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Age and growth of argentine from Nova Scotia

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A B S T R A C T

A method of age determination on Argentina silus (A) from Nova Scotia is described. The growth rate of argentine from the Browns and Emerald Banks has been studied based on summerised length-age data for 1965-1975. The results have not revealed any difference in growth rate of argentine from these areas. A. silus has an isometrical growth pattern.

I N T R O D U C T I O N

Some discrepancies in argentine age reading with a Polish biologist Zukowski made us to set forth the method of age reading which is suggested in the present paper. The studies on argentine growth rate had been undertaken before. However, the material from which a difference in growth rate of argentine from Browns and Emerald Banks originated was unreliable (Shevchuk,1973), and the problem required further consideration.

Material and Methods

The argentine age can be determined by scales or otoliths. As far as the scales of argentine are easy to remove, it is common practice to read the age by otoliths. Samples for age reading have been collected by research vessels. A total of 10 thous. otoliths have been sampled and treated. The otoliths were preserved dry. The annual rings are better seen on the otoliths if they are placed in water solution of liquid ammonia (from 2 to 12 hours) before treatment. Then the otoliths are washed and

looked through under the binocular at magnification 18 in black alcohol containing cuvette in falling light. Argentine otolith consists of the front acute part and the obtuse back part. The age can be better determined by the acute part since it presents more contrasting annual rings. Winter growth zones (hyalines) are distinguished as dark rings, in contrast to white (opaque) summer growth zones. A boundary between the outer hyaline and inner opaque zones is taken as an annual ring. There is a central nucleus in the middle of the otolith (looking dark in falling light) surrounded by a ringlet, however, not always present.

For determination of argentine growth rate the data on age by seasons for 1965-1975 have been used. A total of 4 thous. specimens have been analysed. A fork length of fish was measured. Since two year old argentine does not practically occur in the catches, the growth data have been obtained by means of back calculation admitting a linear length-age dependence. Taking in to account the inaccuracy of individual weighting procedure in field conditions, a length-weight dependence was used for calculation of growth rate of body weight. This dependence was found by using the data of individual measurements made in the laboratory by technical scales to within 0.1g. The weight-length dependence was estimated according to $W = aL^b$ formula, where W is the body weight in g, L is the body length in cm, and b is the proportionality factor.

Results of studies

A G E

The otolith growth and formation of annual rings in argentine proceed as follows: the spawning of argentine in the Nova Scotia waters continues from February to May. Massive spawning is observed in the mid April. According to Bigelow H.B. and Schroeder W.C. (1953), the larvae after hatching are 7.5 mm in length and have a yolk sack which is completely resolved at the length of 12mm. Fin rays, apart from ventral ones, appear at the length of 45mm. At this length the anus is shifted ahead and a groove on caudal fin becomes evident. Ventral fin rays appear at the length over

50mm. The growth of fish continues through the summer till autumn and an opaque growth zone is formed on the otolith. The formation of a hyaline zone occurs in mid autumn (fig. 1). At this period of life the age of the fish is approximately 6 months, the mean length of fish is 7-12 cm. The measurements of the second visible ring and calculations of the corresponding fish length indicate that this ring is formed at the length of 10 to 16 cm. We consider this ring as the first annual. All the subsequent growth zones on the argentine otolith are clearly seen and present alternating opaque and hyaline zones. A wider opaque zones are decreased with age. Thus, the second growth zone is half as wide as the first one, the forth zone is half as wide as the second and third ones.

On the otoliths of larger mature fish a spawning ring shows up in the 8-9 growth zones.

The examination of 10 thous. otoliths showed that the formation of an annual ring continues from September to November, the greatest increment being observed in the summer period. In order to avoid any confusion between year-classes, the formation of an annual ring is timed to the beginning of the calendar year. Therefore, in fish caught to December 31 the age is reduced by one year, while beginning from January 1 the age is increased by one year.

The results of age determinations are in good agreement with the data of Emery A.R. and McCracken (1966), but differ from those of a Polish biologist Zukowski C.M.S.(1970) (fig.2). According to his data the first visible ring on the otolith is the first annual ring.

Growth rate of the body length

Now we can follow the growth pattern of argentine from Browns and Emerald Bank areas (Table 1, 2, 3). It is evident from the Tables that there is no growth increment in body length of argentine from the above areas.

The intensive linear growth can be marked in argentine in first years of life to 3-4 years. The increment of body length considerably slows down on achievement of this age. Growth rate in females is greater than in males.

Weight-length dependence

The studies of growth pattern of argentine from the Nova Scotia regions indicated an isometrical growth: $W = 0.00809L^{3.065}$, for the power to which the base should be raised approximated the value of three. On this basis a table of body length and weight was made up (Table 4);

Growth rate of the body weight

Growth rate in females is greater than in males(Tables 5,6). Despite this difference the data on growth rate have been averaged for theoretical investigations, and basing on a comparison of growth rate in argentine weight from the Browns and Emerald Bank areas has been made (fig.3). The figure shows no difference in growth rate. The intensive increment of argentine weight occurs during the first years of life (Table 7).

Summary

The results of studies showed that an annual ring on the argentine otolith was formed from September to November. The greatest increment was observed in summer period. The data on age determination are in good agreement with those of Canadian scientists, which makes it possible to use their material in our analysis. There is no difference in growth rate of argentine from the Browns and Emerald Bank areas. The intensive increment of body length and weight is observed in first years of life. The growth is of isometrical pattern.

References

1. Bigelow H.B. and Schroeder W.C., 1953. Fishes of the Gulf of Main. Fishery Bulletin, Vol. 53 Washington, pp.139-149.
2. Emery A.R. and Mc Cracken F.D., 1966. Biology of the Atlantic Argentine on the Scotian Shelf. J.Fish.Res.Bd.,Canada 23, pp. 1145-1160.
3. Shevohuk L.I., 1973. On argentine stock locality in the Northwest Atlantic (ICNAF Div. 4V,4W and 4X).ICNAF Res. Doc. 73/25 Serial No. 2958.
4. Zukowski C.M.S., 1970. Some biological data on argentine from the Nova Scotia area. ICNAF Res.Doc. 70/64, Serial No. 2406.

Table 1. The increment of argentine body length by age.

A G E	:1-2	:2-3	:3-4	:4-5	:5-6	:6-7	:7-8	:8-9	:9-10	:10-11	:11-12
A R E A:	:	:	:	:	:	:	:	:	:	:	:
I N C R E M E N T S											
Browns Bank	cm 3.9	5.2	1.7	1.8	2.0	1.4	1.3	1.2	1.4	0.9	-
	% 27.8	28.8	7.2	7.1	7.4	4.8	4.3	3.8	4.3	2.6	-
Emerald Bank	cm 5.2	3.4	2.5	2.1	1.4	1.5	1.3	1.8	1.5	0.7	1.2
	% 37.1	17.8	11.1	8.4	5.1	5.2	4.3	5.7	4.5	2.0	3.4

Table 2. Length (cm) and age of argentine from Browns Bank.

Quarter	Sex	A G E G R O U P S										
		1	2	3	4	5	6	7	8	9	10	11
IV		14.3	16.3									
I	juv.											
II			18.5									
III			19.8									
IV				22.6	24.6	26.4	28.1	29.6	30.4	31.0	33.0	34.4
I	♂♂			-	25.0	27.6	28.2	30.4	31.6	32.6	34.5	34.6
II				22.8	24.8	26.9	28.6	30.6	32.0	33.6	34.4	-
III				23.7	26.0	28.2	29.0	30.6	31.9	32.4	-	-
IV				-	24.5	26.4	28.8	30.0	31.8	32.8	34.1	35.8
I				23.7	-	27.9	30.1	31.2	32.9	33.5	34.5	-
II	♂♂			24.3	25.0	28.3	30.0	31.3	32.2	34.1	35.2	-
III	♀♀			-	25.7	29.1	30.2	31.9	32.8	33.8	-	-
mean for a year	juv. ♀♀	14.3	18.2									
	♂♂			22.8	25.1	26.7	28.5	29.9	31.0	32.5	33.9	34.5
	♀♀			24.2	25.1	27.6	29.3	30.8	32.2	33.2	34.6	35.3
	♂♂			23.4	25.1	26.9	28.9	30.3	31.6	32.8	34.2	35.1

Table 3. Length (cm) and age of argentine from Emerald Bank.

Quarter:	Sex:	A G E G R O U P S											
		1	2	3	4	5	6	7	8	9	10	11	12
IV		14.0	17.6										
I	juv.		-										
II			19.5										
III			20.5										
IV				22.7	24.7	26.0	27.4	29.7	31.4	32.7	34.4	35.2	36.1
I					25.5	26.5	27.8	-	-	-	-	-	-
II	♂♂				25.0	27.0	28.4	29.4	30.5	33.1	34.3	35.8	37.3
III					26.1	28.4	30.0	-	33.6	34.5	35.0	-	-
IV				22.6	24.0	27.2	27.9	30.9	32.4	33.4	35.6	35.9	37.3
I					25.0	27.2	27.7	-	-	-	-	-	-
II	♀♀				25.1	26.9	29.2	29.9	30.8	33.9	34.7	35.9	-
III					27.5	29.3	31.2	31.9	33.8	34.3	36.2	-	-
Mean for	juv.	14.0	19.2										
a year	♂♂			22.7	25.1	26.8	28.0	29.5	31.1	33.0	34.4	35.4	36.3
	♀♀			22.6	25.1	27.7	29.5	31.0	32.1	33.8	35.4	35.9	37.1
	♂♀			22.6	25.1	27.2	28.6	30.1	31.4	33.2	34.7	35.4	36.6

Table 4. Length and Weight, $W = 0.00809 L^{3.065}$

Body length, cm	Observed weight, g	Theoretical weight, g	Body length, cm	Observed weight, g	Theoretical weight, g
1	-	0.01	26	166(17)	160
2	-	0.07	27	184(24)	179
3	-	0.2	28	198(15)	199
4	-	0.6	29	226(3)	222
5	-	1.0	30	257(5)	246
6	-	2.0	31	281(10)	271
7	-	3.0	32	307(10)	298
8	-	5.0	33	342(20)	327
9	-	7.0	34	365(20)	358
10	-	9.0	35	400(11)	390
11	-	12	36	-	425
12	-	16	37	-	461
13	-	20	38	-	500
14	-	25	39	-	540
15	-	31	40	-	582
16	-	37	41	-	627
17	-	45	42	-	674
18	-	53	43	-	724
19	-	62	44	-	775
20	-	73	45	-	829
21	88(2)	84	46	-	886
22	92(5)	97	47	-	945
23	109(5)	111	48	-	1006
24	129(14)	126	49	-	1070
25	140(16)	142	50	-	1138

Table 5. Weight(g) and age of argentine from Browns Bank.

Quarter	Sex	A G E G R O U P S											Weight-length dependence		
		1	2	3	4	5	6	7	8	9	10	11			
IV		-	-	107	138	171	206	241	262	277	334	379		W = 0.0093	L ³
I	♂♂	-	-	-	-	-	-	-	-	-	-	-			
II		-	-	101	130	166	198	244	279	322	346	-		W = 0.0085	L ³
III		-	-	124	163	209	227	266	302	316	-	-		W = 0.0093	L ³
IV		-	-	-	137	171	222	251	299	328	369	427		W = 0.0093	L ³
I	♀♀	-	-	-	-	-	-	-	-	-	-	-			
II		-	-	120	141	204	243	276	300	356	415	-		W = 0.0090	L ³
III		-	-	133	158	229	256	302	328	359	-	-		W = 0.0093	L ³
Mean for juv.		55	-	-	-	-	-	-	-	-	-	-			
a year	♂♂	-	-	107	137	171	208	241	268	309	360	366		W = 0.0090	L ³
	♀♀	-	-	130	148	193	231	269	307	337	378	422		W = 0.0092	L ³
	♂♀	-	-	117	140	177	220	253	287	321	367	407		W = 0.0091	L ³

Table 6. Weight (g) and age of argentine from Emerald Bank

Quarter	Sex	A G E G R O U P S												Weight-length dependence		
		1	2	3	4	5	6	7	8	9	10	11	12			
IV		-	-	111	143	167	195	249	294	332	387	414	447		W = 0.0095	L ³
I		-	-	-	-	-	-	-	-	-	-	-	-			
II	♂♂	-	-	142	179	208	231	258	290	367	417	472		W = 0.0091	L ³	
III		-	-	-	165	213	251	-	352	382	399	-	-		W = 0.0093	L ³
IV		-	-	109	131	191	206	280	323	354	429	440	493		W = 0.0095	L ³
I		-	-	-	-	-	-	-	-	-	-	-	-			
II	♀♀	-	-	-	144	165	212	227	248	331	355	393	413		W = 0.0085	L ³
III		-	-	-	193	234	282	302	334	375	441	-	-		W = 0.0093	L ³
Mean for juv.		25	64	-	-	-	-	-	-	-	-	-	-			
a year	♂♂	-	-	109	147	179	204	239	280	334	379	413	445		W = 0.0093	L ³
	♀♀	-	-	105	144	193	234	271	301	351	404	421	465		W = 0.0091	L ³
	♂♀	-	-	105	144	183	213	248	282	333	380	404	446		W = 0.0091	L ³

Table 7. Increment of argentine body weight by age.

A R E A S	A G E	:											
		1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	
Browns Increment	gramms	28	62	23	37	43	33	34	34	46	40	-	
Bank	%	103.7	112.7	19.6	26.4	24.3	15.0	13.4	11.8	14.3	10.8	-	
Emerald Increment	gramms	39	41	39	39	30	35	34	51	47	24	42	
Bank	%	156.0	64.0	37.1	27.1	16.4	16.4	16.4	18.1	14.1	6.3	10.4	



Fig. 1. An argentine otolith with two annual rings - body length is 17.9 cm (according to Smith), juv., caught in November. O - the first hyaline zone; I - the first annual ring; II - the second annual ring.

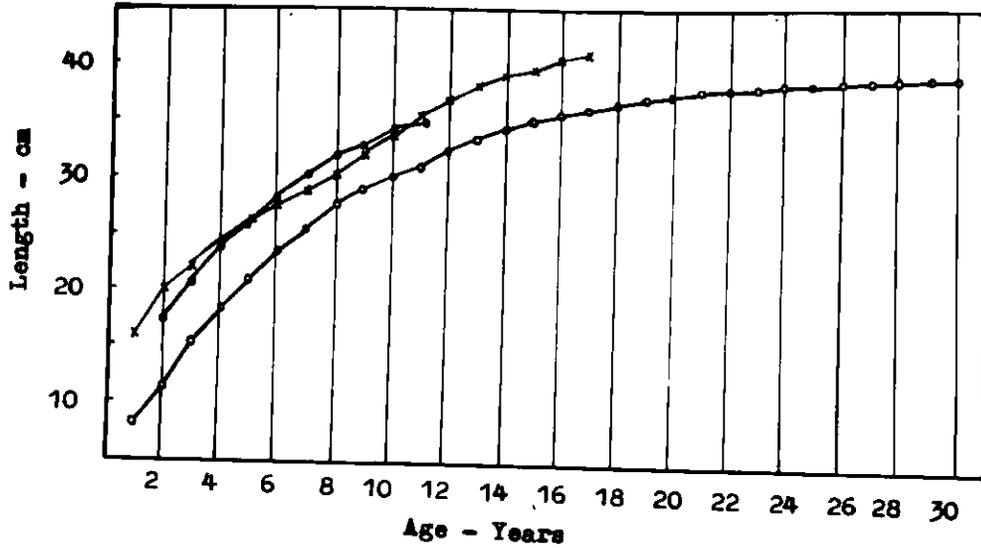


Fig. 2. The curves of linear growth of argentine from Nova Scotia region.
 —•— data of Emery and McCracken; *—*— data of Shevchuk;
 —○— data of Zukowski.

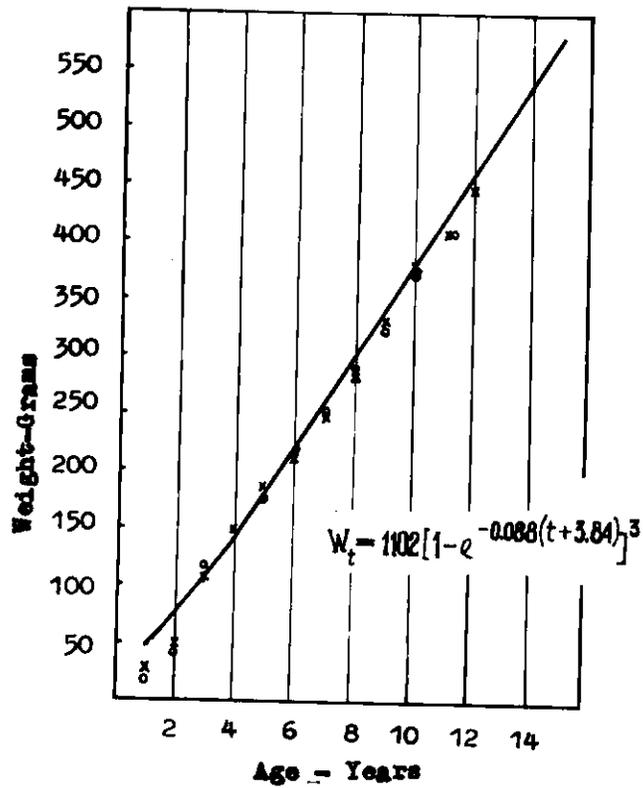


Fig. 3. A curve of weight growth of argentine from Nova Scotia region. ° - mean weight of argentine from Browns Bank; * - mean weight of argentine from Emerald Bank; — - a curve of argentine weight growth constructed according to calculated data.

