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Determination of Fecundity in American Plaice (Hippoglossoides platessoides) and its Variation from 1987 to 1989

by

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SUMMARY

The American plaice presents an oocyte development of the kind "group sychronous", with a fecundity determined in the beginning of its vitellogénesis (May). There are neither new recruitments of vitellogenic oocytes during the gonad development nor losses by atresic processes, which do not have a regulator importance over fecundity.

The relative fecundity was very constant in 3N division, for the range of sizes analyzed, with a mean value of 409 eggs per gram of female weight, but there were changes in the somatic index, and for that reason in the length-fecundity relation.

From these results some considerations are doing in relation to the vital strategy of this species.

INTRODUCTION

The fecundity is the number of eggs that a fish produce during a spawning season, this quantity depends on size, weight, and in some species to the age, being normal to have geografical and interannual variations for the same size. These changes are the result of a vital strategy of the species in the energy allocation over growing and reproduction. The way in which this allocation is carried out is the basis of its vital strategy, and the momment when the fecundity is determined, is one of the aspects that defines this strategy.

Hunter and Macewicz (1985) classify fishes in two groups depending on the momment that they define their fecundity: fishes with determined fecundity, those which define it before the spawning season, and species with undetermined fecundity, those which during the spawning season, may increase it by recruitment of new oocytes in vitellogenesis or decrease it by atresic process (resorption of the oocytes).

In this paper, with a histological analysis of American plaice (Hippoglossoides platessoides) ovaries, sampled during an annual cycle, the oocyte growing in vitellogenesis, the atresic process, the variations in the vitellogenic oocyte number during their development were studied, and when calculating the fecundity from 1987 to 1989 its variations were analyzed.

All this permits us to know the momment when this species determines its fecundity, and the variability levels that took place during last years, aspects we consider as important in the vital strategy of this species.

MATERIALS AND METHODS

During the years 1987 to 1989, 482 American plaice ovaries of sizes between 50 and 55cm were sampled. All months of the year but august and december was sampled. The ovaries were fixed in 10% formaline. For histological analysis a sample from the central part of the ovary was dehydrated, embedded in parafine and sections of 6 microns thickness were stained with Harris's hematoxiline and eosine floxine b.

Oocyte growing

From all the months sampled corresponding to the spawning of 1988, ten ovaries were taken, and in each one 30 oocytes in vitellogenesis and 30 in stage of cortical alveolus were measured, following the oocyte classification of Wallace and Selman (1986). The diameter in each oocyte was calculated as the mean between the longest and shortest diameter of the oocyte, this measurement is considered as representative of the real value of the diameter (Foucher and Beamish 1980). The resuts

were grouped according to the kind of oocyte in 50 micron classes and the monthly frequency was expressed as percentage. The mode of the vitellogenic oocyte size composition was considered as representative of this oocyte diameter for each month, and it was used in the analysis of the oocyte growing.

Histometric method

In order to know when the number of oocytes that will be laid in the next spawning season is determined. The number of oocytes in vitellogenesis was calculated in 132 ovaries from June 1987 to February 1988 by the Weibel and Gomez (1962) method. In two sections from the central part of each ovary the volumetric density mean and the mean number of transections over ten fields (X40) were estimated, using a Weibel multipurpose graticule of 42 points. The fixed ovary volume was obtained by the displacement technique of Scherle (1970).

The relative fecundity was calculated dividing the fecundity by the ovary free female weight.

Gravimetric method

The gravimetric method was used to calculate the relative fecundity from 1987 to 1989 and to test the result obtained by the histometric method. In 30 prespawning ovaries, from January to February 1987 to 1989, three subsamples from the anterior, central and posterior part of the ovary was taken, the weight of the subsamples was of between 100 and 125 mg. The number of oocytes in vitellogenesis (yellow colour) was counted, and the mean value of oocytes per gram of ovary obtained from the three subsamples was used to calculate the fecundity. The relative fecundity was obtained dividing the fecundity by the weight of the female.

In the range of sizes selected for this analysis, we did not find a significant correlation between the size and relative fecundity, and the mean value for each year was considered representative of the relative fecundity.

Atresia

In order to know how the etresic process may affect fecundity, 500 vitellogenic oocytes were counted in all the ovaries sampled from 1987 to 1989, and the number of them in alpha atresia (Hunter and Macewicz 1985) was expressed as percentage for every month.

RESULTS

The monthly oocyte size composition of the vitellogenic and cortical alveolus stages is represented in figure 1. In this figure there is an overlap of the two distributions from may, when the first initial stages of the vitellogenesis are produced, to january, when they are completely separated. Then the oocyte development in American plaice is of the kind "groups synchronous" (Wallace and Selman 1986), and with a fecundity determined before the spawnig season (Hunter and Macewicz 1985).

The beginning of the vitellogenesis took place in may, shortly after of the spawning wich is produced in the second half of march and april. The mean values of vitellogenic oocytes from june 1987 to february 1988 are in table 1, these values did not show significant differences ($p<0.05$) during the period of the gonad development considered. In consequence, the fecundity of a year is determined in the beginning of the vitellogenesis in the year before.

The proportion of vitellogenic oocytes in alpha atresia (table 2) was low during the whole year and showed no trend during the reproductive cycle. These results show that the atresic processes do not work as regulators of the fecundity in American plaice. The number of oocytes that began the vitellogenesis are finally laid during the spawning season, without important losses either during the gonad development or at the end of the spawning.

Figure 2 shows the evolution of the gonadosomatic index, the diameter of the vitellogenic oocyte, and the fecundity during a reproductive cycle. The growing of the gonad, that is reflected in the gonadosomatic index increasing, is due to the growing of the oocyte diameter and not to the progressive increase in the number of vitellogenic oocytes.

The relative fecundity from 1987 to 1989 in 3N NAFO division (table III) shows no significat differences ($p>0.05$), with a mean value of 409 eggs per gram of female weight. The somatic index present no significant differences between 1987 and 1988 and significant ones in 1989. This fact indicates that while the same relation between weight and fecundity was kept, there were changes in the fecundity by sizes.

The relative fecundity and somatic index calculated in 1988 for 3N and 3M divisions (table III) show significant differences, the mean value was 20% lower in 3N than in 3M. These values are not totally comparable because there are five centimetres of diference in the range of sampling.

DISCUSSION

It is known that the species with an oocyte development of the kind "synchronic groups" determine the potential fecundity before the spawning season (Hunter and Macewicz 1985, Urban and Alheit 1988). In these ovaries there is a momment in the oocyte development when a separation between previtellogenic and vitellogenic oocytes is produced in the size composition, in this momment we may consider that there is not new recruitment of oocytes in vitellogenesis and the fecundity has been determined. In American plaice the results obtained show that all the recruitment of oocytes to the vitellogenesis is produced during the beginning of the vitellogenesis (may), much long before of the separation of the oocyte size compositions take place (january).

American plaice shows a growing and feeding period from may to november, with a reserve storage to be used during winter in the metabolism and gonad development (Mackinnom 1972). The determination of fecundity in may, before the feeding and growing period, means that this fecundity is independent of the amount of energy obtained.

Species with a determined fecundity like Salmo trutta, Melanogrammus aeglefinus and Pleuronectes platesa mantained at different levels of feeding (Bagenal 1969, Hislop 1978, Horwood 1989), show a direct relation between feeding level and

fecundity. In American plaice this relation would not be produced in the same year if we take into account the absence of new recruitments of oocytes in vitellogenesis, and the slight importance of the atresic process as fecundity regulator. This later circunstance has also been confirmed also in others pleuronectiformes with the same oocyte development (Howell 1985, Horwood 1989).

The way in which American plaice fecundity is determined would be in relation with a mechanism of energy allocation in growing and reproduction, independent of the energy surplus produced in the spawning year, like the one proposed by Rinjsdorp (1986) for Pleuronectes platessa. In this model fecundity is only indirectly affected by the amount of energy surplus because of the significant correlation to the somatic condition and the increased fecundity due to somatic growth.

Bagenal (1957) shows the presence of significant interannual differences in fecundity of H. platessoides limandoides. Pitt (1964) found a Log-log relationship between fecundity and fish length, gutted and gilled weight, age and ovary weight, and no differences between the fecundity-length relationship in the Grand Bank and St. Mary's Bay. With these relations obtained by Pitt (1964) from 1957 to 1962, we have calculated the relative fecundity of a 1600 grames female , that is, the mean weight of the samples taken by us in 1988 and 1989. The value obtained was 533 eggs per gram of female (gutted and gilled), that would be a value very close to 513 and 501 eggs per gram (gutted) that was obtained for us in 1988 and 1989 in 3N division. These results show a low variability in the relative fecundity of the American plaice in the Grand Bank.

While relative fecundity was very constant during the period analyzed, the somatic index showed a change of the 9% lower in 1989 than in 1988 and 1987, this mean that there were changes in the relation length-fecundity. This kind of changes has been analyzed here in a very narrow range of sizes (50-55), if the same changes were produced in the rest of the adult females an interannual reproductive variability could happen, what would means for van Beek (1989) one of the possible causes of the variability in recruitments.

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TABLE I

Mean relative fecundity (R.F) (Fecundity / gutted female) from june 1987 to february 1988, standard desviatión (S.T) and number of ovaries analized (N) in NAFO division 3N

	JUN	JUL	SEP	OCT	NOV	ENE	FEB
R.F.	589	525	617	540	536	485	493
S.T.	.232	123	127	140	185	95	81
N.	20	16	21	20	20	13	20

TABLE II

Percentage of oocytes in alpha atresia from may 1987 to march 1988

Month	Number	Percent
January	20	0.2
February	40	0.14
March	71	0.28
April	46	0.34
May	19	0.29
June	75	0.05
July	56	1.12
September	25	0.32
October	56	0.02
November	49	0.15

TABLA III

Mean relative fecundity (R.F.) (Fecundity/weight), and somatic index (S.I) (Size X 100/ Weight) and their standard deviation in American plaice of 3N and 3M NAFO divisions from 1987 to 1989.

Year	Number	Size	Div	F.R.	S.D.	S.I.	S.D.
1987	23	50-55	3NO	384	80	3.392	0.427
1988	30	50-55	3NO	419	78	3.357	0.461
1989	25	50-55	3NO	421	82	3.094	0.453
1988	10	45-50	3M	516	62	4.133	0.479

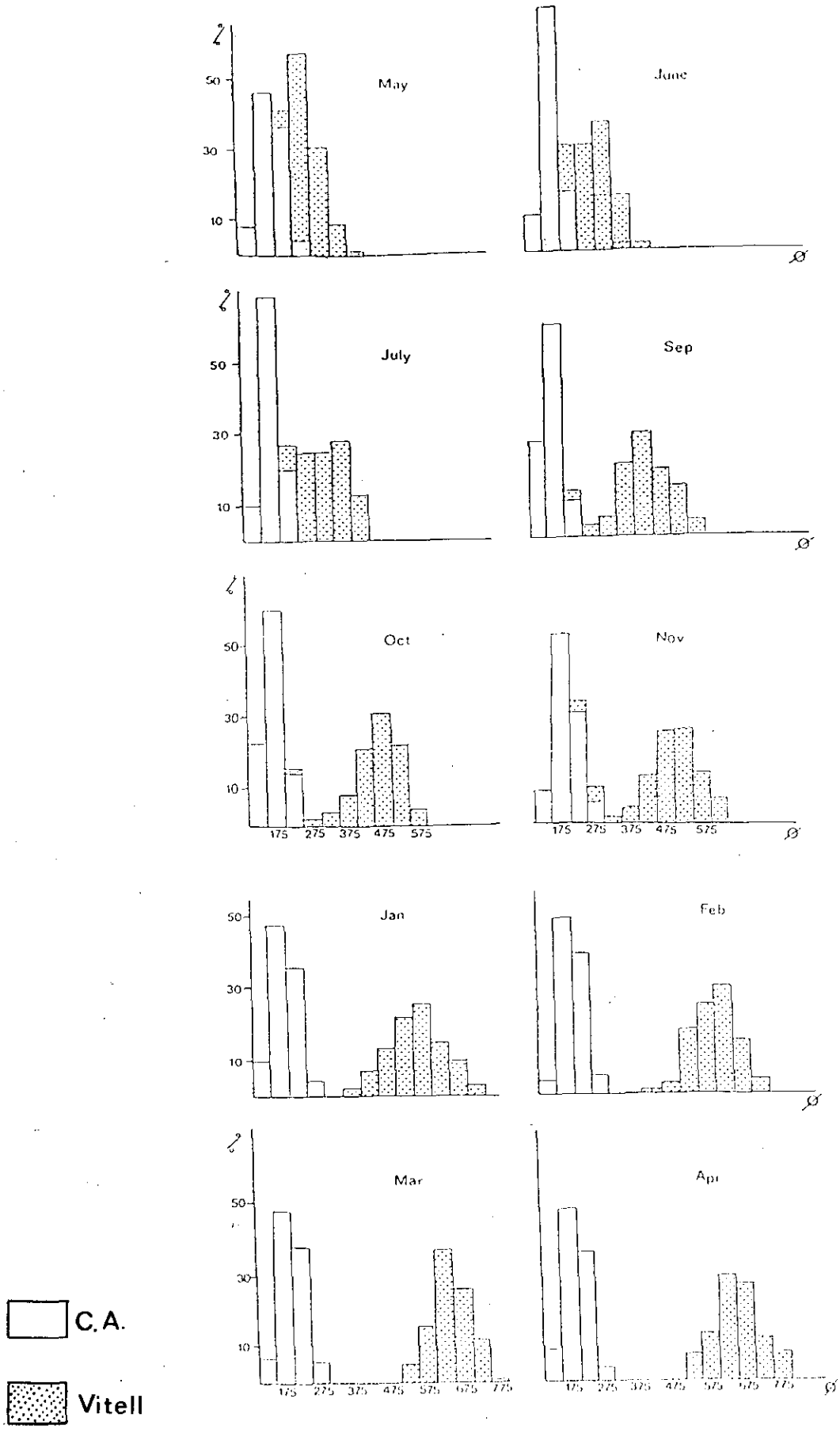

Figure 1. Size composition of oocytes of American plaice in cortical alveolus (C.A.) and vitellogenesis (Vitell) stages from May 1987 to April 1988.

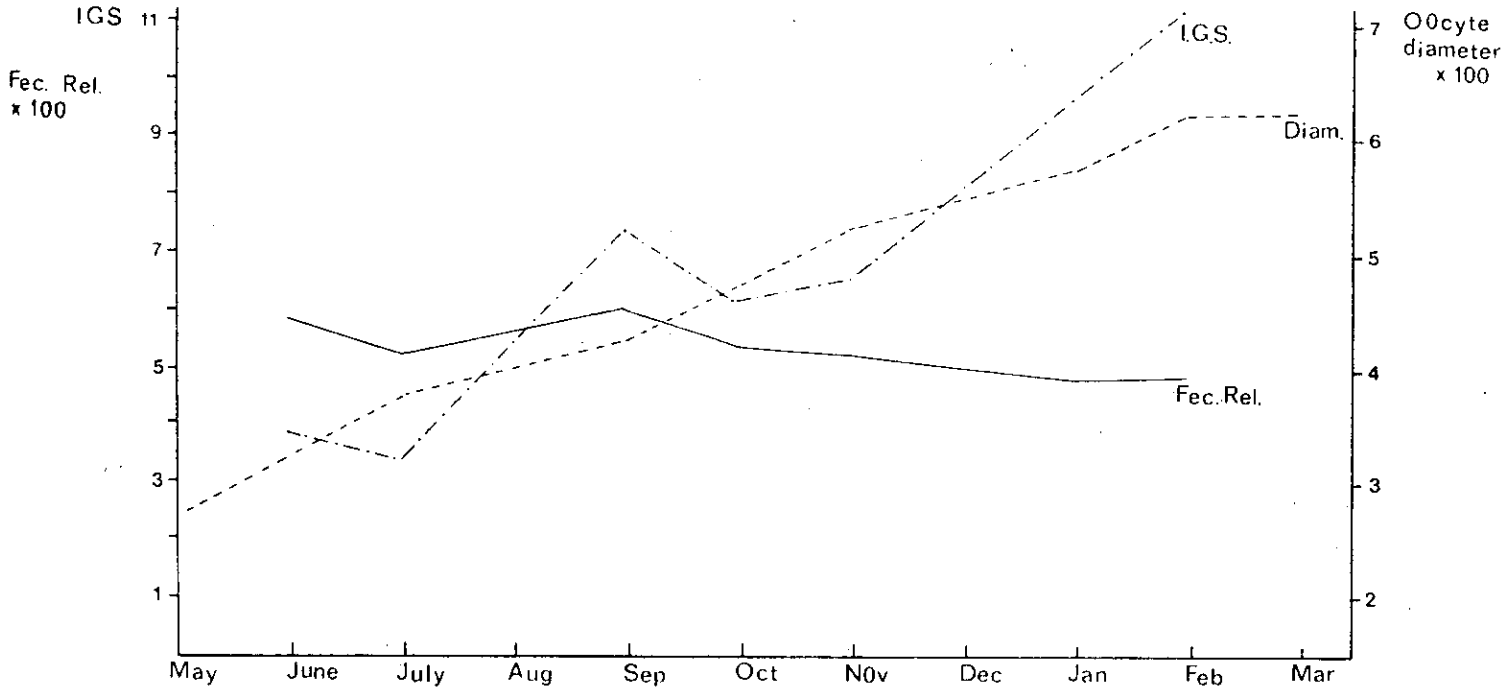

Figure 2. Evolution of the Relative fecundity (Fec.Rel), Diameter of vitellogenic oocytes (Diam), and Gonadosomatic index (I.G.S) from June 1987 to February 1988 in American plaice