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The use of Electronic Length Frequency Analysis computer program for age, growth and management assessment of Mugilidae *Liza falcipinnis* (Linné, 1758) from Ebrié and Grand-Lahou lagoons, Ivory Coast.

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Abstract:- Age, growth, mortality and exploitation status of *Liza falcipinnis* were studied in Ebrié and Grand-Lahou lagoons, Ivory Coast from January 2006 to December 2007. A total of 2162 specimens were examined (914 and 1248 in Ebrié and Grand-Lahou lagoons respectively). Monthly length frequency data were analyzed by FiSAT software for estimation of population parameters. Asymptotic length ($L\infty$) was 39.9 and 42.0 cm for Ebrié and Grand-Lahou lagoons respectively. Growth coefficient (K) was 0.36 $year^{-1}$ and 0.20 $year^{-1}$ respectively in Ebrié and Grand-Lahou lagoons, and the calculated growth performance index (φ') was 2.76 and 2.59 for Ebrié and Grand-Lahou lagoons respectively. Total mortality (Z) by length-converted catch curve was estimated at 1.28 $year^{-1}$ and 1.43 $year^{-1}$ respectively in Ebrié and Grand-Lahou lagoons, fishing mortality (F) at 0.46 $year^{-1}$ and 0.53 $year^{-1}$, and natural mortality (M) at 0.82 $year^{-1}$ and 0.90 $year^{-1}$ respectively in Ebrié and Grand-Lahou lagoons The exploitation level (E) was estimated to be 0.36 and 0.37 in Ebrié and Grand-Lahou lagoons respectively. The recruitment pattern was continuous with two major peaks event per year. The exploitation level (E = 0.36 and 0.37 < 0.50) and lower fishing mortality (0.46 $year^{-1}$ and 0.53 $year^{-1}$) indicate that the *Liza falcipinnis* stock is under-exploited. Wherever, the majority of fish caught in the both lagoons at a size far below the first sexual length. This suggests for management purpose and conservation the reproducing part in the both lagoons.

Keywords:- Sickle fin mullet, length frequency, first maturity, population structure, West Africa

I. INTRODUCTION

Studies of age, growth, mortality rate and exploitation rate are crucial for stock assessment [1]. The growth parameters and the mortality rate are the important tools to assessment the exploitation level of the pelagic species [2]. However, fish stock assessment should be carried out for each stock separately, since an essential characteristic of a stock is that its population parameters remain constant throughout its area of distribution [2]. There are many tools for assessing the exploitation level and stock status. Of these, FiSAT (FAO-ICLARM Stock Assessment Tools) has been most frequently used for estimating population parameters of fish and shellfish [3].

Mugilidae fishes are important ichthyofaunal components of tropical fresh and brackish water ecosystems. They are important ecologically and commercially, and are widely exploited and cultured. *Liza falcipinnis* is one of the most valued fish for Ivorian consumers [4]. This species has a wide distribution in the Ivorian lagoons. In spite of its widespread occurrence in the Ivorian waters and economic importance, very little is known about the dynamic population of *Liza falcipinnis*. The purpose of this study was to estimate the population parameters and exploitation level of *Liza falcipinnis* to assess the stock position of the species from two complex lagoons (Ebrié and Grand Lahou in Ivory Coast.

II. MATERIAL AND METHODS

A. Study area

Their areas were 566 km² and 190 km² with a maximum depth of 20 and 3 m respectively in Ebrié and Grand-Lahou lagoons [5]. *Liza falcipinnis* were collected in the Ebrié and lagoon and Grand-Lahou lagoons, as shown in Fig. 1.

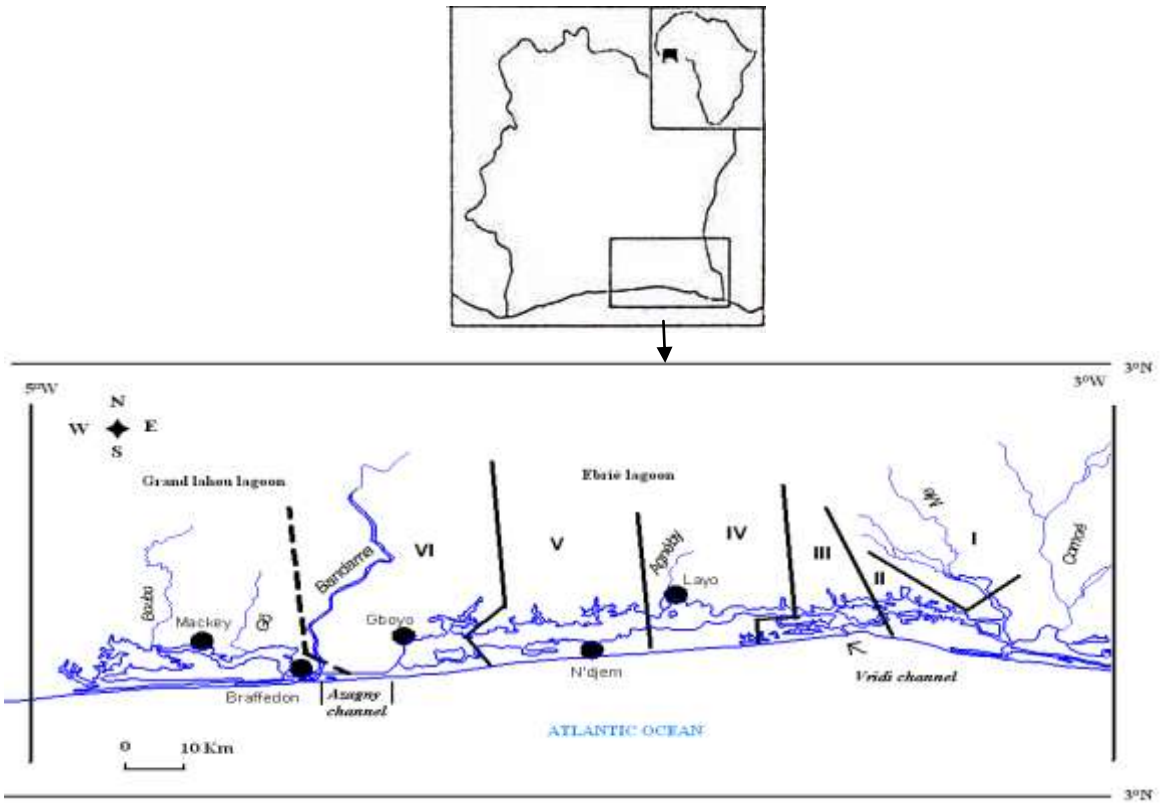

Fig 1: Map of Ebrié and Grand-Lahou lagoons (Ivory Coast) showing the sampling site (●)

B. Fish sampling

Monthly samples of *Liza falcipinnis* were collected at five sites in Ebrié and Grand-Lahou lagoons from January 2006 to December 2007. At each level lagoon, the experimental fishing has been carried out at night and daylight. The fish were caught using gillnet and identified by Albaret's key [4].

C. Measurements

Each fish was measured to the nearest cm for the fork length (FL), total body weight (TW) and eviscerated body weight (EW) were measured to the nearest 0.01 g. The sex was determined by the macroscopic gonad investigation. The size of the first sexual maturity was given for the males and the females while regarding as mature fish presenting of the gonads at the stage equal to or higher than 4 and 5 of sexual maturation [6]. The proportion of mature individuals (P), by class of size of 1cm, was adjusted by the function of Ghorbel *et al*. (1996) [7]. Ebrié and Grand-Lahou lagoons' data sites were pooled monthly and subsequently grouped into length classes at 2 cm intervals. Population parameters data analysis were based on the Electronic Length Frequency Analysis (ELEFAN 1) computer program, incorporated in Food and Agriculture Organization-International Center for Living Aquatic Resources Management (FAO-ICLARM) Stock Assessment Tool (FiSAT) were used to estimate the growth parameters (K, L_∞, t_o) [8]. The estimation of the growth parameters were based on the Von Bertalanffy Growth Formula (VBGF) expressed as: $L_t = L_\infty\ [1\text{-}e^{-k(t\text{-}to)}]$, where L_t = mean length at age t; L_∞ = asymptotic length; K = growth coefficient; t = age, t_0 = the hypothetical age at which the length is zero [9] with $\log_{10}(-t_0) = -\ 0.392 - 0.275\log_{10} L_\infty - 1.038 \log_{10} K$. Once the growth parameters of VBGF were obtained, a linearized length-converted catch curve [10] was constructed using the following formula to estimate total mortality (Z): $\text{Ln}\ (N_t / \Delta_t) = a + bt$, where N = is the number of individuals of relative age (t) and Δ_t is the time needed for the *Liza falcipinnis* to growth through a length class. The slope (b) of the curve with its sign changed gives Z. Natural mortality (M) was estimated using the empirical relationship of Pauly ([11] 1980). $\text{Log}_{10} M = -\ 0.0066 - 0.279\ \log_{10} L_\infty + 0.6543\ \text{Log}_{10} K + 0.4634\ \text{Log}_{10} T$ where M is the natural mortality, L_∞ the asymptotic length, K the growth coefficient of the VBGF and T the mean annual habitat water temperature (°C). Z and M obtained, fishing mortality (F) was estimated using the relationship: $F = Z - M$; where Z is the total mortality and M, natural mortality. The exploitation level (E) was obtained from $E = F/ Z = F/ F + M$. The recruitment pattern was obtained by projecting the length-frequency data backwards on the time axis using growth parameters [12]. Relative yield per recruit (Y / R) and biomass per recruit (B / R) were estimated according to the model of Beverton & Holt (1957) [13] using the knife-edge selection.

D. Data analysis

The percentages of the sexes were compared by means of the test of homogeneity (χ^2). The statistical analyzes were carried out with the software *Statistica 7.1* for the reproductive biology data and FiSAT (FAO-ICLARM Stock Assessment Tools) software for the population dynamic data.

III. RESULTS

A. First maturity size

A total of 1001 specimens (408 males, 506 females and 87 juveniles) in Ebrié lagoon and 1327 specimens of *Liza falcipinnis* (519 males, 729 females and 79 juveniles) in Grand Lahou lagoon were analysed. The first sexual maturity size was 21.0 cm (FL) for males and 27.9 cm (FL) for females in Ebrié lagoon and, 24.7 cm (FL) for males and 27.9 cm (FL) for females in Grand Lahou lagoon, as shown in Fig. 2. But, any significant difference were observed between the both sex and the both lagoons (χ^2= 0.97; p > 0.05 for males; χ^2= 0.19; p > 0.05 for females).

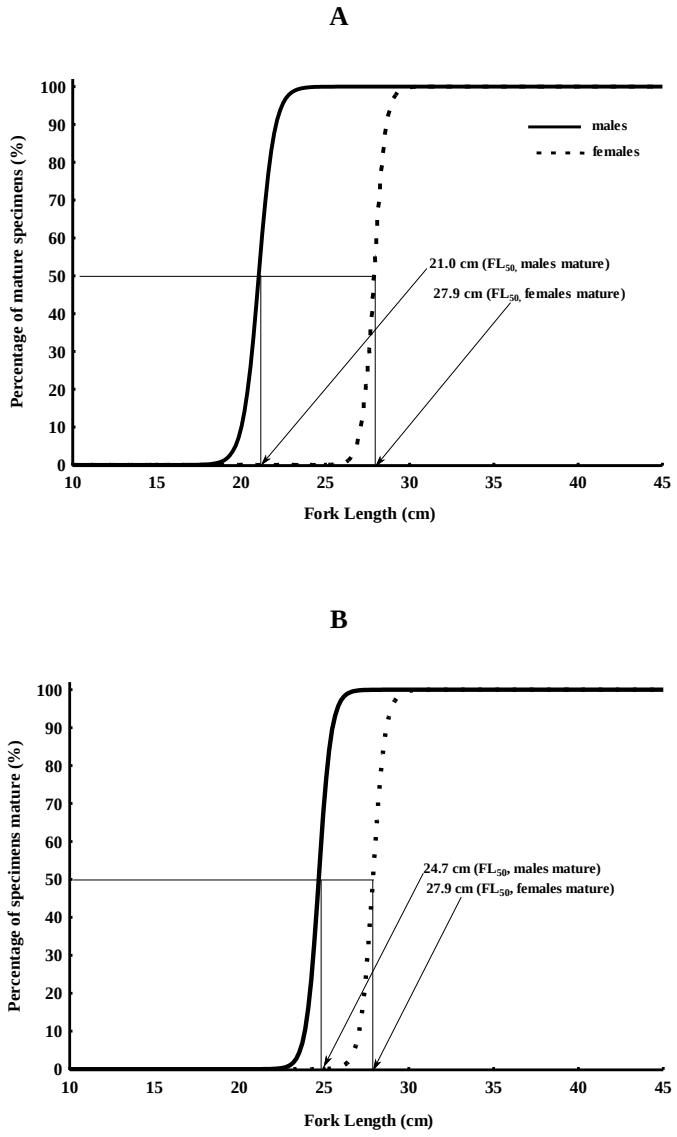

Figure 2: Fork length at first sexual maturity (L_{50}) for male and female *Liza falcipinnis* caught in Ebrié (A) and Grand-Lahou (B) lagoons from January 2006 to December 2007.

A. Growth parameters

The values of L_∞ and K obtained were 39.9 cm and 0.34 year^{-1} for *Liza falcipinnis* in Ebrié lagoon. They were 42 cm and 0.43 year^{-1} respectively in Grand-Lahou lagoon. The hypothetic age (t_o) was -0.45 and -0.35 year^{-1} in Ebrié and Grand Lahou lagoons respectively.

C. Mortality and exploitation rates

The total mortality coefficient, the natural mortality coefficient and the fishing mortality coefficient were respectively 1.28; 0.82 and 0.46 year^{-1} in Ebrié lagoon. In the same order, the parameters were 1.43; 0.90 and 0.53 year^{-1} in Grand-Lahou lagoon. Exploitation level is estimated to be 0.36 and 0.37 in Ebrié and Grand-Lahou lagoons respectively, as shown in Fig. 3.

D. Length at first capture L_c

The length at first capture was FL_{50} = 19.57 and 16.28 cm in Ebrié and Grand-Lahou lagoons respectively, as shown in Fig. 3.

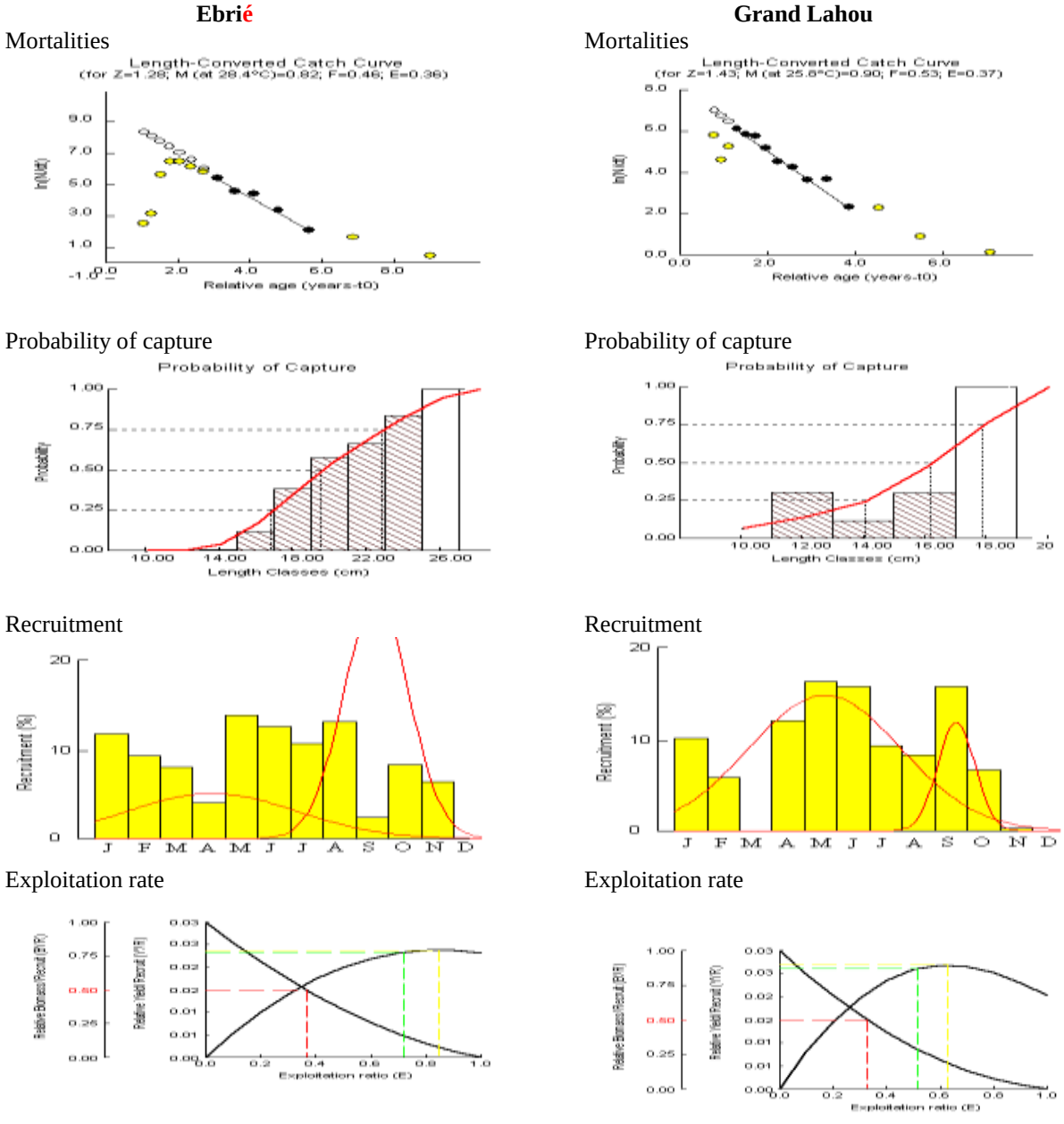

Figure 3: Dynamic population parameters : mortalities, probability of capture, recruitment and exploitation rate of *Liza falcipinnis* in Ebrié (A) and Grand-Lahou (B) lagoon.

IV. DISCUSSION

In the present study, the males reach sexual maturity faster than females. Abou-Seedo & Dadzie (2004) [14] are agreed with our results. The size frequency distribution obtained may be attributed at the selectivity of gillnet. In fact, the fish are trapped by their gills when they try to swim through or many sheets of various mesh sizes of which they are entangled. According to Von Brandt (1984) [15], gillnet is a passive gear and it is a large wall of netting vertically hanging in the water. Gillnets are highly selective for smaller size of fish. Also, age structure and size distribution could be related to fishing pressure [16]. Generally, the effects of fishing on fish communities include a decrease in their abundance, changes in age structure and size composition, and in species composition [17].

The estimated value of L_{∞} in Ebrié lagoon is less than that of Grand Lahou lagoon. It is the same of K. The reasons for the variation in these values may be due to the ecological differences between Ebrié and Grand-Lahou lagoons, feeding variability and fishing pressure. According to Amrollahi *et al.* (2011) [18] and Seyedahmadreza *et al*. (2011) [19], it is possible that the variations in population parameters of *Liza falcipinnis* represent epigenetic responses to the different environmental conditions (temperature, food, geographic location). In this study, the natural mortality was higher than the fishing mortality in the both lagoons and were the same order (F = 0.82 $year^{-1}$ in Ebrié lagoon and F = 0.90 $year^{-1}$ in Grand-Lahou lagoon). The high values of natural mortality in the both lagoons could be explained by the environmental conditions (temperatures and currents), the physiological factors (diseases and old age) and factors due to the fates (meeting with possible predators and predation of eggs) [20]. Information about the magnitude of natural mortality is essential for effective management of exploited fish populations. Unfortunately, natural mortality is difficult to estimate directly because natural deaths are rarely observed [21]. The both lagoons present a similar exploitation rate (0.36 and 0.37 in Ebrié and Grand-Lahou lagoons respectively). These exploitation rates (0.36 and 0.37) are lowest than the maximum allowable limite (Emax = 0.5). Gulland (1969) [22] suggested that in an optimally exploited stock, fishing mortality should be equal to natural mortality, resulting in an exploitation rate of 0.50 $year^{-1}$. Consequently, it indicates that *Liza falcipinnis* is underexploited in the both lagoons. The length at first capture (L_{c50} = 19.57 and 16.28 cm in Ebrié and Grand-Lahou lagoons) is lowest than the length at first sexual maturity (21 and 27.9 cm for male and female in Ebrié lagoon, 24.7 and 27.9 cm for male and female in Grand-Lahou lagoon). The results of this study show that *Liza falcipinnis* is caught in a size smaller than the size at first maturity at both lagoons. The norm is that the length at first capture is greater than the first sexual maturity. In order to maintain a population in equilibrium it is of great importance to give each fish the chance of reproducing at least once in its lifetime to recruit the stock, and therefore the length at first capture should be bigger than size at first maturity [18]. For Morgan (1985) [23], for a sustainable fishery, the length at first capture must be equal to length at first maturity. There exists more than on recruitment. The recruitment pattern shows that the recruitment of *Liza falcipinnis* is continuous all the year with two peaks. This means that two cohorts are produced annually. These observations are similar to those of Djiby (1990) [24]. According to this author, in tropical zone, recruitment is often continuous all the year, with one (which is rare) or more (which is often) maxima separated by minima. The characteristics of recruitment provide additional information on the adaptation strategy and the vulnerability of species in relation to changes in environmental conditions [25]. For this author, the type and intensity of recruitment are important. In specie with short life, a failure of recruitment has an immediate negative effect on the exploitable stock. In revenge, for species with high life, recruitment less directly influences the abundance stock.

V. CONCLUSION

In the both lagoons, natural mortality is higher than the fishing mortality. Though *Liza falcipinnis* is underexploited (E= 0.36 and 0.37 in Ebrié and Grand-Lahou lagoons respectively). It is necessary to impose fishing regulation or by restricting fishing for certain seasons especially in spawning areas or spawning period to maintain stock of equilibrium in the both lagoons. The majority of fish caught in the both lagoons at a size far below the first sexual length. It is also important to change the mesh sizes to catch larger fishes to conserve the reproducing part of *Liza falcipinnis* population in the both lagoons.

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