

MORPHOLOGICAL ASPECTS OF THE OVARY OF *COLUMBA LIVIA* (GMELIN) (COLUMBIDAE, COLUMBIFORMES)

Maria das Graças Ribeiro¹
Maria Eloiza de Oliveira Teles¹
Sandra Maria das Graças Maruch¹

ABSTRACT. The study of the female genital system of *Columba livia* (Gmelin, 1789) is part of the research on the reproductive biology of Brazilian birds. This work describes the morphological aspects of the ovary of *Columba livia*, as well as the histological differences observed in the ovarian follicles during the ovocyte maturation process. Ten *Columba livia* females were studied, whose ovaries had been dissected, fixed in Bouin and Helly solutions, and histologically processed for staining (Hematoxylin-Eosin; Gomori's trichromic and Weigert's technique and Gomori's technique for connective tissue fibers). The ovary has an irregular surface, is located in the abdominal cavity, and relates to the cranial portion of the left kidney and caudal extremity of the left lung. Histological examination shows that the ovary is covered with simple cubical epithelium, underlined by loose connective tissue that continues internally, surrounding the follicles. The ovarian follicles were described, in their different stages of development, with basis on the morphological changes occurring in the ovocyte and in the layers that surround it, in each phase of maturation. Among the follicles, groups of cells of two distinct types, surrounded by connective tissue, are observable: clear cells with a spherical nucleus, and acidophilic cells with a slightly elongated nucleus. The studies of the ovary of *Columba livia* reveal histological similarities between this species and *Columbina talpacoti* (Temminck, 1811), whose ovaries were examined by RIBEIRO *et al.* (1991).

KEY WORDS. Columbidae, birds, genital apparatus, ovary

From ample distribution in planet, originating in the tropical region of the old world, had being immigrated to the Americas, the Columbidae are an example of successful adaptation in Brazil (SICK 1984).

Studying the order Columbiformes is important in many aspects. For instance, in regard to ecological aspects, as the Columbiformes present a large ability to adjust to different habitats, as woody savana, meadows, cultivated areas and even to big cities; in regard to economical aspects, since many species are used as a nourishment source; in regard to epidemiological aspects, as they can lodge parasites and transmit diseases as toxoplasmosis, salmonellosis, besides ornithosis (BUENO *et al.* 1962); in regard to ontogenetic aspects, through the enlightenment of different morphofunctional patterns that appear in birds; in regard to phylogenetic aspects, since they provide data that enable the establishment of

1) Laboratório de Histologia Animal, Departamento de Morfologia, Universidade Federal de Minas Gerais, Caixa Postal 2486, 31270-190 Belo Horizonte, Minas Gerais, Brasil.

links among different groups of vertebrates, elucidating some evolutive aspects.

BUENO *et al.* (1962), HOFFMANN & VOLKER (1969), VANTYNE & BERGER (1976), GILBERT (1979), GHETIE (1981), SICK (1984), among others, described the external morphology, systematics and even the behaviour of some Columbiformes. Nevertheless, almost nothing is known on their internal morphology, reproductive biology, population control and not even about the consequences of the parasitosis that strike some Columbiformes species on human health, as well as the effects of indiscriminate use of contraceptive substances in the control of population of those birds. *Columba livia* (Gmelin, 1789) pertains to order Columbiformes and is a species widespread in Brazil, Bolivia, Chile, Peru and other South American countries. As the study of the reproductive biology of this species is performed, one intend to provide data that may contribute to the elucidation of its reproductive cycle, as well as to propose new alternatives to the control of its population according to parameters that are more concerned to ecology and that present less drastic consequences.

The study of the ovarian morphology of *Columba livia* and the description of the ovarian follicles represent the first step in the path towards the determination of the different stages of follicular and gonadal maturation, period and type of laying of the "rock dove" and of other species of Columbiformes.

MATERIAL AND METHODS

To perform this study, 10 females of the dove *Columba livia* was used caught in Belo Horizonte and neighborhood, in the period from september/1990 up to march/1991. The animals were sacrificed through ether inhalation and were submitted to a ventral, median and longitudinal incision to enable studies on the genital apparatus and a later dissection of the ovary. Ovary fragments were fixed in Bouin solution (LILLIE & FULMER 1976) and Helly solution modified (HOCHEREAU 1963), included in paraffin and processed according to routine histologic techniques (H.E. staining and Gomori's trichromic). To evidenciate elastic fibers, the Weigert technique was used (modified by NOGUEIRA & RIBEIRO 1980) and the Gomori's technique (GOMORI 1952) to demonstrate reticular fibers. The results were analyzed, described and photographed using a photomicroscope Olympus.

RESULTS

The female genital system of the *Columba livia* pigeon is composed of a left ovary and oviduct, with their right counterparts remaining atrophied. The ovary is located in the abdominal cavity and relates to the cranial portion of the lung, as well as with the dorsal portion of the kidney and adrenal gland. The irregular surface of the active ovary corresponds to the mature ovarian follicles, which project beyond the organ's surface. The oviduct is an elongated tube with anatomically and histologically distinct regions that open up into the cropodaeum, the innermost division of the cloaca.

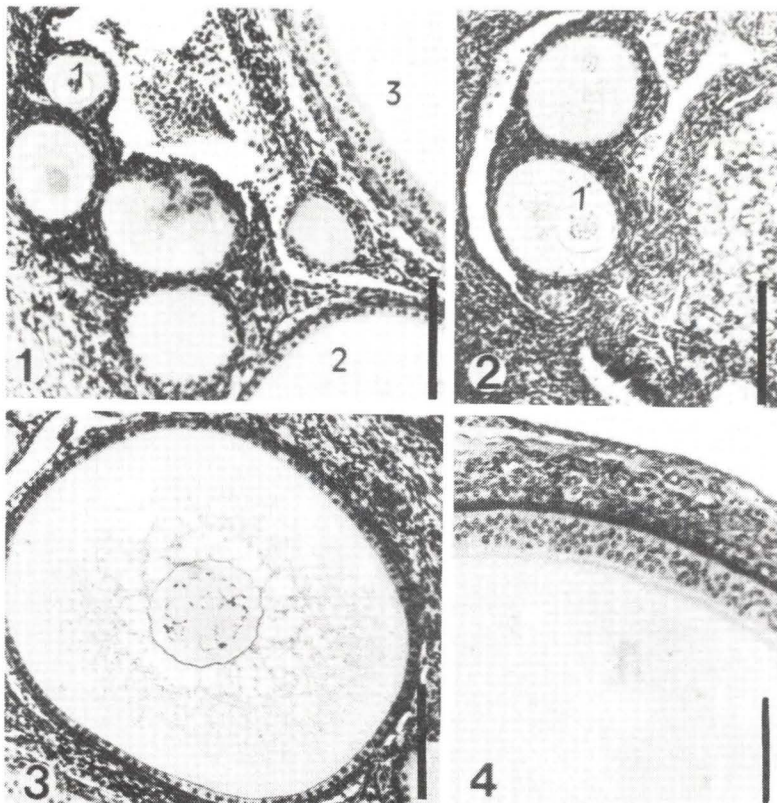
Regarding to the histology, the ovary is covered by a superficial epithelium that is classified as cubical simple epithelial tissue, sustained by connective tissue poor in cells, rich in collagen fibers and scarce in elastic and reticular fibers. That layer of connective tissue forms the tunica albuginea. Internally, the ovary is composed of loose connective tissue, rich in blood vessels, presenting fine collagen fibers, abundant reticular fibers (Fig. 6) and scarce elastic fibers in the follicle wall. Besides smooth muscular fibers and nervous fibers, one can observe, among the follicles, two cell types: clear cells with vacuolated cytoplasm, spherical nucleus, with loose chromatin and evident nucleolus and histologic aspect of a lipid secretory cell (Fig. 2) and cells presenting a more acidophilic cytoplasm, nucleus slightly elongated with a more condensed chromatin.

Before starting the gonadal maturation, one can observe two distinct regions in the ovary: the cortex, a peripheral region where the follicles are found and the medullar region, more central and made of loose connective tissue intensely vascularized and presenting nervous fibers and some smooth muscular fibers. As the gonadal maturation starts, the tunica albuginea gets slimmer and one can almost not distinguish the cortical and medullar regions.

The ovarian follicles undergo different stages of development (Figs 1-5) that are classified as primordial, primary, secondary and tertiary follicles. The primordial follicle (Fig. 2) contains a small ovocyte, showing a cytoplasm of filamentous aspect, where can be observed, near the nucleus, an acidophilic area of irregular aspect. The nucleus is spherical, vesiculous and central with an evident nucleolus. In this stage, the ovocyte is involved by a few cubical cells, that constitute the granulosa stratum. Externally, a delineation of a theca can be noticed, made of a slim layer of collagen fibers, scarce and disperse elastic fibers and abundant reticular fibers, besides fibroblasts nuclei and fibrocytes.

In the primary follicle (Fig. 3), the ovocyte shows an homogeneous cytoplasm, with fine granules and with the irregular acidophilic mass described above standing in the same way near the nucleus. The nucleus, when visible, is placed in central or in slightly eccentric position. A slim, acellular and acidophilic membrane, the perivitelline or pelucid zone, involves the ovocyte. The granulosa stratum cells are more numerous in this stage and are uniformly disposed, forming a layer of cubical cells, showing spherical and vesiculous nucleus with evident nucleolus. Although the theca is thicker in this follicle, no significant histological changes are seen when it is compared to the primordial follicle.

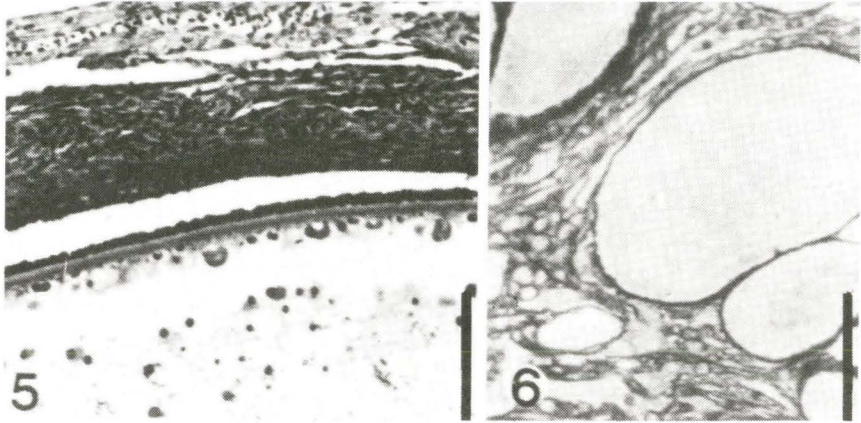
In the secondary follicle (Fig. 4), the ovocyte is more developed, with the cytoplasm showing a clearer and vacuolated central region and a peripheral and more stained region with fine granules. The nucleus reaches, in this stage, a slightly eccentric position. The perivitelline membrane, quite sharp, is very acidophilic. The numerous cubical cells of granulosa stratum are disposed in more than one layer, presenting a stratified aspect. The secondary follicle theca is made of two distinct layers: internal theca, denser and presenting parallel collagen fibers, abundant reticular fibers and scarce elastic fibers and external theca, thicker and showing collagen fibers more loosely disposed, reticular fibers and scarce elastic fibers. During this developmental stage, in the follicle can be noticed, externally



Figs 1-4. Transversal sections of *Columba livia* ovary. (1) Section evidencing a primordial follicle (1), part of a primary follicle (2) and part of a secondary follicle (3) (HE, bar=0,5 μ m); (2) primordial follicles (1) and clear cell groups (*) in the ovarian stroma (HE, bar=0,5 μ m); (3) section of a primary follicle showing cubical follicular epithelium and ovocyte with vesiculous nucleus and cytoplasm with fine granules (HE, bar=0,25 μ m); (4) section of part of a secondary follicle evidencing the follicular wall layers (HE, bar=0,12 μ m).

to the theca, a layer of loose connective tissue, that constitutes the superficial tunica and a covering of pavementous, simple epithelial tissue, the superficial epithelium.

The tertiary follicle (Fig. 5) exhibits an more volumous ovocyte presenting two cytoplasmatic regions quite distinct: a wide, clear and vacuolated central area and a peripheral, acidophilic and granular area; the nucleus reaches an eccentric position, quite displaced to one of the poles of the ovocyte. Surrounding the ovocyte, the six layers identified in the preceding follicle are noticed: perivitelline membrane is acidophilic; granulous stratum, now presenting a lesser number of cell layers; internal and external thecas are more developed; superficial tunica is intensely vascularized and the superficial epithelium presents a single layer of pavementous cells.



Figs 5-6. *Columba livia* ovary. (5) Transversal section of part of a tertiary follicle showing the layers that constitutes its wall (HE, bar=0,12 μ m); (6) Aspect of the ovary showing reticular fibers in the stroma and also surrounding the follicles (HE, bar=0,5 μ m).

Were observed in some of the ovaries studied atretic follicles and they presented the following characteristics: pleatings in the follicle wall, desorganization in the follicular layers, fragmentation of perivitelline membrane and proliferation of the cells of the granulous layer that come to occupy the central room of the follicle, in a more advanced stage of regression. One can observe, also, rests of cytoplasmic material and presence of blood cells.

Post-ovulation follicles were identified and presented morphological changes that are characteristic as the follicular volume reduction, theca desorganization, interstitial cells permanence, invasion and fulfillment of the lumen by cells of the granulous layer.

DISCUSSION

Several studies have been conducted on the biology and systematics of birds. However, little information is available in the literature concerning the morphology of the female genital system. In addition to making comparisons difficult, this reduces the possibility of a more comprehensive discussion about the reproductive biology of these animals.

Many authors, as JOHNSTON *et al.* (1963), ANDREW & HICKMAN (1974), GILBERT (1979), KING (1979), GETTY (1981), RIBEIRO *et al.* (1991), among others, describe in their studies a morphological pattern that is common to the female genital apparatus of various birds species, with variations observed among different species and among diverse stages of the reproductive cycle in the same species. The morphological aspects of *Columba livia* genital apparatus are compatible with the findings described in the literature.

According to ANDREW & HICKMAN (1974), GILBERT (1979) and other

authors, the ovary in birds is developed only on the left side, placed ventrally to the kidney (WORDEN 1956). In *Columba livia*, in the same way that in *Columbina talpacoti* (Columbidae) described by RIBEIRO *et al.* (1991), a more detailed topographic observation showed that the ovary is placed, like in other birds, in the abdominal cavity and is related cranially to the caudal extremity of the lung, ventrally to the abdominal air sac and dorsally to the kidney and adrenal gland. PROCHÁZKOVÁ & KOMÁREK (1970), studying the hen ovary; GILBERT *et al.* (1980) studying the ovary of other species of domestic birds and RIBEIRO *et al.* (1991) studying the *Columbina talpacoti* ovary observed morphological changes in the various functional stages of this organ.

Regarding to the histology, the ovary of *Columba livia* young females, in the same way that in *Columbina talpacoti* (RIBEIRO *et al.* 1991) and in other species studied (ANDREW & HICKMAN 1974; GILBERT 1979), is covered by cubical simple epithelium (superficial epithelium) and below it is found a layer of dense connective tissue (tunica albuginea). Internally, one can notice two distinct regions: cortex, a peripheral region where the follicles are found and medulla, a more central region, made of loose connective tissue, rich in blood vessels and showing also nervous fibers and smooth muscular fibers. As follicular maturation starts, the tunica albuginea gets slimmer and the cortical and medullar regions almost can not be distinguished.

PROCHÁZKOVÁ & KOMÁREK (1970) describe the ovarian follicles of the hen based on the number of cells in the follicular layer and GILBERT *et al.* (1980), on the ovocyte diameter during the ovary growing stage in domestic birds. RIBEIRO *et al.* (1991), studying *Columbina talpacoti*, describes the histologic characterization of the ovarian follicles in primordial, primary, secondary and tertiary follicles based on the set of morphological changes found during the gonadal development in this species.

The study of *Columba livia* ovarian follicles pointed out close similarities to those of *Columbina talpacoti*, also pertaining to the order Columbiformes. The comparative study between these species turns to be fundamental to the establishment of criteria to enable the characterization of both the follicular development stages and the gonadal maturation stages.

Post-ovulatory follicles and follicular atresia were observed in some ovaries. Although calling for more detailed investigation, these were not the object of our study.

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