# THE SYSTEMATIC STATUS OF *MERLUCCIUS* IN THE TROPICAL WESTERN ATLANTIC OCEAN INCLUDING THE GULF OF MEXICO

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## ABSTRACT

Several morphometric and meristic characters are used to compare populations of *Merluccius* from the Gulf of Mexico and Atlantic Ocean. Both populations are shown to have similar values for all characters studied. As a result *M. magnoculus* Ginsburg is relegated to the synonymy of *M. albidus* (Mitchill).

Geographical variation is noted in many of the characters investigated.

The widely distributed gadoid fish genus *Merluccius* contains an indeterminate number of commercially fished species. There are 11 nominal species (Grinols and Tillman, 1970), known variously in the United States as either whiting or hake. The object of this paper is to determine the number of species living in the tropical western Atlantic (including the Gulf of Mexico and Caribbean). Ginsburg (1954) recognized three species from the western North Atlantic. One of these, *M. bilinearis* (Mitchill), is distinct from the other two nominal forms in having more gill rakers on the first arch (15-22 vs. 9-12). This species will not be considered further as it does not occur south of Cape Fear, N.C. *M. magnoculus* Ginsburg was described as new mainly on the basis of its having a longer head and shorter paired fins than its closest relative, *M. albidus* (Mitchill). *M. albidus* is found in the tropical western Atlantic, although not exclusively so, as it is known to occur sympatrically with *M. bilinearis* in the north. Ginsburg further noted that *M. magnoculus* and *M. albidus* were also moderately to slightly divergent in the following characters: maxillary length, snout length, eye diameter, and number of first dorsal, second dorsal, pectoral, and anal fin rays. Moreover, *M. magnoculus* was confined to the Gulf of Mexico while *M. albidus* occurred off the eastern coast of North America from Georges Bank to the Tortugas off the west coast of Florida. The lack of comparative material of equivalent size from the Gulf, the doubtful systematic status of two specimens from Savannah, Ga., and of a single specimen from off Cape Canaveral, Fla., make uncertain Ginsburg's tentative assignation of these specimens to *M. albidus*. Difficulty in identifying subsequent material from the Gulf of Mexico and Caribbean has necessitated a reassessment of the taxonomic status of *M. albidus* and *M. magnoculus*, especially since the stated differences between the two are slight and there is at least some overlap in all characters used to separate them.

Throughout the body of this paper the Atlantic population is taken to include specimens from the Caribbean also.

## MATERIAL

A total of 253 specimens was examined; 86 from the Gulf of Mexico and 167 from along the eastern coast of the Americas, lat 41°30'N south to lat 7°26'N (Figure 1). This total included Ginsburg's material whenever possible. How-

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ever, some of his specimens were in poor state of preservation and too fragile to be handled. The list of specimens is as follows:

### ATLANTIC OCEAN AND CARIBBEAN SEA

U.S. National Museum (USNM): 25769-1 specimen; 26049-1; 26073-1; 31630-1; 31677-1; 31686-1; 31739-1; 31741-1; 31822-1; 31842-2; 31844-1; 31863-2; 32791-1; 33032-1; 44264-1; 45920-1; 155475-2; 159214-1; 159230-1; 186294-5; 186299-1; 186302-1; 190356-1; 205223-1; 205224-1; 205230-1; 205231-1; 205233-1; 205235-1; 205237-4; 205240-2; 205241-1; 205242-1; 205243-1; 205244-1; 205245-1; 205246-1; 250247-1; 205248-1; 205249-1; 205251-1; 205252-1; 205253-1; 205255-1; 205257-2; 205259-1; 205260-1; 205262-1; 205263-2; 206190-1; 206191-1; 206192-2; 206194-1; 206195-7; 206196-1; 206197-1; 206198-1; 206199-1; 206200-1; 206201-2; 206202-5; 206203-4; 206204-1; 206205-30; 206207-2; 206208-5; 207187-3; 207188-1; 207189-1.

University of Miami Marine Laboratory (UMML): 3418-2 specimens; 3696-2; 4431-2; 22957-2; 29224-5; 29506-4; 29508-1.

Museum of Comparative Zoology (MCZ): 37754-2 specimens; 38086-3; 38130-3; 38324-1; 38333-1; 38338-2; 38350-1; 38395-1; 38399-2.

### GULF OF MEXICO

U.S. National Museum (USNM): 92045-2 specimens; 157757-1; 157758-2; 157759-5; 157760-5; 157761-4; 157762-2; 157763-10; 186331-2; 187134-5; 187136-1; 205225-1; 205226-1; 205227-2; 205228-1; 205229-3; 205232-3; 205234-2; 205236-1; 205238-1; 205239-1; 205250-1; 205254-3; 205256-1; 205258-1; 205261-1; 206187-1; 206188-2; 206189-2; 206193-4; 206206-3; 207153-2; 207190-1.

University of Miami Marine Laboratory (UMML): 29507-9 specimens.

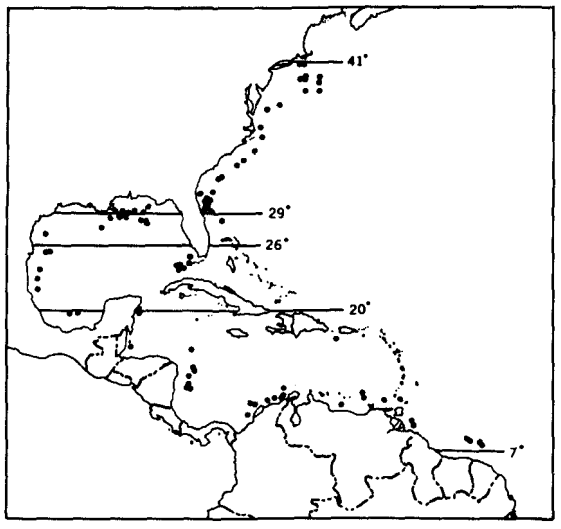


FIGURE 1.—Distribution of samples, western North Atlantic Ocean; equator to lat 45°N.

## METHODS

All counts and measurements were made as described in Ginsburg (1954), so that the data from both studies would be directly comparable. The median fin rays, except the caudal, pectoral rays on both sides, and gill rakers of the outer arch on both sides were counted on all specimens that were not damaged. Total vertebral counts were made on selected specimens. Standard length, head length, snout length, maxillary length, eye diameter, pectoral fin length, and pelvic fin length were measured on all specimens when possible.

## RESULTS AND DISCUSSION

Inspection of the counts and measurements indicates that the Gulf and Atlantic populations are similar in all characters studied. Within each area there are local differences in most of the characters; however, these differences are minor. The Gulf and Atlantic populations have identical or nearly identical ranges for all characters investigated, and the average values for both are generally only slightly divergent.

Differences in the relative head length and the

relative length of the paired fins were the main criteria used by Ginsburg (1954) for recognizing the Gulf population as a distinct species, *M. magnoculus*. These differences, however, were minor. More importantly the material used in his study did not adequately represent either the Atlantic or Gulf population. Thirty of thirty-eight specimens from the Atlantic were taken off Long Island, N.Y., and all 32 of the specimens from the Gulf of Mexico came from north of lat 26°N. Ginsburg was not able to make a valid comparison of the Atlantic and Gulf populations with the limited material available to him.

## HEAD LENGTH

Ginsburg (1954) listed the range of head length taken as a percent of standard length as 27.3-31.3 for *M. albidus* and 29.6-31.3 for *M. magnoculus* but gave no mean values. Average values calculated from the data in Table 8 in Ginsburg (1954) are 28.7 for *M. albidus* and 30.6 for *M. magnoculus*. The specimens from the Atlantic and Caribbean populations examined in this study, had a range of 26.4-32.9 and a mean of 29.0, while the Gulf population had a range of 27.3-31.3 with a mean of 29.7. As can be seen from Table 1 the head length expressed as a percent of standard length is fairly uniform over the entire geographic area represented in this study.

TABLE 1.—Head length as a percent of standard length for the Atlantic and Gulf populations.

| Population | *N* | Range | Mean |
|---|---|---|---|
| Atlantic | | | |
| 7°-20°N | 48 | 27.9-31.8 | 29.8 |
| 21°-41°N | 114 | 26.4-32.9 | 28.7 |
| 7°-41°N | 162 | 26.4-32.9 | 29.0 |
| Gulf | | | |
| 19°-25°N | 42 | 27.3-31.2 | 29.4 |
| 26°-29°N | 43 | 28.6-31.3 | 30.0 |
| 19°-29°N | 85 | 27.3-31.3 | 29.7 |

Although the Gulf population does have a slightly larger head, degree of difference between the two populations reported by Ginsburg is unsupported by the present data. The two populations are not separable on the basis of relative length.

Ginsburg also stated that growth of the head was allometric. The present data indicate that growth of the head is isometric (see Figure 2).

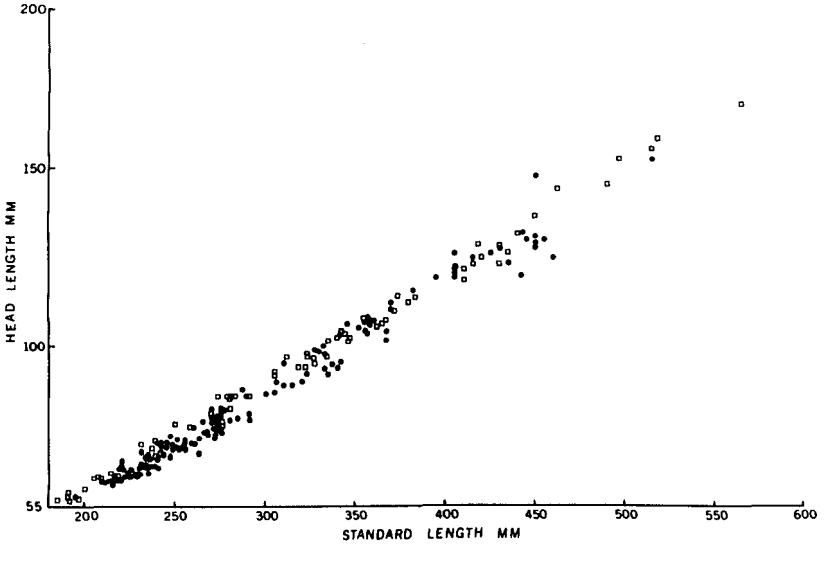


FIGURE 2.—Gulf (squares) and Atlantic (circles) populations: relation of head length to standard length.

## PAIRED FIN LENGTH

Ginsburg (1954) reported the range of pectoral fin length taken as a percent of standard length to be 18.0-21.5 and 15.5-19.0 for *M. albidus* and *M. magnoculus*, respectively. The Atlantic specimens examined in the study have a similar maximum value to that of *M. albidus* (21.7, see Table 2) but the minimum value obtained, 13.7, is much lower. The minimum value obtained from the Gulf population, 13.7, is somewhat lower than the minimum value recorded for *M. magnoculus*, while the maximum value obtained, 19.4, is similar to that given by Ginsburg for *M. magnoculus*. Average values calculated from the data in Table 10 in Ginsburg (1954) are 19.8 for *M. albidus* and 17.0 for *M. magnoculus*. These compare fairly well with the values obtained for the Atlantic and Gulf populations 18.3 and 16.8, respectively.

TABLE 2.—Pectoral fin length as a percent of standard length for the Atlantic and Gulf populations.

| Population | *N* | Range | Mean |
|---|---|---|---|
| Atlantic | | | |
| 7°-20°N | 48 | 13.7-19.5 | 17.3 |
| 21°-41°N | 113 | 15.8-21.7 | 18.8 |
| 7°-41°N | 161 | 13.7-21.7 | 18.3 |
| Gulf | | | |
| 19°-25°N | 41 | 13.7-19.2 | 17.2 |
| 26°-29°N | 42 | 13.8-19.4 | 16.4 |
| 19°-29°N | 83 | 13.7-19.4 | 16.8 |

The range of values for the pelvic fin length expressed as a percent of standard length is 12.8-19.2 with an average value of 15.6 for the Atlantic population and 11.6-17.0 with a mean of 14.3 for the Gulf population (Table 3). Ginsburg also reported a range of 13.5-19.5 for *M. albidus* and 12.0-16.0 for *M. magnoculus*, and the averages computed from data contained in his Table 9 are 16.6 and 14.0 for *M. albidus* and *M. magnoculus*, respectively.

The present data indicate that the Gulf population does have proportionally smaller paired fins than the Atlantic population, however, the differences are much smaller than indicated by Ginsburg. The relative length of the paired fins is similar in both populations and is clearly of no value in separating the two.

TABLE 3.—Pelvic fin length as a percent of standard length for the Gulf and Atlantic populations.

| Population | *N* | Range | Mean |
|---|---|---|---|
| Atlantic | | | |
| 7°-20°N | 48 | 12.8-19.2 | 14.7 |
| 21°-41°N | 114 | 12.8-17.7 | 15.9 |
| 7°-41°N | 162 | 12.8-19.2 | 15.6 |
| Gulf | | | |
| 19°-25°N | 41 | 12.7-17.0 | 15.1 |
| 26°-29°N | 43 | 11.6-16.2 | 13.6 |
| 19°-29°N | 84 | 11.6-17.0 | 14.3 |

Ginsburg (1954) stated that the growth of the pelvic fin was allometric and that the relative pectoral fin length changed little if any with growth. To compensate for this he arranged his material into several size classes and compared similar sizes for both populations. However, he gave no average standard length for the classes, and it is impossible to determine if the size composition of the classes he compared was similar. Figure 3 indicates that growth of the pectoral fin is allometric and not isometric as reported by Ginsburg (1954). The pelvic fin does undergo allometric growth as stated by Ginsburg (see Figure 4).

Since the material examined from both areas is not of the same size composition (the average standard length of the specimens from the Atlantic population is 283 mm while the average standard length of the specimens from the Gulf population is 323 mm) at least some of the difference in paired fin length is due to allometric growth.

Figures 3 and 4 indicate that for some of the Gulf material the paired fins are relatively smaller than in other specimens of similar sizes. The majority of specimens with the smaller fins were collected north of lat 26°N. Most of the specimens with the higher values were collected north of lat 21°N in the Atlantic. Many specimens examined from the northern Gulf have fins of the same size as specimens from the southern Gulf and Atlantic populations. Hence, not all of the northern Gulf material can be distinguished by relative fin size.

The paired fins are poor characters to use in *Merluccius* because they are generally damaged to some degree. It is often impossible to determine if the fine ends of the rays are broken off.

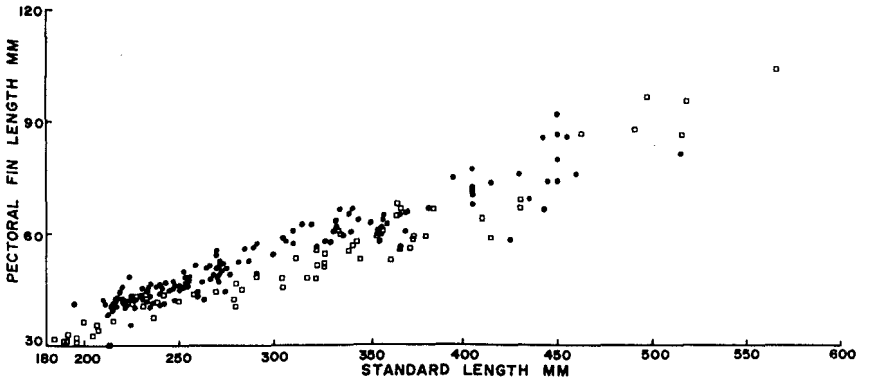


FIGURE 3.—Gulf (squares) and Atlantic (circles) populations: relation of pectoral fin length to standard length.

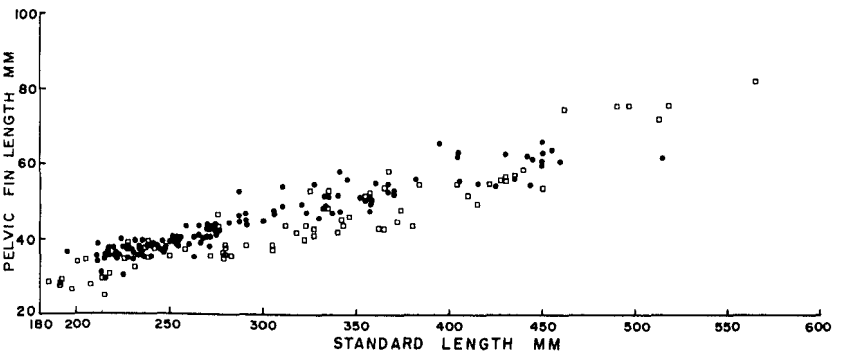


FIGURE 4.—Gulf (squares) and Atlantic (circles) populations: relation of pelvic fin length to a standard length.

Although the proportion and degree of damaged fins should be the same for both populations, a slight error will be introduced, and values presented for these measurements should be considered only as approximations of the real values.

## EYE DIAMETER, SNOUT LENGTH, AND MAXILLARY LENGTH

The values obtained for these characters were similar in the Atlantic and Gulf populations, with the Gulf population having a slightly larger average value for all three characters (Tables 4, 5, 6); these values agree well with those of Ginsburg (1954).

All differences in these characters reported by Ginsburg (1954) may be explained by his limited material. Material from other areas examined in the present investigation indicate there are no differences between the two populations in any of the above characters (Figures 5, 6, 7).

TABLE 4.—Eye diameter as a percent of standard length for the Gulf and Atlantic populations.

| Population | *N* | Range | Mean |
|---|---|---|---|
| Atlantic | | | |
| 7°-20°N | 48 | 4.6-8.4 | 5.6 |
| 21°-41°N | 114 | 4.8-8.4 | 5.9 |
| 7°-41°N | 162 | 4.6-8.4 | 5.9 |
| Gulf | | | |
| 19°-25°N | 42 | 5.2-7.0 | 6.0 |
| 26°-29°N | 43 | 4.8-7.1 | 6.1 |
| 19°-29°N | 85 | 4.8-7.1 | 6.0 |

TABLE 5.—Snout length as a percent of standard length for the Gulf and Atlantic populations.

| Population | N | Range | Mean |
|---|---|---|---|
| Atlantic | | | |
| 7°-20°N | 44 | 8.8-10.7 | 9.7 |
| 21°-41°N | 114 | 8.1-11.1 | 9.2 |
| 7°-41°N | 158 | 8.1-11.1 | 9.4 |
| Gulf | | | |
| 19°-25°N | 42 | 8.7-11.2 | 9.8 |
| 26°-29°N | 43 | 9.2-10.8 | 10.2 |
| 19°-29°N | 85 | 8.7-11.2 | 10.0 |

TABLE 6.—Maxillary length as a percent of standard length for the Gulf and Atlantic populations.

| Population | N | Range | Mean |
|---|---|---|---|
| Atlantic | | | |
| 7°-20°N | 48 | 13.6-16.8 | 15.0 |
| 21°-41°N | 114 | 13.3-17.7 | 14.4 |
| 7°-41°N | 162 | 13.3-17.7 | 14.6 |
| Gulf | | | |
| 19°-25°N | 42 | 13.6-15.9 | 15.0 |
| 26°-29°N | 43 | 14.7-16.2 | 15.3 |
| 19°-29°N | 85 | 13.6-16.2 | 15.2 |

Eye diameter is quite variable and several workers have noted that there are big eyed and small eyed forms in the Caribbean and Gulf of Mexico (D. M. Cohen, National Systematics Laboratory, National Marine Fisheries Service, NOAA, Washington, DC 20560, pers. comm.). Figure 5 indicates that the eye size is quite variable and there is no division between the big eyed and small eyed forms.

Eye size does not appear to be related to sex. Females (73 specimens) with small, intermediate, and large eyes were noted. Only two males were found, both with eyes of intermediate size.

## MERISTIC CHARACTERS

Values obtained for meristic characters (Tables 7, 8, 9, 10, 11) are in agreement with those given by Ginsburg (1954) for both pop-

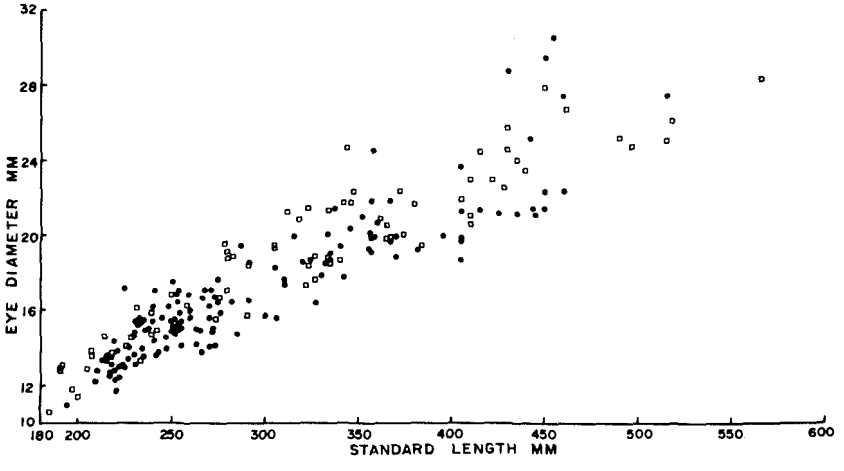


FIGURE 5.—Gulf (squares) and Atlantic (circles) populations: relation of eye diameter to standard length.

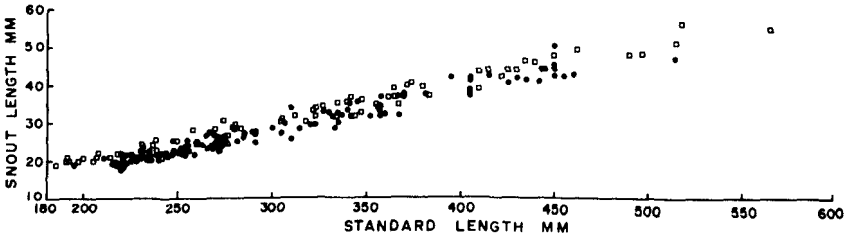


FIGURE 6.—Gulf (squares) and Atlantic (circles) populations: relation of snout length to standard length.

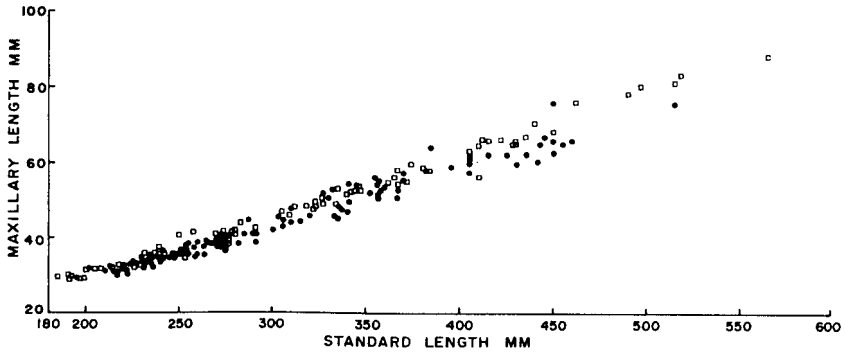


FIGURE 7.—Gulf (squares) and Atlantic (circles) populations: relation of maxillary length to standard length.

TABLE 7.—Frequency distribution of the number of gill rakers on the first gill arch for the Gulf and Atlantic populations.

| Population | Number of gill rakers | | | | | |
|---|---|---|---|---|---|---|
| | 8 | 9 | 10 | 11 | 12 | Mean |
| Atlantic | | | | | | |
| 7°-20°N | 3 | 22 | 46 | 24 | 3 | 10.0 |
| 21°-41°N | 1 | 14 | 157 | 56 | 3 | 10.2 |
| 7°-41°N | 4 | 36 | 203 | 80 | 6 | 10.1 |
| Gulf | | | | | | |
| 19°-25°N | 2 | 21 | 54 | 5 | -- | 9.8 |
| 26°-29°N | 4 | 13 | 63 | 8 | -- | 9.9 |
| 19°-29°N | 6 | 34 | 117 | 13 | -- | 9.8 |

TABLE 8.—Frequency distribution of the number of first dorsal rays for the Gulf and Atlantic populations.

| Population | Number of first dorsal rays | | | | |
|---|---|---|---|---|---|
| | 10 | 11 | 12 | 13 | Mean |
| Atlantic | | | | | |
| 7°-20°N | -- | 14 | 32 | 3 | 11.8 |
| 21°-41°N | 3 | 63 | 49 | 1 | 11.4 |
| 7°-41°N | 3 | 77 | 81 | 4 | 11.5 |
| Gulf | | | | | |
| 19°-25°N | -- | 16 | 24 | 2 | 11.7 |
| 26°-29°N | -- | 4 | 32 | 8 | 12.1 |
| 19°-29°N | -- | 20 | 56 | 10 | 11.9 |

ulations. However, for all characters but the number of first dorsal rays there was an increase in the range of one to three elements. In general, the average values computed from data presented in Ginsburg (1954) for *M. albidus* and *M. magnoculus* agree well with the average values calculated for the Atlantic and Gulf populations respectively.

Total vertebral counts for the Atlantic and Gulf populations were similar in both ranges and averages (Table 12). Geographic variation in most meristic characters is slight. Vertebral elements, pectoral fin rays, and anal fin rays are more variable than other meristic characters examined.

The ranges for all meristic characters studied are identical or nearly so for both the Gulf and Atlantic populations. For all characters there is a difference of less than one element in the average value between the two populations. Within each population there is variation in some or all of the meristic characters studied. The

TABLE 9.—Frequency distribution of the number of second dorsal rays for the Gulf and Atlantic populations.

| Population | Number of second dorsal rays | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 35 | 36 | 37 | 38 | 39 | 40 | 41 | Mean |
| Atlantic | | | | | | | | |
| 7°-20°N | 2 | 14 | 20 | 8 | 3 | -- | -- | 36.9 |
| 21°-41°N | -- | 3 | 22 | 42 | 39 | 9 | 1 | 38.3 |
| 7°-41°N | 2 | 17 | 42 | 50 | 42 | 9 | 1 | 37.9 |
| Gulf | | | | | | | | |
| 19°-25°N | -- | 6 | 14 | 12 | 8 | 2 | -- | 37.7 |
| 26°-29°N | -- | 2 | 10 | 12 | 14 | 5 | 1 | 38.3 |
| 19°-29°N | -- | 8 | 24 | 24 | 22 | 7 | 1 | 38.0 |

TABLE 10.—Frequency distribution of the number of anal rays for the Gulf and Atlantic populations.

| Population | Number of anal rays | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | Mean |
| Atlantic | | | | | | | | | |
| 7°-20°N | 2 | 6 | 22 | 15 | 2 | -- | -- | -- | 37.2 |
| 21°-41°N | 1 | 8 | 42 | 32 | 28 | 2 | 2 | -- | 37.8 |
| 7°-41°N | 3 | 14 | 64 | 47 | 30 | 2 | 2 | -- | 37.6 |
| Gulf | | | | | | | | | |
| 19°-25°N | 2 | 9 | 12 | 7 | 6 | 4 | 2 | -- | 37.6 |
| 26°-29°N | -- | 2 | 2 | 7 | 13 | 15 | 4 | 1 | 39.2 |
| 19°-29°N | 2 | 11 | 14 | 14 | 19 | 19 | 6 | 1 | 38.4 |

TABLE 11.—Frequency distribution of the number of pectoral rays for the Gulf and Atlantic populations.

| Population | Number of pectoral rays | | | | | | |
|---|---|---|---|---|---|---|---|
| | 12 | 13 | 14 | 15 | 16 | 17 | Mean |
| Atlantic | | | | | | | |
| 7°-20°N | 6 | 24 | 57 | 6 | 2 | -- | 13.7 |
| 21°-41°N | -- | 1 | 28 | 124 | 72 | 4 | 15.2 |
| 7°-41°N | 6 | 25 | 85 | 130 | 74 | 4 | 14.8 |
| Gulf | | | | | | | |
| 19°-25°N | -- | 13 | 27 | 25 | 15 | 2 | 14.6 |
| 26°-29°N | 6 | 42 | 28 | 11 | -- | -- | 13.5 |
| 19°-29°N | 6 | 55 | 55 | 36 | 15 | 2 | 14.0 |

northern Gulf population has a slightly higher average value than the southern Gulf population for all meristic characters except pectoral fin rays and vertebrae. The southern Gulf has on the average a greater number of pectoral fin rays and vertebrae (Tables 7, 8, 9, 10, 11, 12). In the Atlantic the more southerly populations have fewer vertebrae, pectoral rays, second dorsal rays, and anal rays and more first dorsal rays than the northern populations.

Material collected between lat 7° and 20°N in the Atlantic has on the average between two and three (2.5) fewer vertebrae than the material collected north of lat 21°N. There is very little overlap in the range of vertebrae in the northern and southern Atlantic populations. Only 1 of 41 specimens from south of lat 20°N has more than 53 vertebrae and only 13 of 87 specimens north of lat 20°N have less than 54 vertebrae (Table 12). However, the relatively few specimens collected between lat 16° and 20°N may not be representative of the population residing there due to sampling error and hence, not represent the true range of vertebrae for that population.

## CONCLUSIONS

The above data suggest that there is but a single species of *Merluccius* in the tropical western Atlantic, including the Caribbean and Gulf of Mexico. The Gulf population as a whole cannot be distinguished from the Atlantic population by means of any of the characters examined. For all of the characters examined differences between both populations are small. Within each area there are local differences in most of the characters; however, these differences are minor. The Gulf and Atlantic populations have identical

TABLE 12.—Frequency distribution of the number of vertebrae for the Gulf and Atlantic populations.

| Population | Number of vertebrae | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 50 | 51 | 52 | 53 | 54 | 55 | 56 | Mean |
| Atlantic | | | | | | | | |
| 7°-20°N | 6 | 7 | 19 | 8 | 1 | -- | -- | 51.8 |
| 21°-41°N | -- | -- | -- | 13 | 41 | 31 | 2 | 54.3 |
| 7°-41°N | 6 | 7 | 19 | 21 | 42 | 31 | 2 | 53.5 |
| Gulf | | | | | | | | |
| 19°-25°N | -- | 1 | 5 | 14 | 10 | 2 | 1 | 53.3 |
| 26°-29°N | -- | 1 | 15 | 9 | 4 | 1 | -- | 52.6 |
| 19°-29°N | -- | 2 | 20 | 23 | 14 | 3 | 1 | 53.0 |

or nearly identical ranges for all characters investigated, and the average values for both are generally only slightly divergent.

The northern Gulf population is, in many characters, divergent from the northern Atlantic population, which led Ginsburg (1954) to describe this population as a distinct species. However, the northern Gulf population is also somewhat divergent from the southern Gulf and Atlantic populations and, in both cases, the divergence is clearly not great enough to warrant recognition at the specific level. Furthermore, the amount of overlap in all characters is of such magnitude that individuals of the northern Gulf population cannot always be distinguished from individuals from other areas. Hence, *M. magnoculus* Ginsburg should be considered a junior synonym of *M. albidus* (Mitchill).

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