

Nature of spawning and formation of fecundity
 in argentine (*Argentina silus ascanius*)

by

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Abstract

Females of the North Atlantic argentine (*Argentina silus*) from the Reykjanes Ridge area become mature at length 34-39 cm. Yolk ovicells diameter is up to 2500 μ m, after the yolk hydration period it reaches 3500 μ m. Vitellogenesis is asynchronous. Spawning has a two-batch pattern. Individual fecundity is from 16×10^3 to 36×10^3 eggs.

Introduction

The Atlantic argentine is distributed in temperate waters of the Atlantic Ocean. In European waters it is distributed from Ireland and Skagerrak along the Norwegian coast and around Iceland, but especially numerous it is off the southern and southwestern coasts of Iceland (Magnusson, 1981).

There is no direct fishery for this species, it is captured only as a by-catch. From 1977 to 1981 the by-catch of argentine increased from 250 t to 9000 t due to intensification of fishery for other species (Johansen, Monstad, 1982). Under such conditions it is important to estimate the size of stock and recruitment.

Information on propagation of argentine is scant and fragmentary. It is known from literary sources that female argentine from different areas of the Norwegian Sea become mature at the length of body 33-38 cm. Propagation takes place from March till September. Fecundity varies from 6×10^3 to 50×10^3 eggs (Borodulina, 1964; Keysler, 1968; Johansen, Monstad, 1982). We failed to find papers describing gametogenesis and sexual cycle of argentine.

The present paper describes some results of studies of ovicells growth and development. On the basis of comparison of histological structure and macroscopic picture of gonads some stages of sexual cycle, nature of spawning and formation of fecundity are considered.

Materials and methods

Observation and data collection was carried out during the R/V "PINRO" cruise in the second half of May, 1988. Altogether 280 females were biologically sampled, most of them were from the Reykjanes Ridge area (63°N 25°W).

During the field sampling fish length and weight and also eggs weight were measured. Maturity stage of sexual glands was estimated using a 6-division maturity scale (Sakun, Butskaya, 1963).

For histological analysis pieces cut from various parts of an ovary were fixed in Bouin's fluid. Histological treatment was carried out according to traditional methods: setting into alcohol of increasing concentrations, paraffin xylol, laying into paraffin. Sections of 6-7 μ m thick were stained with iron hematoxylin according to Heidenhein (Roskin, Levinson, 1956).

Diameter of eggs and fecundity were estimated by formalin fixations. Fecundity was estimated by three portions of eggs (about 15 grams each) taken from the frontal, central and caudal parts of the ovary. Eggs with diameter over 1.5 mm were taken into account.

Results

Catches of argentine taken from depths of 300-400 m brought fish with length from 23 to 39 cm. Sex ratio (males/females) was 1:1.4. Maturity coefficient varied from 0.35 to 1.24%. Ovaries were of milk-white colour. White eggs (diameter 0.5-0.8 μ m) were visible through a semi-translucent membrane.

A histological analysis showed that the ovaries contained a set of sexual cells - oogonia and oocytes of the protoplasmatic growth period. The older generation of oocytes was in the vacuolization phase: in oocytes of 350-500 μ m in diameter small vacuoles were observed in the peripheral zone; these vacuoles will form the cortical layer somewhat later. More later the circumnuclear zone will be

vacuolized. The content of vacuoles was, probably, of lipid nature, and it was washed out in the process of preparations treatment. Until the end of the phase ovicells diameter ranged from 700 to 800 μm (Fig.1). By these indications the ovaries may be related to the second stage of development.

Catches of argentine at depths 500-650 m brought fish of 34-51 cm long. Ovaries of most fish contained maturing eggs. The majority of females were prespawners (stages IV, IV-V), partially spent or spent (stages VI-IV, VI) fishes were also found (Table 1).

In prespawning females ovaries occupied almost the whole body cavity. Eggs of various size which made ovaries to look mosaic were seen through the extended membrane. Yellow-pale ovicells (diameter from 1000 to 2500 μm) and semi-translucent greyish eggs (diameter 2700-3500 μm) were clearly pronounced. Maturity coefficient varied from 6.8 to 21.6%.

Table 1. Ratio of female argentine at various stages of maturity

Number of fish	Maturity stages				
	III	IV	IV-V	VI-IV	VI
180	4.6	78.0	10.2	5.8	1.4

In majority of maturing females the process of accumulation of nutritious substances (yolk granules and drops of fat) was close to completion (Fig.2). Vitellogenesis was asynchronous. Diameters of yolk oocytes varied from 1000 to 2500 μm , those after hydration - 3500 μm . Besides ovicells of trophoplasmatic growth period the ovaries contained oogonia and oocytes of the previtellogenesis period.

The results of mass measurements of yolk ovicells diameter are presented on Fig.3. Two groups of ovicells are revealed: those of size from 1.9 to 2.5 mm were oocytes of the intensive trophoplasmatic growth phase, and from 2.7 to 3.5 mm in size were oocytes of the hydration phase. A smaller amount of oocytes from intermediate size groups testifies to the intermittent-asynchronous type of vitellogenesis. The character of asynchrony allows us to suppose a two-batch type of spawning. Both size groups of yolk ovicells are identified with portions of ovulated eggs (Table 2).

Table 2. Size and percentage of formed batches of eggs in female argentine prespawners

Fish length, cm	Maturity coefficient	Mean diameter of ovicells in batch 1, mm	Mean diameter of ovicells in batch 2, mm	Number of ovicells			
				in batch 1		in batch 2	
				pc	%	pc	%
44.6	20.6	3.2	2.2	9480	46.5	10800	53.5
45.0	14.3	2.7	2.2	11550	58.9	7900	41.1

After spawning of the first batch of eggs the ovaries looked almost the same. The maturity coefficient remained relatively high, from 5.5 to 15.9%. The ovaries contained yolk ovicells diameters of which were from 1.8 to 2.4 mm (Fig.3). Remaining follicles of ovulated ovicells, oocytes of the intensive trophoplasmatic growth phase, oogonia and oocytes of the protoplasmatic growth period - a reserve for sexual cells - were observed on histological sections of ovicells (Fig.4).

After the ovaries had been completely free of eggs their volume reduced, the membrane became wrinkled, the colour of ovaries was reddish because of multiple haemorrhages. Ovary cavities were filled with mucus, blood, remaining single not extruded semi-transparent eggs, empty follicular membranes, oogonia, oocytes of the protoplasmatic growth period and vacuolization phase (Fig.5).

At estimating fecundity the total number of yolk ovicells in ovaries at maturity stages III, IV, IV-V and VI-IV was regarded as ovarial cells (Table 3). The results showed that individual fecundity in females of 41-49 cm long was from 16 to 36 thousand eggs. Like in most fish species fecundity increases with the increase of the fish length and weight. In females at maturity stage VI-IV the resulting figures turned out to be lower. Thus, to obtain representative data it is recommended to collect materials on fecundity of argentine from the Reykjanes Ridge area since May, when maturing ovicells are completing the trophoplasmatic growth period. The diameter of eggs considered should be not less than 1.5 mm.

Conclusion

Female argentine from the Reykjanes Ridge area caught in the second half of May judging by their sexual glands state may be divided into 2 groups: fish of 23-29 cm long (immature) the ovaries of which did not contain yolk ovicells, and those of 34-51 cm long which had maturing gonads. The latter were prespawning, partially spent and spent.

Individual fecundity in females of 40-49 cm long was from 16 thousand to 36 thousand eggs.

Table 3. Individual fecundity of argentine from the Reykjanes Ridge area

No. of fish	Body length g	Body wt, g	Ovary weight g	Maturity stage	Maturity coefficient, %	Mean* diameter of yolk ovicells mm	Mean number of ovicells in a portion weighed, pc	Total number of yolk ovicells in an ovary, ('000)
I.	41	790	71	III	9,0	2,0	3410	16.140
2.	43	920	103	IV	11,2	2,1	2635	18.090
3.	43	970	88	III	9,1	2,0	3572	20.960
4.	44	990	64	III	6,5	1,8	4950	21.120
5.	44	1040	116	IV	11,2	2,4	2593	20.050
6.	44	1190	245	IV-Y	20,6	3,2	1203	19.670
7.	45	1000	108	IV	10,8	2,1	2723	19.600
8.	45	1015	116	IV	11,4	2,3	2439	18.860
9.	45	1000	109	IV	10,9	2,1	3062	22.250
10.	45	1070	153	IV-Y	14,3	2,7	1907	19.450
11.	46	1045	153	IV	14,6	2,5	2074	21.150
12.	46	1070	175	IV-Y	16,4	2,9	1783	20.800
13.	46	1090	143	IV	13,1	2,3	2531	24.130
14.	47	1090	147	IV	13,5	2,3	2215	21.710
15.	47	1170	142	IV	12,1	2,6	2415	22.860
16.	47	1180	170	IV	14,4	2,3	3158	35.790
17.	47	1228	168	IV	13,7	2,4	2420	27.160
18.	47	1254	122	IV	9,7	2,1	3287	26.730
19.	48	1320	162	IV	12,3	2,2	2545	27.490
20.	49	1390	161	IV	11,6	2,2	2525	27.190
Partially spent females								
21.	40	670	52	VI-IV	7,8	2,2	2255	7.820
22.	43	830	48	VI-IV	5,8	2,2	1835	5.870
23.	43	858	87	VI-IV	10,1	2,5	1552	9.000
24.	43	920	146	VI-IV	15,9	2,9	1287	12.530
25.	44	970	68	VI-IV	7,0	2,2	2240	10.150
26.	44	965	83	VI-IV	8,6	2,2	2430	13.450
27.	46	1010	55	VI-IV	5,5	2,2	2151	7.890
28.	47	1180	117	VI-IV	9,9	2,6	1478	11.630
29.	48	1250	112	VI-IV	9,0	2,5	1650	12.320
30.	49	1260	115	VI-IV	9,1	2,3	2233	17.120

* Mean diameter estimated in 100 ovicells of senior generation



Fig.1. Vacuolization of cytoplasm in ovicells of argentine.
Oc. 7 x, lens 8 x.

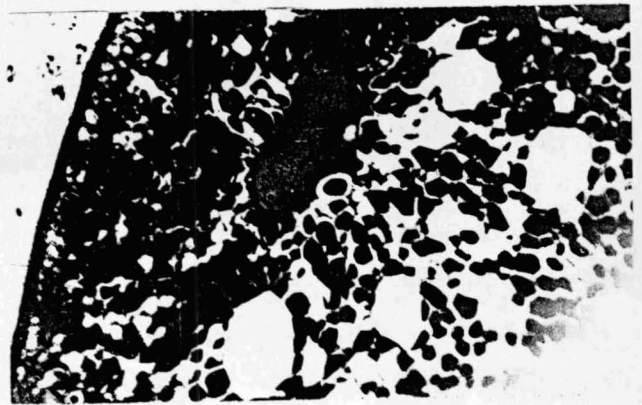


Fig.2. Accumulation of nutritious substances: granules of yolk and drops of fat.
Oc. 7 x, lens 20 x.

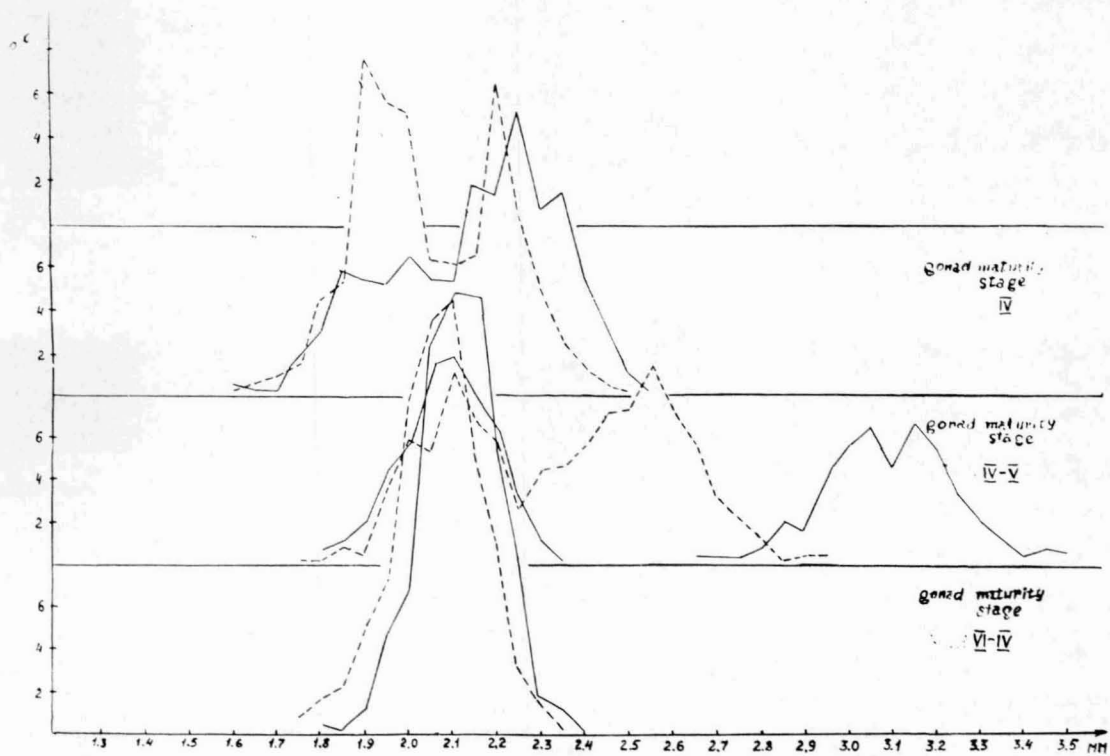


Fig.3. Length composition of yolk ovicells in argentine at various stages of maturation

♀ - IV	- - -	Matur. coeff. 13.1%	♀ - IV-V	- - -	mat. coeff. 14.3%
	—	Mat. coeff. 13.7%		—	mat. coeff. 20.6%
♀ - VI-IV	- - -	Mat. coeff. 5.5%			
	—	Mat. coeff. 7.8%			



Fig.4. Ovary of argentine at maturity stage VI-IV. Senior oocytes are in the intensive trophoplasmatic growth phase. Oc. 5 x, lens 3.5 x.



Fig.5. Ovary of argentine at maturity stage VI. Residual follicles are in the centre. Oc. 7 x, lens 8 x.

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