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Meristic Variation in Golden Redfish, *Sebastes marinus*, Compared to Beaked Redfishes of the Northwest Atlantic *

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Abstract

Counts of the vertebral elements in 3,611 specimens and the anal and dorsal fin rays in 1,379 specimens were utilized to examine meristic variation in *S. marinus* in the Northwest Atlantic from West Greenland to the Grand Bank-Gulf of St. Lawrence, for comparison with data reported in similar studies of the beaked redfishes, *S. mentella* and *S. fasciatus*. The χ^2-test of independence for meristic frequencies showed no significant differences between sexes or among depth zones except for significant depth variation of anal fin-ray and dorsal fin-ray frequencies on Flemish Cap. Geographic variation in *S. marinus* meristics was less than in the beaked redfishes. *S. marinus* was found to be similar to *S. mentella* in having 30 vertebrae (excluding urostyle), 8 anal fin rays and 15 dorsal fin rays, whereas *S. fasciatus* usually has 29, 7 and 14 elements respectively. The recently-adopted common name "golden redfish" is considered to be appropriate for *S. marinus*.

Introduction

The classification of Northwest Atlantic redfishes, *Sebastes* sp., has been confused for many years. Templeman and Sandeman (1957) and Templeman (1959) described two types of redfish in the Newfoundland area: the *marinus*-type, usually found at shallow depths (<300 m), is orange or yellowish red in color, has relatively small eyes, and possesses a weakly-developed, blunt symphyseal knob on the lower jaw; and the *mentella*-type, usually found at greater depths, is bright red in color, has relatively large eyes, and possesses a well-developed, long pointed chin. This distinction was confounded by the discovery of a third redfish species, *S. fasciatus* (Barsukov, 1968). Morphological differences between *S. mentella* and *S. fasciatus* were described subsequently by Barsukov (1972), Barsukov and Zakharov (1972), Litvinenko (1974, 1980) and Templeman (1980). Ni (1981a, 1981b) supported the existence of *S. fasciatus*, concluded that meristics were good discriminators for separating the two beaked redfishes, *S. mentella* and *S. fasciatus*, and provided morphological guidelines for their separation. Ni (1982) described the temporal, depth and geographic variation of meristics in the beaked redfishes, suggesting that *S. fasciatus* occurs on the Scotian Shelf and the Grand Bank areas whereas *S. mentella* occurs largely in the Gulf of St. Lawrence, off Labrador and northward off Baffin Island. However, the status of *S. marinus* in the classification scheme of redfishes is unclear because of the difficulty in obtaining enough specimens of the three species from the same depth and locality to employ discriminant analysis. In this paper, the sexual, depth and geographic variation in vertebral, anal fin-ray and dorsal fin-ray frequencies in *S. marinus* are examined and the meristic differences among the three Northwest Atlantic redfish species are discussed.

Materials and Methods

The elements of 3,611 vertebral columns and the anal and dorsal fin rays of 1,379 specimens were counted in *S. marinus* samples collected during 1957-69 in the Northwest Atlantic from Davis Strait southward to the Scotian Shelf. Grouping of the data by the Northwest Atlantic Fisheries Organization (NAFO) divisions (subareas in the Baffin Island-West Greenland region) provided a convenient partition of the continental shelf into areas which facilitated comparison with published data on beaked redfishes (Ni, 1982). *S. marinus* occurs rarely off northern Labrador (Div. 2GH), in the Gulf of St. Lawrence (Div. 4ST) and on the Scotian Shelf (Div. 4VWX) (Ni and McKone 1983), and no analysis could be performed for these areas.

Samples were collected from bottom otter-trawl catches of research vessels at depths from 100 to 500 m along the slope of the continental shelf. The data was arbitrarily divided into four depth strata (<200, 200–299, 300–399, ≥400 m) for the study of variation in meristics with depth. Vertebral counts excluded the urostyle. Anal fin-ray counts were determined from the number of pterygiophores connected with the anal rays, the bifurcated ray elements associated with the posteriormost pterygiophore being counted as one ray.

Variation of the meristic frequencies in each NAFO division by sex and depth interval was analyzed by

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using the BMDP4F computer program of Dixon *et al.* (1981), involving the application of Pearson's χ^2-test, with Yate's correction when the frequency table was 2 x 2. Geographic variation was deduced from the patterns of means and modes of the meristic frequencies.

The meristic characters of *S. marinus* were compared with those of the beaked redfishes (Ni, 1982) by using the BMDP3D computer program of Dixon *et al.* (1981), involving Levene's w-test for variances and the appropriate t-test for means. The group means of the three meristic characters could then be tested simultaneously by the multivariate F-statistic, utilizing the Hotelling T^2 and the Mahalanobis D^2 tests (Morrison, 1976).

Results

S. marinus meristics

The meristic frequencies illustrated in Fig. 1 are those for which statistical parameters are summarized in Table 1. To justify combination of the data for males and females, χ^2 tests were applied to the meristic frequencies for each NAFO area and for all areas combined, with no resultant significant difference between sexes ($P>0.05$ in all cases). Insofar as the data were adequate to test for variation in meristic frequencies by depth zones (<200, 200–299, 300–399, ⩾400), significant differences were evident for both anal and dorsal fin rays in the samples from Div. 3M (Flemish Cap) and for all three meristic characters when data for all areas were combined (Table 1).

The dominant vertebral count was 30 in all areas (Fig. 1), with only slight variation in the means (29.97–30.16) despite the great variation in sample size (Table 1). Except for the relatively high percentage of abnormal vertebrae (3.57%) in *S. marinus* from Div. 3L (northern Grand Bank), no particular geographic trend was evident.

The mode of the anal fin-ray frequencies was 8 in most areas, except Subarea 1 (West Greenland) and Div. 3K (Northeast Newfoundland) where 8 and 9 rays were both prevalent and in Subarea 0 (Baffin Island) where the dominant number was 9 rays (Fig. 1). Unlike the vertebral averages, the mean anal fin-ray counts exhibited a wider range (8.00–8.69), with a decreasing trend from north to south (Table 1).

The dorsal fin-ray frequencies were dominated by a mode at 15 in most areas, except Div. 2J (southern Labrador) and Div. 3O (southwestern Grand Bank) where 14 rays were almost as prevalent as 15 and in

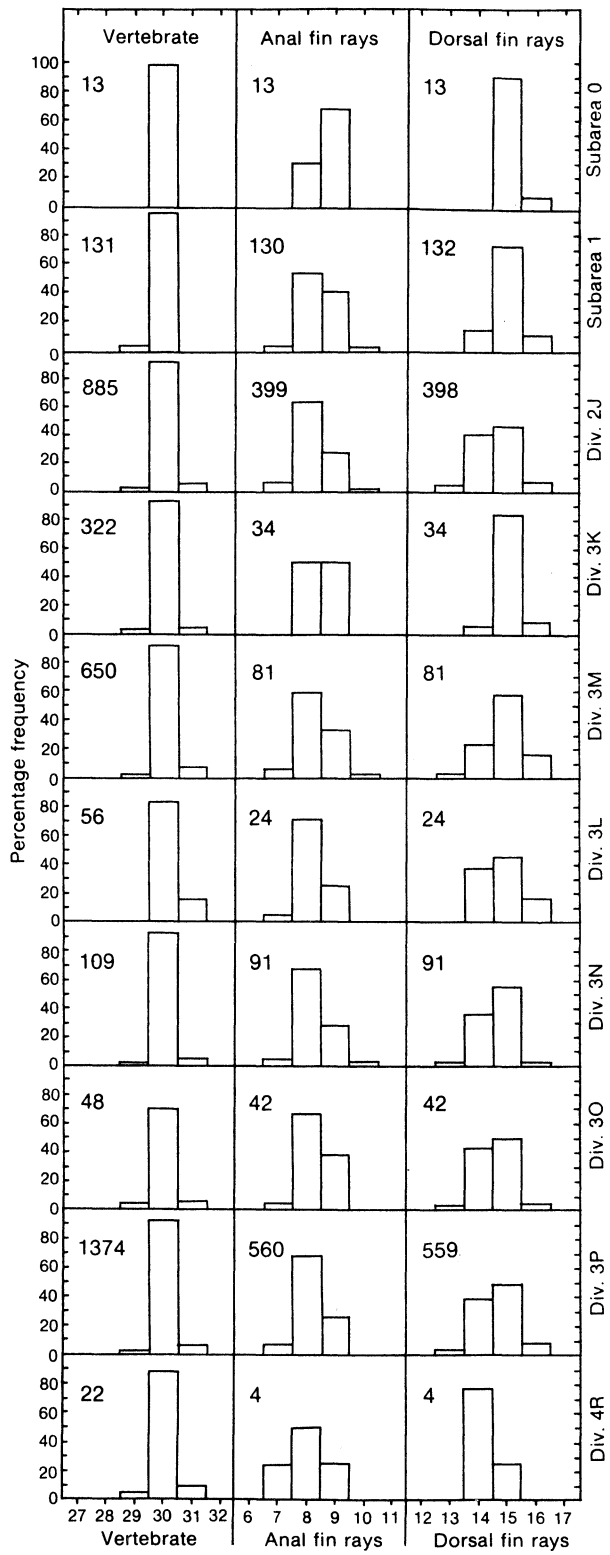

Fig. 1. Vertebral, anal fin-ray and dorsal fin-ray frequencies by area for *S. marinus* in the Northwest Atlantic.

TABLE 1. Statistical data by area for vertebral, anal fin-ray and dorsal fin-ray counts in *S. marinus*, and probability (P) values associated with χ^2 tests applied to meristic frequencies by sex and depth. (* indicates significant difference, ** indicates highly significant differences, and ... indicates data inadequate for statistical test.)

NAFO area	No. of fish	Meristic statistics				P(χ^2) values		Percent abnormal vertebrae
		Range	Mode[a]	Mean	SE	Sex	Depth	
Vertebral counts[b]								
Subarea 0	13	30	30	30.00	0.000	...	...	0.00
Subarea 1	131	29–30	30	29.97	0.015	1.00[c]	0.58	0.76
Div. 2J	885	29–31	30	30.04	0.009	0.44	0.21	0.78
Div. 3K	322	29–31	30	30.01	0.013	0.63	0.71	0.62
Div. 3L	56	30–31	30	30.16	0.050	0.38[c]	0.83	3.57
Div. 3M	650	29–31	30	30.07	0.011	0.36	0.71	0.31
Div. 3N	109	29–31	30	30.05	0.024	0.18	0.89	0.00
Div. 3O	48	29–31	30	30.02	0.047	0.08	0.59	0.00
Div. 3P	1,374	29–31	30	30.05	0.007	0.41	0.18	0.36
Div. 4R	22	29–31	30	30.04	0.080	0.06	...	0.00
Total	3,611[d]	29–31	30	30.04	0.005	0.74	0.04*	0.52
Anal fin-ray counts								
Subarea 0	13	8–9	9	8.69	0.133	0.96[c]	...	
Subarea 1	130	7–10	8,9	8.42	0.049	0.70	0.30	
Div. 2J	399	7–10	8	8.22	0.029	0.83	0.68	
Div. 3K	34	8–9	8,9	8.50	0.088	0.48[c]	...	
Div. 3L	24	7–9	8	8.21	0.104	0.40	0.83	
Div. 3M	81	7–10	8	8.30	0.067	0.30	<0.01**	
Div. 3N	91	7–10	8	8.23	0.061	0.52	0.55	
Div. 3O	42	7–9	8	8.24	0.082	0.67	0.75	
Div. 3P	560	7–10	8	8.21	0.024	0.40	0.27	
Div. 4R	4	7–9	8	8.00	0.408	...	...	
Total	1,379[d]	7–10	8	8.25	0.018	0.46	<0.01**	
Dorsal fin-ray counts								
Subarea 0	13	15–16	15	15.08	0.077	0.81[c]	1.00[c]	
Subarea 1	132	14–16	15	14.95	0.044	0.05	0.80	
Div. 2J	398	13–17	15,14	14.58	0.035	0.86	0.76	
Div. 3K	34	14–16	15	15.03	0.067	0.32	...	
Div. 3L	24	14–16	15	14.79	0.147	0.32	0.15	
Div. 3M	81	13–16	15	14.89	0.079	0.17	<0.01**	
Div. 3N	91	13–16	15	14.59	0.064	0.69	0.82	
Div. 3O	42	13–16	15,14	14.57	0.097	0.76	0.49	
Div. 3P	559	13–17	15	14.62	0.029	0.32	0.91	
Div. 4R	4	14–15	14	14.25	0.250	1.00[c]	...	
Total	1,379[d]	13–17	15	14.67	0.018	0.33	<0.01**	

[a] Where two values are given, first is dominant and the second has a frequency greater than 40%.
[b] Abnormal vertebrae excluded from analyses.
[c] Yate's correction applied in 2 x 2 table.
[d] Total includes one specimen from Div. 2H.

TABLE 2. Statistical comparison between meristic characters of *S. marinus* and the beaked redfishes, based on Levene's w-test, the appropriate t-test, and the multivariate F-statistic, with the differences being significant (*) at P<0.05, highly significant (**) at P<0.01, and not significant (ns) at P>0.05.

NAFO area	Vertebrae		Anal fin rays		Dorsal fin rays		All meristics
	w-test	t-test	w-test	t-test	w-test	t-test	Multivariate F
Subarea 0[a]	(ns)	(**)	(*)	(ns)	(**)	(**)	(ns)
Subarea 1	**	**	ns	*	**	**	**
Div. 2J	**	**	**	**	ns	**	**
Div. 3K[b]	**	**	**	**	—	—	—
Div. 3L	**	**	**	**	ns	**	**
Div. 3M	**	**	**	**	**	**	**
Div. 3N	**	**	**	**	ns	**	**
Div. 3O	**	**	ns	**	ns	**	**
Div. 3P	**	**	**	**	**	**	**
Div. 4R[a]	**	**	(ns)	(ns)	(ns)	(ns)	(ns)

[a] Characters in parentheses pertain to small samples of *S. marinus*.
[b] Dashes indicate lack of beaked redfish specimens.

Div. 4R (eastern Gulf of St. Lawrence) where the dominant number was 14 (Fig. 1). Like the anal fin-ray averages, the mean dorsal fin-ray counts exhibited a relatively wide range (14.25–15.08), with a decreasing trend from north to south (Table 1).

Comparison between *S. marinus* and beaked redfishes

The meristic data for *S. marinus* (Table 1) were compared statistically with similar data for beaked redfishes in tables 3–5 of Ni (1982). Significant differences between *S. marinus* and beaked redfishes were prevalent for each of the three meristic characters by use of Levene's w-test of variances and the appropriate t-test of mean values and also for the combined characters by use of the transformed multivariate F-statistic (Table 2). The absence of significant differences for some comparisons in Subarea 0 and Div. 4R was probably due to insufficient data for *S. marinus*. Only the variances (w-test) showed no significant differences for anal fin-ray counts in Subarea 1 and Div. 3O and for dorsal fin-ray counts in Div. 2J, 3L, 3N and 3O. Geographic variation in *S. marinus* was less than in the beaked redfishes (Fig. 2).

Discussion

Redfish described in this paper were identified by following the criteria of Templeman and Sandeman (1957). A possible error was the misplacement of some small *S. marinus* with the beaked redfishes, but *S. marinus* constituted a minor portion of the overall catches of redfish by research vessels in the Labrador-Newfoundland region (Ni and McKone, 1983). The meristic data for beaked redfishes are unlikely to be biased by a small number of misclassified *S. marinus*.

The meristics of *S. marinus* in the Northwest Atlantic were relatively stable: no sexual difference was found in any area or in all areas combined, and only in Div. 3M was significant depth variation observed for anal and dorsal fin-ray counts (Table 1). For all three meristic characters, significant differences among depth zones for the combined data of all areas imply geographic variation of meristics in *S. marinus*. The area contributing the greatest difference was Div. 3M (Flemish Cap), indicating that the stock of *S. marinus* there may be distinct from those of adjacent areas. Geographic clines in anal and dorsal fin-ray counts contrast with the stable vertebral counts (Fig. 2).

Barsukov and Zakharov (1972) first described the morphological differences among the North Atlantic redfishes, but they admitted that more intensive investigations were necessary for a definitive solution to the redfish classification problem. Ni (1982) presented the results of a detailed study of meristics in the beaked redfishes, *S. mentella* and *S. fasciatus*, and this study

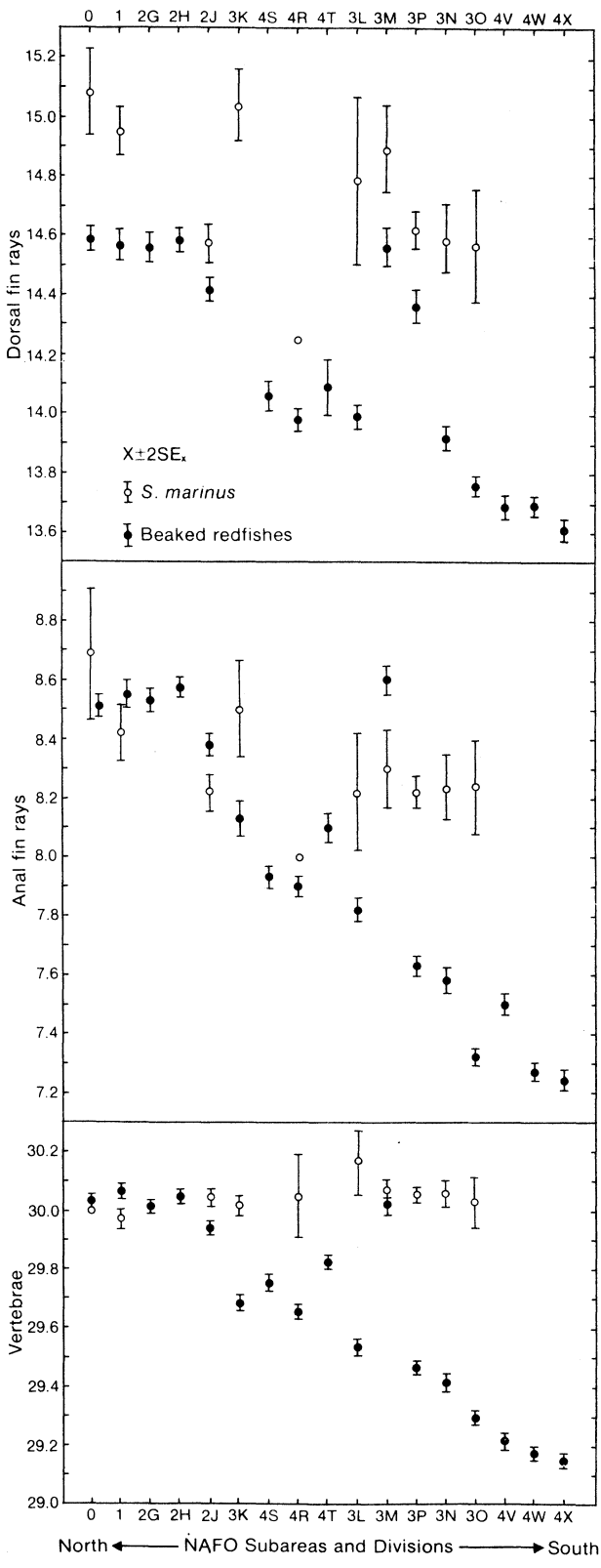

Fig. 2. Geographic variation in average numbers of vertebrae, anal fin rays and dorsal fin rays in *S. marinus* and beaked redfishes of the Northwest Atlantic. (Horizontal bars represent the 95% confidence limits.)

TABLE 3. Statistical data recorded in the literature for meristic frequencies of North Atlantic redfishes: *S. marinus*, *S. mentella*, *S.* fasciatus and *S. viviparus*.

Area	Vertebrae[a]			Anal fin rays			Dorsal fin rays			Source
	No.	Mode	Mean	No.	Mode	Mean	No.	Mode	Mean	
Sebastes marinus										
Barents Sea	22	30	29.91	244	8	7.92	56	15	14.54	Barsukov and Zakharov (1972)
Iceland, W. Greenland	21	30	29.57	26	8	8.12	42	14,15	14.43	Barsukov and Zakharov (1972)
NAFO Div. 2J,3K,3L	66	30	29.92	66	8	8.39	—	—	—	Barsukov and Zakharov (1972)
Sebastes mentella										
Barents Sea	37	30	30.14	137	8	8.48	80	14	14.29	Barsukov and Zakharov (1972)
Iceland	253	30	30.17	282	9	8.49	34	15	14.65	Barsukov and Zakharov (1972)
Iceland and Greenland	37	30	30.27	42	9	8.72	—	—	—	Barsukov (1972)
NAFO Subarea 1	146	30	29.99	235	9	8.53	57	15	14.53	Barsukov and Zakharov (1972)
NAFO Subarea 1	546	30	30.06	591	9	8.55	591	15	14.57	Ni (1982)
NAFO Subarea 0	397	30	30.02	526	9	8.54	153	15	14.59	Barsukov and Zakharov (1972)
NAFO Subarea 0	599	30	30.03	771	9	8.51	771	15	14.59	Ni (1982)
NAFO Div. 2G	435	30	30.01	825	9	8.53	468	15	14.56	Ni (1982)
NAFO Div. 2H	948	30	30.04	1,282	9	8.57	983	15	14.59	Ni (1982)
NAFO Div. 2J	202	30	30.04	203	9	8.61	—	—	—	Barsukov and Zakharov (1972)
NAFO Div. 3K	232	30	30.03	233	9	8.51	—	—	—	Barsukov and Zakharov (1972)
NAFO Div. 3L	100	30	30.03	100	8	8.62	100	15	14.67	Ni (1981b)
NAFO Div. 3O	109	30	30.10	297	9	8.94	42	14	14.61	Litvinenko (1974)
NAFO Div. 3M,3P	49	30	30.00	48	8	8.37	—	—	—	Barsukov and Zakharov (1972)
NAFO Div. 3M,4V	48	30	30.02	48	8	8.40	—	—	—	Barsukov (1972)
NAFO Div. 4R[b]	5,335	30	29.65	2,205	8	7.90	1,482	14	13.98	Ni (1982)
NAFO Div. 4S[b]	2,465	30	29.75	1,588	8	7.93	759	14	14.06	Ni (1982)
NAFO Div. 4T[b]	2,053	30	29.82	522	8	8.10	219	14	14.09	Ni (1982)
Sebastes fasciatus										
NAFO Div. 2J,3K	228	29	29.36	232[c]	8	7.63	96[c]	14	13.79	Barsukov and Zakharov (1972)
NAFO Div. 3L	99	29	29.31	100	7	7.02	100	14	13.69	Ni (1981b)
NAFO Div. 3L[d]	1,743	29	29.53	1,850	7,8	7.82	1,658	14	13.99	Ni (1982)
NAFO Div. 3N[d]	1,299	29	29.41	1,279	7	7.58	1,274	14	13.92	Ni (1982)
NAFO Div. 3O	1,885	29	29.29	1,993	7	7.32	1,693	14	13.76	Ni (1982)
NAFO Div. 3O	124	29	29.05	124	7	7.22	84	14	13.63	Litvinenko (1974)
NAFO Div. 3M,3N,3O,3P	455	29	29.12	455	7	7.27	196[e]	14	13.67	Barsukov and Zakharov (1972)
NAFO Div. 4V[f]	1,061	29	29.21	1,239	7	7.50	952	14	13.69	Ni (1982)
NAFO Div. 4W[f]	2,598	29	29.17	1,608	7	7.27	1,607	14	13.69	Ni (1982)
NAFO Div. 4X[f]	1,176	29	29.15	1,013	7	7.24	1,014	14	13.61	Ni (1982)
NAFO Div. 4W,5Z	447	29	29.19	489	7	7.22	106[g]	14	13.73	Barsukov and Zakharov (1972)
Sebastes viviparus										
Norway Coast	60	29	29.00	88	7	7.02	84	13	13.42	Barsukov and Zakharov (1972)
Rockall Bank	48	29	29.00	50	7	6.80	—	—	—	Barsukov and Zakharov (1972)
Iceland	113	29	29.00	87	7	6.97	47	14	13.85	Barsukov and Zakharov (1972)

[a] Where necessary, data were adjusted to exclude urostyle.
[b] Samples contain some *S. fasciatus* from shallow water.
[c] Samples from Div. 3K only.
[d] Samples contain some *S. mentella* from deep water.
[e] Samples from Div. 3O and 3P only.
[f] Samples contain few *S. mentella* from deep water.
[g] Samples from Div. 4W only.

of the sexual, depth and geographic variation of meristics in *S. marinus* completes the overall investigation of meristic characters in the Northwest Atlantic redfishes. It is easier to separate *S. marinus* from beaked redfishes (Templeman and Sandeman, 1957) by morphometric characters than to separate *S. mentella* from *S. fasciatus*. This study confirms the hypothesis of Baruskov and Zakharov (1972) on differences and similarities in meristics among the redfish species. *S. marinus* is similar to *S. mentella* in having 30 vertebral (excluding the urostyle), 8 anal fin-ray and 15 dorsal fin-ray elements, whereas *S. fasciatus* usually has 29, 7 and 14 elements respectively, these latter counts being similar to those in the European redfish, *S. viviparus* (Table 3). It was also found that *S. marinus* has less variation in anal and dorsal fin-ray counts than the beaked redfishes.

With regard to the common name of *S. marinus*, NAFO follows the Fisheries and Agricultural Organization of the United Nations (FAO) World List of Species and uses "golden redfish" as the common name for this species, in reference to the orange red or golden red color, instead of "ocean perch" or "redfish" as in the

4th edition of "A list of common and scientific names of fishes from the United States and Canada" (American Fisheries Society, 1980). This colorful vernacular name is appropriate because it follows the principles governing the selection of common names.

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References

AMERICAN FISHERIES SOCIETY. 1980. A list of common and scientific names of fishes from the United States and Canada (4th edition). *Spec. Publ. Amer. Fish. Soc.*, N. 12, 174 p.

BARSUKOV, V. V. 1968. The systematic relationship of redfishes of the genus *Sebastes* of the Northwest Atlantic. *Doklady Akad. Nauk SSSR*, **183**: 479-482. (Transl. from Russian in Dokl. Biol. Sci., 183: 734-747.)

1972. Systematics of the Atlantic redfishes. *Tr., PINRO*, **28**: 128-142. (Fish. Res. Bd. Canada Transl. Ser., No. 2531, 1973.)

BARSUKOV, V. V., and G. P. ZAKHAROV. 1972. Morphological and biological characteristics of the American redfish, *Tr., PINRO*, **28**: 143-173. (Fish. Res. Bd. Canada Transl. Ser., No. 2488, 1973.)

DIXON, W. J., M. B. BROWN, L. ENGELMAN, J. W. FRANE, M. A. HILL, R. I. JENNRICH, and J. D. TOPOREK. 1981. BMDP statistical softward, 1981. Univ. Calif. Press, Berkeley, CA.

LITVINENKO, N. N. 1974. Coloration and other morphological characters distinguishing juvenile *Sebastes fasciatus* from juvenile *S. mentella* (Scorpaenidae). *J. Ichthyol.*, **14**: 591-595.

1980. The structure, function and origin of the drumming muscles in the North Atlantic ocean perches of the genus *Sebastes* (Scorpaenidae). *J. Ichthyol.*, **20**: 89-98.

MORRISON, D. F. 1976. Multivariate statistical methods. McGraw-Hill Book Co., Toronto, Canada, 415 p.

NI, I-H. 1981a. Separation of sharp-beaked redfishes, *Sebastes fasciatus* and *S. mentella*, from northeastern Grand Bank by morphology of extrinsic gasbladder musculature. *J. Northw. Atl. Fish. Sci.*, **2**: 7-12.

1981b. Numerical classification of sharp-beaked redfishes, *Sebastes fasciatus* and *S. mentella*. *Can. J. Fish. Aquat. Sci.*, **38**: 873-879.

1982. Meristic variation in beaked redfishes, *Sebastes mentella* and *S. fasciatus*, in the Northwest Atlantic. *Can. J. Fish. Aquat. Sci.*, **39**: 1664-1685.

NI, I-H, and W. D. McKONE. 1983. Distribution and concentration of redfishes, in Newfoundland and Labrador waters. *NAFO Sci. Coun. Studies*, **6**: 7-14.

TEMPLEMAN, W. 1959. Redfish distribution in the North Atlantic. *Bull. Fish. Res. Bd. Canada*, **120**: 1-173.

1980. Incidence of subcaudal melanophores in pre-extrusion larvae of redfish species in the Newfoundland-Labrador area. *J. Northw. Atl. Fish. Sci.*, **1**: 7-19.

TEMPLEMAN, W., and E. J. SANDEMAN. 1957. Two varieties of redfish in the Newfoundland area. *Fish. Res. Bd. Canada, Atlant. Prog. Rep.*, **66**: 20-23.