

## Some reproductive aspects of black mullet *Mugil capurrii* on the Northern coast of Senegal, West Africa

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**Abstract.** The study of reproductive aspects of *Mugil capurrii* (Perugia, 1892) was made from the analysis of both biological sampling data on landings of artisanal fisheries and experimental fishing data at sea and in the estuary of the Senegal River at the sites of Kayar, Fass Boye and St. Louis on the Northern coast (Grande côte) of Senegal between 2010 and 2012. Advanced gonad maturation and/or reproduction of *M. capurrii* occurs between the months of November and June. It also would perform well at sea and in the estuary of the River. During the advanced gonad maturation period, females are dominant in the population of the species. Size at first sexual maturity ( $L_{50}$ ) is reached at 29 cm FL for males and 31 cm FL for females of *M. capurrii*. Having determined the essential parameters and/or biological indicators in the development of fisheries management planning process of *M. capurrii*, this study is an important contribution to the implementation of the policy of sustainable management of fisheries resources which was launched on Senegal.

**Key Words:** reproduction, *Mugil capurrii*, Grande côte, Senegal.

**Résumé.** L'étude des paramètres de reproduction de *Mugil capurrii* (Perugia, 1892) a été réalisée à partir de l'analyse à la fois de données d'échantillonnages biologiques sur des débarquements de pêche artisanale et de données de pêches expérimentales effectuées en mer et sur l'estuaire du fleuve Sénégal au niveau des sites de Kayar, de Fass Boye et de Saint-Louis sur la côte Nord (Grande côte) du Sénégal entre 2010 et 2012 à la fois. La maturation avancée des gonades et/ou reproduction de *M. capurrii* se déroule du mois de novembre jusqu' au mois de juin. Elle s'effectuerait aussi bien en mer que dans l'estuaire du fleuve. Pendant la période de maturation avancée des gonades, les femelles sont dominantes dans la population de l'espèce. La taille de première maturité sexuelle ( $L_{50}$ ) est atteinte à 29 cm LF chez les individus mâles et à 31 cm LF chez les individus femelles de *M. capurrii*. Ayant permis de déterminer des paramètres et/ou indicateurs biologiques indispensables dans les processus d'élaboration de plans d'aménagement des pêcheries de *M. capurrii*, cette étude est une contribution importante dans la mise en œuvre de la politique de gestion durable des ressources halieutiques dont s'est lancée le Sénégal.

**Mots Clés:** reproduction, *Mugil capurrii*, Grande côte, Sénégal.

**Introduction.** The reproduction can be defined as a biological process of living organism to inherit the properties of its parent to their offspring in order to ensure the continuing survival of the concerned species. The main objective of the reproduction is to maintain the existence of the species and therefore fish have strategies and tactics to achieve this objective (Muchlisin 2014). Thus, understanding its unfolding within a fish population is of great interest to assess the status of populations (Ndour et al 2014) and for the management of the resource (Grandcourt et al 2009; Jakobsen et al 2009; Muchlisin et al 2010). Many measures of management of fisheries resources and fisheries are based on indicators related to the reproduction of fish (Froese 2004; Ngom Sow et al 2011; Ndiaye et al 2013; Ndour et al 2013a). Indeed, the provision of information relating to the period of reproduction, size at first sexual maturity of a species or to the proportion of males or females in the catch of a species is fundamental in the management process. This study

aimed to investigate the reproduction of *Mugil capurrii* (Perugia, 1892) on the Northern coast of Senegal, fits perfectly into this dynamic.

Various studies have been conducted on the study of life history traits (Ibáñez Aguirre & Gallardo-Cabello 2004; Ndour et al 2011; Whitfield et al 2012) including reproductive of *M. capurrii* in Mauritania (Vall 2004) and in Guinea (Trape & Durand 2011). However, despite the ecological and economic importance of this species in Senegal, there is no study on the reproduction of this species.

However, in the management of fisheries resources policy which was launched on Senegal, available knowledge on the biology of mullets including black mullet *M. capurrii* is a fundamental aspect in the elaboration of management plans and its successful implementation. Therefore, this objective is the cornerstone of this study.

## Material and Method

**Data.** Biological samplings were conducted on three landing sites (Kayar, Fass Boye, St. Louis) on the Northern coast of Senegal at sea and in the estuary of the Senegal River (Figure 1) in 2010 (July, August, September), 2011 (June, October, November, December) and 2012 (January). Experimental fisheries using a hawk net having a mesh between 20 and 25 mm were carried out in addition to samples collected from the artisanal fishery landings, using different kinds of fishing gear, to cover a wide range of sizes. Individuals captured were measured (fork length (FL) in cm) using a direct reading ichtyomètre, weighed (g) using an electronic balance (Soehnle Professional), then sexed and the sexual stage determined. In total 520 individuals including 325 at sea, having a size between 12 and 50 cm FL and 195 individuals on the estuary of the River, varying in size between 15 and 35 cm FL, were captured.

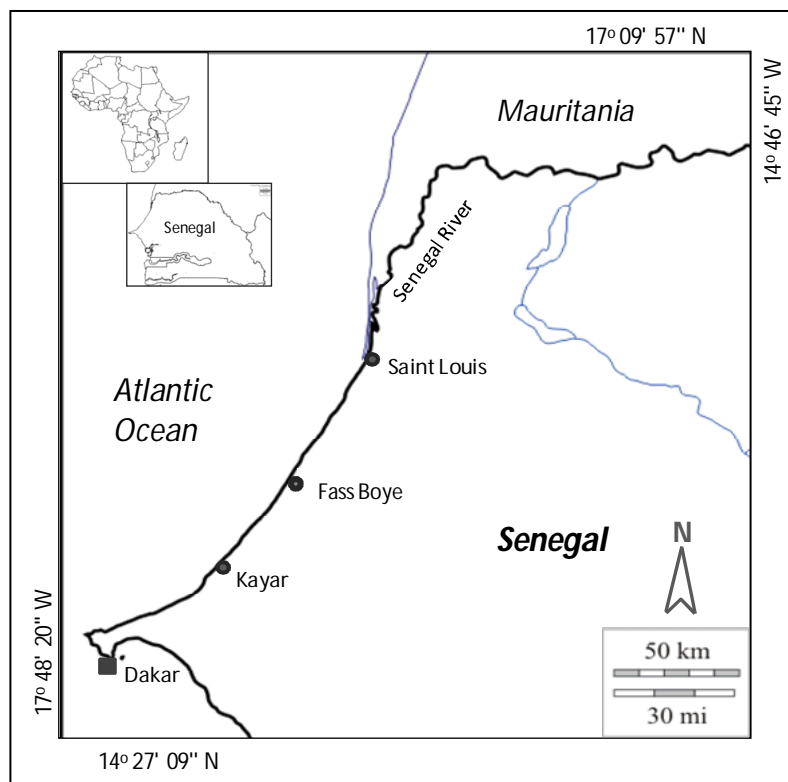


Figure 1. Location map of the study area (landing sites) along the coastline of the Northern Coast (Grande côte) of Senegal (Ndour et al 2013b).

## Treatment

**Gonadosomatic index (GSI).** Gonads were removed and weighed in grams to calculate the gonadosomatic index of individuals in the population of *M. capurrii*. This GSI is calculated using this formula:

$$GSI = (Pg/P) * 100$$

where,  $Pg$  is the gonad weight (g) and  $P$  is the total fresh weight unviscerated (g).

**Sexual stages.** For the determination of sexual stages, the scale of maturation adopted by Albaret & Legendre (1985) was used. It identifies seven sexual stages consisting of immature individuals (stages < 3), mature individuals with a first group of advanced sexual maturity status (stages between 3 and 5) and a second group stage (6-1 and 6-2) corresponding to the post-spawning and characterized by the presence in the ovary of a small number of large residual oocytes atresia.

**Sex-ratio.** The sex ratio is calculated from individuals whose sex has been determined; because the male and female gonads can not be differentiated in a size less than the size of the smallest mature individual. The sex ratio was calculated as the ratio of female and male multiplied by 100.

$$S = F/M * 100$$

where  $S$  is the sex ratio,  $F$  the number of female and  $M$  is the number of male.

**Size at first sexual maturity.** The size at first maturity ( $L_{50}$ ) is the size at which 50% of individual's gonad stage greater than 3 or equal to 3 on the scale of sexual maturation (Albaret & Legendre 1985). It was determined specifically during the reproduction period of the species. The  $L_{50}$  was determined by a logistic function modelling the percentage of mature individuals by size range 1 cm (FL). The logistic function is expressed by this equation:

$$\% M = 1/(1 + \exp. * (-a (CI-L_{50})))$$

where ' $\% M$ ' = percentage of sexually mature individuals by size class, ' $a$ ' = constant that depends on the increase in the proportion of mature individuals, ' $CI$ ' = central value of each size class, and ' $L_{50}$ ' = length corresponding to 50% of mature individuals in the population.

## Results

**Gonadosomatic index (GSI).** The highest gonadosomatic index means were obtained in November (3.9) and January (4.6) (Figure 2a) at sea. In the estuary, the GSI means were less than 2. The highest GSI in the estuary were obtained during the months of June ( $1.4 \pm 2.6$ ) and July ( $1.7 \pm 3.1$ ) (Figure 2b).

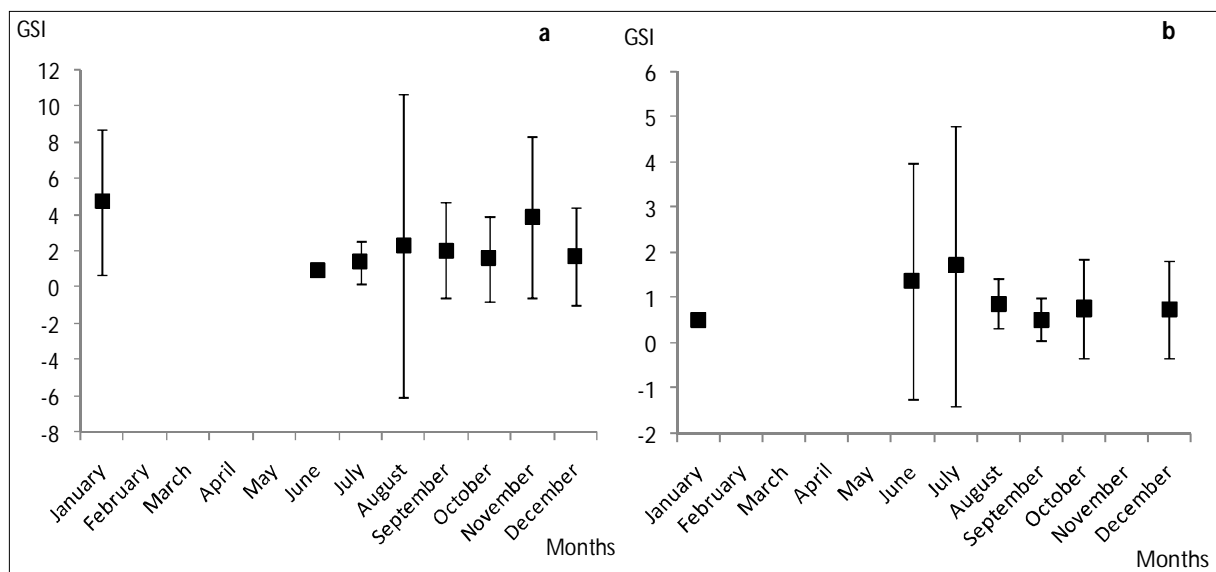


Figure 2. Seasonal variations of the gonadosomatic index (GSI) in populations of *M. capurrii* at sea (a) and in the estuary of the Senegal River (b) on the Northern Coast (Grande côte) of Senegal between 2010 and 2012.

**Sexual stages.** At sea, a strong presence of stages 4 and 5 was noted during the months of June, July and December. Sexual stages  $\geq 6$  were observed during the month of December. In contrast a strong presence of immature individuals (stages  $< 3$ ) was noted in September, August and January (Figure 3a). In the estuary of the Senegal River, the evolution of sexual stages shows a relatively large proportion of sexual stages 3, 4 and 5 during the months of June, July and December. Sizable proportions of stages 6 and 6-2 were recorded during the month of December. A strong presence of sexual stages  $\leq 3$  was observed from June to August in the species (Figure 3b).

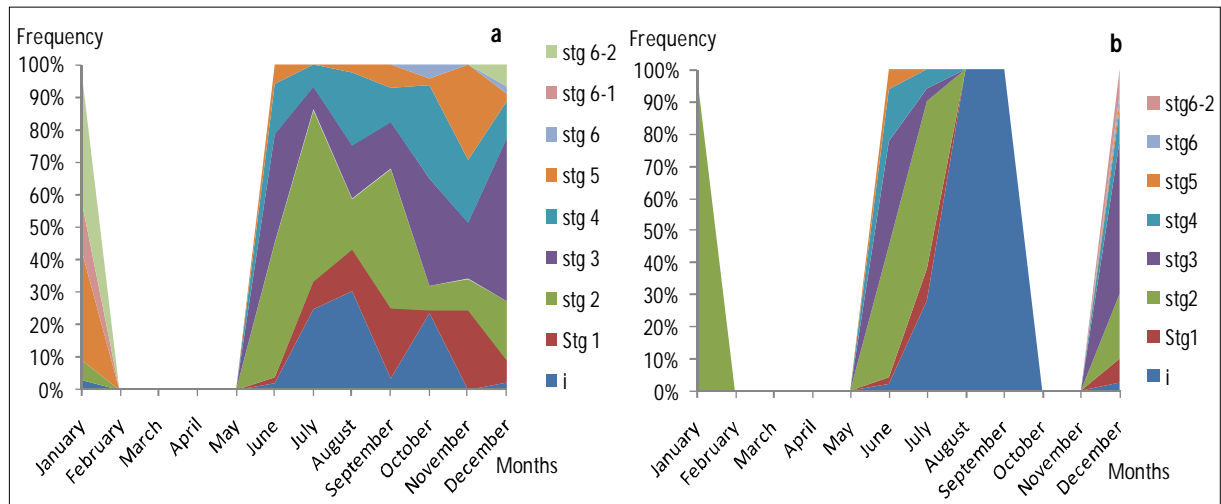


Figure 3. Seasonal variation of sexual maturity stages in populations of *M. capurrii* at sea (a) and in the estuary of the Senegal River (b) on the Northern Coast of Senegal between 2010 and 2012.

**Sex-ratio.** At sea, on all months sampled, male was predominant with the exception on December and January (females  $> 50\%$  - Figure 4a). In contrast, in the estuary of the River, female was predominant in the catch during the month of December (Figure 4b).

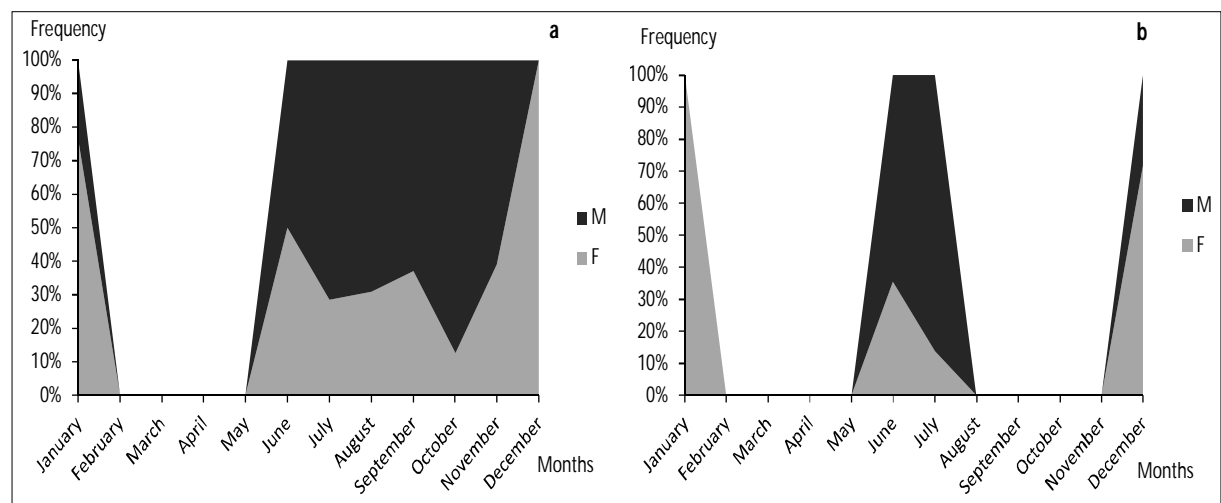


Figure 4. Seasonal variations of the sex ratio in populations of *M. capurrii* at sea (a) and in the estuary of the Senegal River (b) on the Northern Coast (Grande côte) of Senegal between 2010 and 2012.

**Size at first sexual maturity.**  $L_{50}$  is reached at 29 cm FL for males and 31 cm FL for females. For both sexes, the determined  $L_{50}$  is 30 cm FL (Figure 5).

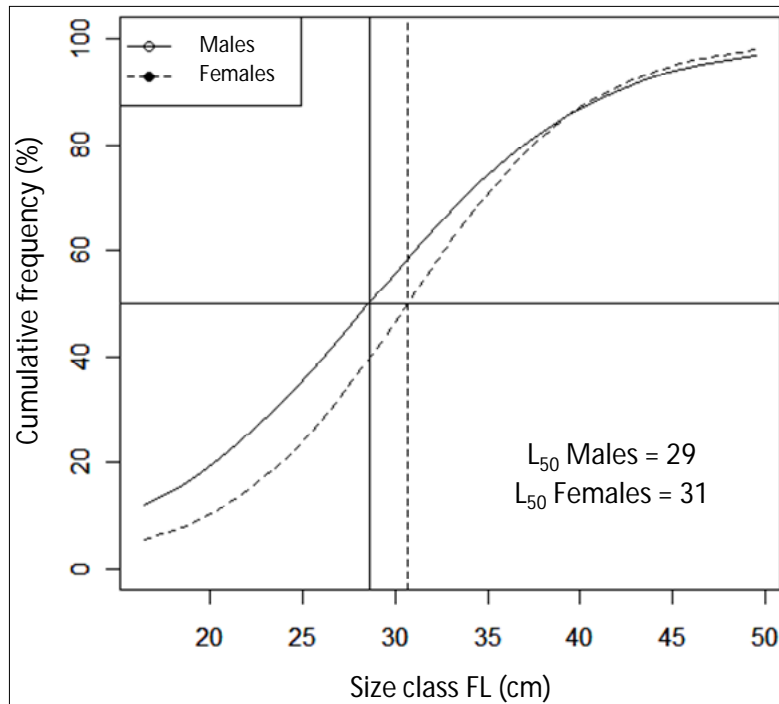


Figure 5. Size at first sexual maturity ( $L_{50}$ ) for males and females of *M. capurrii* on the Northern coast (Grande côte) of Senegal between 2010 and 2012.

**Discussion.** Variations in the gonadosomatic index and sexual stages indicate an advanced maturation of gonads and possibly an early reproduction of the species in November and could continue until June. The presence of sexual stages  $\geq 4$  with high GSI during this period is an argument to this hypothesis. Advanced gonads that may correspond to an early reproduction of the species was observed in June, July and December at sea and in the estuary of the River. This situation noted on the estuary could be explained by the brackish waters in this part of the River during this time of the year.

The dominance of females during the months of December and January would be an additional indicator of advanced gonad maturation period which shows the beginning of reproduction in the species. In contrast, equal proportions of males and females recorded in June at sea (50% females and males 50%) indicate the end of the reproductive period of the species. This result is important because it adds to the list of indicators for determining the period of reproduction, a new indicator which is the sex ratio for *M. capurrii*. These observations confirm the sex segregation mentioned by Brusle & Brusle (1977). However, for black mullet *M. capurrii*, sex segregation would be for the purpose that females gather in breeding areas during the reproduction period, which consequently facilitates their capture by fishing during this period.

To our knowledge, this study is one of the first in Senegal to achieve the determination of the  $L_{50}$  for *M. capurrii*. Similarly information on the size at first sexual maturity of the black mullet *M. capurrii* are very limited in the world (Vall 2004). Sizes at first sexual maturity determined in males (29 cm FL) and females (31 cm FL) of this species are lower than those obtained in males (49 cm FL) and females (53 cm LF) of *M. capurrii* by Vall (2004) in Mauritania. This difference is related to the nature of the data used in the determination of this parameter, because in Mauritania, the data used are from commercial fishing, in contrast, the data used in our study are both commercial and experimental fishing data, covering a wider range of sizes including small individuals (Ndour et al 2013b).

Through the variation of gonadosomatic index and observed sexual stages in the populations of the species on the estuary of the Senegal River, it turns out that the reproduction of *M. capurrii* could occur in the estuary of the River especially during periods of flood recession, where the water of the River is brackish. Sex segregation is

also noted in favor of females over the period from December to January in the species. Fundamental information in the resources and fisheries management process, the determination of biological indicators in fish species, as was done in this study is an important contribution to the implementation of the policy of sustainable management of fisheries resources (based on fisheries management) which was launched on Senegal.

**Conclusions.** This study has shown that the reproduction of *M. capurrii* can take place both at sea and in the estuary of the River Senegal from November to June. Females are dominant during the sexual maturation period of the species (November to June), Consequently, the sex ratio has been identified in this study as a potential indicator of the period of advanced sexual maturation and/or reproduction of *M. capurrii*. The size at first sexual maturity is reached at 29 cm FL for males and 31 cm FL for females. Determination of reproductive aspects of *M. capurrii* is essential both to refine the understanding of the biology of the species and to provide decision makers with biological indicators used in the formulation of management plan for the species. For this purpose, it is important to take into account both the spatial segregation between stages of sexual maturity and seasonality of reproduction of the species.

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