Aspects of Reproduction, Age and Growth of the Lane Snapper, *Lutjanus synagris* (Linnaeus, 1758) in Jamaican Coastal Waters

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ABSTRACT

The lane snapper, *Lutjanus synagris* (Linnaeus), 1758 is the most important commercial species taken by the large and growing seine and trammel net fishery on the south shelf of Jamaica. Samples from the commercial net fishery between February, 1996 and June, 1999 showed a size range from 150 – 430 mm FL (fork length) with a mean of 232.1 mm FL (± 52.4, N = 1,094), both sexes combined. Most fishes in samples were already gutted by beachside vendors. Mean sizes for males and females were 219.5 (± 72, N = 99) and 220.0 mm FL (± 9.82, N = 235), respectively. Weight range for both sexes combined were 75 - 1,100g. Mean size at maturity was 268 mm FL (± 0.27) and 221 (± 1.85) in males and females respectively. Sex ratio (F:M) was 2.6:1.0 in the size range 150 - 310 mm FL, and above that 100% female. Prolonged spawning was found with a maximum in July for both sexes. Sagittal otoliths were examined whole and by thin (300 micrometres) section and revealed opaque and hyaline bands. Whole otolith ages produced a maximum of six years but sections showed maximum ages of at least 12 years and that whole otolith analysis alone could seriously underestimate age. Marginal increment analysis showed one opaque zone was laid down in July and one hyaline in March annually. The relationship between otolith weight and fork length was described by the regression equation $Y = 0.0403X - 1.543$ ($r^2 = 0.9407$) for males, and for females $Y = 0.0405X - 1.1716$ ($r^2 = 0.9711$). ELEFAN routines produced $K = 0.25$, $L_{\infty} = 320$ mm FL and to $= -0.0001$, for males and for females $K = 0.070$, $L_{\infty} = 538.7$ mm FL, to $= -3.795$, phi prime = 4.346.

KEY WORDS: *Lutjanus synagris*, population dynamics, Jamaica, otoliths

INTRODUCTION

The family Lutjanidae is the most valuable finfish component of Jamaican commercial landings. The fishery on the island shelf is dominated by trap gear, but nets are the second most common fishing gear (Sahney 1983, Munro 1983). As a group, frequency and mean size of fishes from trap catches have generally been in decline for years, probably due to overfishing (Aiken and Haughton 1987). There is a trend towards the use of nets such as seines and tangle nets, away from traps in order to avoid trap theft. The lane snapper (*Lutjanus* *synagris*, Linnaeus, 1758) is one of the more commonly taken seine and tangle net fishes. However, one exception to the trend of declining catches is thought to be the lane snapper, which seems to have produced consistently modest catches for many years. This species is taken almost exclusively by beach seine and tangle (called "Chinese") monofilament nets. Lane snappers are common over nearshore seagrass beds, and muddy, soft substrates, particularly on the south coast (Figure 1). The importance of net gears has greatly increased in the period since at least 1980. The abundance of this species may be a function of it being relatively unaffected by the intense trap fishery which has decimated reef fishes. The lane snapper has never been the focus of a dedicated study, and thus little is known of the biology in national waters, almost nothing of age and growth on this species in Jamaica. Munro and Thompson (1983) collected some Jamaican data on lane snappers but only as a small part of a much larger study on reef fishes, and additionally, their findings were all length-based. Some extraterritorial comparative data on age, growth and reproduction of lane snapper are available from Cuba (Claro and Reshetnikov 1981, Claro 1983, Rubio 1986, Rubio et al. 1985, Pozo et al. 1991, Pedroso and Pozo 1991, Salahanghe 1981), Puerto Rico (Acosta and Appeldoorn 1992), Mexico (Torres-Lara and Chavez 1987, Torres-Lara and Salas-Marquez 1990, Torres-Lara et al. 1990, Torres-Lara et al. 1991), Trinidad & Tobago (Manickchand-Dass 1987), and the United States (Manooch and Mason 1984).

The objectives of this study were to investigate the use of otoliths (earstones) as a method to provide age and growth information which would be new to Jamaica. Also an objective was to refine earlier conclusions on lane snapper reproductive biology as well as to investigate the ease with which marks in otoliths could be assessed for aging fish as a routine procedure.

STUDY AREA AND METHODS

The study area of this small-scale fishery-dependent investigation was the central south island shelf in the centre of which was the main sampling site, Old Harbour Bay fishing beach, the largest such beach in the island (Figure 1). Data collected there from February 1996 to June 1998 included fork length (mm), weight (g), sex and maturity stage (if whole), and the pair of sagittal otoliths. All fish had to be quickly returned to suppliers so this requirement determined that the method of otolith collection had to be the least destructive "up-through-the gills" method. Sexual maturity was recorded as either immature, active or ripe, a modification of the technique Munro (1983) successfully used for Jamaican reef fishes. Whole otoliths were viewed in a watchglass in glycerine using binocular microscopy. Selected otoliths were mounted in epoxy resin, then sectioned with a high-speed diamond saw, ground to 300 micrometeres on a lapping machine. Afterwards each was mounted on a small microscope slide for viewing with a compound microscope. Otolith radius was measured with an ocular micrometer where one ocular micrometer unit was equal to 14.7 micrometers (μ). Validation of otolith periodicity was determined by marginal increment analysis (analysis of monthly distribution opaque-edged (fast growth) otoliths in randomly selected specimens from fishes within the commercial size range).

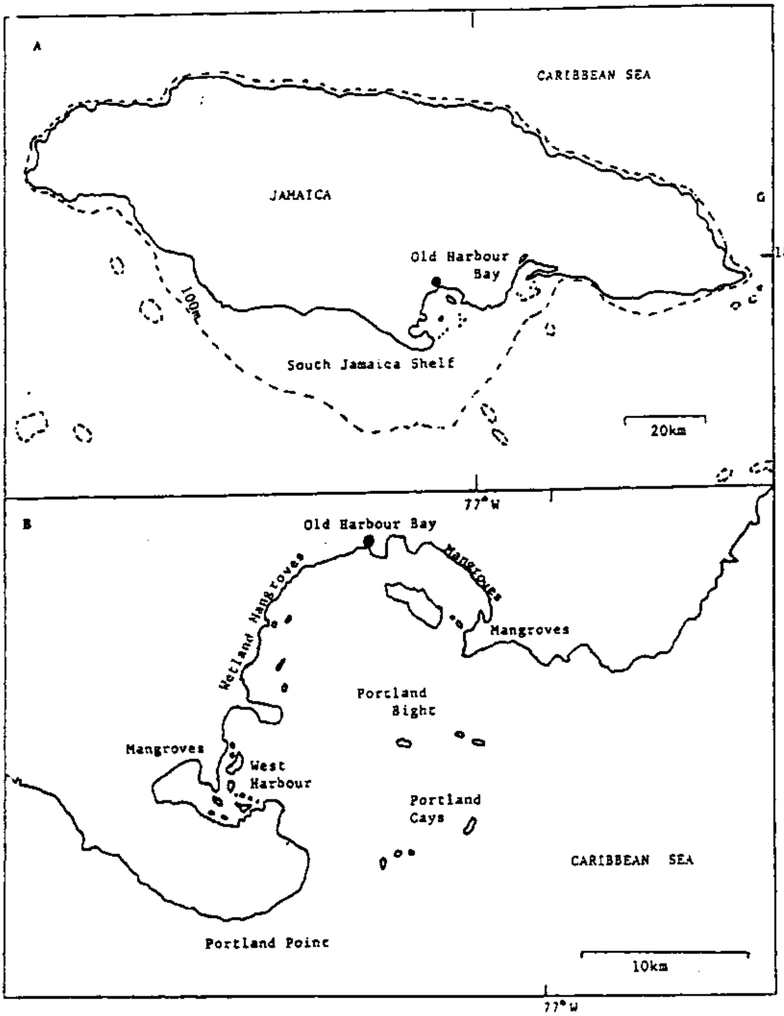

Figure 1. A map of Jamaica showing the 100 m depth contour and proximal oceanic banks (A), and Portland Bight and Old Harbour Bay sampling sites

RESULTS

Population Structure

Investigation of population structure showed that the size range (sexes combined) landed from the commercial seine and tangle net fishery on the south shelf was from 150 – 430 mm FL (fork length) with a mean of 232.1 mm FL (± 52.4 mm, N = 1,094) Figure 2. Mean size for males was 219.5 mm FL (± 3.72mm, N = 99) and for females 220.0 mm FL (± 52.4 mm, N = 235), Figures 3 and 4, respectively. Sex ratio (F:M) was found to be 2.6:1.0 in the size range 150 mm – 310 mm FL. Above 310 mm FL, there was 100% females. Table 1 lists the sex ration results and compares it to other findings elsewhere for the species.

Table 1. Sex ratios in *Lutjanus synagris* by geographic location

Location	Population Ratio (F:M)	Ratio at Length	Reference
Cuba	1.3:1.0 (N = 1,640)	ND	Claro, 1981
Cuba	1.9:1.0 (N = 1,441)	80 - 420 mm FL 50 - 70% F > 420 mm FL, 100% F	Rodrigues-Pino, 1962
Colombia (Caribbean)	1:1.3 (N = 2,472)	100 - 400 mm F 40 - 60% F	Erhardt, 1997
Jamaica	1.0:1.0 (N = 99)	170 - 350 mm FL	Thompson and Munro, 1983
Jamaica	2.6:1.0 (N = 326)	150 - 320 mm FL >320 100% F	This Study

Reproduction

Female lane snapper achieved first sexual maturity at 170 mm FL while males did this at 150 mm FL. Female mean size at maturity was 268 mm FL (± 0.27) while that for males was 221 mm FL (± 1.85 mm). Table 2 presents these results and compares them with those for Cuba, the nearest (160 km) Caribbean neighbour with this species. Study of the spawning season showed that ripe and spent individulas could be found throughout the year indicating prolonged spawning. Spawning maxima for both males and females were found from July to August annually. Figures 5 and 6 show the monthly distribution of immature, active and ripe specimens. Arrows indicate maxima for ripe individuals. Table 3 compares these results with periods of maximum spawning elsewhere.

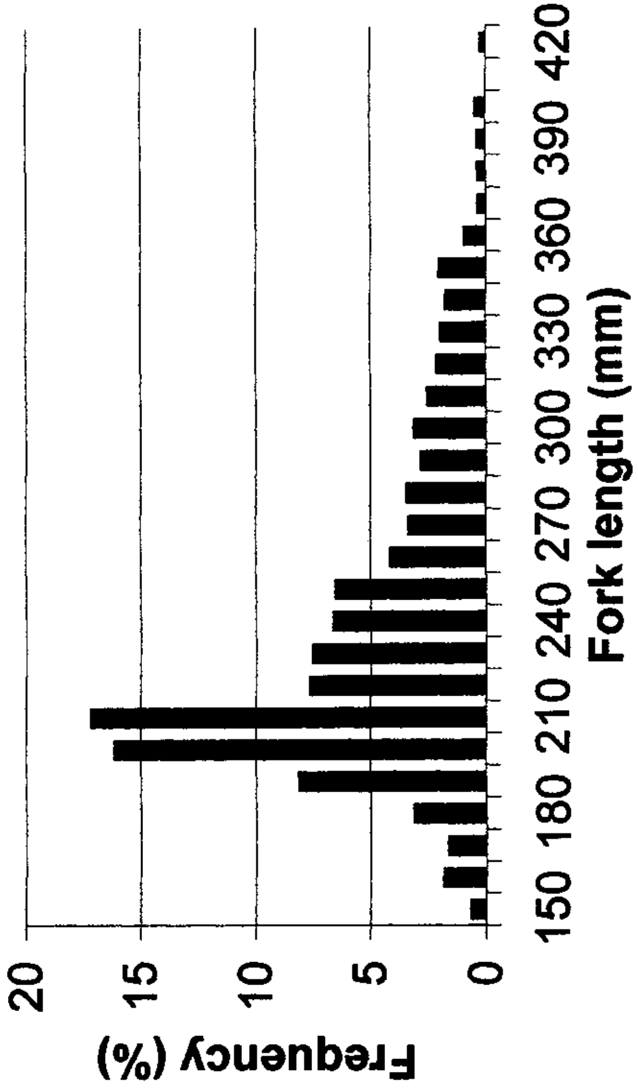

Figure 2. Cumulative length-frequency of male and female *L. synagris* during 1996 - 1998 at Old Harbour Bay, Jamaica. (N = 1,094; Mean = 232.1 mm FL)

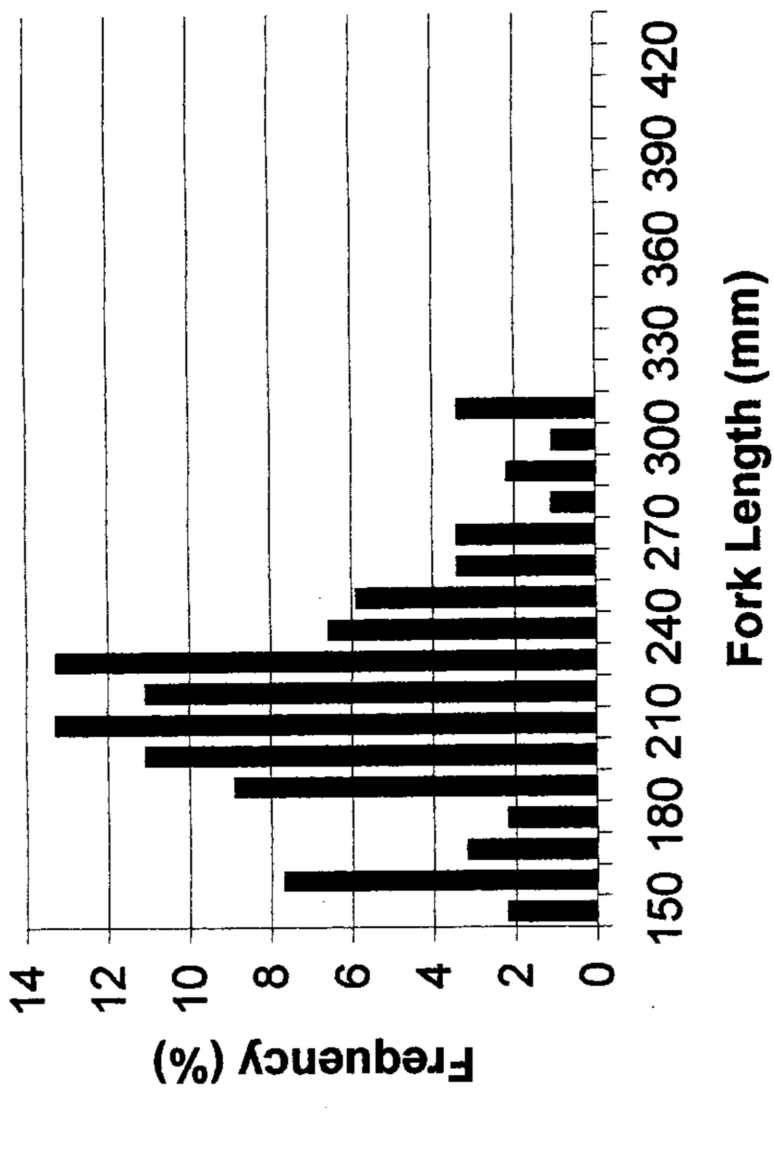

Figure 3. Length-frequency of male *L. synagris* during 1996 - 1998 at Old Harbour Bay, Jamaica. (N = 90; Mean = 219.5 mm FL)

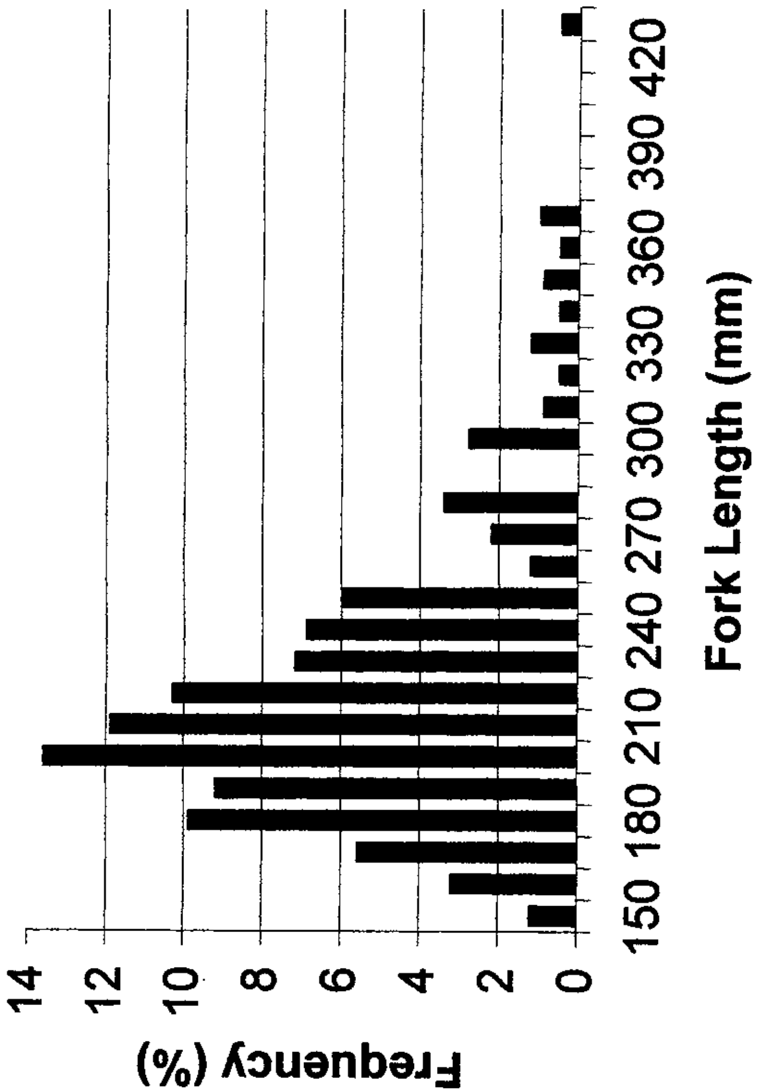

Figure 4. Length-frequency of female *L. synagris* during 1996 - 1998 at Old Harbour Bay, Jamaica. (N = 26; Mean = 220.0 mm FL)

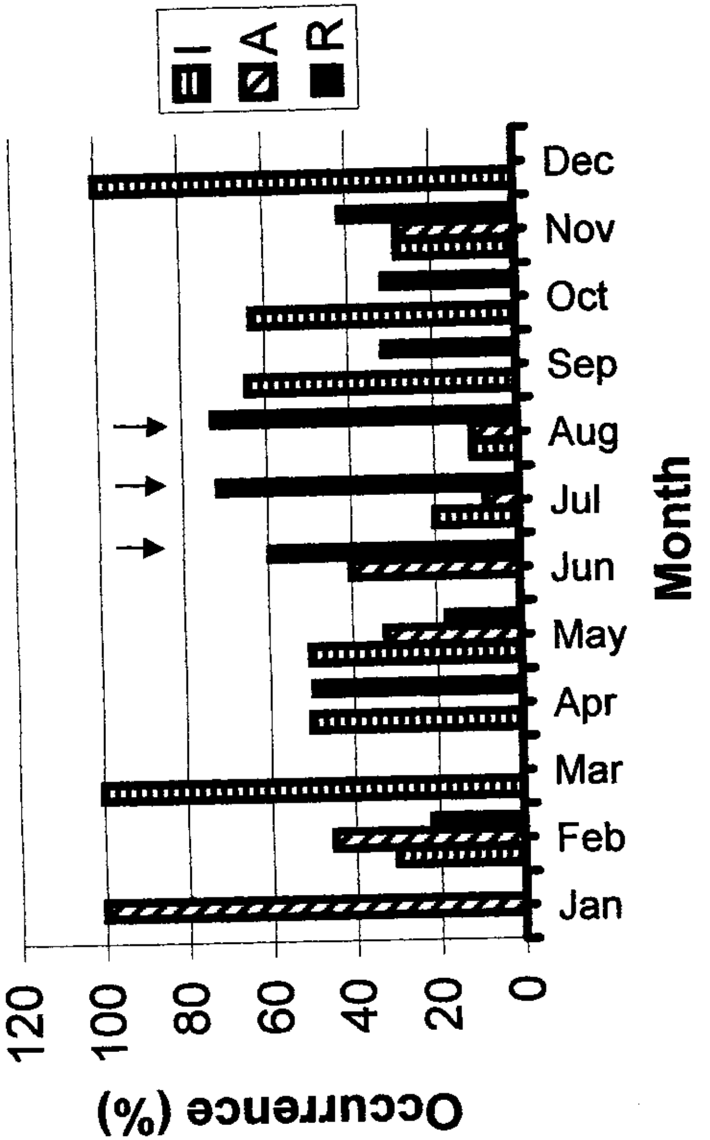

Figure 5. Frequency of occurrence of immature (I), active (A) and ripe (R) male *L. synagris* during 1996 - 1998 at Old Harbour Bay, Jamaica (arrows indicate spawning season)

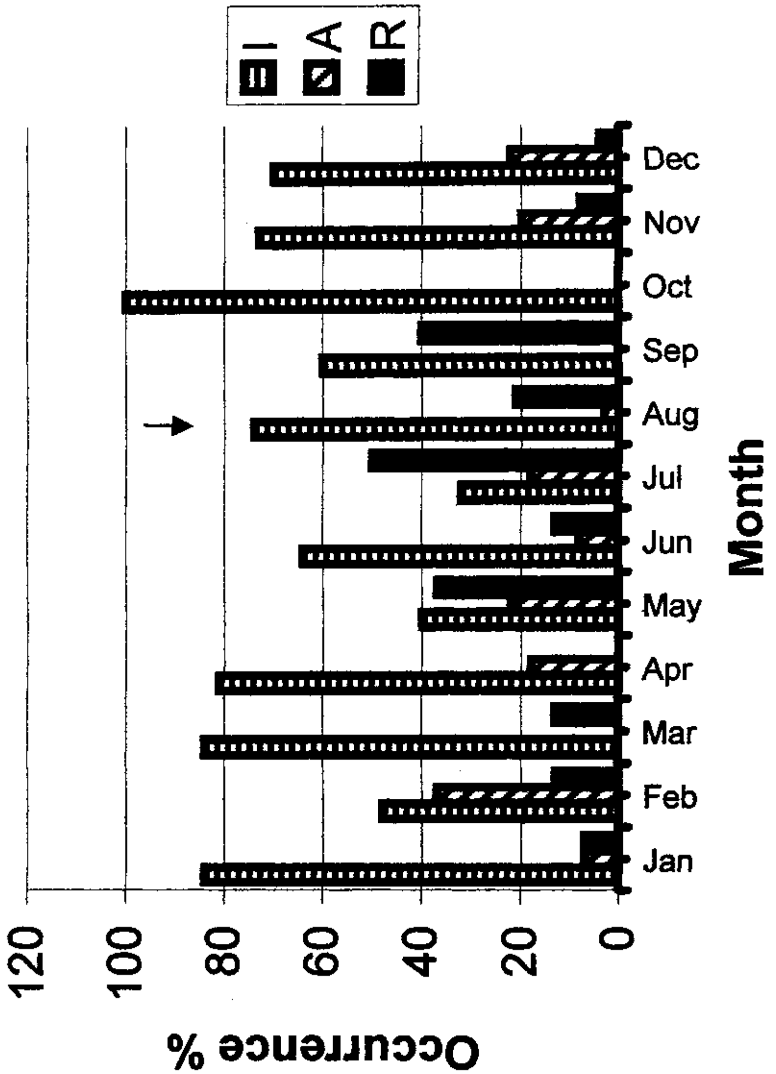

Figure 6. Frequency of occurrence of immature (I), active (A) and ripe (R) female *L. synagris* during 1996 - 1998 at Old Harbour Bay, Jamaica (arrows indicate spawning season)

Table 2. Size at maturity in *Lutjanus synagris* by geographic location

Location	Sex	Length at first maturity (mm)	Maximum length in Population (mm)	Percent of max. length at first maturity	Referemce
Cuba	M	91 TL	300 TL	22.8	Reshetnikov and Claro, 1976
	F	91 TL	400 TL	22.8	
Cuba	M	85 FL	275 FL	30.9	Ridriguez-Pino, 1962
	F	85 FL	310 FL	27.4	
Jamaica	M	183 FL	410 FL	44.6	Thompson and Munro, 1983
	F	176 FL	410 FL	48.4	
Jamaica	M	150 FL	320 FL	48.4	This study
	F	170 FL	430 FL	39.5	

Table 3. Spawning season of *L. synagris* by geographic region

Location	Maximum spawning time (months)	Analysis Type V = visual H = histological	Reference
Cuba	March - Sept.	V/H	Ridrigues-Pino, 1962
Cuba	April - Sept.	V	Reshetnikov and Claro, 1976
USVI	March - May Aug.	V	Erdman
Jamaica	March - April	V	Thompson and Munro, 1983
Jamaica	July - Aug.	V	This study
Trinidad	Jan. - Dec. (ripe)	V	Manckchand-Dass, 1987
Colombia (Caribbean)	Jan. - June Sept. and Dec.	V	Erhardt, 1997

Age and Growth

Examination of sagittal otoliths revealed clear patterns of marks in both whole and sectioned specimens. Generally, these were clearly defined opaque (fast growth) and hyaline (slow growth) zones. Marginal increment analysis of 300 sagittal otoliths showed that opaque (fast growing) margins were deposited in July and August. Hyaline (slower growth) zones were laid down in March annually. Thus, lane snapper had one opaque and one hyaline zone deposited each calendar year. Figure 7 shows the periodicity of deposition of these zones each year. Examination of whole otoliths showed a maximum age of six years in the range 150 –360 mm FL (N = 78). However, sectioned otoliths in the size range 150 – 390 mm FL showed a maximum age of 14 years (a female, N = 94). Figures 8 and 9 show the maximum age found in whole and sectioned lane snapper otoliths. Age analysis of sectioned otoliths is taken to be a more accurate indicator of true age, given validation by marginal increment analysis which proves that only one opaqe/hyaline zone pair is deposited annually. Length-frequency analysis and age-frequency analysis suggests that the majority of the females landed are 2 – 5 years in age while the males are from 1 to 3 years old. Also, the data suggest that males do not live as long as females.

Analysis of otolith radius versus length data showed a significant relationship where fork length (both sexes combined) was related to otolith radius by the regression equation $Y = 1.5262X - 3.9574$ ($r^2 = 0.08452$; N = 54) and is shown in Figure 10. Otolith weight changes with fork length analyses showed a significant relationship in male lane snapper related by the regression equation $Y = 0.04303X - 1.1543$ ($r^2 = 0.9407$, N = 15) and shown in Figure 11. For otoliths from females, weight was related to fork length by the equation $Y = 0.0405X - 1.1716$ ($r2 = 0.9711$, N = 24) and shown in Figure 12.

Growth patterns estimated from ELEFAN analyses suggest that males and females have different growth rates and the von Bertalannfy growth parameters derived were; males K = 0.25-yr, L_{∞} = 320 mm FL and t_o = -0.0001 (Figure 13) and for females, K = 0.076-yr, L_{∞} = 538.7 mm FL, and t_o = -3.970 and phi prime value = 4.346 (Figure 14).

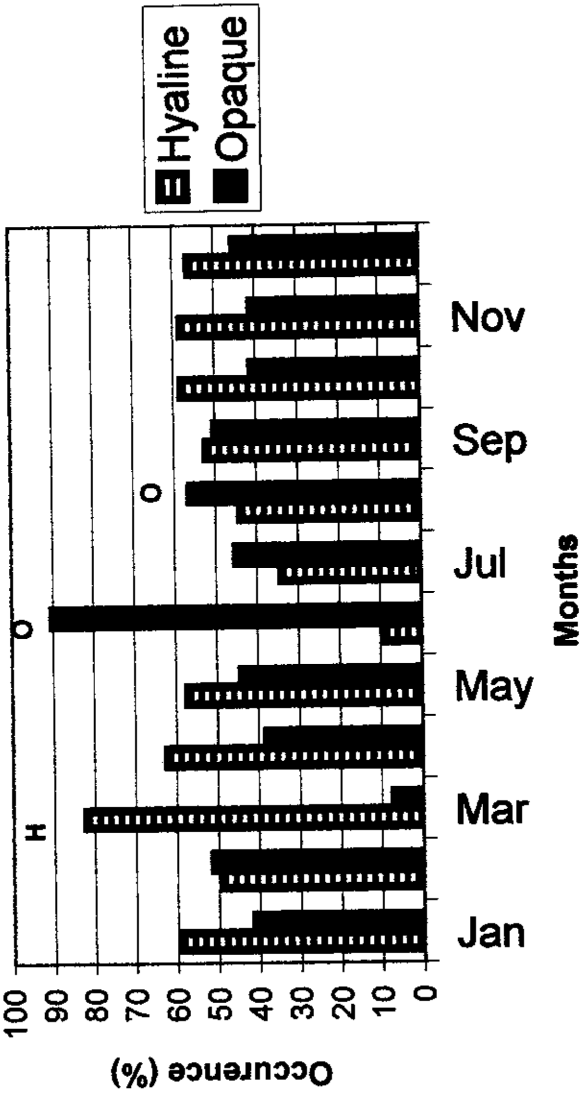

Figure 7. Marginal increment analysis, by month, of the otoliths of *L. synagris* showing hyaline vs. opaque margins

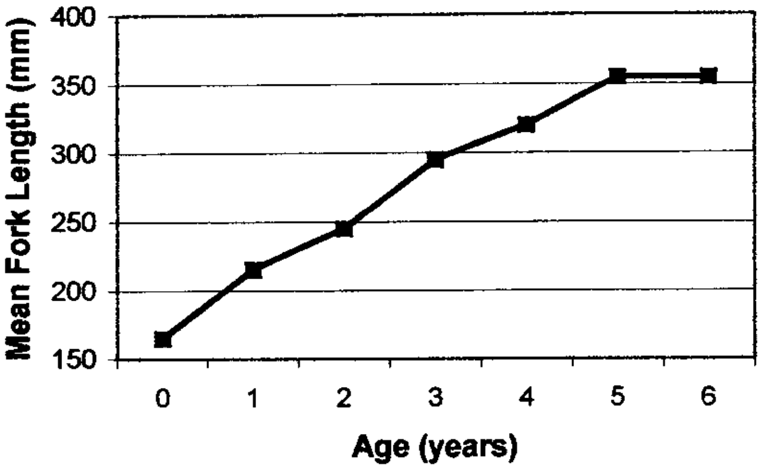

Figure 8. Maximum age found in whole otoliths of *L. synagris* from Jamaica

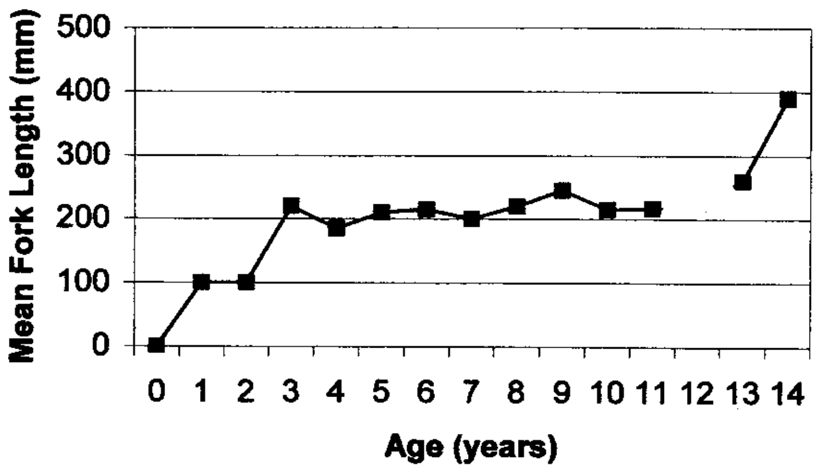

Figure 9. Maximum age found in sectioned otoliths of *L. synagris* from Jamaica

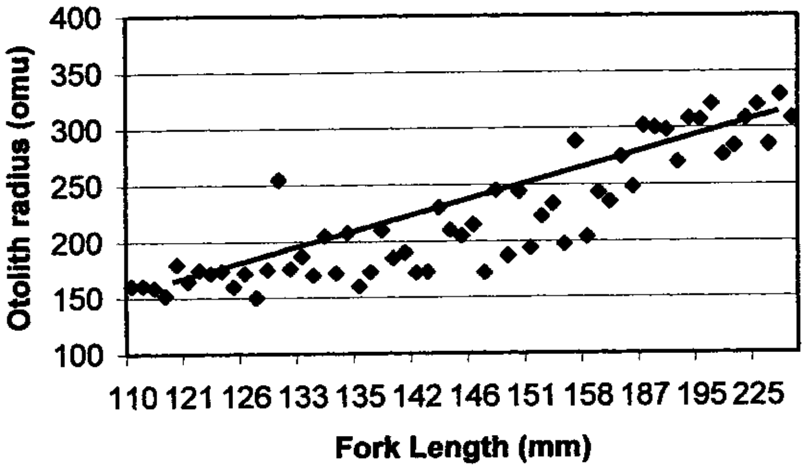

Figure 10. Fork length vs. otolith radius of *L. synagris* from Jamaica. y = 1.5262x - 3.9574; R^2 = 0.8452

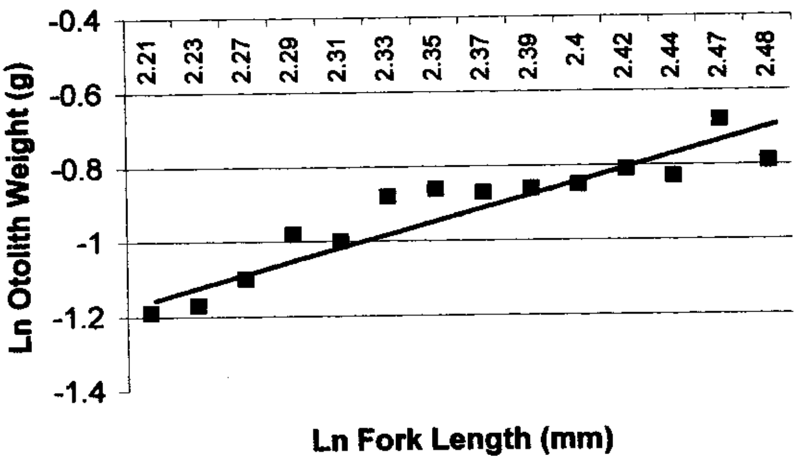

Figure 11. Linear regression for fork length vs. otolith weight of male *L. synagris* from Jamaica. y = 0.0403x - 1.1543; R^2 = 0.9407

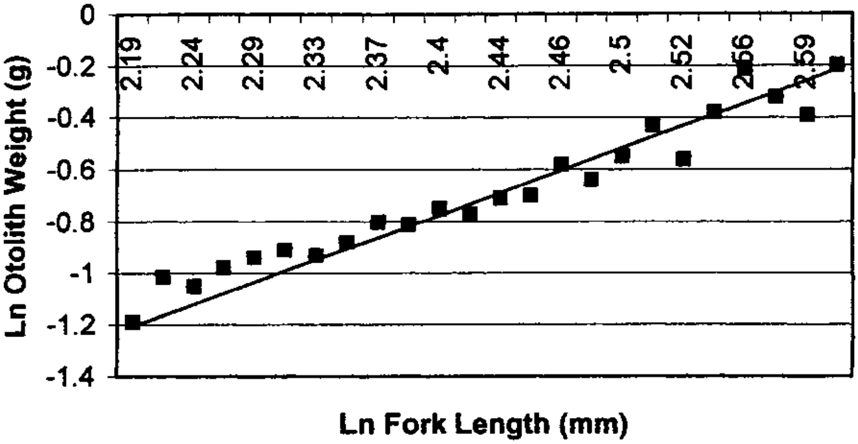

Figure 12. Linear regression for otolith weight vs. fork length of female *L. synagris* from Jamaica. y = 0.0405x - 1..1715; R^2 = 0.9711

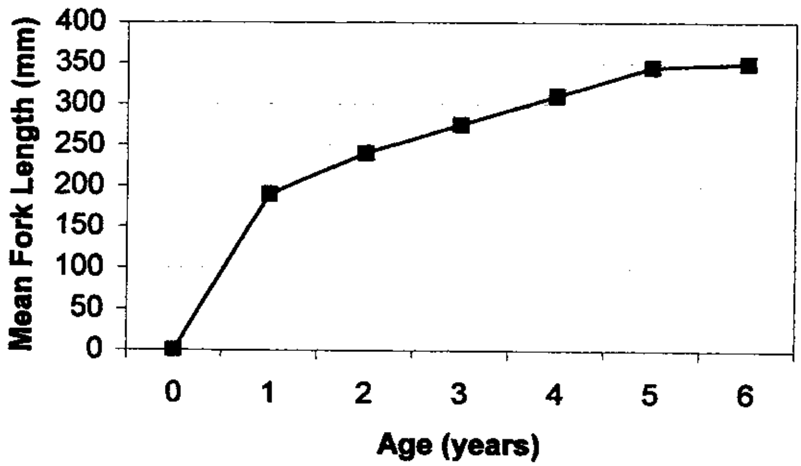

Figure 13. Growth patterns estimated from ELEFAN analyses for male *L. synagris* from Jamaica

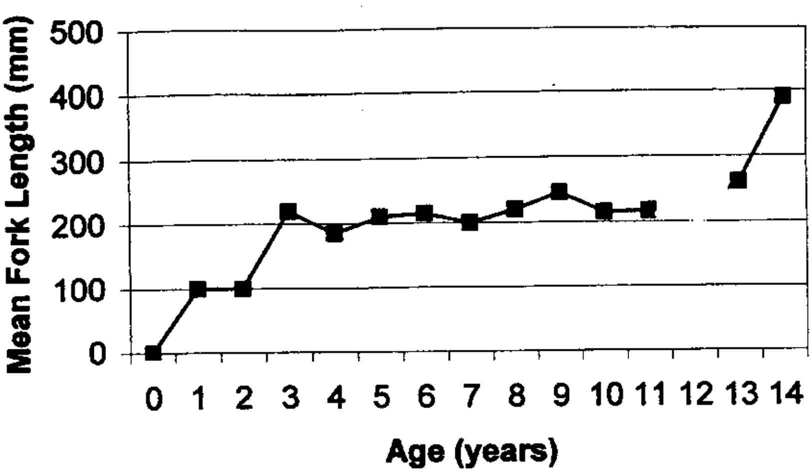

Figure 14. Growth patterns estimated from ELEFAN analyses for female *L. synagris* from Jamaica

DISCUSSION

The present study showed in part that lane snapper in Jamaican waters could attain an asymptotic size of at least 430 mm FL. The maximum size to which this species grows in other areas was not greatly different. Sex ratio (male to females) increases with increasing age. The largest lane snappers are female (>320 mm FL). Age at sexual maturity for males and females is approximately two years for males and three years for females. Males arrive at sexual maturity and spawn brfore females of the same age. This means that it is possible that young viable males could spawn with more fecund slightly older females. Estimates of mean percentage of otoliths with opaque zones at growing edges suggest that these zones are produced in summer at the time of maximum reproductive activity. Validation through marginal increment analysis showed that one opaque and one hyaline zone is produced in sagittal otoliths each year. Whole otolth analysis produced for both sexes a maximum age of six years. Sectioned otoliths produced maximum ages around 12 years. Lane snapper in Jamaican waters therefore attain a greater age than previously known. This is close to the 10 years maximum age in Florida (Manooch and Mason 1984) and greater than most other areas except for Bermuda with 19 years (Luckhurst, pers.

comm. 1998). Male fish gow more slowly than females and are outlived by females. These latter can achieve at least 12 years, but males appear not to survive beyond approximately six years. Otolith sections provided more accurate ages than did whole otolith. The present study suggests that the use of whole otolith age analysis alone could markedly underestimate age in lane snapper. It is notelworthy that many of the studies in the literature did not use sections but relied on somle ageing of whole otoliths. This general preference for whole otolith ageing may be due to the higher cost and time consumption of section preparation. Perhaps the most significant finding is that lane snapper can attain a much greater age than previously expected in Jamaican waters. This suggests that if this is typical of other reef fishes, then the already seriously overfished stocks may take even longer to recover (within an overall management plan) than thought earlier. Removal of larger (>320 mm FL) fishes will direcly impact females fishes more than males, and will have significant implications for future fish stocks

With training and practice, otolith analyses could become part of the fish aging methodology in Jamaica. It is recommended that a combination of analytical methods always be used in ageing investigation rather than one method.

ACKNOWLEDGEMENTS

I am grateful to the Fisheries Division of the Ministry of Agriculture, which assisted in establishing contacts at various early trial data collection sites. This study could not have been done without the continuous cooperation of vendors at the Old Harbour Bay landing site, St. Catherine, particularly Isola Simpson and Merlene Chastri.

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