mexico and South Atlantic Bight populations, this should be done with cognizance that Gulf of Mexico populations could serve as a source of recruits to South Atlantic Bight populations.

ACKNOWLEDGMENTS

This work was initiated upon the urgings and assistance of our friend, the late Lionel Walford, and could not have been accomplished without the cooperation and assistance of other persons whom we wish to gratefully acknowledge. S. Turner and M. Horvath assisted in processing samples. R. Trout provided valuable statistical council and R. Vrijenhoek availed us of his electrophoresis facilities and expertise. Fran and Lou Puskus and commercial tilefish fishermen in Barnegat Light, N.J., helped us obtain Mid-Atlantic Bight samples. M. Godcharles, Marine Research Laboratory, Florida Department of Natural Resources, helped us obtain samples from west Florida. Samples from off Texas, South Carolina, and the Yucatan Peninsula (Campeche Bank) were obtained from National Marine Fisheries Service RV *Oregon II* cruises. Financial support was provided by a New Jersey Sea Grant (R/F-2), a small grant from Rutgers University Research Council, the New Jersey Agricultural Experiment Station (Project No. 12409), and the Center for Coastal and Environmental Studies, Rutgers University.

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