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Histoarchitectonics of Retina of Chicken Embryos in Ontogenesis

Oksana Dmitrieva
Department of Veterinary Medicine
Velikolukskaya State Agricultural Academy
Velikiye Luki, Russia
oksana.sergeevna85@mail.ru

Anna Kozlovskaya
Department of Veterinary Medicine
Velikolukskaya State Agricultural Academy
Velikiye Luki, Russia
89118952551@yandex.ru

Nadezhda Shcherbakova
Department of Veterinary Medicine
Velikolukskaya State Agricultural Academy
Velikiye Luki, Russia
shn@vgsa.ru

Alexander Shutenkov
Department of Veterinary Medicine
Velikolukskaya State Agricultural Academy
Velikiye Luki, Russia
vet@vgsa.ru

***Abstract*—Development of industrial poultry farming allows obtaining a large number of quality products with effective payback period of feed in a short time. The growth in the poultry production has become significant and sustainable primarily due to an increase in grain production, as well as the creation of a solid forage base, which is used in poultry feeding. The main food poultry products are eggs and meat, and their production largely depends on genetically determined productivity. Fertility and viability of birds depends on changes that occur under the influence of environmental conditions. The article presents data on the histoarchitectonics of retina in chicken embryos studied on the 7th, 10th, 13th, 15th, 17th and 20th days of incubation of antenatal ontogenesis and 40th day of postnatal ontogenesis. It was established that the effect of riboflavin on the retina in the eye contributes to an increase in the number of cells per unit area, which leads to an increase in the thickness of its layers.**

Keywords—chicken embryo, retina, riboflavin, antenatal ontogenesis.

I. INTRODUCTION

Industrial poultry farming is one of the key sectors of agriculture. Poultry farming is the most important livestock industry; it provides the population with protective food products – eggs and meat, and industrial poultry provides feather and down [1].

Meat is obtained from all types of poultry. Of course, broilers, the undisputed leaders in the meat production among all birds, are the basis for the production of poultry meat. Rapid growth in artificially bred broiler chickens is ensured by enriched feeding.

Mainly, the hens are bred for the egg production. Eggs are one of the main sources of animal protein for the population [2].

There are two parallel processes in our country – on the one hand, the expansion of poultry farms and, on the other hand, an increase in the population's demand for natural eggs from organic farms and ordinary farms.

A necessary and important condition for organizing large poultry farms is egg incubation, and the incubation result depends on many factors. It requires uniform egg production, which is full-fledged for incubation. A scientifically based and proven incubation regimen has been created [3].

Color vision of birds is the ability of the eye to distinguish colors using daylight, that is, to distinguish the spectral composition of visible radiation and the color of objects. It is provided by several photoreceptors of the retina (cone cells) of various types, characterized by spectral sensitivity. This is determined by the absorption spectrum of the visual pigments.

Depending on the number of cone cell types with different absorption spectra of visual pigments, there are dichromats, trichromats (including primates and humans), and tetrachromats (birds).

The bird's retina consists of an internal sensitive membrane consisting of nerve cells, blood vessels, and cells that enable functioning of metabolic processes.

The retina of birds is similar to the structure of the retina of other vertebrates; it is also upside down and consists mainly of the same elements. Ten layers are clearly visible throughout the fiber: the pigmented layer, the photoreceptor layer, the outer glial limiting membrane, the outer nuclear layer, the outer plexiform layer, the inner nuclear layer, the inner plexiform layer, the ganglion cell layer, the nerve fiber layer and the inner glial limiting membrane [4].

Photoreceptors (rods and cones) of chicken retina have rods of one type, like the other species of diurnal birds have, but in chicken there are six types of cones.

Four types of cones are most sensitive to violet, blue, green and red, and the other two types provide tetrachromator color vision in birds [5-7].

Riboflavin has a preventive effect, enriching the tissue with oxygen and helping the conduction of a nerve impulse to the retina, thereby simplifying this process. This substance is actively involved in the synthesis of hemoglobin and in metabolic processes that occur in the body, and thereby leads the visual function to normal state [8-10].

Eggs for incubation should have a whole, clean and smooth shell. The eggs should be oval, slightly narrowed at the sharp end and without calcium deposits, ridges and bands around the egg. The air cell must be immobile and located at the blunt end. The yolk should be central with a slight offset towards the blunt end. There should be no foreign matter in the egg (dark or reddish spots) [11].

II. METHODS

Studies were conducted in the scientific laboratory of the Velikie Luki State Agricultural Academy. The following

methods were used for the laboratory studies: morphometric, histological, anatomical and variation-statistical methods.

Hatching eggs were divided into experimental and control groups. Eggs of the experimental group were placed into a solution of riboflavin with a concentration of 0.002%.

Eggs of the control group were not subjected to pre-incubation treatment. Biological control was carried out on an ovoscope, which helped on timely removal of unfertilized eggs, eggs with blood rings and frozen embryos.

III. Results

The article presents research data on histoarchitectonics of the retina.

When examining the retina of the 7-day-old embryo (Fig. 1), 6 layers in the retina were discovered, and an additional inner layer of the retina started to appear, located between the outer layer of the retina and the layer of ganglion cells.

Our studies have found that in the 7-day-old embryo, the main visual elements in the retina are well differentiated, and differences also appear in its central and peripheral regions.

The limiting membranes and the outer nuclear layer are differentiated in the central part of the retina. Behind it, the inner nuclear layer appears, and the inner plexiform layer is more distinct, followed by layers of ganglion cells and nerve fibers. In the peripheral retina, differences are distinct between two limiting and two plexiform layers.

Eight layers of retina are distinguished at the age of 10 days (Fig. 2). The photoreceptor layer receives trophic support through the pigment epithelium from the comb. During this period of development, pigment cells are absent in the comb.

All ten layers clearly differ and are visible on the 13th day of incubation (Fig. 3). Histological sections of chicken embryos on the 15th and 17th days of development, where all layers of the retina are clearly visible, are shown in (Fig. 4, 5). The embryo's retina acquires the final structure on the 20th day (Fig. 6).

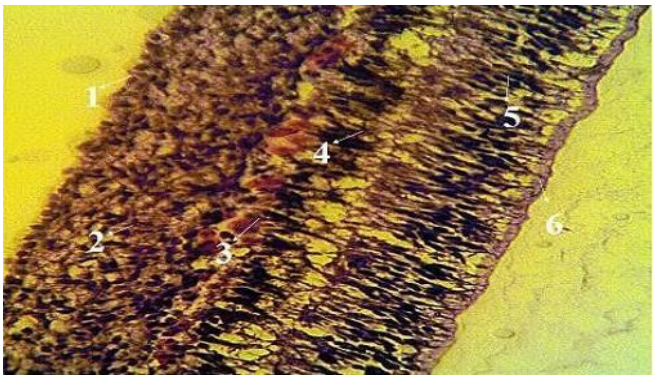

Fig. 1. Structure of the retina. Experimental group, 7th day of incubation. H&E stain. 10x. 1) the pigmented layer, 2) the photoreceptor layer, 3) the outer glial limiting membrane, 4) the outer nuclear layer, 5) the outer plexiform layer, 6) the inner nuclear layer

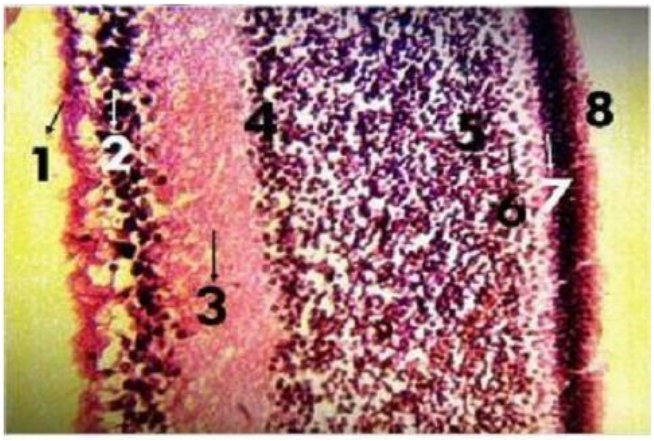

Fig. 2. Structure of the retina. Experimental group, 10th day of incubation. H&E stain. 10x. 1) the pigmented layer, 2) the photoreceptor layer, 3) the outer glial limiting membrane, 4) the outer nuclear layer, 5) the outer plexiform layer, 6) the inner nuclear layer, 7) the inner plexiform layer, 8) the ganglion cell layer

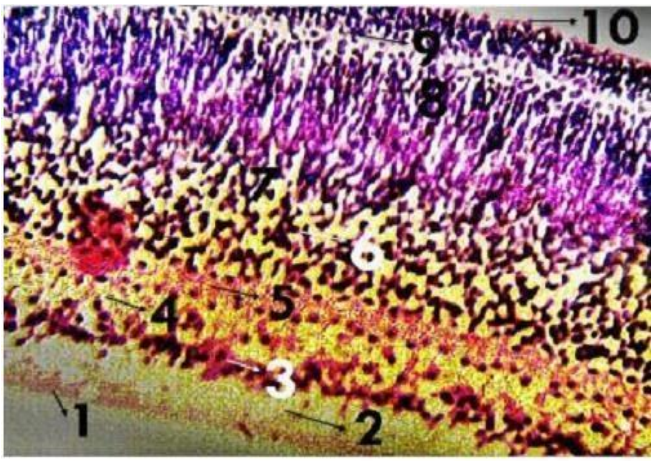

Fig. 3. Structure of the retina. Experimental group, 13th day of incubation. H&E stain. 10x. 1) the pigmented layer, 2) the photoreceptor layer, 3) the outer glial limiting membrane, 4) the outer nuclear layer, 5) the outer plexiform layer, 6) the inner nuclear layer, 7) the inner plexiform layer, 8) the ganglion cell layer; 9) the nerve fiber layer; 10) inner glial limiting membrane

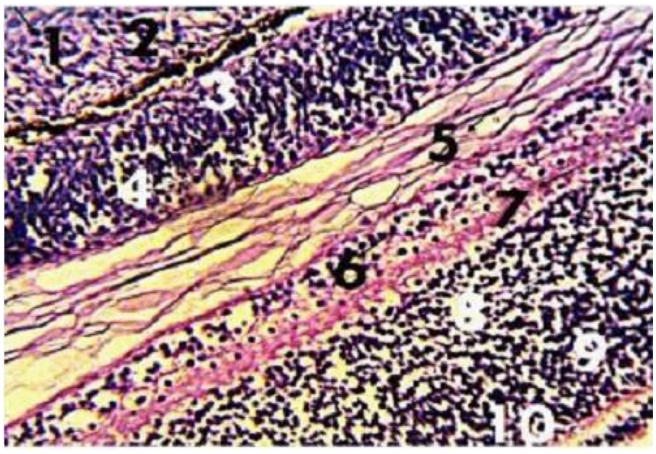

Fig. 4. Structure of the retina. Experimental group, 15th day of incubation. H&E stain. 40x. 1) the pigmented layer, 2) the photoreceptor layer, 3) the outer glial limiting membrane, 4) the outer nuclear layer, 5) the outer plexiform layer, 6) the inner nuclear layer, 7) the inner plexiform layer, 8) the ganglion cell layer; 9) the nerve fiber layer; 10) inner glial limiting membrane

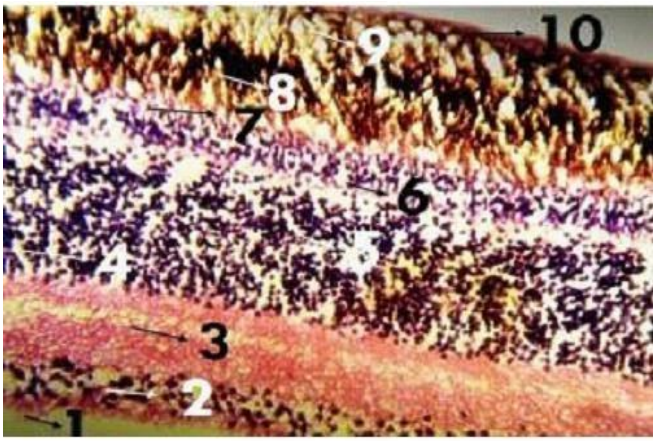

Fig. 5. Structure of the retina. Experimental group, 17th day of incubation. H&E stain. 40x. 1) the pigmented layer, 2) the photoreceptor layer, 3) the outer glial limiting membrane, 4) the outer nuclear layer, 5) the outer plexiform layer, 6) the inner nuclear layer, 7) the inner plexiform layer, 8) the ganglion cell layer; 9) the nerve fiber layer; 10) inner glial limiting membrane

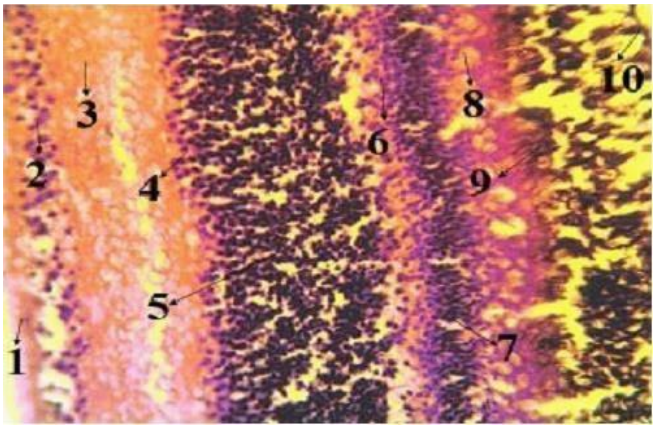

Fig. 6. Structure of the retina. Experimental group, 20th day of incubation. H&E stain. 40x. 1) the pigmented layer, 2) the photoreceptor layer, 3) the outer glial limiting membrane, 4) the outer nuclear layer, 5) the outer plexiform layer, 6) the inner nuclear layer, 7) the inner plexiform layer, 8) the ganglion cell layer; 9) the nerve fiber layer; 10) inner glial limiting membrane

The effect of riboflavin in the development of retinal layers is clearly visible in Figures 1-6.

The pigment layer of retina in birds of the experimental group exceeded the control group by the 10th day – by 35%, the 13th day – by 12.2%, the 15th day – by 8.4%, the 17th day – 9% and the 20th day – by 7%. In the experimental group, the layer thickness was statistically better than in the control group, and the significant difference was characterized by regular small differences across all three development groups – from 0.02% to 0.05%. This layer most rapidly develops from 10th to 13th day, a more moderate stage of development is observed from 13th to 17th day, and from 17th to 20th day of incubation the layer increases in the growth rate again.

We conducted a study in the retina on the 40th day of the development of postnatal ontogenesis. On this histological section, all layers of the retina are visible.

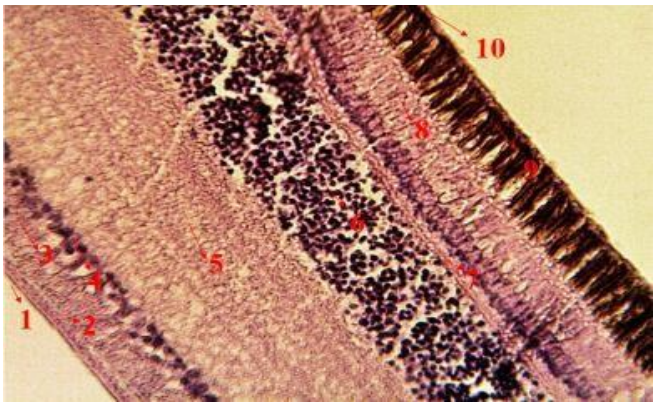

Fig. 7. Structure of the retina. Experimental group, 40th day of postnatal ontogenesis. H&E stain. 40x. 1) the pigmented layer, 2) the photoreceptor layer, 3) the outer glial limiting membrane, 4) the outer nuclear layer, 5) the outer plexiform layer, 6) the inner nuclear layer, 7) the inner plexiform layer, 8) the ganglion cell layer; 9) the nerve fiber layer; 10) inner glial limiting membrane

The histological section (Fig. 7) shows the layers of the retina and the ganglion cell layer has the greatest thickness. It is followed by the inner nuclear layer, the outer nuclear layer, rods and cones, but the layer of nerve fibers turned out to be the thinnest. The measurement of the size of each retina layer revealed: the ganglion cell layer is 65.34 ± 1.05 μm and 64.33 ± 1.16 μm; the outer glial limiting membrane is 34.13 ± 1.34 μm and 41.22 ± 1.06 μm; the outer plexiform layer is 41.11 ± 1.12 μm and 26.44 ± 1.67 μm; the outer nuclear layer is 38.98 ± 1.15 μm and 37.76 ± 1.34 μm, in the experimental and the control groups, respectively.

Thickening of all retina layers is clearly visible on the histological section due to the impact of riboflavin.

IV. Conclusion

In our research we established a positive impact of riboflavin on the thickness of retina in chicken embryos in ontogenesis. The retina layers in the experimental group were significantly thicker than in the control group. A change in retinal thickness is associated with an increase in the number of cells in the layers of the retina.

The effect of a riboflavin solution with a concentration of 0.002% stimulated the development of the eyeball by 0.72% and the retina by 141.03 μm (148.93 μm in the experimental group and 141.03 μm in the control group).

The inner glial limiting membrane is making 8% of the whole retina, the nerve fiber layer – 8%, the inner plexiform layer – 4.8%, the inner nuclear layer – 3.2%, the outer plexiform layer – 5.9%, the outer nuclear layer – 7.6%, the inner glial limiting membrane – 6.1%, photoreceptor layer – 10.6% and pigmented layer – 7.0%.

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