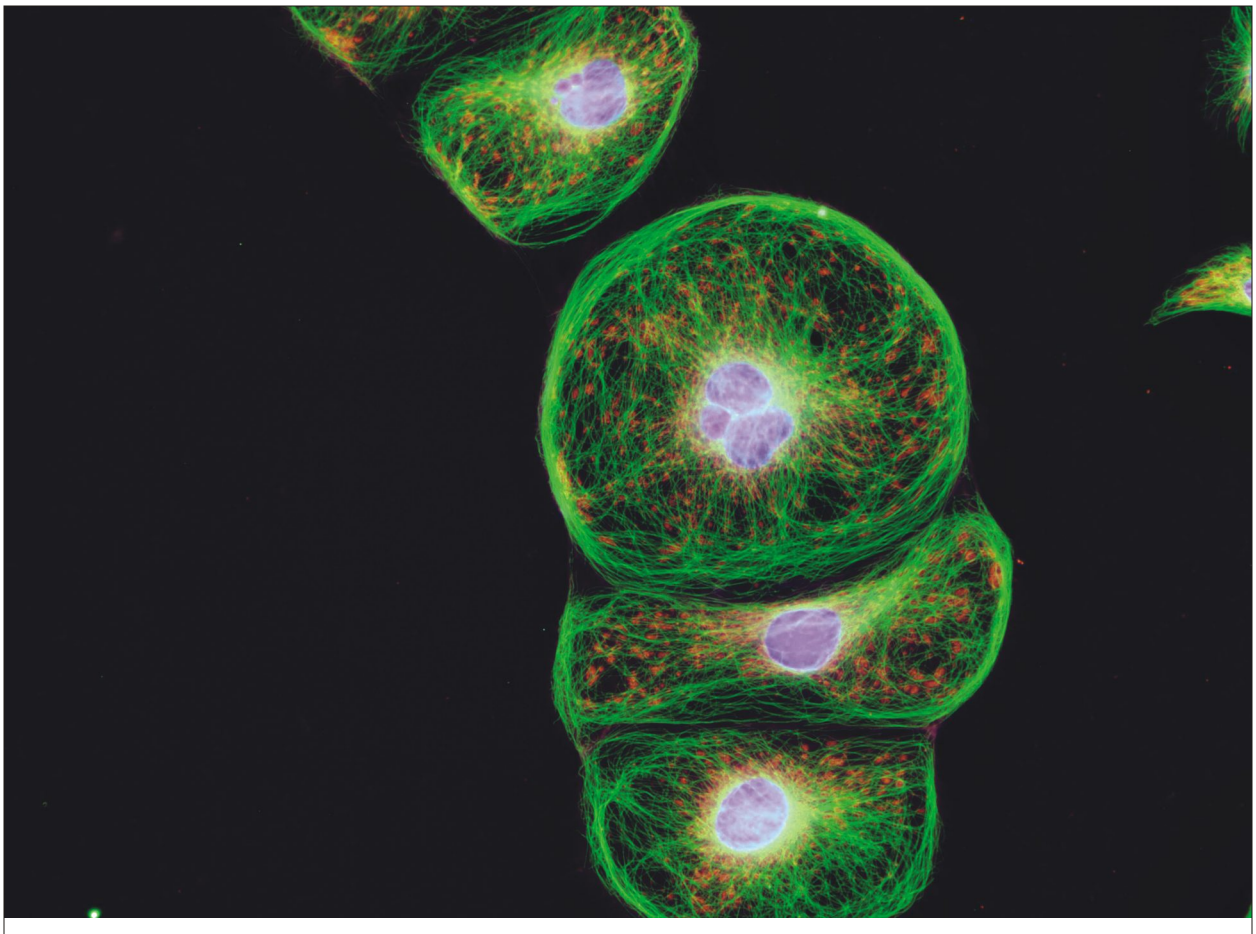

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Research Article
Histology and Ovogenesis of *Chloroscombrus chrysurus* (Carangidae, Linnaeus, 1766) on Ivorian Continental Self of Ivory Coast

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Abstract

Background and Objective: The reproduction of *Chloroscombrus chrysurus* was influenced by abiotic and biotic modifications of the environment. The research aimed to explain the stages of *Chloroscombrus chrysurus* on ovogenesis. **Materials and Methods:** In the field, captured animals are immediately conditioned with ice. The fish caught were weighed to the nearest gram and dissected. The gonads of each specimen were removed, observed and described then they were fixed by immersion in formaldehyde 10% for histological studies. **Results:** The macroscopic analysis of the gonads made it possible to establish in the female a scale of sexual maturity which comprises six stages. Considering the evolution of the ovary during the first five stages, it was done in three phases: The formation phase which corresponds to the first two stages, the growth phase which was represented by stages III and IV. The phase of ovigerous females which third phase. The oocytes from the oogonia, following the phenomena of previtellogenesis and vitellogenesis were transformed into the follicle and then the telolecithal egg. Embryonic development took place from this egg. **Conclusion:** In *Chloroscombrus chrysurus* female, the gravid stages III to V prove to be the crucial stages during which the accumulation of reserve necessary for embryonic takes place and can used be as farmed fish.

Key words: *Chloroscombrus chrysurus*, sexual maturity, oogenesis, yolk granule, follicle

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Fishing was one of the oldest activities by which man obtained fish products. Today, it has become a prosperous industry with all that it involves in terms of technological means. Following technological progress and the demand for fish which has increased in the countries, the consumption of fish has increased significantly. In Ivory Coast, despite fluctuations in supply and demand due to galloping demographics and the economic context, fishing and aquaculture remain a major source of food and financial income for the populations. According to the work of Chan *et al.*[1], fish flesh was composed of 17 to 20% proteins, mineral salts, trace elements and vitamins. Among the marine species exploited were the species *Chloroscombrus chrysurus* belonging to the Carangidae Family. This species, highly prized by consumers, occupied a significant place in the landings of specimens sold on the local market. These specimens are very important for the population. However, very little data exists on its reproductive biology and ecology either in the Ivory Coast or in the rest of the world. The literature only mentions the work on the Ivorian continental shelf[2] and those of the authors Amponsah *et al.*[3] and de Queiroz *et al.*[4], respectively who carried out research in Beninese waters and Brazilian waters. The high demand for this target species on the markets by the population induces intensive fishing which could lead to its extinction in the medium or long term. Generally speaking, according to Elhassan *et al.*[5], for better sustainable rational management of fisheries resources, it was necessary to have reliable knowledge on the reproduction parameters and the progress of the gametogenesis of species. Several studies exist on the biological parameters of reproduction. These parameters were studied in fish, *Heterotis niloticus,* in *Elagatis bipinnulata*, in *Galeoides decadactylus*, respectively by Irène *et al.*[6], Assan *et al.*[7] and Konan *et al.*[8]. Despite the strong literature on reproductive biology, very little work concerned fish oogenesis. However, to overcome this state of affairs, control of the biological parameters of reproduction coupled with oogenesis was essential to consider subsequent fish farming in order to compensate for the possible deficit on the local market. The present work relating to ovogenesis relates respectively to some indications relating to the differentiation and histology of the ovary during sexual maturity. The objective of the present work was to make known the stages of the telolecithal egg formation process in *Chloroscombrus chrysurus* for the optimization of fertilization and production.

MATERIALS AND METHODS

Materials

Study area: The biological material used for the work is the specimen *Chloroscombrus chrysurus* in Fig. 1. *Chloroscombrus chrysurus* was collected monthly from commercial fishing at the level Abidjan fishing port in coastal waters of the continental shelf of Ivory Coast. Specimens (n = 1563) were caught between January, 2018 and December, 2018. Each fish has been described in preceding works Smith-Vaniz and Carpenter[9]. The Ivory Coast has a continental shelf with an area of 11000 km^2 with a maritime frontage of 550 km. The study area, the Ivorian continental shelf (Ivory Coast) extends between Assinie in the East and Tabou in the West, in Fig. 2.

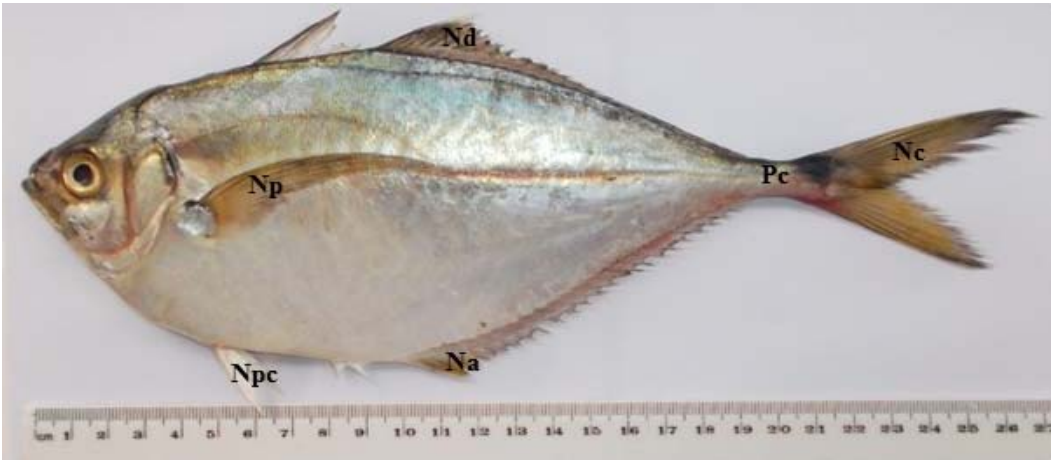

Fig. 1: Appearance of a specimen *Chloroscombrus chrysurus*
Na: Anal fin, Nc: Caudal fin, Nd: Dorsal fin, Np: Pelvic fin, Npc: Pectoral fin and Pc: Caudal peduncle

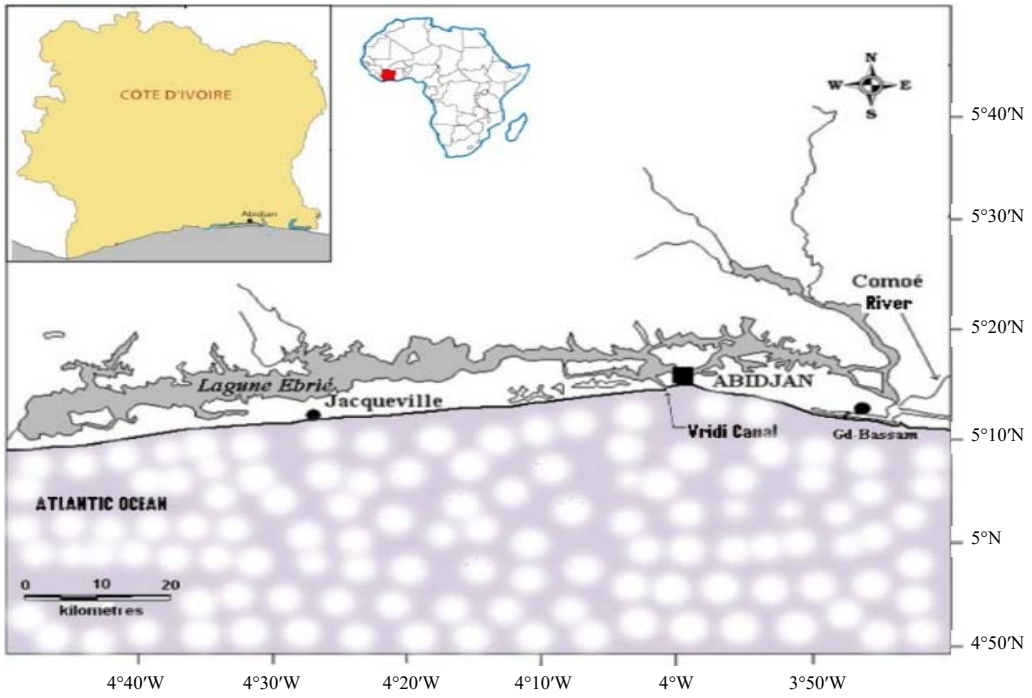

Fig. 2: Map of fishing study area

Methods

Fish processing: In the ground, immediately the specimens are packaged in a cooler under ice in order to avoid alteration of the ovaries. All the manipulations were done in a very short time in order to avoid the ovaries putrefaction which tends to liquefy quickly.

The ovaries were examined and photographed using a digital camera (Olympus SZ-20). The ovaries are observed, then they are fixed by immersion in 10% formalin for histological studies.

Histological technique: The preparation of histological processing was carried out by adopting standard histological techniques. Additionally, the ovaries isolated from the same specimen were immersed in 10% formalin fixative for two weeks and used for histological processing. The gonads were gradually dehydrated in increasing ethanol baths (70, 90 and 100°C) and then pre-impregnation in toluene. The actual impregnation, as well as the inclusion, were carried out in liquid paraffin, Parafina Para Histologia whose melting point is 58-60°C. Sections of at approximately 7 µm width with a microtome, Microm HM 310. The sections have been collodioned in order to avoid their detachment. The preparations of slides were treated and stained with hematoxylin and orange G. The slides were finally mounted using Eukitt and observed under a binocular light microscope (Olympus CKX 41) at various magnifications and photographed.

Determining the stages of oogenesis: Aspects of the study of oogenesis are based on the description of the different phases of the microscopic evolution of gonads. The stages of oogenesis are based the following microscopic criteria: Size of the oocytes, homogeneity or heterogeneity of the cytoplasm and presence or absence of yolk granules served as a basis for the presence of the study Assan *et al.*[7]. The measurement of different female sexual cells was made using video micrometer software incorporated into photomicroscope, Olympus CKX 41.

RESULTS

Internal anatomy of the ovaries of *Chloroscombrus chrysurus*: The reproductive organ of a female of *Chloroscombrus chrysurus* is lodged in the posterior part of the visceral cavity of fish. Almost, indistinct, two ovarian lobes are attached to each other forming a single mass. In the same female, two adjoining ovarian lobes may be of different sizes, but they are generally at the same stage of development as we have seen during the dissections. The compactovaryis slightly spread out on the ventral side of the fish. It is

surrounded by a thin gonadal wall which hints at numerous yolk-filled oocytes. A little above the anus, they unite to give a short and wide oviduct that ends at the level of urogenital orifice. The entire ovary changes from translucent pink to orange -yellow in colour, vary in appearance and size during the sexual maturity scale.

Macroscopic and microscopic characteristics of the ovaries of *Chloroscombrus chrysurus*: According to the macroscopic study, six stages of scale sexual maturity were identified in females of *Chloroscombrus chrysurus* and served as a basis for microscopic study. The different macroscopic and microscopic transformations of ovaries were described and represented by the figures corresponding to different stages of the scale sexual maturity. Microscopic observation of ovaries at the different phases of sexual maturation made it possible to observe evolution of the sexual cells according to the stage of oogenesis. Oocyte evolution is distinguished by pre-vitellogenic followed by vitellogenic with reference to the size of oocytes, the homogeneity of their structure, quantity and distribution of cytoplasmic inclusions.

Immature (stage I): Ovary measured 15 to 20 mm (23±9 mm) and weighed up to about 0.3 to 0.5 g (0.45±0.09 g) in specimens of 194 to 212 mm FL (204±13 mm FL). The ovaries were elongated, almost transparent and recognizable to their shape in conical. They have no blood vessels or oocytes visible by transparency on the surface of the ovarian wall in Fig. 3a. Histological observation indicated that in the immature phase, the ovary is surrounded by conjunctive envelope. It is made up

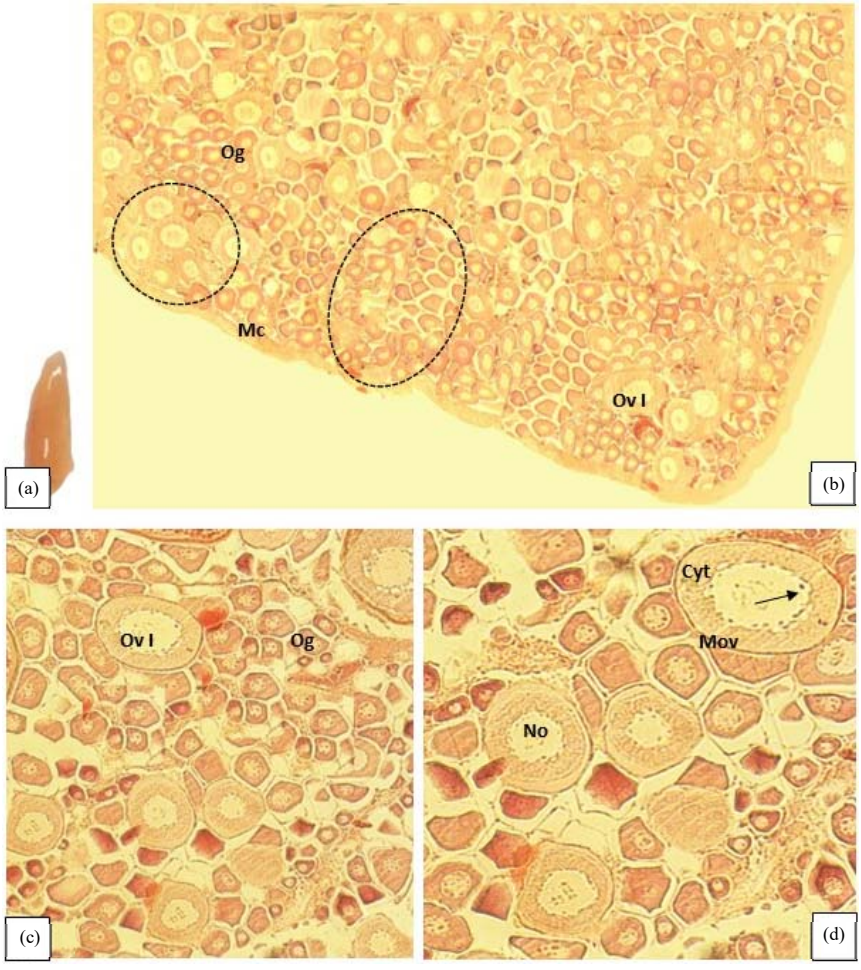

Fig. 3(a-d): Macroscopic and micrographs showing details of the ovary in *Chloroscombrus chrysurus* of the sexual maturity scale (a) Macroscopic appearance of the overy of stage I, (b) Overview of a portion of showing oogonia and oocytes I and (c-d) Details of oogonia and oocytes highlighting the basic structure of cell

Cyt: Cytoplasm, Mnu: Nuclear membrane, Mov: Oocyte membrane, No: Nucleus, Nu: Nucleolus, Og: Oogonia, Ov I: Oocyte I, Coloring: Hematoxylin and orange G, Magnification: B×100, C and D×400

of cells grouped according to their size and age class. Immature stage was also characterized by a large amount of oogonia and oocyte. These different cell groups are randomly arranged in the ovary in Fig. 3b. The oogonia variable size, was represented by small cells whose diameter was between 8 µm to 15 µm (13±1.7 µm). The stage was characterized by small and spherical cells (oogonia) consisting of a thin cytoplasm membrane surrounding homogeneous cytoplasm in Fig. 3c. Cytoplasm contains a rounded nucleus bounded by nuclear envelope. The nucleus size was between 4 to 9 µm (6±1.2 µm). The nucleus occupies a central position contains eight to twelve nucleoli arranged against nuclear envelope. As a result of the growth of their cytoplasm, oogonia were transformed into primary oocytes of a spherical shape whose thin cytoplasm around the nucleus is conspicuous. The diameter of the oocyte was understood between 30 to 50 µm (45±1.1 µm). Nucleus of the oocyte has a diameter of between 7 to 15 µm (12±1.4 µm) was equipped with approximately twelve to sixteen nucleoli arranged against the nuclear envelope. The immature stage I, follicular cells are not visible in Fig. 3d.

Onset of maturation or early maturing stage (stage II): Ovary measured 2.4 to 3.5 cm (3.3±0.24 cm) and weighed up to about 0.50±0.07 and 1.8±0.15 g in specimens of 200 to 220 mm FL (209±8 mm FL). At the onset of maturation, ovaries increased in size and were orange yellow in colour in Fig. 4a. It was lacking vascularization and no oocyte was visible to the naked eye when looking through the ovarian membrane. Macroscopically observation the onset of

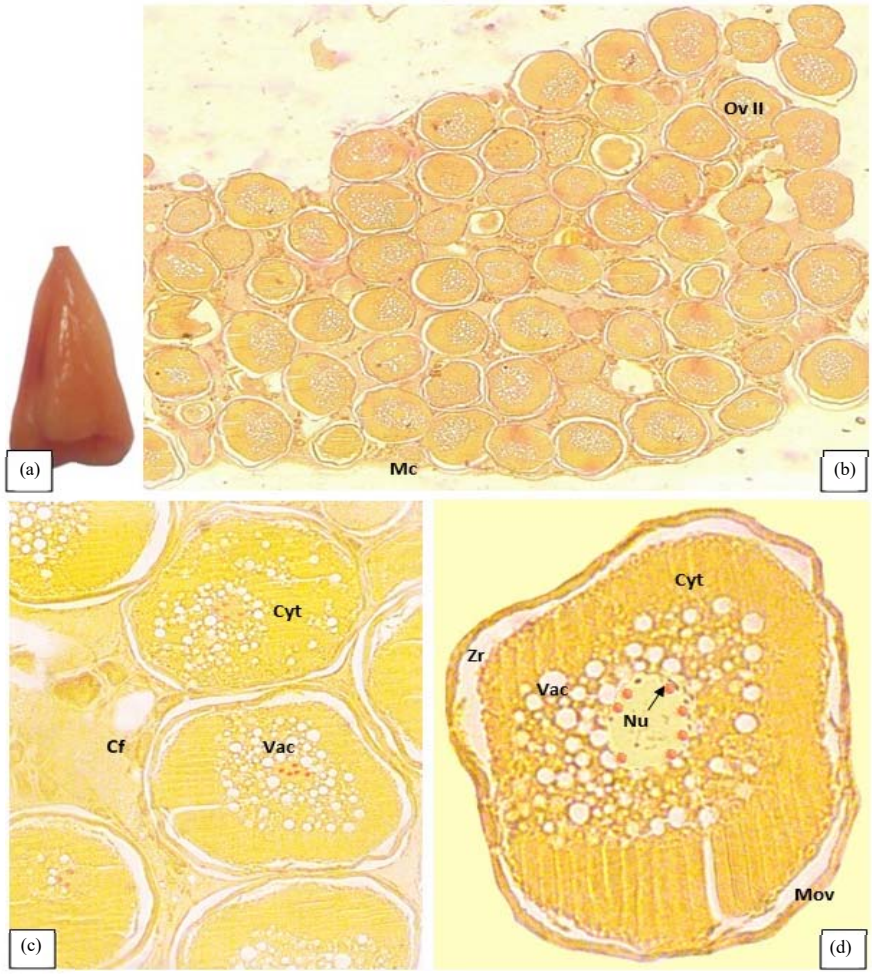

Fig. 4(a-d): Macroscopic and microscopic appearance of the ovary in *Chloroscombrus chrysurus* at stage II of the sexual maturity scale, (a) Macroscopic appearance of the overy at stage II, (b) Overview of a portion of overy showing an oocytes bundle in previtellogenesis and (c-d) Detailed view of oocytes in previtellogenesis highlighting its structure

Cf: Follicle cell, Cyt: Cytoplasm, Mov: Oocyte membrane, Nu: Nucleus, Nup: Nucleoplasm, Ov II: Young follicle pf previtellogenesis, Vac: Vacuole, Zr: *Zona radiata*, Coloring: Hematoxylin and orange G, Magnification: B×40, C×100 and D×400

maturation (stage II), ovary delimited by the conjunctive tissue was characterized by presence of homogeneous range of oocyte of variable size. The structure of oocyte remains unchanged in Fig. 4b. This stage also features by vacuolization (i.e. appearance of vacuoles). Mostly spherical oocyte, presents heterogeneous cytoplasm characterized by the appearance of the vacuoles. The arrangement of vacuoles in the cell was done according to centrifugal gradient according to the size. These vacuoles were at first few in number, small in size and occupied the cytoplasm in Fig. 4c. Thus, the smaller vacuoles were occupied at the periphery of nucleus and the larger ones were distant from the nucleus. The presence of vacuoles was a precursor sign of vitellogenesis, namely the synthesis of yolk vesicle. This is the start of phenomenon of cytoplasmic vacuolization which takes place centrifugally. Oocyte at this stage can be referred to as a young previtellogenic follicle. The follicle continues its cytoplasmic growth to reach diameter between 35 to 60 µm (45±1.9 µm). Structurally, the young follicle was made up from outside inwards: The *Zona radiata*, an oocyte membrane and heterogeneous cytoplasm. The nucleus had five to ten nucleoli arranged against nuclear envelope in (Fig. 4d).

Maturation stage III or ripening stage: The conical ovary was at an average height between 3±0.29 and 4.5±0.33 cm with a base of about 2.3±0.5 cm. As for its mass, it varied from 1.5±0.2 to 2.8±0.31 g in specimens of 213 to 230 mm LF (224±13 mm LF). Stage III corresponds to pubescent stage in the female. At the maturing stage (III), the ovaries were orange yellow in colour, with bloody vessels on their surface that are conspicuous in Fig. 5a. The vascularization was very characteristic, since it presents main bloody vessels which undergo several ramifications. These were oogonia which have the same structure as the preceding stage and follicles in

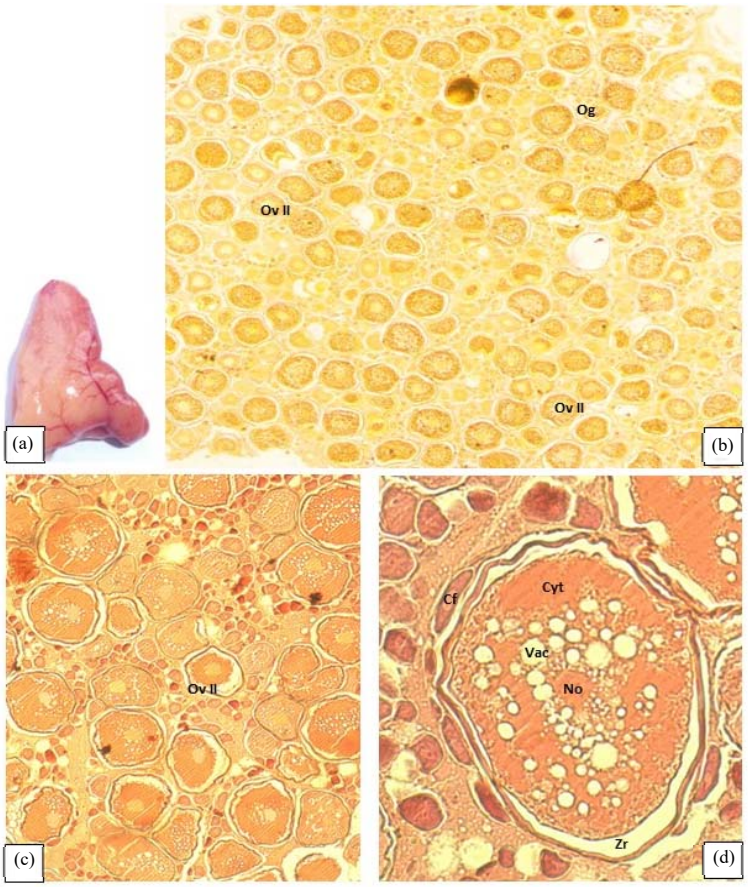

Fig. 5(a-d): Macroscopic and microscopic appearance of the ovary in *Chloroscombrus chrysurus* at stage III of the sexual maturity scale, (a) Macroscopic appearance of the overy (b) Overview of a portion of overy showing an oocytes bundle in previtellogenesis, (c) Detailed view of portion of overy at stage III and (d) Detailed view of a follicle in previtellogenesis

Cf: Follicle cell, Cyt: Cytoplasm, No: Nucleus, Og: Oogonia, Ov II: Young previtellogenesis follicle, Vac: Vacuole, Zr: Zona radiata, Coloring: Hematoxylin and orange G, Magnification: B×40, C×100 and D×400

Fig. 5b. In the maturing stage, follicles were characterized by invasion of the cytoplasm of vacuoles. The phenomenon of vacuolization was accentuated and continued in follicles.

Histological observation indicated that in maturation stage III, oocytes were distinguishable with the naked eye when looking through the ovarian membrane in Fig. 5c. At this stage, ovary was bounded by conjunctive tissue. It contains cells at different stages of sexual development. We note the follicles increased in diameter and reached size between 65 to 110 µm (90±1.5 µm). Each follicle was consisted from outside to inside of follicular cell layer, *Zona radiata,* oocyte membrane, heterogeneous cytoplasm containing vacuoles increased in variable size and centrally positioned nucleus. The follicular cells form oval or round were arranged in a single layer against the periphery membrane. They consist of a thin plasma membrane, the cytoplasm stretched and an oval central nucleus in Fig. 5d. These follicles were still considered pre vitellogenic follicles.

Pre-spawning (stage IV): Ovary measured 4±0.51 to 5.5±0.60 cm and weighed up to about 4.5±0.25 and 6.7±0.34 g in specimens of 225 to 245 mm FL (235±9 mm FL). Ovary remained very firm, turgid and was orange red in color. Ovary had a grainy appearance. At this stage, oocytes or eggs were distinguishable with the naked eye when looking through the ovarian membrane. The blood vessels were surface of the ovarian membrane more conspicuous in Fig. 6a. The oocytes remain agglutinated in packets after rupture of the ovarian membrane and can be expelled under the slightest pressing from the fingers. Histology at the pre-

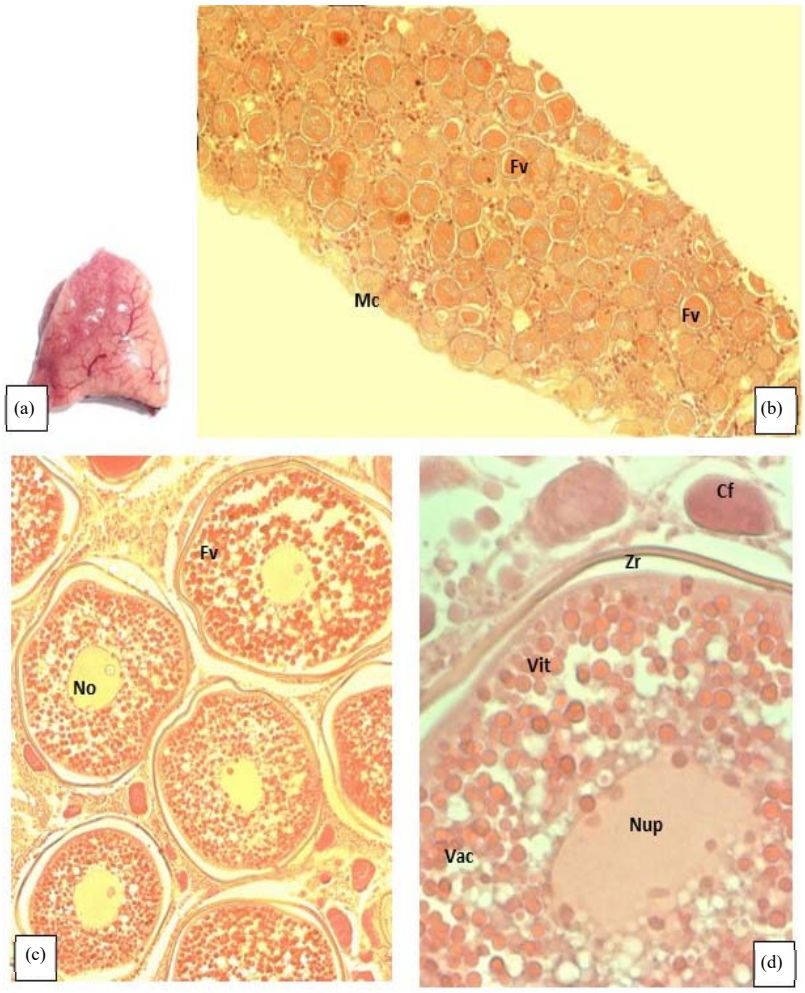

Fig. 6(a-d): Macroscopic and microscopic appearance of the ovary in *Chloroscombrus chrysurus* at stage IV of the sexual maturity scale, (a) Macroscopic aspect of the overy of stage IV, (b) Overview of a portion of overy showing follicles at vitellogenesis and (c-d) Overview of portion of overy showing follicles at the start of vitellogenesis

Cf: Follicle cell, Fv: Follicle at the start vitellogenesis, No: Nucleus, Nup: Nucleoplasm, Vac: Vacuole, Vit: Granule of yolk, Zr: *Zona radiata*, Coloring: Hematoxylin and orange G, Magnification: B×40, C×100 and D×400

spawning stage (IV), the ovary was mainly composed young vacuolar follicles which enter into vitellogenesis. The vacuoles increased in size and intermixed with the yolk granules that scattered within the cytoplasm. This stage was characterized by the progressive invasion of yolk granules into the heterogeneous cytoplasm of the follicles. These were progressive destruction of nuclear membrane of the vitellogenic follicle in Fig. 6b. This phenomenon results in the fusion of the mixture of nucleoplasmic and cytoplasmic contents. During vitellogenesis, the synthesis and appearance of granules of yolk of different size color take place in these follicles in Fig. 6b. Observation of the yolk granules makes it possible were distinguishable two types of yolk according to the coloration, namely brown yolk and light in colour of yolk granules. These follicles were considered to be the start of vitellogenesis. In the follicles, the phenomenon of cytoplasmic vascularization was accentuated by the appearance of large vacuoles resulting from the coalescence of small vacuoles. These follicles, similar in structure to those of the previous stage, had increased in diameter and reached a maximum size 160 µm (mean size) in Fig. 6c. These follicles at the start of vitellogenesis were made up from outside towards the inside of follicular cells, of the *Zona radiata*, of the oocyte membrane, of the vacuolar cytoplasm containing the numerous yolk granules. There were fewer than ten nucleoli pressed against the existing nuclear membrane fragment in Fig. 6d.

Spawning stage or gravid female (stage V): The ovary was disproportionate four-sided polygon. The posterior part directed towards the urogenital orifice was long about 5.5±0.62 cm. The average length of the anterior part of the ovary does not exceed 7±0.70 cm. Ovary weighed up to about 6.0±0.24 to 8.5±0.33 g in specimens of 240 to 263 mm FL (245±7 mm FL). At this stage, the ovaries were reddish yellow or orange-yellow in colour. We witness an increase in the volume of the ovaries which occupied almost the entire general cavity. Large and very turgid, the ovary vas delimited by a very thin ovarian membrane. This ovary contains oocytes which are perfectly visible and can be expelled at the slightest abdominal pressure as if it were egg laying in Fig. 7a. At the

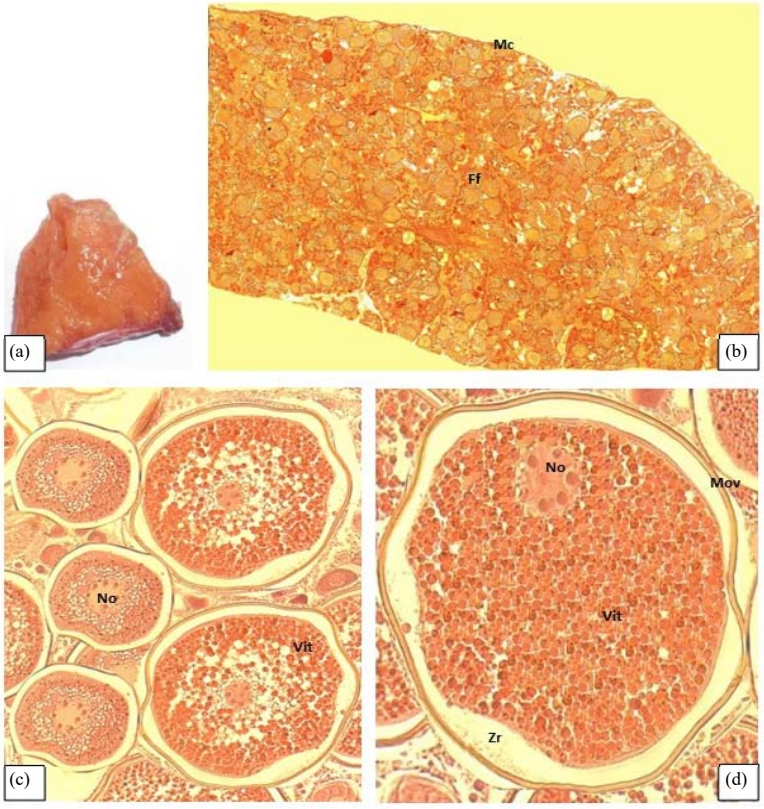

Fig. 7(a-d): Macroscopic and microscopic appearance of the ovary in *Chloroscombrus chrysurus* at stage V of the sexual maturity scale, (a) Macroscopic aspect of the overy of stage V, (b) Overview of a portion of overy showing follicles at end of vitellogenesis and (c-d) Detailed view of the follicles at the end of vitellogenesis

Ef: Follicle at end of vitellogenesis, Mov: Oocyte membrane, Vac: Vacuole, Vit: Granule of yolk, Zr: Zona radiata, No: Nucleus, Coloring: Hematoxylin and orange G, Magnification: B×40, C×100 and D×400

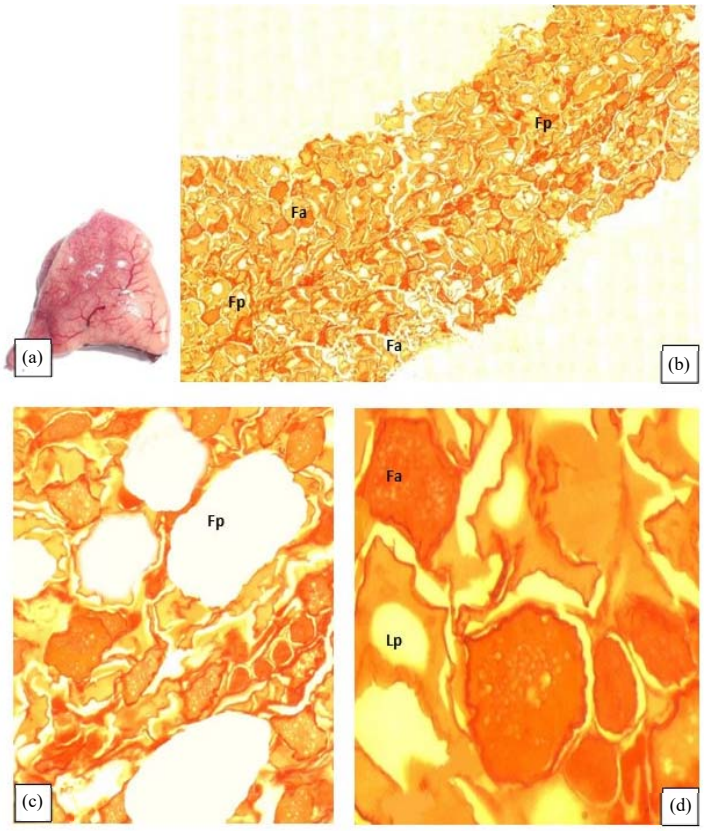

Fig. 8(a-d): Macroscopic and microscopic appearance of the ovary in *Chloroscombrus chrysurus* at stage VI of the sexual maturity scale, (a) Macroscopic aspect of the overy at stage V, (b-d) Detailed view of the follicles at the end of vitellogenesis
Fa: Atretic follicle Fp: Post ovulatory follicle, Lp: Post ovulatory lacuna, Coloring: Hematoxylin and orange G, Magnification: B×40, C×100 and D×400

microscopic level, ovary surrounded by connective tissue reveals the presence of a set of follicles at the end of vitellogenesis in Fig. 7b. The follicles increased in diameter and reached maximum size, 200 µm (mean size). Vitellogenesis continues in the cytoplasm of the follicles by accentuation and fusion of the yolk granules in Fig. 7c. The vascularization continues with the coalescence of vacuoles in the cytoplasm. The spawning period corresponded to the yolk deposition and maturation stage. The yolk granules were peri-membrane while the vacuoles were peri-nuclear. These phenomena resulted in cytoplasmic heterogeneity of all the follicles. It was deduced from these observations that the particularity of this stage is the widening of *Zona radiata*, the increase in the number of yolk granules and vacuoles in the zones mentioned above in Fig. 7d. These follicles at the start of vitellogenesis were made up from outside towards the inside of follicular cells, of the *Zona granulosa,* of the *Zona radiata* and mature oocyte or mature egg. The mature oocyte was made up of an oocyte membrane, heterogeneous cytoplasm containing peri-membrane yolk granules and peri-nuclear vacuoles, the nucleus in Fig. 7d. The mature oocyte or eggs mature representing the telolecithal egg of the fish was expelled during spawning.

Post spawning (stage VI): The stage VI corresponded to the post-spawning stage. At this stage, ovary measured 3±0.28 to 5±0.35 cm and weighed up to about 2.7 to 3.5 g (3.2±0.20 g) in specimens of 224 to 263 mm FL (234±11 mm FL). At the post spawning, the ovary was less voluminous, very flaccid, blood red in color and very vascularized in Fig. 8a. At the microscopic level, the ovary was delimited by a conjunctive envelope in Fig. 8b. The post-spawning was characterized chiefly by the presence of empty follicles and atretic oocytes. Just before ovulation, the follicle will rupture, releasing the ripe egg. After ovulation, the follicle expels the telolecithal egg materialized by a large central gap in the follicle, forming the post-ovulatory follicle in Fig. 8c and d.

DISCUSSION

Macroscopic appearance of the ovaries: Macroscopically, the ovary of *Chloroscombrus chrysurus* was directly connected

to urogenital orifice. It presented shape, color, size, vascularization and granulation which varied according to the stages of sexual maturity. The ovary is presented as single mass. It was conical in shape in juvenile and parallelepipedic in adult. In *Chloroscombrus chrysurus* was that the ovary would consist of two lobes and that one of the two ovarian lobes would have degenerated or that two lobes would have completely fused to give the single ovarian structure. The present results differ from those obtained in certain works. In certain fish, the ovaries, numbering two lobes, were in the elongated from and unite in the posterior part to form an oviduct of the variable size as mentioned by Marcelle *et al.*[10] and Bahou *et al.*[11], respectively at in *Pomadasys jubelini* and *Auxis thazard.* Generally, color was the distinguishing feature of sexual maturity status and gonad dimorphism. *Chloroscombrus chrysurus*, the color of the ovary changed from orange-yellow in juvenile to reddish-yellow in adult. This coloring was explained by the presence of yolk contained in the follicles because yolk has an orange-yellow color. The variation in color of the ovary is explained by the migration of the carotenoid pigments contained in the muscles towards the ovaries during their maturation[9]. In *Chloroscombrus chrysurus*, the size of the ovaries increased during the first five stages of maturity, then regressed at stage VI. This variation in the size of ovaries was explained by the cytoplasm increase and proliferation of the oogonia. These observations were similar to those made in the majority of fish. Djadji *et al.*[12] had demonstrated that the ovaries gradually increased in size according to the scale of sexual maturity and reached a larger size at stage V, then dropped at post- spawning stage. During sexual maturity, the contents of the ovary become more and more compact, leading to the great firmness and appearance of oocytes through the ovarian membrane. At post-spawning stage, the loss of firmness of the ovary was explained by the expulsion of the oocytes into the natural environment in fish[11].

Histology of the ovary of *Chloroscombrus chrysurus*: The histological structure of the ovary at the different stages of the sexual maturity scale indicated that the ovary was delimited by a conjunctiva envelope which enveloped all the sex cells. At stage I or Immature, the oogonia and oocytes were randomly grouped according to their size and age class. At the onset of maturation, the ovary was characterized by the presence of cytoplasmic inclusion in the oocytes resulting in oocytes of variable size. This cellular variation was related to age and the presence of cytoplasmic inclusion. The younger ones don't contain vacuoles while stage III ovaries were characterized by the presence of young previtellogenic follicles containing vacuolar cytoplasm. The pre-spawning stage and spawning stage showed vitellogenic follicles containing vacuoles and yolk granules. At stage VI, was characterized by the presence of an empty follicles. Djadji *et al.*[12] and Naminata *et al.*[13] demonstrated the presence of all the same sex cells. Of *Chloroscombrus chrysurus,* the presence of two populations of sex cells according to their size makes it possible to classify this species among the specimens with synchronous ovaries by group[13]. The set of sex cells was spherical in shape as described in Teleostean fishes[13]. Sex cells were structurally composed of the oocyte membrane, cytoplasm and the nucleus containing several fish-like nucleoli as seen in the Cichlidae, *Thysochromis ansorgii*[14]. During oocyte maturation, the follicles of *Chloroscombrus chrysurus,* were surrounded by a layer of follicular cells. This peculiarity had also been observed in Scombridae, *Euthynnus alletteratus*[11]. According to D'almeida *et al.*[15] follicular cells have a nourishing function.

Oogenesis: *Chloroscombrus chrysurus,* the anlage of the ovary included cohorts of oogonia which are involved in oogenesis. The process of oogenesis in *Chloroscombrus chrysurus,* comprises two main stages during which the oogonia is transformed successively into oocytes and follicles. The previtellogenesis phase corresponds to the first two stages of sexual maturity. As for the vitellogenesis phase, it takes place from stage III to stage V of the sexual maturity scale. The same steps had been described during oogenesis in fish by D'almeida *et al.*[15] and Tyler and Sumpter[16]. Throughout the maturation of the oocytes, the latter's cytoplasm becomes progressively heterogeneous due to the presence of vacuoles and granules of yolk. The presence of vacuoles of variable size and spherical shape was a characteristic sign of the phenomenon of previtellogenesis. This vacuolation was a characteristic phenomenon in teleost fishes as well as in Crustaceans. In fish, the phenomenon of cytoplasmic vacuolation has been observed in many species such as the Clupeidae, *Pellonula leonensis*[13] and the Scombridae, *Euthynnus alletteratus*[11]. The processes of cytoplasmic transformation of follicles observed are the continuation phenomenon of vacuolation followed by the accumulation of yolk reserves, characterized by the presence of granules yolk. These cytoplasmic transformations have been observed in fish by Bahou *et al.*[11] and Naminata *et al.*[13]. According to the work of Rinchard *et al.*[17] and Patiño and Thomas[18] the granules of yolk accumulated in the follicles constitute the first nutritional resource of the larvae and juveniles of teleost fish. The phenomenon of oogenesis was responsible for the considerable increase in the size and volume of the follicle.

Chloroscombrus chrysurus, the fertilization was external because according to the present work, the eggs were expelled into the natural environment. It results in the presence of an empty follicle characterized by a large central gap which materializes the release of egg. The same observations have been reported in other teleost fishes of[17]. In *Chloroscombrus chrysurus*, the diameter of the oogonia and oocytes goes from 8 to 45 µm average at previtellogenesis to nearly 200 µm at vitellogenesis. The increase in oocyte diameter is due to an accumulation by endocytosis of vitellogenin by the oocytes[18-20].

CONCLUSION

The macroscopic and microscopic description showed that stage V, is the capital stage in the reproductive cycle of the species. Thy study constitutes a database for the rational management of the available stock of *Chloroscombrus chrysurus.* The managers should ensure the catches take into account the size at sexual maturity (stage III to V).

SIGNIFICANCE STATEMENT

This macroscopic study coupled with the microscopic aims to shed light on the stages of the telolecithal egg formation process. Thus, knowledge of the state of the egg increases the success of fertilization in a natural or artificial environment. Ovogenesis takes place in an ovary. The oocytes resulting from the oogonia, following the phenomenon of pre-vitellogenesis and vitellogenesis, transform into follicles then into a telolecithal egg ready for fertilization. In the female of *Chloroscombrus chrysurus,* stage III to V prove to be the capital stages during which the accumulation of the necessary reserves, the yolk for embryonic development in fish, takes place.

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