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Morphology of the Extrinsic Gasbladder Musculature in the Golden Redfish, *Sebastes marinus*

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Abstract

The morphology of extrinsic gasbladder musculature of *Sebastes marinus* was examined to provide criteria that may be useful in discrimination of the three Northwest Atlantic redfishes, particularly for small individuals. The investigation revealed that *S. marinus* has a short, wide L-shaped gasbladder muscle which is generally tricipital. The most frequent pattern of tendons extending posteriorly was attachment of dorsal head tendons to ventral rib 2, passage of central head tendons between ribs 2 and 3, and passage of ventral head tendons between ribs 3 and 4. This is significantly different from the long, narrow gasbladder muscle of beaked redfishes, with passage between ribs 2 and 3 in *S. mentella* and between ribs 3 and 4 in *S. fasciatus*.

Introduction

The classification of Atlantic redfishes (*Sebastes* sp.) in the Northwest Atlantic is not completely understood. External morphological differences were used by Templeman and Sandeman (1957) to separate the golden redfish, *S. marinus*, from the beaked redfishes, *S. mentella* and *S. fasciatus*. However, identification of specimens less than 25 cm long is difficult because the morphological characters used in differentiating between them are not well defined. Ni (1981) reported that the route of passage of the extrinsic gasbladder muscle was the most useful character for discriminating between *S. mentella* and *S. fasciatus*. He found that the passage was between ventral ribs 2 and 3 in *S. mentella* and between ventral ribs 3 and 4 or ribs 4 and 5 in *S. fasciatus*.

Hallacher (1974) examined the morphology of the extrinsic gasbladder musculature in 82 species of rockfishes and found that few species could be separated by species-specific morphology. In an addendum to his article he reported that William Eschmeyer had examined specimens of North Atlantic redfishes and concluded that the gasbladder muscle passed between ribs 2 and 3 in *S. marinus* and between ribs 3 and 4 in *S. fasciatus*, thus reclassifying specimens of the latter type which Hallacher had previously called *S. marinus* to be *S. fasciatus*. Litvinenko (1980) reported that a characteristic of *S. marinus* was the attachment of a tendon to the second rib. The purpose of the research reported in this paper was to examine the morphology of the extrinsic gasbladder musculature of *S. marinus* and provide criteria that may be useful in distinguishing the three Northwest Atlantic redfishes.

Materials and Methods

The materials for this study consisted of 30 specimens of *S. marinus* which were collected during bottom-trawl surveys of Flemish Cap (NAFO Div. 3M) in February and St. Pierre Bank (Div. 3P) in June 1982 at depths from 147 to 262 m. All specimens were orange or yellowish-red in color, with relatively small eyes and a blunt, bony extrusion of the lower jaw (Templeman and Sandeman, 1957). Fork length of the fish ranged from 28 to 54 cm. The specimens were frozen after capture, thawed prior to measurement and dissection, and then preserved in 10% formalin.

The extrinsic gasbladder musculature was exposed by dissection as described by Hallacher (1974). All specimens had a pair of gasbladder muscles, one on either side of the body in the area of the midline just posterior to the operculum. In preliminary dissections, no structural differences were observed between the two sides and subsequent examination was concentrated on the left side (Fig. 1).

In this paper, "tricipital" refers to three heads of the extrinsic gasbladder muscle, and "trifurcation" refers to a three-branched tendon from a head of the muscle.

Results and Discussion

The origin of the extrinsic gasbladder muscle is on the occipital region of the cranium. It extends posteriorly to the supracleithrum where it has a second smaller attachment. From this attachment dorsally, there is a myoseptum. The muscle exhibits a characteristic L-shape from the myoseptum posteriorly (Fig. 2),

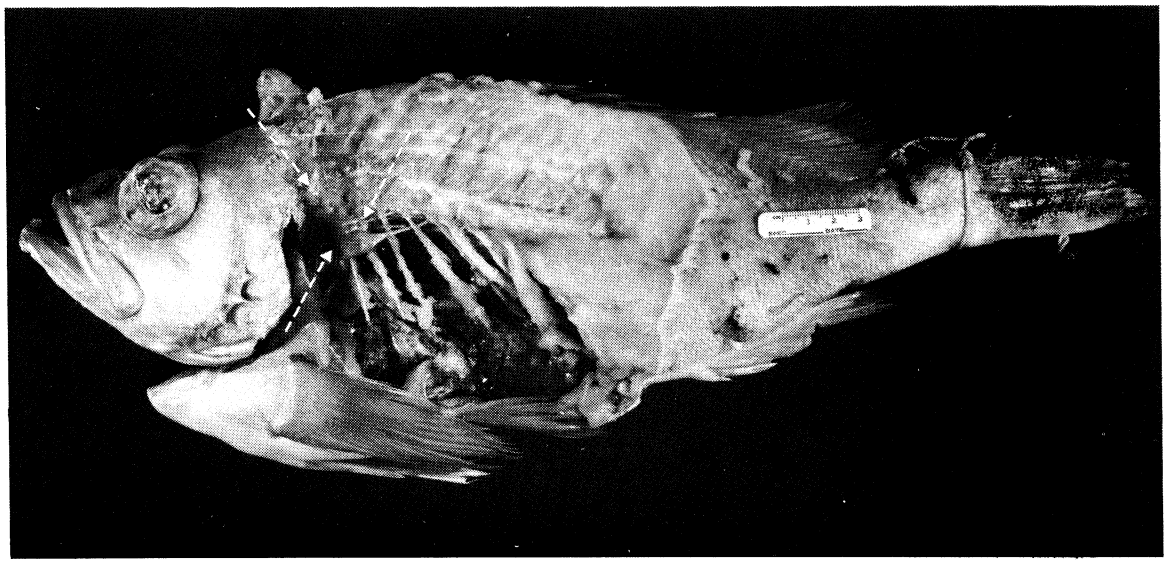

Fig. 1. *Sebastes marinus* (51 cm, male) showing the position of the extrinsic gasbladder muscle. Muscle was separated from myosepta to show typical L-shape.

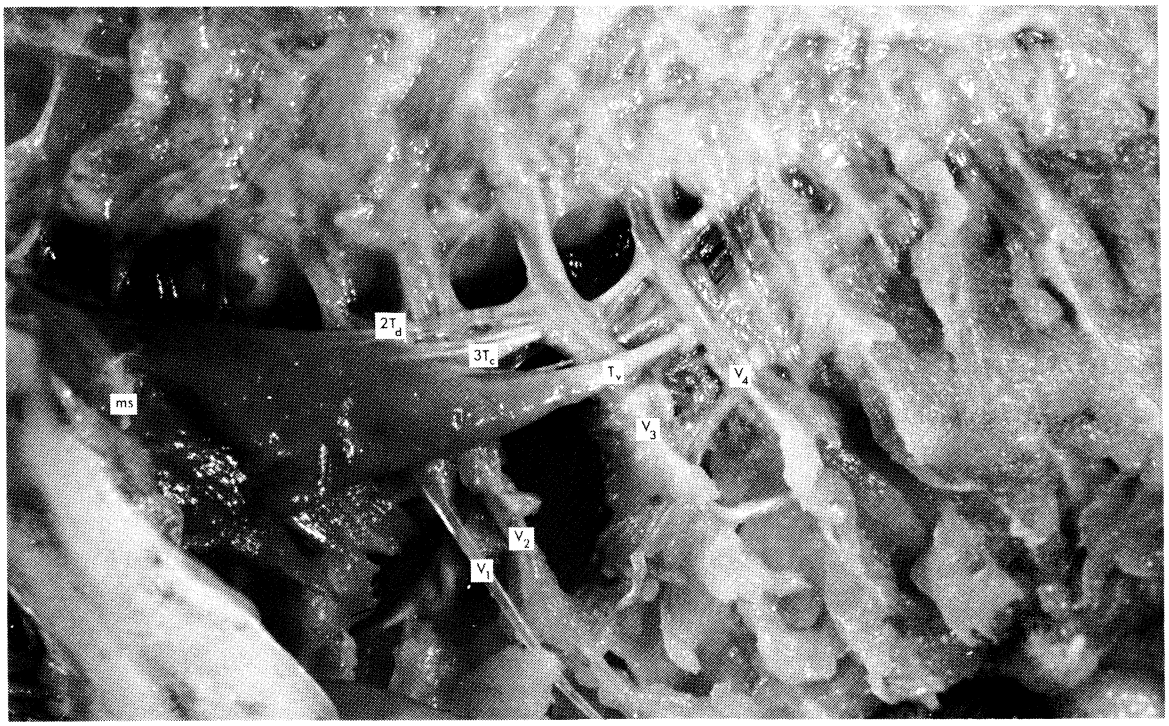

Fig. 2. Extrinsic gasbladder muscle of *Sebastes marinus* showing tendons (T_d, T_c and T_v) extending posteriorly from dorsal, central and vertical muscle heads respectively. Ventral ribs are designated V_1 to V_4. Muscle was separated from myosepta (MS) to see the characteristic L-shape more clearly. Tendons from the central and ventral muscle heads extend posteriorly and insert on the parapophyses of the 8th and 9th vertebrae.

and it is this section of the muscle that has multiple heads. The specimens had either tricipital (87%) or tetracipital (13%) gasbladder muscles. The most ventral head was frequently the largest, with reduction in head size dorsally. The tendons attached to the muscle heads also followed this sequence in size. The overall appearance of the gasbladder muscle in *S. marinus* is short and wide in contrast with the long and narrow gasbladder muscle in *S. mentella* and *S. fasciatus* (Ni, 1981).

TABLE 1. Patterns of gasbladder muscle tendon passage in 30 *Sebastes marinus* specimens examined. (T_d, T_c or T_v are single tendons from dorsal, central or ventral muscle heads respectively; 2T and 3T are bifurcated and trifurcated tendons; values in parentheses represent the vertebral number, or rib number if preceded by r, to which tendons are attached; x represents damaged tendons.)

Specimen No.	Fork length (cm)	Capture depth (m)	Sex	Ventral rib attachment or passage of tendons			
				2	2-3	3	3-4
1	28	220	M	$2T_d$	$3T_c(x)$ $T_v(x)$	—	$T_v(x)$
2	30	151	M	—	$T_d(6)$ $2T_c(7)$	—	$3T_v(8)$
3	33	203	M	T_d	$2T_c(7,8)$ $T_v(9)$	—	$T_v(9)$
4	33	203	M	T_d	$2T_c(8)$	T_d	$2T_v(9)$
5	34	159	F	T_d	—	$2T_c$	$2T_v(8)$
6	35	203	M	T_d	$2T_c(6)$	T_d	$2T_v(7)$
7	35	262	M	$2T_d$	$2T_c(7)$ $T_v(8)$	—	—
8[a]	35	203	F	T_d	$3T_{cl}(r4, 8, 8)$	T_{cu}	$2T_v(9)$
9[a]	36	203	M	T_dT_{cu}	$2T_{cl}(8)$ $T_v(9)$	—	—
10	36	203	M	$2T_d$	$2T_c(8)$ $2T_v(9)$	T_d	—
11	37	203	M	T_d	$T_d(7)$ $2T_c(8)$	T_c	$T_v(9)$
12	38	203	M	T_d	$3T_c(8)$ $T_v(9)$	T_d	$2T_v(9)$
13	38	220	F	T_d	$2T_c(7, x)$	—	$T_v(8)$
14[a]	41	262	M	$2T_d$	$T_{cu}(7)$ $T_{cl}(8)$	—	$T_v(9)$
15	41	159	F	$2T_d$	$T_c(7)$	$3T_c$	$T_v(8)$
16	43	159	F	—	$3T_c(8)$	T_d	$2T_v(9)$
17	45	191	F	T_d	$T_c(8)$ $T_v(9)$	T_c	$T_v(9)$
18[a]	46	159	M	$2T_d$	$2T_{cl}(8)$	$2T_{cu}$	$T_v(9)$
19	46	220	F	$2T_d$	$3T_c(r4, r4, x)$	—	$T_v(x)$
20	47	191	M	T_d	$2T_c(7, 8)$ $T_v(9)$	T_c	—
21	47	262	F	$2T_d$	$2T_v(6)$	$2T_c$	$T_v(7)$
22	48	262	F	T_d	$2T_c(8)$ $T_v(9)$	—	—
23	49	159	M	—	$T_c(8)$ $T_v(9)$	$2T_d$	$T_v(9)$
24	49	159	M	$2T_d$	$T_c(x)$ $2T_v(x)$	—	—
25[b]	51	191	M	—	$3T_c(r4, 8, 8)$	$2T_d$	$T_v(9)$
26	51	159	F	—	$2T_c(7)$	$2T_d$	$2T_v(8)$
27	52	262	F	$2T_d$	$2T_v(7)$	T_c	—
28	54	159	M	—	$T_c(7)$	$2T_d$	$2T_v(5, 8)$
29	54	191	F	—	$T_c(8)$ $T_v(9)$ $T_d(7)$	T_d	—
30	54	191	F	—	—	T_dT_c	$T_v(9)$ [T_c][c]

[a] Specimens with four muscle heads, for which T_c tendons are replaced by T_{cu} (central upper) and T_{cl} (central lower) tendons.
[b] Specimen illustrated in Figures.
[c] This tendon was attached to rib 4.

The pattern of tendon passage varied from specimen to specimen (Table 1). The pooling of data for similar muscle heads revealed that dorsal heads had 64% of 52 tendons attached to rib 2 and 30% attached to rib 3. The central heads had 75% of 69 tendons passing between ribs 2 and 3 and 22% attached to rib 3. The ventral muscle heads had 36% of 50 tendons passing between ribs 2 and 3 and 64% between ribs 3 and 4. The most frequent pattern of tendon attachment and/or tendon passage posteriorly was the attachment of dorsal tendons to rib 2, passage of central tendons between ribs 2 and 3, and passage of ventral tendons between ribs 3 and 4 (Table 2).

The number of tendon branches extending from the gasbladder muscle was generally six, with mean values of 5.8 for tricipital muscles and 6.0 for tetracipital muscles. Preliminary examination of *S. mentella* and *S. fasciatus* specimens (unpubl. data) indicated

TABLE 2. Summary of gasbladder muscle tendon passage or attachment in *Sebastes marinus*, emphasizing muscle heads from which tendon branches (in some cases, the largest) originated.

Ventral rib attachment or passage of tendons[a]				Specimen No. (Table 1)	Frequency
2	2-3	3	3-4		
d	c	—	v	1, 3, 4, 6, 11 12, 13, 17, 19	9
—	c	d	v	16, 23, 25, 26, 28	5[b]
d	cv	—	—	7, 10, 20, 22, 24	5
d	v	c	—	21, 27	2
d	c_l	c_u	v	8, 18	2
d	—	c	v	5, 15	2
dc_u	c_lv	—	—	9	1
—	dc	—	v	2	1
d	c_lc_u	—	v	14	1
—	—	dc	v	30	1
—	dcv	—	—	29	1

[a] Muscle heads d, c, c_u, c_l and v are dorsal, central, central-upper, central-lower, and ventral respectively.
[b] Pattern illustrated in Figures.

TABLE 3. Frequency of tendon insertions (percentages in parentheses) on a rib or vertebra. (A bifurcated tendon is regarded as having two insertions even if both are on the same structure.)

No. of heads	Position of muscle head	No. of tendons	Insertions on ventral ribs			Insertions on vertebrae				
			2	3	4	5	6	7	8	9
3	Dorsal	44	26 (59)	15 (34)	—	—	1 (2)	2 (5)	—	—
	Central	50[a]	—	12 (24)	4 (8)	—	2 (4)	11 (22)	21 (42)	—
	Ventral	40[b]	—	—	—	1 (3)	2 (5)	5 (13)	11 (28)	21 (53)
4	Dorsal	6	6 (100)	—	—	—	—	—	—	—
	Central upper	5	1 (20)	3 (60)	—	—	—	1 (20)	—	—
	Central lower	8	—	—	1 (12)	—	—	—	7 (88)	—
	Ventral	5	—	—	—	—	—	—	—	5 (100)

[a] Excluding 6 damaged tendons.
[b] Excluding 5 damaged tendons.

that the number of gasbladder muscle heads was one (occasionally two) and the number of tendon branches from the muscle heads in those species was 1 or 2 and 2 or 3 respectively, as observed by Ni (1981, table 2). Thus, the number of tendon branches generally decreases in series from *S. marinus* to *S. fasciatus* to *S. mentella*. This reverses the conclusion of Litvinenko (1980), who reported that the gasbladder muscle in *S. marinus* generally has fewer tendons than that in *S. fasciatus*. Insertions of tendons were generally on vertebral parapophyses 7 to 9 for central and ventral muscle heads and on ribs 2 or 3 for dorsal heads (Table 3.)

There were no observed differences in tendon passage and attachment due to depth, sex or area, but material from other areas should be examined, especially from West Greenland, where additions to the stock are from adjacent spawning areas in the Northeast Atlantic (Travin and Pechenik, 1962; Ni and Sandeman, MS 1982).

The extrinsic gasbladder muscle of *S. marinus* appears to exhibit a variety of patterns with regard to passage of tendon branches between (or attached to) ribs in the 30 specimens examined. However, there seems to be good morphological criteria (shape of gasbladder muscle, number of muscle heads, and number of tendon branches) to enable discrimination of *S. marinus* from the beaked redfishes, *S. mentella* and *S. fasciatus*.

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