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# INTRODUCTION

Bay of Biscay (ICES Div. VIIIa,b,d) is considered one of the main spawning areas of the so called northern stock of Atlantic European Hake (*Merluccius merluccius*). Due to the economical importance and the stage of this stock, several studies on the reproductive behaviour of this species have been conducted in the last years, some of them partially founded by the E.U. DG XIV (Study Contract n° 95/038 (BIOSDEF) and n° 97/015 (DEMASSESS)).

## MATERIALS AND METHODS

Hake gonads were obtained at sea from commercial catches of longliners and trawlers working in the Bay of Biscay (ICES Div. VIIIa,b,d) and with basis on the two main Basque Country's fishing ports, Ondarrao and Pasajes, along the period 1996-1998 (Map I). Gonads were fixed in 4% formaldehyde buffered solution, right after the fish was caught, and later analysed at the laboratory.

## Fecundity studies

Only gonads with hydrated oocytes were used for fecundity studies. The samples were collected between December-July of the period 1996-1997 and during March-April 1998. At the end of the study, a total number of 207 females (40-97 cm total length) with hydrated oocytes were studied and more than 161,000 hydrated oocytes were counted.

To check for possible statistical differences in the number of hydrated oocytes between each gonad lobule and between different parts of the gonad, a previous study was carried out. As no statistical differences at 95 % confidence interval were found between them, random samples from the medium part of the right lobule of the gonad were routinely used.

Three samples of rather similar weight (range 0.05-0.25 g) and from the medium part of the gonad were taken. The epithelium covering the oocytes was meticulously removed with a surgical blade and oocytes were carefully separated one from each other using a lancet. Then oocytes were placed on a Petri plate and observed under a profile projector provided of a digital measuring system. Hydrated oocytes (close to 1 mm or bigger) of each sample were counted and recorded.

Values of "batch fecundity" (total number of hydrated oocytes), "batch fecundity by gram of mature female" (total number of hydrated oocytes/female total weight), and "relative batch fecundity" (total number of hydrated oocytes/female gutted weight) were calculated.

### Oocyte diameter evolution study

A monthly study of the changing diameter of the Hake oocytes along a "synthetic" biological year [1996-1998] was carried out. When possible, 5 females > 40 cm in total length for each month of the "synthetic" biological year in the [1996-1997] period, and all females > 45 cm length for the period March-April 1998 were chosen.

A preliminary study was deployed to check for statistical differences in the number of oocytes between each lobule and between different parts of the gonad, but no statistical differences at 95 % confidence interval were found. Whenever possible, 3 or 2 sub-samples were taken from the medium part of each gonad in the months of the peak spawning period or in the rest of the year, respectively.

At the end of the study 39 samples from females 40-50 cm length and 41 samples from females >50 cm were studied and more than 14,400 oocytes were measured under a profile projector provided of a digital measuring system. For each sub-sample the diameters of 200 oocytes were measured and recorded. Mean frequencies of diameters of 0.1 mm of interval were analysed along the whole year.

## RESULTS & DISCUSSION

## 1. Batch fecundity

- Batch fecundity appears to be dependent of fish total length (in cm) (Figure 1). A significant relationship ( $p=0.0000$ ) was found between both parameters. A linear regression was adjusted and the equation obtained was:

Batch fecundity =  $-395820 + 9924.04 \text{ Length}$ , ( $n = 205$ ,  $r^2 = 57.6513$ )

- Batch fecundity appears to be rather constant in relation to the female weight (Figure 2a, 2b). This is, by gram of female the same number of oocytes are produced independently on their total or gutted body weight.

• To detect for differences in batch fecundity between different discrete fish sizes and sampling months, a further analysis was carried out. Four length ranges were chosen: 40-49, 50-59, 60-69 and  $\geq 70$  cm. To balance the analysis, all those months, in which not all length ranges were presented, were removed from the analysis. Thus, from the synthetic period [December to July], January, June and July were eliminated.

At a 95 % confidence level, length ranges have a significant effect ( $p=0.0000$ ) in batch fecundity, but no interactions between this factor and the different months were detected (Figure 3). Thus, a further analysis was carried out to detect which length range contribute more in the batch fecundity differences. At a 95% confidence level, batch fecundity calculated for each length range differ significantly between all groups ( $p<0.000$ ).

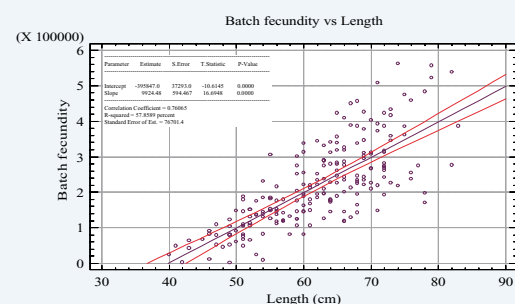
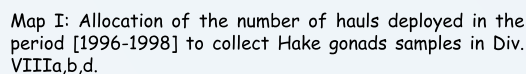


Figure 1: Adjusted regression to the batch fecundity data calculated for different total length sizes of Hake in Div. VIIIA,b,d in the period [1996-1998].

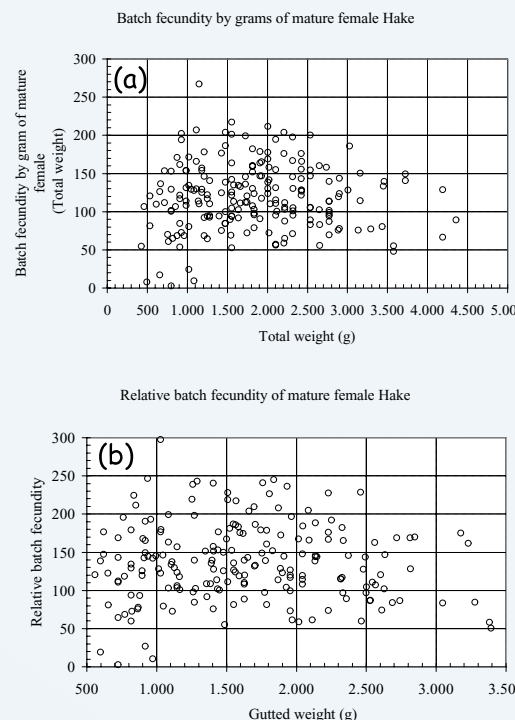


Figure 2: (a) Batch fecundity by gram of female and (b) relative batch fecundity calculated for Hake in Div. VIIIA,b,d during the period [1996-1998]

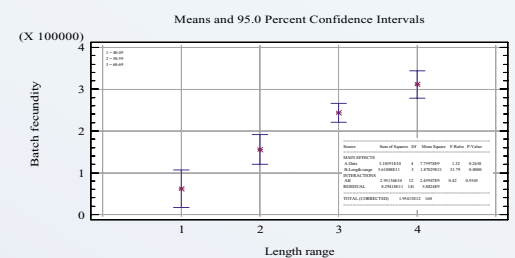


Figure 3: ANOVA carried out to establish the effect of fish length range in the batch fecundity of Hake in Div. VIIIta,b,d. Means and 95% confidence limits of batch fecundity in relation to length range are included. Size ranges selected: (1): 40-49, (2) 50-59, (3) 60-69 and (4)  $\geq 70$  cm fish total length.

► Batch fecundity appears to be significantly determined by Hake size, but fish catch month appears not to have a significant effect. These conclusions support the theory that smaller and probably younger fish are able to produce less hydrated eggs than the larger ones, and thus their batch fecundity is comparatively lower than the larger ones and that the month effect does not appear evident in the batch fecundity values.

## 2. Evolution of the oocyte diameter along the year

Figure 4 shows the monthly distribution of the mean diameters of all the oocytes measured, grouped in intervals of 0.1 mm, for smaller and bigger fish.

- For smaller females (40-50 cm length), large amount of small oocytes appear during January and start increasing their sizes along the first half of the year. In May, the largest oocytes and a marked lack of oocytes between large and small sized ones are found. In the second part of the year, larger amount of small size oocytes appear. (There were not data for June and September, but from the Figure 4 monthly sequence, the oocyte diameter for these two months was expected to follow the same general pattern of contiguous months: higher frequencies of small oocytes and lower numbers of medium-sized oocytes in June, and medium frequencies of medium and small sized oocytes in September). The unexpected large frequencies of large size oocytes of small females found in October are likely to be due to an inadequate number of gonad sampled during this month.

- For bigger females ( $> 50$  cm length), the largest and more frequent oocytes were measured during the first half of the year, which coincide with the Hake spawning period that is considered, by other studies, to be from January to May. During the second semester these females presented only small and medium sized oocytes with a total absence of largest oocytes.

► This study supports the theory that large (older) Hake females in the Bay of Biscay mature earlier and at mainly at the beginning of the first semester, while that smaller (younger) females mature later and mainly at the end of the spawning season.

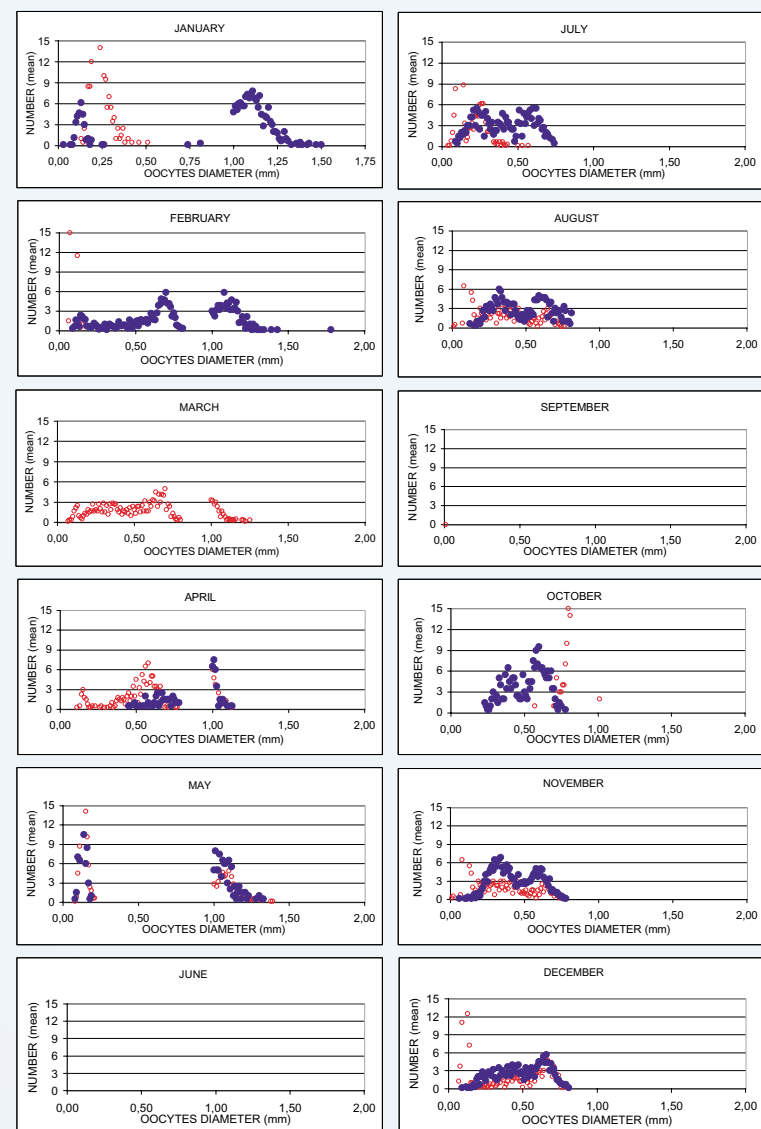


Figure 4: Bay of Biscay Hake oocyte diameter evolution along a synthetic year in the period [1996-1998]. Red dots correspond to < 50 cm length fish and blue dots to ≥ 50 cm length fish.

## ACKNOWLEDGMENTS