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ASSESSMENT OF GONAD MATURATION OF *Megalops atlanticus* AND WATER QUALITY OF ITS HABITAT

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ABSTRACT

The Aquacultural potential of *Megalops atlanticus* and its food and feeding habits cannot be thoroughly determined without knowledge of some aspects of its bioecology. This study investigated the gonad maturation of *Megalops atlanticus* to the water quality of its habitat. A total of 1,115 fish specimens from three (3) sampling stations, A (Igbo-Ejo-334), B (Tamaro-448), and C (Ito Agan-333), were collected between January 2016 and April 2018. Sexes were differentiated by both macro and microscopical examinations of the genitals. The gonadal stages were determined using histological examinations of the gonads. Water parameters (pH, dissolved oxygen, turbidity, salinity, CO_2, temperature, total alkalinity and total hardness) were measured following American Public Health Association Standard method. The gonadosomatic index (GSI) of the fish at Station A, B and C respectively were 0.26 ±0.17, 0.421 ± 0.25 and 0.27 ± 0.20. The percentage of male fish that belonged to gonadal stages I, II, III, IV, V and VI were 44%, 32%, 40%, 42%, 47% and 45% respectively, while females were 46%, 38%, 34%, 41%, 39% and 38% respectively. Only turbidity and total hardness showed significant difference ($p > 0.05$) across the sampling stations. The peak turbidity (133± 46.67NTU) and total hardness (123.0±33.94mg/L) were recorded at Tamaro. In conclusion, *M. atlanticus* in Lagos Lagoon is still at sub – adult stage, a feature which indicates that it is an anadromous species which migrates to the sea for development to adult stage. The water parameters were within World Health Organization permissible limits. The abundance of females in the sample may be an added advantage for more recruitment of *M. atlanticus* in Lagos Lagoon.

Keywords: Gonadosomatic index, Water parameters, Food and feeding habit, Lagos lagoon

INTRODUCTION

Megalops atlanticus, is a large, typically migratory elopomorph fish found in coastal and inshore waters of the tropical and subtropical Atlantic Ocean (Wade, 1962, Seymour *et al*., 2008,). Atlantic Tarpon are a prized sportfish and recreational fish that generates billions of dollars and thousands of jobs annually in the United States (Ault *et al*., 2008, Seymour *et al*., 2008). Being a highly mobile macropredator, Atlantic Tarpon use different habitats and resources throughout their life cycle, forage on a wide variety of prey, and are themselves prey to several shark species (Ault *et al*., 2008, Hammerschlag *et al.*, 2012). According to Adams *et al*. (2012), Atlantic Tarpon are listed as vulnerable by the International Union for Conservation of Nature (IUCN), due in part to regional exploitation, loss of natal habitat, poor water management, and offshore disturbances such as oil spills (Ault *et al.,* 2008). Tarpon support an economically important recreational throughout their range in the Caribbean, sub-tropical and tropical Atlantic Ocean, and the Gulf of Mexico (Adams *et al*., 2013). Despite the economic importance of tarpon and their dependence upon backwater habitats, little information is available on juvenile tarpon growth, survival, and emigration – all characteristics that can be used to evaluate nursery habitat quality (Beck *et al*., 2011), and thus estimate the impacts of habitat loss and degradation, as well as habitat restoration effectiveness. Most of the prior research has focused on development of their leptocephali larvae (Wade, 1962, Crabtree *et al*., 1992, Shenker *et al.*, 2002) as well as demographic aspects of adults such as age, growth, and reproduction (Crabtree *et al.*, 1995, Andrews *et al*., 2001). Juvenile tarpon has highly vascularized swim bladders that allow them to survive in hypoxic or anoxic conditions by gulping air. This ability allows them to use habitats that exclude many predators and competitors (Seymour *et al*., 2008). These conditions are typically found in back-bay and creek habitats that characteristically have calm waters, a freshwater source with tidal influence and vegetative fringe (Adams *et al*., 2013). Therefore, the aim of the study is to examine the food and feeding habit of *M. atlanticus* and assess the stages of the gonad maturation of the fish via histological studies.

MATERIALS AND METHODS

Study Areas

The study areas (Tomaro Creek, Igbo - ejo and Ito - agan) located within Lagos Lagoon in Nigeria lies between longitudes 3°20' and 3°50'W and latitudes 6°24' and 6°36'N (Figure 1). Lagos Lagoon is the largest lagoon system in the West African coast, covering 208 km^2. The lagoon is bounded in the north by Ogun River, Majidun, Agoyi and Ogudu creeks. The southern margin is bounded by Five Cowries and Badagry creek and in the east by Lekki and Epe lagoons. The lagoon opens into the Atlantic Ocean via Lagos habour. It is shallow in depth and in most places more than 1.5 meters deep. The lagoon is surrounded by marshy ground which is permanently white mangrove forest. The dominant plants are *Rhizophora racemosa, Drepanocarpus lunatus, Avecennia nitida, Dalbergia ecastaphyllum, Typha australis* and *Phoneix reclinata*. The sedges include *Cyperus articulatus, Paspalum vaginatum* and *Cyperus papyrus.* The prominent ferns are *Achrosticum* sp., *Marsilead*sp., *Cylosorus* sp. and *Ceratopleris* sp. Palms are mainly *Pandanus candelabrum* and *Raphia hookeri*.

Lagos lagoon has several species of fishes, some abound in large numbers and serves as breeding and feeding grounds for some of them. The fresh water fishes include Tilapias (*Oreochromis niloticus*, *Tilapia melanotheron* and *T. zilli*) and Catfishes (*Clarias*and *Chrysichthys*sp). Marine fish species are Mullets (*Mugil* and *Liza*sp). Ten pounder (*Elopslacerta*), Clupeids (*Ilishaafricana*, *Ethmalosa fimbriata*) and Sciaenids (*Pseudotolithustypus* and *P. senegalensis*). The indigenous species are mudskipper

(*Periophthmuspapilio)* and gobiid (*Bathygobiussoporator*). Common shellfishesinclude crabs such as *Cardisoma armatum*, *Callinectes amnicola, Goniopsi spelli* and Prawn (*Macrobranchium vollenhoveni*).

Due to seasonal distribution of rainfall, Lagos lagoon experiences seasonal flooding which introduces a lot of detritus and pollutants from the land. The lagoon presently serves as a major drainage channel receiving domestic wastes as well as industrial effluents from industries in the area (Lawson, 2011).

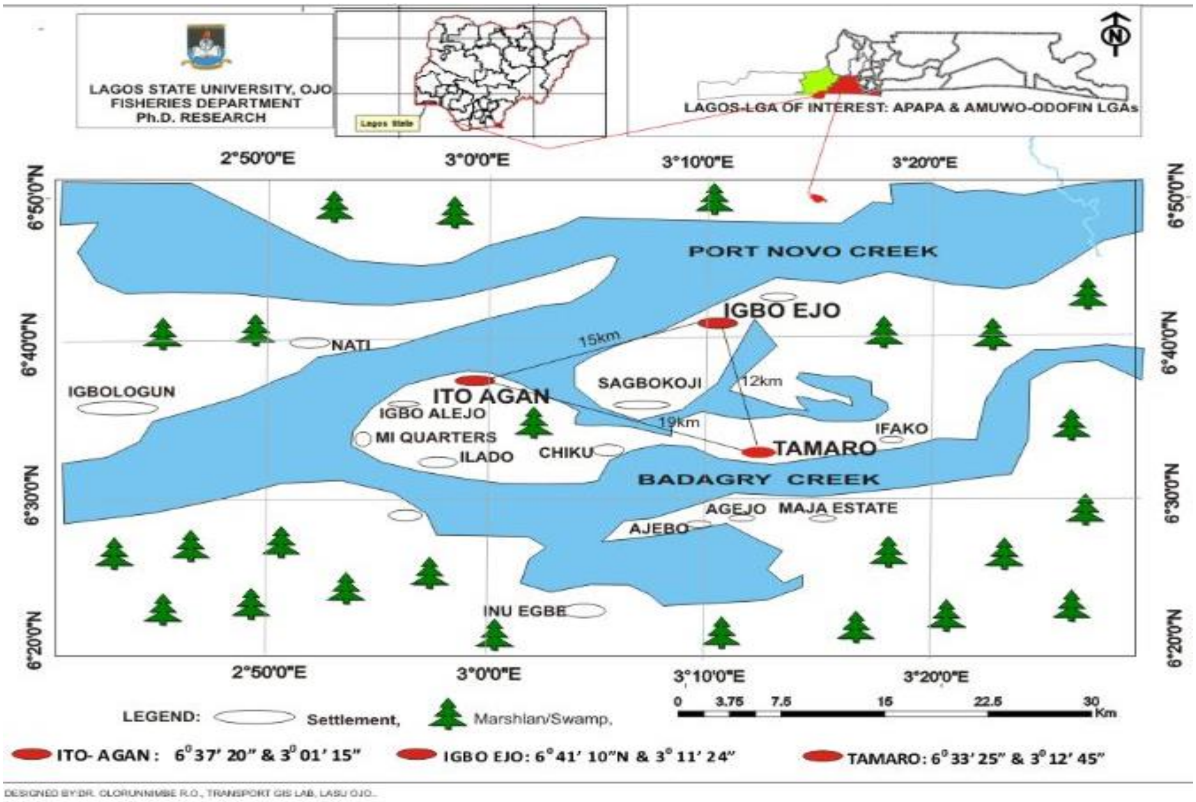

Figure 1: Location of study areas (Tamaro creek, Ito-Agan, Igbo - Ejo) within Lagos Lagoon

Collection of Fish Samples

The fish specimens were collected from the fishermen catches at Tamaro Creek, Ito - agan and Igbo-ejo in Lagos lagoon, Lagos, between 0700 hour and 0900 hour, January 2016 and April 2018 every sampling day. The fish were caught with cast nets (12- 22mm) and gill nets (18 – 45mm) mesh sizes. Fishing crafts used in these water bodies included dugout canoes, and motorized outboard engines. All the samples were transported to the laboratory in ice and preserved in a deep freezer at -20°C until examination and analysis.

Preparation of Fish Samples

The specimens were brought out of the deep freezer and allowed to thaw and the body length and weight were measured. Total and standard lengths were measured using a one-meter measuring board graduated in cm. The fish was wiped with a dry napkin before weighing.

Collection and analyses of water samples

Water samples collected from sampling stations (Igbo – ejo, Tamaro and Ito -agan respectively) were analyzed for Air temperatures (^0C), Water temperature (^0C) Dissolved oxygen (DO) mg/L, Turbidity (NTU), pH, Salinity, Rainfall, Hardness, Carbon dioxide (Co_2), using the appropriate standard laboratory procedures (APHA, 2005).

Sex Ratio

Each specimen was dissected and the gonads were removed. The sex of each specimen was identified by examination of the gonads. The proportion of the two sexes relative to one another was used to calculate the sex ratio.

Test for goodness of fits was determined statistically by Chi-square(X^2) using the formula below:

$$X^2 = \frac{(O-E)^2}{E}$$

Where O = Observed, E = Expected Frequency.

Stages of gonad maturation

The maturity of each specimen was examined by both macro and microscopic examinations of the gonads. The gonads are classified as: Stage 1: Immature, Stage 2: Maturing/Developing, Stage 3: Mature/Ripening, Stage 4: Ripe, Stage 5: Spent and Stage 6: Recovering.

RESULTS AND DISCUSSION

Physico-chemical parameters/Ecological studies of Lagos lagoon

The physico-chemical parameters included dissolved oxygen, alkalinity, salinity, carbon-dioxide, turbidity, hardness, temperature (surface and air) and pH. The mean surface temperature- 26.0 ± $4.26^{O}C$, 25.5 ± $3.54^{O}C$, and 25.5 ± $3.54^{O}C$ for Igbo-ejo (station A), Tamaro (station B) and Ito -agan (station C) respectively were not significantly ($p<0.05$) different; while water temperature was 24.0± $4.24^{O}C$, 23.5 ± $4.95^{O}C$ and 23.5± $3.54^{O}C$. Also, not significantly different. Similarly, the dissolved oxygen (mg / L), salinity, carbon dioxide, total hardness, alkalinity and pH for (Station A), (Station B) and (Station C) were not different statistically.

Table 1: Summary of Water Quality Analysis of the three (3) sampling stations

Parameters	Station A (Igbo – Ejo)		Station B (Tamaro)		Station C (Ito- Agan)	
	Range	**Mean ± SD**	**Range**	**Mean ± SD**	**Range**	**Mean ± SD**
Air Temp.(^{0}C)	23 - 29	26.0± 4.26^a	23 – 28	25.5± 3.54^a	23 – 28	25.5± 3.54^a
Water Temp.(^{0}C)	21 – 27	24.0± 4.24^a	20 – 27	23.5± 4.95^a	21- 26	23.5± 3.54^a
DissolvedOxygen(mg/L)	3.1 - 7.5	5.3± 3.11^a	3.4 -7.5	5.5± 2.90^a	3.9 –7.1	5.5± 2.26^a
Salinity(ppt)	0.2- 0.8	0.5± 0.42^a	0.2 - 0.3	0.3± 0.07^a	0.2 - 0.4	0.3± 0.14^a
Turbidity (NTU)	70 – 175	122.5± 74.25^a	100 -166	133± 46.67^b	80 -143	111.5± 44.55^c
Total Hardness(mg/L)	88 -131	109.5± 30.40^a	99 – 147	123± 33.94^b	88 -135	111.5± 33.23^c
Carbon dioxide(mg/L)	12 -26	19± 9.90^a	17 – 26	21.5± 63.64^a	12 – 22	17.7± 7.07^a
Alkalinity(mg/L)	9.7 -12.5	11.1± 1.98^a	9.8 -12.5	11.15± 1.91^a	10 – 14	12± 2.83^a
pH	5.8 - 6.9	6.4± 0.78^a	5.5 – 6.9	6.2± 0.99^a	5.9 - 6.9	6.4± 0.71^a

Mean ± SD value with different superscript across the row = significant different ($p<0.05$)

Various stages of the gonad of *M.atlanticus* examined in this study included immature male whose gonad was characterized by spermatogonia in the germinal epithelium of seminiferous tubules, male on stage II-developing with a gonad structure in which sseminiferous tubules was still at initial stage of development and contains spermatocytes; male *M.atlanticus* at maturing stage (stage III) with gonad structure of small and larger spermatids and sperms, The gonad of male specimen at mature/ripe stage showing lobules that are more densely packed by spermatids and sperms, the gonad structure of male at spent stage with unfilled testis with spaces, few spermatids and sperms sand a male at Recovering stage with lobules that are empty or contain residual sperm cells. However, there was no variation in the gonad histology of *M.atlanticus* examined across the sampling stations. The gonad stage 1 of the female *M. atlanticus* as presented in Plate 1 *was* characterized by more Oogonia, small oocytes in chromatin nucleolus stage (CNS) and a few early cortical alveoli stage (CAS) (arrows). Plate 2 showed the developing stage with few medium oocytes in early cortical alveoli stage and small oocytes in chromatin nucleolus stage (CNS). Plate 3 represent the maturing female (stage III) with different size of oocytes (Oc) at different stages of maturation and vitellogenesis including Cortical alveoli stage (CAS) and perinucleolus stage (PNS) oocytes (arrows). This observation affirmed that the environment from which the fish species were harvested were still suitable for their growth and general wellness. Histological examination of gonads has also been used to estimate the location of *M. atlanticus* spawning habitat (Stein *et al*., 2012). For instance, Females collected from the Florida Keys and Boca Grande Pass off the West Coast of Florida contained ovaries with post ovulatory follicles (POF) and advanced vitellogenic oocytes, suggesting *M. atlanticus* spawn in this region from April through July (Crabtree *et al*., 1997). Examination of gonads from *M. atlanticus* caught off the coast of equatorial Ceara State, Brazil suggested that spawning occurs there from October through January (De Menezes and Paiva, 1966). In this study, the gonad stage 1 of the female *M. atlanticus was* characterized by more Oogonia, small oocytes in chromatin nucleolus stage (and a few early cortical alveoli stage; the developing stage had few medium oocytes in early cortical alveoli stage and small oocytes in chromatin nucleolus stage; the maturing female (stage III) with different size of oocytes at different stages of maturation and vitellogenesis including Cortical alveoli stage and perinucleolus stage (PNS) oocytes. The female gonad which belong to ripe stage(stage IV) was characterized by advanced stage of vitellogenesis. Many mature and hydratedoocytes are present, including cortical alveolar stages. Flaccid and empty ovary, thick ovary wall Oocyte of all stages present but primary Oocyte predominatewere observed in female at spent stage. For the stage VI (recovering), the observed features in the gonad were large empty spaces filled up ovary, few eggs attached to ovary wall.

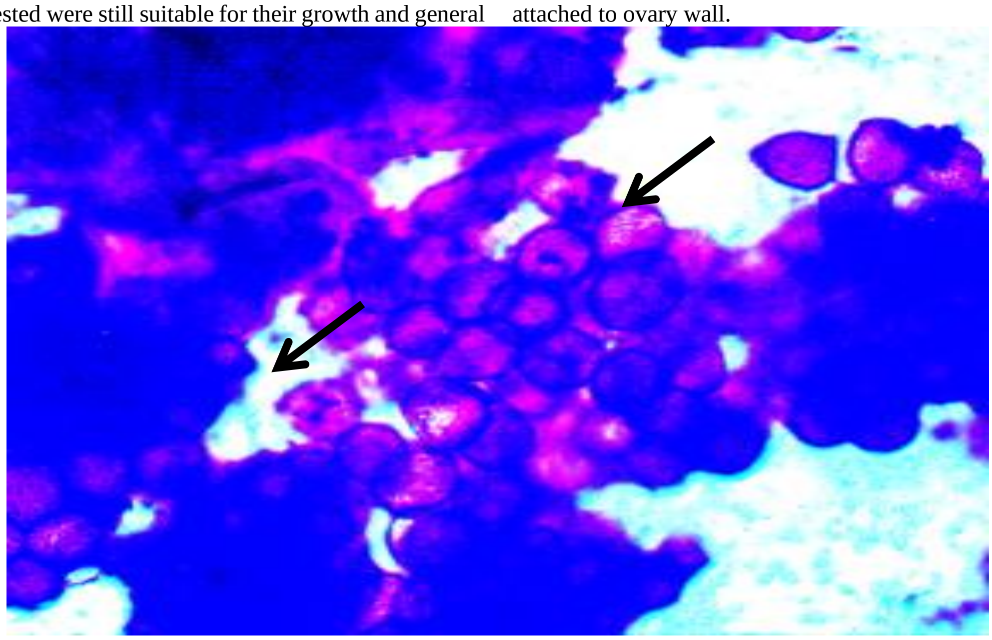

Plate 1: Female, Stage I- (Immature). Characterized by more Oogonia, small oocytes in chromatin nucleolus stage (CNS) and a few early cortical alveoli stage (CAS) (arrows).Haematoxylin and Eosin stain X100

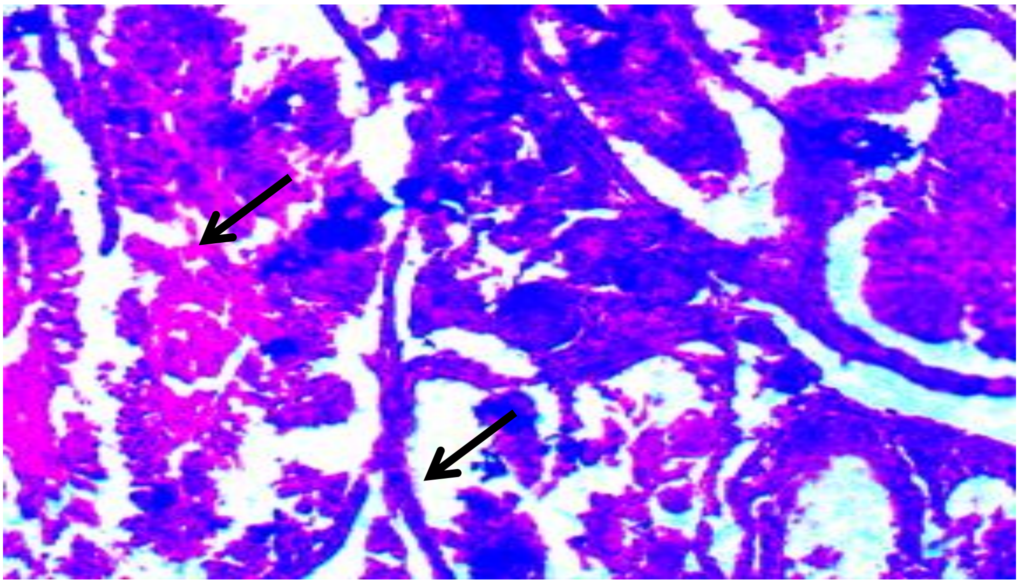

Plate 2: Female, Stage II – (Developing) .Characterized by small oocytes in chromatin nucleolus stage (CNS) and a few medium oocytes in early cortical alveoli stage (CAS)(arrows)Haematoxylin and Eosin stain X400

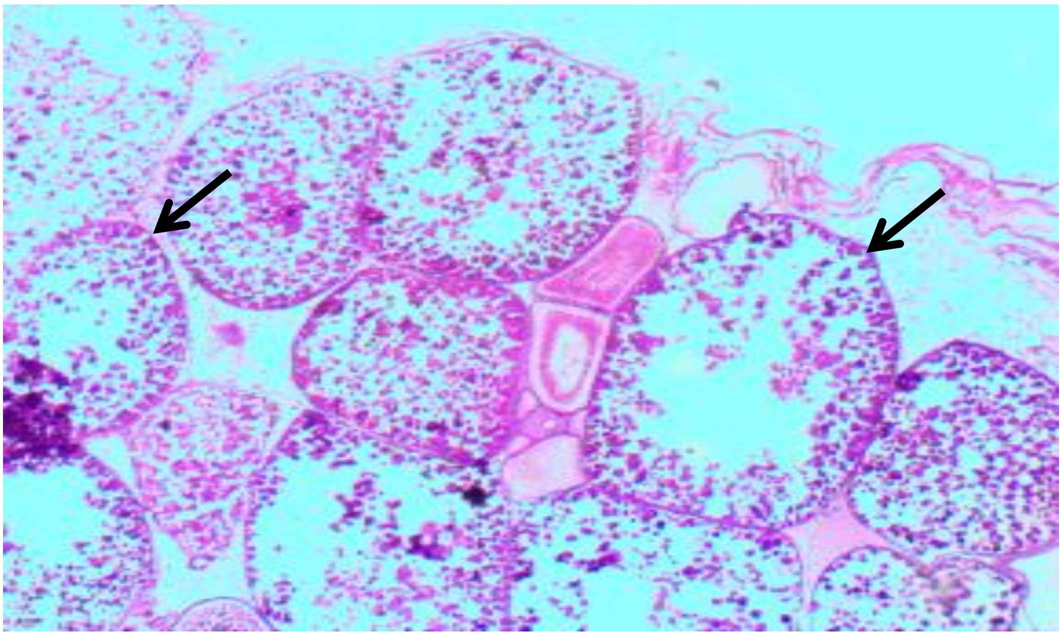

Plate 3: Female, Stage III (Maturing)- Showing different size of oocytes (Oc) at different stages of maturation and vitellogenesis including Cortical alveoli stage (CAS) and perinucleolus stage (PNS) oocytes (arrows). Haematoxylin and Eosin stain X400

The female gonad which belong to ripe stage(stage IV) was characterized by advanced stage of vitellogenesis. Many mature and hydrated (arrow) oocytes (OC) are present, including cortical alveolar stages (CAS)(arrows) as presented in Plate 4. Flaccid and empty ovary, thick ovary wall Oocyte of all stages present but primary Oocyte predominate (arrows) were observed in female at spent stage (Plate 5). For the stage VI (recovering), the observed features in the gonad were large empty spaces filled up ovary, few eggs attached to ovary wall (Plate 6).

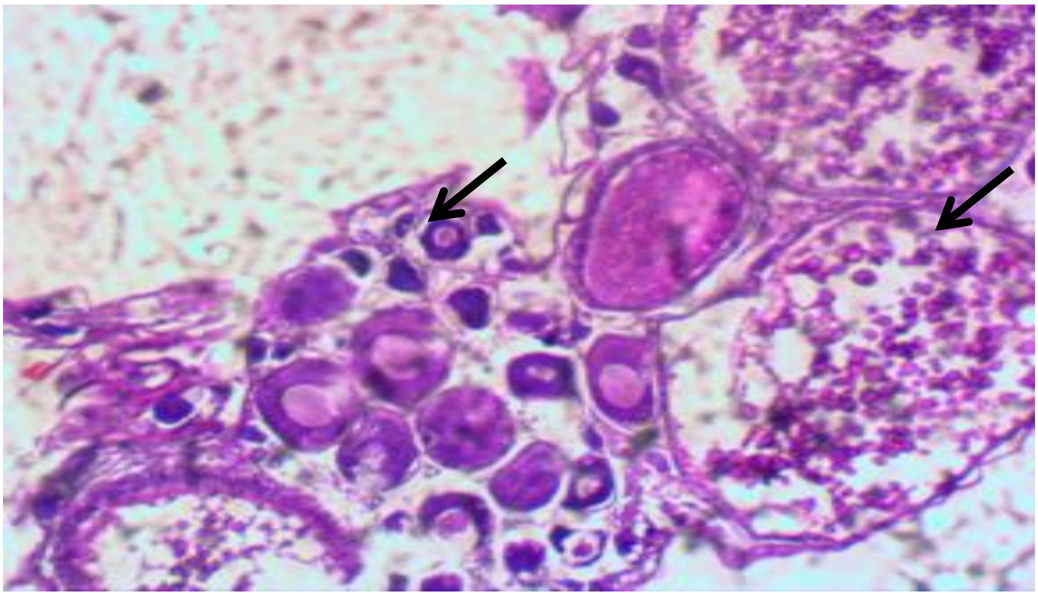

Plate 4: Female, Stage IV(Ripe). Characterized by advanced stage of vitellogenesis. Many mature and hydrated (arrow) oocytes (OC) are present, including cortical alveolar stages (CAS)(arrows)Haematoxylin and Eosin stain X400

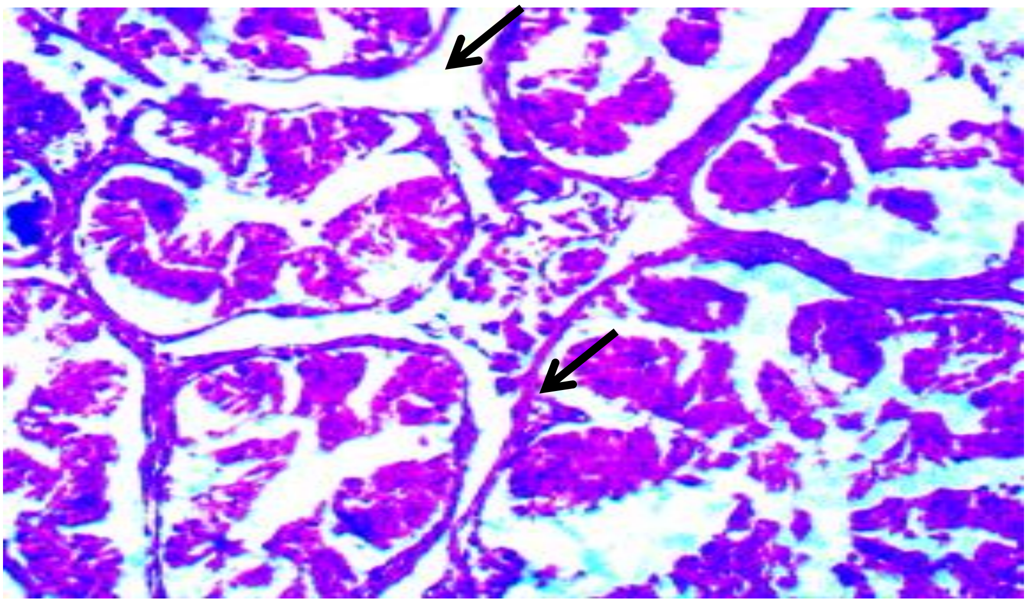

Plate 5: Female, Stage V – (Spent) Flaccid and empty ovary, thick ovary wall Oocyte of all stages present but primary Oocyte predominate(arrows)Haematoxylin and Eosin stain X400

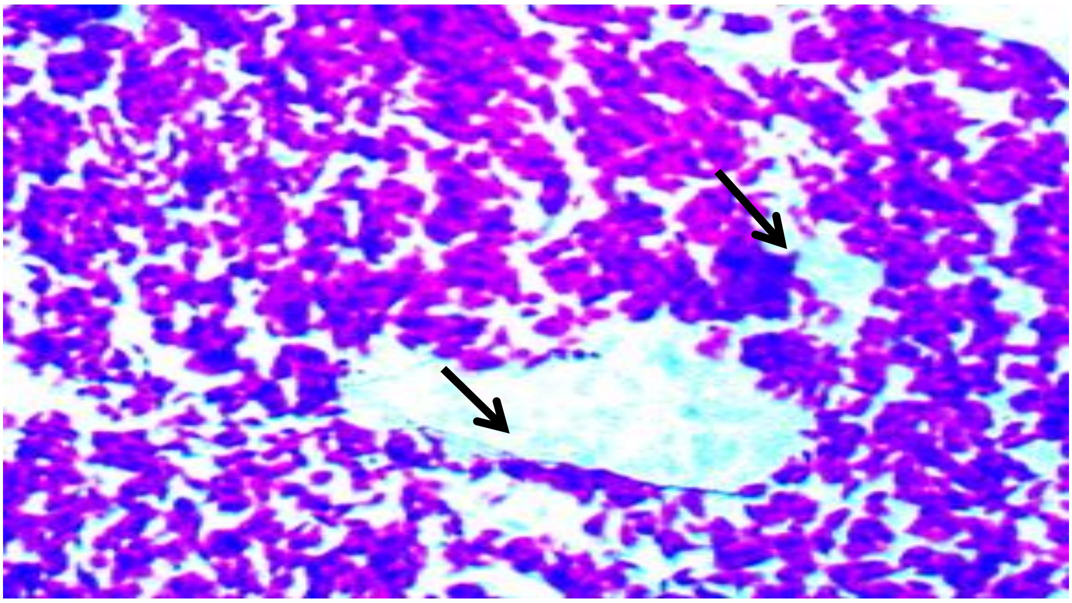

Plate 6: Female Stage VI – (Recovering) Large empty spaces filled up ovary, few eggs attached to ovary wall(arrows).Haematoxylin and Eosin stain X400

Studies have shown that Atlantic Tarpon begin to move to estuarine and coastal waters at the end of the juvenile and sub-adult stage in response to increasing food requirements and efforts to join spawning populations (Stein III *et al*., 2012; Adams *et al*.2019; Seeley *et al*., 2017; Seeley and Walther, 2018). For this study, the Geometric Index of Importance (GII) for stomach contents of Juvenile and Sub-Adult *Megalops atlanticus* respectively from Igbo-ejo, Tamaro and Ito - agan in which food like Copepod, Cladoceran Diptera, insect parts, Trichoptran, fish scales, fish eggs, Rhagovelia, and *Macrobrachium* spp. were most prevalent in their stomach affirmed that *Megalops atlanticus* is a carnivore. Atlantic Tarpon typically recruit to upper estuarine habitats such as brackish, lagoons, mangroves, and tidal creeks where predation is thought to be low and food resources are high ((Wallace *et al*., 2014, Seymour *et al*., 2008). At the sub-adult stage, Atlantic Tarpon appear to become more dependent upon deeper water habitats such as rivers, sloughs, and canals that provide access for emigration into coastal waters (Ault *et al*., 2008).

CONCLUSION

Megalops atlanticus in Lagos Lagoon is still at sub – adult stage, a feature which indicates that it is an anadromous specie which migrates to the sea for development to adult stage. The water parameters were within World Health Organization permissible limits and this imply safe habitat for this species. However, the abundance of females in the sample may be an added advantage for more recruitment of *M. atlanticus* in Lagos Lagoon.

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