One member of this family developed a spontaneous choroidal detachment about three months after sclero-corneal trephining, and this persisted unchanged for a year. It was (unsuccessfully) treated by a cautery puncture and is still present.

The second family comprises six siblings out of a family of ten, one of whom died in infancy. Of the nine living siblings, eight are said to be glaucomatous, and six have been examined. Of these five were glaucomatous, and one was unaffected.

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IRITIS (WHITE EYE) IN FOWLS

BY

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With an account of the Histological Changes in the Eye

BY

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Introduction

IRITIS in fowls, or "white eye" as it is called, is one of the manifestations of the disease-complex which is most commonly known as "fowl paralysis." The other manifestations are paralysis, leucæmia and the development of lymphocytomata. In this paper we are chiefly concerned with the changes in the eye, as these are usually the first to occur. The iritis is more commonly associated with paralysis, which it generally precedes, than with leucæmia and the lymphocytomata. The condition is widespread and it is thought to be transmissible and to be caused by a filtrable virus. Chickens are most susceptible and the disease-complex may appear in all breeds.

Cause.—We regard the condition as being one of the sub-acute or chronic manifestations of disease which arise in fowls as a result of the activity of the pathogenic developmental or mutation forms of the *Bacillus coli communis* which have their habitat in the intestinal canal. Climate, artificial feeding, confined space, incubation, intensive breeding, etc., lower the animals' resistance,

which resides in the protein particles in the plasma. This plays into the hands of the micro-organisms which cause what we term "infections from within." The increased or pathogenic activity of these micro-organisms attracts activity from the protein particles in the plasma with the result that those which escape being sent into true solution agglutinate, increase in size and eventually become precipitated. The enlarged or hydrated protein particles are precipitated for the most part in the peri-vascular lymphatic vessels in the systemic system, as opposed to the portal and pulmonary systems. When the systemic system is involved in animals the manifestations are more generalised than is the case in man and the eyes are more frequently affected. The greater generalisation of disease in animals is probably to be explained by their falling victims less often to minor ailments than man and to being dosed with fewer drugs. A possible explanation for the eye being more frequently attacked is the greater depth of the anterior chamber allowing the entrance of more lymph and thus a greater number of the hydrated protein particles which are directly responsible for the lesions produced. These hydrated protein particles cause the lesions by attracting activity from the cells of the tissues and organs with which they come into contact, and, to make good the loss sustained the host brings up his second line of defence which are the leucocytes. The first leucocytes to be advanced are the polymorpho-nuclear variety and then the mono-nuclear type which develop eventually into plasma cells. The condition is not ordinarily transmissible, and, the explanation for many animals being attacked about the same time is that the primary invaders are operative over the areas affected. To-day the condition is so common that cases can be found any day of the year and almost on any farm. The lesions are not caused by ultra-microscopic viruses, although these may be formed from the hydrated protein particles by passing them through a filter. The young of all animals and man are more susceptible than adults to the activity of the developmental forms of the *Bacillus coli communis*, when they become active first, since with each succeeding exhibition of activity a greater degree of immunity is established against the invaders.

Symptoms.—The colour of the iris changes to varying shades of grey, first in one eye and then in the other. *Synechia* form, the pupil becomes contracted and finally obliterated and the animal is rendered blind. No other changes but those in the eye may be noticed, and they may exist some time before paralysis sets in in either a wing or a leg. As a rule the legs are affected before the wings.

Blood Changes.—In cases of iritis no changes in the leucocytes are to be observed. The changes do not occur until paralysis

appears and then as a rule only when the condition is acute and severe. In these cases the granular form of the polymorpho-nuclear variety is increased at the expense of the rod variety and of the mono-nuclear leucocytes. When leucæmia supervenes the mono-nuclear leucocytes increase at the expense of the polymorpho-nuclear leucocytes and different types of leucæmia, according to the variety of the leucocyte which is advanced, may be found. Three types of leucæmia are generally described, erythro-leucæmia, lymphatic leucæmia and myeloid leucæmia. In the last two types, which may be both leucæmic and aleucæmic, especially in the former, growths commonly appear some of which are not to be differentiated from sarcomata.

Pathological Changes

(a) The Eye Changes

The affected animals, as well as normal controls, were killed, the heads cut off and fixed in formalin (10 per cent.), Zenker's solution and absolute alcohol. After fixing, the eyes were removed, decalcified, and following passage through the alcohols, were embedded in paraffin or celloidin. When the fat content, especially of the iris muscle, was to be investigated the embedding

FIG. 1.

Normal fowl's eye. Antero-posterior section. Note especially the normal adhesion of the ciliary process to the lens pad, which largely takes the place of our suspensory ligament; the large canal of Schlemm and the bone (B) and cartilage in the sclera.

was done in gelatin and sections were cut with the freezing microtome. The sections were stained with hæmatoxylin and eosin, Mallory's phosphomolybdic acid, Sudan iii and Pappenheim's stain for the detection of plasma cells. In some of the specimens examined changes were found in every portion of the eye where capillary vessels are normally present, and even in the

FIG. 2.

A portion of the iris showing an early case of iritis. There is slight infiltration of cells mainly in the anterior sphincter bearing portion.

extra-ocular muscles, whereas in all the essential lesion was an irido-cyclitis.

The Iris.—The least affected cases show a slight peri-vascular invasion of leucocytes, which is most marked in the anterior part of the iris which contains the striped sphincter pupillae muscle. As the severity of the infection increases this anterior zone is found to become densely infiltrated while the posterior zone is only slightly affected (Fig. 2). In the most severe cases the iris is observed to become so densely infiltrated as to make it difficult

to describe its structure. In these specimens the iris is greatly thickened. The pigment epithelium swells and degenerates as the severity of the iritis increases (Fig. 3). The pigment particles agglutinate into balls which wander into the iris tissue, or into

FIG. 3.

Severely affected pupillary portion of iris. The iris is densely infiltrated with cells which obscure its structure. The pigment is rolled into balls. There are exudate and cells in the anterior chamber.

FIG. 4.

The normal iris of a fowl stained with Sudan iii to show the fat which is normally present in the fibres of the sphincter pupillae.

the posterior chamber. One of the most remarkable features about the condition is the disappearance of the normal fat of the iris (Fig. 4). The yellow colour of the eye of the fowl is due to a doubly refracting oily fat which is present in the muscle fibres of the sphincter. The fat stains red with Sudan iii, and violet with

Nile blue. The disappearance of the fat may be the result of the dehydrator or katabolic action of the hydrated protein particles which are precipitated *in loco* or may be carried away by leucocytes. According to Jaensch and Lerche the first change is a loss of the doubly refracting property, when the fat continues to stain with Sudan iii but fails to do so with Nile blue. Later when the fat has vanished there is nothing left to stain with Sudan iii. The changing of the colour of the iris from yellow to grey is

FIG. 5.

Slight infiltration of cells among the striped ciliary muscle fibres.

due in part to the cellular infiltration of the structure and in part to the disappearance of the fat. The extra-ocular fat is not affected.

The Ciliary Body.—This structure and its processes are less affected than the iris. The ciliary processes are infiltrated with a varying number of leucocytes, the vessels are dilated and the whole structure is thickened. The cells may wander into the circumlental space through gaps in the pigment epithelium which swells, becomes depigmented and finally vanishes. A migration of cells and pigment from the area which corresponds to the *pars plana* in man into the vitreous may occur. And, when this happens a fine network of connective tissue is formed. In the severe cases leucocytes invade the fibres of Crampton's and Muller's muscles (Fig. 5). The changes in the ciliary body usually terminate at the *ora serrata*, but they may extend further back.

The Anterior Chamber.—This space is filled with plasma which contains a varying number of leucocytes. As the leucocytes increase deposits (k.p.) are formed on the back of the cornea. Exudation into the pupil causes posterior *synechiæ*. Cells are found early clothing the fibres of the *ligamentum pectinatum* and these increase *pari passu* with the extension of the inflammation.

FIG. 6.

Corneo-scleral junction. There is infiltration of the conjunctiva, subconjunctival vessels, ciliary muscle, canal of Schlemm and *ligamentum pectinatum*, and iris.

The Canal of Schlemm.—This space in fowls is much larger than in man. Cells infiltrate the walls to the extent of producing wart-like masses which project into the canal (Fig. 6).

The Choroid.—This structure is little affected. The vessels are dilated, but not abnormally so, and they may be filled with red blood-corpuscles, which being nucleated, are apt to be mistaken at first sight for leucocytes. Some observers have made this mistake and have described the choroid as being infiltrated with leucocytes. Evidence may be found of peri-vascular infiltration and in the severe cases, when the *choriocapillaris* is involved, the cells of the pigment epithelium are affected. The cells swell, the pigment

shows signs of wandering and the place of the former may be taken by inflammatory cells from the choroid. In these cases the rods and cones may be destroyed and the retina may become invaded by cells and pigment.

The Retina.—This structure in the fowl, which contains no bloodvessels, may be affected secondarily to the choroid, but it is never attacked primarily (Fig. 7). The papilla and pecten may

FIG. 7. Optic nerve
The normal pecten.

be infiltrated with leucocytes. And, when the latter is involved in this way it resembles the ciliary processes. The optic nerve is generally affected (Fig. 8). The vessels in the septa are infiltrated and the endothelial cells contain a nucleus which appears to be poor in chromatin. The nerve fibres, unlike those of the peripheral nerves, escape. Nerve changes are to be seen in the whole of the medullated portion of the optic nerve and are especially marked at the chiasma.

The cells comprised in the infiltration can be separated into three types: plasma cells, lymphocytes and endothelioid cells.

FIG. 8.

The pecten in fowl paralysis. The vessels are filled with normal nucleated red cells; but around these and in the vitreous are inflammatory cells. There is also some infiltration of the nerve head.

The plasma cells which are recognised by their eccentric cartwheel nucleus staining with methyl green and their cytoplasm with pyronin in Pappenheim's method of staining, are by far the most numerous. The plasma cells evolve from the lymphocytes which are too well known to need description. The endothelioid cells, characterised by an indefinite cytoplasm and a large feebly-staining nucleus, are probably young connective tissue cells. Jaensch and Lerche admit to finding eosinophile cells which give the appearance of sympathetic ophthalmia in man.

(β) The Nerve and Other Changes

The nerve stems and their branches are swollen and infiltrated with leucocytes. The changes are generally asymmetrical and may be limited to one side of the body. The part of the nerve adjacent to the spinal cord is usually the part which is most

severely affected, but the pathological changes cease abruptly at the point where the fibres enter the cord. The meninges are generally involved and peri-vascular changes may be found in the cord. The brain is less frequently attacked. The tumour-like masses which are to be found in the ovaries, liver, spleen, kidneys, lungs, mesentery, gizzard, pancreas, muscles and skin are of the nature of what we have called "lymphocytomata." These swellings are composed of cells of the mono-nuclear variety and of their parent cells the endothelial cells, different types of cells are to be found and the swellings range from innocent to malignant growths.

Relationship between Fowl Paralysis and the corresponding manifestations of Disease in Man

The irido-cyclitis which occurs in fowls is not to be differentiated from the manifestation of disease which appears in man as a symptom of intestinal toxæmia. It may similarly be associated with lesions in the spinal cord, more rarely in the brain and with anæmia which is usually of the pernicious type. This form of irido-cyclitis is not to be differentiated from the type which is found most frequently in a gonococcal infection where rheumatism is another most common symptom. The gonococcal irido-cyclitis is caused by the protein particles which have been hydrated by the activity of the gonococcus and not by the presence of the micro-organisms in the eye. It is interesting to note that the gonococcus belongs to the *Neisseriæ*, which have developed from Friedländer's bacillus, which with the *Bacillus acidi lactici* are the most active micro-organisms in the intestinal tract of fowls suffering with irido-cyclitis. There is no fundamental difference between the leucæmias and the various forms of lymphocytomata in fowls and those which are found in man.

Prevention and Treatment

Fowl paralysis is best prevented by keeping poultry under the best conditions possible and feeding them naturally. The ground upon which the birds live should frequently be changed and it should be green. The animals should not be overfed and all artificial foods should be avoided. Eggs and chicks should not be incubated and excessive in-breeding and egg-laying should be done away with. Provided treatment is begun early, and the most efficacious remedy is Banifex which is prepared from the micro-organisms isolated from the excreta, the animals recover, the irido-cyclitis disappears and the eye becomes normally

pigmented once more. Banifex contains the washings of an emulsion of micro-organisms which have been collected from as many birds as possible in different areas and over a period of a few years. The emulsion from which the washings are made contains 1000 million micro-organisms per c.cm. Two injections made intra-muscularly on consecutive days give the best results. Once the nerves become involved, leucæmia appears or tumours form, treatment is unavailing. Anahæmin has not given in my hands the results in fowls obtained in man, but this may be due to my not having treated the cases which are best suited to this remedy. Whether vitamin E, which contains α - and β -tocopherol, is able to disperse the hydrated protein particles as some have alleged, I am unable at present to decide.

REFERENCES

- ELLENBERGER and BAUM.—Handbuch der vergleichende Anatomie der Haustiere (Comparative Anatomy of Domestic Animals). 16th Ed. p. 1025, 1928.
 JAENSCH and LERCHE.—*Arch. f. Ophthalm.*, Vol. CXXXI, p. 359, 1933.
 PAPPENHEIMER, DUNN and CONE.—*Jl. of Exp. Med.*, Vol. XLIX, p. 227, 1929.
 PAPPENHEIMER, DUNN and SEIDLIN.—*Jl. of Exp. Med.*, Vol. XLIX, p. 87, 1929.

NOTE ON PHLYCTENULAR OPHTHALMIA

BY

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THE discussion on phlyctenular ophthalmia calls for some comment. It was in Southern Australia some time ago a very common condition, and after much experience I came to regard it as a deficiency disease. It was frequently seen in girls whose diet consisted largely of tea and bread and butter. With a full diet and the usual local treatment it disappeared. It is now in private practice almost a curiosity.

But the evidence adduced by Dr. Sorsby and others re-opens the question.

Tuberculous disease in Victoria has been greatly lessened though it is still unpleasantly frequent. The hypothesis is obviously that if a phlyctenular ophthalmia case gives a positive tubercular result tubercle is to be regarded as the cause.

The lessening of tuberculous disease may be due to better conditions and greater care taken to avoid infection, but it may also be the expression of a biological process of elimination. Furthermore if the current view is taken both tubercle and