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RAPPORT DES SEXES ET FECONDITE DES SAUMONS (*SALMO SALAR* L.) CAPTURES SUR UNE RIVIERE DE BRETAGNE NORD (FRANCE).

SEX RATIO AND FECUNDITY OF ATLANTIC SALMON (*SALMO SALAR* L.) CAUGHT ON A NORTHERN BRITTANY RIVER (FRANCE).

by

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RESUME:

Durant la saison de pêche 1979, sur l'Elorn, un échantillon (38 %) des captures de saumon atlantique (saumon de printemps) a pu être ouvert pour la détermination du sexe et l'observation des caractéristiques des gonades.

Les résultats montrent que le sex ratio est largement en faveur des femelles (1 ♀ : 0,07 ♂) chez une population constituée exclusivement de saumons de printemps.

L'observation des ovaires montre deux générations d'ovocytes, la première étant en prévitellogénèse. La fécondité potentielle (nombre d'ovocytes en prévitellogénèse par kg de poids frais) varie, pour des poissons de 70 à 79 cm, de 1980 à 2980 ovocytes par kg.

L'impact de ces observations sur l'évolution du stock de saumons de printemps est discuté.

SUMMARY.

During the fishing season in 1979, 38 % of the catches of atlantic salmon (spring salmon) in the river Elorn have been sampled for sex determination and observation of the characteristics of the gonads.

The results showed that the sex ratio is largely in favour of females (1 ♀ : 0,07 ♂). The observation of the ovaries showed two classes of oocytes, the first one being in previtellogenesis.

The potential fecundity (number of oocytes in previtellogenesis per kg of body weight) fluctuated from 1980 to 2980 oocytes per kg in fish of 70-79 cm length.

The impact of these observations on the evolution of the spring salmon stock is discussed.

INTRODUCTION.

Since 1971, studies concerning the characteristics (weight, length and age) of atlantic salmon stocks have been undertaken on the main rivers of Brittany (FONTENELLE, 1975 ; HARACHE et PROUZET, 1977 ; PROUZET *et al.*, 1978 ; BAGLINIERE *et al.*, 1979).

Moreover, some observations have been carried out on the sex ratio either during the spawning season on a tributary of the Blavet river (FONTENELLE, 1975) or by the analysis of dead salmon following an accidental pollution (BAGLINIERE *et al.*, 1979).

The purpose of this preliminary communication is to complete the fragmentory observations already collected and bring new informations on the sex ratio and potential fecundity of atlantic salmon caught during the fishing season.

MATERIAL AND METHODS.

The length-weight data and samples of gonads and scales have been collected by the anglers themselves during the fishing season (beginning of March - mid June). On the Elorn river, 53 % (32 fish) of the catches have been analysed for length-weight and age, and 38 % (23 fish) have been sampled for sex determination. Another 8 salmon caught in a nearly stream : the Penzé river were added to this sample.

The gonads were frozen as soon as possible and conveyed to the laboratory for the determination of weight and stade of vitellogenesis. They were, then, fixed in a solution of formol (10 %), salted (9°/$_{oo}$) during at least 24 hours, dried and weighted again.

The potential fecundity (oocyte number of the class of maximum size) was estimated from the census made on a sample of six lamellae previously weighted (one anterior, medium and posterior on each ovary). The mean diameter is determined on a sample of 48 ovocytes (8 per lamellae examined).

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RESULTS.

Characteristics of the salmon examined for age and sex determination.

The almost totality of the salmon (94 %) sampled on Elorn river in 1979 or on Penzé river in 1978-1979 (85 %) were spring salmon (1 or 2 years in freshwater). On each river, the weight and length of the sample sexed in 1979 were not significantly different from the whole sample (table 1).

Sex ratio and fecundity.

The sex ratio of the spring salmon caught on these rivers were largely in favour of females : 1 ♀ : 0,05 ♂ on the Elorn river ; 1 ♀ : 0,17 ♂ on the Penzé river and 1 ♀ : 0,07 ♂ for the whole sample. For the grilses, we may note that the two fish sampled were males.

The observation of ovaries of spring salmon (table 2) showed an homogeneous generation of oocytes, in previtellogenesis. The diameter of the ovocyte fluctuated from 1.5 to 2.4 mm according to the fish. The diameter of the oocytes of the next generation rarely exceeded 0.25 mm and have not been numbered. The number of oocytes in previtellogenesis per kg varied from 1980 to 2980 in fish of 70-79 cm length.

The relationship between potential fecundity (F) and weight (W) (fig. 1) may be explained by the following formula :

$$\text{Log } F = 0{,}622 \log W + 8{,}326$$

$$\text{or } F = 4129\ W^{0{,}622} \quad (R = 0{,}620 \text{ ; significant at } P = 0{,}01)$$

DISCUSSION.

The sex ratio of the spring salmon largelly in favour of females confirms the observations made on the Scorff river where 86 % of the spring salmon (2 or 3 years in seawater) were females (BAGLINIERE *et al.*, 1979). These observations agree with those made on canadian rivers : PALOHEIMO and ELSON, 1973 (more than 50 % of females among large salmon, only 30 % among grilses), RUGGLES and TURNER, 1973 (86 % of females among large salmon, 22 % among grilses).

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The potential fecundities calculated on the spring salmon sample are, on an average, high and superior to the number of oocytes or ovules generally observed and cited in the litterature (table 3).This result is not surprising as the degenerescence of a part of germinal cells a common phenomena that can affect diverse stages of the ovogenesis and, particularly, the vitellogenesis as showed by PERSON (1963) with pink salmon (*Oncorhynchus gorbusha*) and MELNIKOVA (1964) with *Salmo salar*. Consequently the potential fecundity observed at a given stage is superior to the "ultimate fecundity". The precise relationship between these two fecundities cannot be established without observations realised on the same population during the ovulation phase.

Considering the scarcity of adult salmon at time of spawning (large spawning surfaces inoccupied), the high potential fecundity and the apparent high proportion of females within the spring salmon population, one may assess that the sport fishery which exploits almost exclusively the spring run, affects probably widely the reproductive potential of salmon from the Elorn river as suggested by HARACHE and PROUZET (1977).

The heavy fishing pressure exerted on this population may be considered as partially responsible of the decline observed during the last ten years and will, probably, largely condition the future recruitment of the salmon stock (PROUZET *et al.*, 1978). However, at the present stage of knowledge and with the investigation tools available, it remains impossible to precise the respective proportions of spring salmon and late run fish (October - December) in the total egg production of the Elorn river.

One of the first conservatory decisions would be to delay the beginning of the angling season after the 1st of May to exploit the grilse run, and to create sanctuaries for spring fish on the middle and upper part of the river to increase the reproduction potential, in relation with the important environmental restauration program undertaken on the Elorn river.

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FIGURE 1 : RELATIONSHIP BETWEEN FECUNDITY AND WEIGHT

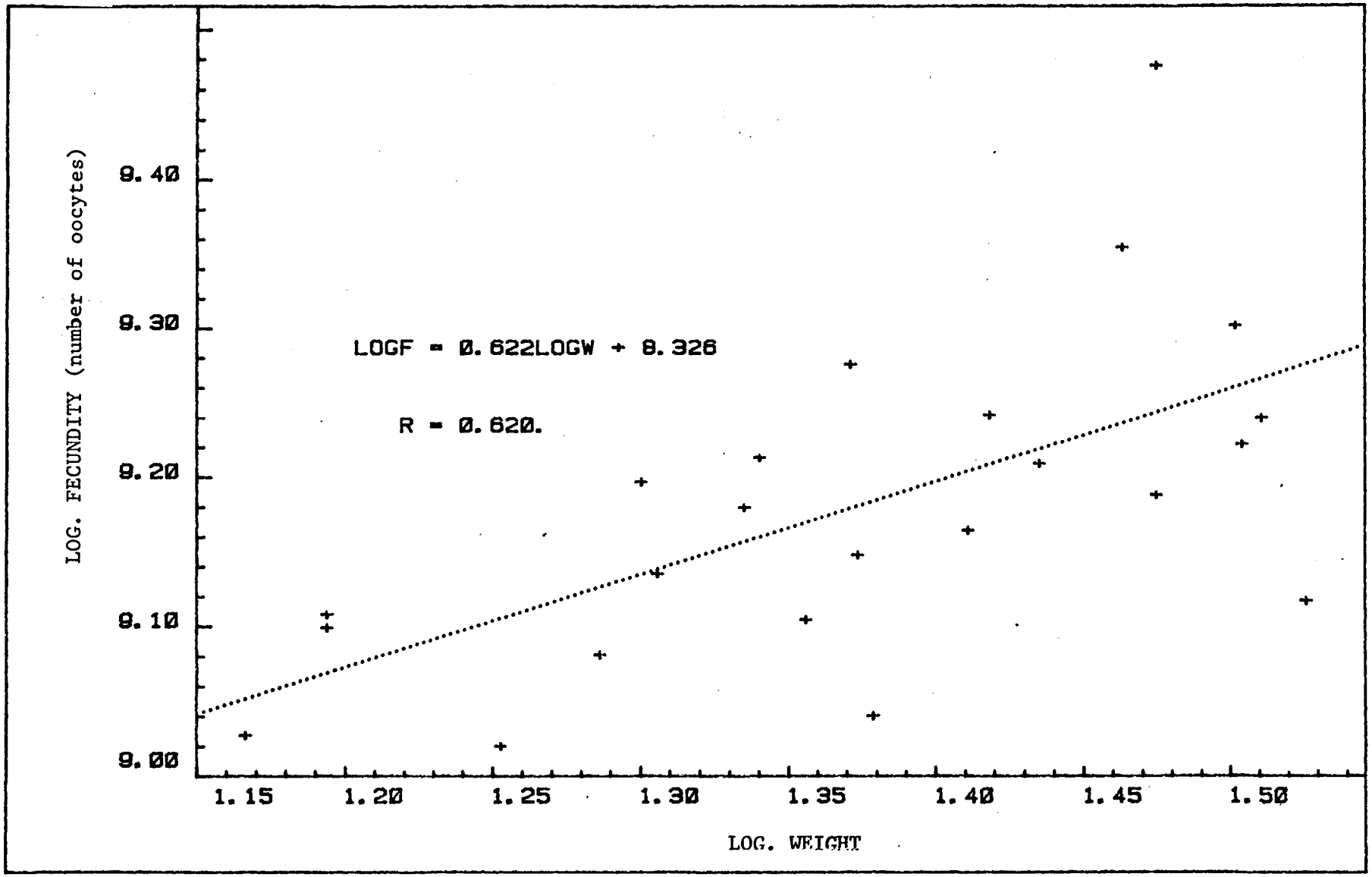

TABLE 1 - CHARACTERISTICS OF SALMON SAMPLED AND EXAMINED FOR SEX DETERMINATION IN THE ELORN AND PENZE

			ELORN	PENZE
CHARACTERISTICS OF THE CATCHES SAMPLED	WEIGHT (Kg)	SS	4.08 ± 0.19 (**)	4.36 ± 0.26
		G	2.75 (*)	1.6 (*)
	FORK LENGTH (cm)	SS	74.47 ± 1.25	77.32 ± 1.43
		G	57 (*)	60 (*)
	AGE	1.1^+		1 (4%)
		2.1^+	1 (3%)	
		1.2	14 (44%)	11 (44%)
		2.2	16 (50%)	12 (44%)
		1.3	1 (3%)	3 (11%)
CHARACTERISTICS OF THE SAMPLE EXAMINED FOR SEX DETERMINATION.	WEIGHT (Kg)	SS	3.87 ± 0.23 (N = 22)	4.14 ± 0.64 (N = 7)
		G	2.75 (*)	1.6 (*)
	FORK LENGTH (cm)	SS	73.76 ± 1.17 (N = 21)	75.6 ± 2.13 (N = 7)
		G	57 (*)	60 (*)
	AGE	1.1^+		1
		2.1^+	1	
		1.2	10	4
		2.2	8	

(*) - 1 fish

(**) - Standart deviation of the mean

SS = Spring Salmon

G = Grilse

TABLE 2 - CHARACTERISTICS OF THE OVARIES AND POTENTIAL FECUNDITY

DATE	ORIGINE	FORK LENGTH (cm)	WEIGHT (g)	AGE	WEIGHT OVARY (g)	G.S.R. (%)	OVOCYTE DIAMETER (mm)	POTENTIAL FECUNDITY (ovocyte number)	FECUNDITY / KG
03/04/79	Elorn	74.0	3690	1.2	42.25	1.14	1.88 *0.14*(*)	9.280 ± 420(**)	2400 < 2510 < 2630
01/04/79	Elorn	70.0	3300	2.2	45.31	1.37	1.88 *0.09*	8.950 ± 455	2570 < 2710 < 2850
/04/79	Elorn	79.0	4530	2.2	25.90	0.57	1.51 *0.16*	10.300 ± 540	2150 < 2270 < 2390
01/04/79	Elorn	75.0	3500	2.2	30.76	0.88	1.76 *0.11*	8.270 ± 400	2250 < 2360 < 2480
06/04/79	Elorn	76.0	4500	1.2	33.47	0.74	1.65 *0.13*	10.120 ± 310	2180 < 2250 < 2320
30/03/79	Penze	75.5	3950	1.2	26.33	0.67	1.62 *0.12*	9.400 ± 590	2230 < 2380 < 2530
30/03/79	Elorn	72.5	3800	1.2	≈50	≈1.30	1.91 *0.16*	≈9.700 ± 800	2340 < 2550 < 2760
25/03/79	Penze	76.5	4370	1.2	56.98	1.30	2.08 *0.12*	9.780 ± 290	2170 < 2240 < 2300
17/03/79	Penze	73.5	3970	-	37.76	0.95	1.88 *0.14*	8.440 ± 340	2040 < 2130 < 2210
03/06/79	Penze	76.0	3620	1.2	29.91	0.83	1.67 *0.13*	8.790 ± 695	2240 < 2430 < 2620
17/03/79	Elorn	71.0	3210	-	50.91	1.59	1.99 *0.12*	8.330 ± 460	2450 < 2595 < 2740
/03/79	Penze	75.0	4100	1.2	38.68	0.94	1.81 *0?15*	9.550 ± 250	2270 < 2330 < 2390
03/03/79	Elorn	75.0	4130	2.2	37.31	0.90	1.72 *0.13*	10.320 ± 480	2380 < 2500 < 2620
03/03/79	Elorn	73.0	3670	2.2	27.43	0.75	1.60 *0.13*	9.870 ± 390	2580 < 2690 < 2795
08/03/79	Elorn	72.0	3820	1.2	28.96	0.76	1.62 *0.11*	10.030 ± 540	2480 < 2630 < 2770
03/05/79	Elorn	72.0	3880	1.2	47.43	1.22	1.91 *0.15*	9.000 ± 730	2130 < 2320 < 2510
30/04/79	Elorn	75.0	4320	2.2	44.64	1.03	1.78 *0.14*	11.550 ± 650	2520 < 2680 < 2820
15/04/79	Elorn	71.5	3940	-	34.10	0.87	1.66 *0.13*	10.680 ± 310	2630 < 2710 < 2790
03/05/79	Elorn	76.5	4600	1.2	78.80	1.71	2.24 *0.08*	9.110 ± 280	1920 < 1980 < 2040
20/05/79	Elorn	71.0	3300	1.2	37.10	1.12	1.84 *0.15*	9.030 ± 240	2660 < 2740 < 2810
18/04/79	Elorn	73.0	4370	1.2	40.30	0.92	1.68 *0.14*	13.040 ± 610	2840 < 2980 < 3120
28/04/79	Elorn	74.0	4200	2.2	36.71	0.91	1.80 *0.17*	9.990 ± 810	2280 < 2485 < 2690
04/06/79	Elorn	75.5	4490	1.2	49.05	1.09	1.88 *0.10*	10.960 ± 210	2390 < 2440 < 2490

(*) Standard deviation (**) Confidence interval of the mean at 0.05 G.R.S. = Gonado Somatic Ratio

TABLE 3 - VALUES OF EGG NUMBER / KG OF BODY WEIGHT

EGGS NUMBER / KG	SPAWNER CHARACTERISTICS (length and weight)	OBSERVATIONS	REFERENCES
1725	2.61 Kg	Stripping	PIGGINS 1973
1420	-	Stripping	NALL 1930
1400	-	-	JOCKIEL 1958
1170 - 3050	79 cm, 4.25 Kg	Stripping	BAUM & MEISTER 1971
1971	2 sea winter fish	Stripping	BAUM & MEISTER 1971
1060 - 1500	70-80 cm, 3.6 - 4.5 Kg	Stripping	Mc CARTHY 1972
1560	4 Kg	Counting in the redd	JONES & KING 1949
1050 - 3110	55.5 - 84.5, 2 - 6.5 Kg	Counting in the ovaries	POWER 1969