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POULTRY DISEASES
AND
THEIR TREATMENT

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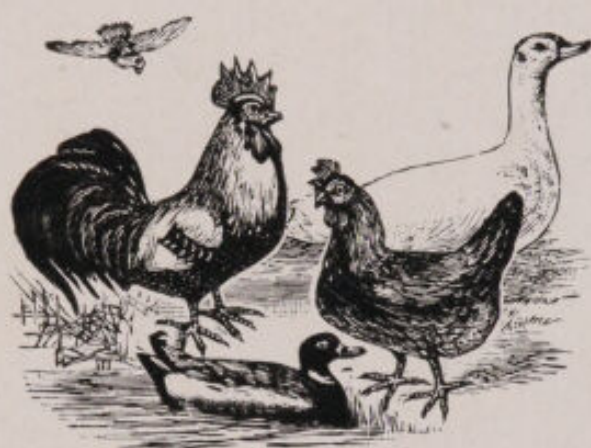
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VETERINARY MEDICINE SERIES

No. 2

Edited by D. M. Campbell, D.V.S.

POULTRY DISEASES

With A Chapter On The
ANATOMY OF THE FOWL

BY

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SECOND EDITION

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FOREWORD TO SECOND EDITION

This book is written to fill a demand from veterinary students, students in poultry husbandry courses at agricultural colleges, veterinary practitioners and others interested in the scientific treatment of poultry diseases.

An effort has been made to make the language so plain that all can comprehend the subject matter, which is a summary of results of experimental research in the laboratory of pathology of the author and of many other investigators.

For the purpose of simplification, the synonyms are given for the various names of diseases. Then follow, in order, the cause, or causes, the symptoms, the conditions found upon post-mortem examination, and lastly the treatment and means of eradication for each disease.

The author is indebted to Dr. D. M. Campbell, editor of the *American Journal of Veterinary Medicine*, for helpful suggestions as to arrangement and other matters.

The first edition being exhausted in so short a time is evidence that it met the expectations of the author and the publisher—that it filled a real need. This second edition has been thoroughly revised and brought down to date. Much new information in the chapters on anatomy of the fowl, foods poisonous to fowls and poultry materia medica has been added.

West Raleigh, N. C., October, 1917.

B. F. KAUPP.

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CONTENTS

List of Illustrations.....	9
----------------------------	---

SECTION I.

Anatomy	17
---------------	----

The skeletal anatomy of the fowl; the musculature; the visceral anatomy; structure of the digestive tract and its adjacent organs; structure of the respiratory tract; the circulatory system; the blood of normal fowl; the nervous system; organs of special sense; the reproductive organs of the hen; the male reproductive organs; the urinary secretion.

SECTION II.

Sanitation	53
------------------	----

Site for poultry plant; buildings and runs; water supply; disinfection; disposal of sick and dead birds.

SECTION III.

External Parasites	65
--------------------------	----

Lice of birds; effects of louse infestation; dealing with louse infestation; scabies; scaly legs; air sac disease; chigger or red mite infestation; fleas affecting birds; tick infestation; the begbug of poultry; fungi affecting birds; thrush or sore mouth; tinea favosa; pneumomycosis; mycosis of pigeons; white scale of the comb; bee stings; the gray canary louse; the canary mite; baldness of canaries.

SECTION IV.

Internal Parasites	87
--------------------------	----

Important round worms; unimportant round worms; tapeworms; the thorn-headed worms; flukes.

SECTION V.

Diseases of the Digestive Tract.....	101
--------------------------------------	-----

Obstruction of the beak; pip; stomatitis; impaction of the crop; impaction of the intestines; tympany of the crop; enlarged crop; gangrene of the crop; catarrh of the crop; depraved appetite; chicken cholera; enterohepatitis; dysentery; white diarrhea; croupous inflammation of the pigeon; coccidiosis in wild ducks; protozoal hepatitis of pigeons; renal coccidiosis; blastomycosis of the goose; sarcocystis; cloacitis; peritonitis; ascites; nephritis; calculi; purulent inflammation of the abdomen of the hen; intestinal diseases of canaries.

SECTION VI.

Blood Diseases	133
----------------------	-----

Apoplectiform septicemia in chickens and pigeons; septicemia of geese; fowl typhoid; myeloid leukemia; sleeping sickness of chickens; septicemic diseases of canary birds; fowl pest; thrombosis; spirochetosis; pericarditis; endocarditis; rupture of the heart and large blood vessels; hypertrophy of the heart.

SECTION VII.

Constitutional Diseases	141
-------------------------------	-----

Going light; tuberculosis; pseudo-tuberculosis; actinomycosis; disease of the subcutem.

SECTION VIII.

Diseases of the Liver.....	149
----------------------------	-----

Fatty degeneration; fatty infiltration; rupture of the liver; inflammation of the liver; inflammation of the bile ducts; enterohepatitis; unimportant diseases.

SECTION IX.

Diseases of the Ovary and Oviduct.....	153
--	-----

Prolapse or eversion of the oviduct; obstruction of the oviduct; rupture of the oviduct; broken eggs in oviduct; prolapse of the cloaca; abnormal eggs; epizootic abortion in birds; inflammation of the oil gland.

SECTION X.

Tumors	159
--------------	-----

Hematoma; multiple tumors of the ovary; cystic ovary; abdominal cyst; contagious epithelioma; sarcoma; teratoma; adenoma; epithelioma; osteoma; horny growths on the cuticular surface of fowls.

SECTION XI.

Diseases of the Respiratory Passages	167
--	-----

Obstruction of the trachea; catarrh; asthma; ulcerative pharyngitis; bronchitis; congestion of the lungs; pneumonia; pneumomycosis; swell-head in young turkeys; chickenpox; diphtheric roup; pox of turkeys; contagious inflammation of the air sacs in geese; contagious nasal catarrh of birds; conjunctivitis; ulceration of the cornea; respiratory troubles of canaries; asthma of canaries.

SECTION XII.

Diseases of the Organs of Locomotion.....	187
---	-----

Leg weakness; infectious articular inflammation in young geese and ducks; paralysis of the wings of pigeons; abscess of the foot; gout of fowls.

SECTION XIII.

Diseases of the Brain and Nerves.....	195
Dizziness; hemorrhage of the brain; epilepsy; myelitis; polyneuritis; paralysis of the auditory nerve of the fowl.	

SECTION XIV.

Bacteria of the Intestinal Tract of Chickens.....	201
---	-----

SECTION XV.

The Egg.....	203
Composition; parasites in eggs; bacteria of eggs; bacteria in fresh eggs.	

SECTION XVI.

Malformations	207
---------------------	-----

SECTION XVII.

Fractures—Wounds—Anesthesia.....	211
Repair of the fracture of bones of the domestic fowl; wounds; anesthesia and restraint of the fowl; injury to the sternum; gangrene; frozen combs; broken beak.	

SECTION XVIII.

Castration of the Bird.....	221
Caponizing; ovariectomy of the pullet.	

SECTION XIX.

Foods Poisonous to Fowls.....	227
The rose chafer; arsenical poisoning; salt poisoning; other mineral poisons; ptomain poisoning; botulism; corn cockle poisoning.	

SECTION XX.

Poultry Remedies.....	231
Poultry materia medica.	
Index	241

Unable to display this page

ILLUSTRATIONS

FIG.		PAGE
1.	The Bony Skeleton of the Domestic Fowl.....	12
2.	The Visceral Organs of the Hen.....	14
3.	Visceral Organs of the Right Side of a Fowl.....	23
4.	Visceral Organs of the Left Side of a Fowl.....	24
5.	Section Through the Median Line of a Pullet.....	25
6.	Transverse Section Through the Thoracic Region.....	27
7.	Heart of Fowl with Its Main Branches.....	33
8.	Blood Vessels of the Pelvis and Thigh of the Fowl.....	35
9.	Brain and Eyeball of the Fowl.....	37
10.	Section Through the Eye of a Hen.....	39
11.	Cochlear Labyrinth of a Hen.....	40
12.	The Pelvic Organs of a Pullet.....	42
13.	The Pelvic Organs of a Hen.....	43
14.	Section of Ovary of the Hen.....	45
15.	Diagrammatic Structure of the Egg.....	46
16.	Generative Organs of a Cockerel.....	48
17.	Pelvic Cavity of a Cock.....	49
18.	Spermatozoa.....	50
19.	Menopon Biseriatum.....	66
20.	Menopon Pallidum.....	66
21.	Goniocotes Hologaster.....	67
22.	Lipeurus Infuscatus.....	67
23.	Goniodes Stylifer.....	67
24.	Lipeurus Baculus.....	68
25.	Eggs of the Goniodes Stylifer.....	68
26.	Inexpensive, Durable Spray Pump.....	71
27.	Sarcoptes Mutans.....	73
28.	Scaly Legs.....	74
29.	Cytodites Nudus.....	75
30.	Trombidium Holosericeum.....	76
31.	Dermanyssus Gallinæ.....	79
32.	Pulex Avium.....	80
33.	Sarcopsylla Gallinacea.....	81
34.	Argas Miniatus.....	82
35.	Acanthia Inodora.....	83
36.	Ascaris Inflexa.....	88
37.	Heterakis Papillosa.....	88
38.	Heterakis Papillosa, Head Extremity.....	88
39.	Heterakis Papillosa, Tail Extremity.....	90
40.	Spiroptera Hamulosa.....	91
41.	Syngamus Trachealis.....	92
42.	Taenia Infundibuliformis.....	96
43.	Nodular Taeniasis.....	97
44.	Blood Smear from Case of Cholera.....	107
45.	Enterohepatitis in a Turkey.....	112
46.	Cloudy Swelling Due to Enterohepatitis.....	113
47.	Section of Liver from a Case of Enterohepatitis.....	114
48.	Blood Smear from a Case of Enterohepatitis.....	115
49.	Section of Kidney from Turkey That Died of Enterohepatitis.....	116
50.	Cecum from a Case of Enterohepatitis in a Turkey.....	117

ILLUSTRATIONS

FIG.		PAGE
51.	Hemorrhagic Enteritis in a Hen.....	118
52.	Section Through Cecum from Case of White Diarrhea.....	122
53.	Coccidium Tenellum in Various Stages.....	122
54.	Croupous Inflammation in a Pigeon.....	124
55.	Pulmonary Coccidiosis in a Duck.....	127
56.	Intestinal Coccidiosis in a Duck.....	127
57.	Thrombosis in a Hen.....	137
58.	Spirocheta Gallinarum.....	138
59.	Acute Spirochetosis.....	138
60.	Hematoma of Ovary in a Hen.....	159
61.	Multiple Tumors of Ovary of a Hen.....	161
62.	Hen With an Abdominal Cyst.....	162
63.	Heads of Two Chicks Affected with Contagious Epithelioma.....	163
64.	Obstruction of the Trachea.....	167
65.	Chickenpox.....	174
66.	Roup in a Chicken.....	175
67.	Diphtheric Roup in a Chicken.....	177
68.	Skiagraph of Head and Neck of Chicken.....	181
69.	Ulceration of the Cornea.....	184
70.	Thorn Abscess.....	190
71.	Paralysis of the Auditory Nerve.....	199
72.	Monster Chick (dipygus tetrabrachium).....	207
73.	Polymelus.....	208
74.	Umbilical Hernia of a Baby Chick.....	209
75.	Sections Through Bones at Different Stages of Fractures.....	213
76.	Poultry Operating Table.....	216
77.	Injury to Sternum.....	217
78.	Gangrene of the Foot of a Turkey.....	218
79.	Top of Barrel As An Operating Table.....	223
80.	Capon and Cock.....	225

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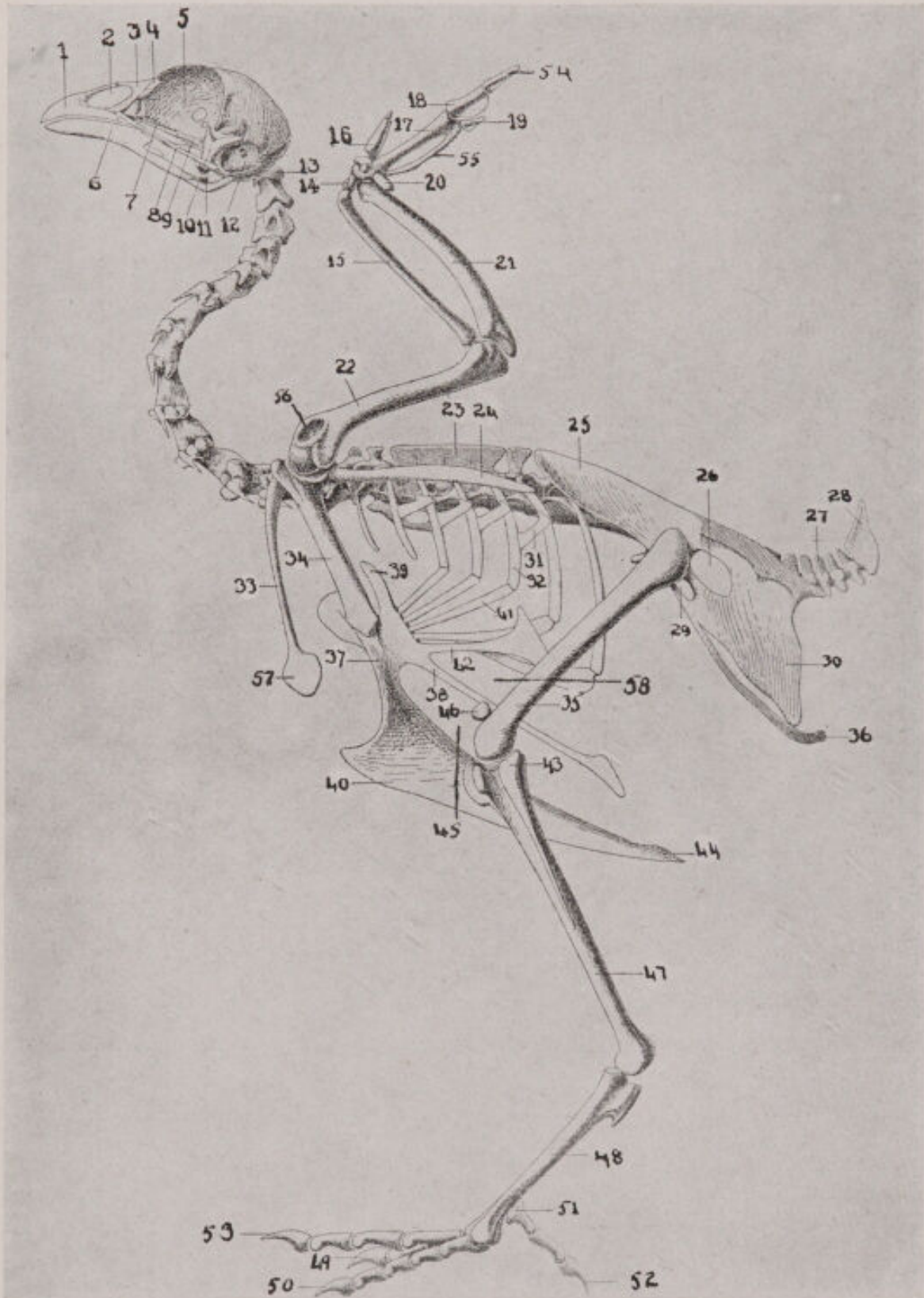


FIG. 1. THE BONY SKELETON OF THE DOMESTIC FOWL.

EXPLANATION OF FIG. 1

Head and Neck

1, os incisivum—premaxilla; 2, anterior nasal opening; 3, os nasale—nasal bone; 4, os lacrimale—lacrimal bones; 5, lamina perpendicularis of the ethmoid bone; 6, os dentale—inferior maxilla or lower jaw; 7, the malar bone; 8, os quadratojugal; 9, os pterygoideum—pterygoid bone; 10, os quadratum; 11, os auriculare; 12, foramen or opening for the passage of the fifth nerve from the cranial cavity; 13, atlas or first cervical vertebra.

Trunk and Limbs

14, os carpi radiale; 15, radius; 16, first digit (thumb)—false wing bone; 17, metacarpus; 18, second (middle or large) digit; 19, third (rudimentary) digit; 20, os carpi ulnare; 21, os ulnae (elbow); 22, os humeri; 23, dorsal (thoracic) vertebra; 24, os scapulare; 25, ilium; 26, foramen ischiaticum; 27, coccygeal (caudal) vertebrae; 28, ploughshare bone; 29, foramen obturatum; 30, ischium; 31, uncinate process of the rib; 32, vertebral portion of the rib; 33, os clavícula; 34, os coracoideum; 35, femur (thigh bone); 36, pubis; 37, sternum—breastbone; 38, lateral internal process of sternum; 39, costal process of sternum; 40, keel of the sternum; 41, sternal portion of the rib attaching to the sternum; 42, lateral external process of the sternum; 43, fibula; 44, posterior process of the sternum; 45, internal notch of sternum; 46, patella (knee cap); 47, tibia; 48, metatarsus; 49, 50, 53, principal digits; 51, rudimentary digit; 52, first toe.

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EXPLANATION OF FIG. 2

Digestive and Genito-urinary Tract

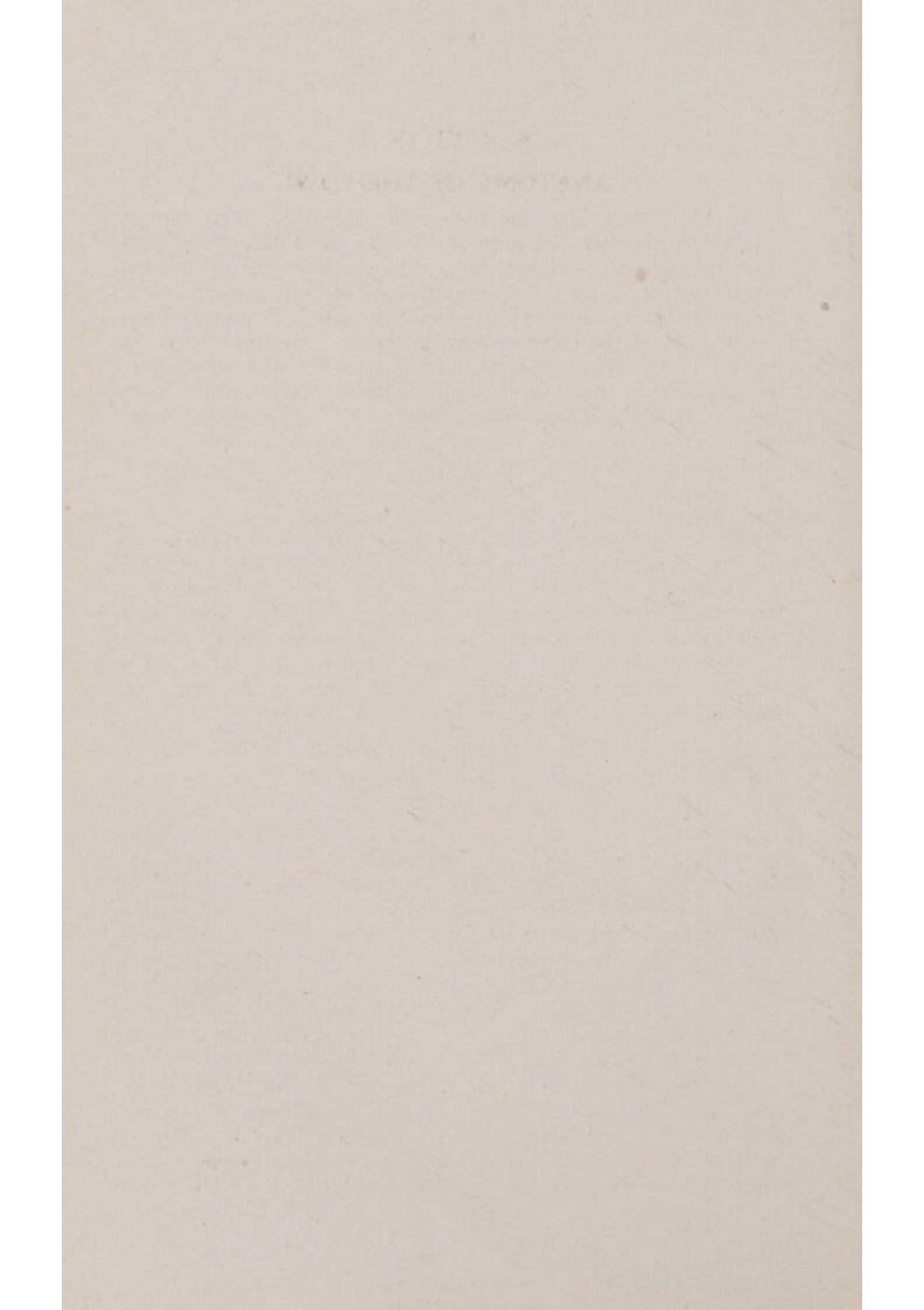
1, beak; 2, tongue; 3, pharynx; 4, esophagus (gullet); 5, crop; 6, second portion of esophagus; 7, proventriculus; 8, gizzard; 9, duodenum; 10, first portion of the small intestine; 11, floating portion of small intestine; 12, ceca; 13, blind extremities of ceca; 14, colon; 15, rectum; 16, cloaca; 17, opening of egg sac into rectum; 18, anus; 19, mesentery; 20, opening from ureter into rectum; 21, kidney; 22, left ovary; 23, egg canal; 25, pancreas; 26, liver (turned back); 27, gall bladder; 28, spleen.

Organs of Respiration

29, nostrils; 30, frontal sinus; 31, maxillary (infraorbital) sinus; 32, turbinated bone; 33, posterior nares; 34, glottis; 35, larynx; 36, trachea (wind-pipe); 37, false larynx; 38, lung.

Organs of Circulation

39, heart (pulled down to bring it into view); 40, aorta; 41, left brachial artery; 42, carotid artery.



SECTION I

ANATOMY OF THE FOWL

In the young bird the bones, for the most part, contain cavities filled with red marrow. In the adult bird these cavities are largely filled with air. The air passes from the respiratory organs into these cavities. This air is supposed to be renewed in the process of respiration. In the running birds most of the bones contain marrow. Separate bronchial tubes of the lungs are continued by the air sacs which communicate with the air spaces of the bones. The air spaces are more abundant in the larger bones as the humerus, ulna and radius.

The air passes into the air passages and bony cavities of the head, then through the superior larynx, trachea and inferior larynx into the bronchi. From air tubules here, the air passes into the air cells of the body cavities and then into the air cells of the bones. In the process of breathing the air is drawn out of the air sacs located in the body and bone cavities. Fresh air in turn is forced through the small communicating tubules which enter the hollow bones through small openings in their bony walls.

For study of the skeleton it may be divided into the three regions: head and neck, the trunk and the limbs.

THE HEAD AND NECK

(The numbers refer to Fig. 1)

The bird's head is rather small and conical in shape and is composed of several bones as shown in Fig. 1. The os incisivum or premaxilla (1) forms the anterior point and base of the upper jaw. It is elongated anteriorly into a V point in the fowl and flattened in the water fowl as the duck and goose. This portion constitutes the beak. This bone, together with the os dentale (6) forms the prehensile organ or means of picking both solids and liquids. This organ contains the anterior nasal opening (2) through which air passes on its way to the lungs. The lamina perpendicularis of the ethmoid bone (5) forms a thin wall between the two orbits or eye cavities. It contains an opening or foramen for the passage of the optic nerve and a smaller opening, the ethmoid foramen, for the passage of the ethmoid nerve. The os palatinum or palatine bone encircles the guttural opening of the nasal passage and forms the greater part of the hard

palate or roof of the mouth. It articulates with the pterygoid, superior maxilla and premaxilla. The os pterygoideum or pterygoid bone (9), articulates with the sphenoid and os quadratum (10). The os quadratum articulates with the temporal, maxilla, zygomatic and pterygoid. The os auriculare (11) is interposed between the maxilla and quadrate bone. The atlas (13) or first cervical vertebra articulates anteriorly with the condyle of the occipital bone and the axis, the latter being located posteriorly.

There are fourteen cervical vertebrae in the fowl, fifteen in the duck, eighteen in the goose and twelve in the pigeon.

The long column of cervical vertebrae serves as a sort of balancing pole, and by changing in form and direction it varies the center of gravity. In flying, the bird changes the center of gravity from the region over the legs to the region of the wings. When at rest the head and neck are thrown backwards, carrying the center of gravity back over the legs. The first cervical vertebra is the atlas. This is the smallest of the vertebrae and is ring-shaped. Anteriorly it articulates with the single condyle of the occipital bone. This anterior articular surface is half-moon shaped and forms a deep articular joint called a ball and socket joint. This type of joint makes possible, movements in all directions. The condyle of the occiput also touches an articular end of the odontoid process of the axis or second cervical vertebra. Posteriorly there are found two small lateral wings possessing articular facets which articulate with similar facets on the lateral wings of the axis. The posterior part of the body is provided with an articular facet which articulates with a similar articular surface on the anterior portion of the body of the axis.

The body of each succeeding vertebra articulates with the one immediately anterior and posterior to it. Between each two is a pad of fibro-cartilage. Above these bodies and below the neural spines, we find a large neural canal which is occupied by the spinal cord. Between each two vertebral segments in the cervical region, the neural canal is exposed, due to the neural arches incompletely bridging the canal in that location. This space is protected or bridged over by an intervertebral ligament.

The dorsal spines of the cervical vertebra are very small, the ventral are more distinct. The anterior oblique spines are provided on their under surfaces with articular facets, which articulate with similar articular facets on the upper side of the posterior oblique process of the vertebral segment in front. The ventral spine on the last cervical segment is

well developed. The transverse processes on either side of the cervical vertebra are penetrated by a vertebral foramen. Through each of this series of foramina passes a vertebral artery, vertebral vein and a spinal nerve. The transverse processes of the last cervical vertebra are provided with ridges and excavations for muscular and tendinous attachments.

TRUNK

(The numbers refer to Fig. 1)

The dorsal or thoracic vertebrae (23) number seven in the fowl and pigeon, and nine in the duck and goose. These bones are usually fused or consolidated, giving great support and stability to the wing. The dorsal vertebral region is short. The first and sixth vertebrae articulate similar to the cervical vertebra, that is, by the bodies and the oblique processes. The seventh dorsal is fused with the first lumbosacral vertebra. The transverse processes of the dorsal vertebrae from the second to the sixth are well developed and bridged over with a thin wing of bone. The ventral spines are well developed and partly fused to form a continuous ridge.

In the bird the lumbar and sacral vertebrae are consolidated. In the embryo there are fourteen distinct vertebrae which soon consolidate with each other and with the ribs. With these vertebral segments are fused the last dorsal and first coccygeal vertebral segments. This fusion is so complete that the segments are indicated only by the intervertebral foramina through which the spinal nerves extend. This fused lumbosacral region forms the roof of the pelvic region. The lumbosacral vertebrae and ilia are fused. The dorsal spines of the vertebral segments are indicated only in the anterior portion.

The joints of the coccygeal or caudal vertebrae (27) are freely movable since in the birds of flight the tail is used as a rudder. The terminal bone (28) is called the ploughshare bone.

There are seven coccygeal vertebrae. The last segment is the larger and is supposed to have originated from the fusion of several segments. It is shaped like a ploughshare and is called the pygostyle. It supports that part which gives rise to the twelve main tail feathers.

The ribs are divided into the true and false.

The true ribs articulate with the sternum by means of an intermediate bone. The false ribs do not articulate with the sternum, but are floating.

The first rib articulates with the quadrate portion of the

last cervical vertebra and the first dorsal segment. The last rib articulates with the under side of the ilium at its anterior alar portion. This rib is situated similar to the true ribs, but instead of articulating directly with the sternum the second portion lies against the second portion of the rib just anterior to it. The ribs are provided with two articular facets on the dorsal portion, and these articulate with similar facets on the dorsal vertebrae. The true ribs are called sternal ribs, and each succeeding sternal rib is longer than the one preceding it. Nearer and nearer these ribs assume a horizontal position. The proximal end of the sternal rib articulates with the distal end of the vertebral rib. The sternal end is provided with two small ridges.

From the posterior border of the second, third, fourth and fifth vertebral ribs and near their middles are flat uncinat bony processes projecting upward and forward overlying the succeeding rib, giving greater surface for muscular attachments and greater stability to the thorax. The vertebral portion of the rib (32) articulates inferiorly with the sternal portion (41) joining it to the sternum or breastbone, with which it articulates. The two portions of the rib are joined by a diarthrodial articulation. The uncinat process of the rib (31), is flat and projects backward onto the succeeding rib, giving added stability to the thorax. These processes are absent from the first and last ribs.

The sternum or breastbone is a large four-sided plate of bone, the posterior portion of which overlaps the ribs on the outer side. On the inferior portion of the sternum there is a leaf-like ridge called the crista sterna or breast ridge (or keel). This bony expansion gives a greater surface for the attachment of muscles.

The sides are provided with an external and an internal process forming an internal and an external notch. These notches are bridged over by a broad ligament, to which the muscles are attached. In the poor flyers, as the fowls, these notches are large. The sternal end posteriorly is called the zyphoid process. Anteriorly it is provided with lateral external processes, the costal processes. In the center of the anterior part is the episternal process.

LIMBS

The os scapulare (24) is elongated, narrow and presents smooth surfaces. Anteriorly it forms a portion of the glenoid cavity and is united to the fork of the coracoid by means of fibro-cartilage.

The os clavícula (33) terminates below in the hypocleideum

(57) and unites to the breastbone by means of a ligament. The superior extremity rests within and opposite the glenoid cavity, against the scapula (24) and coracoid (34). These three bones form a passageway through which extends the tendon of the levator muscle of the wing. This bone is termed the "wish bone." Its forks are elastic and prevent the wings coming toward each other during contraction of the depressor muscles. The os coracoideum (34), with the scapula, forms a glenoid cavity at its proximal end in which articulates the head of the humerus. Inferiorly it articulates with the sternum. The os humeri (22) presents an articular head inferiorly which occupies the glenoid cavity. It articulates superiorly with the radius (15) and ulna (21). The os ulnac is larger than the radius. This bone articulates inferiorly with the humerus and superiorly with the carpus in company with the radius and is provided with a short olecranon inferiorly. The two bones meet at both extremities but bow apart in the middle. A strong ligament binds the ends so that pronation and supination is impossible. This limits movements to a gliding motion lengthwise. The carpus is made up of two bones, the os carpi radiale (14) and the os carpi ulnare (20). The metacarpus (17) consists originally of two bones but they are fused or consolidated at the extremities. The first digit, thumb or false wing bone (16) is a styloid-shaped phalanx. The second, middle or large digit (18), consists of two phalanges, the second phalanx (34), and the third or rather rudimentary finger (19).

The pelvis is voluminous and very strong. The three pairs of bones composing it are: the ilium (25); the ischium (30); and the pubis (36).

The ilium is long and is consolidated with the last two dorsal, the lumbar and the sacral vertebrae. It is excavated on the internal face to receive the kidneys.

The ischium forms a part of the sides of the pelvic cavity.

The pubis is long and thin and extends along the inferior border of the ischium.

The femur or thigh bone (35) articulates superiorly with the ilium by the cotyloid cavity. This cavity is provided with a foramen or opening at its bottom which passes through the bone. The femur articulates inferiorly with the patella (46), the fibula (43) and with the tibia (47). The fibula articulates superiorly with the external condyle of the femur and the head of the tibia and inferiorly is consolidated with the tibia. The tibia terminates below in two condyles which articulate with the proximal end of the metatarsus, (48). The

metatarsus terminates inferiorly with three articular surfaces or facets which articulate with the three principal digits, (49), (50) (53). A conical eminence is noted near the inferior third which turns backwards and is the base of the spur. Most fowls have four digits. The os metatarsale or rudimentary digit (51) projects backward and is made up of three phalanges. The second or internal toe (49) is provided with three phalanges, the third or middle toe (53) is provided with four phalanges, and the external or fourth toe (50) is provided with five phalanges.

VISCERAL ANATOMY OF THE HEN

THE DIGESTIVE TRACT

Mouth

The mouth cavity is characterized by the changing of the jaw bones into the beak. There are no teeth. The tongue is shaped like an Indian arrow, with prominent, rather hard and sharp pointed papillae, along its posterior border.

There is an upper and lower beak. The upper beak is provided with sharp free edges. There are no lips or cheeks. The upper jaw forms the base of the upper beak, and the lower jaw forms the base of the lower beak. The beaks are covered by a continuation of the epidermis. The beak is formed of horn-like material that is rather hard and resists wear to which it is subjected.

In many water birds, as geese and ducks, a thin dermoid structure is formed over the edges of the beak, in which numerous branches of the trigeminus terminate in taste buds.

In chickens the beak terminates in a sharp point, while in water birds, as geese and ducks, the beak is flat, spatula-like, and grooved transversely at its free margin. The roof of the mouth (hard palate) is provided with a slit that extends antero-posteriorly, and is about one inch in length; this is the posterior nares. There are on the hard palate four or more cross bars, each of which is provided with hard filiform papillae that point backward. The tongue presents a flat surface superiorly, and is covered by a thick strata of corneous epithelium. The dorsum (upper surface) is provided with many small filiform papillae, that point backwards. The body of the tongue is made up of muscles and connective tissue. The tongue of swimming birds is thinner than that of chickens. The tongue is an organ possessing both of the senses, taste and touch. The transverse row of filiform papillae of the posterior portion of the roof of the

mouth marks the border between the oral and pharyngeal cavities. Both palatine and maxillary salivary glands are present. The parotid, submaxillary and sublingual glands are present also in some species of birds, but are rather rudimentary. They have ducts through which their secretions are discharged into the mouth.

Pharynx

The mouth cavity terminates in the pharynx. The pharynx is covered by a mucous membrane. There is a transverse ridge, provided with filiform papillae pointing backwards,

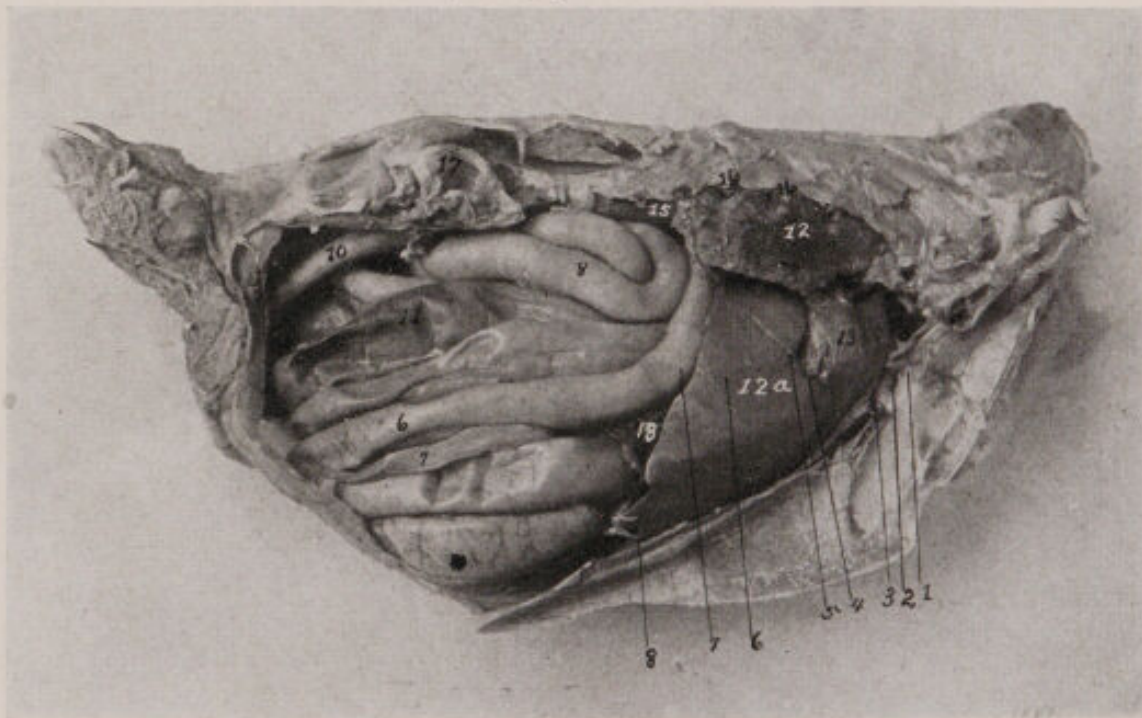


FIG. 3. VISCERAL ORGANS OF THE RIGHT SIDE OF A FOWL.

The right abdominal and thoracic walls have been removed; 6, duodenal loop; 7, pancreas; 8, small intestines; 10, rectum; 11, ceca; 12, right lung; 12a, right lobe of the liver; 13, base of the heart; 17, kidney; 18, the gall bladder located on the right lobe of the liver. The gizzard is not visible from the right side.

and located on the supero-posterior portion of the larynx, that marks the posterior edge of the pharynx.

The pharynx communicates with the mouth cavity anteriorly and with the esophagus and larynx posteriorly.

Esophagus

The esophagus is a muscular tube lying posterior to the trachea. The first portion passes over to the right side as it reaches the anterior surface of the breast, where it forms an expansion called the crop. The second portion enters the thorax through the anterior thoracic opening and occupies a

space between the lungs and passes over the base of the heart. Some areas of the mucous membrane of the crop contain mucous glands. The crop is simple in the fowl, forming two symmetrical sacs in the pigeon and spindle-formed in ducks and geese. In the pigeon during and shortly after hatching time, in both sexes, it produces a milky fluid which serves as nourishment for the young. The esophagus terminates in the stomach.

Stomach

Some anatomists call the proventriculus the *pars glandularis* and the gizzard the *pars muscularis*. The *pars glandularis*

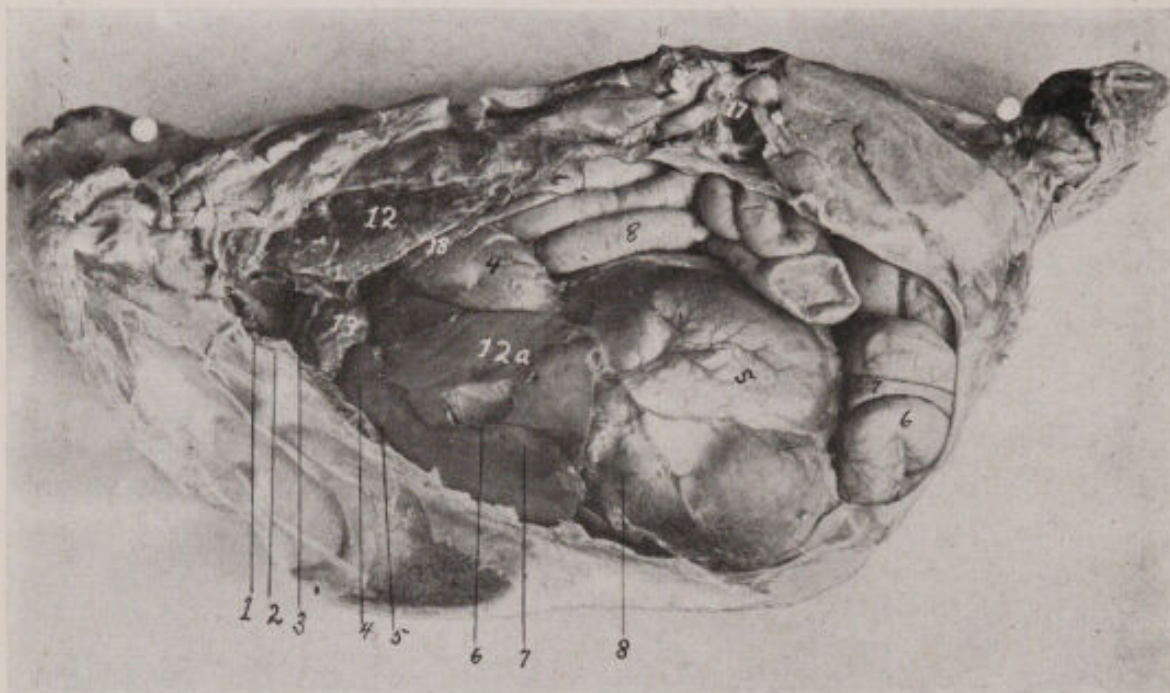


FIG. 4. VISCERAL ORGANS OF THE LEFT SIDE OF A FOWL.

The left abdominal and thoracic walls have been removed; 4, the proventriculus; 5, gizzard; 6, extreme end of the duodenal loop; 7, pancreas; 8, the small intestines; 12, lungs (it will be noted that the lungs occupy the superior part of the thoracic cavity and that there is no distinct pleural sac, but that the lungs push up between the ribs; in fact, the ribs are covered on the inner and lateral sides by the lungs); 12a, the liver; 13, base of the heart; 17, kidney; 18, diaphragm.

(proventriculus) lies dorsal to, and midway between, the two lobes of the liver, taking an oblique course to the left. It terminates in the gizzard. Its mucous surface is studded by papilla-like projections, which furnish openings to glands of the type of those in the fundus of the stomach of the horse and other quadrupeds.

Gizzard

The *pars muscularis* is round, muscular and flattened laterally and lies to the right and posterior to the proventriculus.

It lies partly behind and partly between the lobes of the liver and consists of a hollow organ. It is somewhat contracted at the sides and stands obliquely in the abdominal cavity. In granivorous birds the walls are very thick, being made up for the most part of two powerful muscles. The cavity is lined with a very thick stratified epithelium. These heavy horny pads form grinding surfaces. Certain portions of the mucous lining contain mucous glands, which by some anatomists have been regarded as modified pyloric glands of mammals.

The small intestine originates on the same side of the gizzard

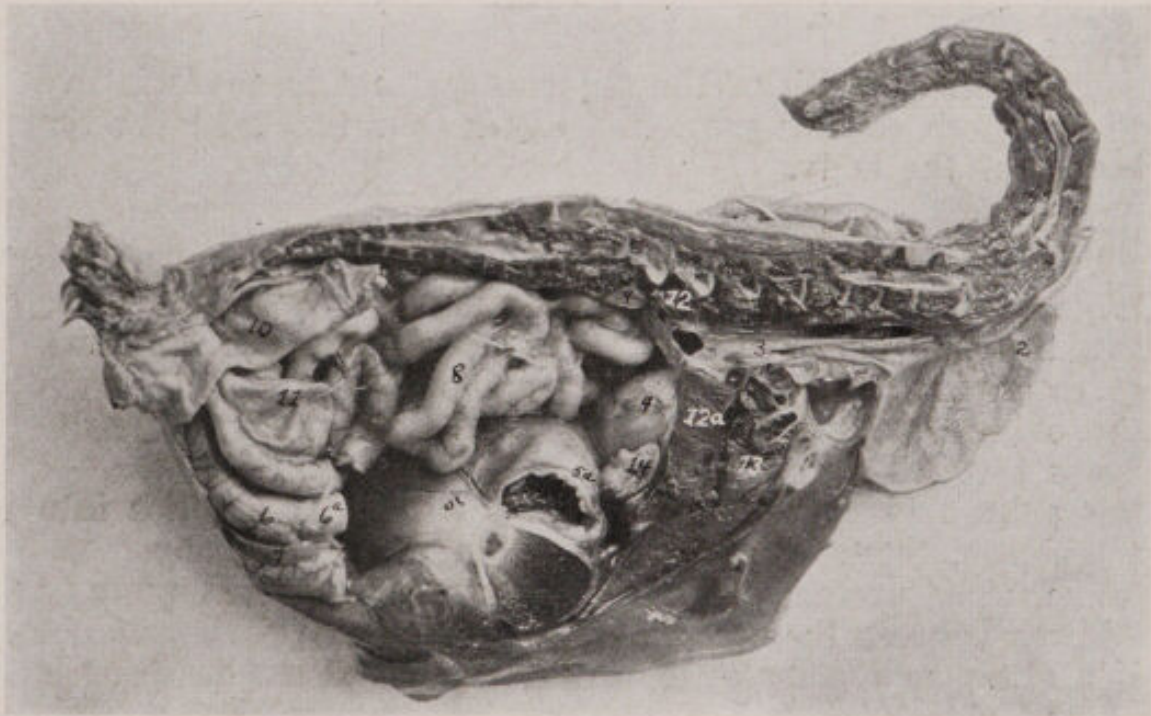


FIG. 5. SECTION THROUGH THE MEDIAN LINE OF A TWO-POUND PULLET.

No. 1, the stump of the first portion of the esophagus; 2, left wall of the crop; 3, second portion of the esophagus located just below the vertebra; 4, the proventriculus lying anterolaterally to the gizzard, superoposterior to the liver and to the left of the spleen; 5, the gizzard; 6, duodenal loop; 7, pancreas; 8, floating portion of the small intestines; 9, ovary; 10, rectum; 11, ceca; 12a, liver; 13, heart.

zard that the proventriculus enters and about one-half inch distant.

Small Intestine

The first portion of the small intestine is called the duodenum, which forms a long loop called the duodenal loop. This loop passes obliquely to the right side and proceeds along the outer right abdominal wall, passing round toward the right side, following along the posterior abdominal wall, where the terminal portion of the loop rests. The remaining portion of the small intestine forms a thick coil supported by a mesen-

tery and occupies the space between the two large abdominal air sacs.

Large Intestine

The large intestine is very short. At the point where the small intestine terminates in the large intestine, there is given off two long blind pouches—the ceca. These blind pouches are directed toward the head. The ceca in pigeons are comparatively short, while in fowls and ducks and geese they are quite long. The major portion of the ceca is narrow, becoming larger in calibre near the blind extremity. The large intestine or colon extends backward in a straight line with the under surface of the vertebrae and terminates in the cloaca.

The entire length of the alimentary tract in fowls is five to six times, and in geese and ducks four to five times, the length of the body.

Cloaca

The cloaca is a sacculation with greater diameter than the large intestine and communicates anteriorly with the large intestine and opens to the external world through the anus. It receives the feces, urinary secretion and the eggs from the oviduct in the female. The vas deferens of the male opens through a papilla on the anal mucous membrane. At the point where the rectum (large intestine) empties into the cloaca, there is a strong, oblique fold of mucous membrane. The ureters empty at the summit of small papillae midway between the vasa deferens. The mouth of the oviduct is a slit. In the males of ducks, geese and swans there is present a copulatory organ, somewhat resembling the penis of mammals.

A small round or pear-shaped sac called the bursa of Fabricius is located in the dorsal wall of the cloaca. The cavity communicates, through a short canal, with the posterior border of the cloaca close to the anal wall. The mucous membrane lining the bursa contains glands. The bursa is larger in the young, but decreases in size with age. It apparently reaches its greatest size in chickens at about four months of age, at which time it may measure two to three centimeters by one and one-half centimeters. By ten or eleven months of age it has become quite rudimentary. Its function is not known. Glands similar to those of mammals are located in the intestines.

Liver

The liver is the largest gland in the body and consists of two lobes—a right and a left. The right lobe is somewhat

larger than the left, in most birds, except in the turkey and guinea, where they are of equal size. The liver lies behind the heart, the apex of which extends into the fissure between the anterior portion of its two lobes. The inferior surfaces

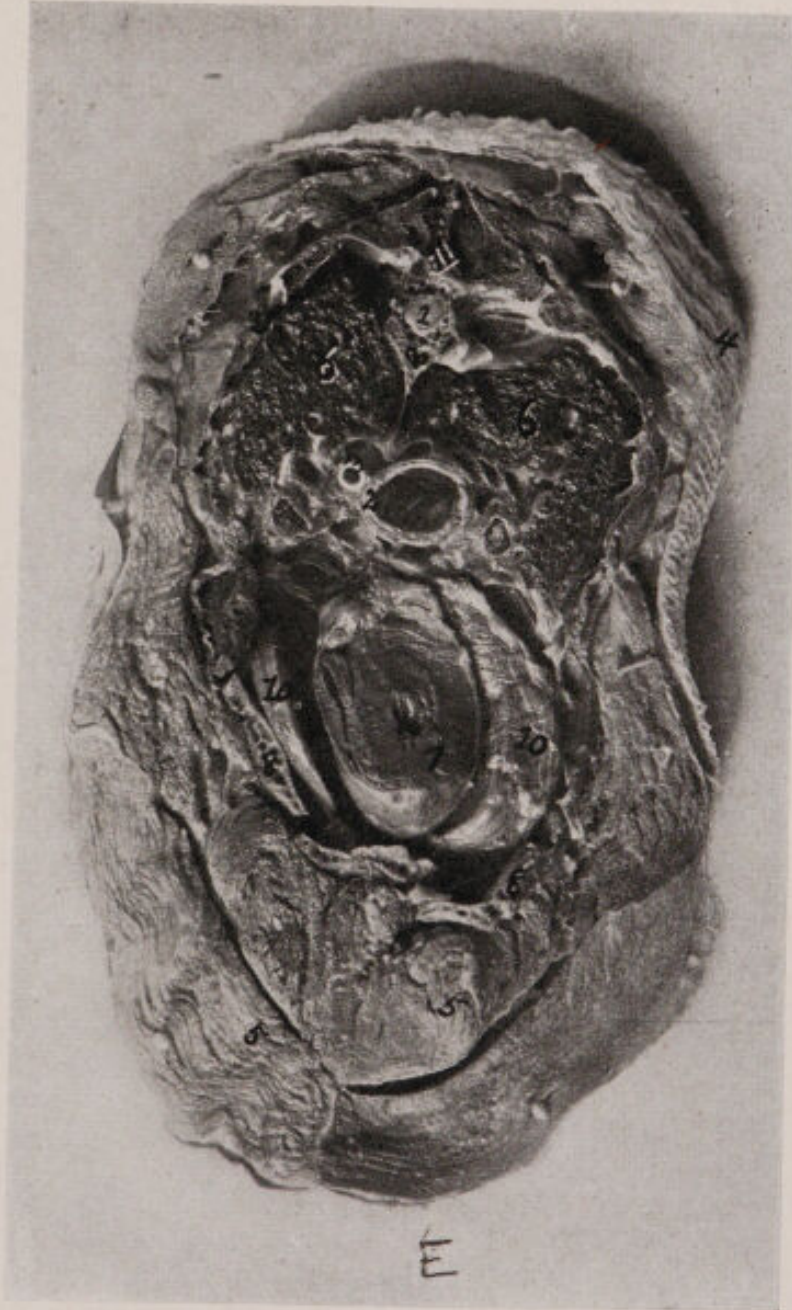


FIG. 6. TRANSVERSE SECTION THROUGH THE THORACIC REGION, LOOKING BACKWARD.

No. 1, spinal cord; 2, esophagus; 3, trachea; 4, skin; 5, pectoral muscles; 6, lungs; 7, heart; 8, breastbone;

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of the liver are convex and covered by a layer of visceral peritoneum. The two lobes are held together by a small ligament. A filiform ligament extends from the inner surface of the sternum and becomes lost in the serous covering of

the liver. This ligament assists in holding the liver in position. Most species of birds are provided with a gall bladder, which is located on the posterior surface of the right lobe of the liver. In birds without a gall bladder (pigeons, guineas) the main gall ducts of the two lobes of the liver unite and empty as one duct into the duodenum. In birds having a gall bladder the ductus hepaticus passes from the left lobe of the liver to the duodenum, while the bile from the right lobe empties into the gall bladder, from whence the gall is carried to the duodenum through the ductus cysticus.

In fowls the ducts of the liver and pancreas empty into the duodenum in the following order: First, the ductus pancreaticus, from the pancreas; second, the ductus hepaticus, directly from the left lobe of the liver; and, third, the ductus cysticus, from the gall bladder of the right lobe of the liver. In ducks the ductus hepaticus and ductus cysticus are united. This common duct empties into the duodenum close to the pylorus. The two branches of the pancreatic duct empty close behind the hepatic duct. In the pigeon the ductus hepaticus is double and extends from the left lobe, while a third duct carries the bile from the right lobe. (Gadow.) There are apparently three pancreatic ducts in this species.

Pancreas

The pancreas is a pale, long, yellowish, lobulated gland, sometimes called the abdominal salivary gland, and lies between the two branches of the long duodenal loop. In some species of birds the gland is divided into three distinct lobes, each provided with its own duct, which carries the secretion to the duodenum.

Spleen

The structure of the spleen is the same as in other animals. It is reddish brown in color in the fowl, shaped like a horse chestnut, and lies to the right in an angle formed by the proventriculus, liver and gizzard. Its shape varies in the different species of birds. In some it is globular, while in others lenticular.

THE RESPIRATORY TRACT

Nasal Cavities

The nasal cavities are short and narrow. The two nasal passages are separated by a cartilaginous septum and, in part, by a bony wall. In ducks and geese the external nasal opening is found toward the base of the beak. Through the

openings one can see through from one nostril to the other (nares perviae). The external openings are either round or slit-like. They are often surrounded by a thin dermoid structure and a border of peculiar feathers. Each nostril is provided with a turbinated bone divided into three parts, which may be considered as three turbinated bones. The middle turbinated bone is the largest and the lower one the smallest. A small, flat gland, peculiar to birds (fowls, ducks and geese), lies on the frontal bone in close proximity to the mesial corner of the eye. A duct extends from this gland forward and empties into the nostrils. The posterior nares opens into the mouth cavity through a slit-like opening in the roof of the mouth.

Larynx

Air passes through the nostrils and pharynx into the superior larynx. The superior larynx is a musculo-cartilaginous valve located at the superior extremity of the trachea. There is no epiglottis. A ring-like cartilage, the cricoid, is located at the base of the larynx. This forms the principal support. This cartilage is divided into four parts, namely, two side parts, one unequal ventral part and an unequal dorsal part. Some of these parts at times and in some species are fused. The arytenoid cartilages, three in number, are flexible and joined to the superior part of the cricoid. These cartilages bound supero-posteriorly the entrance of the larynx. At times the arytenoids become partially bony.

The walls are smooth and in the superior larynx there are no vocal cords. This organ is sometimes called the larynx cranialis, in contradistinction to the true larynx or larynx caudalis. The true larynx is located at the bifurcation of the trachea into the right and left bronchi; it is provided with delicate vocal cords. This organ is absent in voiceless birds. It is sometimes called the larynx bronchio-trachealis. In fowls it is flattened laterally. The last rings lie close together in fowls, but are connected in pigeons and more or less completely fused in geese. This structure is called the tympanum (drum). A bony, arrow-like passage is found between the tympanum and the opening into the bronchi. This bears a small half-moon-shaped fold, which is concave from above. On either side of this passageway there is located an elastic membrane, the *membrana tympaniformis interna*, which forms the inner wall of the adjacent bronchus. Laterally and between the tympanum and the two bronchial rings on either side there is a membrane called the *membrana tympaniformis externa*. Singing birds possess a well

developed muscle which in fowls, ducks and geese is rudimentary. In the male duck the inferior extremity is enlarged into a large sac, called the bulla tympaniformis. The left bronchus has a perceptible share in the formation of this bulla. This bulla is a resonance box.

Trachea

The trachea consists of closed rings round in shape and connected by short connecting bands. In fowls these rings are cartilaginous, while in singing birds they may be partly bony. The trachea is moved by means of two muscles.

Lungs

The lungs are two in number, red to pink in color and firmly connected with the costal wall. The ribs indent the lungs, allowing a part of the outer surface to project slightly between them. The ventral free surface is turned towards the body cavity and is covered by the rudimentary diaphragm. The rudimentary diaphragm contains some muscular structure and is attached to the ribs and vertebrae. The pointed anterior lobe extends to the first rib. The posterior part terminates in a broad surface and extends back as far as the anterior end of the kidneys. The bronchi communicate with the air sacs by openings from the posterior border. The two bronchi are broadened after they enter the lung, which is at the beginning of the second third and on the ventral surface. They lose their cartilaginous rings and continue as duct-like channels to the extreme posterior edge, where they terminate into cartilaginous rings called the ostium caudale, from which point they communicate with the ventral or large abdominal air sacs. Each bronchus gives off a ventral bronchus, called the bronchus diaphragmaticus caudalis, through which the air is conducted to the ostium intermedium caudale and into the caudal cella thoracica diaphragmatica. Each bronchus gives off lateral bronchi which extend to the ventral surface of the lung. They form blind pouches or air sacs (alveoli) near the surface of the lung.

Two bronchial systems take their origin from the main bronchus, the ventral and the dorsal. The bronchus clavicularis arises from the dorso-medial wall of the main bronchus a short distance after it enters the lung and before it broadens out. This bronchus gives off a large branch, called the bronchus cervicalis. It bends round the base of the main bronchus and the pulmonary artery and supplies the dorsal surface of the lung, and through the ostium claviculare it supplies air to the air sacs on the respective side (dorsal air

sac). It terminates close to the middle of the lung, where it communicates, through a small opening, with the diaphragmatic air sac.

The bronchus cervicalis extends forward in the direction of the original trunk and anteriorly communicates with the cervical air sac through the ostium cervicale.

There is also given off from the main bronchus the bronchus cervicularis dorsalis and medialis. The first extends with a few bronchi into the clavicular air sac. The bronchus diaphragmaticus cranialis extends laterally, dorsally and medially, and terminates in the thoracic air sac through the ostium intermedium craniale. The bronchus caudalis originates from the dorso-median wall and extends to the caudal and middle portions of the lung. There is given off another bronchus called the bronchus lateralis from this lateral bronchus.

There extend from the main bronchus several bronchi in the medial half of the lung. There are six to ten dorsal bronchi (bronchi dorsales). Numerous perpendicular, narrow, thick-walled tubes lying close to each other are given off from the dorsal wall of the main bronchus and other bronchi mentioned. These tubes have been called the "lung pipes," which by lateral pressure become five- or six-sided tubes. The mass of the lungs are made up of these tubes. These tubes terminate near the surface of the lung. The ends of these tubes, which lie at right angles to the main channel, form sacculations somewhat simulating the air sacs of mammals. Connective tissue, through which pass blood vessels and nerves, fills in the space between these lung tubules.

Air Sacs

The air sacs are bladderlike structures with delicate walls. The sacs are lined with a mucous membrane which is a continuation of the mucous membrane of the bronchi. They are connected with the bronchial tubes but do not communicate with each other. They also communicate with air spaces in many of the bones of the trunk and limbs. Bronchial tubes extending to the surface of the lung communicate directly with these air cells. The air sacs continue partly into the bones and line the walls of these spaces. These air spaces, some of which are of considerable size, add to the bulk of the body of the bird without increasing its weight. They reach their highest state of development in the fliers and swimmers and are less developed in running birds. The air sacs are as follows: The anterior thoracic air sac, from which arises the

axillary cell which extends to the humerus, breastbone and ribs. This is the only air sac that is single, the balance existing in pairs. The cervical air sacs lie on the last cervical vertebra and extend into the cervical vertebra. The infero-posterior thoracic air sac (ventral, phrenic or diaphragmatic). The supero-posterior thoracic air sacs (dorsal phrenic or diaphragmatic air sacs). These air sacs or cells lie between the lungs and the abdominal viscera at the rudimentary diaphragm and aid in keeping separate the thoracic and abdominal viscera. The abdominal air sacs, which are by far the larger of all the air sacs, extend from the anterior to near the posterior border of the abdominal cavity. Part of the abdominal viscera lies between them. They extend to the pelvis and thigh bones. The cavities of the head receive their air from the nasal passages.

Thymus Gland

The thymus gland is present in young birds and is located along each jugular vein in the neck. The parts of this gland are elongated and lobulated.

Carotid Glands

These are two round or oblong glands abundantly supplied by blood vessels and lie at the base of the carotid arteries.

Adrenal Glands

These small reddish-like bodies lie at the anterior end of the kidneys.

THE CIRCULATORY SYSTEM

The heart is located in the thoracic cavity with the base directed in a cranio-dorsal direction. The apex directed downward and backward lies in the anterior portion of the fissure formed by the two lobes of the liver. It is surrounded by a pericardial sac which is often attached by means of connective tissue to the adjacent air sac. The structure of the heart is similar to that of mammals, except that the tricuspid valves of the right auriculo-ventricular opening are replaced with a strong double muscular plate which extends from the outer chamber wall. The papillary muscles are absent in the right chamber. The aorta is given off from the left ventricle and the pulmonary artery from the right ventricle as in mammals. The bicuspid valve frequently is provided with three points. The venae cavae (two anterior and one posterior) empty into the right auricle. The pulmonary veins empty through one common opening into the left auricle.

The structure of the blood vessels are the same as in mammals. The pulmonary artery emerges from the right ventricle, is short and divides into a right and a left branch, which go to the respective lungs.

The aorta emerges from the left ventricle, is short and gives off the right and left coronaries and bifurcates into the brachiocephalic dexter (the right branch) and the brachiocephalic sinister (the left branch). The brachiocephalic dexter gives off the posterior aorta which winds round the right bronchus and passes along the lower portions of the vertebrae. It then bifurcates to form the right carotid and right subclavian artery. Farther along the left and right carotids communicate and at this point the thyroid gland is located. The brachiocephalic sinister bifurcates into the left carotid and the left subclavian artery.

In some species of birds the two carotids unite and form one carotid called the carotid primaria. The carotids give off branches to adjacent parts as they pass toward the head. A vertebral artery is given off, which supplies the vertebrae. At the level of the head each carotid divides into two branches, one supplying the brain, eyeball and adjacent parts, and the other the remainder of the cranial structures. The two subclavian arteries each give off a sterno-clavicularis which supplies the anterior sternal region up to the shoulder, where it divides into arteries which supply the breast and the arm. The thoracic cranialis is also given off from the brachiocephalic as well as the thoracic caudalis, the latter supplying the large breast muscle. At about this point there is also a branch, the internal mammary, given off and which follows along the inner border of the sternum. The axillary artery may be considered a continuation of the brachiocephalic; it supplies the muscles of the wing system.

The posterior aorta extends along the lower borders of the vertebra as far as the pelvis. It gives off on its way intercostals, which pass, one along the posterior border of each rib and are disposed of similar to those of mammals. It also gives off a celiac axis supplying the stomach, liver and spleen, two mesenteric branches (mesentericus cranialis and m.

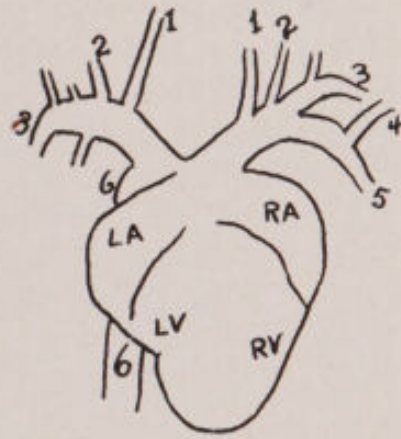


FIG. 7. HEART OF FOWL WITH ITS MAIN BRANCHES.

1, carotid artery; 2, sterno-clavicularis artery; 3, axillary artery; 4, thoracic cranialis artery; 5, thoracic caudalis; 6, posterior aorta; LA, left auricle; RA, right auricle; LV, left ventricle; RV, right ventricle.

caudalis) supplying the mesentery and small intestine. The posterior aorta also gives off lumbar arteries and renals, the latter supplying the kidneys, also arteries to the testes (testicular) in the male and ovarian arteries supplying the ovary in the female. At the hind extremities there is given off the external iliac at a line near the junction of the anterior and the middle thirds of the kidney. This supplies the pelvic and outer muscles of that region. The aorta divides into two branches, the ischiatica, and also sends an artery back along the under side of the caudal vertebra (the sacralis media). The ischial artery, in company with the ischial nerve, passes through the foramen ischiaticum, giving off branches to the muscles of that region.

The pulmonary veins, two in number, originate from a short stem (pulmonary artery) which springs from the right ventricle. These veins furnish the lungs with functional blood, which is returned to the heart through pulmonary veins entering the left auricle.

There are three venous trunks carrying the venous blood from the body and extremities. These are a left and a right anterior vena cava (vena cava cranialis) and a posterior vena cava (vena cava caudalis). These three vessels empty into the right auricle. Each anterior vena cava receives the jugular and subclavian vein of its respective side. The right jugular is larger than the left. They are located ventrally to the skull, where they anastomose through an oblique vein. (It is at this point that a bird is stuck in slaughtering.) At the inferior portion they receive blood from the vertebral vessels. They receive branches from the head (the cranial vein), also neck and back vein. The subclavian receives the blood from the veins of the breast and wing (sterno-clavicularis and thoracic-cranialis and caudalis, mammary and axillary veins). The subclavian empties into the anterior vena cava.

The posterior vena cava is short and receives the blood from the external and internal iliaes, hepatic, renal hypogastric and coccygeal veins. It also receives the blood from the porta hepatis, which collects blood from the abdominal viscera, especially the intestines.

THE BLOOD OF NORMAL FOWL

The blood of the fowl is made up of organized and unorganized elements. The unorganized part is plasma and the organized cells. The cells are elliptical-shaped nucleated red blood cells measuring 7x12 microns, oval nucleated thrombocytes, and white blood cells. The white blood cells consist of mast cells, eosinophiles, polymorphonuclear leukocytes, large mononuclear leukocytes and lymphocytes. The red

blood cells number about 3,500,000 per cmm., the white blood cells 30,000 per cmm., the thrombocytes 50,000 per cmm.

The lymphocytes constitute fifty-four per cent, the large mononuclear leukocytes twelve per cent, the polymorphonuclear leukocytes twenty-five per cent, the eosinophiles six per cent, and the mast three per cent.

LYMPH VESSELS

Lymph vessels are numerous. Those of the hind extremity empty into the veins on the border between the tail and the pelvis. There are very few lymph nodes. At the entrance



FIG. 8. BLOOD VESSELS OF THE PELVIS AND THIGH OF THE FOWL.

a, posterior aorta; a, b, external iliac artery; c, ischiadic artery; e, the ureter; f, the ischiadic nerve; g, the main artery of the thigh; h, the femoral vein; i, the internal iliac vein; j, the external iliac vein; k, the middle sacral artery.

of the thoracic cavity there are located two or more small lymph glands.

THE NERVOUS SYSTEM

The brain and spinal cord are surrounded by three membranes as in mammals. The brain is divided into the cerebrum, cerebellum and medulla oblongata. The pons varolii is either lacking or at most consists of a few narrow oblique fibers. The cerebral hemispheres are separated superiorly by a deep longitudinal fissure. There are no convolutions.

The fissure lateralis is well marked and is located laterally about the posterior border of the anterior third of the cerebrum. The epiphysis, a small body, is located between the hemispheres and at the posterior portion of the longitudinal fissure. The olfactory nerve consists of two conical bodies projecting forward from between the anterior portion of the hemispheres. The hypophysis (infundibulum), cruri cerebri and optic chiasm are similar to those of mammals. The corpus callosum is lacking or at most marked by only a few diagonal fibers. The hippocampus and the septum lucidum of mammals are lacking. The lateral sinuses are well developed. The lateral walls are thin and the grey matter small in quantity. At the base of each of the sinuses there is found an eminence which corresponds to the corpus striatum of mammals. At the postero-inferior portion of the cerebral hemispheres there are rounded eminences called the sight eminences. They are bounded on the dorsal side by the bridge of Sylvius. Their cavity communicates with the aqueductus cerebri which connects the third and fourth ventricles.

The cranial nerves number twelve, as in mammals. The olfactory (first cranial nerve) leaves the cranial cavity through a foramen which represents the perforated plate of mammals. It passes through the dorso-median part of the eye cavity, thence into the nasal cavity, where its fibers terminate in the mucous membrane.

The optic nerve (second cranial) forms the chiasm at the base of the brain. At this X the two nerves of sight cross. The motores oculorum (third cranial), the pathetici (fourth cranial), and abducens (sixth cranial) are distributed to the muscles of the eyeball. The trifacial (fifth cranial) gives off three branches, the ophthalmicus, the maxillaris and the mandibularis. The branch corresponding to the lingual of mammals is lacking. The facial (seventh cranial) is not well developed. The auditory (eighth cranial) extends into the labyrinth of the ear. The glosso-pharyngeal (ninth cranial) gives off a branch extending to the tongue; the remainder of the nerve is distributed similar to that in mammals.

The vagus (tenth cranial) and the spinal accessory (eleventh cranial) intertwine themselves in the proximity of the skull. The course and distribution of the vagus is similar to that in mammals. The hypo-glossal (twelfth cranial) is the motor nerve of the tongue.

The cerebellum or lesser brain is located in the posterior part of the cranial cavity. Numerous oblique fissures mark the upper surface, dividing it into a leaf-like structure. The

fourth ventricle is located under the cerebellum. Lateral pedicles attach it to the lower structures. The medulla oblongata is broader than the spinal cord. It connects the spinal cord with the brain.

The spinal cord terminates posteriorly in a thread-like termination without forming a cauda equina as in mammals. There are cervical and lumbar segments from which are given off nerves for the wings and the hind extremities. The dorsal segment is marked by an enlargement. The central canal as well as the mode of entrance and exit of the fibers is the same as in mammals.

The number of nerves that are given off from the spinal cord depends upon the number of vertebral segments. The spinal nerves are given off in pairs; each nerve originates from one dorsal and one ventral root, as in mammals; one nerve for each side of the body. The spinal ganglion is located on the dorsal root. Each spinal nerve divides into a small dorsal nerve supplying the muscles and other structures in the region above the level of the spinal column and a larger ventral branch supplying the body walls below the level. The spinal nerves have been placed in four groups, as follows; cervical (neck), dorsal (back), lumbar (loin), and caudal (tail) nerves. The wings receive their nerve supply from the brachial plexus. The brachial plexus is made up of the last two or three cervical nerves and the first one or two dorsal nerves. The structures in the pelvic region are supplied from branches of the ventral branches of the lumbar nerves. The nerves of the shoulder and pelvis are essentially the same as in mammals. The nerves of the skin and tail are small.

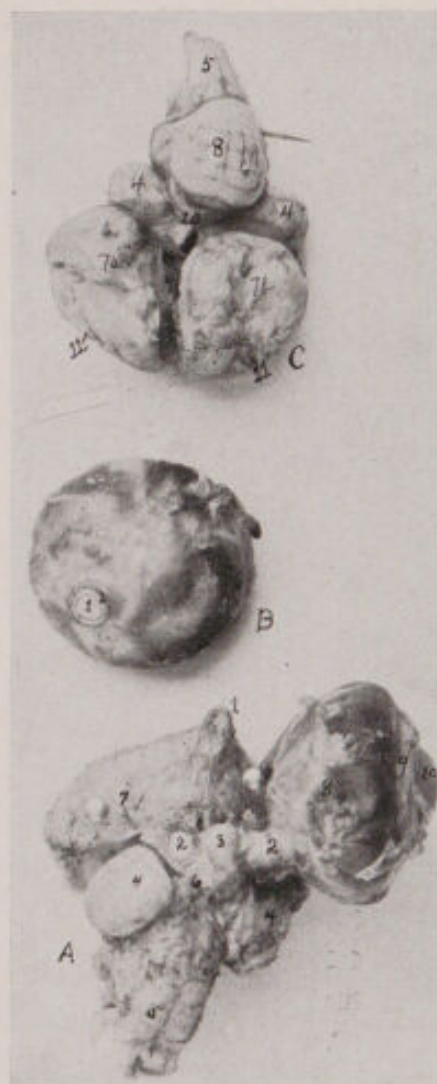


FIG. 9. BRAIN AND EYEBALL OF THE FOWL, SLIGHTLY ENLARGED.

A—1, the olfactory nerves; 2, the optic nerve; 3, pituitary gland, slightly dislodged posteriorly; 4, optic lobes; 5, medulla oblongata; 6, optic chiasm; 7, right cerebrum; 8, eyeball; 9, sclera; 10, cornea.

B—1, optic nerve; 2, its sheath.

C—4, optic lobes; 5, medulla oblongata; 7a, right and 7b, left, cerebral hemispheres; 8, cerebellum; 9, fissure longitudinalis; 10, fissure transversalis.

The sympathetic nerves have their origin at the cranio-cervical ganglion which lies at the base of the skull. From this ganglion fine filaments are sent to most of the cranial nerves as well as connecting branches. The sympathetic trunk extends along the cervical vertebra, occupying an oblique canal. It exchanges filaments with the cervical nerves. It continues on either side of the base of the vertebra through the thoracic and abdominal cavities. Branches from these trunks go to form the splanchnic nerve system supplying the visceral organs of the abdominal cavity. The right and left trunks finally unite, forming the ganglion coccygeum.

ORGANS OF SPECIAL SENSE

The Eyes

The eyes are rather large in proportion to the size of the body. The sense of sight is well developed. The eyes stand to the side of the head in the domestic birds. The orbital cavities are separated laterally by a bony septum (the septum inter-orbitale), but are not completely surrounded by bone. The lower eyelid is the larger and often incloses a small cartilaginous plate. The lower lid is more freely movable than the upper. The third eyelid (*membrana nictitans*) is well developed. A special muscle draws it from the inner canthus of the eye over the ball. There are no tarsal glands as in mammals. The muscles of the eyelids are of the smooth variety and in the place of eyelashes there may be found minute feathers. The gland of the eyelid lies on the nasal side and is often larger than the lacrimal (tear) gland. Its secretion is poured out onto the third eyelid. The tear gland (lacrimal) lies in the angle close to the temple. The tear gland is small and has one or more ducts emptying into the conjunctival sac at the temple side of the eyeball. The lacrimal sac and lacrimal duct carrying the tears to the nasal cavity are similar as those of mammals. The eyeball is made up of three coverings. The cornea covers the anterior portion of the eye and the sclera the outer remaining portion of the eyeball. The sclera is made up of small overlapping scales, connective tissue and a cartilaginous cup extending from the optic nerve at the posterior pole to the equator of the globe. The scleral ring is at the anterior border of this cartilage. The anterior chamber of the eye is large. The middle layer of the posterior portion of the eyeball is called the choroid, and is rich in pigment and blood vessels. The retina forms the inner coat and is rich in a dark pigment. The ciliary body consists of many folds. The ciliary muscle consists of oblique fibers arranged in three

bundles. Numerous wedge-shaped folds rich in blood vessels and containing pigment are found at the point of entrance of the optic nerve. In some birds these folds extend forward and are attached to the lens capsule. The iris forms a partition between the anterior and posterior chambers and is perforated in the center by a round hole, the pupillary opening. It contains a dark pigment on the posterior or lens side. This color or pigment gives the color to the eye. The yellow coloring of the eye is caused by the fat pigment, lipochrome. The widening and especially the intense narrowing of the pupil is in part due to oblique muscles (sphincter pupillare). The ciliary muscles are quite active. The retina does not contain blood vessels and the structure is similar to that of mammals. The crystalline lens in birds is rather flattened on the anterior side except in birds of nocturnal habits, in which it is very convex. It differs from the lens of mammals in that the lens epithelium develops into fibers in the equatorial portion and are arranged almost perpendicular to the axis of the eyeball. These are located near the ring pads. The portion for the passage of light is relatively small.

The Organs of Hearing

The outer ear is lacking. A skin fold surrounds the external opening of the ear in chickens and is called the ear lobe, while in other birds the outer ear opening may be surrounded by peculiarly formed feathers. The outer canal is short and contains an ear gland. This canal is lined with the continuation of the skin and connects with the ear drum. The tympanic membrane is convex externally and is stretched in a bony ring. The ear drum forms an irregular cavity which is in relation to the air cavities of the skull and with the bony and cartilaginous ear trumpet in connection with the pharyngeal cavity. The columella only is present, which may be compared to the stirrup of mammals. The inner ear consists of a bony labyrinth surrounded by a spongy bone substance. In it is distinguished the vestibule, the three half-circled canals and the cochlea. The vestibule is a small irregular cavity which communicates with the cochlea and through the fenestra vestibularis with the drum cavity. The endolymph of the vestibule contains microscopic crystals of calcium carbonate. The semicircular canals are relatively larger

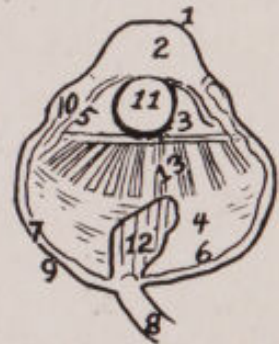


FIG. 10. SECTION THROUGH THE EYE OF A HEN.

1, cornea; 2, anterior chamber; 3, posterior chamber; 4, vitreous chamber; 5, iris; 6, retina; 7, choroid coat; 8, optic nerve; 9, sclerotic coat; 10, scleral ring; 11, lens; 12, pecten; 13, corpus ciliaris.

and thicker walled than in mammals. The ampulla are the upper and back canals with bony walls. The cochlea is a tube thinly covered at the blind end and contains the cuticular cochlea. At its point it is broadened for the formation of the lagena. The cavity of the cochlea is divided by the spiral walls, the scala vestibuli and the scala tympani. These walls are visible in the vestibulum so that they may be seen at the beginning of the cochlea.



FIG. 11. COCH-
LEAR LABY-
RINTH OF A
HEN

1, vestibule;
2, semicircular
canals; 3, am-
pullae; 4,
cochlea; 5,
fenestra vesti-
bularis; 6, fe-
nestra cochlea-
ris.

Organs of Smell

The olfactory nerve, after merging from the cranium through the olfactory foramen passes down and spreads out, terminating in filaments on the mucous membrane of the nasal passage.

Organs of Taste

The tongue is considered the taste organ. In most birds the thick stratified squamous epithelial dorsal surface is little adapted for taste perception. The ninth nerve is the nerve of taste. The lingual branch of the trigeminus is missing. Filaments of the first and second branches of the trifacial, which is broadened in the mucous membrane of the hard palate, furnish taste filaments to that part. Taste buds are then found on both the tongue and hard palate.

Organs of Touch

The organs of touch are the skin and feathers. The skin consists of an epidermis and dermis. The skin contains no sweat glands. In fowls and many other birds there is provided a tail (rump) gland. This is a tubular gland which secretes an oily substance that is carried to the surface through a common duct. The bird, by obtaining some of this oil substance on its beak, oils the feathers. This oil preserves the feathers from becoming dry and brittle and prevents loss from weather conditions. In a few birds special touch and taste perception is provided by the edges and point of the beak. The dermis (corium) is well developed and furnishes ample muscular means for the raising and lowering of the feathers. The corium is thin. Papillary bodies are present only in a few areas, as the region of the eyes and on the toes. Thickened epithelial elevations are noted on the ventral portion of the toes, where there is great wear as a result of contact with the ground.

The muscles of the skin are well developed in certain parts of the body. They are divided into primary and secondary muscles. The secondary muscles are branches of the skeletal muscles. On the feathered parts of the skin the epidermis is thin, rather dry on the surface and is provided with continuous scale-like layers. The stratum corneum is thick on the horny sheath of the beak, on the dorsal surfaces of the toes, the spurs of the cock, and the scaly plates of the shanks. The feathers covering the surface of the body represent a special epidermal formation, analogous to the hair of animals. Feathers occur over the whole surface of the body except on certain parts of the under surface, and the neck, shanks and toes. Some breeds are provided with a row on the outer edge of the shanks and outer toe. The corium is not very rich in blood vessels. It forms a thick net-like structure in the comb, gills and similar appendages of chickens and turkeys. The only gland that is present is the tail (rump) gland (*glandula uropygii*). The gland is round or oval and in fowls the size of a pea. In geese it is the size of a hazelnut. A median septum divides the gland into two halves; at times there may be found two ducts leading from this gland, but there is usually only one. The gland is largest in swimming birds. The gland is a tubular one and is provided with a sinus into which the cells pour their secretion. The corium often contains mucous sacs.

The feathers develop from a papillary structure of the corium. This corresponds to the hair papilla of mammals. The feather is divided into a quill, a midrib or shaft, primary and secondary barbs. The free end of the quill occupies the papilla of the skin and is roundish, rather three-sided in shape. It is hollow, with thin dividing septa. It has a cup-shaped depression at the free end which surrounds the feather papilla and includes a horny mass. The shaft is provided with four sides and four edges and is solid. It contains a white spongy substance. From the sides of the shaft the primary barbs extend out, and in most breeds on either border of these primary barbs we find secondary barbs or barbules which dovetail into the secondary barbs or barbules of the adjacent barb. These form the web of the feather. There are no barbules in the fluffy portion of the feather nor in feathers of the silky breeds.

The feather coat is changed twice a year, either in late summer or fall, and in spring or early summer. A chick molts four times before growing its adult feathers.

THE REPRODUCTIVE ORGANS OF THE HEN

The physiological basis of reproduction of the female fowl is the left ovary and left oviduct. The right ovary and oviduct are absent, due to the fact that they degenerate during embryonic life.

The ovary is located in the sublumbar region of the abdominal cavity and to the right of the median line and touching the left adrenal gland and just anterior to and below the anterior portion of the kidney. It is located superior to the liver and at the juncture of the abdominal and thoracic cavities. It appears as a cluster of spheres or globe-shaped bodies

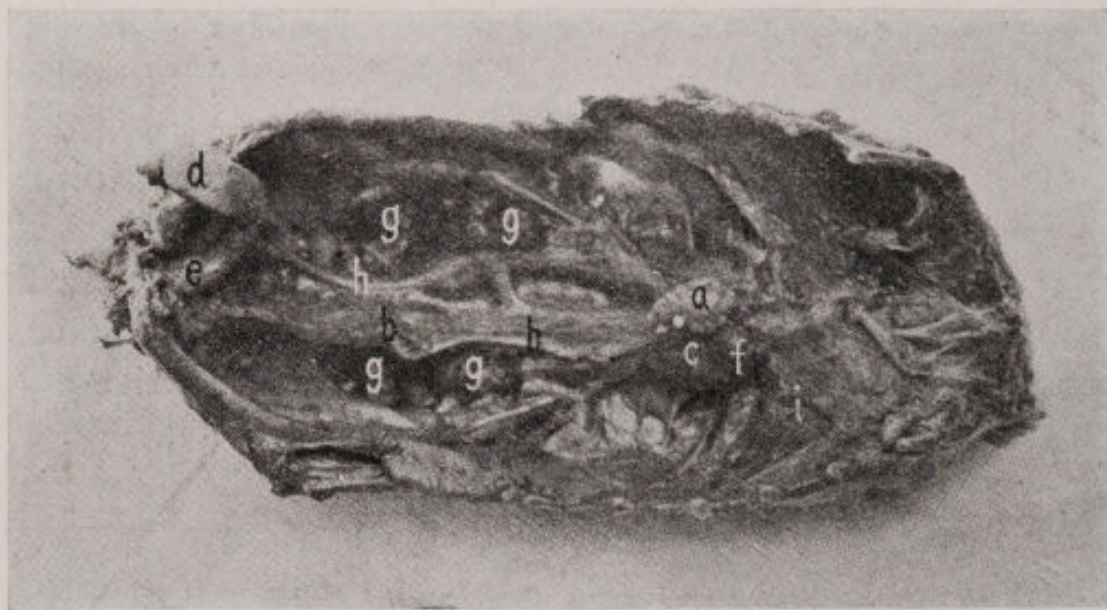


FIG. 12. THE PELVIC ORGANS OF A PULLET.

a, ovary; b, oviduct; c, infundibuliform portion or origin of the oviduct; d, rectum; e, cloaca into which the oviduct empties; f, adrenal gland; g, kidney; h, ureter carrying the secretion of the kidney to the cloaca; i, lung.

which in the adult hen number from 900 to 3,500. Fig. 12, letter *a*, represents an ovary of an adult White Wyandotte pullet that has never functionated. The undeveloped ova are noted in a grape-like mass. Fig. 13, letter *a*, represents an active ovary from a three-pound White Leghorn bantam hen. This hen was developing one egg a day, having laid an egg only three hours before being killed: *b* represents the yolk of an ovum which would probably have been fully developed in less than twenty-four hours. The ovum is surrounded by a thin membrane or capsule very vascular, as shown in Fig. 13. This capsule is continued back onto the stalk which attaches it to the central fibrous supporting portion of the ovary. This portion is attached to the structures of the back. When the yolk portion of the ovum is fully developed the cap-

sule ruptures and the yolk falls into an expanded portion of the oviduct at *c*, Fig. 13. This portion of the duct is very thin and gradually merges into a thicker wall, in which portion the mucous membrane is thrown into folds. The yolk is surrounded by a delicate membrane, the vitelline membrane, which holds the mass intact, thus giving it the spherical appearance.

After the stigmen ruptures and the yolk is discharged into

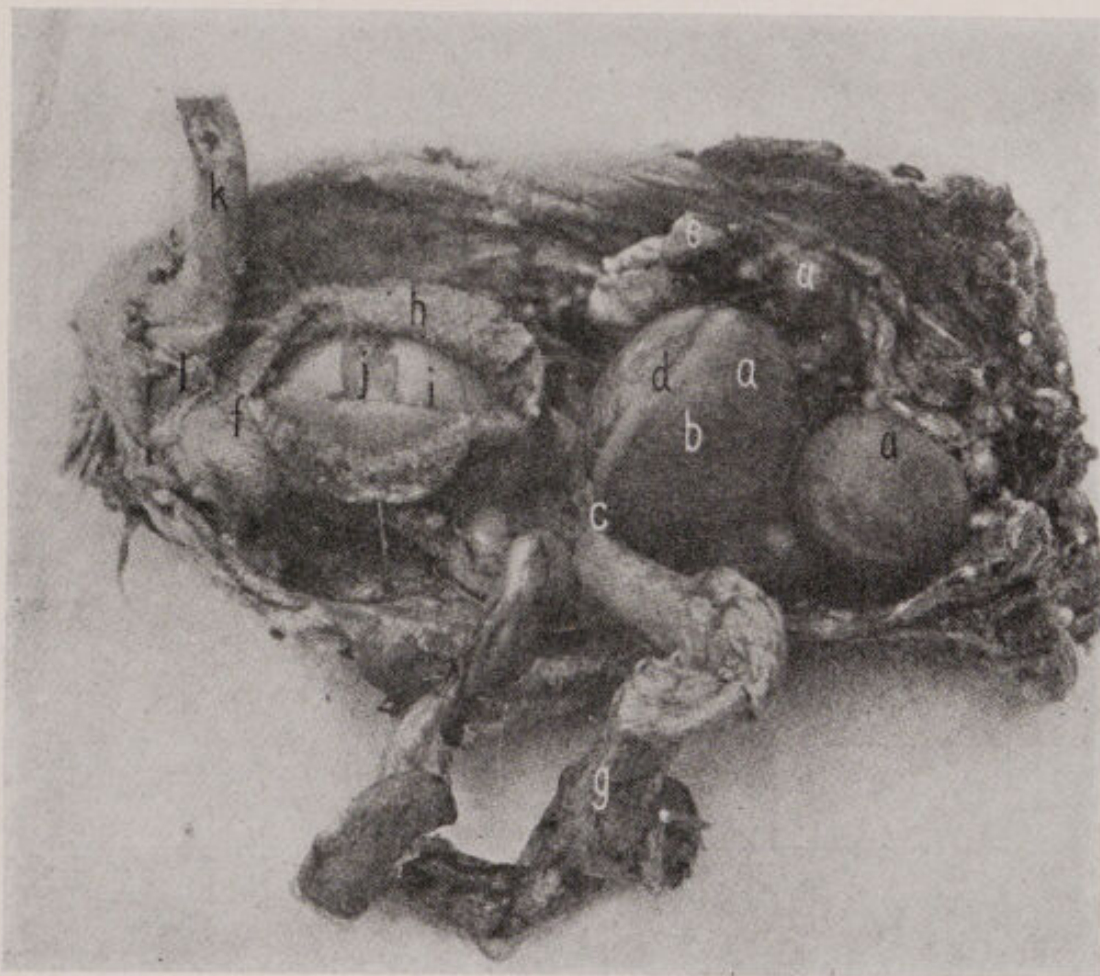


FIG. 13. PELVIC ORGANS OF A HEN.

a, the ovary; *b*, ovum fully developed; *c*, infundibuliform portion of the oviduct; *d*, stigma or point of rupture of follicle; *e*, a degenerated ovum; *f*, portion in which shell is formed; *g*, a portion of the oviduct torn from its ligaments and laid over to one side; *h*, showing the villus-like mucous membrane; *i*, albuminous portion of newly formed egg; *j*, the yolk of the same; *k*, rectum; *l*, cloaca.

the egg canal there remains a cup-shaped cavity attached to the ovary and which is called the calyx, which gradually disappears.

One by one the yolks are developed to full size or to maturity from the mass of undeveloped ova of the ovary as illustrated in Fig. 12, letter *a*. Fig. 13, letter *b*, shows an ovum or yolk reaching full development, and *d* shows a non-vascular

line the stigma where the follicular wall is becoming thin preparatory to discharging the yolk into the oviduct. The discharge of the yolk into the oviduct is sometimes spoken of as ovulation.

The yolk has its origin in a minute sphere containing a nucleus, as illustrated by *a*, Fig. 14. This nucleus marks the point of the development of the embryo chick after fertilization. It is noted to be located in the central portion. When the cell begins the development of the yolk there is noted first a deposit of fine granules of yolk around the central nucleus. These granules of yolk material gradually extend towards the cell wall. This deposit is known as the latebra or the flask-shaped mass of white yolk forming thin layers of yellow yolk.

Later, when the ovum has reached a size of about 0.66 millimeter in diameter, the nucleus occupies a position just under the vitelline membrane and at the end of the flask-shaped mass, as illustrated in *a*, Fig. 14.

Later there are formed several layers of yellow yolk deposited around the central mass of white yolk, apparently brought about through the secretion of the peripheral layer of protoplasm.

The spermatozoa, *a*, Fig. 18, make their way by aid of their terminal flagella or tails through the oviduct and fertilization takes place as soon as the yolk has entered the oviduct. Only one spermatozoon is utilized in this fertilization process. The balance are repelled from the cell.

After the yolk passes into the oviduct albumen is formed around it in the second or upper portion by specialized columnar epithelial cells.

The contraction of the muscles of the oviduct forces the contents along. When the albumen formation is completed the newly forming egg passes into the isthmus or third portion where through the activity of other specialized cells a membrane is formed around the mass.

In the lower portion, as illustrated in Fig. 13, letter *f*, the calcium layer or shell is formed to protect the delicate mass within from external violence. Here the tint or color is produced in shells other than white.

The formation of the albumen around the yolk in the upper portion of the oviduct is probably accomplished in about three hours. The membrane surrounding the egg mass is formed in the isthmus in about the same length of time. The formation of the shell and the expulsion of the egg will be accomplished in from twelve to eighteen hours.

The yolk is of less specific gravity than the albumen, hence it gradually rises with the blastoderm uppermost; if allowed to remain, the blastoderm may become adherent to the egg membrane and cause death of the embryo, hence the necessity of turning the egg kept for hatching and during the first eighteen days of incubation.

There is just as high a production of eggs from an indi-



FIG. 14. SECTION OF OVARY OF THE HEN.

a, undeveloped ova showing their nuclei; b, one in which deposit of yolk has begun; c, a section through the center showing the germinal vesicle.

vidual without the service of a male as with such service. In other words, the spermatozoa have no influence on the rate and number of the development of eggs.

The egg as laid consists of an outer shell coating giving it a gloss or so-called bloom, which may be considered as a pro-

protective coat. The shell consists largely of lime salts. An outer shell membrane is located just inside the shell and an inner membrane dips across at the large end of the egg, forming the air cell. This membrane consists of a fibrous structure, the fibers of which extend in all directions. The air chamber becomes larger as incubation goes on, in order to meet the respiratory needs of the embryo or as we may say the fetus, the head being almost invariably developed in that end if the egg lies on its side. The albumen and a portion of the yolk become appropriated for the formation of the embryo chick.

Immediately surrounding the yolk there is a dense layer of albumen and outside of this a less dense layer.

In the albumen at either pole of the yolk is a long mass of dense and partially twisted albumen apparently adherent to the vitelline membrane or yolk sac, and to the inner shell membrane by the other end. By some this has been regarded

as a stay, so to speak, which to a certain extent prevents violence to the delicate structures within the central part of the egg.

The albuminous portion (egg white) consists of 86.2 per cent water, 13 per cent protein, 0.2 per cent fat and 0.6 per cent ash and possesses a caloric value of 1,608. The egg yolk consists of 16.1 per cent protein, 33.3 per cent fat, 1.1 per cent ash and 49.5 per cent water, with a caloric value of 265.

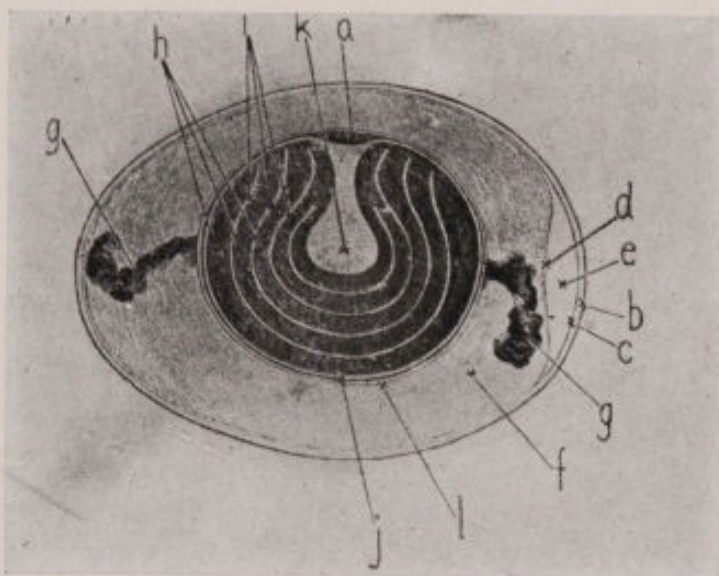


FIG. 15. DIAGRAMMATIC STRUCTURE OF THE EGG.

a, the blastoderm; b, the shell; c, the outer shell membrane; d, the inner shell membrane; e, the air cell at the large end; f, the albumen; g, the chalaza; h, the dark yolk; i, the white yolk; j, the vitelline membrane; k, the flask-like white yolk; l, a fluid albuminous layer which immediately surrounds the yolk.

The hen egg corresponds to the ovum of higher animal life where after fertilization of the ovum development of the fetus takes place normally in the uterus of the mother. The ovum of mammals is made up of a male and a female pronucleus as in the hen egg and protoplasm and deutoplasm, the deutoplasm being nutriment for the embryo till it has developed sufficiently to draw on the nutriments of the blood from the

mother's uterus. In the case of the bird there is no uterus in the sense that we speak of it in higher animal life, hence no uterine placenta, because there is no fetus developed in the bird, but to take its place there is stored up an abundance of food, taking the place of the deutoplasm and maternal nutrients of higher animal life. Nature has been elaborate in storing up food for the embryo and the baby chick, for the yolk is apparently almost wholly intended to be drawn upon the first seventy-two hours of the baby chick's life or until it is strong enough to follow the mother and till hatching of the brood is over. An examination of a newly hatched baby chick will show this yolk in the abdominal cavity and much still unabsorbed.

The active or functioning oviduct is a rather large, tortuous tube varying in size and length, according to the size of the hen, and filling a large part of the left half of the abdominal cavity as illustrated in Fig. 13. In a single comb Rhode Island Red pullet weighing six pounds and producing an egg a day, the oviduct was found to measure twenty inches in length. In a White Wyandotte pullet weighing five pounds, and whose ovary and oviduct had not yet become active, the oviduct measured but five inches. See Fig. 12, letter *b*.

It can readily be seen that in a very fat hen with the intestines, liver and other organs and a functioning ovary and oviduct, as illustrated in Fig. 13, the abdominal cavity would be crowded. When this crowded condition arises there may be a partial or complete cessation of the function of the ovary and oviduct, hence the hen ceases to lay.

The oviduct originates at the anterior portion of the abdominal cavity, Fig. 12, letter *c*, by an expansion at the ovary in such a way as to receive the yolk when it is discharged from the yolk sac of the ovary. This portion is anatomically known as the funnel, ostium abdominale or infundibulum. The oviduct may be divided into five portions, as follows: (1) The principal albumen secreting portion, (2) a more constricted portion, (3) the isthmus, (4) the shell gland portion, sometimes referred to as the uterus, and (5) the outer passage by some known as the vagina. The vaginal or outer portion of the oviduct is guarded by a rather well-developed sphincter muscle. The oviduct is attached to the surrounding structures by dorsal and ventral ligaments.

The oviduct consists of three main coats, namely: an external serous, a middle muscular being made up of an outer longitudinal and an inner circular layer, and an internal mucous coat which is thrown into folds both primary and sec-

ondary and provided with columnar epithelial cells. The oviduct has great power of dilatation, but tears easily if the traction is too much in one direction. A rupture of the oviduct sometimes occurs.

THE MALE REPRODUCTIVE ORGANS

The generative organs of the male fowl are the testes and vas deferens or seminal tubules.

In the cockerel, before sexual maturity, which is denoted in physical appearance by the male bird crowing, the testicles, two in number, are very small, measuring only about one-half inch long and scarcely one-fourth inch in diameter. They

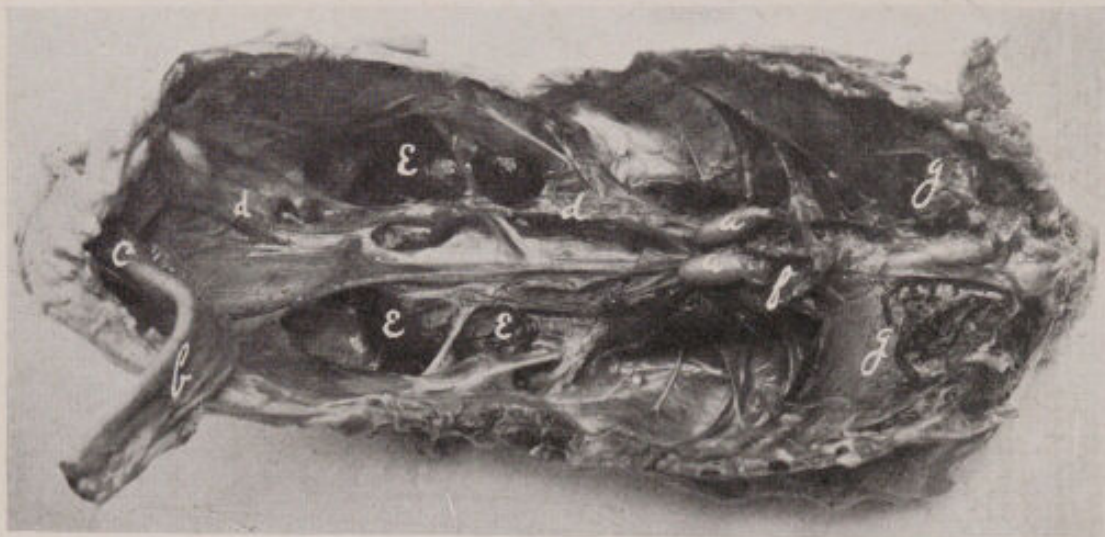


FIG. 16. GENERATIVE ORGANS OF A COCKEREL.

a, the testicles; b, the rectum cut and turned back; c, the cloaca into which the duct terminates; d, the vas deferens; e, the kidneys; f, the adrenal gland; g, the lungs.

resemble, in shape, a navy bean and are yellowish-white in color. Fig. 16 illustrates the testes at *a*, and at *d* may be seen the undeveloped vas deferens or seminal tubules.

As the male bird becomes sexually active the testicles develop to enormous size, measuring two inches in length and seven-eighths of an inch in diameter, as illustrated in Fig. 17, which is from a single comb White Leghorn cock one year old.

The testis is made up of a globus major and globus minor, or epididymis, the latter rather rudimentary. The globus major forms the major portion of the testicle. The epididymis is short and from it originates the vas deferens as shown in Fig. 17, letter *d*.

The testicular tissue is made up of fine intertwined sperm

canals, united by a web of bands. In chickens the canals are broad. They are the secreting tubules in which are formed the spermatozoa (see Fig. 16), and a quantity of fluid in which the spermatozoa are transported and an internal secretion.

The left testis is usually larger than the right. They increase in size during rutting (breeding season).

The testicles are surrounded by a thin and delicate membrane, which is very vascular, as is shown in Fig. 17, letter *a*.



FIG. 17. PELVIC CAVITY OF A COCK, SHOWING THE FULLY DEVELOPED AND ACTIVE TESTICLES.

a, the testicles; *b*, the rectum cut and turned back; *c*, the cloaca; *d*, the vas deferens; *e*, the kidneys; *f*, the lungs.

The testicles are located just back of the lungs in the region of the adrenal gland and below the anterior portion of the kidney and in front of the three last ribs. They are attached by means of loose connective tissue to the abdominal aorta, veins and bodies of the vertebrae.

The tube carrying the fluid or semen from the testis is called the vas deferens and originates in the epididymis, which is very short and is located on the upper and inner surface of the testicle and extends backward attached by connective tissue to the roof of the lumbo-pelvic cavity and to the inner side of the kidney. This tube at first small gradually becomes larger and is tortuous as it reaches the cloaca. It empties its contents at the summit of a small eminence in the cloacal mucous membrane.

That an internal secretion is manufactured in the testicles is proved by the physical changes which take place after the testicles are removed. The bird loses his vim, energy and masculine appearance and ambitions and becomes sluggish, lays on fat and is hated by both males and females alike. It often shows some femininity in that it will take a brood of chicks and mother them. The meat becomes more tender and more palatable. In short, there is the same change that is noted in other animals that have been castrated.

THE URINARY SECRETION

The kidneys are elongated and lobulated, measuring 2.5 inches long in the fowl of average size and occupying irregular

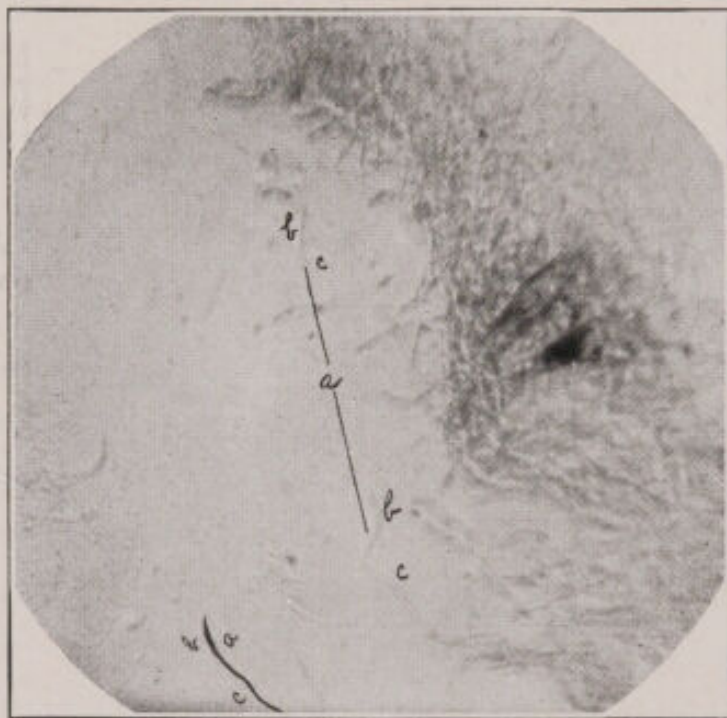


FIG. 18. SPERMATOOA FROM A SMEAR FROM FLUID OF THE VAS DEFERENS OF A S. C. W. LEGHORN COCK.
a, the spermatozoa; b, the head; c, the tail.

cavities in the lumbo-pelvic roof. There are three distinct lobes, and each lobe is made up of lobules. The uriniferous tubules terminate on the surface of the kidney, forming the ureter. The ureter extends along the surface of the kidney, receiving the contents from the various tubules which empty into it. The ureter empties into the cloaca. The kidney tissue is very soft and of a reddish-brown color.

The urinary secretion is very thick and at times pasty or creamy in consistency, filling the ureter lumen. The salts are

abundant. In many cases the material solidifies on exposure to the air in less than one minute. The salts dry on the outer surface of the droppings and appear as white, chalky material.

The urinary secretion has been found by investigation carried on in this laboratory to be acid to litmus in reaction.



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main dry on account of the good underdrainage. If this underdrainage is not provided, the floor at certain times will be wet and many of the birds will become sick. Colds and roup are among the ills such conditions favor.

The modern poultry house equipment includes a removable dropping board built horizontally and about thirty inches above the floor. The perch poles are located horizontally and about fourteen inches apart, and about ten or twelve inches above the dropping boards. At one end is built a coop in which to break up the broody hens, and the nests are made about fourteen inches square and placed just under the outer edge of the dropping boards or at one end and, like the other equipment, are movable. By this arrangement the entire floor is available for scratch material such as straw, stover or leaves, and in this scratch material the grain ration is thrown. If ventilation is needed in the back during the hot nights of summer it is provided high up so that no drafts will be on the birds. In the winter this ventilator is kept closed. The back, ends and top are made tight so that there will be no drafts upon the birds.

Sunlight is one of the most powerful of disinfectants, even a parasiticide for certain young parasites, and is necessary to the health and contentment of the fowls. It has the advantage also of revealing filth in the building which might otherwise escape the eye of the attendant, and remain to breed disease in the flock. In cold climates windows must be provided for light, as it would otherwise be dark when the curtain was down.

The scratch material or litter in which the grain is thrown is usually cleaned out once every three months, at which time the house should be thoroughly cleaned and disinfected, using a spray pump. Whitewash gives a clean appearance, but most practical poultrymen have discontinued its use, for lime makes the legs rough and scales flying in the air are said to sometimes fly into the eyes and cause irritation. In spraying, use any standardized coal tar disinfectant dip. Use twelve tablespoonfuls to each gallon of water or a four per cent solution. The spray mixture can be used much better when the lime is left out. Lime in a dry state has no destructive action upon lice or mites, as we have shown in this laboratory that mites will live in dry lime for more than three days and, in fact, till they die of starvation.

The perch poles should be saturated with kerosene or a four per cent solution of some standardized coal tar disinfectant dip. This dip is of short lasting qualities, and for that reason

the kerosene lasts longer, and has given better results in our tests. The perch poles should be free from cracks and, if possible, should not touch the wall. For that reason many swing the perch poles from the ceiling. The dropping boards should be cleaned twice a week, or once a day is better. Mites multiply in the droppings as well as in the cracks of the perch pole and cracks where the pole rests upon its support.

WATER SUPPLY

Fowls require water in abundance at all times for the best production of eggs (which are sixty per cent water) and flesh (which is sixty to eighty per cent water) and to avoid great suffering during hot weather.

The water should be clean, supplied fresh every day, and in vessels so arranged that the birds cannot get into them and thus contaminate it with the filth from the yards which adheres to their feet. As is shown under the discussions of the various infectious diseases and parasitisms, these are spread in most cases, not by direct contagion between the sick and the well birds, but, indirectly through the medium of the soil and the roosts on which the birds live, the food that they eat, and the water that they drink.

The vessels containing the drinking water should, under normal conditions, be thoroughly cleaned and disinfected daily in hot weather, and once a week the remainder of the year. When disease is present in the flock, the vessels for drinking water should be cleaned daily, regardless of the season, and this practice should be continued for several days after all symptoms of the disease have ceased to appear in the flock. Vessels containing water for small chicks should be cleaned daily.

The cleaning is mainly a matter of thorough washing; the disinfection of drinking vessels can best be accomplished with a five per cent solution (in water) of carbolic acid.

Chickens tolerate certain antiseptics internally very well and do not resent the taste of them in drinking water to the extent that other animals do, and it is a wise policy to use antiseptics in the drinking water whenever an infectious disease is present on the premises or when the purity of the water is under suspicion.

The most desirable antiseptic to use in the drinking water is potassium permanganate. Place a quantity of the crystals in a large bottle or jar and fill with water; of this solution use sufficient in the drinking water to give it a slight color which will remain for some hours. More water can be added to the

stock solution from time to time, as needed, care being taken to keep an excess of the permanganate crystals always in the bottom of the jar.

Permanganate of potash may be used to advantage in water containing a large amount of organic matter.

Pure carbolic acid may be used in the drinking water with good effect during the presence of contagion, or to insure the purity of the water. Add a sufficient quantity to make a one-half of one per cent solution (five teaspoonfuls to the gallon). Do not use the permanganate and the carbolic acid at the same time.

Under many conditions, particularly when enteric diseases are present in the flock, mercuric chlorid (corrosive sublimate, bichlorid of mercury, perchlorid of mercury) is a valuable antiseptic for the drinking water. Employ it in solutions of 1 to 5,000 to 1 to 10,000 (from three-fourths to one and one-half grains to the gallon).

Both mercuric chlorid and carbolic acid are very poisonous and must be handled with great care. On this account, the comparatively harmless potassium permanganate should be used, or chinosol, which is equally harmless, may be used in a solution of 1 to 2,000.

DISINFECTION

The removal of parasites and disease germs or their destruction is termed disinfection. Because of the ability of these organisms to multiply, from a single individual or a single pair, at an astonishing rate and speedily reinfest the premises, it is obvious that to be of any value the disinfecting must be thoroughly done.

The first step in any disinfection is the removal of *all* visible filth. A small lump of manure behind a nest box or a single grain of dirt in a crack in the floor or on the roosts may furnish the hiding place from which will emerge the parasites or germs to reinfest the whole building, and spread disease anew among the flock, thus undoing the whole of the disinfection.

Disinfection of Buildings

The first operation in disinfecting a poultry house, therefore, is the thorough removal of all manure, trash and litter. If the roosts and nests are removed from the building, they must be cleaned and disinfected before they are returned; if left in the building during the disinfection, they must be as thoroughly cleaned as the remainder of the building, and

the disinfectant used must be applied to them as carefully as to other parts of the building.

The floor and roosts should next be scraped, and they and the walls and ceiling carefully and vigorously swept. All parts of the interior of the building must then be thoroughly scrubbed with water, to which lye has been added, and a broom or stiff brush and then flushed out, using plenty of water. The building is then, and not till then, ready for the use of the disinfectant.

There are three different classes of agents that may be successfully used in disinfection. The disinfectant may be applied (1) in gaseous form, (2) as a liquid, or (3) heat may be utilized.

A gas may be used in disinfecting only when the building can be closed tightly enough to prevent its ready escape. This excludes the great majority of poultry houses; but in such as it can be employed, all doors, windows and other openings must be tightly closed and sealed for several hours. After disinfecting a building with gas the interior should be sprayed, as directed under the use of liquid disinfectants.

Of the gases that may be used, only three need to be considered here—hydrocyanic acid, formaldehyd and sulphur dioxid.

Hydrocyanic acid gas is extremely poisonous, a single breath of it sometimes sufficing to kill a man. It possesses the advantage of requiring but a few minutes to effectively disinfect a building and of killing all living organisms in it, bacteria, molds, parasites and even roaches and other vermin, and rodents. It will also destroy the eggs of parasites. It is extremely dangerous, however, except in professional hands and its use must not be attempted by the poultryman.

Excluding hydrocyanic acid on account of the hazard attending its use, formaldehyd is the gaseous disinfectant of choice. It may be procured in a forty per cent watery solution known as formalin, from which the gas may be readily generated.

After hermetically sealing all openings into the building except one door, place in an earthen or metal vessel two quarts of formalin for each 1,000 cubic feet of space in the building, place this vessel in a much larger one and set on the floor, then empty into the formalin one-half pound of potassium permanganate for each quart of formalin and retreat from the building at once and close the door.

The temperature of the room, during the disinfection, should be above 50 degrees Fahrenheit, and the more it is

above this temperature, the better. Moisture in the air is an aid in this sort of disinfection; it may be secured by sprinkling the floor just before starting the generation of the gas. The building should be kept closed six to twenty-four hours. It must be thoroughly aired before the fowls are permitted to reënter it.

Such disinfection may not destroy rats and mice, or the larger parasites and their eggs.

For disinfecting with sulphur fumes, the ordinary commercial flowers of sulphur should be used. It must be burned in the building to generate sulphur dioxid, which is effective in disinfection only in the presence of water vapor; therefore some means for providing the necessary moisture in the building must be provided. This may be accomplished by spraying the walls and ceiling until they are dripping, just before beginning the disinfecting, or by boiling a large vessel of water in the building during the generation of the sulphur fumes.

Fire is required to generate the sulphur fumes and care must be taken not to endanger the building with it. A large iron vessel partly filled with live coals may be used; set it on the floor, or if the floor be of combustible material, on several bricks laid on the floor, and pour onto the live coals two pounds of sulphur for each 1,000 cubic feet of space in the building. Care should be taken to ascertain that the sulphur actually begins to burn.

The building should remain hermetically sealed for from twelve to twenty-four hours and then be thoroughly aired before the fowls are admitted.

Compared with hydrocyanic acid and formaldehyd, sulphur dioxid is a feeble disinfectant, but effective work may be done with it by a thorough, careful application, and attention to all details.

The disinfection of the drinking water and drinking fountains is discussed fully under "Water Supply." (See page 56.)

Disinfectants that can be applied in liquid form are best suited for disinfecting the ordinary poultry house. It requires longer to apply them than it does to prepare for disinfection by gas, and germs and parasites protected in crevices and in decayed surfaces of wooden walls cannot be reached, as by the gaseous disinfectants. Fowls need not be shut out of the building for several hours, as is the case when the gas is used. This is often a considerable advantage. Furthermore, the germs and parasites hidden in the walls and roosts

and buried in the decayed surface of wooden buildings can in a great measure be covered up and rendered harmless by the use of whitewash, which should always be a part of the cleaning-up and disinfecting of a poultry house.

Liquid disinfectants are best applied with the spray pump, and all the force possible should be used in throwing the spray on the walls. In this way it will reach all parts of an uneven surface better than when applied with a brush, and much time will be saved in its application.

Disinfectants will act more vigorously when applied hot, and solutions should always be at least warm when they reach the surfaces to be disinfected. A copious quantity should be used. The solution may cost but a fraction of a cent, or at most a few cents a gallon, and it is a poor policy to economize by using an insufficient amount. Every part of the surface of the interior of the building should be thoroughly wet and completely covered with solution when disinfection is completed; great care must be observed that no part is skipped.

Mercuric chlorid is one of the most powerful disinfectants, but it is intensely poisonous and must be used with caution. No puddles of the solution should be left from which the birds may drink when they come into the building, and tablets of this disinfectant must on no account be left where children can get them or where their elders may mistake them for something else, e. g., a headache remedy.

For disinfecting buildings the mercuric chlorid should be applied in a solution of one to five hundred (one ounce to four gallons of water) and four times as much common salt (one ounce to the gallon) should be used with it. The solution should be applied as hot as can be handled with a spray pump. After the surface is dry it is a good precautionary measure to apply the disinfectant a second time.

There are a great number of disinfectants that may be used in solution for disinfecting poultry houses, but certainly none are superior to the coal tar disinfectants. Formalin, for example, is exceedingly irritating to the eyes and respiratory passages of the one doing the spraying. Potassium permanganate needs to be applied in almost saturated solution to be effective, and thus becomes expensive. A solution of copper sulphate is not fatal to all parasites. Crude petroleum leaves the building unsightly and the odor persists unduly long, and so it is with many others.

Of the coal tar disinfectants, crude carbolic acid perhaps stands at the head on account of its low cost; however, it is

quite variable in composition. It should be used in five per cent solution. Use two pounds of the crude carbolic acid to each five gallons of the whitewash. Cresol, another of the coal tar products, gives satisfactory results in two per cent solution (one pint to six gallons water). Pure carbolic acid is rather too expensive for this sort of disinfection; if used, a five per cent solution (one pint to two and one-half gallons water) should be employed. Kreso dip (Parke, Davis & Co., Detroit), zenoleum (Zenner Disinfectant Co., Detroit), liquor cresolus compositus (U. S. P.), creolin (Pearson), and many other standardized coal tar disinfectant dips, may be used.

The coal tar disinfectant dips when mixed with water produce a soapy emulsion. The alkalinity of the soap is a factor that assists in its penetration, although kreso and like products penetrate almost any place, yet the soapy emulsion helps to bring into activity the cresols and hydrocarbons of the products.

Recently it has been shown that a one per cent creolin solution in low grade kerosene used as a spray is a very effective parasiticide. Any of the standardized coal tar disinfectant dips may be likewise used.

While spraying is in progress, remove all eggs from the nests, as eggs readily absorb objectionable odors.

Heat is one of the most reliable disinfectants. It may be utilized in poultry house disinfection in the form of a flame from a gasoline blow torch. Every portion of the walls, ceiling, floor, roosts, nests and boxes must be carefully flamed. This method, though tedious, is effective. Used with ordinary care, it is devoid of danger to the operator or building.

Disinfection of Yards

A complete disinfection of poultry yards and runs, that is, a destruction of all the disease germs and parasites with which the premises may be contaminated by an infected flock, is scarcely possible by the ordinary means employed in poultry house disinfection. Fortunately it is seldom necessary.

When it is remembered that the germs of nearly all diseases, and the eggs of nearly all internal parasites of poultry, are eliminated in the dejecta (feces) of affected birds, the danger from contaminated runs will be better appreciated, and with the realization that each mature hen produces nearly thirty pounds of manure per year, the importance of the yards as a factor in the spread of disease is seen to be very great.

The problem of having clean (non-infected) yards for poultry can be solved only by a change of grounds from time to time. As mentioned heretofore, the movable poultry

house offers many sanitary advantages. Plowing or spading a yard, thus exposing surface layers of the soil to the disinfecting action of the sunshine, and keeping the birds off it for a season, offers the most practical means of disinfecting it. Growing crops in yards while idle tend to use up the organic matter deposited in the droppings.

Where the construction of the poultry buildings is such as preclude a change of location, the two-yard system can in most cases be installed. It offers many advantages: While one yard is being used, the other may be plowed and a crop grown. This may be a crop upon which the birds may be turned for half an hour each evening to allow them a feed of green forage.

In any system of yards where the area of the ground is small for the number of birds, the yard should receive frequent attention at the hands of the cleaner. If the yard is grassed, and the grass is short, it should be swept weekly, gathering the manure in piles and carting it away, as street cleaners do. A yard that is bare of vegetation can be cleaned in the same way, even more easily and effectually. This will lengthen the "sanitary life" of a yard to many times its duration without such cleaning.

Immediately surrounding the poultry house there should be a strip of gravel on which the birds may be fed, and on which they will spend much of their time, to the very great saving in contamination of the yard. The feeding ground, of course, should be cleaned (usually by sweeping) frequently, and it may be thoroughly wet down with a disinfectant in case of a serious outbreak of infectious disease.

DISPOSAL OF SICK AND DEAD BIRDS

A strict adherence to the rules of sanitation would require that the well birds be removed from the buildings and enclosures in which sick birds are found, or in which birds have died of disease, and that they be not returned until after thorough disinfection of the building and grounds. Such a procedure is not often practicable, and the poultryman is left the alternative of removing the sick or dead birds from the flock to prevent as far as possible an extension of the infection.

Whenever an ailing bird is discovered in any flock it should be isolated immediately. Do not wait to discover what is the matter with it, whether it is an infectious disease or a disease at all, or to decide as to its treatment. Remove it from the well birds first and decide upon further measures after-

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SECTION III

EXTERNAL PARASITES

More than thirty species of external parasites infest birds; their economic importance is very great; fowls heavily infested with any of them are unprofitable, and many of these parasites are so injurious as to kill the infested birds.

It is necessary to know something of the life history of these parasites and their habits to intelligently combat their parasitisms. This information is given as briefly as possible in the following pages:

The external parasites affecting birds consist of *lice*, which infest all ages and breeds; *scab parasites*, producing scaly legs; the *air sac mite*, which is a modified scab parasite and infests the air sacs; the *chigger* (chigger or jigger) or red mite, a great pest in the hot summer months; a distinct bird *flea*; the *chicken bug*, which in many respects resembles the common bedbug, and the *ring worm*. In all, seven different classes.

LICE OF BIRDS

This embraces a group of biting lice; their bodies are flat and their mouth parts are arranged for biting and cutting. They live upon feathers, epidermis and secretions of the body of their host. As may be noted in Fig. 19, the mouth parts are located just back of the antennæ and are not always visible. The antennæ consist of five articles or joints each. The thorax in some species is long and narrow, in others short and globular. They are provided with three pairs of legs which are attached to the thorax. The free extremity of the legs is provided with two hooklets or claws which enable them to hold on to their host. The body and legs may be covered with a greater or less quantity of hair or bristles.

The lice of birds are placed under the following genera: Menopon, Goniodes, Goniocotes, Lipeurus, Docophorus and Nirmus.

Menopon biserialum (the large chicken louse).—This is the largest louse found upon chickens. It is about one-twelfth of an inch in length. It is light in color. Fig. 19 illustrates this louse much enlarged; the short mark at the right shows the actual length of this louse. This parasite is common on the heads of young chickens.

Menopon pallidum (the small chicken louse).—This louse is illus-

trated in Fig. 20 and, as may be seen, is smaller than the *M. biserialatum*. In some parts of the country this louse is the more common of the two and is a source of considerable trouble. It may spread from chickens to other animals and birds.

Goniocotes gigas.—This is the largest species of the genus *Goniocotes*, and is recognizable by its large size and full-rounded head. In color it is a light yellow with bands and outlines along the outer border of the abdomen. The female reaches the length of 4 mm. and the male 3 mm. This species has been found rather common in North Carolina, but not apparently so in the West and Middle West. It is also reported as common in Australia and reported from England. It infests chickens.

Goniodes dissimillia.—This is a rather large louse and is appar-

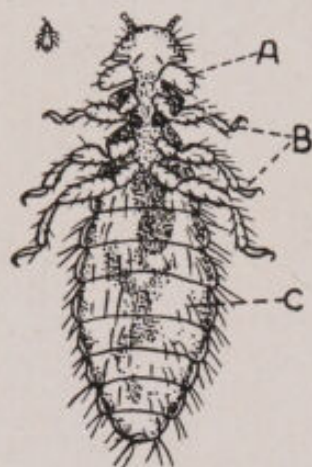


FIG. 19. MENOPON BISERIALUM.

A, head provided with mouth parts for biting, feelers (antennae) and eyes; B, legs attached to the thorax; C, abdomen.

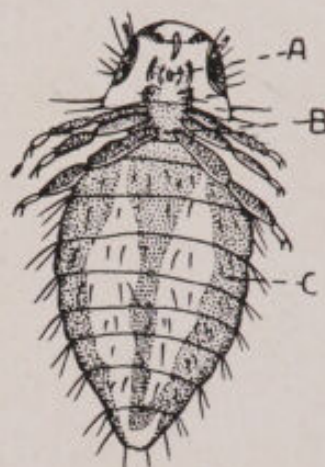


FIG. 20. MENOPON PALLIDUM.

A, head; B, thorax; provided with three pairs of legs; C, abdomen with hairs.

ently rare. The head is subquadrate, the thorax short and narrow and the abdomen large and globular.

Goniocotes hologaster.—The head is nearly quadrate, the thorax narrow and the abdomen short and globular. Fig. 21 illustrates this species.

Lipeurus infuscatus.—This is another louse that may infest chickens. It has been studied in the author's laboratory and has also been reported by Osborn as occurring in Iowa. However, it is not very common. Fig. 22 illustrates this louse. This louse is long and slender. The front part of the head is rounded, the thorax a trifle narrower than the head and the abdomen is long and thin.

LICE OF TURKEYS

Goniodes stylifer.—This is the common turkey louse. Its head is well rounded in front, rather square cut, with scallops behind; the thorax is narrow and the abdomen large and globular. Fig. 23 illustrates this louse.

Lipeurus polytrapezius.—This is a long, slender louse, with two or three bristles extending from each segment of the abdomen. Its head is well rounded in front and the thorax is rather broad and long.

LICE OF DUCKS

Menopon obscurum.—The head is crescent-shaped in front and the abdomen has dark, lateral bands. It is dark fawn colored.

Lipeurus squalidus.—The head is narrow and somewhat elongated in front. There are six hairs on the front part of the head. This louse is common in some localities.

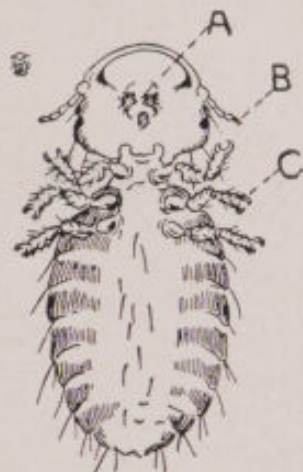


FIG. 21. GONIOCOTES HOLOGASTER.
A, mouth parts; B, antennæ; C, hooklets on free extremity of leg.



FIG. 22. LIPEURUS INFUSCATUS.
A, mouth parts; B, abdomen; drawing to right of head indicates actual size.

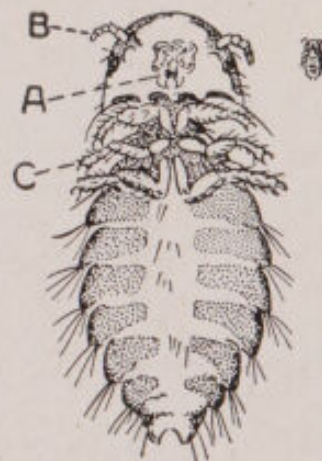


FIG. 23. GONIODES STYLIFER.
A, mouth parts; B, antennæ (feelers); C, legs; drawing to right of head indicates actual size.

LICE OF GEESE

Lipeurus jejunus.—A slender, pale, yellowish-white louse. It is probably universally distributed.

Trinoton continuum.—This is a fairly large louse, covered with few hairs. It is common on geese.

LICE OF PIGEONS

Lipeurus baculus.—This is the common louse of the pigeon. It is long, slender, light-colored and the abdominal segments are provided with two or three hairs on each side. Fig. 24 illustrates this parasite.

THE GRAY CANARY LOUSE

This insect is provided with a slender, elongated body and a large head, provided with strong jaws. It lives upon the feathers of the bird. It does not suck blood. Its sharp claws irritate the skin and cause discomfort to the bird. The eggs of the gray louse are cemented to the feathers and are easily removed.

Treatment.—Blow pyrethrum into the feathers. Use only the best grade powder. Repeat this treatment every three days till the bird is free from parasites. Disinfect the cage with a two per cent solution of any standardized coal tar disinfectant dip.

THE CANARY MITE

The canary mite is a small spider-like parasite scarcely visible to the unaided eye. Normally it is whitish in color but when fully engorged with blood is a bright red. It lives by sucking blood from its host. These mites are usually not found on the birds during the day but make their attacks at

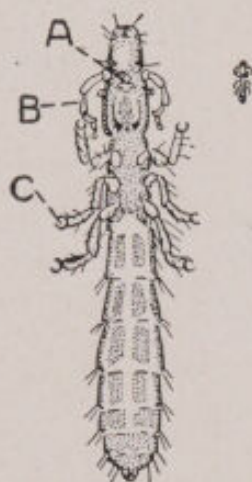


FIG. 24. LIPEURUS
BACULUS.

A, mouth parts; B, antennæ; C, legs; drawing to right of head indicates actual size.



FIG. 25. EGGS OR
NIT OF THE GONIODES
STYLIFER (GREATLY
MAGNIFIED).

A, egg cemented to the barbs of the feather.

night. They may be found in clusters in the slits of the end of the perch poles, or around the metal supports, or, in wooden cages, they may hide in crevices. They multiply very rapidly and myriads soon produce a serious condition of the bird.

Treatment.—The treatment consists of the same measures as outlined under the gray canary louse.

LIFE HISTORY OF LICE

The females of lice are slightly larger than the males. They lay oval, white or whitish-yellow eggs (nits), and securely cement them to the barbs of the feathers. This is illustrated in Fig. 25. When the eggs hatch they break open at the end or a small cap is lifted from the end, in much the manner that a chick escapes from the egg. The young have much the same shape as the adults and are ordinarily considerably lighter in color. The males are usually less

numerous than the females. If conditions are favorable the eggs hatch in from ten days to three weeks, and the lice live for a considerable period, several months under favorable conditions. During their development they moult frequently, sometimes as often as ten times, becoming slightly darker with each molt.

Lice breed with great rapidity; it has been computed that the unhindered reproduction of a single pair would reach the enormous total of 125,000 individuals in the third generation, which may mature in eight weeks!

EFFECTS OF LOUSE INFESTATION

Chicks hatched in the incubator are free from lice and stay so until placed with lousy hens or chicks, or in quarters infested by lice. Lice produce much irritation; the effect of large numbers upon birds is quite marked. The lousy birds scratch, pick at the feathers, show signs of being drowsy, may refuse to eat, and, in growing birds, development is retarded.

Young chicks infested with lice often sit around, moping, with wings hanging down, and in a week or two may die. For this reason brooder chicks sometimes thrive better, grow faster, and are freer from certain ailments than chicks hatched by the hen. It has been said that lousy birds show a greater tendency to wallow in the dust than those not infested.

The effect of lice upon older birds is not so severe as upon younger ones, but is noted in conditions of flesh and in the production of eggs. The irritation is sometimes so severe that hens desert their nests. Their combs may become dark or black. Birds unable to rest day or night become emaciated and die.

To find the lice, part the feathers and the lice will be found running over the skin or base of the feathers. A favorite location for lice is around the vent, where the temperature is warm; but they may be found on any part of the body and at all seasons of the year, but are most common in the hottest months of the year, July and August. During these months conditions are more favorable for their propagation.

DEALING WITH LOUSE INFESTATION

A time-honored and very effective method of treating young chicks for lice is to grease the head and neck, under the wings and around the vent. Blue ointment, lard and sulphur, salt and butter, and various other greases are used, but none is more effective than lard alone, which, although

tedious to apply, is justified by the excellence of the results obtained from its application. Care must be exercised in using blue ointment, as there is some danger accompanying its excessive use. The same is true to a large extent of the other ointments.

Older chickens may be either dusted with insect powder or dipped in a preparation for destroying the parasites as we dip larger animals. Pyrethrum is an excellent powder for ridding birds of lice; this should be sprinkled in the dusting places of the infested chickens. Dusting places should always be provided.

An insect powder gun is needed for dusting the birds. This may be secured at almost any drug store.

If it is the wish to dip the birds, prepare a five per cent solution of creolin, or the same strength of either Zenoleum or Kreso dip.

The Maine Agricultural Experiment Station gives the following directions for freeing birds from lice:

When the treatment of individual birds for lice becomes necessary some kind of powder dusted into the feathers thoroughly seems to be, on the whole, the most effective and advisable remedy. The powder used must be of such a nature, however, that it will be effective. There are so-called "lice powders" on the market which are no more effective than an equal quantity of any inert powdered substance would be. It is not only a waste of money but of time as well to use such powders. At the Maine Station no louse powder has been found that is so satisfactory as that originally invented by Mr. R. C. Lawry, formerly of the poultry department of Cornell University. This powder (which can be made at a cost of five cents per pound) is described as follows by the Maine Station:

In using any kind of louse powder on poultry, it should always be remembered that a single application of it is not sufficient. When there are lice present on a bird there are always unhatched eggs of lice (nits) present, too. The proper procedure is to follow up a first application of powder with a second at an interval of four days to a week. If the birds are badly infested at the beginning, it may be necessary to make still a third application.

The louse powder which the station uses is made at a cost of only a few cents a pound, in the following way:

Three parts of gasoline and one part of crude carbolic acid, 90-95 per cent strength, or, if the 90-95 per cent strength crude carbolic acid cannot be obtained, take three parts of gasoline and one part of cresol.

Mix these together and add gradually, with stirring, enough plaster of paris to take up all the moisture. As a general rule it will take about four quarts of plaster of paris to one quart of the liquid. The exact amount, however, must be determined by

the condition of the powder in each case. The liquid and dry plaster should be thoroughly mixed and stirred so that the liquid will be uniformly distributed through the mass of plaster. When enough plaster has been added the resulting mixture should be a dry, pinkish-brown powder having a fairly strong carbolic odor and a rather less pronounced gasoline odor. Do not use more plaster in mixing than is necessary to blot up the liquid.

This powder is to be worked into the feathers of the birds affected with vermin. The bulk of the application should be in the fluff around the vent and on the lower side of the body and in the fluff under the wings. Its efficiency, which is greater than that of any

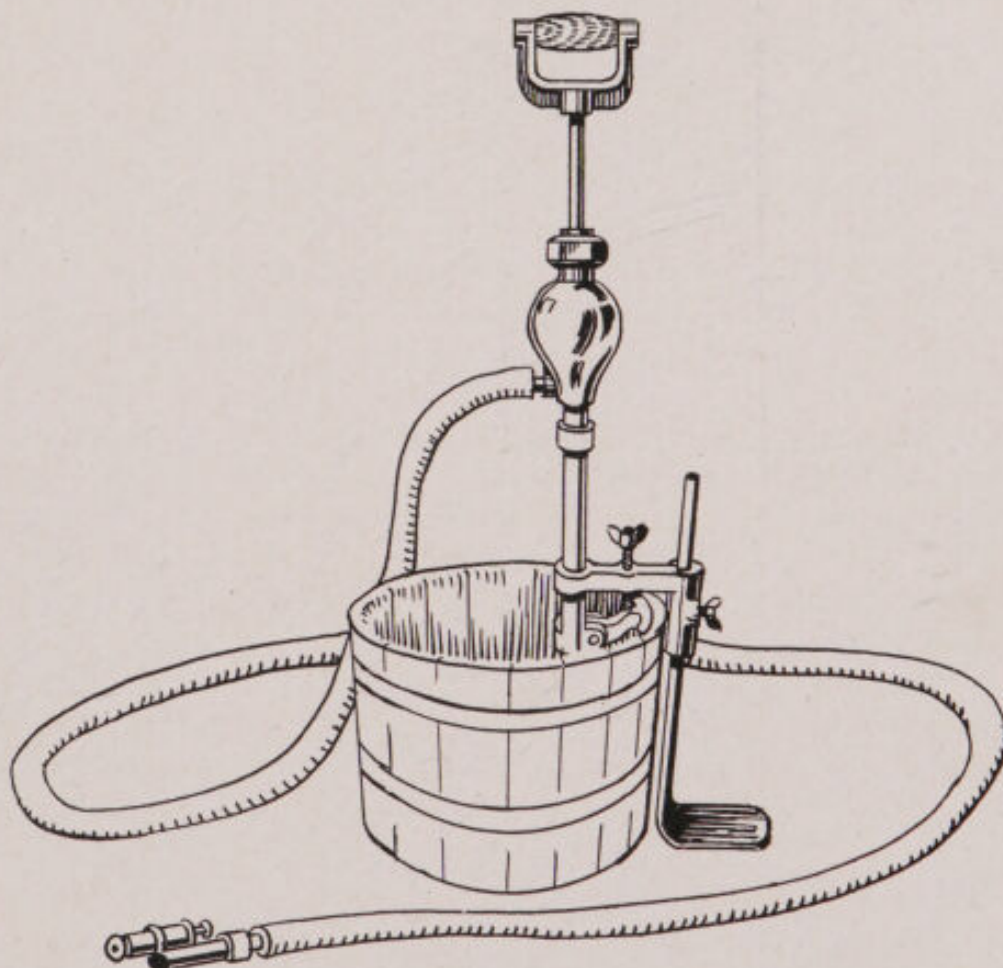


FIG. 26. INEXPENSIVE, DURABLE SPRAY PUMP.

other louse powder known to the writer, can be very easily demonstrated by anyone to his own satisfaction. Take a bird that is covered with lice and apply the powder in the manner just described. After a lapse of about a minute, shake the bird, loosening its feathers with the fingers at the same time, over a clean piece of paper. Dead and dying lice will drop on the paper in great numbers. Anyone who will try this experiment will have no further doubt of the wonderful efficiency and value of this powder.

After freeing the flock from lice, care should be exercised that a reinfestation is not brought about by the introduction of lousy birds.

The infested henhouse should be thoroughly and frequently cleaned and the walls sprayed. The spray should contain some parasiticide as carbolic acid five per cent, creolin five per cent or corrosive sublimate one part in one thousand. The roosts should be scrubbed with boiling water and after drying in the sun should be saturated with kerosene. The litter and straw should be removed from the nests and burned and the nest boxes disinfected before refilling them with straw. If the henhouse be tightly closed, doors, windows, cracks and all openings, and thoroughly fumigated with sulphur fumes and water vapor, it will aid in destroying lice or other parasites that may be in the cracks and crevices, and difficult to reach with the spray. Fig. 26 illustrates a cheap and convenient spray pump for applying the spray. With this some force is used which drives the parasite-destroying fluid into the cracks and crevices not possible to reach where it is applied with a brush.

SCABIES

The acarids, or mites, as they are commonly called, are exceedingly common, widely distributed and of great economic importance. They are eight-legged parasites, belong to the spider family and are so small as to be nearly or quite invisible to the unaided eye, though readily discernible with the aid of a hand lens of low magnifying power.

There are numerous species of mites that infest birds. Some live on the feathers and scales of the skin, others bore into the skin and still others inhabit deeper portions of the body.

There is one form of scabies called depilating scabies that is very rare, and so far as the author knows has not been reported in this country. It affects the body of both chickens and pigeons. The one on chickens is the *Sarcoptes laevis* variety *gallinae* and the one on pigeons is the *Sarcoptes laevis* variety *columbae*.

The acarids parasitic for birds are placed under the following genera: *sarcoptes*, *cytodites*, *trombidium* and *dermanysus*. Unlike the various genera of lice, the scab parasites differ greatly in the effects which they produce, and therefore a separate discussion of each one will be given.

SCALY LEGS—SCABIES OF THE LEGS—FOOT MANGE

This condition is very common; it constitutes leg scabies, and is caused by a parasite called the *Sarcoptes mutans* variety *gallinae*.

SARCOPTES MUTANS

Description.—This parasite is one of the same family of scab parasites that infest horses, cattle, hogs, sheep and cats. That particular branch of the family affecting chickens is distinguished by calling it "variety gallinæ"; gallinæ being a Latin word meaning "of the chicken." Owing to the small size of the parasite, it is often called a mite. Fig. 27 illustrates the parasite magnified 100 times; the actual size of the parasite is shown by the small dot in the square at the right side of the drawing. In the drawing it will be noted that the legs are short and strong and that its mouth parts are arranged for biting the skin. They subsist upon serum that exudes at the point of attack and forms scales or scabs (see Fig. 28).

Life History.—The female lays her eggs under the scabs, where in about ten days they hatch, if conditions are favorable. The larvæ or young mites are provided with only three pairs of legs and are not provided with sexual organs. They pass through several molts and are finally developed into the adult stage, and at that time are provided with four pairs of legs, with genital organs and are sexually mature.

The tearing off of the scabs favors the escape of the parasites, which in warm weather may live in the filth, roosts, nests or other parts of the building for at least thirty days, and may in that time find their way upon other birds and infest them, causing in turn scaly legs on the new host. Thus birds become affected by being placed in infested quarters, or by having an infested bird placed in the same lot or enclosure as at poultry shows, should any of the birds there be infested.

Symptoms.—This parasite attacks chickens, turkeys and cage birds, but the writer has not observed it infesting ducks or geese. It always attacks the unfeathered portion of the legs above the foot, and often the upper portion of the toes. The minute parasite crawls under the scales of the legs and there irritates the tissue by attacking it with its strong mouth parts. As a result of this irritation a vesicle or small blister appears. The blister is practically microscopic in size and later ruptures. This small quantity of serum dries and forms a minute scale. These scales accumulate until later large, scaly masses appear. Fig. 28 is a good illustration of this condition.

The parasites can be found as minute white specks in the serum between the scab and leg. Both legs are usually affected at the same time. Itching is present and the birds may pick at the affected parts. Itching is more intense at night. The birds may become weak, stop laying and even die from the effects of the irritation and loss of rest.



FIG. 27. SARCOPTES MUTANS, VARIETY GALLINÆ.

A, mouth parts; B, short, stubby legs; C, dot indicating actual size of parasite.

Treatment: Eradication.—The scabby patches should be soaked with soapy water till the scabs can be easily removed (this will take time, but in valuable birds it will pay; if of insufficient value to justify this expenditure of time and labor, kill the bird and burn the affected parts, the legs and feet). After removal of all scabs possible, scrub thoroughly with gasoline or kerosene or kerosene emulsion, using a nail brush

and taking pains to make certain that the liquid reaches the deepest parts.

Kerosene emulsion is made as follows: Kerosene (coal-oil) one-half gallon, common soap, two ounces, water, one quart. Dissolve the soap by boiling in the water, add this solution, boiling hot, to the kerosene and stir with an egg-beater, or otherwise violently agitate. When ready for use take one part of the emulsion and add to this nine parts of water.

Lime-and-Sulphur Dip.—This well-known parasiticide used warm and scrubbed thoroughly under the scales is very effective. The lime and sulphur dip is made as follows: Unslacked lime, one-third of a pound, sulphur, one pound, water, four gal-

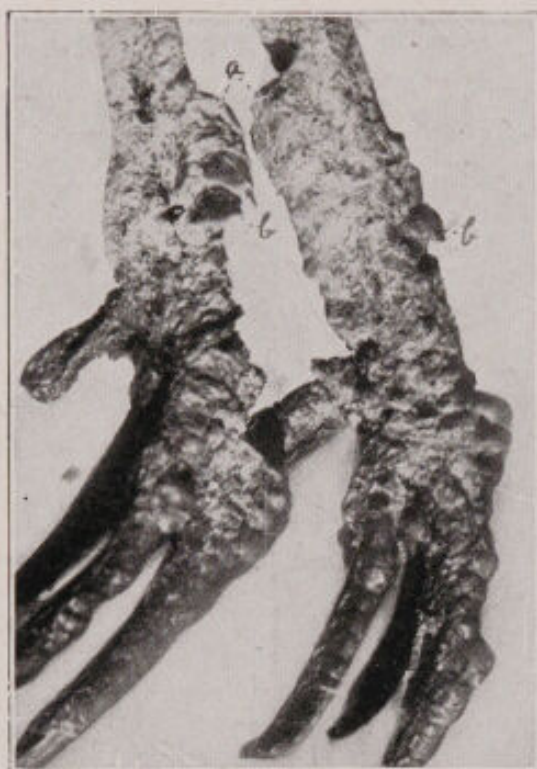


FIG. 28. SCALY LEGS (SCABIES).

a, mass of scabs due to dried serum that exudes from injured part; b, scale of leg forced up and out of place by accumulation of dried serum.

lons. This mixture should be boiled for two hours and the amount lost by evaporation made up by adding water. The lime acts as a solvent for the sulphur; the dissolved sulphur is a valuable parasiticide.

Commercial Disinfectants.—Five per cent solution (in water) of creolin, zenoleum, or kreso dip is also effective. These solutions should be used warm.

Premises.—For the eradication of scab parasites from infested premises, follow the directions given for ridding premises of lice. (See page 72.)

AIR SAC DISEASE

This is a very serious malady of birds that is fortunately rather rare in this country; it is exceedingly difficult to eradi-

cate once it has become established in a flock. It is due to a scab parasite called *Cytodites nudus*, synonyms for which are: *Cytoleichus sarcoptides*, *Cnemidocoptes mutans*, and air-sac mite.

Cytodites Nudus

Description.—The body of this parasite is ovoid in shape as illustrated in Fig. 29. It is whitish in color and is provided with conical-shaped mouth parts, through which it sucks fluids from the parts infested. The legs are rather short, conical, and in both male and female all are provided with suckers, which aid in moving about and in holding on. The legs are composed of five articles (segments or joints) each. The larva has three pairs of legs and the adult four pairs.

Life History.—The ovigerous female lays eggs, as a rule, but at times has been observed to deposit eggs ready to hatch and even young larvæ. The larvæ pass through changes similar to those of the scaly-leg mite by moulting several times, and finally reaching the adult or sexually developed stage.

Symptoms.—The air sac mite inhabits the abdominal air sacs, the air spaces of bones, and the air cells (alveoli) of the lungs of chickens and pigeons. If only a few parasites are present no symptoms may be noticeable, but if they exist in large numbers their effects may be serious. The bird will become thin in flesh and even emaciated, will appear dull, stay apart from the others of the flock, and the comb will usually be pale in color. The wings will droop and there will be labored (heavy, difficult) breathing. Coughing may occur and a rattling of mucus (rales) in the trachea or bronchi may often be heard.

Postmortem Appearances. — By a careful examination of the infested air sacs or the bronchi and sacules of the lungs, the mites may be found appearing as minute white specks, about the size of the scaly leg parasites.

For the specimen from which the accompanying drawing (Fig. 29) was made, the author is indebted to Dr. W. B. Mack, Reno, Nevada, who obtained it from a flock of birds examined in New York. Besides the white specks moving on the surfaces of the air sacs, whitish-yellow points, due to the irritation caused by the parasite, may be found. The bronchi may be congested. In severe cases inflammation or bronchitis, and even pneumonia, may exist.

The air-sac mite has also been reported as infesting the



FIG. 29. CYTODITES NUDUS.
a, rostrum; b, ambulatorium; c, pedicle of ambulatorium.

liver, kidneys and other abdominal organs, in which cases they produce yellowish, pearl-like nodules or tubercles.

An outbreak of this disease in Colorado was studied by the author during the spring of 1912, in which several birds in a flock of sixty became ill. They were dull and weak, with a partial loss of appetite and a tendency to crane their necks when they tried to swallow, became poor in flesh and after one to two or three weeks died. The comb, in most instances, turned black shortly before death.

On autopsy there were found myriads of small, yellowish-white specks over the abdominal air sacs, lungs and trachea. These specks, when examined under the microscope, proved to be the air-sac mite (*Cytodites nudus*) as illustrated in Fig. 29.

Treatment.—It is said that sulphur given with the feed will be absorbed and eliminated by the lungs in sufficient quantities to kill the parasites that infest them, but this is doubtful. A better method of handling an outbreak of air-sac disease among birds of average value is to kill all the birds in an infested flock and disinfect the premises. None of them should be sold, as they may find their way into other flocks and infest them. It is a very serious disease and one of which it is difficult to rid the flock.

CHIGGER (JIGGER) OR RED MITE INFESTATION

There are two varieties of chiggers found in this country, one is the *Trombidium holosericeum*, the other the *Dermanyssus gallinae*.

Trombidium Holosericeum

This parasite is the common chigger (jigger) or red mite of the henhouse.

Description.—It is very small. The body is oval in shape; it is provided with four pairs of legs in the adult state and three pairs in the larval. The distal end of each leg is provided with two hooklets or claws, with which it clings to objects and which enable it to crawl about. Its mouth parts are conical in shape, as illustrated in the drawing. (See Fig. 30.)

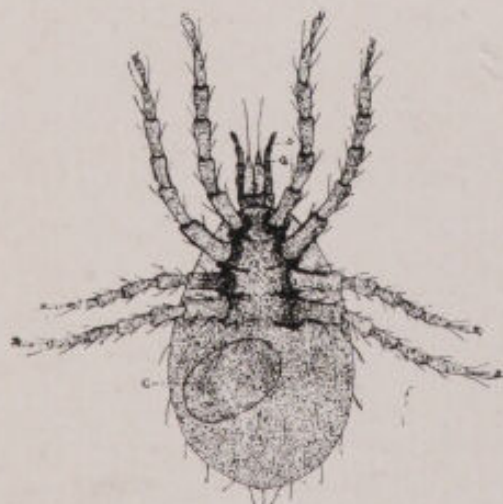


FIG. 30. *TROMBIDIUM HOLOSERICEUM*.
a, mouth parts; b, palpi; c, uterus.

Life History.—Mites lay their eggs in the cracks and crevices and filth of henhouses. If the temperature is warm the eggs hatch in a few days into the asexual, six-legged state. After passing through a few molts it arrives at the eight-legged, sexual or adult state. The parasite multiplies very fast in the warm-

er parts of the summer, July and August, when conditions are more favorable for its propagation.

Symptoms of Trombidium Infestation.—By means of its conical mouth parts, referred to above, it wounds the skin and sucks blood. The engorged parasite is blue to red in color, depending upon the quantity of blood taken into the digestive tract. During the summer of 1911 the author observed one infested flock of chickens in which the affected birds showed symptoms similar to birds infested with lice. They became unthrifty, ceased laying, sitting hens deserted their nests, all exhibited unkempt appearance of the feathers and many died. Many were found dead under the roosts of mornings. Examination of the nests, roosts and birds revealed millions of the parasites. This was in the month of August.

Treatment: Eradication.—The same treatment as for lice will be found very effective. Absolute cleanliness, plenty of kerosene or some standardized coal tar disinfectant dip repeatedly applied to the roosts, and especially the under sides, cracks where the roost pole rests on its support, and the inside of the nests, will prove of value in combating the condition.

There is common belief that tobacco clippings, sulphur, paris green, and a host of liquids, are great destroyers of these formidable foes of the poultry house, but no one so far as we could find has actually made tests to prove it. It was thought best to try a score of the more common agents used.

Mode of Tests.—The tests were run either in open tumblers or sauce dishes so as to have an abundance of air present and to have the tests as nearly under normal conditions as possible.

Agents Used.—The agents used fall into three classes, namely: dry powder, liquid and liquids that give off gases as well as powder that gives off gases. Tests were made with sulphur, air slaked lime, paris green, naphthalene, gasoline, carbolic acid, insect powder, tobacco stems and dust, crude carbolic acid, five per cent carbolic acid, one per cent kresol dip, two per cent kresol dip, five per cent naphthalene in kerosene and pyrethrum.

Sulphur.—Flowers of sulphur was placed in the bottom of two saucers and several hundred mites, some very vigorous, were placed on top of the sulphur. At the end of five hours the mites were still walking over the sulphur. Dry powdered sulphur has apparently no destructive action upon them.

Air Slaked Lime.—Air slaked lime was placed in the bottom of a tumbler. At the end of twenty-four hours the mites had accumulated in a cluster in the center of the dry lime. Upon being poured out onto a paper they were found to still remain vigorous. Dry air slaked lime has apparently no injurious effect upon them.

Paris Green.—Dry paris green (powder) was placed in the bottom of a tumbler and several hundred mites placed in the powder and stirred. At the end of forty-eight hours the mites had formed in a cluster in one edge of the powder. Upon being removed they were found to be as vigorous as before being placed in the paris green. Dry paris green apparently has no ill effect upon mites.

Naphthalene (powdered moth balls).—A quantity of pulverized moth balls were placed in the bottom of a tumbler and several hundred vigorous mites placed on the surface. At the end of thirty

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siticide, that although paris green in solution is a violent poison because of its arsenic content and although tobacco leaves contain nicotine which, when extracted is a parasiticide, yet these agents in their dry state do not destroy mites.

Naphthalene or powdered moth balls, on account of its volatile substances emitted, killed all mites in forty-five minutes.

Insect powder containing gasoline and crude carbolic acid, on account of the volatile substances given off, killed all mites in one minute.

In duplicate tests solutions sufficiently concentrated killed in the following length of time: Crude carbolic acid, twenty seconds; five per cent carbolic acid, one minute; one per cent naphthalene in kerosene, thirty seconds; one per cent kreso dip, ten minutes, and two per cent, in four minutes; ten per cent formaldehyd, in ten minutes. Formaldehyd is a slow parasiticide and must be in quite strong solution. Its gas does not destroy flies. Free nicotine in $\frac{1}{4}$ per cent kills lice in 30 seconds.

In order that parasiticides be effective in the destruction of the mite they must either be in solution or be capable of giving off volatile substances which in themselves are destructive.

Dermanyssus Gallinae*-*Dermanyssus Avium

Description.—By referring to Fig. 31 it will be seen that the body of this parasite, commonly known as the mite chigger, differs from the *Trombidium holosericeum* in that it is ovopyriform in shape instead of oval. The diameter of the posterior third is greater than that of the anterior third. The abdomen and legs are provided with rather short bristles. Its mouth parts are conical in shape and arranged for injuring the skin and sucking blood. The color varies according to the amount of blood contained within the intestinal tract, varying from yellow to a yellowish-red. The free extremity of the legs is provided with an apparatus which enables them to hold on or cling to objects and to move about rapidly.

Life History.—The female, like the female of the preceding genus, lays her eggs in the cracks and crevices and filth of the floors and nests, where they hatch out in a few days, if the temperature be favorable. The young, six-legged asexual larva goes through several moults, finally maturing into the adult, sexual, eight-legged parasite.

*Symptoms of *Dermanyssus Infestation.**—This parasite lives in the poultry houses and dove-cotes, hiding in the straw of nests, cracks and crevices of the roosts, and other places of



FIG. 31. *DERMANYSSUS GALLINAE*.
a, conical-shaped rostrum; b, palpus.

concealment in the daytime. It is the most common and most injurious of mites and is present in every poultry house unless it is kept unusually clean. It comes out at night and makes its attack. Few of these parasites are to be found on the birds (chickens and pigeons) in the daytime, but at night they may be numerous. Birds so harassed at night cannot sleep or rest and soon become emaciated. The laying hens will leave their nests and even cease laying. Birds may be found dead under the roosts in the mornings from the attacks of these mites.

These parasites may also attack horses and other animals kept close to the quarters of infested birds; they cause irritation, the animal scratches, rubs, and unable to rest at night, becomes thin in flesh, and weak. Some persons are annoyed by them.

Treatment.—The same as has been outlined for lice and chiggers. (See page 72.)

FLEAS AFFECTING BIRDS

One genus and species of flea parasitic upon the chickens is known, technically, as the *Pulex avium*. It is far more common in the southern half of the United States than it is in states farther north.

Pulex Avium

Description.—This is the common chicken flea. It resembles to some extent the flea that infests dogs and man, however, a microscopic study shows it to be a distinct species. Fig. 32 illustrates



FIG. 32. PULEX AVIUM.

A, antennae; B, stylet; C, hooklets on free extremity of leg.

this parasite. It is provided with antennae or jointed feelers. In the larval state its mouth parts are arranged for mastication and in the adult for wounding the skin and sucking blood. It is flattened laterally, the thorax being a trifle deeper than the head and is provided with three pairs of legs, of which the posterior pair are longer than the others, giving the insect great power to jump. The free extremity of the legs is provided with two hooklets or claws. In color the chicken flea is light to dark brown.

Life History.—The female lays about twenty brown oval eggs in some dirty, dusty place, such as the floor, cracks, crevices or nests. These eggs hatch in a few days (six to twelve) if the temperature be warm, and from them come wormlike larvae composed of thirteen segments each. The mouth parts are arranged for mastication. The larval stage lasts about eleven days; they then pass through the pupa stage in a tough brown cocoon. The pupa stage lasts about

fourteen days, when the six-legged adult flea emerges from the cocoon.

Chicken Flea Infestation

Symptoms.—In an outbreak of flea infestation studied by the author during the summer of 1911, the presence of the fleas in the flock was first noted because of the insects attacking persons who entered the hen house. Investigation revealed the presence of fleas in large numbers.

It is noteworthy in this outbreak that all the lice and chiggers disappeared from the flock, although the chickens in this flock had been troubled by these parasites, more or less, during the three years preceding. Although fleas irritate the skin and suck blood, no noticeable effect on these birds was noted by the owner. Perhaps, because it being summer, the birds were largely out doors and under favorable conditions as to



FIG. 33. *SARCOPSYLLA GALLINACEA*.
1, male; 2, female; 3, young.

health. Symptoms similar to those produced by lice have been recorded in other cases.

Treatment: Eradication.—Dipping the hens in any of the following solutions, five per cent creolin, five per cent kresol dip, or five per cent zenoleum, is effective in ridding the birds of fleas and preventing their reinfestation for a short time. A dusting powder, used as directed under the discussion of lice, may also be employed with success. Do not neglect to stop reinfestation by treating the premises the same as directed for lice. (See page 72.)

Sarcopsylla Gallinacea—Stick Tight Flea (Jigger)

This is another variety of hen flea. It has been studied in North Carolina. The accompanying photomicrograph, Fig. 33, shows a female, a male and a young one. It will be noted by comparing it with the *Pulex avium* that it is much shorter and different in

shape. These fleas are found particularly in the sandy soil. They are commonly known as the stick-tight fleas.

Description.—The female is 0.75 mm. to 1. mm. in length and the male a trifle shorter. Its posterior legs are much longer than the anterior pair. The posterior angles of the metathoracic scales are angled. The eyes and antennæ are located in the posterior part of the head. It is brown to brownish-black in color.

Habitat.—It lives in shady places, under old houses, on earthen floors, in filth. It is a veritable pest to old birds and especially to young chickens and turkeys.

Life History.—It lays its eggs in dirty filthy corners or sand or while on the bird, under which conditons the eggs roll off on the ground, where they hatch out and go through the changes which bring them to the adult stage. The eggs are oval in shape and white in color, while the eggs of the *Pulex avium* are brown.

Conditions Produced.—It does not have a tendency to hop like the *Pulex avium* but implants itself on the heads and necks of chickens and especially the young. With its powerful proboscis it pierces the skin and sucks the blood and remains in one position, burying itself in the upper layers of the skin producing irritation and inflammation. When removed we find they may jump like species of the *pulex*.

Treatment.—Use louse powder or grease the heads and necks of the young chicks with lard in which has been mixed a small quantity of sulphur or saturate the head and neck with gasoline, being careful not to get the gasoline in the eyes. Saturate the infested premises, including runs, with kerosene.

TICK INFESTATION

The chicken tick is the *Argas miniatus*. It is common in the southern part of the United States.

Argas Miniatus

Description.—The body is flat and thin. It has an overreaching dorsal surface that hides the mouth parts. The mouth parts are provided with mandibles, which have hook-like denticles at the free extremity and a hypostome provided with six rows of irregularly-arranged, toothlike denticles. With this apparatus it holds on to its host. By the side of this apparatus there is, on either side, a palpus, an articulated, fingerlike structure taking the place of antennæ as found in the insect parasites. This tick is a blood sucker. The engorged female is nearly one-half inch long. Fig. 34 is a drawing of a full-grown female, taken from a hen in southern Texas.

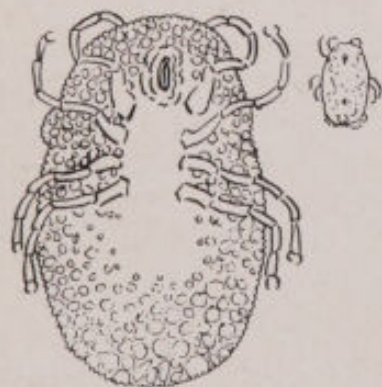


FIG. 34. ARGAS MINIATUS.

Life History.—The engorged female drops from the hen to the ground, and, finding a hiding place under some object, lays her eggs, which, if the weather be warm, hatch in a few days into the six-legged asexual state. Upon gaining access to chickens it begins to draw blood and molts, finally reaching the eight-legged, sexual state. It is now ready to again reproduce.

Symptoms of Infestation.—Large numbers of ticks cause trouble similar to that caused by numerous lice. The parasite, being a blood-sucker, robs the host of considerable blood and causes it irritation. The birds do not thrive, sitting hens leave their nests, laying hens cease laying, young birds make but little growth. Badly infested birds may die.

Treatment.—Combat the parasite with sanitary measures, as outlined for the prevention of lice. (See page 72.)

THE BEDBUG OF POULTRY

The chicken bug or dove cote bug is known as the *Acanthia inodora*. It is often found around unclean roosts and dove cotes. It is closely allied to the bedbug, from which it requires a microscopic study to differentiate it.

Acanthia Inodora

Description.—Fig. 35 illustrates a specimen obtained from an infestation in Colorado. It will be noted that it is provided with long antennæ, which possess long joints or articles. Its head is rather narrow and it has prominent eyes. The thorax is crescent-shaped on the anterior border and is much wider than the head. It is provided with three pairs of legs. Its abdomen, like the abdomen of the louse, is segmented and is practically destitute of hair.

Life History.—The *acanthia inodora* lays its eggs in the filth, where they soon hatch, if the weather be warm, and rapidly develop to the adult state.

Symptoms of Infestation.—This bug is quite a pest in Mexico and some parts of the southern United States. At times they are found in great numbers swarming over the roosts and nests, specking the eggs with their excrement, attacking the hosts at night and sucking their blood. The conditions, as a result, are the same as is the case in any other form of infestation by external parasites.

Treatment.—Similar to the preceding. The chicken bug is at times a formidable foe, even invading dwellings and proving more troublesome than the common bedbug (*Simex lectularius*). They begin to appear about the middle of April, and at times it is necessary to keep the chickens entirely out of doors.

The bugs may live for many months on the filth about a dove cote or henhouse and the disinfection must be most thorough to eradicate them.

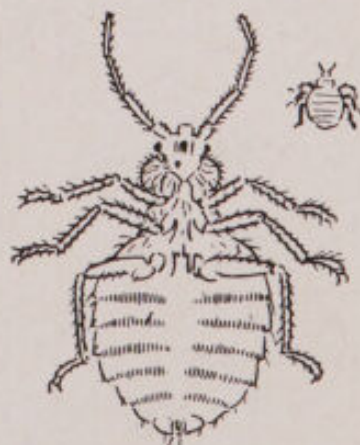


FIG. 35. ACANTHIA INODORA.

BEE STINGS

Young ducklings attempting to catch bees where bee gums are set on the ground are sometimes attacked and so severely stung that many die. Severe swelling, as in other animals, results from the stings.

FUNGI AFFECTING BIRDS

Three harmful fungi affect chickens. One kind affects the mouth, another the skin and the third the lungs. They are more or less common in this country.

Thrush—Aphtha—Sore Mouth

This is a condition affecting the mouth and is due to a low-grade fungus called the *Oidium albicans* (*Saccharomyces albicans*). This consists of hyphæ (fine thread-like processes) which in some instances show well marked chains of cells. It reproduces by forming round or ovoid spores.

Symptoms.—Eberth has reported a case in a bird that was emaciated, dull and died in convulsions. On the inner lining or mucous membrane of the first portion of the esophagus whitish to brownish yellow deposits adhering to the mucous surface were observed. These were found to be composed of the spores and filaments of this fungus. It has also been reported as occurring in turkeys.

Treatment.—If the patches can be seen it is best to cauterize the area with stick of lunar caustic (molded nitrate of silver). Intestinal antiseptics are also indicated such as are given in other intestinal disorders as fowl cholera. (See page 110.)

Tinea Favosa—Honey-Comb Ringworm

This malady is due to another low-grade fungus, the *Achorion schoenleinii*. The fungus somewhat resembles the *Oidium albicans* appearing in hyphæ or threads and reproducing by spore formation.

The hyphæ are three to five microns thick, forming ramifying branches with tapering ends. The hyphæ are matted together, forming mycelia or mat-like masses. Spores varying from three to six microns in diameter are found in the meshes of this mycelia. These spores are egg, ball or biscuit shaped.

The fungus may be grown on artificial media. Upon artificial media it appears as a moss-like growth. It grows best at twenty-five degrees Fahrenheit.

Symptoms.—This disease has been called favus, baldness and white comb. It is a disease that is highly contagious and attacks the comb, face and neck. If not treated, but allowed

to spread and go on uninterrupted, it may later extend to the body.

The disease first appears on the comb or face as whitish or light-gray, small, roundish patches, which vary from the size of a millet seed to a half-inch in diameter. Later these patches may coalesce and form large areas.

The diseased area is covered with a scale which may be depressed in the center and turned up at the edges, giving it a cup-like shape. In the course of four to six weeks the crusts may be one-fourth inch in thickness.

The feathers become dry, erect, brittle and break off at the surface, leaving large denuded areas. A disagreeable odor is given off by the diseased areas which has been likened to that of moldy cheese. As the disease progresses the bird loses its appetite, becomes gradually emaciated, weakens and finally dies.

Treatment.—In the early stage this disease yields to treatment readily. The crusts should be soaked with soapy water containing a five per cent solution of creolin, liquor cresolis, kreso dip, carbolic acid, or similar antiseptic. The fluid should find its way to every part affected. The premises should be disinfected as for lice or other parasites.

Pneumomycosis—Aspergillosis

The third fungus disease affecting birds is usually due to the *Aspergillus fumigatus*, an organism similar to the common green molds. It affects the lungs and is discussed under "Diseases of the Organs of Respiration." (See page 172.)

MYCOSIS OF PIGEONS

This disease is caused by the *Aspergillus glaucus*. The skin is covered with thin yellowish crusts which may be located on any part of the body. The crusts give off an offensive odor. The birds may finally die of exhaustion.

WHITE SCALE OF THE COMB, FACE AND WATTLES

There is a condition among fowls which attacks the comb, face and wattles. The disease manifests itself as very thin, white scales and in some respects simulates white comb due to a fungus but in these cases laboratory examinations have failed to reveal any fungus. The comb, face and wattles become pale. The disease may run pretty well through a flock and suddenly disappear spontaneously.

The best results are attained with a sulphur ointment, five parts flowers of sulphur to 95 parts vaselin, applied once a day to the affected parts.

BALDNESS OF CANARIES

Baldness sometimes is caused by mites or lice. A loss of feathers about the head may also indicate old age or even general debility. At the natural time of molting the growth of feathers may be aided by warmth and a well regulated diet. In addition to the usual food, twice a week give a little bread moistened with milk which has been dusted with a mixture of two parts sulphur and one part potassium chlorate. At the same intervals rub a little carbolized petrolatum on the bald spots.

SECTION IV

INTERNAL PARASITES

Parasites infesting the intestinal canal of fowls are harbored by most fowls, and serious infestations by these parasites are by no means rare. These parasites are commonly spoken of as worms. Other internal parasites, such as gape-worm and air-sac mite, while not so common as the intestinal worms, are by no means unknown, and have the same possibilities of serious infestation.

Intestinal parasites in small numbers infest all fowls without doing perceptible harm, but there is always the possibility that conditions for their propagation may become so favorable as to turn the mildest infestation into a devastating parasitism. Indeed, this very thing has occurred numberless times, and not a few flocks have been entirely destroyed by it. The death of any bird from the effects of internal parasites should be looked upon with apprehension.

Flocks infested with large numbers of round worms are unprofitable in the extreme. The birds are unthrifty, appear unkempt and suffer from diarrhea and constipation. Young fowls are most severely affected.

Internal parasites may be classed under four orders, as follows: *Nematodes*, or round worms; *Cestodes*, or ribbon-shaped segmented worms; *Acanthocephala*, or thorn-headed worms; *Trematoda*, or flat leaf-like worms, called flukes.

IMPORTANT ROUND WORMS

Round worms are the commonest of internal parasites; they may be found in the ceca of nearly all fowls, and usually in other portions of the bowel. When numerous they may seriously interfere with digestion and nutrition, and by their irritation of the intestine cause a stubborn diarrhea. Rarely they become so plentiful in the intestine as to wholly obstruct it.

The round worms include four important internal parasites of birds; the large, round, intestinal worm; the small, round intestinal worm; the gizzard worm; and the gapeworm, besides a number of rare, or for other reasons, unimportant worms, all of which will be described in turn.

Ascaris Inflexa

This parasite, sometimes called the *Heterakis perspicillum*, is commonly known as the large, round worm. It is very com-

mon, having been found by the author in twenty-four out of eighty-seven autopsies.

Description.—This intestinal parasite is round in shape and whitish-yellow to white in color, varying from one to two inches in length. There are two sexes, male and female, the female being considerably the larger. Fig. 36 shows the actual size of the male and the female specimens from which this drawing was made. Some few specimens are much larger than the ones shown.

Life History.—The adult worms deposit large numbers of eggs in the intestines of the infested fowl. These eggs are very minute, microscopic in size and can be seen only when examined under a high power microscope. They pass out of the intestine of the bird with the droppings, are very resistant to dryness and ordinarily do not hatch until taken into the alimentary tract of another fowl. There is some evidence that eggs may hatch in the droppings under

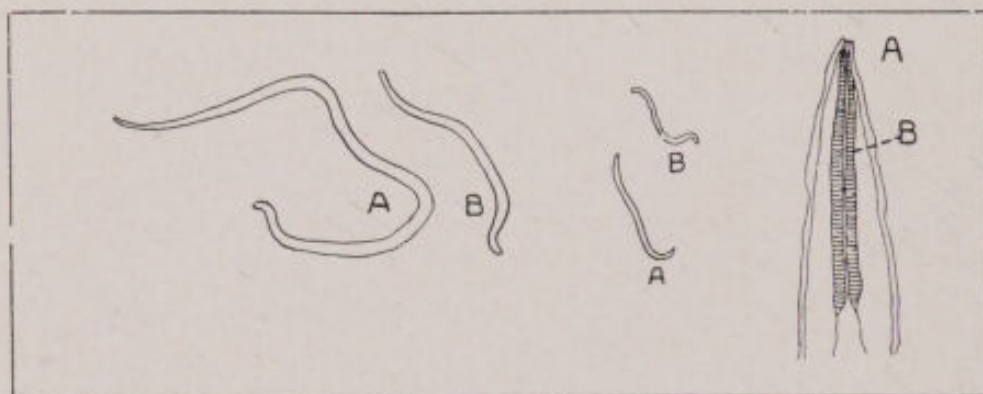


FIG. 36.

FIG. 37.

FIG. 38.

FIG. 36. *ASCARIS INFLEXA* (NATURAL SIZE).

A, female; B, male.

FIG. 37. *HETERAKIS PAPILLOSA* (NATURAL SIZE).

A, female; B, male.

FIG. 38. *HETERAKIS PAPILLOSA*, HEAD EXTREMITY (MAGNIFIED).

A, mouth parts; B, esophagus.

certain conditions. Infestation is brought about by means of food or drink, which has been contaminated with egg-laden droppings. Thus one affected bird may infest an entire flock. The younger worms are found toward the gizzard end of the bowel and the larger ones farther down the small intestines. The development from newly hatched larvæ to full grown males and females is attained in from three to four weeks. If infestation has lasted the required length of time the droppings of an infested fowl will be seen to harbor great numbers of tiny worm eggs.

Symptoms of Infestation.—These parasites harm the host by ingesting food during its digestion by the host, thus robbing it to a certain extent. A few worms may produce no noticeable effect upon the health of the bird, but if present in large numbers they cause serious trouble. It has been found that the excrementitious (waste) matter given off by these and other intestinal worms is poisonous. It is absorbed and has a deleterious constitutional effect, similar to that of

like infestations by parasites in the larger animals and in man.

At times the worms are found in large masses, partially obstructing the bowel, causing constipation, and possibly irritation sufficient to set up inflammation. There may be a loss of appetite, unthrifty condition, unkempt appearance of plumage, dullness, languor and drooping wings, emaciation, loss of color from the comb and mucous membranes followed by death in a few weeks.

By careful examination of the contents of the digestive tract of the birds killed for food purposes the poultry raiser may keep informed as to whether this form of parasitism is present in his flock. If these worms are present in members of the flock close observation will occasionally discover them passed in the feces.

Treatment.—It is necessary to keep the yard and henhouse clean, lime scattered on the floor and about the yard, and the water for the birds kept in a clean fountain and the food in clean troughs, made for the purpose, and disinfected daily, and so constructed that birds cannot step into them. If at all possible, birds should be moved upon new ground. The parasites' eggs in the droppings removed from the henhouse may be destroyed by mixing the manure with unslaked lime.

The birds may be given one teaspoonful of turpentine followed by a tablespoonful of olive oil. If the crop is full the dose of turpentine should be doubled. Five to ten grain doses of areca nut is a good treatment. The areca nut can be mixed with soft feed and fed from a clean trough; it acts as a cathartic as well as a parasiticide. One grain doses of thymol are an excellent treatment for round worms. Two grains of santonin for each bird is likewise an effective treatment.

Heterakis Papillosa

This is another very common worm and is usually found in the ceca or blind guts. The author has found it present in about fifty per cent of the adult birds autopsied in his investigation work among poultry during the past ten years. It is spoken of as the small round worm by poultrymen.

Description.—This worm is much smaller than the *Ascaris inflexa*, being only about one-fourth to one-half inch long. It is white in color. Fig. 37 illustrates the male and female, natural size. Fig. 38 illustrates the head parts, magnified several times, and Fig. 39 the caudal or posterior end of the male, magnified several diameters.

Life History.—So far as known the life history is the same as that of the *Ascaris inflexa*. While the latter infests the small intestines as stated above, this one is found principally in the ceca or blind guts.

Symptoms of Infestation.—When present in large numbers

the small round intestinal worm of chickens (*Heterakis papillosa*) produces considerable irritation and results in an unthrifty condition of the affected bird. It robs the host of nutrients, as does the *Ascaris*.

Treatment.—Sanitary measures for the prevention and eradication of this parasitism and directions for its treatment are the same as for *Ascaris inflexa*. (See page 89.)

Powdered areca nut, powdered pomegranate root bark, turpentine, gasoline, iron sulphate, and tobacco, given both alone and in various combinations in the form of pills or mixed with food, are effective.

Tobacco stems when finely chopped, steeped in water for two hours, and the stems and liquid mixed with the mash

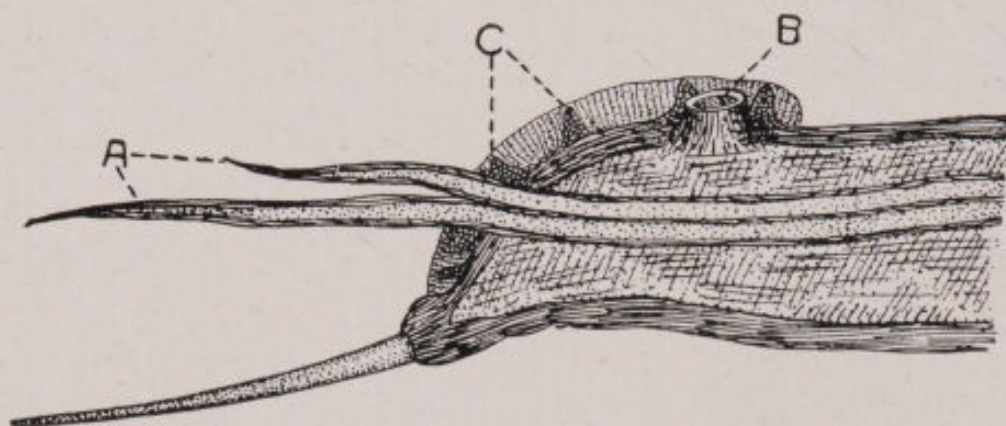


FIG. 39. *HETERAKIS PAPILLOSA*, TAIL EXTREMITY (GREATLY MAGNIFIED).
A, spiculae; B, preanal sucker; C, papilla.

are readily eaten by the fowls and give uniformly good results. The fowls which are very badly infested with roundworms are in most instances entirely freed from these parasites after two doses.

Spiroptera Hamulosa

This is the gizzard worm of chickens. Specimens have been sent to the author's laboratory from Missouri only.

Description.—The male measures about one-half inch in length and the female about three-quarters of an inch. Fig. 40 illustrates the worms, natural size.

Symptoms of Infestation.—The economic significance of this parasitism is due chiefly to the loss of weight and the stunted growth which it causes. The affected birds become anemic, emaciated, extremely lazy and have a ravenous appetite. The worms produce nodules in the walls of the gizzard. The birds become infested from eating food contaminated or soiled with the excrement of infested birds or by taking in young, immature worms through soiled food and water.

Treatment.—The treatment is difficult owing to the fact

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Syngamus Trachealis

This parasite is sometimes called the *Sclerostoma syngamus*, and popularly the forked worm or gapeworm. There is another worm slightly larger than this one that infests the bronchi and trachea of ducks, swans and geese. It is called the *Syngamus bronchialis*.

Description.—The male is very much smaller than the female, upon which it exists as a parasite. Fig. 41 illustrates these worms in copulation as they are always found. A, illustrates a section of mucous membrane. B, the male, which, it will be noted, is much thinner than the female and scarcely one-fourth inch long; and C, the female, about one inch in length. The mouth parts are surrounded by a capsular arrangement by which it holds firmly to the mucous membrane of the trachea (windpipe) or bronchi. The mouth parts are provided with chitinous teeth, with which they wound the mucous membrane; from this wound they suck blood.

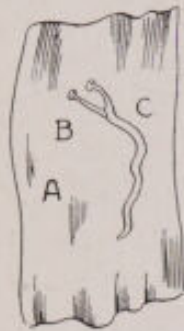


FIG. 41. SYNGAMUS TRACHEALIS (NATURAL SIZE).

A, mucous membrane of trachea; B, male; C, female.

Life History.—The female produces eggs which escape from her body only after she is expelled from the host and her body decomposed. The embryos thus escaping from the decomposing and disintegrating female are taken up by earth worms. Thus, chicks drinking contaminated water, or eating these infested earth worms, in turn become infested; or if the chick should pick up an expelled female containing the mature eggs, the embryos would be liberated in the stomach of the chick, in which case they migrate to the air sacs and air passages and grow to maturity.

Ellers has produced the disease by feeding embryos fresh from the trachea of infested birds. It would therefore appear that an intermediate host is not required, but that a bird may become infested by picking up an expelled worm or some of the tracheal discharge containing the embryos.

Symptoms of Infestation.—Wild as well as tame birds are susceptible to gapeworm infestation (chickens, turkeys, pheasants, partridges, pea-fowl, magpies, black storks, starlings, crows, parrots, swifts, woodpeckers and martins all have been reported as having become infested).

The poultryman's trouble is usually with young chicks and turkeys. The small, immature gapeworms or eggs containing the embryos find their way to the intestinal tract of the young bird as described above, and from the intestine they migrate to the trachea (wind pipe) and its branches and attach themselves, where, by growing in size, they gradually obstruct the passage of air to the lungs. As a result, the bird finds breathing difficult and after a while gasps for breath, extending its head high into the air, finally becoming asphyxiated. Usually a lump may be found by feeling along the trachea, if the worms be lodged in that part of the trachea, which is

palpable. The sick bird coughs and shakes its head frequently. Masses of viscid mucus are expelled from the mouth. The birds frequently open their mouths and make a wheezing noise. Their appetite remains excellent but emaciation soon develops. In later stages the appetite disappears and the feathers are ruffled. A definite diagnosis may always be made upon autopsy by the presence or absence of the worms in the trachea, where, if present, they will be found in pairs attached to the mucous membrane.

Prevention.—Hatch the eggs in an incubator. Do not allow the chicks to run out in wet grass, where they may find earth worms or contaminated water. Feed only in containers which are constructed for the purpose and kept clean.

Treatment.—By grasping the bird in the left hand and forcing its mouth open a doubled horse hair may be run down the trachea and by twisting and again withdrawing, the worms may usually be dislodged. Gentle pressure over the region of the mass may so injure the worms as to cause them to loosen their hold and be expelled by the bird during the coughing which this causes. Care must be exercised lest the trachea be injured. A feather from which all barbs except the tip have been removed may be dipped in turpentine, forced down the trachea, and when the tip has passed the mass of worms it may be twisted as it is withdrawn. This usually results in their removal. By referring to Fig. 2, the location of the opening of the trachea (34) through the larynx may be seen. The *Syngamus bronchialis* affects the bronchi where it causes a catarrhal condition and at times abscess formation.

UNIMPORTANT ROUND WORMS

There are other round worms that may infest the intestinal tract, but they are not common, or important, to the poultry industry. The list follows:

Heterakis Differens

This is a slightly larger species than the *Heterakis papillosa*. Its mouth has no apparent lips; the pharyngeal bulb is distinct; there are two unequal spiculae. It is found in the posterior portion of the intestines of chickens.

Heterakis Compressa

This is a round worm of about the size of the *Ascaris inflexa*. The tail ends in a sharp mucro. It is found in the small intestines of chickens.

Trichosomum

Several species of this genus have been reported from various parts of the world, but have not been observed by the author in this country. They are shaped something like the old-fashioned blacksnake whip. They are blood suckers, and in the adult stage live in the small intestine.

Heterakis Maculosa

A round, white worm found in intestinal vesicles of the pigeon. The male is about three-fourths of an inch and the female about one inch long. At times this worm is a serious menace to the flock, killing many birds. The symptoms are similar to those produced in chickens by round worms.

Dispharagus Nasutus (*Filaria Tite*), Dispharagus Spiralis and Dispharagus Laticeps

These sometimes infest the crop and stomach of the chicken. They are slender round worms and sometimes cause catarrh and if in very large numbers the bird becomes emaciated and dies.

Trichosoma Contortum

This worm infests the crop of ducks and geese. It causes catarrh, dilation of the crop and emaciation. The bird appears dull and may show epileptiform symptoms. After the crop has been infested for about ten days severe symptoms may appear. Obstruction of the crop often follows. A positive diagnosis may be made by irrigating the crop and washing out the small whip-like worms. Both macroscopic and microscopic examination of the material washed from the crop should be made.

Treatment has been rather unsatisfactory. Keep the birds away from infected water. Give each bird one grain thymol and one teaspoonful epsom salts.

TAPEWORMS

Flat Segmented Worms

Tapeworms inhabit the intestinal tracts of all species of birds, animals and men. More than thirty different species of tapeworms have been recorded in poultry.

Tapeworms differ from round worms, in that they have no complete digestive tract, are flat and segmented and have no distinct sex; that is, the male and the female are combined in a single individual (hermaphrodite). The tapeworms all live in the intestinal tract, in their adult stage, and absorb, through their integument, nutrients, taken in and digested by their host; thus they rob their host of food nutrients. The species studied in the author's laboratory are from chickens. The worm is divided into a head, neck and body. The head is provided with four suckers and in some species a circular row of hooklets. The neck in some species is long, in others short, but always unsegmented. The body is composed of segments. These segments grow from the neck. At first they are short and narrow, but become longer and wider as the distance from the head increases. At varying distances from the head the segments become mature, that is, fully developed sexually, and ready to propagate. Each segment is really a separate animal and is a hermaphrodite, that is, provided with both male and female generative organs. Each segment impreg-

nates itself, after which the eggs are developed. As soon as the segment is filled with full developed or mature eggs, the segment detaches itself, passes out with the feces and falls to the ground. Thus, at times, we may find in the excrement of an infested bird the segments, white in color and possessing the power of movement; that is, it contracts and expands, showing it to be alive. This is especially noticeable if the segments be placed in water. Before it is detached each segment absorbs its own nutrients through its integument. This nutrient consists of the food eaten and digested by its host as alluded to above. New segments are constantly developed by the neck of the tapeworm, growing down, becoming ripe, i. e., filled with mature eggs, and detached; if not interfered with, this process goes on almost indefinitely.

Upon disintegration of the segments shed from the worm, and passed out with the feces, the eggs become scattered. The life history of the worm from this state is not well understood. It probably has an intermediate host, by which the eggs are taken up, and within which they pass through a cystic stage and form larvae, which reach the intestine of the bird, become attached and develop to the adult stage.

The larva consists of a head with its fixation apparatus, namely, the suckers and hooklets, if such be present in the adult, and a neck. Having attached itself to the mucous membrane of the intestines, it now absorbs digested food and begins to develop segments, which in a few weeks begin again to be shed at intervals, containing fully developed eggs, which number several hundred in each segment. Under proper conditions, each egg is capable of producing a single tapeworm as before.

Tapeworms of Domestic Fowls

Name	Host	Intermediate host (cysticercoid stage)
Davainea proglottina	Fowl	Slug (<i>Limax cinereus</i>)
Davainea tetragona	Fowl	Snail (<i>Helix</i>)
Choanota Infundibuliformis.....	Fowl	Fly (<i>Musca domestica</i>)
Dicranotaenia sphenoides.....	Fowl	Fly (<i>Musca domestica</i>)
Echinocotylus rosseteri.....	Fowl	Earth worm (<i>Lumbricales</i>)
	Duck.....	Fresh water crustacean (<i>cypriscinereus</i>)
Dicranotaenia coronula.....	Duck.....	Cypris cinerea
Drepanidotaenia gracilis.....	Duck.....	Cypris cinerea
	Duck.....	Cypris viriens
Drepanidotaenia tenuirostris.....	Duck.....	Cyclops agilis
Davainea echinobothrida	Fowl	Not known
Davainea cesticillus	Fowl	Not known
Hymenolepis carioca.....	Fowl	Not known
Davainea echinobothrida.....	Turkey.....	Not known

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solved in warm water, by the mouth or mix in bran, making a wet mash; follow with two or three teaspoonfuls of turpentine. A few teaspoonfuls of a decoction of pumpkin seeds usually rid the bird of tapeworms. This should be followed by a heaping teaspoonful of Epsom salt or a tablespoonful of olive oil. Powdered areca nut in 3-grain doses given in dough ball by the mouth or in wet mash is also effective. Thymol in one-grain doses is said to rid the digestive tract of worms.

Mix one tablespoonful of concentrated lye with four quarts of grain, as wheat, oats and corn, and feed to the infested flock. It is better to fast the birds for twelve to eighteen hours. Give water as soon as the grain has been given as it aids in diluting the lye. Repeat the dose in twenty-four and again in forty-eight hours. The lye acts to some extent as a purgative.

Davainea Tetragona

This is the parasite that causes nodular tæniasis (nodular tapeworm disease). It has been observed and reported as occurring in some of the eastern states and causing quite a loss to poultry raisers.

Fig. 43 illustrates the nodules as they are found and about natural in size. This is from a drawing of the outer (serous) surface of an intestine, which presents a nodular appearance that might be mistaken for tuberculosis. The mucous (inner) surface of the intestine is similarly elevated, and protruding from the nodule into the intestine may be seen a portion of some of the worm. In later stages these nodules may show ulcerations on the mucous surface. There may be seen in these nodules a greenish-yellow necrotic material. A secondary invasion, with pus germs, may take place, in which case pus will be present. Before the nodules are formed these worms may be seen between the villi.

The occurrence of this tapeworm in the intestine is similar to the tapeworm described above (*Tænia infundibuliformis*).

Treatment.—The treatment should be the same as for the *Tænia infundibuliformis* (which see), or mix with the feed one teaspoonful of powdered pomegranate root bark for every fifty adult birds.

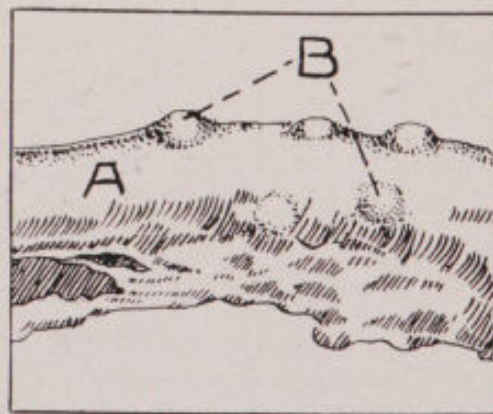


FIG. 43. NODULAR TÆNIASIS (TAPEWORM DISEASE).

A, section of intestine of chicken (natural size); B, nodules (natural size).

Davainea Echinobothrida

This tapeworm infests the small intestines of turkeys. It has been found in turkeys in North Carolina. Its head is slightly larger than the neck, is rounded in front and provided with four suckers and a circular rostellum of hooklets. These hooklets are arranged in a double row. The hooks number about 200 and surround a pit-like cavity. This constitutes its fixation apparatus by which means it holds on to the mucous membrane of the bowel. These worms may reach the length of six inches. The mode of spread of the parasite and treatment of the birds are the same as in the fowl.

Other Taeniae

Two or three other species of tapeworms closely resembling these in their gross appearance have been described, but judging from the records they do not appear to be common. Tapeworms are also found in the intestinal tract of ducks and other birds.

THE THORN-HEADED WORMS**(Acanthocephala)**

The third class of worms listed belong to the order Acanthocephala. The body is cylindrical, but they are not provided with a complete digestive tract, as are the nematodes, or round worms. They have transverse markings, and, like the tapeworms, live by absorbing, through their integument, nutrients eaten and digested by their hosts, thus, to a degree, robbing them. Furthermore, when present in great numbers, these parasites cause digestive derangements and emaciation of their hosts. They are provided with a globe-shaped proboscis, armed with hooklets, which they embed in the mucous lining of the intestines; thus attached by their heads, their bodies float in the intestinal contents.

Echinorhynchus Polymorphus

This is one of the three species of this genus that live in the intestines of the duck. It is also found in the goose.

Description.—The *Echinorhynchus polymorphus* varies in length from one-fourth to one inch. The body is orange-red in color. It has a neck-like construction, just back of the hooked, globe-shaped proboscis. Its proboscis is provided with eight or nine rows of hooklets.

Life History.—This worm reproduces by laying eggs. The intermediate host is certain fish, as the shrimp and crayfish. Ducks become infested by eating fish infested by the larval or cystic form. This parasite is probably rare in the United States.

FLUKES**(Trematodes)**

The remaining group of worms which inhabit the intestinal tract of birds belong to the class of Trematoda and are commonly known as flukes.

The flukes of birds are harbored for the most part in the intestinal tract. If we are to judge from reports, these worms are exceedingly rare in this country.

Notocotyle Verrucosum

Perhaps the most common of the flukes is the *Notocotyle verrucosum*. Its body is white or reddish white and from one-twelfth to one-fourth of an inch long, an oblong oval in shape, narrow in front and rounded behind. It is found in the intestines, principally the cecum or blind gut of chickens and ducks.

No serious results have been attributed to the flukes of poultry, although it is well known that they cause serious maladies in other animals. There have been three or four other similar worms described which closely resemble this one.

INTESTINAL WORMS OF CANARIES

If the bird is infested with worms, these may at times be noted in the droppings. Place in the drinking water ten drops tincture gentian to each ounce of the liquid. After two days give two drops olive oil by the mouth by means of a medicine dropper.

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SECTION V

DISEASES OF THE DIGESTIVE TRACT

Birds are not subject to the manifold ills of the digestive system that prevail in higher animals and man, at least the list of digestive ailments which we recognize in birds are not so numerous as they are in higher animals. Beginning with the anterior portion of the digestive canal, the mouth, we find its part in digestion relatively unimportant compared to that of the same organ in mammals, and its ailments correspondingly fewer and less important.

The food is not masticated in the mouth as in higher animals, but is swallowed whole, passing into the crop, where it is softened by the action of the fluids secreted by that organ and perhaps also by the action of bacteria swallowed with it. After maceration in the crop is accomplished, the food passes into the proventriculus (stomach), where the processes of digestion are carried still further by the secretions (juices) of that organ. The thoroughly soaked and softened food is next received into the gizzard and ground (with the pebbles—grit—always present in that organ) to a paste by the action of its strong muscular walls.

From the gizzard the food passes into the small intestine, where digestion is carried on much as it is in other domestic animals, by the action of the secretions of the intestine, liver and pancreas.

Domestication has affected the feeding habits of birds much as it has the feeding habits of horses. In the wild state birds, like horses, eat most of the time, but they secure their provender more slowly. Under domestication they are fed nutritious, highly concentrated food in a readily accessible form, two or three times daily, and are required to exercise but slightly to get it. Frequent disturbances of digestion, largely due in one way or another to engorgement, is the result.

OBSTRUCTION OF THE BEAK

This condition is very rare. Cases have been noted in which an object, such as a sunflower-seed, has become wedged between the rami (branches) of the inferior maxilla (lower portion of the beak), and serious trouble has resulted from this pressure; for example, paralysis of the tongue, inability to eat, starvation and death.

A bird with obstruction of the beak will shake its head and scratch at its beak. Upon noticing such symptoms in a fowl the caretaker should examine its mouth and remove the obstruction.

"PIP"

Among poultrymen one often hears of "pip" as a disease of fowls, particularly of chickens. It is one of those names like "hollow horn" or "loss of eud," in cattle, which signifies no specific disease or condition, but merely a symptom of some ailment, real or fancied.

In some of the respiratory diseases, particularly in roup and pox, the nostrils may be closed by an exudate and the birds compelled to breathe through the mouth, and if, as is usually the case, the bird has an abnormally high temperature (fever) at the same time there is a tendency for the mouth to become very dry and the mucous membrane may crack and bleed. Owing to its dryness, the epithelium of the tongue may not exfoliate normally, and, being retained, may form a transparent "beak or horn" on the end of the tongue. This dryness of the mouth and the resultant changes are what is known as "pip." This dried end of the tongue should not be picked off as often this causes death of the bird.

This condition may also accompany diseases of the mouth or the respiratory passage, in which, on account of the difficulty in breathing the bird holds its beak partially open. The surface of the mucous membrane may become dried and catarrhal stomatitis follow. The bird will be noted to hold its mouth partly open and at intervals emit a shrill sound, accompanied by a jerk of the head.

Open the mouth and observe the tongue and buccal cavity. The tip, borders and frenum of the tongue are found covered by a hard, dry coating, which may also extend to the buccal mucous membrane. Forceful removal of this membrane results in a bleeding surface which may soon ulcerate as a result of infection and death of the bird is likely to follow.

Treatment.—In such cases the treatment consists in the first place of measures directed at the primary cause; that is, the condition which is producing the dryness of the mouth. The hardening and drying of the membranes of the mouth may be relieved by the application, several times daily, of a mixture of equal parts of glycerin and water.

If cracks and ulcers have formed they should be bathed in a solution of potassium chlorate and water, twenty grains of the former to the ounce of the latter. This is best accomplished by dipping the bird's beak into a vessel, containing

this solution, five or six times and repeating every hour or two. If pus has formed in the ulcers, they may well be cleaned with a few drops of hydrogen peroxid before the potassium chlorate solution is used.

STOMATITIS—SORE MOUTH

The ulcerative form of sore mouth, due to fungi (molds), has been described under external parasites. (See thrush, aphtha, page 84.) Quite frequently in cases of avian diphtheria or roup we find diphtheric patches in the mouth and over the tongue, as illustrated in Fig. 67. This is described under respiratory diseases. (See page 177.)

Simple catarrhal inflammation of the mouth is not common. It may be caused by some irritants, or by bacterial (germ) invasion of an injured part.

Treatment.—A saturated solution of boric acid should be used for bathing the affected parts. If ulcers are present they should first be cleansed with full-strength hydrogen peroxid.

IMPACTION OF THE CROP—CROP BOUND

Obstruction of the crop is generally due to swallowing bodies that cannot pass readily from the crop through the second portion of the esophagus to the stomach and gizzard, that is, to an obstruction of the second portion of the esophagus. Hog bristles, small feathers, straw, etc., are usually the cause of the obstruction. Of the cases examined in the author's laboratory some have been due to each of the agents named. Two incubator-hatched and brooder-raised chicks, just beginning to feather, were given potato parings, after which they died. There was found in each crop a potato paring extending from the crop through the second portion of the esophagus into the stomach.

By referring to Fig. 2 these organs and their relations can be seen.

A second cause of impaction of the crop is due to low vitality of the bird; as a result of acute disease, e. g., cholera, or from improper nourishment, the thin muscular walls of the crop may become paralyzed or so weakened as to be unable to force its contents onward into the proventriculus.

Symptoms.—The animal becomes dull, occasionally opening its beak and fetid gases are sometimes emitted. There is an absence of appetite. The crop appears enlarged, the walls tense, doughy to the touch and foreign bodies may be felt through its walls. Obstruction of the crop rarely disappears spontaneously and if no relief is given the bird may

die in a few days. Death is usually due to exhaustion and starvation. Foreign bodies in the stomach of fowls often cause perforation of its wall. Johnè reports perforation of the wall of the stomach of a goose due to a pointed foreign body.

Treatment.—Surgical interference is the only treatment for this condition likely to be effective. Having diagnosed the case, it is not difficult to clip away the feathers, clean up the surface with mild antiseptics and with a sharp knife open the crop and remove the obstruction. The crop and the skin should then be sutured, and the bird allowed only soft food for a week.

Where the obstruction is due to a weakened condition of the walls of the proventriculus, its contents may sometimes be forced back through the gullet and out of the mouth by careful manipulation with the hands.

IMPACTION OF THE INTESTINES

This condition is rare in fowls on range. It may be due to masses of intestinal worms such as round worms (*Ascaris inflexa*) or tapeworms or it may be due to pebbles, pieces of rags or feathers.

Canaries and other cage birds at times suffer from impaction caused by sluggish peristalsis due to the sedentary life and heavy, indigestible feeds. Impaction of the cecum due to improper feeding may occur. The matting together of the vent feathers may prevent defecation. This is very common in baby chicks affected by diarrhea.

Symptoms.—The birds drop dry feces in small amounts at long intervals and accompanied with considerable straining. There may be depression of the bird, listlessness, loss of appetite. Death may occur from necrosis of the wall at point of obstruction and from exhaustion.

Treatment.—Give a cathartic of castor oil or Epsom salts. Give one-half tablespoonful Epsom salts to an adult fowl and in proportion to small birds.

TYMPANY OF THE CROP (GASEOUS CROP)

This is due to a gas-forming germ, which sets up putrefaction of the contents of the crop. It is usually accompanied by an inflammation (catarrh) of the crop which interferes with its normal function. Birds have been noted to have at times enormously distended crops, which, upon examination, proved to be filled with gas. Usually these crops contain very little feed. This condition often affects chicks as well as older birds.

Treatment.—Give intestinal antiseptics, such as one part of carbolic acid to two hundred parts of water, or mercuric chlorid (corrosive sublimate), one part to ten thousand parts of water, or sulphocarbolates compound.

Immediate temporary relief may be given by liberating the gas through an aspirating needle or a small cannula. The crop may then be irrigated, through the cannula, with a mild antiseptic solution. Follow with two teaspoonfuls of castor oil and feed sparingly on easily digested food.

ENLARGED CROP

Pendulous Crop

The crop may sometimes become very much enlarged, slack and pendulous. This condition is mainly due to injudicious feeding.

Pendulant crop causes little inconvenience to the bird and is incurable except by resection of a portion of its walls. This operation is simple and easily performed.

GANGRENE OF THE CROP

This condition has been observed several times by the author. It resulted fatally to the birds affected in all the cases studied. Upon opening the crop a very offensive odor is noted, the mucous lining will be found in a necrotic state (sloughing) and appear as a dark, sometimes a greenish, caseous mass.

Treatment.—In the earlier stages there may be given, in the feed or water, salol, subnitrate of bismuth or sulphocarbolates compound. If the condition becomes prevalent in a flock, the runs, yards and henhouses should be thoroughly disinfected or the birds completely changed to new grounds, and in any case given clean food and drink. The sick should be separated from the well birds and the dead should be burned.

CATARRH OF THE CROP (INGLUVITIS)

Irregular feeding, a distended crop and irritating and indigestible feed, such as feathers, putrid meat and irritant chemicals, may be mentioned as causes of this condition which is essentially a more or less chronic inflammation of the mucous membrane, lining the crop. If the crop be over-distended the strain on the muscles may be so great that paralysis results. In these cases there is noted a crop filled with a pulpy, soft, more or less gaseous mass.

It may be noted after the ingestion of pointed objects. Too early removal of the squabs from the parent birds (pigeons) has been known to cause ingluvitis because of the fact

that the glands which were active during the feeding of the young suddenly ceased being used and became inflamed.

Symptoms.—There is a loss of appetite. The bird appears dull, stretches its neck repeatedly and swallowing becomes difficult. The crop is tender to pressure, soft to the touch and at times, gaseous. Pressure on the crop may cause fetid gases to escape from the mouth. Repeated attacks cause the development of pendulous crop.

Treatment.—If the crop be distended with a dough-like mass, grasp the bird by the legs, holding the head downward, gently press out the mass; then by introducing water through the mouth and forcing it out as before, the crop, in this way, may be washed out.

Give bland substances, such as gruel and mild antiseptics, such as salol, subnitrate of bismuth or sulphocarbolates compound.

DEPRAVED APPETITE (PICA)

This may be due to a disease of the digestive organs or it may be a vice learned from others. Hens learn to eat eggs by finding them broken or by seeing an egg-eating hen and copying as a cribbing horse acquires the habit from his mate, or as one hog may learn to eat chickens from seeing another eating one.

Feather eating (plucking) is another habit that may be acquired from mimicry. Obstruction of the gizzard, lack of grit, insufficient or unsuitable food and catarrh of the crop are factors of greater or less importance in causing a depraved appetite. Kill the bird; the habit cannot be broken.

CHICKEN CHOLERA—FOWL CHOLERA

Fowl cholera is caused by a germ (*Bacillus avisepticus*), and is a blood-poisoning (septicemia). The germ is rather short, plump, and stains at the poles or ends deeper than the middle, with aqueous fuchsin, hence it is called a polar-staining bacillus. Fig. 44 shows the germ, magnified 1,000 times. This drawing was made from a blood smear from an outbreak among turkeys and chickens, which was one of several outbreaks that have been studied in the author's laboratory. The large objects are various kinds of blood cells. One of these, a white-blood cell (phagocyte), has taken up one of the germs.

Mode of Spread.—Birds often contract this disease from others at shows, and when taken back home infect the remainder of the flock and the premises, or a bird recently purchased from an infected flock, or eggs from an infected flock, or chicks recently hatched in infected surroundings, or in-

fectured droppings carried on the feet of men and animals, from henhouses where the disease exists, or carried by streams or irrigation ditch water, dried and carried by the wind as dust, or carried by wild birds, may be the means of introducing this disease among healthy birds. Even insects have been known to carry the contagion. Buzzards are common carriers of this disease.

The germ of fowl cholera retains its power to produce disease for weeks, and even months, about premises where it has occurred, unless they be thoroughly disinfected. The germs have been kept in test tubes, experimentally, for two years and still proved to be virulent, that is, still capable of producing disease. It resists, for a long time, both drying and zero weather.

Cholera may affect chickens, turkeys, ducks, geese, pigeons and many wild birds. The period of incubation (the time elapsing from the entrance of the germs into the body of the bird until the appearance of the first symptoms of the disease) is given as from twelve to forty-eight hours.

In our experimental work, in which the virus (germ) was introduced into the peritoneal cavity, this period was six to twelve hours; when the virus was given by the mouth it required twenty-four to thirty-six hours to produce the disease. The birds died twelve to seventy-two hours later.

Symptoms.—The onset of this disease may be so sudden that its signs pass unobserved, and finding the dead birds in the nests or under the roosts may be the first notice that the owner has of the existence of disease in his flock; or the birds may have fowl cholera in a more chronic form and live for six to seven days.

In the protracted cases there is noted loss of appetite, great prostration, staring feathers; the bird mopes or sits around with tail and head down, giving the so-called "ball" appearance, the comb is dark, the gait swaying, and there is trembling, convulsions, thirst, and severe diarrhea, with passages of a greenish-yellow color. There is high fever and the bird rapidly becomes emaciated.

The percentage of loss in the flock, if not treated, is very



FIG. 44. BLOOD SMEAR FROM CASE OF CHOLERA.

Showing red blood cells, thrombocytes, mononuclear neutrophils and many of the polar staining germs (*Vibrio avisepticus*) of the disease.

great. The disease spreads rapidly through a flock. Pure-bred birds are more susceptible than scrubs. In an outbreak of cholera among ducks, studied in the author's laboratory, the disease progressed very slowly. Only one to five or six ducks died in the course of a week in the flock of 500.

Postmortem Findings.—Upon opening the abdominal cavity one will first note that the liver is greatly enlarged, very dark in color and tears easily (inflammation, congestion and cloudy swelling); we have found livers that weighed as much as 120 grams, or three times the normal weight. The intestines are congested and contain a frothy material, dark in color. There is an occasional hemorrhage in the lining (*mucosa*) of the intestines. The spleen may be enlarged and its contents soft. Small hemorrhages (*petechiae*) may be found in the heart, its coverings and other parts. The kidneys are dark, enlarged and soft (active and passive congestion and cloudy swelling). The blood does not coagulate readily and is found, upon microscopic examination, to be teeming with the germs causing the disease (*Bacillus avisepticus*).

There is acute hemorrhagic inflammation in the intestines and lungs in association with small hemorrhages on the serous membranes and sometimes a fibrinous exudate of the pericardium and other serous membranes. Some of the blood vessels covering the intestines are injected and the intestinal contents, always in a fluid condition, may be mixed with blood. The mucous lining of the intestines is reddened, particularly in the first portion.

The lungs may be congested and edematous and at times contain areas of croupous hemorrhagic pneumonia. There may be a fibrinous pleuritis. There is a catarrhal inflammation of the upper air passages.

Case Report on Fowl Cholera

A dead duck was sent to the laboratory from the outbreak referred to above. The anatomical lesions found in the carcass were as follows: Hemorrhagic areas in heart and epicardium; inflammation and congestion of the ceca, and congestion of the other portions of the intestines; the liver enlarged, weighing eighty grams, and very dark in color.

Two glycerin agar slants were inoculated from the heart blood and from the liver. Stained smears from the heart blood showed the typical polar-staining *Bacillus avisepticus*. Pure cultures were obtained from the inoculated tubes. A pullet weighing two pounds was given an intraperitoneal injection of the twenty-four-hour agar-slant growth. Twenty-four hours later she appeared sick, showing ruffled feathers, loss of appetite, dullness, head and tail down and temperature 108.2 degrees Fahrenheit.

An examination of the blood revealed the following: Hemoglobin, 90 per cent; erythrocytes, 2,520,000; leukocytes, 6,000 (hypoleuko-

cytosis), thrombocytes, 184,000. The differential count showed: eosinophiles, 37 per cent; neutrophiles, 2 per cent; lymphocytes, small, 52 per cent, large 5 per cent; mononuclear lymphocytes, 4 per cent; mast cells, none.

This bird died at the end of sixty hours. At the autopsy there was noted a fibrinous peritonitis; some petechiae on mucous membranes; the liver enlarged, dark and weighing seventy-two grams (thirty-five grams is the normal weight for a bird of the size of this one). From the blood the germ was isolated in pure culture as before.

[Ward found in experimental cases of fowl cholera there was a destruction of red blood cells and in some an increase of white blood cells—leukocytes.]

In describing this outbreak among ducks the owner wrote in part, as follows:

"Regarding the success I have had in the treatment of cholera among the ducks with the sulphocarbolates of sodium, calcium, zinc and copper, I will, as best I can, give you an idea as to the results and the conditions under which we had to work.

"To begin with we had a large number (about 500) to handle and had to send away for the tablets, which delayed us in beginning the treatment of the disease, and, of course, conditions were pretty bad when we did get started.

"Next we ran into a long stretch of cold weather, the feed froze up nearly as soon as we put it out in the troughs if it was moistened and the drug mixed with it, same thing happened with the water, so we were sure that the ducks were not getting enough of the sulphocarbolates. However, the death rate dropped down about one-fourth in two weeks. As soon as the weather warmed up several snows fell at intervals of about a week, so that the pens were wet and it was hard to disinfect them and difficult to keep the ducks from drinking the water that stood about in the pens. In this way they avoided getting the drug that was dissolved in the water in their drinking fountains. We finally got around that by sprinkling the yards heavily with some coal-tar dip, so that the ducks would not drink this water, but would go to the fountains. This was made rather expensive for the water from the outside would run into the pens and soon dilute the dip already out so that the ducks would soon be drinking this water again. This meant more dip, and the cost of the dip was soon an important item. A considerable quantity of the sulphocarbolates used under these conditions was wasted, for when the feed or water would freeze we had to chop it out of the troughs and thus lose some. The cost of what we used amounted to seven cents per duck.

"If we let up using the drug the ducks would begin dying again, but I do not think it had a fair trial during the first part of the treatment. As soon as the weather got better the death-rate was lowered, and now I believe we have the disease under control. Under favorable conditions I believe this means of controlling cholera would work very nicely. That it will render a flock immune for any length of time I rather doubt. I gave my chickens a three weeks' round of the treatment and for a month now they have been all right, but this morning I noticed a few of them acting as if they were in the cholera business again.

Treatment: Eradication.—The germs are found in the discharge from the bowel and are carried on the feet into feed and water troughs, or are picked up from the ground with the

feedstuff. Birds should be fed out of troughs frequently disinfected with a five per cent solution of carbolic acid, and the water they drink should be similarly guarded. Sick birds should be immediately removed from the flock and the dead ones cremated. The henhouse and nests should be cleaned thoroughly each day and sprayed with whitewash to which sufficient crude carbolic acid has been added to make it five per cent of the whole, or creso, zenoleum or creolin should be used, of the same strength.

A type of spray pump convenient for applying this spray is shown in Fig. 26. The henhouse may also be disinfected with formaldehyd, as follows: Close tightly all doors, windows, cracks and other openings, and for each 1,000 square feet of space in the building, use twenty ounces formalin (forty per cent formaldehyd) and sixteen ounces permanganate of potash. Place these two materials in a vessel and place in the middle of the room and leave for several hours. The yard should be cleaned every day. If the yard be small it may be disinfected by covering it with straw and burning the straw.

For the birds intestinal antiseptics are indicated; the sulphocarbolates compound in one-half grain doses twice daily has given us the best results. Other intestinal antiseptics are hydrochloric acid, one teaspoonful to each quart of water, one per cent of copperas and potassium permanganate.

The following is an account of three of the tests which the author made of the 30-grain sulphocarbolates compound tablets.

"One flock consisted of sixty birds. Several were sick at the time treatment was commenced, and four had died. The discharge from the bowels was of a greenish-yellow color, somewhat simulating fowl cholera. One tablet was dissolved in a pint of water, and this fluid mixed with bran and corn chop. The mixture was then fed in clean troughs. In this way each bird got approximately one-half grain. This was repeated night and morning. No additional birds became sick; only two of the sick died; and the rest recovered.

"Another flock consisted of 175 baby chicks. As soon as these birds were taken from the incubator they were fed the unhatched eggs that had been cooked and chopped. This mixture was reported to possess an offensive odor. The birds began dying, with symptoms of diarrhea, white pasty vent; weakness, dullness, drooping wings, etc.; one-half the flock died before treatment was commenced. One-half tablet was dissolved in warm water and the bread saturated with it. The birds immediately quit dying.

"Still another flock consisted of 200 birds, including a few turkeys. Cholera had appeared on the premises the fall before. The outbreak was studied in the field and in the laboratory. The cholera germ (*Bacillus avisepticus*) was isolated. In the last outbreak fourteen birds had died and several were sick. Treatment similar to that described above was used. Water containing the sulphocarbolates was kept constantly before them. No more birds were taken sick and no more died after the sixth day."

Vaccination with a vaccine made from the germs producing the disease, has given excellent results.

Scholbe states a serum has been prepared, but that it renders immunity only for about two weeks.

Kitt has shown that the blood of chickens immunized against chicken cholera has immunizing effects upon healthy chickens. He has also shown that the white and yolk of eggs of immune chickens possess similar effects.

He has tried immune serum from horses immunized against the *Bacillus avisepticus* but did not have uniform results in producing passive immunity with the immunized horse serum.

ENTEROHEPATITIS (BLACKHEAD)

This is essentially a disease of turkeys, among the young of which it is quickly fatal. It has practically annihilated the turkey-raising industry in sections where it was formerly profitable and carried on extensively. Although the turkey is more susceptible to blackhead than any other bird, serious losses among chickens sometimes occur.

Cause.—This disease is claimed by Dr. Theo. Smith, formerly of the Bureau of Animal Industry, to be due to a protozoon (*Ameba meleagridis*), microscopic in size, which is found in the diseased areas in the ceca (blind pouches) and liver of affected birds, which are chiefly turkeys and rarely chickens. Others attribute the disease to a coccidium. The protozoon is purely a connective tissue parasite and does not enter epithelial cells at any time, as a coccidium.

Mode of Spread.—As will be seen later, the protozoon escapes from ulcers in the ceca and passes out with the feces. Food or water contaminated with the excrements carry the disease germ to other birds. Chronic cases (carriers) in older turkeys or chickens may keep the premises infected for a long time. These germs entering the liver and the mucous membrane lining the ceca, cause inflammation and degeneration. Usually the ceca become infected first and later the liver is invaded and inflammation of its structure ensues.

Postmortem Findings.—Upon first opening the abdominal cavity one's attention is attracted by the enlarged liver with areas of dead tissue (caseation necrosis). Fig. 45 shows a liver about three-fourths natural size, weighing nearly one pound.

The ceca (blind pouches; see Fig. 2, No. 12), one or both, are noted to be enlarged; the enlargement is usually a short distance from the point. Upon opening the ceca, ulcers and areas of dead tissue (caseation necrosis) are observed in the mucous lining. There will also be noted a straw-colored fluid (edema, dropsy) in the loose tissue about the heart.

Fig. 46, taken from an area in the edge of the necrotic portion marked B, in Fig. 45, illustrates the condition. A illustrates the

liver cells as they are first affected (cloudy swelling); B, the cells farther along in the disease process, in which it may be noted that the nucleus has disappeared and the cell is disintegrating (necrosis); C, the congested vessels (passive congestion); D, white blood

cells (eosinophiles) referred to above. There may also be noted in these areas giant cells.

Fig. 47, b, illustrates a giant cell; a, protozoa causing the disease. A like microscopic examination of sections from the kidneys indicates that poisonous products have been taken up by the blood, for in these sections we find degenerative changes (congestion, cloudy swelling and focal necrosis).

Fig. 48 shows a microscopic field from a blood smear from a turkey affected by enterohepatitis. It will be noted that there is an intense eosinophilia. Fig. 49 shows a field from a portion of the kidney, in a state of cloudy swelling and focal necrosis—evidence of absorbed poisonous substance. Fig. 50 shows one of the ceca with a small ulceration caused by the protozoa.

Symptoms.—Enterohepatitis is common in turkeys

between the ages of one month and one year, although I have seen the disease in birds that were much older. Several outbreaks have been studied in this laboratory. Only one case was found in the hen. It has been reported in the peacock.

The symptoms are not manifest till the disease has progressed to a considerable extent. The bird is first noticed to be dull, later the wings and tail may droop; the feathers become ruffled and the bird sits around much of the time; diarrhea supervenes, the discharge being of a greenish-yellow color; there is a loss of appetite; the bird grows gradually weaker, showing muscular weakness, droopy wings, and usually dies in from three to ten days after the first symptoms of the disease become noticeable. In the cases that run longer the bird becomes emaciated. The head may or may not turn purple. From the cases in which the head turns purple the disease gets its name—blackhead.

Although turkeys of all ages are susceptible to blackhead, youth suffers most. Cases seldom appear before the thir-

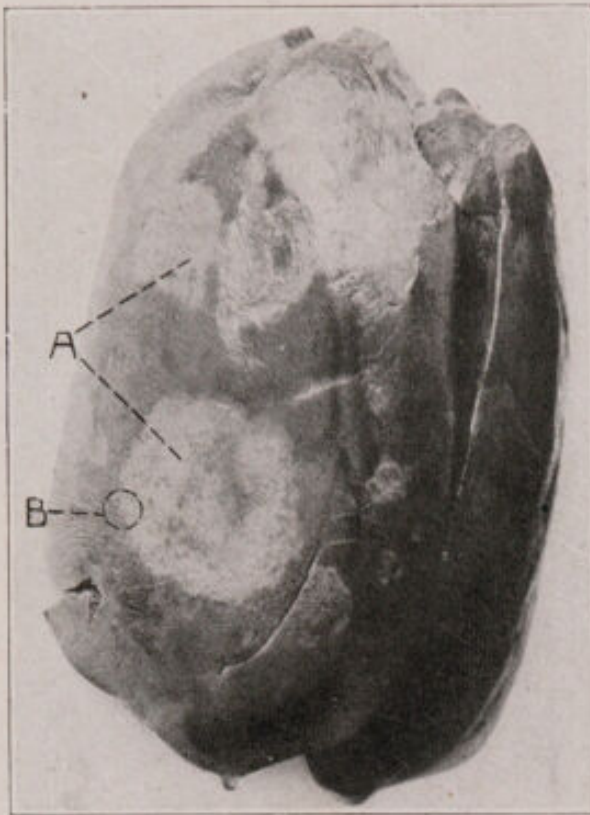


FIG. 45. ENTEROHEPATITIS IN A TURKEY.

A, yellowish-white necrotic areas. This liver weighed 452 grams, nearly one pound.

teenth day. The most critical period begins at about the thirty-fifth day after hatching. Young poults are observed to be sick no more than four to six days. While old birds may recover, young birds probably never do.

Report of a Case of Blackhead

Of eleven turkeys of the flock, six had died. One of the turkeys was brought to the laboratory for further study. The turkey's head was purple; there was a loss of appetite; a diarrhea was present and the discharge was yellowish-green in color. A blood study showed the following: Hemoglobin, 73 per cent; erythrocytes, 2,000,000; leukocytes, 73,000. Differential count: eosinophiles, 86 per cent; neutrophils, 1 per cent; lymphocytes, 11 per cent; mononuclears, 1 per cent; mast cells, 1 per cent. The bird died and an autopsy was held. The following is a summary of the findings:

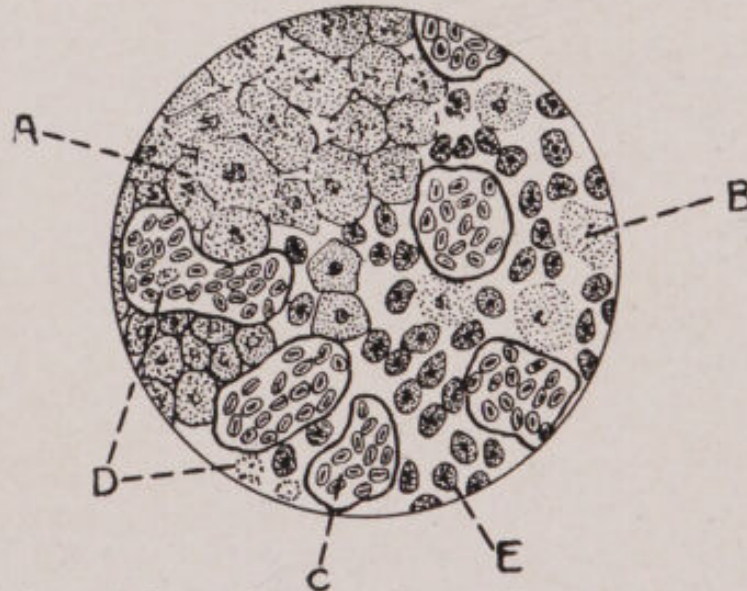


FIG. 46. CLOUDY SWELLING DUE TO ENTEROHEPATITIS. THIS IS A SECTION FROM "B" IN FIG. 66. (MAGNIFIED 900 TIMES).

A, liver cells (cloudy swelling); B, liver cells undergoing disintegration, necrosis; C, congested blood vessel; D, white blood cells, eosinophiles abundant in this disease; E, protozoa causing the disease.

Necrotic areas in the liver measuring up to four centimeters in diameter and of a yellowish-green color. Weight of the liver, 452 grams.

Ulceration of one cecum, four centimeters from the cecal end and extending three cm. in length. The outer surfaces of the ceca showed yellowish-green coloration. There was edema in the pericardial region.

Treatment.—Thorough cleaning of henhouse and yard, followed by careful disinfection; care as to feeding and watering, and intestinal antiseptics are indicated as recommended for fowl cholera. The following tablets gave the best results in our experiments: Sodium sulphocarbolate, $7\frac{1}{2}$ grains; calcium sulphocarbolate, $7\frac{1}{2}$ grains; zinc sulphocarbolate, 15

grains. Dissolve one tablet in each quart of water. This solution can be given as drink or used to mix with soft feed.

It has long been known that milk feeding stimulates rapid growth in poultry as in all other animals. It has also been shown that milk feeding of chicks prevents to a large extent certain intestinal disorders. The same stimulating principle applies to turkeys and there is a possibility that acidity plays

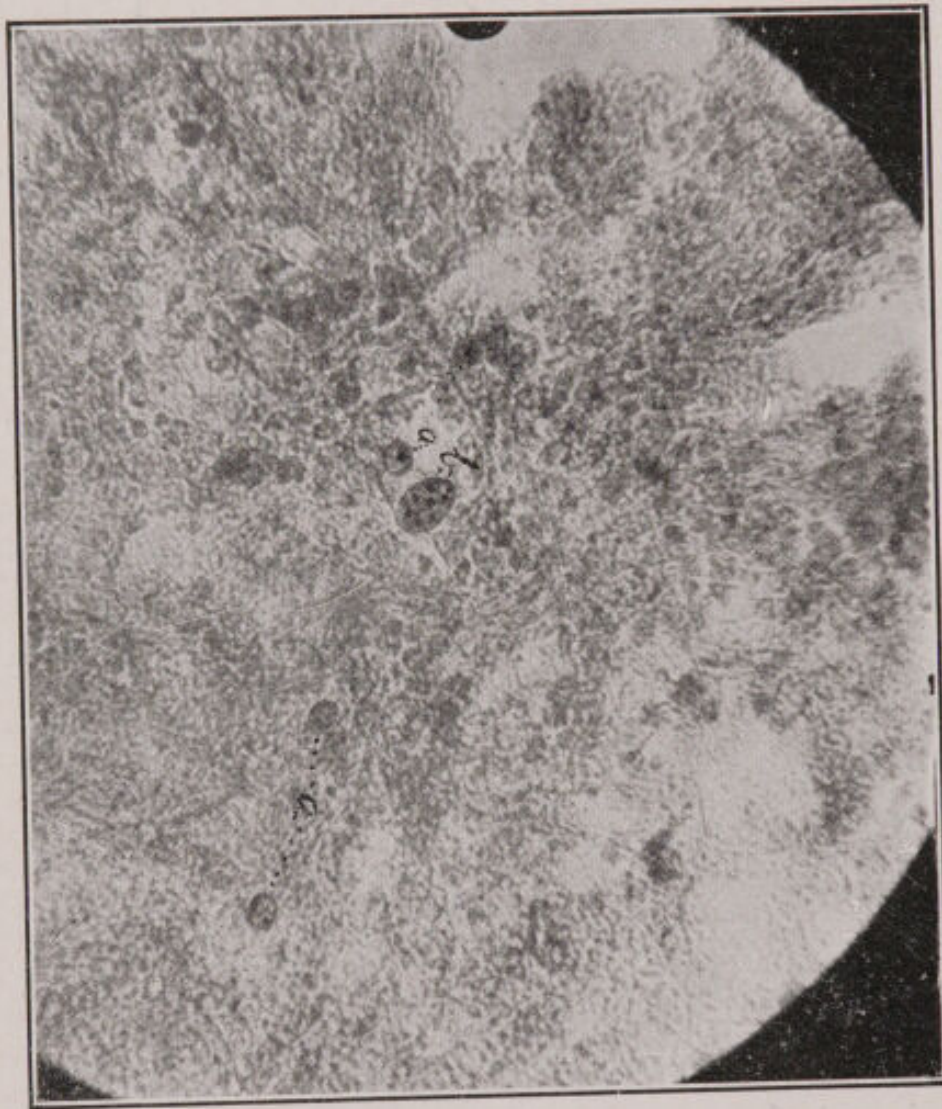


FIG. 47. SECTION OF THE LIVER FROM A CASE OF BLACKHEAD.
a, protozoa causing the disease; b, a giant cell.

an important role. Since the greater mortality is among young poults, Hadley has recommended a limited feeding as follows: First 48 hours no feed; third day, chopped egg including shell is given at the rate of two grams a day. The amount of egg is gradually increased till the end of the tenth day, then gradually decreased until the end of the second week, when egg feeding is discontinued. The fourth day green chopped feed such as lettuce or sprouted oats is given in

increasing amounts. On the fifth day rolled oats are added and discontinued at the end of the sixth week. On the ninth day mash is given as follows: corn meal 6 parts, wheat bran 4 parts, middlings 2 parts, and linseed meal 1 part. Sour milk should be given throughout.

The following scheme of feeding poults has been suggested by Hadley as a means of aiding in warding off blackhead:

1. Hatch the turkey eggs in incubator, in the meantime having hens set on china eggs in nest boxes or brooders on the permanent range.

2. Remove the poults from the incubators about twenty-four hours after hatching, and distribute at night among the hens, giving from twelve to fourteen to each hen. Be sure to see that the hen accepts them before leaving them.

3. Give no feeding before the poults are two days old. Each family may then receive two teaspoonfuls of egg chopped fine with some green feed such as nettles, dandelion, onion tops or lettuce. A little cracker may be added to take up surplus moisture so that the mixture will not be pasty.

4. This ration may be repeated for the remainder of the feedings upon this day, or bread soaked in sweet milk may be substituted for the meal.

5. During the first three or four days of feeding the poults receive four meals each day, at about eight o'clock, eleven, two and five; after this but three meals are given.

6. On the second day of feeding about the same rations are given, but one of the meals may be of chick grain, and some rolled oats may be added to the chopped egg mixture.

7. The third day of feeding is like the second. The poults are allowed to run in their enclosure.

8. On the fourth or fifth day of feeding, the number of meals may be reduced to three, at eight o'clock, twelve and five. The amounts are slightly increased and a little grit may be added.

9. When the poults are about a week old they may be allowed to run free with the old hen on the range on pleasant days when the grass is dry. Chopped egg in the ration is reduced and omitted by the seventh day of feeding.

10. On the sixth day, the feeding is put on a time basis. Several spoonfuls of feed are put on the tray and well distributed, but the poults are not allowed to eat for more than about three minutes at any one meal.

11. By the end of the second week, the time limit is reduced to

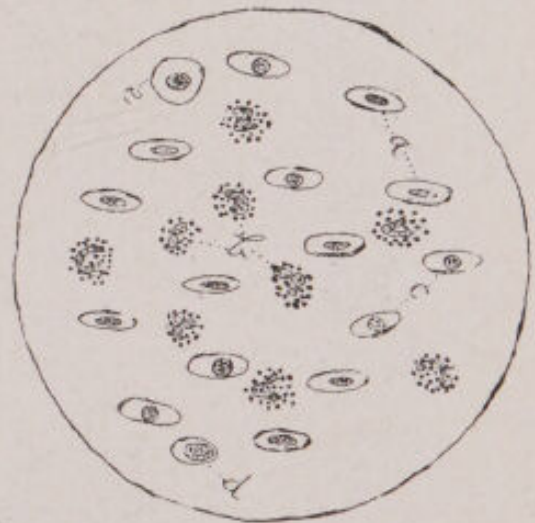


FIG. 48. BLOOD SMEAR FROM A CASE OF BLACKHEAD.

Showing intense eosinophilia; a, red blood cells; b, eosinophiles; c, thrombocytes; d, lymphocytes; e, mononuclear leukocytes.

two and one-half minutes, since the poults are now obtaining more feed on the range in the form of insects.

12. About the same time sour milk is introduced. It (whey and curd well mixed) is placed in shallow pans or in troughs, scattered about the range. It is at first given each morning and night at the rate of about one quart to each forty poults, and is gradually increased in amount until by the beginning of the fourth month one quart may be given for every twenty birds, each morning and night.

13. During the second month, which is the critical period for young birds, the feeding is continued about as in the latter part of the first month. But, after the age of about six weeks, the number of meals per day may be reduced to two. Green feed in the form of chopped carrot tops, onion tops, or lettuce should be given in abundance; it should comprise at least one-half of the

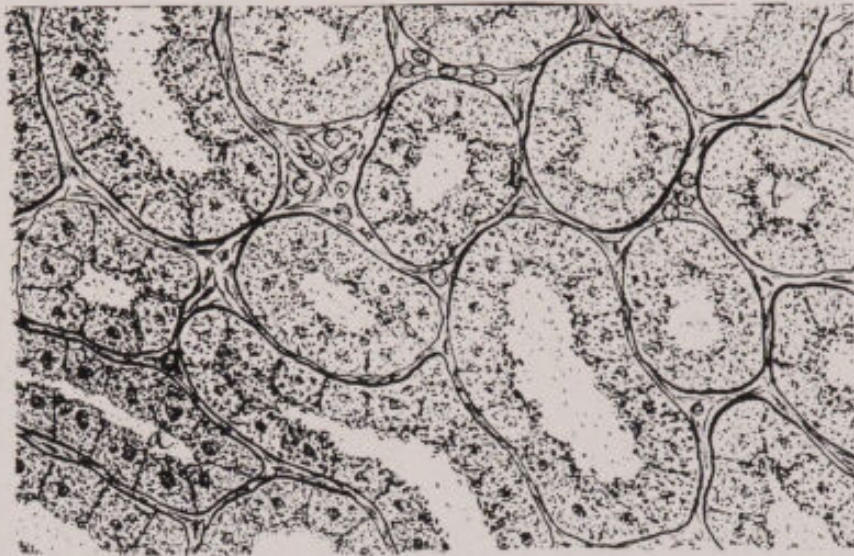


FIG. 49. SECTION OF A KIDNEY, FROM A TURKEY THAT HAD DIED OF BLACKHEAD.

a, cloudy swelling; b, area of focal necrosis.

ration for each meal. The time limit remains at about two and one-half minutes.

14. When the poults are about six weeks old the nest or brooder coops should be replaced by larger houses made of lath and covered partly with roofing paper. Such a house may suffice until the poults are about three or four months old. These may be about three by five feet, and three feet high at the apex. Family houses should then be given up and all the poults, with their mothers, be brought together in a single roosting shed.

15. The feeding for the third month is like that of the second except that the amount of milk is gradually increased and that grain mixture of equal parts of cracked corn and wheat may be gradually substituted for the chick grain.

16. As the autumn months advance and insect life disappears, the time limit may be lengthened to three or three and one-half minutes. In rainy weather the noon-day meal may be added and a four-minute period allowed. Rolled oats may be omitted and the ration made to consist of grain mixture with an occasional feed of rolled oats or bread and milk. A mash may now be allowed containing some beef scrap.

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comes severe enough to set up an inflammation of the mucous lining of the small intestines, it is termed *enteritis*, and when it extends to the large intestines it is called *dysentery*. In both conditions there is an increased thirst, loss of appetite, high fever and fluid discharge, and in the latter the discharges are streaked with blood.

Cause.—Moldy, putrid, or too stimulating food, drinking water which contains much organic matter, and hence is filthy and putrid, and exposure to certain unfavorable atmospheric conditions are contributing factors, as is also the injection of irritant substances, such as lye, paint, spray-mixtures, unslaked lime, etc.

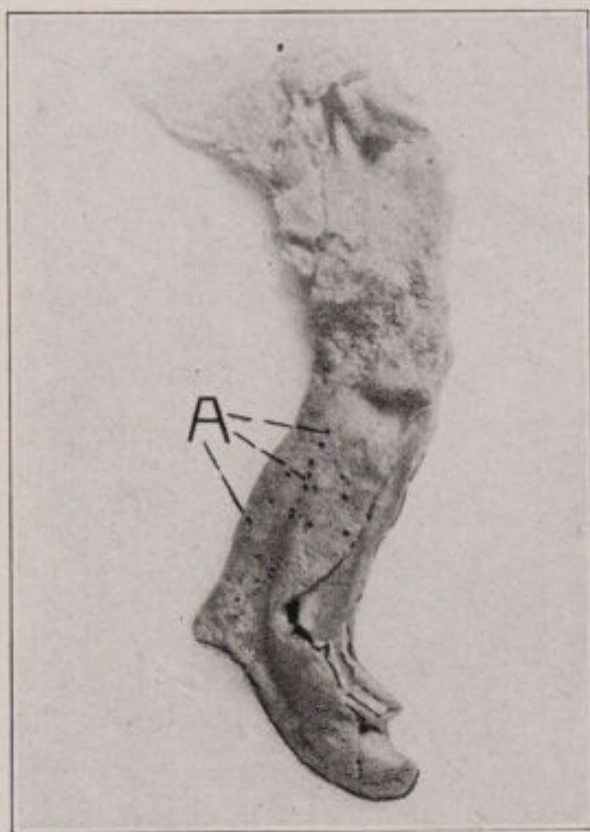


FIG. 51. HEMORRHAGIC ENTERITIS IN A HEN.
A, small hemorrhages (natural size).

Along with diarrhea due to these causes may be mentioned a like condition sometimes caused by the presence in the intestinal tract of certain species of worms and of irritating foods. Exposure in damp coops, cold rains, or draughts often results in digestive derangements of this nature. A bird, during molting, has poor protection against inclement weather, from lack of feathers, and requires more care than at other times.

Symptoms.—The plumage loses its smooth, well-kept appearance; the bird

is depressed and not inclined to move about as much as usual; there may be loss of appetite; the crop is full; digestion is slow; the cloaca is inflamed (red) and sensitive; the evacuations from the bowels are frequent, the discharges being fluid, offensive and varying in color from whitish-yellow to greenish. In later stages the evacuations are quite spasmodic and forcefully ejected (squirting) and the fluff and feathers near the vent are soiled with feces. The affected bird gradually becomes weaker and there is a rise in temperature. It may eat little or nothing; thirst is extreme in some cases. The bird may die in two or three days or it may live for two or three weeks.

Postmortem Findings.—In fatal cases the most noticeable alterations are in the intestinal tract and the liver. Upon opening the small intestines, areas of inflammation are noted, and occasionally a small hemorrhage is found. Microscopic examination of stained sections from the vital organs (liver, kidney, etc.) reveals retrogressive changes; cloudy swelling being most marked. Fig. 51 illustrates one of these cases.

Treatment.—Give the same treatment as that given for blackhead in turkeys and for fowl cholera. A diet of sour milk is helpful. (See white diarrhea, page 124.)

WHITE DIARRHEA

The loss to American poultry raisers from white diarrhea is greater than from anything else, perhaps greater than from all other infectious diseases combined. It strikes at the root of the poultry industry; no one can successfully conduct the business if he is unable to rear a reasonable number of chicks annually.

Without treatment the resulting mortality, when white diarrhea has secured a foothold in a poultry plant, is extremely high, often reaching ninety per cent of the season's hatch. The loss from white diarrhea in dollars and cents is enormous, almost beyond calculation. It is widespread throughout the United States and causes the loss of perhaps ten per cent of all the chicks hatched in this country. By proper measures the disease is fairly easily preventable and a large number of the affected chicks will recover under proper treatment.

Causes.—There are two forms of white diarrhea, due to two distinct causes. A bacillary form due to the *Bacterium pullorum*, a rather short, plump, rodshaped germ with rounded ends; and a protozoal form due to the *Coccidium tenellum*. I have isolated the germ causing the disease from the liver, spleen, kidneys and other organs of chicks dead of the bacillary form of the disease, and in the coccidian form from the ulcers of the cecum and the intestines.

Symptoms: Bacillary Form.—In young chicks there is drooping wings, ruffled feathers, sleepy appearance, huddled together, little or no appetite, abdominal yolk not properly absorbing; whitish or whitish-brown frothy discharge from bowel which adheres more or less to the vent fluff; eyes closed part of the time and apparently no interest in life. "Peeping" much of the time, the appearance in many is stilty, abdomen prominent behind. In these cases after death one finds the yolk unabsorbed or only partially so. The intestines are more or less full. Late fall, winter or early spring hatched chicks are freer from the disease than summer

hatched. This may be explained by the fact that hens with diseased ovaries gradually become poorer layers as the disease processes advance, and hence, only lay in late spring or early summer, when nature intends reproduction of birds. Finally the hen may cease laying.

Symptoms: Coccidian Form.—The symptoms, as I have seen them, are similar to those of the bacillary form, excepting, as a rule, the heavy death rate takes place later.

Mode of Spread: Bacillary Form.—Ovaries of laying hens, diseased, but still functioning, may be infected by the germ. The germ can be isolated, particularly from the yolk, of at least some of the eggs formed in such an ovary. The chicks from infected eggs, as a result, have the disease more or less developed when they are hatched, as conditions which favor hatching also favor the multiplication of the germs to an extent that toxins (poisons) have already been produced in the young in sufficient quantity for the disease to at least manifest itself in a few hours after hatching, although ordinarily they do not begin to die until they are about a week old.

The whitish, frothy, pasty bowel discharge, more or less sticky and having a tendency to "paste up the vent," from these chicks is laden with the germs, and others of the flock soon become infected from contaminated food picked up from the ground. In the former case, chicks may begin to die soon after hatching; in the latter, in from three to four days, a few dying each day.

The death rate is high, reaching in many cases as much as seventy-five per cent or more. Those that recover are stunted and do not make satisfactory growth. The greatest loss is from the first few days to, in some cases, two or three weeks. It is probable that the carriers are chicks that have recovered, but which still carry the organism (especially in the ovary) as the human typhoid carriers carry the germs of typhoid fever, in the infected kidneys and in bowel ulcers. These "carriers," having established an immunity, do not themselves succumb to the disease, and they rarely show any outward symptoms of it.

Insanitary conditions, spoiled feed, dirty, stagnant water, improperly ventilated incubators, brooders and buildings, or badly regulated heat, are factors in weakening the physical condition of chicks and favor ravages of diseases.

Coccidian Form.—The mode of spread of this form is at present problematical. It is possible that a chronic type of coccidiosis occurs in some birds and thus perpetuates and disseminates the protozoa.

Postmortem Findings: BACILLARY FORM.—The liver in general is

usually pale, showing areas of congestion (active and passive congestion and cloudy swelling). The yolk is only partially absorbed; congestion of the intestines may or may not be present. The kidneys are normal in size, but show congestion and cloudy swelling. The carcass is more or less pale, emaciated and anemic.

COCCIDIAN FORM.—Upon postmortem examination the conditions are found to be similar to those in the bacillary form, except there will be noted more or less congestion of the intestinal mucosa (lining), and ulcers in the intestines, principally the ceca. The ceca appear to contain considerable ingesta, and to be interfered with functionally.

Fig. 52 shows a transverse section through an ulcerated area. In these areas we find cloudy swelling, followed by necrosis (retrogressive changes and death of the cells). The remains of the dead cells form a cheesy mass (caseation necrosis). It will be noted in this drawing that only remnants of a few of the glands normally present are yet intact, the remainder of the mucous membrane and in places the submucous layers are invaded by the germ (protozoan). In Fig. 53 the section B has been magnified 900 times.

As explained under the cut, all stages of the *coccidium tenellum* are observed in a mass of dying and disintegrating cells—the remains of the diseased mucous lining of the bowel. Repeated examinations have been made of healthy chicks killed for the purpose, and chicks dying from other causes, and thus far no case has shown these conditions.

In the establishment of the fact that the hen may become chronically infected by the *Bacterium pullorum*, it also means that she is one of the main sources of infection through the eggs she forms and lays. She may remain chronically infected following a case of white diarrhea while a baby chick or she may acquire the infection after she is mature. This acquisition may be by consuming contaminated food. The permanent seat of infection appears to be the ovary, which in many instances becomes so greatly involved that the ova are discolored and misshapen, and the ovary presents a decidedly pathological appearance. The ova harbor the disease organism. Ova which develop apparently normal yolks frequently carry the organism, *Bacterium pullorum*, to the time of full formation of the egg. Infected eggs produce infected chicks and although infected chicks frequently succumb before their embryonic development is completed or before they pip out of the shell (dead germs), a large percentage of them emerge from the shell apparently sound and well. However, they soon acquire the disease and many of them fall prey to the organism which they carried for a long time in their yolk. These chicks are a constant source of infection to other chicks and to the mature stock.

A system has been developed to test the hens to determine if they are bacillary carriers. This consists of applying the agglutination test.

Jones in 1912 reports an outbreak of a disease among adult fowls from which the *Bacterium pullorum* was isolated and to which he attributed the disease. Among 700 hens the mortality was 50 per cent. There had been no history of bacillary white diarrhea on the farm. A neighbor had been meeting with serious losses, however, and a number of eggs from his fowls were incubated on the farm which had hitherto been free from the disease. Nearly all the chicks that were hatched from these eggs died within ten days from bacillary white diarrhea. The eggs that failed to hatch were inadvertently fed to adult hens. In these dead hens the *Bacterium*

pullorum was isolated from various internal organs, as well as from chicks hatched from the neighbor's eggs.

Retger, Hull and Sturges report three fowls out of twelve dying following feeding boullion cultures of the *Bacterium pullorum*. These cultures were fed along with the regular mash. The *Bacterium pullorum* was isolated from the liver, lungs, heart and spleen. They attributed death to these organisms.

Smith and Ten Broeck report that bacterium-free filtrates of five to fifteen day old bouillon cultures of *Bacterium pullorum* were decidedly toxic to full grown rabbits when given by intravenous injections. Death followed within two hours, or there was marked dyspnea, followed by death over night or by loss of weight and subsequent recovery.

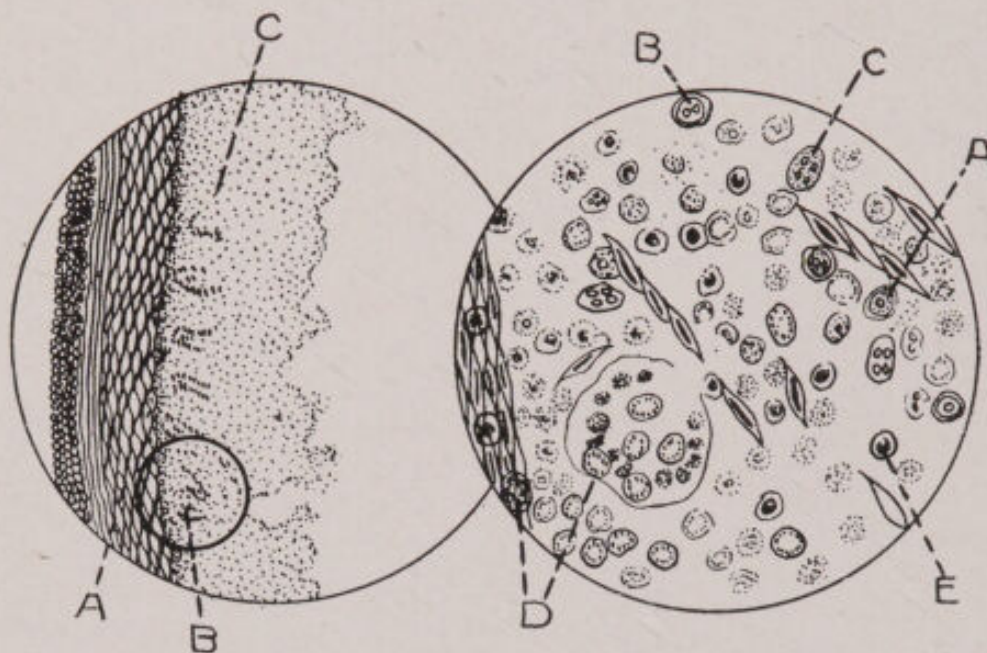


FIG. 52. SECTION THROUGH CECUM (MAGNIFIED 100 TIMES).

From a chick that had died of coccidian white diarrhea. A, muscular layer; B, remnant of gland; C, degenerated disintegrating mass. There is complete destruction of the mucous membrane.

FIG. 53. SECTION "B" IN FIG. 52 (MAGNIFIED 900 TIMES).

Shows various stages of the *Coccidium tenellum*. A, oocyst; B, sporoblast, first stage; C, sporozoite, first stage; D, schizont, merozoites within, surrounded by a disintegrating cell mass; E, polymorphonuclear leukocyte.

Gauge reports that rabbits are very susceptible to very small doses of the *Bacterium pullorum* by subcutaneous injections.

Retger, Hull and Sturges in a summary of their work state that eggs that harbor *Bacterium pullorum* in the yolk in large numbers may produce abnormal conditions, when fed, not only in young chicks, but in adult fowls, young rabbits, guinea pigs and kittens.

When infected eggs are allowed to remain under the hen in nests for a considerable time or in warm rooms during storage and in transit, these bacteria rapidly increase in numbers. In a poultry survey as to the prevalence of bacillary carriers among hens, it was found in Connecticut that out of 107 flocks subjected to the agglutination tests, 1,417 out of 13,831 fowls reacted; that is 10.24 per cent gave positive reactions and of the flocks 74 per cent were infected. In Massachusetts more than 50 per cent in some flocks reacted.

Treatment.—The most of our experimental work with various remedies has been with the coccidian form. In one outbreak, referred to above, 80 per cent of the first hatch of 2,000 chicks had died. We began trying to improve sanitary conditions, and administered various dilutions of permanganate of potash, copperas and carbolic acid. The loss was unaffected. By this time the writer had examined many dozen birds in the laboratory, and in about 50 per cent of the cases, the *Bacterium pullorum* was isolated from the heart blood, liver, spleen and kidneys, and in every case the coccidian ulcers, described above, were observed.

These chicks began dying in numbers at about ten days of age, very few had died before that time, and from this period to the end of the third week the greatest loss occurred. After this time but few died, but those having the disease in light form were stunted and did not make satisfactory growth. With this data now before me, I began on another line of treatment.

During the past ten years I have used, to a greater or less extent, dilutions of mercuric chlorid (corrosive sublimate) as an intestinal antiseptic in chickens. This was used, in this outbreak, in a solution of 1:10,000, with sulphocarbolates of zinc, sodium and calcium. The latter had not given the satisfactory results when used alone that it had in treatment of diarrhea in colts and calves.

Jones (Cornell) has shown that a solution of 1:1,000 (one-tenth of one per cent) bichlorid of mercury, will kill the *B. pullorum* in thirty seconds; a one per cent carbolic acid solution requires five minutes in which to kill this germ; one per cent creolin requires five minutes; three and one-third per cent lactic acid kills it in five minutes, and five per cent carbolic acid kills it in thirty seconds. Mercuric chlorid is therefore fifty times as effective against this germ as is carbolic acid.

Instructions were given for the incubators (containing also the nursery trays) to be tightly closed and fumigated with formaldehyd gas, as recommended under chicken cholera, before filling with eggs.

After chicks were hatched they were not to receive any feed for forty-eight to seventy-two hours, as the yolk contained in their abdominal cavity will furnish food for that length of time, and an engorgement of the intestines might impinge on this part and interfere with its absorption by pressing on the absorbing vessels.

The following solution was to be kept before them from the time of hatching to four weeks of age, and then given

twice a week for the next few weeks: Zinc sulphocarbolate, fifteen grains; sodium and calcium sulphocarbolate, of each seven and one-half grains; bichlorid of mercury, six grains, and citric acid, three grains. This quantity was dissolved in a gallon of water. The result was that eighty per cent of the next hatch was saved.

A diet of sour milk in white diarrhea and other bowel ailments, of a similar nature, has given excellent results. Cultures of the *Bacillus bulgaricus* in milk is recommended in all diarrhea of birds. Chicks should be fed sour milk as soon as hatched.

TRICHOMONIASIS

Trichomoniasis of chicks has recently been described. The baby chicks are attacked at the age of 10 to 14 days. After four weeks old they are immune. Diarrhea may be absent in the early cases but present in later stages and chronic cases. The acute cases die in from one to two days. More vigorous birds enter the chronic stage.

The affected chicks droop, huddle together, do not refuse to eat, wings drag, eyes are closed, heads pale, temperature subnormal, 102° Fah.

At autopsy there are noted no lesions except an anemic condition. The cecum may be slightly enlarged and its contents slimy and the crypts in the mucosa are found to be filled with the *Trichomonas pullorum*.



FIG. 54. CROUPOUS INFLAMMATION IN A PIGEON.

A, necrosing mass made up of pus cells, fibrin and debris.

CROUPOUS INFLAMMATION OF THE PIGEON

There is a condition in pigeons in which there appears a mass in the upper portion of the esophagus and other parts. It is illustrated in Fig 54. The squabs become affected early, and as the diseased or tumor-like area becomes larger, due to the accumulation of croupous exudate,

the bird is unable to eat or swallow. The loss in some breeding establishments is considerable. The disease area mani-

feels itself as a lump in the throat or neck, which is easily felt.

Treatment.—It will be necessary to keep the premises thoroughly clean, constantly disinfected, washed with an antiseptic. The trays after each batch of squabs need to be cleaned and disinfected, as, in fact, does the entire building.

Some good results have been obtained by treating these squabs early with a solution of iodine applied to the part with a swab after first curetting out the mass. Also other antiseptics recommended for chicken cholera may be used. If the disease has progressed very far, it is best to kill the squab and cremate it.

A condition similar to this has been called canker. The following is the experience of Dr. E. J. Foreman who is a breeder of fine pigeons:

"I have had several pigeons die of this trouble or a trouble similar to the condition you describe.

"I have operated on a number by making a free incision and removing the cheesy deposit, swabbing out the cavity with iodine after which they make a nice recovery. The beak is sometimes deformed following the disease and treatment. I never have found pus. The mucous membrane, after the paste-like substance has been removed, is usually reddish in color but I find no ulcer underlying it. This trouble develops in young birds, and mostly in those still accepting feed from the mother.

"The following are the results of some autopsies:

"Case 1.—I found this squab dead in the morning. A mass of yellowish, fibrinous deposit was found in the esophagus at a point near the entrance of the thorax. There was nothing visible in the mouth or nasal chambers.

"Case 2.—This one developed a large tumefaction above the left eye which caused a profuse flow of tears. An incision was made above the eye and the deposit removed, after which the cavity was swabbed with iodine. There was a second exudate in the roof of the mouth. This material was removed and the part swabbed with iodine. The bird made a complete recovery.

"Case 3.—There was a very large swelling in the cervical region in this case. A free incision was made into the tumefaction and the large deposit of putty-like material removed. The cavity was swabbed out with iodine and the incision sutured. Partial recovery followed, but there appeared a small mass of material between the edges of the wound. This material was removed and the part again swabbed with iodine and the bird made a nice recovery. This bird, though recovering, still lacks vigor and may possibly have other affections.

"Where internal lesions appear as in the chest cavity or abdominal cavity the bird manifests symptoms of 'going light,' appears languid, dull, stupid, losing its appetite, gradually becoming emaciated and finally dying. In these cases usually internal lesions may be found.

"Case 4.—This was in a young bird that had escaped from the nest. Its head was badly lacerated by the old birds picking it. There was no indication of canker. After several days the bird died and

at autopsy showed a large mass at the lower part of the crop. There was almost a continuous layer extending over the mucous membrane from the larynx to the bronchi. At the point of entrance of the lungs by the bronchi, there were observed greenish gangrenous spors. The lower bowel was filled with a soft, greenish white fecal matter.

"Case 5.—The symptoms of this bird were those of going light. This bird appeared rather full between the anus and sternum. Upon making an incision the intestines and liver were apparently forced out of the opening. The liver was enormously enlarged. The center was filled with a large cheesy mass, deep yellow or orange in color. There were small spots of this substance throughout the liver. There were also deposits along the course of the intestines.

"Case 6.—This bird passed through the typical symptoms of going light. Great marasmus and cachexia. There was no indication of cheesy matter in the mouth or head. The usual whitish fecal matter was found in the lower bowel. The skin appeared leathery and dark. The abdominal cavity was crowded as in case No. 5. The entire abdominal cavity was covered with material which was closely adherent and seemed very tough.

"In these birds there appears to be no rise in temperature. The average temperature of old birds is about 108 degrees Fahrenheit and of squabs as soon as they leave the nest perhaps a trifle higher. Squabs in the nest appear to have a trifle lower temperature than those that have left the nest. The hen with squabs just hatched perhaps runs a trifle higher."

In a study of the lesion of the esophagus of the squab there was found that the underlying structures, in this case connective tissue in the throat region, was invaded with polymorphonuclear leukocytes and lmpyhocytes. Farther along there is but a mass of leukocytes which have now become pus cells and finally a piled up mass of, at first caseating pus cells in different stages of disintegration, and then simply a homogeneous mass which stains uniformly pink with the hematoxylon-eosin stain. Like in the fowl, pus in the pigeon is not liquid or semi-liquid but of a cheesy nature.

Treatment.—I have successfully treated some of these cases by curetting out the throat which is made possible by grasping the throat below the tumefaction and forcing it upward, then inserting through the mouth the curette and removing the cheesy mass. Then this part is injected by means of a dropping pipette with iodin, alcohol or what is acting very nicely is the menthol, oil eucalyptus and oil thyme given under roup treatment. A similar disease has been studied in the fowl, in which cases the croupous mass accumulates in the pharyngeal region and can be easily scraped off. The parts are then treated the same as in the pigeon.

COCCIDIOSIS IN WILD DUCKS

Two wild ducks (mallards) were sent to the laboratory by the game warden of Colorado during the fall of 1910, with the history that they had been found dead on a reservoir, and

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BLASTOMYCOSIS OF THE GOOSE

This condition has been observed by Martin. At autopsy there were found small cysts attached to the capsule of the liver. The cysts varied in size up to a pea. They are seldom if ever found in the liver substance. The cysts are yellowish-white in color, fluctuate and resemble somewhat the small echinococcic cysts. Upon microscopic examination yeast-like bodies were found which somewhat resembled the *Oidium albicans*. Some may be found in the process of budding. The liquid of the cyst is of a yellowish color and of a gelatinous consistency. The cells are provided with a capsule and contain a homogeneous protoplasm in the center of which is observed a nucleus.

SARCOCYSTIS

Sarcocystis is also called psorospermiosis. It is due to a single-celled sporozoal parasite. It may affect the striped and unstriped muscular tissue, connective tissue and at times the visceral structures.

Kuhn has described a sarcocyst as affecting the domestic fowl.

CLOACITIS

Symptoms.—The anus becomes red (inflamed), protrudes, and later ulcerates. In a case treated in the laboratory antiseptics were applied and injected into the cloaca with the view of destroying the germs causing the trouble, but the bird died. Upon autopsy it was found that acute inflammation had extended the entire length of the rectum. See Fig. 2 for this portion of the anatomy. The latter condition would be called a proctitis.

Hoare describes a contagious catarrh affecting the cloaca and sometimes extending to the mucous membrane of the lower portion of the oviduct and to the rectum. It may be communicated from bird to bird by copulation.

Treatment.—In these cases apply a solution of sulphocarbolates compound, five per cent carbolized vaselin, or a solution of five per cent carbolic acid in warm water. The solutions may be injected with a syringe and the ointment applied with the finger.

The best results have been obtained by the injections of a five per cent solution of sulphate of iron three times a day.

PERITONITIS

Acute peritonitis is rare. It may result from the irritation that follows from rupture of the oviduct. It may accompany aspergillosis or fowl cholera.

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SUPPURATIVE INFLAMMATION OF THE GIZZARD

A Single Comb Rhode Island Red cock two years old, used as a breeder, showed a slight diarrhea, "mopiness" and no interest in life. He became gradually weaker and died.

The carcass was thin there being an absence of retroperitoneal fat. There was a suppurative inflammation of the posterior half of the gizzard. The posterior portion of the gizzard cavity contained a quantity of cheesy pus. The liver weighed 60 grams and presented a greyish mottled appearance. The testes were in an atrophic condition showing that he was entirely inactive as a breeder.

A section of the gizzard including a portion of apparently normal gizzard tissue and through the involved area was prepared and sectioned and stained with hematoxylin, eosin and picric acid. A portion of the adjacent muscle was densely infiltrated with polymorphonuclear leukocytes as well as a zone of newly formed connective tissue. This was apparently a chronic suppurative inflammation. The pus consisted of fibrinous material and masses of pus cells.

Sections of the liver prepared and stained with hematoxylin and eosin showed intense active and passive congestion with hemaciderosis. There was an acute inflammation, the polymorphonuclear leukocytes appearing more densely infiltrated in the perivascular spaces and immediately adjacent tissue. In some areas the inflammation appeared rather diffused while in other parts of the liver there appeared a tendency toward focalized areas of inflammation.

CALCULI

Urinary sediment in the form of calculi has been found in the fowl. These deposits may be located in the small collecting and transporting tubules of the renal tissue and may consist principally of uric acid. These deposits appear as small nodules.

PURULENT INFLAMMATION OF THE ABDOMEN OF THE HEN

Purulent abdominal inflammation is quite common in hens. Especially is this the case with hens of two or more years of age. Nonspecific infections are the cause of a portion of these cases.

The following case serves as an example of purulent peritonitis of the hen.

The subject was a two-year old S. C. Rhode Island Red hen. After death the unfeathered region of the head was of a deep

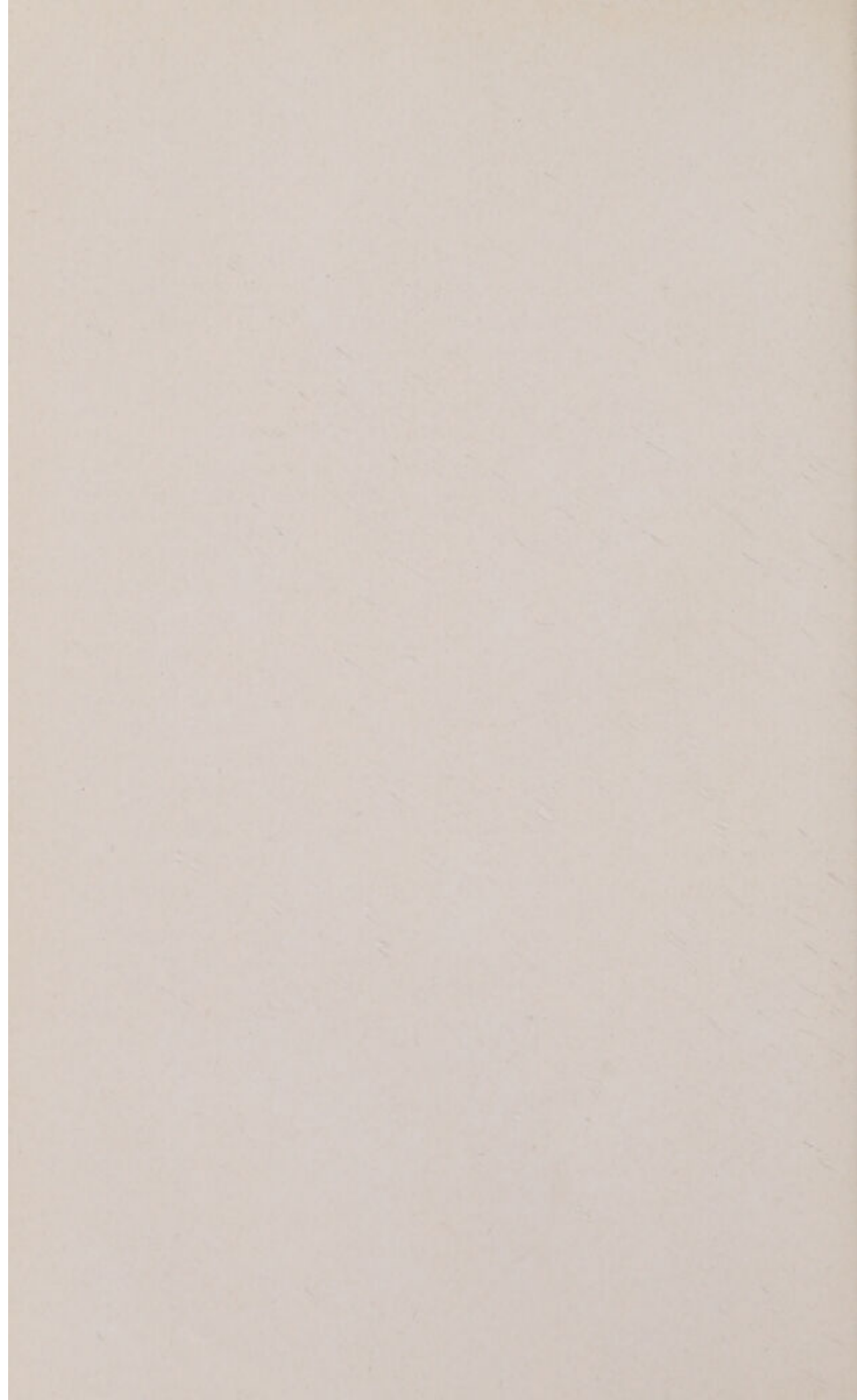
purplish red. There was slimy mucus in the mouth. The general condition of the plumage was fairly good. The carcass had a fair amount of fat on it. The liver appeared dark, but normal in size. The gall bladder was full of bile. The peritoneal surfaces were covered by a mildew-like material. The carcass was cold due to the fact that it had been in refrigeration over night. This mildewed condition may have been due, in part, to this cause. The spleen was normal in size and appearance. The intestines appeared normal except for the above described condition. Ingesta and a small amount of gas were contained in the intestines. The ceca and large intestines contained a small amount of ingesta. The pancreas appeared normal. The kidneys were of a light mottled grey, the anterior lobes appearing swollen and highly congested—apparently blocked with the pasty, white urinary secretions. There was present cloudy swelling. The ureters were distended with urinary secretions of a pasty nature. The ovary was inactive and of a pinkish color. The accumulated material of the right ureter was thinner and more slimy than the left, and upon a microscopic examination, was found to be teeming with short, chained, streptococci; pus cells of both mononuclear and polymorphonuclear varieties and sodium urate crystals were present. There was about 5 cc. of a thin, milky liquid in the peritoneal cavity. The streptococci seemed to be confined to the abdominal region affected with purulent inflammation. Microscopic examination of the pleural fluid, lungs, blood and heart blood revealed nothing abnormal.

A microscopic examination of sections from the kidneys stained with hematoxylin and eosin showed both active and passive congestion, with cloudy swelling. There were pus cells and hemorrhage into the collecting tubules. Areas here and there showed localized nephritis as evidenced by the area being packed with polymorphonuclear and mononuclear leukocytes, similar to those found in the peritoneal exudates.

INTESTINAL DISEASES OF CANARIES

Intestinal troubles in canaries are usually due to errors in feeding and watering. In diarrhea remove all green feed and do not give any soft feed. Give just the normal seed supply. Feed the bird with a small piece of wet bread on which has been sprinkled subnitrate of bismuth. If the case does not yield to this treatment place in the drinking cup one ounce of clear water in which has been placed four drops tincture of opium and fifteen drops whisky or brandy.

In case of constipation give plenty of green feed such as lettuce, apple, chick weed. Add a pinch of Epsom salts to the drinking water. Make the water so that it has a faintly saline taste of the Epsom salts.



SECTION VI

BLOOD DISEASES

Under blood diseases come the septicemias, as apoplectiform septicemia, septicemia of geese, typhoid of fowls, and spirochetosis, all caused by germs which live and multiply in the blood stream.

APOPLECTIFORM SEPTICEMIA IN CHICKENS AND PIGEONS

This disease is due to the *Streptococcus gallinarum*, which grows in long or short chains. It can be readily grown upon artificial media and does not liquefy gelatin. Experimental inoculations with this organism killed the following animals: chickens, mice, rabbits and swine. It does not kill guinea pigs or dogs. The germ multiplies in the blood.

Symptoms.—Apoplectiform septicemia is rapid in its progress. The bird shows great prostration, feathers ruffled, loss of appetite, and the condition rapidly terminates in death. Often birds die in from twelve to twenty-four hours after the first symptoms appear. Birds in which no symptoms of the disease had been noticed may be found dead under the roosts. This disease often causes great loss to pigeon fanciers.

Postmortem Findings.—The spleen is enlarged, dark and soft; focal necrosis is noted in the kidneys, spleen and liver. Cloudy swelling also occurs preceding this state. Pneumonia may be present. The germs can be isolated in pure culture from any of the organs named.

Treatment.—Observe the rules of sanitation, as directed for chicken cholera (Page 110). If possible, separate the well birds from the sick. Vaccination with a vaccine made from the *Streptococcus gallinarum* has given good results. Sulphocarbolates compound may be tried, as outlined in the article on chicken cholera before mentioned.

SEPTICEMIA OF GEESE

This disease has been described as being caused by a germ which closely resembles the polar staining germ of chicken cholera. It multiplies in the blood.

Symptoms.—Geese are often found dead without having been noted to have been ill. The majority die very quickly, that is, within two or three hours after the first symptoms appear. Occasionally a bird may live for several days and finally die.

Postmortem Findings.—Small pinpoint hemorrhages may be noted, especially in the mucous lining of the intestines. Usually the digestive tract contains feed in all stages of digestion, indicating that the disease is very rapid in its onset. Considerable mucus may be found in the mouth and throat. Inflammation may be noted in the liver, pericardium (heart sac), spleen and kidneys.

Treatment.—Sanitary measures the same as those given for chicken cholera. (See page 110.)

FOWL TYPHOID. INFECTIOUS LEUKEMIA

This is due to a short, plump germ with rounded ends. It is called the *Bacterium sanguinarium*, and is easily isolated from birds dead of the disease. It reproduces the disease in inoculated birds, multiplying in the blood.

The disease is confined to chickens. The period of incubation is given as one to two months. The course of the disease is from one to two weeks to as long as three months. Birds rarely recover.

Symptoms.—Anemic or blanched appearance of the mucous membrane of the head, with a dull appearance and great prostration, usually ending in death in about four days, is characteristic of this disease. In some cases the affected bird may live three to four weeks. Moore reports a decrease in red blood cells and an increase in white blood cells, the latter principally the *polymorphonuclear leukocytes*.

Postmortem Findings.—The liver is enlarged and mottled with greyish patches, due to areas of leukocytic invasion. The germ can be isolated from the internal organs. The kidney shows congestion, which may be recognized by the minute red lines. The intestines may be congested. The spleen usually appears normal in size and color. The red blood cells gradually diminish and a leukocytosis (an increase of the white blood cells) appears.

MYELOID LEUKEMIA

Schmeisser has shown that spontaneous leukemia occurs in the fowl. It is transmissible by the intravenous or intra-peritoneal injection of an organic emulsion.

The chemical picture and changes produced in the blood and organs are analogous to those which occur in human leukemia.

In a case of spontaneous leukemia the following differential count was found:

Polymorphonuclear with eosinophilic rods	8 per cent
Polymorphonuclear with eosinophilic granules	0 per cent

Lymphocytes	2 per cent
Large monocuclear cells.....	30 per cent
Mast cells	0 per cent
Mononuclear myelocyte with eosinophilic granules.....	52 per cent
Unclassified cells	8 per cent
	<hr/> 100 per cent

It is associated by an infiltration of large mononuclear leukocytes. Atrophy of the bone marrow is noted. There is noted an accumulation of white blood cells in the bone marrow, spleen and liver. The bone marrow appears greyish-red in color.

Treatment.—Prompt isolation of the well from the sick birds and sanitary measures as given for fowl cholera should be observed.

SLEEPING SICKNESS OF CHICKENS

This disease is due to a gram-positive encapsulated streptococcus. As prominent symptoms there is noted reddened and swollen conjunctiva. The bird appears “droopy” and drowsy. The comb and wattles appear pale. There is a diarrhea and emaciation rapidly ensues.

SEPTICEMIC DISEASES OF CANARY BIRDS

Septicemia of Canary Birds

This disease is due to a motile bacillus. The cultures on potatoes are a characteristic yellowish-grey. As a prominent symptom there is noted a soot-like discoloration of the skin. At autopsy there is noted small necrotic foci in the liver.

Cholera of Canary Birds

This disease is due to a non-motile bacillus. It does not take the polar staining. In cultures it produces fetid gases. On potato it produces yellowish colonies. It is very fatal running a rapid course. Chickens and pigeons inoculated with the pure culture succumb to the disease.

Infectious Necrosis of Canary Birds

The bird appears droopy with loss of appetite. Singing birds cease to sing and remain quiet on the perch. Upon examination of the mouth cavity diphtheric areas are noted. On autopsy small necrotic areas are noted in the liver and spleen. The germ is a short non-motile Gram-negative bacillus.

Typhoid of Canary Birds

This disease is due to a bacillus of the enteritidis group. The prominent symptoms are those of debility, difficult respi-

ration and diarrhea. The course is rather rapid. On autopsy there is noted an acute gastro-intestinal catarrh, and a fibrinous inflammation of the serous membranes and cloudy swelling of the liver and kidneys.

FOWL PEST

(*Pestis Avium*)

This is an acute contagious and infectious disease of fowls. It may attack chickens, geese, turkeys, pheasants, sparrows, parrots, pigeons and owls. The infective agent is contained in the blood, nasal discharges, nervous system and droppings.

The disease may be transmitted to chickens by inoculation of emulsions from these sources from the infected fowl. These emulsions filtered through porcelain and the filtrate injected into a chicken produced the disease. Landsteiner claims that the blood corpuscles are more virulent than when serum alone is injected.

The virus kept in sealed glass tubes retains its virulency for at least three months. The filtrate proved virulent for only one week. Centanni found that a temperature of 65 degrees Fahrenheit killed the virus at once and 55 degrees Fahrenheit in thirty minutes. The virus remained active in dried liver and spinal cord for 200 days, and in blood mixed with glycerin 270 days. Drying in a thin layer kills it (Ostertag). It is destroyed by five per cent creolin, three per cent chlorate of lime and one per cent corrosive sublimate.

The disease is probably spread by contaminations from the droppings and nasal secretions. The feet of man and animals, utensils and clothing coming in contact with the contagion may transmit the disease. Birds introduced into the flock from infected flocks or placed in infected runs or coops may serve as a source of infection. Macerated parasites (blood sucking) removed from sick birds and these injected into susceptible birds did not produce the disease.

Symptoms.—The period of incubation is from three to five days. The bird first appears depressed with loss of appetite; later dull and sleepy. The comb and wattles appear dark red and the bird sits with droopy wings, and gives a peculiar loud cry when picked up. The walk is irregular and staggers. Toward the end of the disease greyish scales sometimes develop on the skin, especially on the face and around the eyes. The nasal discharge is of a reddish or greyish color and rather viscid in consistency. Similar secretions are noted in the mouth and throat. The bird if distressed by obstruction from mucus accumulation may throw its head causing a discharge of a quantity of the secretion. The droppings are grey or

greenish and occasionally diarrhea accompanies the disease. The disease is fatal in from two to three days to seven days, depending on the natural resistance of the bird and the virulency of the causative organism.

Autopsy.—In very acute cases lesions may be absent or only lightly marked. There may be hemorrhages in the serous membranes as the peritoneum, pericardium or on the viscera, and congestion of the liver, spleen and kidneys. In less acute cases there may be edema of the subcutaneous connective tissues of the neck and breast. The pericardium may contain a quantity of pale yellow, slightly cloudy fluid. Fibrinous exudate has been noted in the pericardium and peritoneum. There is a catarrhal swelling of the conjunctival mucous membranes. The mouth and nasal passage contain a quantity of mucus. The lungs may be congested. The intestines may be congested or there may be inflammation. Hemorrhages may be noted.

Treatment.—Steps should be taken as in other contagious and infectious diseases. Maggiora claims that hyperimmunized goose blood has curative properties as well as capability of producing passive immunity.

THROMBOSIS

A bird was sent to the laboratory with the history that it had been sick for several weeks. There was a partial loss of appetite, finally complete loss; the bird showed weakness and a gradual emaciation. The hen died in about two weeks after coming to the laboratory.

On autopsy there was noted great emaciation. All organs appeared normal except the circulatory system. There was thrombosis (complete plugging) of the right brachial artery (artery to right wing) and the same of the large vessel to the liver, as well as of the iliac and femoral artery of the left side (artery to left leg). Upon microscopic examination there were found white

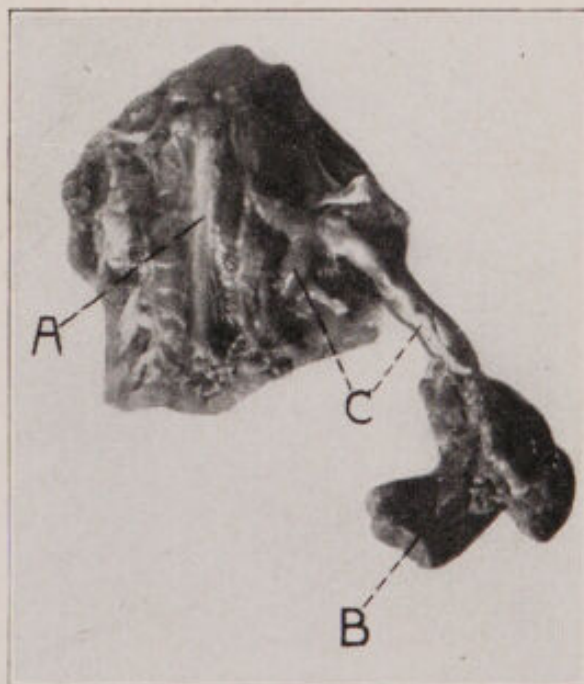


FIG. 57. THROMBOSIS IN A HEN.

A, pelvic bone, central portion; B, muscle of thigh; C, blood vessel containing a white thrombus.

thrombi. Fig 57 illustrates this condition. It may be seen that the blood vessels are quite distended by the blood fibrin.

SPIROCHETOSIS

This is a blood disease (septicemia) due to a spiral-like microscopic organism that is supposed to be carried from bird to bird by means of the chicken tick; illustrated in Fig. 34.

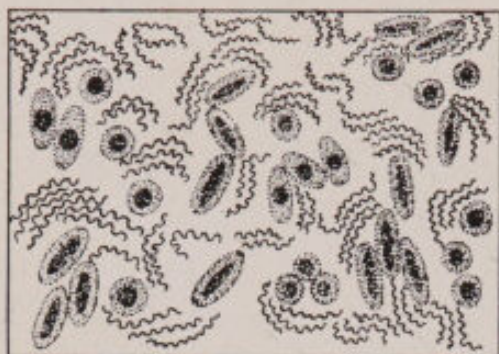


FIG. 58. SPIROCHETA GALLINARUM.

This drawing, made from a blood smear, shows red blood cells (oval), thrombocytes and leukocytes (round) and spirochetes (corkscrew-like).

Fig. 58 shows a drawing of the germ. It is the *Spirocheta gallinarum*; the slide from which this drawing was made was kindly sent to the author by Dr. Balfour of Khartoum, Sudan, Africa. It may affect the chicken, goose, lark and other birds.

This disease was first recognized in Brazil; it is found in Africa and Europe. A disease occurs in the southern part of

the United States, where the chicken tick is abundant, that presents symptoms similar to those of spirochetosis; so far as the author knows, no definite work has been done to determine the true cause of it.

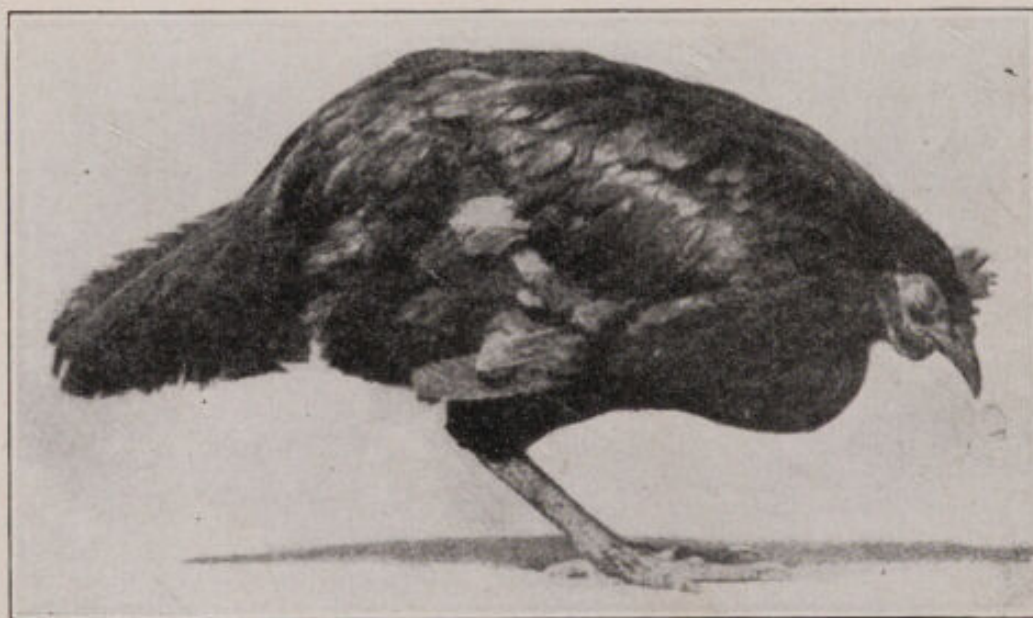


FIG. 59. ACUTE SPIROCHETOSIS (AFTER BALFOUR).

Spirochetosis is most common among chickens, but also infects geese, ducks, pigeons and sparrows.

Symptoms.—Dullness, loss of appetite and rapid emaciation

first; the head and tail are down, and the bird stands around in corners or on the roost, with its eyes closed. Fig. 59 shows a photograph of a typical case. Note the attitude of head, tail and body.

Another form of septicemia in chickens is caused by a comma-shaped germ—the *Spirillum Metchnikovi* or *Vibrio Metchnikovi*.

The symptoms are similar to those of fowl cholera, except that there is no, or at most but slight, elevation of the temperature. Diarrhea is constantly present. Inflammation of the bowel and enlarged liver (hepatitis) is noted. The disease has not been reported in this country. It may exist unrecognized.

PERICARDITIS

This is an inflammation of the pericardium or heart sac; there is usually a sero-fibrinous effusion about the heart, and it is often spoken of as dropsy of the heart sac or dropsy of the heart. It is, of course, not strictly a blood disease, but it is often associated with diseases of the blood and of the lungs, as a complication; further than this its cause is not known, but may result from exposure to cold and dampness. It may be a complication of fowl cholera, of acute tuberculous origin, or pneumo-pericarditis, the latter an extension of the inflammation from the lung structures to the pericardium.

Symptoms.—A diagnosis of pericarditis cannot ordinarily be made during the life of the bird, but is easily demonstrated on autopsy. Among the symptoms are intense dyspnea, the beak being held open. Tumultuous heart action, extreme exhaustion on exercise may exist. The bird may fall if forced to move and death may occur from syncope. There may be a degeneration of the heart muscle and possibly a rupture of the pericardium.

Treatment.—Treatment is unsatisfactory; numerous cases occurring in the same flock should lead to the enforcement of better hygienic conditions, especially to better protection from cold and dampness.

ENDOCARDITIS

This is an inflammation of the lining membrane of the heart, usually affecting the valves also. Nothing is known of its cause, but it is of not infrequent occurrence during the course of certain diseases of the blood. It cannot be diagnosed during life, and therefore cannot be treated. From what we know of the cause of endocarditis in man and animals, we should expect exposure to cold and dampness to be a factor in

the cause of this disease, and as such to be avoided. Verrucose pericarditis has been found. The nodules form in a line or in an irregular manner in the vicinity of the valves. These nodules may become so large that they interfere with the action of the valves and a regurgitation of the blood results.

Chronic endocarditis is often found. In old birds calcification of the aortic walls has been observed.

RUPTURE OF THE HEART AND LARGE BLOOD VESSELS

Internal hemorrhage (bleeding) due to rupture of the heart or large blood vessels is common in overfed fowls. It may be caused by any excitement or overexertion in such birds. It is described in this section because affecting organs of circulation.

Symptoms.—There is a sudden blanching of the comb and mucous membranes followed by great weakness, coma and death. No treatment is practicable.

HYPERTROPHY OF THE HEART

The causes of this condition have been thought to be obstruction of the circulation due to tuberculous growths in the liver or mesentery and also a sequela of gout and rheumatic conditions. It is found in both fowls and cage birds.

Symptoms.—The most prominent symptom is that of dyspnea accompanied by a wheezing sound.

SECTION VII

CONSTITUTIONAL DISEASES

Under this head we class "going light" and tuberculosis.

Both cause considerable loss to the poultryman. There is much doubt as to whether the former should be classed as a disease; certainly this term as usually applied refers merely to a symptom of a disease (often tuberculosis or enteritis) or a condition in which there is a progressive loss in the weight of the bird.

GOING LIGHT (ASTHENIA)

Those who look upon going light as a specific disease consider it as one that affects chickens and pigeons. It may affect old or young birds. It is called going light because the bird becomes gradually lighter until emaciated. It is a disease that is found in all parts of the United States. A germ called the *Bacterium asthene* has been isolated by one investigator from the intestines of sick birds. It resembles the *Bacillus coli communis* always present in the intestinal tract of chickens.

The affected birds have a good appetite; in fact, at times a ravenous one. The loss of flesh is continuous for a few weeks, when the bird dies.

In eleven cases of going light examined by the pathological laboratory of the United States Bureau of Animal Industry three were found to be infected by the *Bacillus enteritidis*. This germ is dangerous to man. It affects cattle and has resulted fatally to those persons eating infected meat.

Postmortem Findings.—Usually on autopsy all organs appear normal so far as gross appearance goes, but extreme emaciation as described above is noted.

The following is the result of a blood study in these cases:

Report of Cases of Asthenia

Two outbreaks have been investigated by the author. One in a flock of Rhode Island Reds, in which flock there were about two hundred birds which should have weighed about two pounds each. The disease affected a gradually increasing number. The feed consisted of grain, insects picked up from the fields, and plenty of green grass. As it was irrigation time, the birds had access to the irrigating ditches. The henhouse and yard were kept clean. It was advised to change the run and continue giving a variety of good green feed and grain with a good supply of water. The disease finally disappeared from the flock. All efforts at the labora-

tory to isolate any germ which might have been the cause of the disease were unsuccessful.

The second flock was from eggs that had been produced by birds in which roup had appeared the preceding winter. Five birds about four months old were sent to the laboratory for study with the following history: The birds had good hygienic surroundings, were moved from place to place, given fresh water and good quality of feed, with plenty of green stuff, but without success; the birds not only did not thrive, but continued to lose flesh and finally died, notwithstanding that most of them had a ravenous appetite.

Chick No. 3.—Hemoglobin, 65 per cent; erythrocytes, 2,920,000; leukocytes, 28,000. Differential count: polymorphonuclear neutrophils, 39 per cent; eosinophiles, 30 per cent; lymphocytes, 29 per cent; mast cells, 2 per cent.

Chick No. 4.—Hemoglobin, 65 per cent; erythrocytes, 2,600,000; leukocytes, 14,000. Differential count: eosinophiles, 31 per cent; mononuclears, 8 per cent; lymphocytes, 60 per cent; basophiles, 1 per cent.

Chick No. 5.—Hemoglobin, 75 per cent; leukocytes, 34,000; erythrocytes, 3,000,000. Differential count: polymorphonuclear neutrophils, 4 per cent; eosinophiles, 50 per cent; basophiles, 3 per cent; mononuclears, 4 per cent; lymphocytes, 39 per cent.

Chick No. 6.—This bird was about four months old, stunted in growth, "going light," and had contracted roup from another bird. The blood study shows the following: hemoglobin, 60 per cent; leukocytes, 16,000; erythrocytes, 3,600,000; thrombocytes, 436,000. Differential count: eosinophiles, 3 per cent; mononuclears, 4 per cent; lymphocytes, 89 per cent; mast cells, 4 per cent.

All efforts to isolate germs from the liver, spleen, kidneys and heart-blood were unsuccessful.

More study must be done on this disease to determine the true cause, before rational treatment can be outlined.

Treatment.—Best results, in flocks of young birds, have been obtained by giving one tablespoonful of Epsom salts to each 12 birds. Dissolve the Epsom salts in water and use this water to mix with bran or mash. Repeat twice weekly. See that the flock has plenty of shade and clean, pure water at all times.

The birds should receive one-fourth to one grain ferrous sulphate once a day in soft feed. The prognosis is not hopeful.

With our present knowledge we will look to sanitary surroundings for the control of this condition—clean coops and yards, good feed and water. A tablespoonful of powdered ginger to each dozen hens may be given with advantage once or twice a day in soft feed.

In going light in addition to a cathartic of Epsom salt the following given once daily has yielded fair results: calcium carbonate 120 grains, magnesium sulphate 240 grains, sodium bicarbonate 360 grains, sodium chlorid 60 grains, sodium sulphate 120 grains. This is one dose for 120 birds.

TUBERCULOSIS

This is a disease of great importance to the poultryman, not only on account of its destructiveness to his flock, but also on account of its relation to the health of himself and family; for while fowls are not very likely to contract tuberculosis from domestic animals or from man, yet fowls that have the disease are a serious menace to the other animals on the farm as well as to the poultryman and his family.

Cause.—The *Bacillus tuberculosis*, which was discovered by Koch in 1882, is the cause of this disease. There are four principal types of this organism. The one most commonly infecting man is designated as the human type. The one peculiar to cattle is designated as the bovine type; and the one peculiar to fowls the avian type; and there is still another type of the tubercle bacillus which affects fish and other cold-blooded animals.

While there are some differences in the shape of the organisms grown for a considerable time in the various animals and some differences (biochemically) when grown in artificial media after isolation, yet the type peculiar to any of the warm-blooded animals will grow in any of the other warm-blooded animals, that is, the types are interchangeable, which means that the bovine type may cause tuberculosis in man and the human type may cause tuberculosis in birds, etc. Most authors consider that while the chicken has considerable resistance to the human type, it will and does become infected by this type.

It has been found that a large percentage of hogs fed swill from houses where tuberculous persons have expectorated into it, become tuberculous, and when slaughtered, there is a considerable loss from condemnation of those badly affected. (Busman.)

Tuberculosis among chickens is rare in some portions, and is very common in other localities in the United States. Although it is widespread throughout the United States and Canada, it was first reported in this country in 1900 and received but slight attention until 1903. It also occurs in turkeys, pigeons and pheasants, and two cases in wild geese were reported at the Ontario Agricultural College. The loss from this disease seems to be increasing.

VanEs and Schalk have produced tuberculosis experimentally in twelve sparrows by feeding them chopped tuberculous liver of a hen.

Mode of Spread.—In the progress of tuberculosis of chickens at times there is noted a diarrhea. In these cases there are tuberculous ulcers of the mucous lining of the intestinal

tract and the spread is very rapid through the flock, as birds are continually picking feed from the ground and floors where contamination is sure to have taken place.

If scraps be fed to which tuberculous sputum has found its way or if the birds are allowed to devour parts of an animal dead of the disease, there is a liability of their contracting tuberculosis.

They may also contract the disease by the introduction of a tuberculous bird into a flock. Tuberculosis among wild birds has been mentioned as a possible fact. There is also danger of spread from eggs from a tuberculous hen where the eggs are purchased for hatching—prenatal infection.

There is also a possibility that birds, by following tuberculous cattle, may become infected, as do hogs. It has been argued that the temperature of the bird is so high (105° F. to 107° F.) that it furnishes an unfavorable field for the human and bovine types of germs, which thrive at temperatures close to 98° and 101° F., respectively. It has, however, been found that these germs soon adjust themselves to such changes in temperature and to a certain degree to differences in food.

One case, a hen, was sent to the laboratory with the history of having had access to the sputum of a person afflicted with tuberculosis. Upon autopsy small pearl-like nodules were found throughout the liver, in the lung substance and over the serous lining covering the intestines and abdominal cavity. A microscopic examination of the lesions revealed the bacillus of tuberculosis. It more closely resembled the human than the avian type.

Symptoms.—An absolute diagnosis cannot be made during life from the physical signs. The symptoms observable are common to many conditions, especially in the early stages when there are no positive external symptoms by which it may be recognized. The bird becomes emaciated. The rapidity of emaciation, like in other animals, depends on the progress of the disease; that is, the susceptibility of the bird, as well as the degree of infection.

The comb appears pale, the bird becomes dull and sleepy. If the joints become affected there will be lameness, in case the affection is in the legs, and swollen joints, and often in affection of the skin and visible mucous membrane there is ulceration (sores). This latter condition has been observed especially in parrots. These skin lesions are made up of a cheesy material (caseation necrosis), which is covered by a thick, rather hard crust, whitish in color. At times these crusts become rather horny in nature.

The red blood cells in a tuberculous fowl may be greatly reduced (as low as 1,000,000), and the hemoglobin as low as

thirty-five per cent. The white blood cells are slightly increased in numbers.

Diagnosis.—Many investigators claim that birds will not react to subcutaneous injections of tuberculin or to tuberculin dropped into the eye of a tuberculous bird. VanEs and Schalk have shown that tuberculin (50 per cent) made from the avian type tubercle bacilli, injected rather superficially in the comb or wattles (intradermal method) will produce a swelling as in similar tests in mammals. Only about one drop is injected. In a test of 600 birds it was found that the intradermal test was accurate in 97.77 per cent.

Post Mortem Findings.—Owing to the fact that most birds are infected with tuberculosis through contaminated food, we find most of the lesions in the abdominal organs. Of these the liver is the most often diseased. Next in frequency may be named the spleen, peritoneum or lining of the abdominal cavity, ovaries, gizzard, intestines, lungs, kidneys and bones.

As indicated above, the areas may appear as pearly, greyish-white nodules varying in size from a pin-head to a pea, or even larger. In these larger nodules there will be noted a cheesy mass which, as the lesions become older, becomes impregnated with calcium (lime) and then cuts like gritty material. Lime deposits in tuberculous lesions of birds are not so abundant as in tuberculosis of mammalia. In healed tubercles there may be a solid calcareous (stony) mass. Usually the diseased organs are enlarged.

Upon opening the intestines of a tuberculous bird there may be noted ulcers, usually small in size, and a thickening of the wall. The abdominal lymph glands are tuberculous. At times these show small tubercles from the size of a pin-head to larger, at other times a cheesy mass (caseation necrosis), and in still older areas an infiltration with lime salts. Small tubercles may also be found in the lungs and other adjacent tissue.

Like in the higher animals, the bones become tuberculous, there is noted swelling, tubercles and caseation; later calcification.

Treatment.—Treatment of the affected bird is not to be thought of. As shown above, the germs of the disease are so often spread through the droppings that the only sure means of eradicating the disease from a flock is to kill all the birds in the flock and if possible move the henhouse to a new location and have new runs. If this is not practicable, thoroughly disinfect with five per cent carbolic acid or five per

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PSEUDO-TUBERCULOSIS

The symptoms are similar to those of true tuberculosis.

Upon autopsy the lungs may be noted to be thoroughly studded with nodules varying in size up to that of a pea. The nodules are firm to the touch and when sectioned are found to be dense and appear homogeneous.

The lesions may be mistaken for tuberculosis, parasitic cysts, nodular taeniasis, aspergillosis or coccidiosis.

ACTINOMYCOSIS

Furlan reports, that in four geese three months of age there was found a fibrinous exudate over the pericardium and peritoneum. Microscopic examination of scrapings from these lesions showed colonies resembling those of actinomycosis.

DISEASE OF THE SUBCUTEM

There is found, at times, peculiar disc-shaped yellowish or yellowish-grey bodies in the loose connective tissue that attaches the skin to the underlying structures. These bodies are only one or two millimeters in diameter and upon being sectioned and studied under the microscope show by their microchemical action that they contain calcium salts. This condition is found in birds of any breed and in any condition, but is most common in birds rather than in flesh. There is no evidence of it being an acute reaction of the tissues and is apparently of no constitutional significance. All efforts to isolate an organism or to reproduce the condition have been negative. There is a possibility that it may be a calcification of a parasitic invasion.



SECTION VIII

DISEASES OF THE LIVER

Inflammation and necrosis of the liver as seen in many of the infectious diseases have already been referred to under the discussions of these different diseases, as chicken cholera, blackhead, tuberculosis, etc. Aside from diseases of the liver due to infection, the commonest cause of ailments of this organ is improper feeding. It is with great difficulty that diseases of the liver can be recognized except upon postmortem examination. Treatment, as a rule, is useless.

FATTY DEGENERATION

There is a disease process in the protoplasm of the liver cells, by which the normal secreting cells of the liver are to a greater or less extent replaced by fat cells. The liver is smaller than normal, unless fatty infiltration is also present; it appears slightly yellowish, and when cut through with a knife, the blade of the instrument will have a greasy appearance, due to the fat that adheres to it.

Symptoms.—Birds affected with fatty degeneration of the liver show varied symptoms, but ordinarily they are dull, eat little and the comb turns dark to black. They gradually become thin in flesh and finally die. Usually the bird will live from two or three weeks to three months after the symptoms first appear. On autopsy all organs as a rule appear normal except the liver.

Treatment.—There is very little that can be done for this condition. Podophyllin in one-grain doses every three days may be given with some hope of relief.

FATTY INFILTRATION

This condition may be a physiological or normal process until the accumulation of fat occurs in such quantities as to interfere with the function of the liver cells.

The liver is one of the so-called storehouses of the body for fat. In it is stored a surplus until needed by the body for use (for combustion for the production of heat and energy)

Overfed hens, or those closely housed and not forced to work, or fed too heavily on carbohydrates (starchy feeds) store up much of the surplus nutrition in the liver as well

as in other portions of the abdomen, especially in the mesentery and in the abdominal walls.

In these cases, on autopsy, the liver will be found to be enlarged, brownish or greyish-brown in color (mottled), friable (tears easily), and when cut through appears "greasy," much fat adhering to the knife blade. In these cases rupture of the liver often occurs when the hen is stepped upon by a large animal, is thrown or jumps a long distance on hard ground or a concrete floor. Heavy hens with clipped wings are prone to this injury.

In the liver, in which excessive fat is stored up, there is, after a while, an encroachment upon the protoplasm to such an extent that the cells cannot properly functionate and then death of the bird may occur. In these cases a microscopic examination shows the nuclei of the cells to be pushed to one side, and the protoplasm atrophied and disappearing. This is a pathological condition.

RUPTURE OF THE LIVER

In cases where the liver is excessively congested with blood or is overly filled with fat, as mentioned above, violence may result in rupture.

One case that may be of interest came to the laboratory, and at autopsy was found to be ruptured, with considerable blood (hemorrhage) in the abdominal cavity (among the intestines). The rupture or tear was about three-quarters of an inch long and on the left lobe. The organ was double its normal size. Upon microscopic examination it was found to be congested and occasional small ruptures (hemorrhages) were found throughout the liver substance.

This bird was in a yard with a horse and it is supposed to have been kicked or stepped upon, as the left side was bruised.

CONGESTION OF THE LIVER

There are two kinds of congestion of the liver, active and passive. Active congestion precedes inflammation and is a state in which the capillaries, arterioles and arteries are engorged with blood. It is caused by local irritation.

Passive congestion of the liver is usually due to a weak heart or a leaky valve between the two cavities of the right side. The blood backs up into the liver, and the central veins of the lobules and capillaries, between the columns of liver cells, become engorged. It gives the cut surface a peculiar yellowish mottled appearance called "nutmeg liver," from a fancied resemblance that it bears to the sectional surface of a nutmeg.

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Jaundice is very rare, and appears to result from a long-continued mild congestion of the liver.

Cercomoniasis (spotted liver) is a type of disease of the liver due to infection (*Monocercomonas gallinarum*) that may be associated with severe diarrheas.

Aspergillosis is a disease due to a fungus (*Aspergillus fumigatus*, and sometimes other species). It commonly affects the lungs (pneumomycosis, which see), but may, and occasionally does, affect the liver.

Amyloid degeneration of the liver, spleen and kidneys has been noted in birds afflicted with tuberculosis. In some cases the liver appears granular and brittle. Amyloid deposits in these organs have also been observed in this laboratory in hens dying of purulent peritonitis.

SECTION IX

DISEASES OF THE OVARY AND OVIDUCT

PROLAPSE OR EVERSION OF THE OVIDUCT

This is a common ailment of laying hens. Stimulating feeding and aggravated constipation have been found associated with this condition. When the eggs are large and considerable straining takes place during their passage, and in inflammation of the mucous lining of the oviduct or egg canal, prolapse or a protruding of the mucous membrane through the cloaca may be observed. In constipation, the bowels becoming gorged, and this in addition to the obstruction when the egg canal contains one or more developing eggs, and the ovary, being active, is larger and adds to the bulk, predisposes to prolapse.

This condition is most often seen in hens that are heavy layers. It perhaps occurs most often in old hens. If the prolapsed or protruding mucous membrane is allowed to extend through the anus, it soon becomes inflamed from exposure to the air and infection. Later the parts may become ulcerated as a result of mechanical injuries or the attack of germs.

Treatment.—Wash off the accumulated material on the vent feathers with clean, soapy, warm water. After cleansing the hands, replace the protruding mass, using on the fingers carbolized vaselin, three to five per cent strength. Keep the hens on a light diet for several days so that the parts may have a rest and the irritation causing the trouble subside. It is best to give only soft feed and liquids. Give the hen a tablespoonful of olive oil and plenty of clean water.

OBSTRUCTION OF THE OVIDUCT (Egg Bound)

This is a common ailment of laying hens, perhaps the commonest of all discussed conditions of the oviduct. The poultry raiser calls it "egg bound," by which he means there is something in the oviduct which the bird cannot force out.

The upper portion of the oviduct, or that part which receives the ovum (yolk) as soon as it is fully formed in the ovary and delivered, is lined with secreting cells. In this part the albumin which surrounds the yolk is formed. Further along the glands secrete the shell or calcium layer after form-

ing around the mass a fibrous membrane or sac. It can be readily seen, for all this to be brought about, there must be an abundant blood supply. An inflammation of the egg duct (usually the result of infection from the digestive tract by way of the cloaca) means an arrest of function of these glands. There are other cells that secrete mucus which lubricates the passage way, and these, too, are arrested in their function. The result is a stoppage of the egg.

Other causes are: eggs of too large size, exhaustion of the bird and atony and paralysis of muscular walls of the oviduct and vagina, volvulus or twisting and stricture of the oviduct. Weakened muscles, the result of disease, improper nourishment and overwork are contributing factors.

Symptoms.—The hen goes frequently to the nest and repeatedly makes expulsive efforts but cannot lay. If the obstruction is well along in the egg canal the egg may be felt as a hard object in the posterior part of the abdomen. In many cases the obstruction is so far up the oviduct it cannot be felt or seen and we must depend for diagnosis upon the action of the bird, which suffers acutely under these conditions.

Treatment.—First be sure that the bird will not lay the egg unaided. Allow her to remain quiet and alone for a couple of hours; she will often relieve herself unaided. If it is evident that the bird must be given help, wash the hand carefully with soap and water and lubricate the fingers with three to five per cent carbolyzed vaselin, which can be secured at any drug store, pass the fingers through the anus and cloaca into the egg canal and remove the egg. At times the egg is large and it may be necessary to break the shell in order to remove it. If the egg is broken, make sure that all parts of the shell are removed. By referring to Fig. 2 the relations of these organs may be seen.

After the removal of the egg give the hen a tablespoon of olive or castor oil and place on a light feed for a few days. Recovery usually occurs in the simple uncomplicated cases which form the majority; in complicated cases death is often the result.

RUPTURE OF THE OVIDUCT

This is usually a complication of obstruction of the oviduct. It is frequently fatal in a very short time and in such cases can be diagnosed only upon postmortem examination.

Cause.—Vigorous contraction of the muscular walls of the egg canal in expulsion efforts sometimes results in a rupture of the wall. When this occurs the usual sequel is peritonitis (inflammation of the serous lining of the abdominal cavity)

and the death of the bird. Disease processes sometimes so weaken the wall that it gives way under the stress of natural contraction.

Symptoms.—The hen ceases to lay, the abdomen becomes larger and often one or more eggs can be felt by palpating the lower portion of the abdomen. Often the hen is noted to sit up penguin-like-fashion, walking with tail and posterior portion of the abdomen dragging the ground. There is nothing to do except to kill the bird. At autopsy there will be found many yolks in the abdominal cavity, possibly one or more with shells and possibly an inflammation of the lining of the cavity (peritoneum).

BROKEN EGGS IN OVIDUCT

Eggs in the oviduct, as well as ova still undelivered, are often found broken as a result of a kick of a large animal or of the hen being stepped upon. Death usually follows, if not immediately from the injury, which breaks the egg, after several days as a result of complicated obstruction of the oviduct resulting from the fibrous exudate thrown out about the broken yolk.

We have also studied cases of ruptured ova due to heavy hens roosting on high roosts and by jumping upon the hard floor, causing rupture of the larger forming yolks or ova or of eggs in the egg canal.

PROLAPSE OF THE CLOACA

This may occur in heavy laying hens that roost on high perches and fly a long distance to the ground, and especially when the wings are clipped. If these birds are allowed low roosts and put on a limited diet they recover. Some of these conditions have been studied in the author's laboratory and the trouble overcome by observing this rule.

ABNORMAL EGGS

Many different kinds of abnormal eggs are produced by fowls owing to various diseased or other abnormal conditions of the generative apparatus. Because of the rarity of their occurrence such eggs are of little importance to the practical poultry raiser, but they possess much interest for the scientific investigator.

Soft-shell Eggs.—This is a condition where eggs are laid without a sufficient amount of shell substance covering the shell membrane. The commonest cause is overfeeding, another cause is the lack of sufficient shell-making material in the feed; still another cause is fright, which may cause a premature detachment of the yolk.

The cause should be remedied and the condition will disappear without further treatment.

Yolkless Eggs.—These are small eggs, in which the albumen and

shell are formed about a small portion of detached yolk, a minute piece of hardened albumen or a bit of coagulated blood instead of the normal yolk.

Double and Triple Yolk Eggs.—These eggs with two yolks are common. They are caused by two yolks getting into the oviduct and being enclosed together in the albumen and shell. Three-yolked eggs, which are rare, have a similar origin.

Bloodspecks, Blood Rings, Egg Inclusions.—These have little significance; particles of coagulated blood, due to hemorrhage when the ovum (yolk) is discharged from the ovary, are most common, but lumps of bacteria, worms, fecal matter, etc., have been found.

Blood clots may be found in either the yolk or white (albumen).

If hemorrhage occurs in the yolk, the clot has formed in the ovary before it was delivered into the oviduct. If the clot is in the white it has occurred in the upper portion of the oviduct.

Dwarf Eggs

Dwarf eggs of fowls vary greatly in size and shape. There are two distinct types; first, the prolate spheroidal shape, similar to a normal egg; and second, the cylindrical type.

The internal structure of the dwarf egg varies in its makeup. Some dwarf eggs contain a small yolk surrounded by a membrane, others a small quantity of yolk without a yolk membrane, and still others no yolk. When yolks are present usually there is no germinal disc.

The albumen in the dwarf eggs differs in its density. It may be dense and appearing like that of a normal egg. There is also found all gradations between these two extremes. The tendency is to a density greater than normal.

The size of the egg is apparently related to the size of the nucleus which by its presence gives stimulus to albumen secretion.

A bird may suffer a disturbance in her physiological functions of reproduction, and produce dwarf eggs since normal eggs are produced both before and after dwarf egg formation and the cause of such dwarf egg production is of a temporary character. Dwarf egg production appears in both pullets and old hens and occurs at a rate of five to eight per 10,000 eggs produced. It may occur at any time during the laying period, but most often in the spring or early summer.

The yolk of an egg constitutes, on an average, 24.37 per cent of the weight of the egg, and 33.91 per cent of double-yolked eggs and 35.52 per cent of triple-yolked eggs.

The shape of the eggs is determined by the action of the circular and longitudinal muscular fibers of the oviduct wall.

The egg being a semifluid body has a tendency when free, to assume a globular shape, but at the time of the formation of the membrane it is larger than the oviduct lumen, hence there is a tendency under pressure exerted by the oviduct wall to elongate the mass in the direction of the long axis of the oviduct as this is the line of least resistance.

The degree of pressure will depend upon the size of the egg and the tonicity of the muscular coats of the oviduct.

The exact length as compared to the breadth will depend upon the tonus of the circular and longitudinal muscular fibers. A strong tonus of the circular fibers and weak longitudinal fibers may greatly alter the normal shape of the egg. The two sets of muscles are independent in their action.

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SECTION X

TUMORS

Tumors of various kinds affect birds, but are less common than in higher animal life. There is almost no literature on the subject. The following reports from the author's labora-

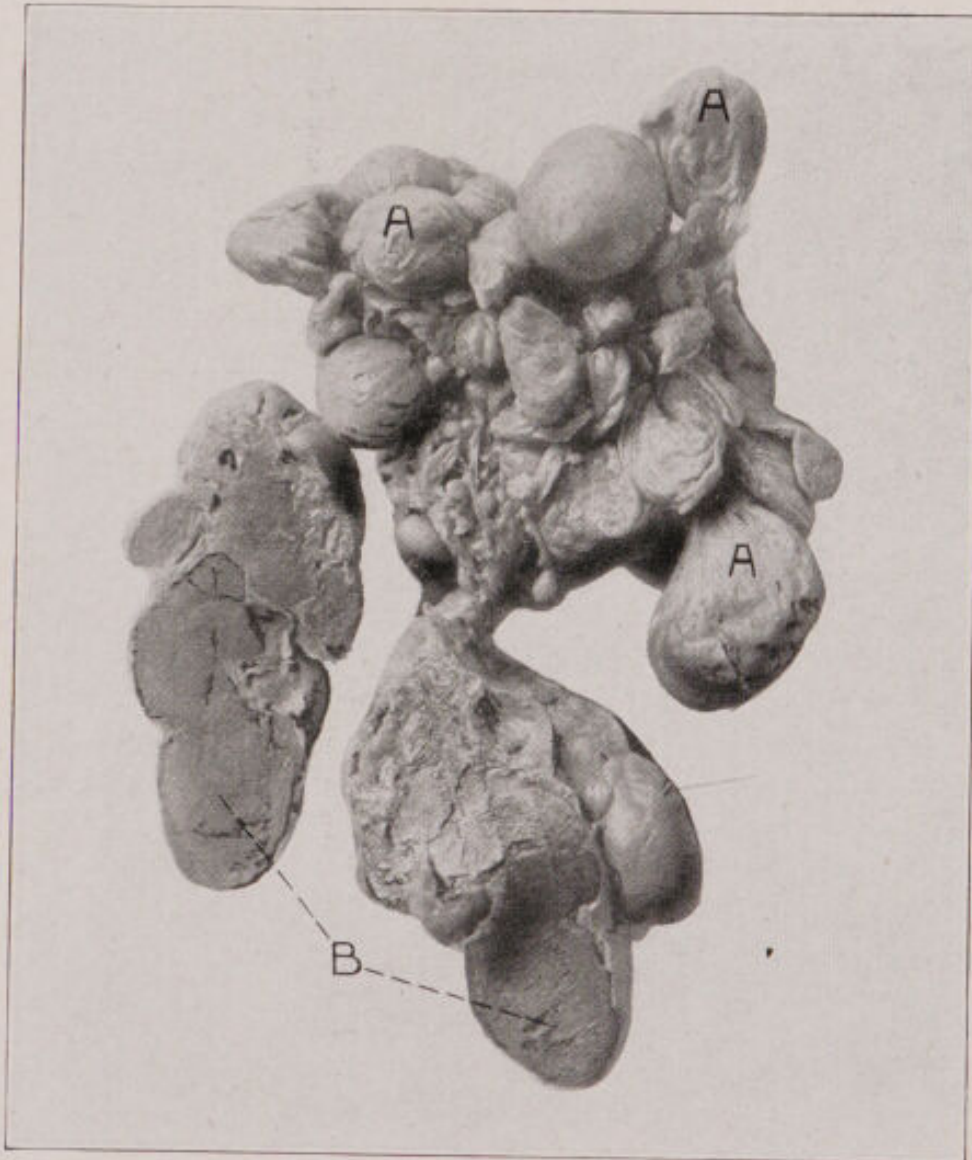


FIG. 60. HEMATOMA OF OVARY IN A HEN (NATURAL SIZE).
A, diseased ova; B, sectioned surface of two of the blood tumors.

tory are given for their interest, rather than their utilitarian value.

Occurrence of Tumors.—Some definite data as to the occurrence of tumors is given by the Maine Experiment station in the *Journal of Agricultural Research*.

It was found that of 880 birds autopsied at that station 79, or 8.96 per cent, had tumors; that is, there were 90 cases of tumors per 1,000 birds.

There was no significant difference in frequency of occurrence of tumors between birds that died from natural causes and apparently normal birds that were killed.

There is a significant correlation between age and the occurrence of tumors. Only 7.37 per cent of the birds under two and one-half years of age had tumors, while neoplasms were present in 19.17 per cent of those that were over that age.

In birds with tumors which died from natural causes, the tumors were the probable cause of death in from one-third to one-half of the cases.

There was a tendency to the association of hypertrophied liver, spleen or kidney with the presence of tumors in other organs.

Death often resulted from internal hemorrhage from the tumors, the underlying tissue, or the hypertrophied liver or spleen.

The tumors can be classified into cystic and tissue tumors; 22.78 per cent of the tumors were cystic and 74.68 per cent were of solid tissue structure. There were two cases of tissue tumors to which cysts were attached.

In the females the organs most frequently affected were the genital organs; 37.76 per cent of all tumors being in the ovary and 18.36 per cent in the oviduct and oviduct ligament.

In most cases the tumors were confined to one organ. In fifteen cases, however, the tumor had evidently undergone metastasis, since tumors of similar nature occurred in from two to four organs.

HEMATOMA, BLOOD TUMORS

Occasionally considerable hemorrhage takes place in the ova as they are in process of formation. These fail to find their way into the oviduct and become hematomata, or blood tumors. Fig. 60 illustrates one of these cases, natural size. The sectioned surfaces of two of the tumors is shown.

Exciting causes, like those that cause inflammation and congestion, are present. A rupture of a small, congested vessel causes the clot. Ergot in small quantities should be given to combat the condition.

MULTIPLE TUMORS OF THE OVARY

One of the commonest of tumors consists of yolks, or ova, which have formed, but failed to enter the oviduct. Later these masses become hard and irregular in shape, yellowish in color, consisting of dried (inspissated) yolks forming concentric layers. Ovarian infection by the *Bacterium pullorum* is a common cause of this condition. Fig. 61 illustrates one of these cases, natural size.

CYSTIC OVARY

Cystomata, or cysts, are found at times in the ovaries. These cysts are apparently imperfectly developed ova varying in

size, and contain a colorless liquid. They are attached to the ovarian mass by pedicles.

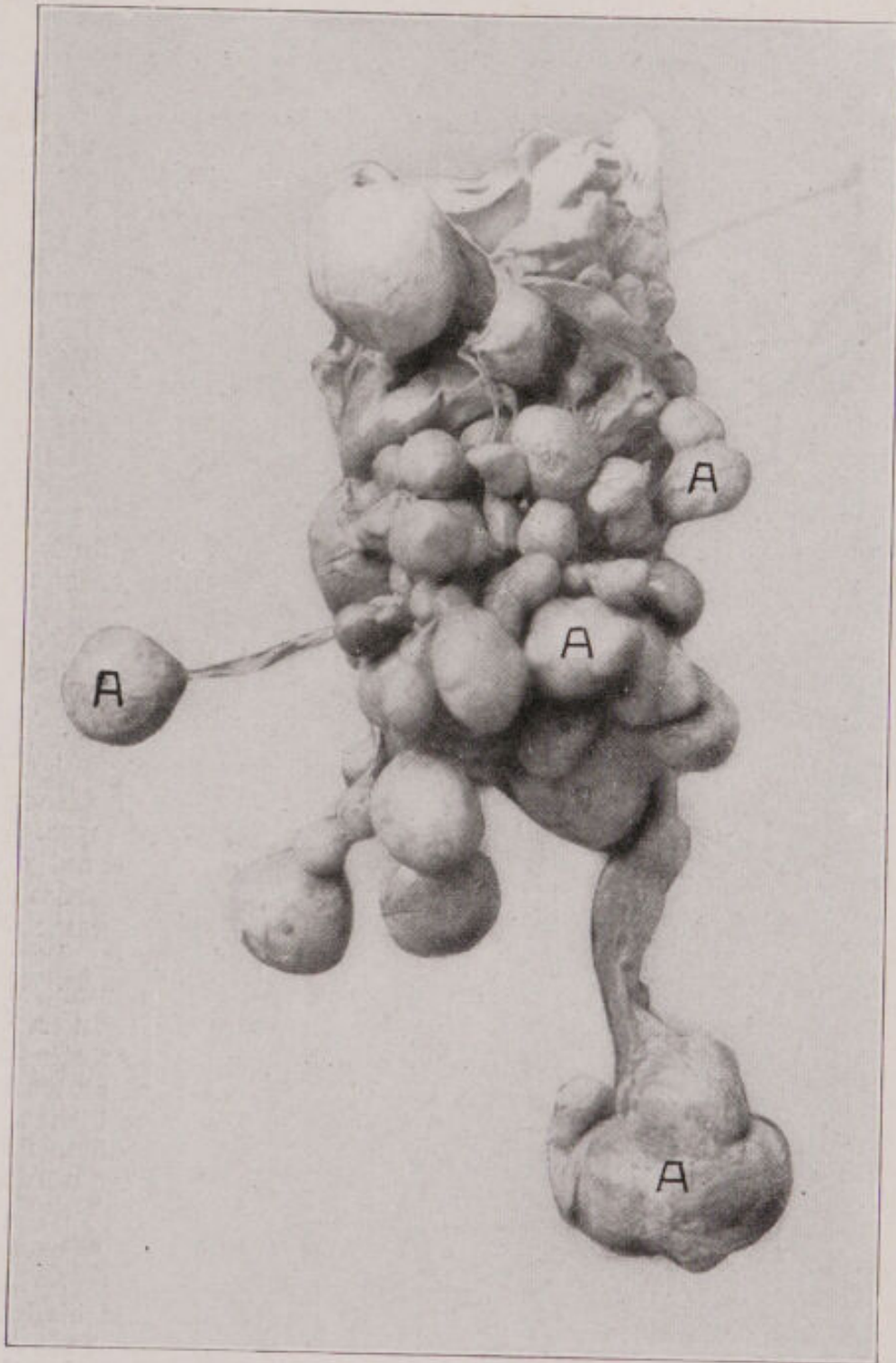


FIG. 61. MULTIPLE TUMORS OF OVARY OF A HEN (NATURAL SIZE).
A, ova that have undergone degeneration. Note the pedicle-like structure joining to the ovarian mass.

A CASEOUS ABDOMINAL TUMOR

A single comb Rhode Island Red hen, two years old, was kept on one of the test farms for breeding purposes, that is, as a part

of the farm flock. She was apparently in good health so far as indicated by actions and general appearance.

Upon palpation of the abdominal cavity there was noted a tumor-like mass, freely movable and located in the left posterior quadrant. The mass was apparently about the size of an average sized hen egg. A diagnosis of tumor was made and it was decided to operate.

The bird was brought from the pen in which she had been kept, receiving the usual care. After an anesthetic (chloroform) was administered the feathers were plucked from over the region of the tumor and the seat of operation was sterilized with fifty per cent alcohol.

An incision about three inches long was made over the region



FIG. 62. A HEN WITH AN ABDOMINAL CYST.

The upright attitude is a diagnostic symptom of an abdominal tumor or ruptured oviduct.

cision was made through the center when it was found that the tumor was cyst-like, containing a semi-solid or putty-like, finely granular, yellow material. The mass was surrounded by a rather thick, fibrous capsule.

AN ABDOMINAL CYST

A one-year old rose comb Rhode Island Red hen. This bird was from the same flock as the preceding bird.

The hen assumed an upright position as shown in Fig. 62, otherwise appeared in good condition.

Choloroform anesthesia was administered. The feathers were plucked from over the posterior abdominal region and the skin sterilized with a fifty per cent solution of alcohol. An incision three inches in length was made through the skin and aponeurosis of the abdominal muscles. The layer of retroperitoneal fat was very thin. A cyst about four inches in diameter was encountered.

of the tumor. After making the incision through the skin and controlling the cuticular hemorrhage, a mass of retroperitoneal fat about three-fifths inch thick was encountered. Incising this fat caused very little hemorrhage and in fact lipectomy was resorted to in order to remove the obstructing mass. A tumor 7 cm. long and 5 cm. in diameter was easily dissected out of the mass. The tumor apparently had its origin from the superior ligament of the oviduct.

The tumor was hardened in a ten per cent solution formaldehyd and an in-

The cyst wall was made up of white, fibrous connective tissue. The wall was thin. The cyst contained a colorless liquid which escaped from the punctured cyst wall. The cyst was attached by means of a pedicle to the roof of the lumbo-pelvic cavity about midway of the kidneys. The cyst apparently had its origin from the superior ligament of the oviduct. The oviduct contained in its posterior portion a fully developed egg with shell.

CONTAGIOUS EPITHELIOMA

Cause.—This is a specific infectious disease. It is transmitted from one bird to another in the infected flock. It is quite widely distributed, being reported in Europe and other



FIG. 63. PHOTOGRAPH OF THE HEADS OF TWO CHICKS AFFECTED WITH CONTAGIOUS EPITHELIOMA.

countries and has been observed in many sections of the United States.

Symptoms.—The disease appears first as a catarrhal inflammation of the mucous membranes of the head followed by the development of epitheliomatous enlargements which may involve any part of the head, especially the unfeathered portions. These epithelial growths at first appear small, have a smooth surface and a hyperemic zone; later they may develop to the size of a hazelnut or larger. Necrosis may take place in various portions of the new growth; the sloughing may leave ulcerative surfaces which may cicatrize. The lesion may obstruct the sight and even obliterate the eye. The nasal lesions may interfere with respiration and cause the bird to hold its mouth partly open.

A microscopic examination shows the structure to be that of an epithelioma. The cells are arranged in more or less irregular rows supported by a network of connective tissue

which is arranged in bundles between the nests. The cells are of the epithelioma type. There may be observed necrosing foci.

Birds having contagious epithelioma always die, while those with chicken pox show a very large percentage of recoveries. The two diseases are easily distinguishable.

SARCOMA

Sarcomata are a type of malignant tumors; that is, they spread in much the same manner as cancers (carcinoma). They are fatal in time. The flesh of birds affected with sarcoma should not be eaten.

A case of sarcoma was studied by the writer, in which the tumors involved the ovary, intestines, peritoneum (lining of the abdominal cavity) and the liver. These tumors vary in size, are whitish-yellow, and soft when sectioned. The study under the microscope showed it to be a spindle celled sarcoma.

Rous has reproduced spindle celled sarcoma by transplanting portions of a sarcoma obtained from a Brown Leghorn hen, into the breast of both Barred Plymouth Rocks and Leghorns. He obtained better growths from the inoculations into the Plymouth Rocks.

The filtrate also produced sarcoma but the tumors did not appear until several months had elapsed after the inoculation of the filtrate.

Round-celled sarcomata are often found in the fowl. We have succeeded in transplanting a round-celled sarcoma from a Single Comb White Leghorn hen into a Partridge Plymouth Rock Cockerel.

TERATOMA

An interesting case of teratoma in a black Wyandotte cock about twenty-one months old is described by Mr. Sheathes in the *Journal of Comparative Pathology*. (Vol. XXIV, part 2).

The tumor was found in the abdominal cavity and involved the mesentery. The left testicle was absent. The growth measured 3x4x6 inches and was enclosed by a thin, fibrinous membrane. The tumor mass consisted of a multitude of cysts ranging up to the size of a pea, islands of cartilage, cavities lined with stratified epithelium and minute feathers. The conclusion was drawn that this tumor probably originated from the left testicle.

ADENOMA

An adenoma is a tumor that has some resemblance to a normal gland. It is made up of connective tissue and asini, or cavities, lined by columnar or cuboidal cells. One tumor of this type affecting the spleen of a hen was sent to the laboratory. The spleen was about twice normal size.

EPITHELIOMA

This is a type of cancer. A case was brought to the laboratory with the history that it had a "growth" on the side of the head for several months. The tumor was flat and about one inch in diameter. A microscopic examination revealed it to be an epithelioma.

OSTEOMA

Osteoma is a term applied to a tumor that consists of caseous tissue. This kind of tumor usually arises from the bones of the skeleton but may develop in parts away from the normal bony structure.

Osteomata usually occur singly in the body, that is, they are localized. If the new bony growth arises in connection with the skeleton it may be designated according to its locations and relations.

If the new bony growth is small and circumscribed and attached to the old bone it is called an osteophyte. If it be larger and more tumor-like it is called an exostosis. If the newly circumscribed bony growth is located within the bone cavity it is called an enostosis.

New bony growths not attached to the skeleton may be classified as follows: those which have their seat in the periosteum but are separated from the bone are called movable periosteal exostoses; those lying near the bone are called periosteal osteomata; those located some distance from the bone, in muscle and tendon and disconnected, osteomata; and those situated in other organs, as the lungs, mucous membrane of the trachea, the skin or abdominal walls, are heteroplastic.

Osteomata may occur either single or multiple. Frequently there are found multiple, circumscribed bony growths in great numbers on the bones of the extremities and trunk. The favorite seat of these new bony growths appears to be on the epiphyseal ends of the bones and the point of insertion of tendons, or both may be involved in the same individual and at the same time. Zeigler says it is probable that such growths are to be referred to as inherited predisposition of the part affected to overgrowth, or to a disturbance in the development of the skeleton. The bony plates and spicules, which in rare cases develop in the lungs or in the mucous membrane of the air passages, may occur in large numbers.

The development of the bone takes place partly through the formation of osteoblasts, and partly through metaplasia of formed tissues. The matrix is formed chiefly from the

connective tissue of the periosteum, as well as that of the tissue from which the osteoma arises; and also from that of the perichondrium and endosteum. If an exostosis develops in such a manner that cartilage is first formed from the proliferating periosteum or bone marrow, and from that cartilage, bone is later developed, it is called a cartilaginous exostosis; when the exostosis is formed directly from the proliferating periosteum without an intermediate stage of cartilage, it is known as a connective tissue exostosis.

If the connective tissue in a bony tumor is abundant, and in fact a predominating substance, it is called an osteofibroma. This form of tumor appears quite commonly among bony tumors.

An abundant production of bone in a chondroma leads to the formation of an osteochondroma. These latter are usually found in the long bones.

A condition in which the muscles become bony in nature is called *myositis ossificans*. The tendons of birds and especially those of the leg often become ossified, especially in old birds. This is also the case in some of the vertebral ligaments.

One case of generalized osteoma has been studied in a fowl.

HORNY GROWTHS ON THE CUTICULAR SURFACE OF FOWLS

Horny growths are reported as occurring on the cuticular surfaces of fowls, by Gadow. Horny growths have been observed on the cuticular surfaces and on different parts of the body of cattle and other animals.

A case which we have observed is of importance on account of its immense size as compared to the size of bird upon which it was found.

Dr. Leonard of Asheville sent to this laboratory a specimen with the case history that it was excised from the thigh region of a two-year-old hen. No further history could be obtained. The specimen measured 14 centimeters long and 7.5 centimeters in diameter at the base. The outer structure is horn-like, resembling the horny structure of the spur or claw. There will be noted that here and there a feather has developed. The inner core consists of connective tissue and some adipose tissue and is soft in consistency.

PAPILLOMA—WARTS

True papillomata have been observed in the fowl. They occur on the cuticular surface and consist of a connective tissue core covered by stratified epithelia.

SECTION XI

DISEASES OF THE RESPIRATORY PASSAGES

In the fall, winter and spring, these diseases are a scourge to the poultry raiser, unless strict sanitation is observed.

OBSTRUCTION OF THE TRACHEA

This is uncommon, except as a result of gapeworm infestation. Fig. 64 illustrates a case that was sent to the laboratory with the statement that it had "gapes." This bird would extend its head high into the air, gasping for breath as one whose trachea is obstructed by gapeworms; it was weak and unable to stand squarely upon its feet. It was destroyed for examination. A piece of a grain of corn was found in the trachea, surrounded by an accumulation of mucus due to the irritation its presence in the trachea had caused. The foreign body and the accumulated mucus were obstructing the passage of air to the lungs; hence, the asphyxiation. In some cases a whole grain of corn has been found lodged in the trachea of an adult fowl.



FIG. 64. OBSTRUCTION OF THE TRACHEA.
Showing depression (drooping wings, inability to stand, etc.) from partial asphyxiation.

CATARRH, COLDS

Cause.—Sudden changes in the weather, cold, damp weather roosting in drafts and chilling by getting wet in cold rains are often factors in the production of catarrh among birds. Such affections are more or less contagious, but bad sanitation plays an important part in their spread. Weak stock and poorly nourished birds are predisposed to this contagion.

Symptoms.—The appetite may be somewhat diminished. The bird sneezes, throws its head and may expel some mucus. The discharge at first is watery and later becomes more or less thick (muco-purulent). The eyes may show more or less inflammation (conjunctivitis) and the eyelids may become adherent. The characteristic offensive odor of roup is absent.

Treatment.—The same treatment as outlined under roup (see page 179) has given us uniformly good results.

The following report of one of the experiments by Mr. Coulton, under the direction of the author, illustrates the course and treatment of colds in birds:

With the advent of cold weather, early last fall, a large number of our chickens contracted colds, which was extremely discouraging, to say the least. We had over one hundred chickens, besides turkeys, and fully twenty-five per cent were affected at one time. In addition to the colds which affected the throat, nostrils and eyes, many were affected with canker in the mouth. The ordinary remedies, kerosene, roup cures, etc., were all used, with little effect. We finally got from the drug store (at the suggestion of Doctor Kaupp) some sulphocarbolates compound tablets and used them, but the improvement was not very marked. Later tablets furnished by the pathological laboratory of the Colorado Agricultural College (sulphocarbolates compound, thirty grains, with six grains bichlorid of mercury to the tablet) were tried. This was not only placed in the drinking water, but a solution was used in a syringe to wash out the nostrils and mouth. This treatment was marvelously effective. It acted like a charm. The catarrhal condition continued, however, until the following treatment was used (also at the suggestion of Doctor Kaupp):

The nostrils were washed out with a twenty per cent solution of common baking soda; then with peroxid of hydrogen, and finally with the following preparation: oil of eucalyptus, twenty drops; oil of thyme, one dram, and petrol oil, two ounces. A warm solution of the soda was always used and the other materials were warmed by setting the bottles in hot water. This treatment was also applied to the eyes, and the ulcers in the mouth were swabbed with it. The results were remarkable. It was almost impossible to make a record of these cases, as a large portion of the flock were affected. Furthermore, it was impossible to give them all the daily treatment prescribed. Sometimes they would go several days without treatment. In mild cases, however, from two to three applications effected a cure.

March 17th we found a young cockerel in a very roup condition. He had been hatched late in the fall and had never been very vigorous. His eyes were swollen shut, nostrils discharging badly, and, withal his was not a promising case. We isolated him and gave him the regulation treatment, as described above. Notwithstanding that it stormed several, and he was not well feathered, the next day he was showing decided improvement, and after three treatments, covering about a week, all evidence of the trouble had disappeared and to all appearances he was in better condition than at any time during the season.

A day or two later we found two others belonging to the same brood in about the same condition and after one treatment there was evidence of improvement, but after a few days, not having been able to give them careful attention or regular treatment, they seemed to be worse, and we used the hatchet treatment. I am satisfied, however, from our experience, both with chickens and the turkeys, when taken in time and treated regularly it is seldom necessary to lose one. We estimated that by this treatment we saved ninety-nine per cent of those affected.

ASTHMA

Cause.—Asthma in fowls and canaries may be due to aspergillosis of the air passage or it may be due to other catarrhal conditions of the mucous membranes of this passage.

Symptoms.—Wheezing sounds are noted and in expiration there is a creaking, whistling sound.

Treatment.—Good sanitary surroundings, clean coop, no draft. Treat local condition of which this is a symptom.

ULCERATIVE PHARYNGITIS

Symptoms.—The bird may remain on the roost much of the time; there is an unkempt appearance of the plumage; there is gradual loss in flesh when the appetite is interfered with, and the bird may find it difficult to swallow. In eating corn, wheat and particularly whole unhulled oats the throat is irritated and swallowing is difficult, the bird choking down, opening its mouth, and sometimes protruding its head into the air. A coughing sound is made as the bird throws its head. While on the perch or standing tucked up around the yard, the bird may be noted to occasionally open its mouth, and in fact sitting or standing with its mouth partly open is a diagnostic symptom.

Appearance.—When the mouth is opened and the pharynx observed it will be noted to be covered, to a more or less degree, with yellowish white ulcers varying in size from a wheat grain to as large as one's thumbnail.

Microscopic.—In an examination of the sections from diseased areas under the microscope one finds an ulceration of a diphtheric nature.

History.—This condition has been studied in many flocks where roup has not appeared for years and where there were no symptoms of any of the three types of roup. It is not believed to be caused by the roup microorganism, but an entirely separate disease.

BRONCHITIS

In some cases we have no catarrh commencing in the head, principally the nasal chambers, extend down and involve the trachea (wind-pipe), and even to the bronchi (branches of the trachea leading to the lung tissues). Sudden changes in the weather, dampness and roosting near a crack in the henhouse so that a cold wind blows upon them, or, in fact, in any draft, are the principal causes of bronchitis.

Sym. rattling sound may be heard in the region

of the trachea and bronchi (neck and anterior part of the thorax)—mucous rales. The bird may be seen to gasp for air by extending the head upward. This is due to an accumulation of mucus in the air passages which partially closes them, thus preventing the bird from getting enough oxygen into its lungs. The affected bird coughs, and there may be dullness and partial loss of appetite.

The condition may pass off in a few days, may respond to treatment, or may last for several weeks and end in recovery or in death. In the latter case there is marked emaciation; in the former the bird coughs up mucus for a long time, but otherwise appears well.

Treatment.—A tablespoonful of castor oil, to which 5 to 10 drops of turpentine have been added may be given, and if catarrh be present, treatment should be as outlined under roup. Give one-grain doses quinin sulphate three times a day. Place the bird in warm, clean, comfortable quarters, free from drafts. Give plenty of clean water and soft feed (bread or middlings moistened with milk), to which has been added 2 grains of black antimony for each bird. Feed twice daily.

There is a bronchitis and tracheitis found among fowls that is apparently contagious. This disease occurs in the same pen each year when young, apparently susceptible birds are placed in such yards. The affected bird manifests a rattling in the throat and trachea, wheezes, coughs, the comb and face appear dark and the bird loses flesh. Laying hens cease to lay and cocks cease to fertilize eggs. The treatment that has given excellent results consists of injecting into the trachea some of the menthol and oil mixture mentioned under treatment for roup. To do this one attendant must hold the bird, a second hold the mouth open and the operator forcing the larynx up with one hand drops, with a medicine dropper, some of the above mixture into the trachea. Usually about three or four drops are sufficient. This should be repeated every two or three days if necessary.

CONGESTION OF THE LUNGS

This is an engorgement of the blood vessels of the lungs. Congestion of the lungs is quite apt to result in pneumonia, of which it may be said to be the first stage. It has been observed in young birds and in birds during their molting season, when they are poorly clad with feathers and exposed to inclement weather.

Young chicks that are allowed to run out in the early morning and become wet with cold dew, and chicks allowed to become wet with the cold spring rains and become chilled, are likely to suffer from congestion of the lungs and pneumonia.

A contraction of the blood vessels of the skin and periphery forces an abnormal amount of blood to the internal organs, and congestion is the result. Improper feeding and lack of exercise are also contributing factors. Birds having this ailment will be noted to be sleepy and stupid, and to breathe rapidly. In some cases the breathing is difficult. The comb becomes bluish and the bird may die because it cannot get enough air into the lungs (asphyxiation). Upon postmortem examination the lungs will be found engorged with blood.

The pressure of the blood in the engorged blood vessels of the lungs may close the smaller air passages which they surround, or may burst their thin walls and fill the bronchi with blood. In either case rapid asphyxiation occurs.

Treatment.—Congestion of the lungs runs an exceedingly rapid course, terminating in recovery, pneumonia, or death. Treatment is impractical. The ailment should be prevented by good feeding and adequate protection from cold or wet weather.

PNEUMONIA—INFLAMMATION OF THE LUNGS

Bronchitis, described in the foregoing, often terminates in pneumonia (broncho-pneumonia). It has been the experience of the writer that broncho-pneumonia, following an attack of bronchitis, is the commonest form of the disease.

The causes of pneumonia are the same as the causes of colds and bronchitis, except that the exposure is often more severe.

Symptoms.—There is an entire loss of appetite, with thirst and constipation. The bird stands with the head drawn in, drooping wings and ruffled feathers; breathing is rapid and painful, and there may or may not be coughing. There is usually a discharge of thick, adhesive mucus from the nostrils; the eyes may be inflamed and water freely. The bird has every appearance of severe illness.

Treatment.—Except in the case of birds of unusual value, treatment is wholly impractical, owing to the amount of care and nursing necessary and because of the doubtful outcome.

If treatment is undertaken, the birds should be warmly housed and the best of ventilation maintained. Spirits of camphor, two drops, and brandy, 10 drops, should be given hourly in a teaspoonful of warm milk; if the comb becomes dark, add one drop of fluid extract of digitalis to the medication.

Autopsy.—Upon opening the bird that has died from pneumonia, the affected part of the lung will be found to be dark red, and when cut through it is liver-like in appearance

and texture. Serum (yellowish fluid) and blood may exude from the surface.

PNEUMOMYCOSIS—ASPERGILLOSIS

This disease is due to a fungus belonging to the genus *aspergillus*, an organism similar to the common green molds. The species that usually affects the lungs of birds is the *Aspergillus fumigatus*.

Symptoms.—The affected birds are sluggish and stay apart from the remainder of the flock; they sit about on the roosts, or in some corner; they are very weak, and later become unable to stand. There is a loss of appetite; the feathers have an unkempt appearance; the wings are drooping and the eyes partially closed. The respiration is accelerated and there is a rattling of mucus in the trachea and bronchi. Fever is present, and there is ordinarily considerable thirst. The affected bird usually dies after a prolonged illness.

Postmortem Appearance.—Whitish or yellowish nodules, varying in size up to a pea, will be noted in the affected parts; which may be the trachea, bronchi, lungs and the various air sacs. The fungus may grow upon the surface of the mucous membranes forming, at first, a felt-like, whitish mass which takes on color according to the species of the fungus as it fruits (forms spores). This membranous material, to the naked eye, resembles a fibropurulent exudate. The obstruction of the air sacs causes the difficult breathing and asphyxiation.

Inflammation is evident in the diseased areas. Sections through these areas of disease show the mycelia (thread-like branches of the mold) and the characteristic spores. Focal necrosis, preceded by cloudy swelling, is noted in the kidneys and other vital organs. A secondary invasion of pus-producing organisms may take place and on autopsy abscesses may be found in the liver, kidneys, spleen and other organs.

Treatment.—This is a difficult problem. Placing the affected birds in a close box and smoking them with tar has been advocated. Efforts should be made to eradicate the disease from the premises by cleaning and disinfecting them as for roup and other infectious diseases. (See pages 110 and 179.)

SWELL-HEAD IN YOUNG TURKEYS

The most characteristic symptoms of this ailment is swelling of certain parts of the head, especially in the region of the maxillary or infraorbital sinus, which becomes filled with

a gelatinous, colorless substance. (For location of this sinus see Fig. 2, No. 31.)

These swellings may disappear in a few days or weeks or may remain for several months. In the latter instance the swelling may contain a cheesy material of foul odor, and in some cases cause death.

Treatment.—Open the swollen part and allow the morbid collection to drain out. In addition, use the same treatment as outlined under roup.

CHICKENPOX

This disease affects chickens, turkeys, pigeons and geese.

Cause.—Some investigations indicate that it is due to an ultra-microscopic virus (germ) and that the same germ is also the cause of avian diphtheria, or roup. The two conditions are, in many cases, found associated. (An ultra-microscopic germ is one that will pass through the pores of porcelain filters and cannot be seen with the microscope or grown in visible quantities upon culture media.)

In structure the nodules resemble an epithelioma. Contagious chickenpox can be transmitted from an emulsion of the material of a pox nodule, by inoculating the face and comb of a healthy bird.

It has been proved that a maceration of the scrapings from the pox in physiological salt solution and injected subcutaneously, will render immunity against further inoculation of the disease by scarification and introduction of the virus in the face and comb.

One investigator has claimed that chickenpox is due to a protozoon (an animal parasite microscopic in size), but other investigators have failed to find this organism.

Symptoms.—The disease appears as small nodules, varying pin-point size up to the size of a pea, or even much larger. It may be accompanied by roup; in fact, we have studied both diseases in the same flock, an occurrence which is not uncommon. The question naturally arises, Are both due to filtrable viruses, and are both present in the same outbreak, or are both due to the same cause? Fig. 65 illustrates a case of this disease. The nodules or pimples are at first smooth and firm. They may be red and have a hyperemic zone. Later the surface may ulcerate and spread until a sore a half-inch in diameter is observed. With proper treatment these usually heal. The general tendency of chickenpox is to run a mild course.

Mosquito bites form red pimples, which must be differentiated from pox nodules.

One investigator has reported that immunity against chickenpox does not confer immunity to roup.

Haring and Kofoed have shown that there is a specific antibody developed in birds affected with chickenpox. By the use of the complement-fixation method the blood from the diseased fowl exhibited fixation of the complement not shown by normal fowl blood, thus showing that it is a specific germ disease. The antigen was prepared both from the tumors on the head and from the liver of birds sick of the disease.

Treatment.—The same sanitary regulations should be put into force as under fowl cholera. No birds should be sold

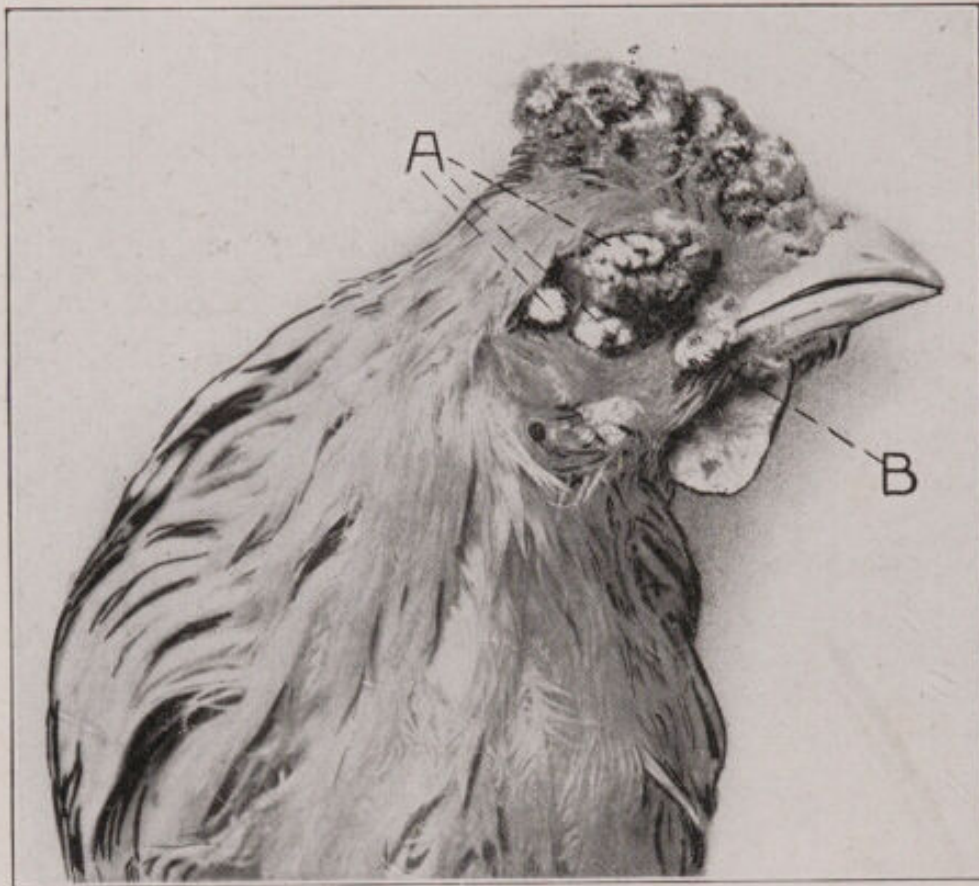


FIG. 65. CHICKEN POX.

A, epithelial, tumor-like nodules; B, an ulcer.

from the flock while the disease exists among them. Cleaning of yards and houses and keeping them clean, as well as frequent disinfection, are essential. Antiseptics, as recommended under cholera, may be given in the feed and water. The heads of affected birds should be bathed in an antiseptic solution. The nodules may be touched with lunar caustic and 24 hours later covered with vaselin.

DIPHThERIC ROUP

There is considerable confusion regarding contagious epithelioma and diphtheria of fowls, and authorities upon infec-

tious diseases are not agreed as to whether they are distinct diseases or somewhat different types of one affection. The reason for this confusion is readily apparent when a careful study of the diseased birds is undertaken, provided a sufficient number of outbreaks are considered. Until recently they were considered as two distinct diseases; the former presenting "scab-like" nodules upon the skin of the unfeathered portions of the head; the latter diphtheria-like false membranes in the nose, mouth, throat, eyelids and cavities in the head. Diphtheritic roup occurs in outbreaks in which the skin is never affected. Contagious epithelioma may attack the comb and wattles alone, but it frequently affects also the lining membranes of the eyelids, the covering of the front of the eyeball and the mouth and nostrils. It is especially likely to attack the borders of the eyelids and the corners of the mouth, extending thence to the surface of the adjacent lining membranes. When the latter are affected, the tissue changes cannot be distinguished from those which occur in outbreaks of diphtheria in which the skin is never affected.



FIG. 66. ROUP IN A CHICKEN.
A, bulging of infraorbital or maxillary sinus.

In many infectious diseases the microorganisms which cause them may be distinguished microscopically by some structural or staining peculiarity; or they may be isolated and cultivated in artificial media by standard bacteriological methods and recognized by some property possessed by them; in still others there are certain specific reactions which may be utilized for differentiation; again the inoculation of test animals may serve to identify and separate them from some other infections. In this disease or group of diseases, those methods are not available. The microorganism which causes roup is not known; it cannot be grown artificially in cultures, nor have the attempts to cultivate that which causes chickenpox or contagious epithelioma succeeded. Fowls can be success-

fully inoculated with contagious epithelioma, producing typical tissue changes upon the comb and wattles, or in the eye and mouth, using the virus contained in the scabs removed from the comb or wattles of sick birds for inoculation. Such inoculations, however, do not serve to distinguish one disease from the other, provided contagious epithelioma and diphtheria or roup are separate and distinct diseases.

Transmission of the disease is not very difficult. Usually about 70 per cent of healthy birds will show symptoms of the disease after associating with an affected one for a short time. Actual contact is not necessary, as is shown by the spread of the disease at poultry shows. It has been noted that in experimental work in using an infecting bird with pox lesions, mucous membrane lesions of roup would appear in the birds subjected to and developing the disease, and in some cases where the roup type was used, pox lesions would develop in the exposed contracting birds.

Emulsions of scrapings from either cutaneous or mucous membrane lesions injected subcutaneously, submucously or applied to scarified areas on the skin, would in some cases produce the generalized form of the disease, that is, both pox and roup types combined.

As hinted before in this disease, there are secondary invaders which cause aggravated symptoms. These infections manifest themselves after the filtrable virus has produced more mild symptoms. The more common of these secondary invaders is the *Bacillus diphtheriae columbarum* of Loeffler.

Therefore the filtrable virus is the necessary primary invader which lowers the bird's resistance and thus prepares the tissues for the invasion by the secondary organisms. Neither factor alone will cause the typical disease.

Mode of Spread.—Diphtheric roup is spread by birds introduced into a flock from infected premises, and by exposure, as at poultry shows. A chronic type of the disease in one or more birds (carriers) in a flock may serve to infect others when they are weakened by predisposing causes, as by exposure to cold or dampness, or by roosting in drafts, or in badly ventilated buildings. The beak bathed with nasal discharges constantly contaminates the drinking water and feed.

Symptoms.—There are three forms of the disease or the lesions. Any or all may be present in the same bird.

1. *The nasal type.*—This type is characterized at first by a thin, watery discharge with an offensive odor characteristic of roup. Later the catarrhal product becomes somewhat thicker (mucopurulent) and the nostrils become occluded (glued shut), and quite frequently there is a bulging of the sinus

(cavity) in front and below the eye. This is due to an accumulation of the inflammatory products in this sinus. Fig. 66 illustrates this common swelling.

2. *The diphtheric type.*—This type affects the mouth and often accompanies the nasal form. Fig. 67 illustrates diphtheric ulcerations, which are yellowish or yellowish-white in color. From these necrosing patches the disease receives its name, avian diphtheria.

3. *The ocular type.*—In this form there is first noted an

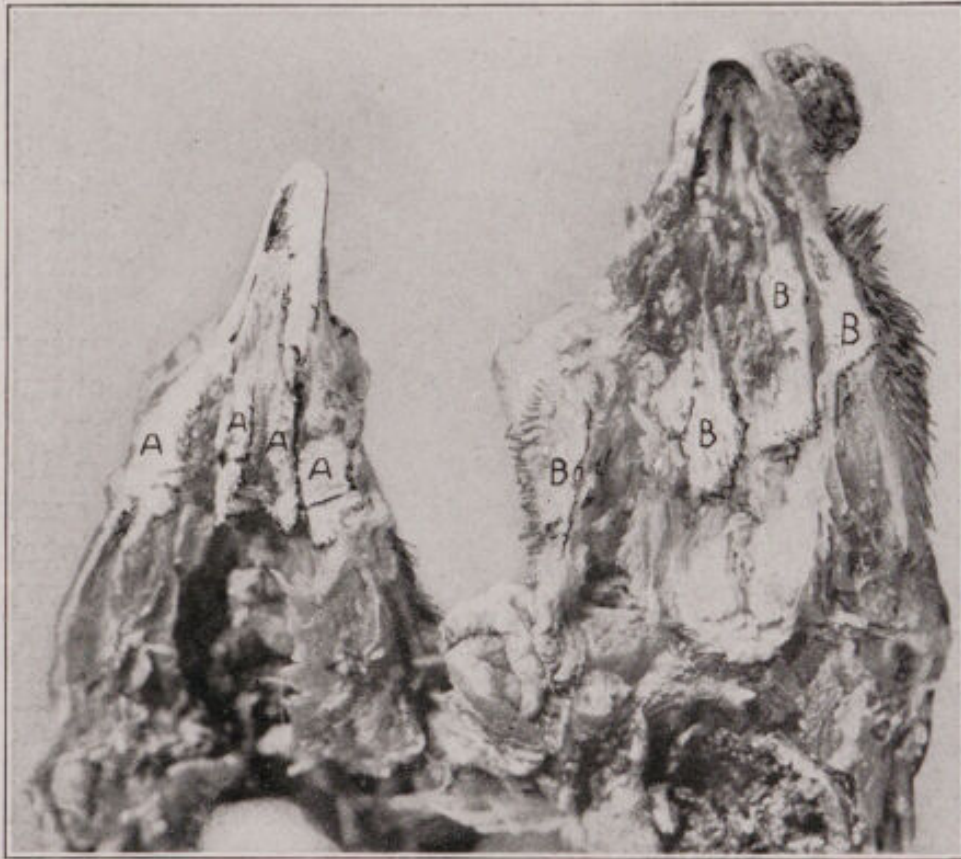


FIG. 67. DIPHTHERIC ROUP IN A CHICKEN.

A, the yellowish-white diphtheric patches on upper surface of tongue and lower jaw (natural size); B, diphtheric patches on hard palate and upper jaw.

inflammation of the mucous membrane covering the anterior portion of the eyeball (conjunctivitis). As the disease progresses, the catarrhal product accumulates as a watery, clot-like mass, whitish in color. The eyelids stick together and hold the material as it accumulates, till the part bulges outward.

There is noted sneezing, shaking the head, and expulsion of mucus. There is a loss of appetite, the bird appears weak, walks unsteadily, and becomes emaciated rapidly. At times breathing is difficult, and there is often a diarrhea.

Three stages then follow: catarrhal, characterized by a mucus, or mucopurulent, discharge; diphtheric, affecting the mouth and throat and characterized by the formation of a membrane on the surface which may be followed later by sloughing (formation of a mass of dead tissue); and conjunctival, affecting the eyes, and often causing a destruction of the eyeball.

General Symptoms.—In the early stages before much secondary infection takes place, there are no marked general symptoms. Later marked general symptoms appear. The birds show dullness, assume a sitting posture, wings are held pendant, plumage becomes rough and the patients show much depression. The comb and wattles grow bluish-red in color, later they are pale and cold. In the colder climates the disease often assumes a subacute or chronic form, while in warmer climates the acute form is more often observed. Frequently, however, the disease assumes the character of a chronic catarrh.

Diagnosis.—The disease usually makes its first appearance in the fall of the year and often occurs as the cutaneous form; it may be overlooked, especially if the birds are on the range. The mucous membrane form usually makes its appearance soon after housing for the winter. The sneezing, mouth breathing, occluded nostrils, and an occasional inflamed eye, are significant especially when rapidly spreading through the flock. Soon after, a few will refuse food and appear depressed.

It must also be suspected when similar symptoms appear after adding new birds to a healthy flock or returned birds from shows.

A peculiar characteristic and offensive odor is associated with this disease, and poultrymen familiar with it often recognize the disease from the odor alone. The same odor is given off by cultures.

Differential Diagnosis.—Wounds on the skin around the head, usually pick inflicted, appear suspicious, but these heal rapidly without extensive thickening. An injury to the eye, even though serious, will not cause the formation of the characteristic yellow deposit. Difficult respiration is rarely seen in more than one bird in a flock. Healthy flocks and those intended for exhibition purposes may be vaccinated to establish immunity. This has proved very satisfactory. The immunity established will last for at least one year.

Postmortem Appearance.—The toxin (poison) from the areas of disease is very destructive, as the rapid emaciation of the bird, following a severe attack, shows. Upon examina-

tion of the membranes that have formed in the mouth, it will be found that when they are removed there is left a raw, granular-appearing surface. Upon microscopic examination, there may be seen cellular infiltration, with a destruction of cells of the mucous membrane underlying the diphtheric patch. An examination of the maxillary (suborbital) sinus (see Fig. 2, No. 31) will reveal it to be filled with a purulent material, which is often cheesy in consistency. The wall over this part is very thin and can be easily opened with a knife.

A microscopic study of sections of the head, through the inflamed area (the mucous lining of the nasal passage) shows considerable thickening and an acute inflammation (invasion of *polymorphonuclear leukocytes*); at times the entire passage is "plugged" with the mucus.

On examination of the eye and mucous membrane surrounding the anterior portion of the eyeball, there may be seen a cloudy condition of the cornea, the anterior portion of the ball (*keratitis*). There is also an acute inflammation of the mucous membrane of the eye (*acute conjunctivitis*).

In cases studied in this laboratory it has been found that the acute inflammation extends to the iris and ciliary muscles and their surrounding structures.

Treatment.—Correct any bad sanitation or hygiene, which may be a predisposing cause. The henhouse should be well ventilated, but should allow no drafts on the birds, and should be kept clean and free from dampness. It should be cleaned and disinfected daily with some of the mixtures heretofore described and recommended for this purpose. If the bird is not a valuable one, kill and cremate it, the body as well as the head.

General Preventive Measures.—Isolation of all diseased fowls from the flock and the removal and burning of all dead fowls.

Cleaning and disinfecting of the houses and yards. The resistance of chickenpox virus to the action of disinfectants makes it imperative to disinfect the houses and yards thoroughly.

Quarantining for two weeks of all the new stock and of birds returned from poultry exhibits.

Careful examination of *each* fowl occasionally, if the disease is present in the neighborhood.

Preventive Vaccination.—The immunization of fowls against chickenpox has been practiced by a number of investigators.

Medicinal treatment differs, with the location of the lesion. For the ulcers, or diphtheric patches, in the mouth, nothing is better than cauterizing with lunar caustic. A solution of

silver nitrate cannot be used, as the fluid will run down and burn other parts of the mouth and throat.

With the thumb and finger press open the eyelids and with clean absorbent cotton remove the white catarrhal material, then apply the same remedy as for injection into the nostrils. The following has given good results in our experimental work and with those to whom we have recommended it:

Wash out the nasal passage with a twenty per cent solution of sodium bicarbonate (common baking soda), using a medicine dropper or, better, a small syringe, as the material must be forced so as to pass through the nasal passage into the mouth (refer to Fig. 2, Nos. 29 to 33). Then inject, in like manner, peroxid of hydrogen. The soda dissolves and removes the mucus, and the peroxid of hydrogen cleans out the cavity. The parts should then be cleansed with essential oils, which may be applied directly to the inflamed mucous membranes. Inject a quantity of the following:

R

Oil of thyme.....	30 drops
Oil of eucalyptus.....	20 drops
Menthol	10 grains
Oil of petrol.....	2 ounces
Mix thoroughly.	

In aggravated cases, repeat this treatment three times a day. Give an abundance of clean water and soft, easily digested feed.

DIPHThERIC INFLAMMATION OF THE EYES IN DUCKS

There is first noticed an itching of the eyes manifested by the duck rubbing them. There is noted later an inflammation of the conjunctival mucous membrane accompanied by a thick yellowish secretion. Diphtheric areas may develop with ulceration of the cornea. The conjunctival discharge appears to be caustic to the skin with which it may come in contact. The ducks become emaciated. The disease may last for several weeks. There appears to be no marked changes in the internal organs.

POX OF TURKEYS

We have been studying a condition among turkeys in this laboratory for the past few months that appears to be different from any disease we have heretofore studied. It is, in some years, quite prevalent in the Southeastern States and in Cuba.

The turkeys brought to the laboratory were kept in the back yard of a city residence. There were four in the flock and one after the other had become affected.

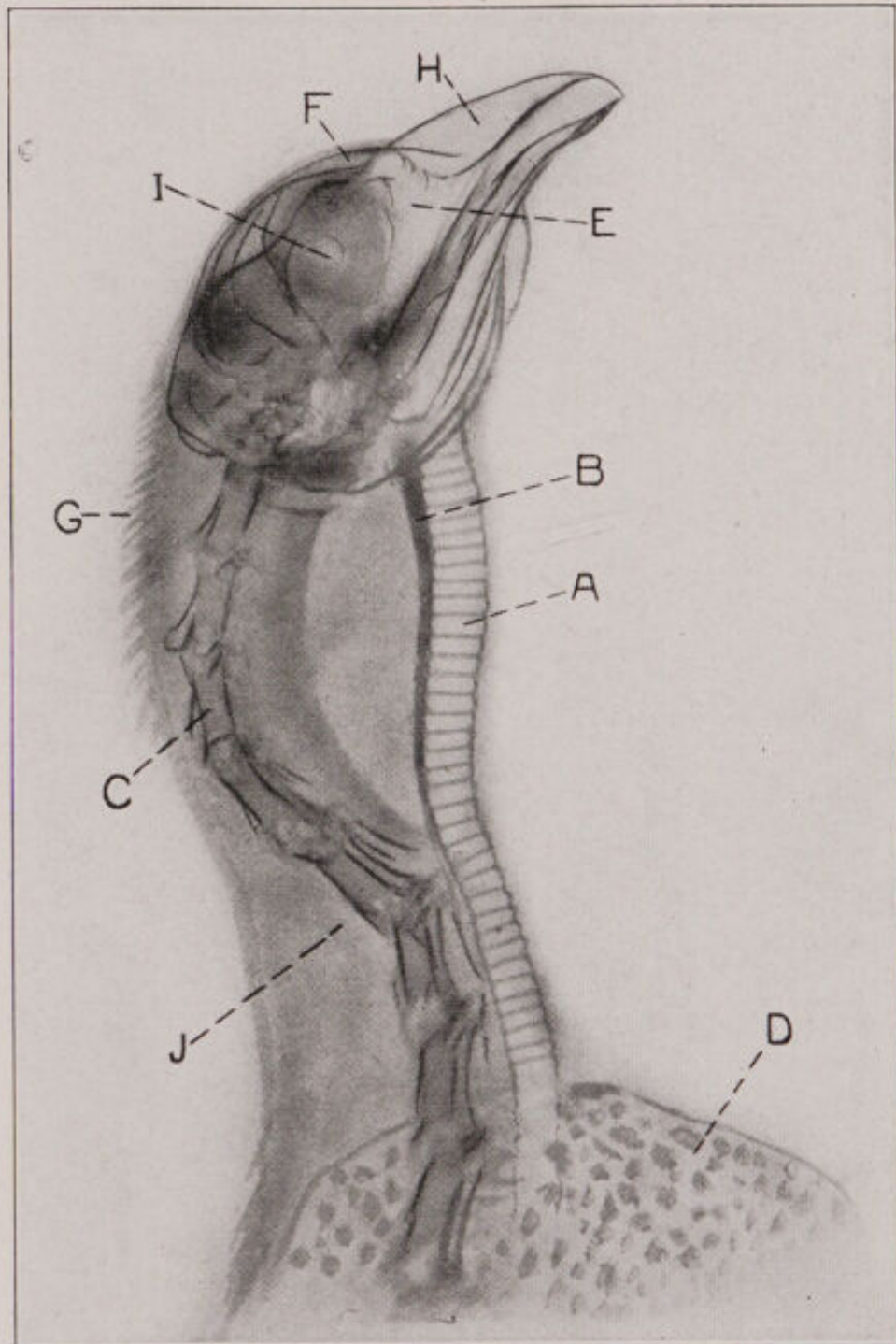


FIG. 68. SKIAGRAPH OF HEAD AND NECK OF CHICKEN.

A, trachea; B, esophagus; C, vertebra; D, crop filled with grains of wheat; E, infraorbital or maxillary sinus; F, frontal sinus; G, feathers; H, nostrils; I, eyes; J, musculature.

From the standpoint of a field study it appears to be contagious.

The pox are noted on the unfeathered portions of the head

and neck. There is at first noted a small pimple-like elevation, which gradually becomes larger and in the course of a few days may appear four or even five millimeters in diameter and two or three millimeters in elevation. They do not appear as is the case in chickenpox; that is, they have no rounded bleb-like appearance, but have almost perpendicular walls, with flat tops, and are shaped like an opera hat.

In the course of a few days, in many cases without any treatment, the diseased area becomes dry and the side walls may be picked off, leaving a whitish, scar-like spot. The disease usually does not appear very virulent and little or no treatment is required. In some cases where we have advised the use of a five per cent carbolized vaselin, excellent results have been reported. Again, where we have had cases under our observation, they recovered without treatment. However, there can be little doubt but that at times the attacks are rather severe and may even cause death. While this has been reported to us upon good, reliable sources, yet we have not personally made such observations. The cases studied in the laboratory did not appear to suffer constitutionally, as there was no loss of appetite and the birds were in good flesh.

Only one test was made to determine if the disease could be transmitted. The curetted material from a fresh nodule was rubbed in a scarified area of the comb of a three-year-old White Orpington cock. The results of this one test were negative. No opportunity was afforded to conduct experiments upon birds not exposed to the disease, though such procedure is contemplated.

CONTAGIOUS INFLAMMATION OF THE AIR SACS IN GEESE

This is an infectious disease caused by a slender bacillus.

The symptoms are those of weakness, staggers gait, great depression, difficulty in rising, kicking at the head, accelerated respiration, snoring sounds and opening the mouth. The bird usually dies in about six to eight days. The disease is confined exclusively to geese.

On autopsy the air sacs are noted to appear yellowish in color, with their inner surfaces covered with a fibrinous material. Similar deposits are found on the serous surfaces of the liver, spleen, intestines and peritoneum.

CONTAGIOUS NASAL CATARRH OF BIRDS

This condition has been called *Coryza avium contagiosa*.

Cause.—This disease can be reproduced by experimental inoculation. It occurs epizootically, mostly among young

fowls, during damp, cold weather and more often in the fall or spring. It may attack old hens. Here it is of economic importance because of the loss in the egg yield. Many young birds succumb to its ravages. The mucous secretions of the head contain the virus. A bacillus resembling in some respects the diphtheria bacillus has been found accompanying the disease which Colin and others have termed the bacillus of fowl diphtheria.

Symptoms.—The contagium is spread by the nasal discharges becoming disseminated. The entire flock in the course of two to six weeks may become affected. The sick bird stays apart from the balance of the flock and sits around with ruffled feathers and droopy wings. There is a partial loss of appetite, tears may be seen to accumulate in the conjunctiva. The outer nasal passage becomes closed and breathing is accomplished with difficulty and by way of the mouth. The bird sneezes and shakes its head. The eyes are kept closed and the eyelids become adherent by a small amount of secretions which dry on the outer edge of the lids. The infra-orbital sinus may become filled and bulge out, much as is often the case in roup. The mortality may run as high as 95 per cent. The nasal secretions remain thin. It is differentiated from roup by the fact that diphtheric membranes never form in the mouth or eye and there are no sores on the head in contagious nasal catarrh.

Treatment.—The same treatment and other sanitary regulations as in roup are indicated in this malady.

CONJUNCTIVITIS

Most inflammations of the respiratory passages extend to and involve the eye structures also. These affections of the eye have been described under catarrh, roup, etc.

There are many causes of inflammation of the mucous membrane of the eye aside from the specific germs heretofore mentioned. A chick was brought to our laboratory with one eye swollen. Upon examination, there was found a piece of straw about one-fourth of an inch in length lodged in the conjunctival sac. Upon removal of this piece of straw, and the application of a one-per-cent solution of zinc sulphate, the inflammation subsided in the course of a day or two.

The number and variety of foreign bodies that may gain access to the eye structures and set up inflammation are numberless. In most cases their careful removal and washing the eye with a saturated solution of boracic acid or a solution of zinc sulphate and water, 1 to 100, constitute all the treatment that is required.

Similar washes are indicated for conjunctivitis due to injuries, spurring, picking blows, etc.

ULCERATION OF THE CORNEA

Conjunctivitis is an inflammation of the mucous membrane surrounding the anterior part of the eyeball. At times this inflammation spreads by contiguity to the cornea. The inflamed cornea becomes cloudy and finally may totally obstruct the eyesight. There is frequently found in connection with this an ulceration of the cornea. Fig. 69 is a case of a single comb Rhode Island Red chick which had developed keratitis when three weeks of age. The eye was enucleated, hardened in 40 per cent formaldehyd solution and sectioned for study. It was found that there was a pan-hemorrhagic condition.

Ulceration of the cornea is sometimes found in conjunction with the eye type of roup. There is an intense conjunctivitis, an accumulation of quantities of purulent or catarrhal products in the conjunctival sac and a keratitis and later panophthalmia.



FIG. 69. ULCERATION OF THE CORNEA WITH HEMORRHAGE INTO THE ANTERIOR, POSTERIOR AND VITREOUS CHAMBERS IN A THREE DAYS OLD CHICK.

RESPIRATORY TROUBLES OF CANARIES

The cage of the canaries should be kept clean, free from drafts and the birds should have a well regulated food supply. When the bird is first noticed to be ill, isolate it, regulate the diet and look to good sanitary conditions of the cage and keep it in a well regulated temperature. Canaries are subject to cold drafts and it may be said that most of their common ailments come from this sort of exposure.

In ordinary colds there is noted difficult breathing, with

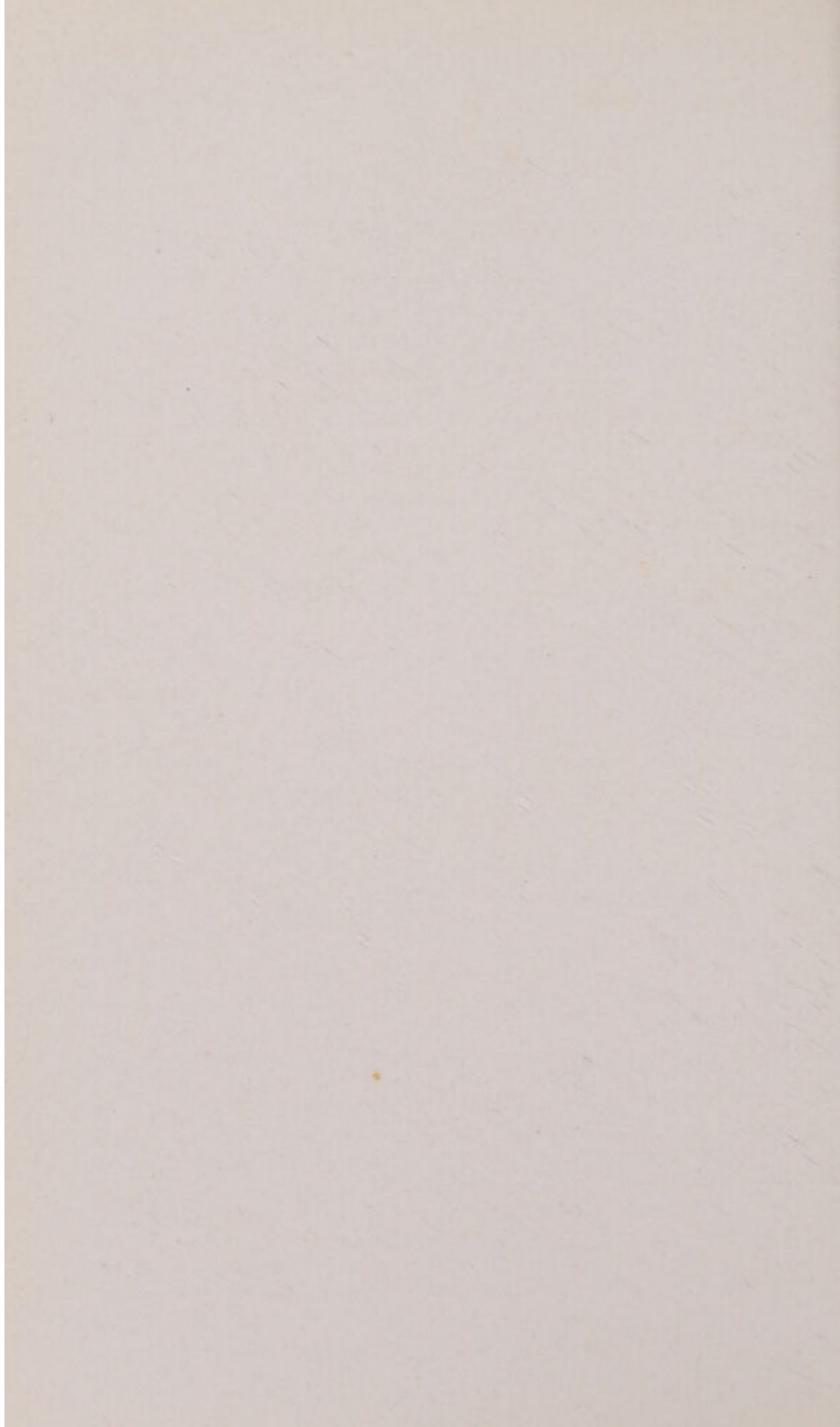
some liquid discharge from the nostrils. This may be accompanied with coughing. As the cold progresses the symptoms become more aggravated. Breathing becomes more difficult and rapid. The catarrhal secretions may partially or completely block the nasal passage.

ASTHMA OF CANARIES

This is a chronic affection of canary birds. In the breathing processes there is a labored expiration. In severe cases a contraction of abdominal muscles is evident in forcing air from the lungs. Asthma is more evident at night, and often birds apparently free from it during the day will wheeze when at rest.

False asthma may be caused by indigestion and overeating. Fanciers consider asthma as hereditary and do not recommend such birds for breeding. There is little that can be done for this condition except to give a light diet.

Treatment.—Place in the drinking cup one ounce of water to which has been added 20 drops of syrup of tolu, 10 drops sweet spirits of niter, and 10 drops of glycerin. If the case is severe add 10 drops of whiskey or brandy. Pneumonia is quite often fatal. The birds become very weak and usually die in from two to seven days.



SECTION XII

DISEASES OF THE ORGANS OF LOCOMOTION

LEG WEAKNESS

This is a condition in which the birds cannot bear their own weight or have difficulty in doing so. It occurs in young as well as in old birds but there is a possibility that the cause in young birds is different from that in old birds. Knowledge as to the causes of leg weakness, so common at times in certain localities, is imperfect. The conditions are being investigated, however, in several laboratories.

Possible Causes.—In young chicks some of the causes are believed to be improperly heated brooders, too much bottom heat, damp and badly ventilated houses and keeping chicks constantly on wooden floors. We have seen it in our flocks where they were on wooden floors and as soon as they were turned out on dirt runs the disease disappeared. It has been reported where the chicks were kept on cement floors but usually disappearing, as in our experience, when the chicks are allowed to run out on dirt during the warmer part of the day. There is little doubt that overheating and too much under heat is one prime causative factor; for, since the hovers supplying top instead of under heat came into common use there does not appear to be so much leg weakness among the baby chicks. It appears to be the artificially-brooded chicks that develop leg weakness and the disease is supposed to be unknown among the natural brooded chicks especially where the hen and brood are provided with the combination sitting and brooding coop.

Leg weakness may be observed in birds that are heavily fed and that grow rapidly and where the birds' weight appears to increase faster than their strength. Overcrowding and close ventilation are no doubt contributing factors.

In adult birds leg weakness may be due to rheumatism and possibly to some extent this may be the case in younger birds. Cockerels are apparently more often affected than pullets. It is apparently more prevalent among the heavier breeds than among the lighter ones.

Symptoms.—Leg weakness or paralysis among old birds is widespread in the United States. It usually appears sporadically and could hardly be considered in the sense of a contagion. In addition to the leg weakness which at times results

in a total loss of the legs, there is usually noted a fetid diarrhea. The bird may or may not have a loss of appetite, it gradually becomes emaciated and finally dies. The bird in the later stages lies helpless upon its side, often with one or both legs extending backwards from the body.

Leg weakness among baby chicks at times appears suddenly and with a change in environmental conditions it disappears just as suddenly. The worst cases die and the milder ones may recover. The condition may affect only one, or at most a few birds. The same condition also applies to old birds. There is unsteadiness in walking, and in badly affected cases the bird sits around till finally the muscular function is entirely arrested when the leg or legs extend backward from the body. In the baby chicks the legs present a shriveled appearance.

Birds so affected do not find it possible to obtain their portion of feed unless helped, as the other birds crowd them away. The only safe way is to remove them from the flock and give them extra care. Such birds, if not helped and given proper feed, do not gain in flesh as do the balance of the flock and they become thin in flesh.

As a differential diagnosis between leg weakness and rheumatism, it may be said that in rheumatism the lameness shifts, disappears and reappears, and in case of affection of the joints there will be noted swelling which will be hot and painful to the touch. In leg weakness these symptoms never appear.

Post Mortem Appearance.—No definite lesions can be found in the baby chick that has died of leg weakness. All organs in old fowls that have died of paralysis are apparently normal except the bowel which is highly injected and at times may show petechiæ of the mucosa. The vent fluff is usually soiled as a result of diarrhea.

All efforts, in this laboratory, to isolate a causative germ or to reproduce the disease have failed. There has been no organism isolated from the blood nor from the internal organs that will reproduce the disease and inoculations of emulsions from the brain and spinal cord of birds dead of the disease have failed to reproduce it.

While we feel sure that leg weakness in baby chicks is due to environmental conditions, we are not so sure that paralysis of adult fowls is not due to a germ. This work is still being carried on in this laboratory.

Treatment.—Give to old birds one-sixth grain doses of sulphate of strychnin, in tablet form or in capsule, three times a day. If rheumatism is suspected give two-grain doses of

salicylate of sodium three times a day. Give one teaspoonful of castor oil in severe cases in adult fowls.

Properly ventilate the quarters, keep them clean, free from dampness, and supply the birds with good wholesome feed and water. If the cause is a lack of lime salts (rachitis), milk and lime water should be given freely. Feed ground bone and meat meal to baby chicks and place the chicks on the ground, at least, through the warmer part of the day. Even temperature and proper heat must be supplied baby chicks at all times. We have found by laboratory studies that fifteen minutes chilling may cause congestion of the lungs and kidneys and result fatally.

Remove the affected birds, in case of disease among young chicks, and reduce the amount of fat forming feeds. Give the proper protein ration. A narrow ration is needed. (N. R. 1:3) Feed oatmeal and oats, cracked and whole wheat, plenty of green feed, sour milk and one teaspoonful fluid nuxvomica to each pint of water.

INFECTIOUS ARTICULAR INFLAMMATION IN YOUNG GEESE AND DUCKS

Freeze and Lucet report infectious arthritis in young ducks and geese five to eight weeks old. The organism isolated in all their investigations was the *Staphylococcus pyogenes aureus*. They were able to reproduce the disease with inoculations of pure cultures of the organism.

Symptoms.—The acute type causes lameness. If the affected joint is in the wing, the wing will hang pendulous. There is a loss of appetite, diarrhea and at times slight conjunctivitis. The course is rapid, resulting fatally in three or four days after the first manifestation of the disease.

In the chronic type, arthritis is the most prominent symptom. Diarrhea may be present in the onset of the disease and the bird may recover in two to three weeks. The bird is stunted and does not fatten satisfactorily.

The structural changes consist of a serous or sero-fibrinous inflammation of the joints. There is a hemorrhagic inflammation of the bone marrow. In chronic cases purulent osteomyelitis may occur. Intestinal catarrh is noted.

Treatment.—This consists of local applications; fomentation of the affected joint with hot water thirty minutes twice daily.

PARALYSIS OF THE WINGS OF PIGEONS

The shoulder and elbow of the wing of carrier pigeons are sometimes affected by arthritis, which has been described as

infectious. The affected wing droops and the bird is unable to fly.

Predisposing causes are, housing in cold lofts and allowing the birds to roost in drafts.

The affected birds should be isolated from the balance of the flock.

Abscess formation sometimes occurs, pus being of a caseous consistency. Birds may recover, but if abscesses form they may lose the power of flight.

ABSCESS OF THE FOOT

Abscess of the foot may be caused by injury due to a thorn as a Russian thistle or hedge thorn having punctured the soft parts. In Figure 70 there is illustrated an abscess of this nature. The thorn has penetrated the soft parts be-

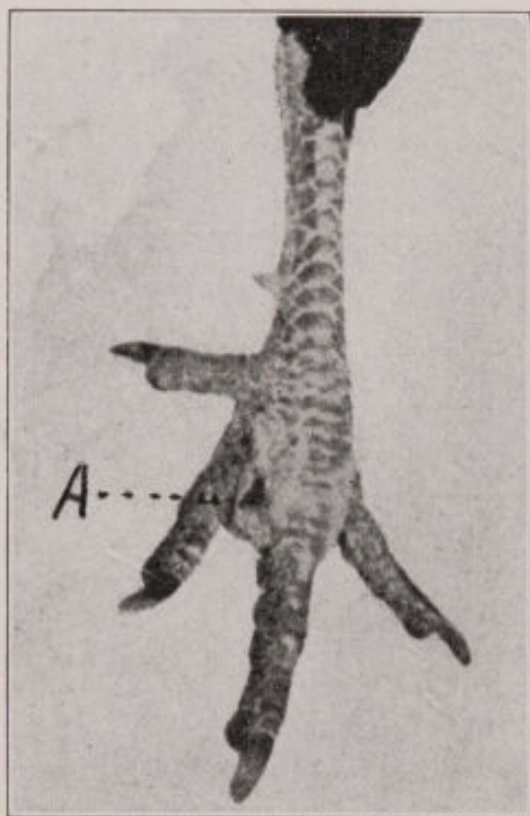


FIG. 70. THORN ABSCESS.

A, opening through which cheesy pus was liberated.

tween the two inner toes. A, indicates an opening through which a cheesy pus was removed by aid of a curette. No treatment other than opening the abscess and scraping out the pus was given. The bird made a perfect recovery.

Abscess of the sole of the foot is of common occurrence. This condition is sometimes called "bumble foot." The sole of the foot becomes bruised by a thorn prick, stone bruise or other injury resulting in suppuration. It may also result from birds jumping onto hard floors from high perches. Pus in the domestic fowl is always of a cheesy nature; that is, there is no liquid present so that simple lancing will not be ef-

fective as the pus will not drain out, but must be scraped out. It is best in treating these conditions to make a bold incision laying open the parts and carefully curette out every particle of the material, then saturate with tincture of iodine and dress with absorbent cotton and bandage. Dress the wound once daily.

After treatment of the foot, place the bird in a clean, dry place, preferably on straw, so as to keep dirt out of the sore.

After the foot has healed it will be found to be somewhat larger than normal. The sole of the foot will be somewhat tender for a while, and to prevent rebruising and reformation of an abscess it is well to place a leather pad on the sole of the foot.

A condition due to cactus thorns has recently been studied. This condition occurs in baby chicks and is manifested by the legs and feet becoming somewhat shrivelled or appearing "dried up." The toes may become crooked and finally dry gangrene and death of the young bird result. This condition has been produced experimentally.

GOUT OF FOWLS

Gout of the joints is an inflammation of the fibrous and ligamentous parts of the joints. It is accompanied by an excess of uric acid and deposits of urates of sodium in and around the joints.

Gout may also attack the internal organs and cause deposits of sodium urates in them. This type is called visceral gout.

Gout attacks man and some of the lower animals such as fowls and dogs.

The histology of urate deposits, both experimental and gouty, have been studied by Krause, Rosenbach and Freudweiler. Their results all indicate that uric acid and urates excite slight inflammatory reactions, cause a slight local necrosis, and seem to act as a weak tissue poison. However, they may be deposited without causing necrosis.

That urates may cause necrosis in the tissues has been definitely established, and this may lead to connective tissue formation and contraction.

Gout is more common in birds force-fed and given rich nitrogenous diet and in old birds where the eliminating action of the kidneys is more or less impaired. Birds normally excrete large quantities of uric acid, which appears on the outer surface of the droppings as a whitish liquid or semi-liquid.

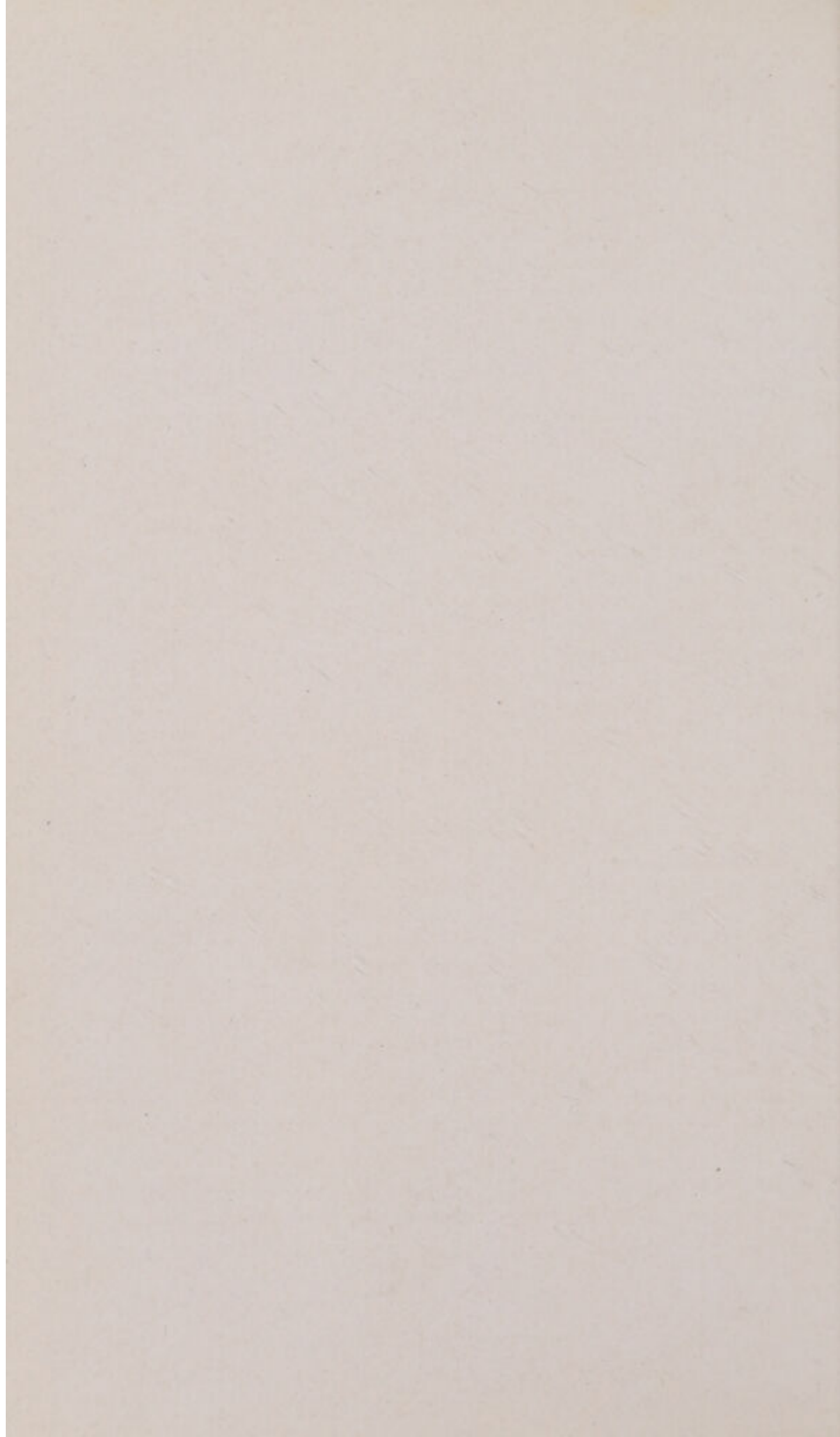
It would appear that the preponderance in the blood of substances which are of acid reaction favors the precipitation of uric acid.

Uric acid is converted into sodium urate by the salts in the blood in two ways: First, by breaking down of the nuclealbumins of the tissue and especially perhaps of those contained within the leukocytes; and second, from similar substances contained in the food (Greene).

Excess of uric salts in the blood may be produced either

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When gout assumes a chronic type, the prognosis is unfavorable. When ulcers are present it is observed that they do not entirely heal. The birds finally become unable to move about and care for themselves, become emaciated, exhausted and die.



SECTION XIII

DISEASES OF THE BRAIN AND NERVES

DIZZINESS—VERTIGO

Affections of the brain are comparatively rare in birds. Vertigo has been known where the brain is congested, especially in very fat, plethoric birds. Excessive heat in hot summer weather; absorption of poisonous substances (toxins) from the intestinal tract; irritation due to intestinal worms; injury to the head, as by a blow, etc., are the chief causes of dizziness in birds.

Vertigo has been observed in baby chicks. The birds appear dizzy, finally fall over on their side helpless and in a few minutes may recover or finally may die.

Symptoms.—The adult bird throws its head upward, backward, and to one side. It may walk sidewise or backward, and have an unsteady walk—staggery. The bird may be drowsy, and even have epileptiform symptoms.

Treatment.—Place the affected bird in cool, well ventilated, comfortable quarters, free from drafts, and for the adult give thirty grains of Epsom salt, dissolved in warm water. Give also two-grain doses strontium bromid every hour. Thorough purging is one of the first essentials.

In case of limber neck (due to eating rotten meat) and prostration, give one-fifth grain strychnin three times a day. (See page 229.)

HEMORRHAGE OF THE BRAIN

This condition is technically called apoplexy. It may be due to over-straining, as in egg-laying, in very fat birds. Injury to the head and over-stimulating food are also causes.

Symptoms.—The hen may be found dead on the nest. The symptoms are of short duration: the attack comes on suddenly, as the hemorrhage soon presses on the brain structures so that the function of that part stops and the animal is seen to stagger, fall, and die immediately.

Postmortem Findings.—Upon opening the brain cavity and examining the brain, there will be found hemorrhages (clots) in the brain substance.

EPILEPSY

In the attack the bird emits sharp sounds, makes flopping movements with its wings, falls on its side or back, moves

its feet rapidly, rolls its eyeballs, bends its neck round to one side, opens and shuts its beak alternately, and moves the whole body to and fro.

After one or two minutes the spasms cease and the bird gets up, staggers and may at first support itself with its beak and outstretched wings and finally falls because of a fresh attack or it may gradually recover from the first attack without any immediate renewal of the spasms.

Hemiplegia sometimes follows as a sequel of this disease.

Epileptiform attacks are sometimes caused by internal parasites.

Treatment should consist of a physic. During the attack the bird should be cared for to prevent its injuring itself.

MYELITIS

Myelitis is an inflammation of the spinal marrow or its membranes. There are indications of a deep seated burning pain. It is accompanied by various nervous and vascular irregularities of function.

Myelitis in the cervical region of the bird has been observed and is noted to manifest itself by paresis and hyperesthesia of the wing, lateral flexion of the neck during repose so that the beak may be directed backwards. During feeding the head may be carried in a normal position.

POLYNEURITIS

Ohler has shown that birds fed on a diet wholly of wheat bread develop a polyneuritis similar to *polyneuritis gallinarum* as produced in fowls with a diet of polished rice. The disease made its appearance in from twenty-one to eighty-two days, with an average of about forty days.

In the large majority of the fowls the first symptoms of paralysis were a slight unsteadiness, together with evidence of an involvement of the nerves supplying the extensor muscles of the legs, manifested by a high step and a tendency to bring the foot down with a flop. In many fowls there seems to be difficulty in coördination early in the disease. In such cases the fowls teeter slightly forward as if trying to balance on their toes and walking is with a decided ataxic gait. As the disease progressed in all cases walking became more and more difficult, until the birds could only squat in the cages, and this condition was soon followed by one of complete paralysis. The disease usually began with peripheral paralysis and later an involvement of the higher nerve centers. When fowls were fed on white bread made without yeast, they came down with a polyneuritis somewhat sooner

than when fed with bread containing yeast. Holst found the same to hold true in feeding pigeons with ship biscuits. When fowls were fed on whole wheat bread, they remained perfectly well for as long as seventy-five days. It is apparent that whole wheat bread contains some element, or elements, lacking in the white bread, which is necessary to maintain the proper bodily metabolism. Fowls force-fed came down fully as soon as those that were allowed to eat at will, indicating that it is not a matter of how much feed is taken, but its quality.

Fowls fed on whole corn remain perfectly well for a period of sixty-three days, but when they are fed on the inside of the corn kernel they come down with the disease as when fed on wheat bread.

Tests were run to determine the effects of a starvation diet. Two fowls were started on normal diet, then the amount was gradually cut down, until after about twenty-one days the birds were receiving nothing but water. One fowl went for thirty-eight days without food and the other for fifty-six days. In neither fowl was there a typical picture of paralysis; the symptoms presented appeared to be due to muscular weakness.

Wellman and Bass produced polyneuritis in fowls by feeding in a like manner, sago, boiled white potato, corn starch, wheat flour, corn grits, boiled sweet potato, cream of wheat, puffed rice and macaroni.

It is apparent according to the work of Holst that pigeons fed on biscuits baked of rye flour, either with or without yeast, do not develop polyneuritis, while pigeons fed on wheat bread do.

The following case report gives the clinical picture:

During the first ten days the fowl ate heartily of diet, and appeared at all times active and well, except for more or less diarrhea. On the eleventh day the fowl began to refuse feed and on the fifteenth day forced feeding commenced. The first symptom of paralysis was noted on the twenty-second day. On this day the fowl was slightly unsteady and stood teetering forward and backward on its toes; when forced to walk it did so with a high step pushing the feet well forward as if trying to brush something from in front of it. Three days later a slight head tremor was noted, and the bird walked with a decidedly staggering gait, but did not fall. Next day both wings drooped, it walked with great difficulty, and every now and then the joint formed by the tibia and the metatarsus seemed to give way and the fowl suddenly assumed a squatting position. It remained in the cage squatted most of the time on the flexed tarsometatarsus, with the extremities also flexed. On the following day the bird could not stand. The comb was cyanotic, there was convulsive movements now and then with retraction of the head. Next day it was prostrated. The duration of the disease was six days.

PARALYSIS OF THE AUDITORY NERVE OF THE FOWL

Anatomy of the Parts

It may be well first to give the origin and distribution of the auditory nerve before taking up the disease of the same.

In the fowl the facial (seventh pair of cranial nerves) and the auditory or eighth pair, are so intimately associated, it appears well to give the origin and distribution of both at the same time.

The facial nerve originates, with the auditory, from the cerebellum. It divides into three parts, the first probably from the complex ganglion with the posterior roots of the auditory. This root belongs to the somatic sensory group of nerves. From this same group originates the auditory which spreads out into the cochlea and takes the impression of sound. This nerve is short and thick, and at the point where it loses its medullary covering on entering the cochlea there is developed a ganglion. This ganglion is similar to the spinal ganglion.

The second part originates by one root which is located medially and ventrally from the deeper ganglion cells. Some of the fibers from this root constitute the vestibular branches and accompany the auditory and supply the anterior part of the ear labyrinth and semicircular canals. The larger part of the fibers of this trunk make up the intermediate part of the facial. The geniculate ganglion is formed at their fusion. The sympathetic sphenopalatine nerve emerges from this ganglion, coming out of the aqueduct of Fallopius.

The third part is called the *portia dura* and is the main *facialis*. It is located opposite the auditorius intermedius. Its roots may be traced to the complex ganglion, from which they take a ventral direction.

Paralysis of the Cochlear Nerve

The paralysis of the cochlear nerve, the true organ of hearing, may be a congenital defect and has been observed in am-biotic animals. It is due to a defective condition of the spinal ganglion with resulting degeneration of the organs of Corti. Paralysis of the nerve may also be caused by inflammatory changes in the internal ear or intracranial disease in the neighborhood of the medulla oblongata. It has been observed as a symptom in coccidiosis and also in fowl plague.

Paralysis of the Vestibular Nerve

This condition is frequently observed in birds. It is often caused by inflammation of the middle or internal ear. It has been observed in fowl pest. It is also brought about in

earies of the petrous temporal bone. Concussion of the brain and hemorrhage of the internal ear is also a causative factor. Certain disease conditions of the cerebellum and medulla oblongata may cause an interruption in the conductivity of the vestibular nerve. In pigeons it is observed in contagious meningitis.

The symptoms of bilateral disease of the cochlear nerve are easily recognized owing to the fact that there is complete deafness. If it is unilateral the symptoms may be so meager that its presence entirely escapes the observation of the owner.

Unilateral paralysis of the vestibular nerve is evidenced in all species by the head being held in an oblique manner, the diseased side being held lower. The head may be held in a position under the front part of the body with the lower part of the head turned back towards the sound side. This turning of the head may be slight or 45° to 75° , but in birds it may be as much as 180° or even more. If the head be carried under the body the dorsum of the cranium may touch the ground. There is frequently a horizontal rolling of the eye-balls towards the sound side. There may be difficulty in taking food, and in birds it is commonly quite impossible. If the disease is bilateral it closely resembles cerebellar ataxia, only the symptoms are limited to the head and neck.

If the paralysis is due to an injury, the disease as a rule is not permanent and the symptoms all disappear in a few days or weeks. If the condition is due to pathological changes in the auditory nerve or nerves the symptoms are persistent, depending on the nature of the primary cause. The bird may, after a while, die.

In traumatic causes the bird needs to be kept in a quiet place free from annoyances, and, if necessary, artificial feeding is resorted to. If there has been an injury and hemorrhage takes place in the tissues, surgical interference may be indicated. In cases in pigeons due to contagious menin-



FIG. 71. PARALYSIS OF THE AUDITORY NERVE OF A SILVER CAMPINE HEN.

gitis an attempt should be made to isolate the diseased bird and carry out thorough disinfection. Calomel should be given to the bird and cold water packs applied to the head.

Cases of Vestibular Paralysis

Figure 71 shows a picture of a Silver Campine hen which was sent to the laboratory. This hen had the run of the farm with the balance of the flock. She was about two years old.

There was nothing in the history of the case to indicate whether the hen had met with an accident or had a diseased condition of the auditory nerve. The bird, as is shown in the cut, held her head under the body with the top of the head resting on the floor. A thorough examination of the external auditory canals did not reveal any signs of violence or parasitism. Eating was accomplished with difficulty and the bird died after suffering in this manner for a period of sixty days.

A second case in which the bird showed similar symptoms and in which examination of the auditory canals and skull was negative, after a period of five weeks, gradually showed signs of improvement and finally recovered.

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In the third portion of the intestines, or ileum, may be found green and white molds, *Cladothrix asteroides*, *Bacillus cloacae*, *Bacillus ramosus*, *Sarcina lutea* and *Sarcina aurantiaca*, *Staphylococcus pyogenes albus* and *citreus*, *Staphylococcus cereus albus*, *Bacillus fluorescens liquefaciens*, *Micrococcus astero sporus*, *Streptococcus lacticus*, *Bacillus lactis aerogenes*, *Bacillus coli communis*, *Bacillus prodigiosus*, *Bacillus mesentericus*, *Bacillus cereus*, *Bacillus megatherium*, *Bacillus fusiformis*, *Bacillus subtilis*.

Practically the same microorganisms are to be found in the cecum. The same may be said of the cloaca, with possibly the addition of the *Bacillus aerogenes capsulatus* and *Staphylococcus pyogenes aureus*.

It must be remembered that the intestinal flora is probably not the same for all birds, as different surroundings or environment, different sources of food, as well as different food and water, play a part in carrying germs to the intestinal tract.

SECTION XV

THE EGG

COMPOSITION

An average-sized hen egg weighs about two ounces, of which eleven per cent is shell, thirty-two per cent yolk, and fifty-seven per cent white. The principal chemical constituents of the egg are as follows: Ash (mineral matter) nine per cent; fat (hydrocarbon) nine and three-tenths per cent; proteids (nitrogenous matter) eleven and nine-tenths per cent; and water, sixty-five and five-tenths per cent.

Composition of the Egg Shell

Gadow gives the composition of the egg shell as follows:

	Per Cent.
Calcium carbonate	91.44
Magnesium carbonate	2.03
Calcium phosphate70
Organic phosphate	4.92
Water73
Loss (or traces of other salts)....	.18
<hr/>	
Total	100.00

ANIMAL PARASITES IN EGGS

Reports have been made that worms have been found in eggs. The author has not had the good fortune to examine any of these worms for the purpose of classification, but it is probable that the *Ascaris inflexa* or *Heterakis papillosa* and other round worms, normally inhabiting the intestines, may find their way up the egg canal and be incorporated with the egg as it is formed. By referring to Fig. 2, it will be seen that a live worm, possessing power of movement as these worms do, passing into the cloaca (16) from the rectum (15), can pass up the egg canal (23) and thus be incorporated in the albumen of the egg, as it is formed around the yolk. These conditions are rare.

BACTERIA OF EGGS

Several investigators have, of recent years, devoted much time to the investigation of the bacterial flora of eggs. It is

needless to say that all understand that the spoiling of eggs is due to the multiplication of bacteria in them, when the egg is brought under proper temperature. The cold storage of eggs holds them under conditions unfavorable for the rapid growth of these bacteria. When eggs are kept cold the bacteria within them are in a more or less dormant state and hence by reason of this retardation of germ growth the eggs keep longer.

Eggs can be successfully desiccated (dried) and such powdered product is on the market. The moisture in it is so reduced that germs do not grow and, like any other dried product, it keeps well. This desiccated product retains the qualities of the fresh egg for a long time. One pound represents about three and one-half pounds of raw egg or an amount obtained from thirty eggs. The egg contains considerable fat and because of this the dried product gradually undergoes a change at warm temperatures, much as butter does, finally giving off a rancid, fishlike odor.

It is not probable that the yolk or ovum becomes infected while it is being formed in the ovary, unless the ovary, from which it develops, be diseased. It has been shown that birds that have had white diarrhea while chicks and recovered, grown to maturity, and commenced laying, have diseased ovaries, ovaries which harbor the *Bacterium pullorum*, the cause, or at least one of the causes, of white diarrhea, and this germ is incorporated within the yolk of the egg. Chicks which hatch from such infected eggs develop white diarrhea soon after hatching. This is an important means of spreading this disease and one before which sanitation is powerless.

Ordinarily the internal organs, as the ovaries, kidneys, spleen, etc., are sterile unless diseased, as just stated. However, Conradi maintains that he has found bacteria in these supposedly sterile organs in seventy-two cases out of one hundred sixty-two.

The germs that have been alluded to under intestinal flora of chickens can easily find their way into the cloaca and up the oviduct, as illustrated in Fig. 2. The yolk or ovum when fully developed in the ovary is delivered, in a similar manner, as in higher animal life, into the first portion of the oviduct (uterus), which at its free extremity is rather funnel shaped and is called the *ostium infundibulum*. This egg canal which can be likened to the uterus of higher animals is about eighteen to twenty inches long and is lined with tubular glands which secrete the albumen, and in the posterior portion the shell. This material is formed from foods carried by the blood, which is very abundant in these walls.

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extent to which the primitive trace is cleft, and also by the limitations of the dichotomy to the cephalic or caudal extremity of the neural axis. Either or both extremities may become bifid. The cephalic or head extremity may become bifid alone and a double head, or still further bifid and the posterior extremities single or the posterior extremity become bifid and the anterior single.

Figs. 72 and 73 illustrate a duplication of the legs. The rudimentary legs are perfect, but not so well developed as the other two. This is *polymelus*.

UMBILICAL HERNIA OF THE BABY CHICK

We have examined many chicks in cases where they have died after partly pipping out of the shell. The shells were

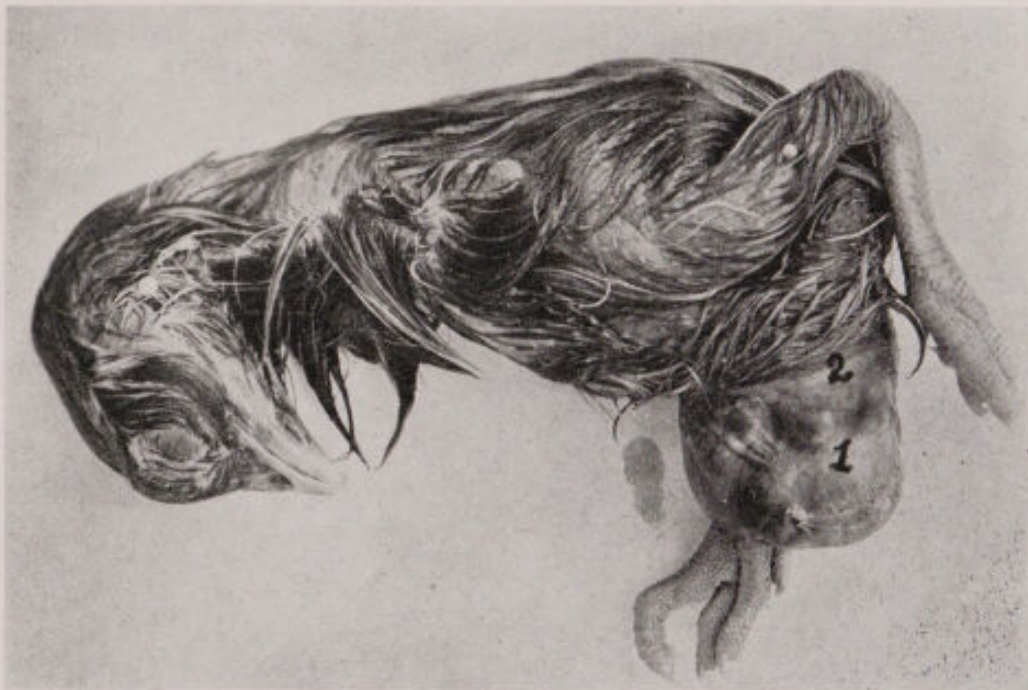
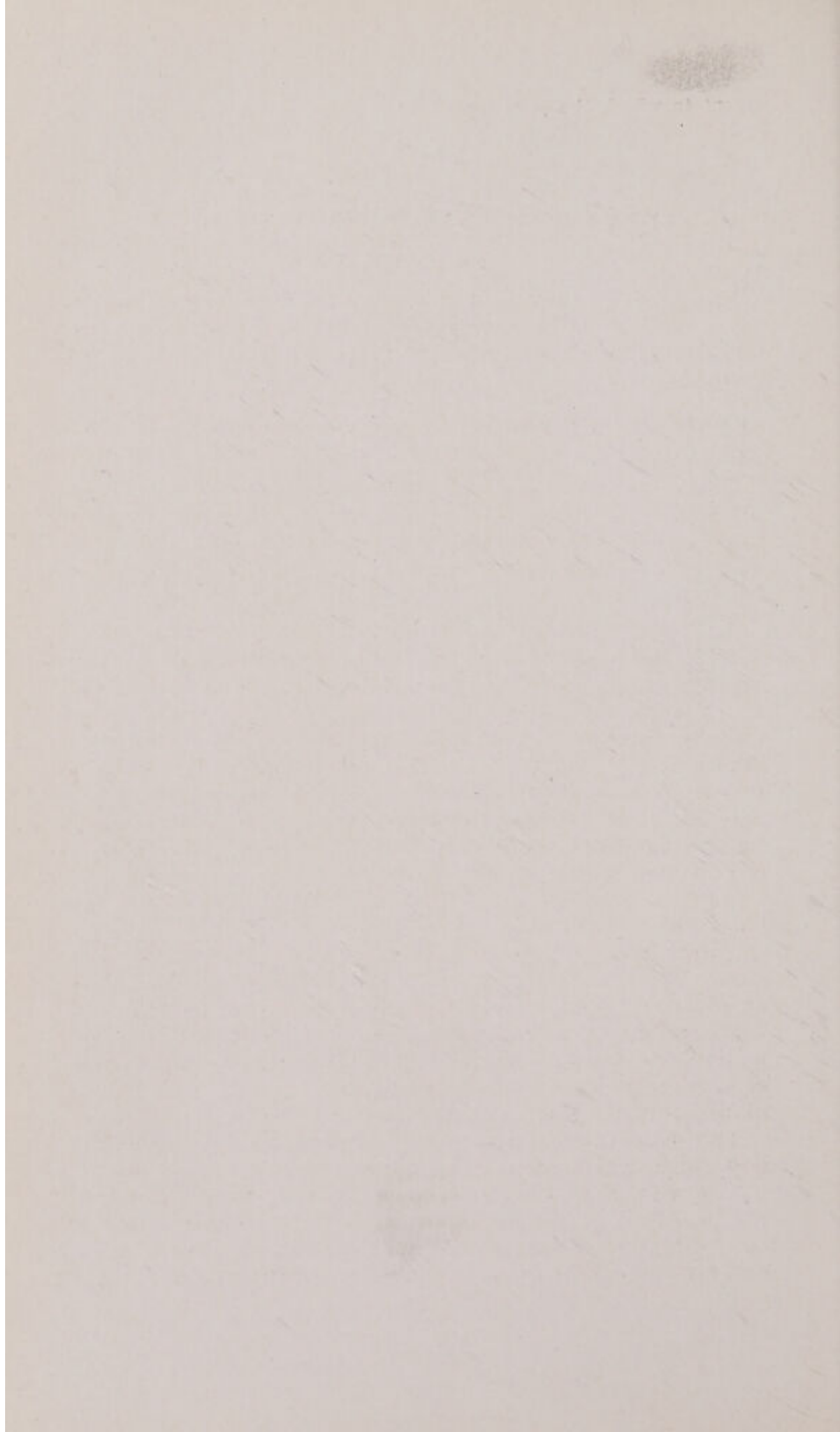


FIG. 74. UMBILICAL HERNIA OF A BABY CHICK.
1, portion of egg sac not included; 2, umbilical ring.

carefully removed and an examination, in many, showed a rupture of the umbilicus at its point of attachment. At this point the abdominal wall is very thin, and is not reinforced by elastic tissue, as in quadrupeds, and if the membranes become very dry and tough, the straining by the chick in its efforts to free itself may prove fatal. Fig. 74 shows a hernia as a result of excessive straining. No. 1 is the abdominal yolk sac which has been forced through the umbilicus, No. 2.



SECTION XVII

FRACTURES—WOUNDS—ANESTHESIA

FRACTURES

Fractures or broken bones among birds in the poultry yards are of rather common occurrence, especially where birds are allowed the run of the farm or ranch, as is the usual custom.

REPAIR OF THE FRACTURE OF BONES OF THE DOMESTIC FOWL

This work is divided into three groups, as follows: First, the structure and development of the bones of the domestic fowl; second, the kinds of fractures and the reparative processes; third, means of control of the bird and care of the fracture.

I. The Structure of Bones

In the gross study of bones we find that in the limbs as the legs and wings they form levers which have to sustain weight of the body and confer the power of locomotion, either during walking, running or flying. The femur, tibia and humerus are examples. The shaft of the long bone is narrowed and contracted, which affords greater space for the bellies of the muscles. The extremities are generally somewhat expanded for greater convenience of motor connection, for the purpose of articulation and to afford a bony surface for muscular attachment. Some long bones are slightly curved, thus affording greater strength.

Where there is required great strength and at the same time motion it is divided into a number of small bones. As an example we have the patella and the two carpal bones.

Where the principal requirement is that of extensive protection or the need of large bony surface for the attachment of muscles, we find osseous structures expanded into flat bony plates, as is the case in the skull and pelvis.

The respiratory apparatus of the domestic fowl consists of two lungs, which occupy the upper thoracic region, pushing out between the ribs, and is made up of a series of air tubes and air sacs. Some of the bronchi or air tubules communicate with air sacs or bladder-like structures located at the anterior thoracic region, others at the diaphragmatic region.

Many of the bones of the fowl, as the head, vertebrae and humerus, contain air cavities. The air sacs send extensions into these cavities.

Bones of fowls nearly always develop from a connective tissue foundation. The inorganic substance of the bone is compressed in or between the fibers of the connective tissue, while the cells of the latter are transformed into bone cells. Between fibers are calcified bone cells, each of which rests in a cavity of the matrix, called lacuna.

The bone cells have processes that anastomose with the processes of other cells. They lie in special canals known as canaliculi.

The histological structure of the bone of the domestic fowl is similar to that of mammals, with the exceptions given above, and the reader is referred to any histology for further study.

II. Reparative Processes of Bone

A fracture of bone may be defined as a sudden solution of continuity in a bone. The cause of fractures in a fowl are: first, injury or trauma, receiving a blow as from a stick or stone or being stepped upon by a large animal, as a horse or cow, or by the infliction of a gun shot wound; second, muscular action. Bones are most resistant to traction, next to pressure and less resistant to flexion or bending and least of all to torsion. External violence may be direct or indirect. In fracture from direct violence the bone is broken at or near the spot where violence is applied. As a rule the soft structures surrounding the fracture are more or less injured and more serious results may follow than in fractures by indirect violence. In this kind of fractures the bone may be comminuted or fissured and perhaps driven into vital organs, as the liver or lungs, if the fracture be near these regions, or into the brain if in the cranial region.

External violence is the most common cause of fracture in the fowl. The most common bones that are fractured are those of the legs and next those of the wings.

Fractures may be classified as follows: first, simple fractures—those breaks in the continuity of the bone where the skin is not broken; second, compound, also called open, or complicated fractures—those where the break is accompanied by a break through the skin and soft parts extending to the seat of fracture.

A series of studies was made in this laboratory of repaired fractures of fowls of long standing, after which a series was made of the nature and rapidity of repair of fractured bones

of the domestic fowl. The birds were chloroformed and the bones fractured and set while the birds were still under anesthesia. The metatarsus and ulna were selected. The appliance that was used to hold the bones in place was cotton, one inch cloth bandage, wooden splints and glue. At the end of each experiment the bird was chloroformed and the bone removed. After a physical examination, the bone was sectioned longitudinally, photographed and the lesion of one-half cut out and placed in ten per cent hydrochloric acid solution for forty-eight hours for decalcification, and then passed



FIG. 75. SECTIONS THROUGH BONES AT DIFFERENT STAGES OF FRACTURES. 1, five days standing; 2 and 3, thirteen days standing. Note the provisional plug and provisional callus.

through three changes of absolute alcohol; then alcohol and ether equal parts; then embedded in celloidin and sectioned. The sections were stained in hematoxylin and eosin and clarified in oil of cedar or beechwood creosote, and mounted in balsam for microscopic study.

In a study of a fracture of the metatarsus of a single comb Rhode Island Red of eight days' standing, the following picture presented itself. The gross specimen showed a mottled reddish white zone in the region of the fracture indicating that immediately following the fracture there was an extravasation of blood which had collected

around and between the fragments and between the ends of the compact portion of the bone and had also invaded, to a certain extent, the marrow cavity. The fluid at this time did not give evidence of advance organization and was rather jelly-like allowing the fractured ends of the bone to fall apart by slight traction. There was present the initial hyperemia of repair. This hyperemia was most marked in the periosteum. Leukocytes had invaded this part, as shown by microscopic examination. Proliferative changes had taken place in the connective tissue and in fact this was observed in cases of only forty-eight hours' standing. The most active cellular multiplication was in connection with the fibrous structure of the periosteum. This forms the germinative or reparative tissue from which arises the osteoblasts. The nature of the new formed structure was that of connective tissue and is plainly shown in the photomicrographs. The first picture shows the commencement of this organization into trabecular-like arrangement forming the periosteal callus and the provisional plug. It can be seen that this had been formed and poured out from the periosteum. This field showed many fibroblasts and was packed with osteoblasts and osteoclasts and in still other fields of the trabeculae a homogeneous matrix with formative bone cells in their lacunae. The repair was apparently one of intramembranous bone formation with islands of newly formed bone at the end of the fifth day.

Another study of a fractured metatarsus of thirteen days' standing was in a one-year-old single comb White Leghorn hen, that was of low vitality and the reparative processes were more tardy than in section of a similar case in which the bird was in a good state of health. After the metatarsus was removed it could, with considerable force, be made to spring, which was not the case with the latter specimen. Both birds showed the reparative processes far enough advanced to have the cast removed with safety.

From these two studies it is rather indicative that repair in the bone of the domestic fowl is quite rapid and that two weeks is ample time to allow the bandage or cast to remain on. The illustrations, both photographic and photomicrographic, show the provisional, intermediary calluses and the provisional plug.

III. The Treatment of Fractures and Care of the Bird

In simple or so-called subcutaneous fracture of bones the fragments of the bone should be placed in perfect apposition. The normal shape of the bone should be restored as far as possible. The loose arrangement of the muscles in the fowls makes this an easy task.

The next step is to apply an apparatus holding the parts firmly in place while the reparative processes are being accomplished. In applying the apparatus, circulation must not be interfered with and nerves must be safeguarded. After the setting is complete the bird must be provided with a clean coop and a grassy run where other birds cannot interfere. Good food and water should be provided and an occasional examination made to determine if all is well with the bone undergoing repair.

If the fracture is on a feathered part, the feathers that are

in the region to be manipulated should be removed. Next apply a thin layer of cotton, carefully holding the fractured parts in the proper position; then apply about three thin, narrow splints of wood of proper length in such a manner that they cannot chafe the leg and do injury to the skin. Next apply a one-inch cotton bandage, at the same time saturating it with glue. In a few hours the liquid glue will become hard and the parts will be firmly held in position.

At the end of fourteen or fifteen days, carefully remove the bandage. Confine the bird for a few days longer and then allow it to run in its accustomed quarters.

As to feed, for the first two or three days after injury give easily digested food, such as bread soaked in milk or wet mash. Later some grain may be fed, but only two light feeds should be given while the bird is in confinement. Pure, clean water should be kept before the bird at all times.

WOUNDS

Birds possess a high immunity to pyogenic infection (the germs that ordinarily infect the wounds of animals); and wounds, whether accidental or surgical, unless very serious, heal with great rapidity. The degree of tolerance of infection that the peritoneum of birds possesses is probably not equalled by the peritoneum of any other domestic animal. For example, birds rarely die from infection after caponizing. Death when it occurs as a result of this operation is ordinarily due to hemorrhage. Man and animals (except the dog) survive abdominal operations only when done under aseptic precautions.

Wounds should be cleansed with antiseptics as in mammals. Full strength iodine favors healing and is an excellent antiseptic. This is to be applied after the wound has been cleansed with water.

ANESTHESIA AND RESTRAINT OF THE FOWL

Chloroform (Squibbs), may be administered by means of the carton a one-fourth-pound bottle is packed in. A small hole is cut in the bottom of the box to admit air and a small pledget of cotton placed in the box to absorb the chloroform.

The hen is very susceptible to chloroform, quickly going under its influence and quickly coming out again. Care needs to be exercised lest too much be given and the bird die from an overdose. In administering the chloroform the head of the bird is first thrust into the box. The bird usually

struggles very little and is soon completely under its influence. The cover is then removed or held one or more inches from the nostrils as indicated by appearance of the bird. If an overdose be given, open the mouth and resort to artificial respiration as with other animals; many are thus revived.

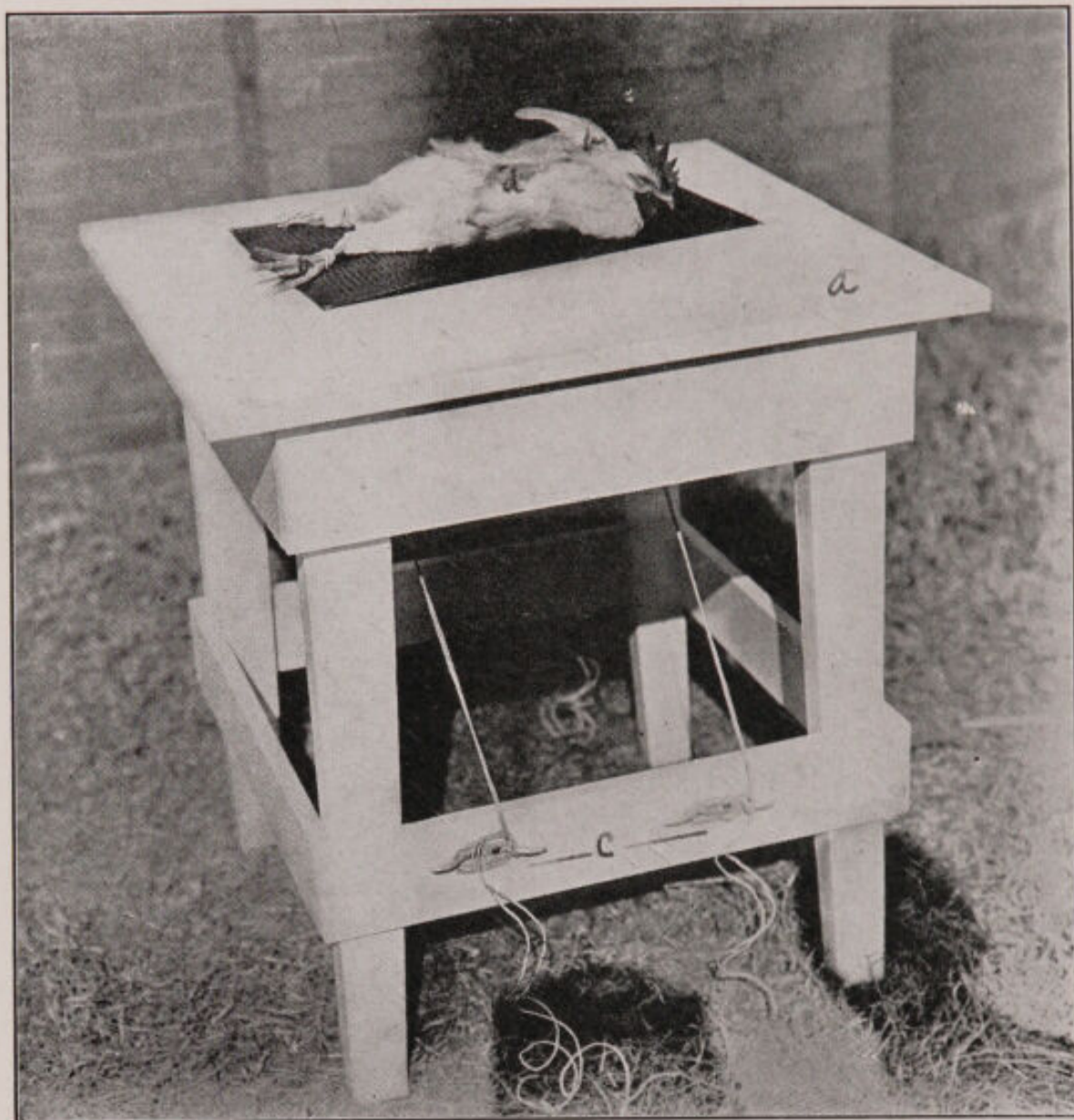


FIG. 76. POULTRY OPERATING TABLE.

Note is made of respirations and eye reflexes as in anesthetizing other animals.

After the limbs are entirely relaxed an assistant holds the bird on its back or it may be tied to the operating table.

A poultry operating table has been designed by the writer. This table consists of a top (a) two feet wide and thirty inches long. This table is provided with four-inch cross-pieces as shown in the cut (c) which are located

about half way from the top to the ground. These cross-pieces are provided with two awning hooks on either side. Holes are bored through the top at suitable locations. The loop of the string is run through the hole on its respective side and over the legs or base of the wings (h) and the legs and wings drawn down snugly to the top and the free portions of the string wrapped around the hook and given a half hitch.

INJURY TO THE STERNUM

If chicks are allowed to roost on small limbs of trees or sharp poles before the breastbone becomes sufficiently ossified

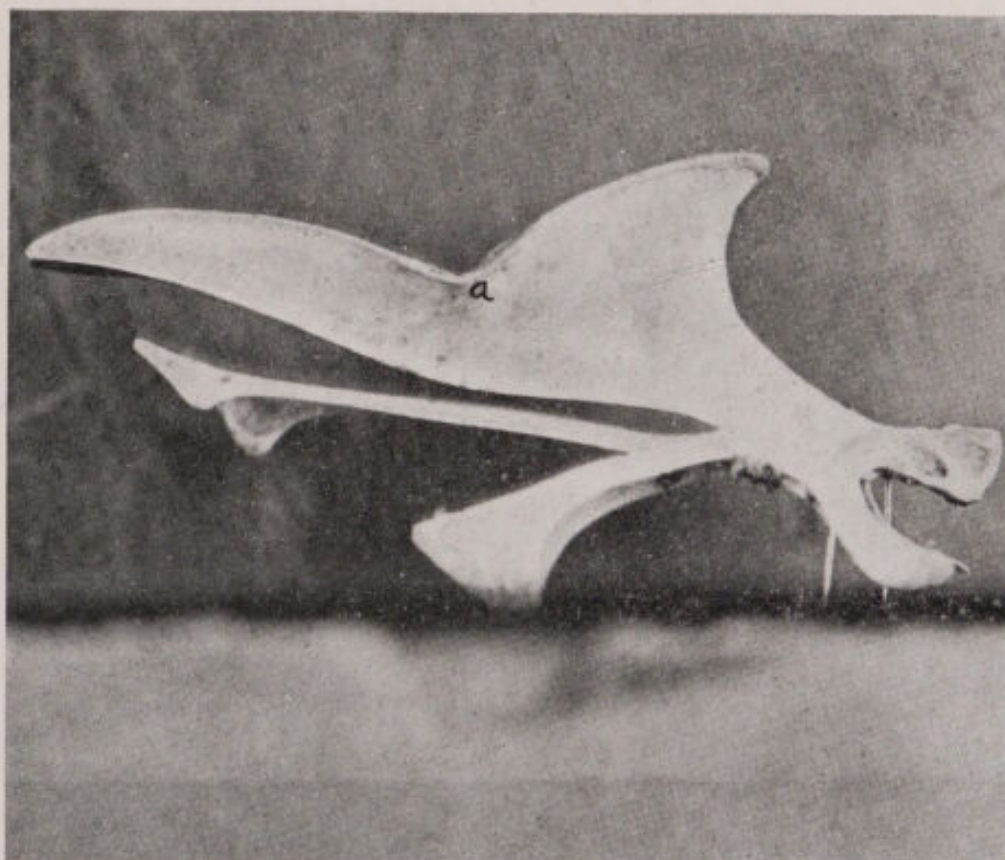


FIG. 77. INJURY TO STERNUM, A RESULT OF ROOSTING ON SOME SHARP OBJECT WHILE QUITE IMMATURE.

there is likely to be a dent or curvature of the free margin. Fig. 77 illustrates this kind of an injury. The dressed carcass from such a bird would bring at least two cents less per pound on the large city markets than if the breast was straight and presented a pleasing appearance.

CURVATURE OF THE SPINE

Eggs should lie on their sides in the incubator. If allowed to stand on end in the last days of incubation there is

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than when the house is tightly closed, because the more free circulation of air allows the watery vapor from the lungs of the birds to disseminate more rapidly and humidity is lessened.

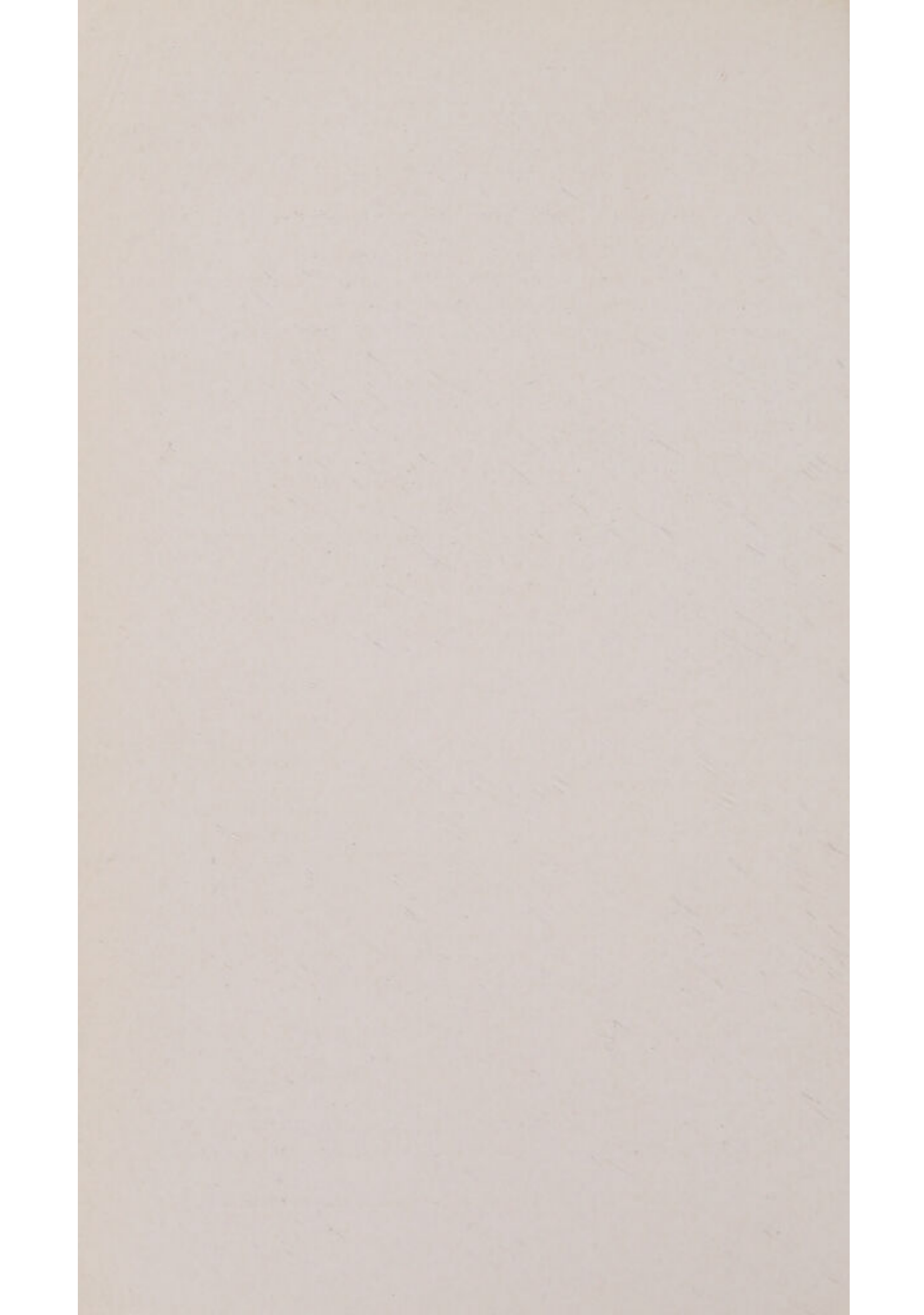
When wattles and comb are frozen, remove the bird to a warmer room but not one heated by a stove. Apply carbolized vaselin twice a day.

BROKEN BEAK

The beak often becomes broken through fighting or some other violence. Such a fowl needs attention. It may starve through its inability to pick up feed or its beak may grow deformed.

The bird should be given feed in such a manner that it can easily pick it up, or the new and developing horny material may become injured. Mash, both wet and dry, given in a cup, is recommended. The cup should not be allowed to become so nearly empty that the bird strikes the bottom with its beak.

Often chicks are hatched with crossed beaks making the act of prehension a difficult one.



SECTION XVIII

CASTRATION OF THE BIRD (CAPONIZING)

There are great possibilities in the more extended practice of capon production. The fact that there is a growing demand, making their value as a meat product superior to that of the cock or cockerel, and the fact that they bring about thirty cents a pound while the uncastrated bird brings only about fifteen cents, together with the fact that they become very much larger, makes this phase of poultry husbandry a productive and remunerative one.

The male bird after the removal of his reproductive organs loses his masculine appearance, becomes sluggish and gains weight rapidly as a result of his inactivity.

From the loss of that internal secretion manufactured in the testes we note that there is the same difference which is observed in other animals under the same treatment. The development of the gelding as compared to the horse and of the barrow as compared to the boar, are some concrete examples.

The same improvement in meat is noted in the castrated or caponized bird as in the steer over the meat of the bull or the meat of the barrow compared with that of the boar, hence capon raising is highly desirable and if properly managed is a profitable undertaking.

A capon of the Plymouth Rock, Wyandotte or Rhode Island Red breed should weigh fully seven or eight pounds when eight months of age.

Light capons are produced from the Rocks, Wyandottes and Reds while the heavy capons are produced from the Brahmas and Cochins.

The cockerel should be caponized when he weighs from one to one and one-half pounds, which will probably be about the eighth to the tenth week.

If the birds are allowed to become too old before operation the testes are found to be very large, the removal of which may prove fatal to the bird. If the birds are hatched from March to May the operation could be performed in the months of June to September and with proper feeding and care these birds should then be ready to market from December to March.

The equipment needed to perform this operation is a table

provided with means of confining the bird on it and instruments consisting of a knife or scalpel with which to make the incision or cut through the abdominal wall, a hook for tearing through the peritoneum or lining of the abdominal cavity, air sac walls and at times through the mesentery and a spreader for holding the wound open while the removal of the testes is accomplished.

The intestines may be pushed to one side by aid of the end of a scalpel.

An improvised table may be made by taking a barrel, using two cords and two weights of sufficient size to hold the bird down, usually about the size of a half brick. The cords are doubled and one is looped around the legs, the other around the base of the wings and a half brick tied to the free ends as shown in Fig. 79.

A poultry operating table designed by the writer consists of a top two feet wide and thirty inches long. This table is provided with four-inch cross pieces, as shown, (Fig. 76) which are located about half way from the top to the ground and provided with two awning hooks on either side. Holes are bored through the top at suitable locations. The loop of each cord is run through the hole on its respective side and over the legs or base of the wings and the legs and wings drawn snugly down to the top and the free end of the cord wrapped around the hook and given a half hitch.

If the bird or birds are to be operated on in the forenoon, no feed should be given on the previous day. It is also well to withhold water as an abundance of water causes more hemorrhage, owing to the increased amount of liquid in the body tissues. It is rather difficult to accurately and satisfactorily operate when the intestines are gorged with feed.

The operation is best performed in the bright sunlight unless the operator is provided with a head reflector.

The instruments should be kept in a shallow pan of antiseptic, as ereolin, or better, formaldehyd solution. A small amount of absorbent cotton should also be at hand. After the bird is confined pluck a few feathers over the field of operation (between the last two ribs). It is well to place a small chunk of ice in the pan of antiseptic and use the ice water in sponging the field of operation. The cold water thus acts as an antiseptic as well as causing a contraction of the capillaries of the region and less hemorrhage will result.

When ready to make the incision pull the skin over so that after the incision is made and the skin released the wound into the abdominal cavity will be closed. In making the incision through the skin the bird will struggle very little. The

knife or scalpel should be very sharp and the incision made quickly to minimize pain. The upper point of the incision should be about one-half inch from the center of the backbone or vertebrae. The incision should be about one inch long. As a nerve, artery and vein pass along the posterior border of each rib, it is necessary not to cut close to the posterior border but make the incision close to the anterior border of the last rib.

A second incision is now made in the same wound, this time cutting through the abdominal muscles. Care must be exercised not to cut too deep and injure the internal organs. If the peritoneum is not cut this can be broken through by aid



FIG. 79. Top of Barrel As An Operating Table.

of the hook and insert the spreaders. Now tear through the walls of the air sac and push the intestines to one side and the uppermost testis will be in plain view. The testis will appear bean-shaped, about one-half inch long and yellowish-white in color. It lies close to the body of the vertebrae and large abdominal blood vessels, being attached by connective tissue. If it is the desire to remove both testes through the one opening it is necessary to tear through the mesentery or web-like membrane supporting the viscera, care being taken not to make the opening too close to its attachment to the vertebrae or fatal hemorrhage may take place as a result of rupturing these delicate vessels.

If the opening has been properly made the lower testis will

be in plain view. Always remove the lower one first as, if the upper one be removed first, some hemorrhage may take place that will make it very hard to find the lower one later. For beginners it is better to operate from both sides, each time removing the upper one.

The testicular tissue is very soft and it is necessary to use great care to remove all of the tissue. If it is crushed it will be very difficult to successfully remove it so that it is necessary that the operation be done with skill. If care is not used often the end of a testis will break off and this part remaining makes a "slip." This small particle will furnish some internal secretion and the bird can be regarded neither as a cockerel nor as a capon. Slips are undesirable. The accidents may be as follows: on account of the testes lying close to the vertebræ in close proximity to the abdominal aorta and other large vessels and the capsule of the testis being attached to them, too much traction or improperly applying the tractors may result in rupture of the vessel and fatal hemorrhage occur at once. If the aorta is ruptured there will be noted a hissing sound and the bird becomes pale in the face and comb and immediately collapses. In this case cut off the head and the bird can be used for food. If the bird is allowed to struggle after the operation a large vessel already injured by the operation may rupture and fatal hemorrhage result.

After the operation if the incision has been properly made no suture is necessary, but if the opening in the abdominal wall be large it is well to take one or two sutures with clean, sterile cotton or silk thread.

After the operation is completed remove the bird as carefully as possible and quietly place in a clean coop or run bedded down with clean straw. Do not allow them in coops or inclosures where they can jump upon boxes, perches or fly, as they must be kept down on the floor for a few days.

Supply the birds with clean, fresh water and give them ground feed mixed with milk as soon as they are placed in their runs. They apparently do not suffer any inconvenience from the operation and will eat heartily immediately after.

On the third day examine each bird to make sure there are no "wind puffs" or emphysematous conditions, that is, air worked under the skin from the edge of the wound or incision. If wind puffs or emphysema is present puncture with clean, sterile, sharp knife and allow the air to escape. Birds have a great resistance against the common germs of wound infection, as staphylococci and streptococci and fatalities from this cause are very rare, if at all.

The wound should be entirely healed in three weeks' time.

Fig. 80 shows a Barred Plymouth Rock capon and a Barred Plymouth Rock cock. Note difference in head and general appearance between the capon and the cock. Capons are usually marketed at about ten months of age.

OVARIECTOMY OF THE PULLET

An unsexed (spayed) pullet is called a poulard. Spayed pullets make more rapid growth without the handicap of egg production, at a later stage, and the meat is of improved quality and flavor. The spayed pullet takes on some of the

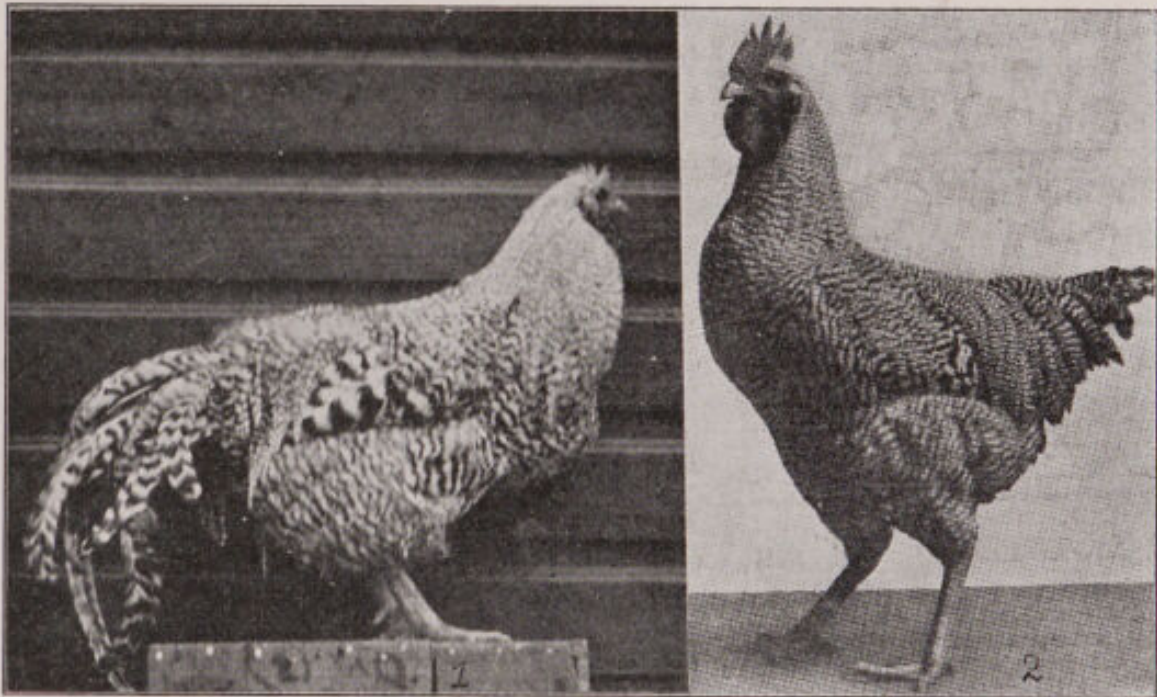


FIG. 80. 1, capon; 2, cock.

appearance of a cockerel. The poulard, like the capon, becomes an outcast and is never known to cackle.

The pullets are usually operated upon at about the same age as in caponizing the cockerel and usually in the late spring or early summer. The pullets are prepared in the same manner as cockerels for caponizing. The incision is made in a similar manner as in the cockerel and the undeveloped egg cluster is found in the pullet in a similar location to that of the testicles in the cockerel. With a pair of artery forceps grasp the undeveloped oviduct, which will be found to be about the size of a broom straw, and remove about one inch of this and the ovary. Care must be taken not to cut or rupture any of the large abdominal blood vessels lying just back of the ovary and against the vertebrae (a similar precaution as in caponizing). The removal of a section of the

oviduct and ovary prevents the further development of the egg canal and functioning of the cells of the canal and the formation of eggs. Pullets that have begun to develop eggs cannot be successfully operated upon.

The after treatment is the same as for capons.

SECTION XIX

FOODS POISONOUS TO FOWLS

THE ROSE CHAFER (*Macrodactylus Subspinosus* Fab.)

In the spring of the year when the grapes are in bloom, large numbers of the common rose-chafers (rose bugs) often appear to feed upon the blossoms and later attacking the young and developing fruit and leaves of the plant. The beetle is about one-third inch long, of a light brown color and is covered by numerous lighter hairs. It is provided with long, spiny legs. This bug may also be found on roses, from which its common name is derived. It may also be found on other shrubs and upon apple, plum, cherry and peach trees. When numerous and its preferable food scarce, it may attack different grasses and grains.

The bug passes through the four stages, namely: ova, larva, pupa and adult.

Lamson has shown that when large numbers are eaten by small chicks death may occur from their poisonous effects in from nine to twenty-four hours. It was found that fifteen to twenty rose chafers were sufficient to kill chicks seven days old in seven days; twenty-five to forty-five proved fatal to chicks twenty-one days old. Chicks over ten weeks old did not die from their effects.

The symptoms usually appear an hour after the bird eats a large quantity of these bugs. The first symptoms noted are those of a dozing attitude, the bird becomes weak, and finally prostrate and is unable to walk. Some may recover from the poison. Occasionally convulsions are noted in the dying chick. The poison appears to be a neuro-toxin. Post mortem does not reveal any lesions.

Prophylactic treatment consists of keeping the young chicks away from parts of the premises that are infested by these bugs.

ARSENICAL POISONING

Arsenical poisoning may occur from the birds drinking spray mixtures containing paris green or other arsenical compounds, from eating rat poison, etc. Cases have been brought to our attention where birds had been poisoned by eating grasshoppers. The grasshoppers had been given arsenic in

bran, and the birds, devouring large numbers of them, became ill, and many of them died.

Symptoms.—Loss of appetite, black comb, dullness, sitting, moping and unsteady gait, increasing weakness, and death. Judging from the effect of poisonous doses of arsenic on higher animals, the poisoned birds must have been in considerable pain, but they did not show it; birds do not manifest pain as other animals do.

Autopsy.—The liver was normal, except that it was a trifle dark in color. There were no noticeable changes in the other abdominal organs, except the intestinal tract. Upon opening the intestines there were noted patches of hemorrhage and areas of congestion and inflammation.

Treatment.—This is scarcely worth while. Demulcent drinks, as water in which slippery elm bark has been soaked, or even milk, are indicated, after a full dose of castor oil.

SALT POISONING

Poisoning among chickens and turkeys from eating common salt or drinking brine is quite common and the losses from it are large. It may occur from eating salt pork, or fish, or from drinking the brine left from freezing ice cream, and in many other ways. The symptoms and treatment vary but little from arsenical and other poisons.

Dr. Geo. H. Glover, Colorado, reports a case in which a lady in baking a cake made a mistake and used common table salt instead of sugar. After the cake was baked and the mistake discovered the young housewife concluded to feed it to her nice flock of chickens, consisting of twenty-three hens and one rooster. All the birds except the rooster died.

It has been determined that twenty-five grains of salt per pound of live weight is sufficient to produce death in birds.

OTHER MINERAL POISONS

Saltpeter poisoning, from eating fertilizer; *phosphorus* poisoning, from eating rat poison; *lead* and *zinc* poisoning, from eating paint, and *copper* poisoning, from drinking bordeaux mixture, have been described; all are infrequent.

PTOMAIN POISONING

Limber neck is one of those convenient generic terms which poultrymen sometimes apply to any ailment in which the bird is too sick to hold up its head. It is a very prominent symptom in all forms of ptomain poisoning.

Cause.—Ptomain poisoning may be due to eating any kind

of food in which putrefaction has set in, but is usually the result of eating decaying meat or fish.

Because of the more favorable conditions for the rapid putrefaction of meat in very hot weather, ptomain poisoning occurs chiefly in mid-summer, and on farms where the fowls have an extended range, including patches of high weeds that effectually conceal dead animals from the caretaker, until the loss of a large portion of the flock compels cutting weeds and a diligent search for the carcass.

The beginning of ptomain poisoning in a flock is usually something like this: During very hot weather a bird dies in the tall weeds, it may be from disease or from violence, and in three or four days its carcass is filled with maggots and in an advanced stage of decomposition; it is found by the other birds and devoured, with the consequent death of many of them, some of them dying in out of the way places and remaining undiscovered by the keeper, and in turn poisoning others, and so on.

Oftentimes the keeper is responsible for the beginning of the trouble by thoughtlessly throwing some small animal which he has killed (opossum, weasel, rat, etc.) where the fowls find it. If the weather conditions are favorable to rapid decomposition, ptomain poisoning in the flock will result and the "vermin" dead will destroy more birds than ten of its kind would destroy during life.

Maggots are usually found in the crops of birds dying from eating putrid flesh, and if the poultryman holds autopsies on the dead birds, he is quite apt to conclude that the maggots have killed them. Such is not the case.

Treatment.—Give a tablespoonful of castor oil and one-fifth grain doses of sulphate of strychnin, the latter every four to six hours.

Experiments have been conducted to determine the exact dosage of strychnin for an average-sized hen. It has been found that the dose should be from one-sixth to one-fifth of a grain three times a day. The author has given one grain repeatedly without ill effect, but when given in solution and on an empty crop it killed the bird.

BOTULISM (Limber Neck)

Dickson has recently reported the results of several outbreaks of botulism among persons and the same condition among fowls where they had eaten some of the same kind of meat. In one case fifty fowls were affected after eating home-canned corn which had caused the death of a woman who had tasted it. In another case between fifty and one hundred fowls became paralyzed and

died at the same time that a woman who cared for them had died of "bulbar paralysis." Eight fowls, in another case, showed the same symptoms and died after eating home-canned string beans which had caused the death of a woman who had tasted them. And in still another case seven fowls died after eating home-canned apricots which had also caused the death of five people.

In all cases in human and fowls the symptoms and the course of intoxication were the same as those of botulism and in the histologic examination of one case, after autopsy, showed the typical thrombosis and hemorrhages which have been shown to be characteristic of the condition. The organism recovered from the fowls were identical in morphological and cultural characteristics to the *Bacillus botulinus*. The toxin from these cultures produced typical symptoms when fed to other fowls. The birds become dull, inactive, refuse to eat, remain quiet; their feathers are ruffled, and the birds gradually become weak. This is manifested in the legs, wings and finally in the neck, so that they are unable to stand; drop the wings; the neck is limber, the beak rests on the floor and finally prostration results. Death usually occurs in less than twenty-four hours after feeding. It has been found that the *Bacillus botulinus* may develop in decaying vegetables so that limber neck due to this organism may be obtained from this source as well as decaying meat.

CORN COCKLE POISONING

Chickens eating large quantities of corn cockle, in ground form, incorporated in their feed in the form of mash, have been poisoned.

The seed contains a poison, sapotoxin, which causes a severe inflammation of the entire digestive tract, including the crop. Great prostration and death follow.

SECTION XX

POULTRY REMEDIES

With the development of veterinary medicine there has come a knowledge of drugs and their applicability to diseases of the domestic fowl. The author has devoted much time and thought, the past few years, in rational medication of fowls and has worked out a dosage based on the physiological tests of the drugs upon healthy fowls and also the application in disease.

The following brief discussion of poultry *materia medica* and its therapeutic application is thought best in this volume.

In medicating birds it will be well either to give the drug by the mouth in capsule or in tablet form, since in a large number of cases the liquids administered as a drench find their way down into the trachea and bad results follow. Liquids may be mixed with mash or soaked in bread in cases where the fowl has not completely lost its appetite or where it does not object to the taste.

The larynx of the fowl is not provided with an epiglottis and, in struggling birds, stands more or less open.

Birds require a comparatively larger dosage to obtain the full physiological results than do mammals. A large amount of unsatisfactory medication of fowls in the past has come about through the lack of rational medication.

Poultry Materia Medica

ALOIN

Source—A neutral principle obtained from aloes.

Properties—Small acicular crystals, in color yellow to yellowish brown; odorless and bitter taste.

Use—Cathartic.

Indication—Constipation.

Dose—For adult fowl, 1 to 2 grains.

AMMONIUM CARBONATE (SMELLING SALTS)

Source—A mixture of ammonium chlorid or sulphate, and calcium carbonate, is sublimed and resublimed.

Properties—White, hard, translucent, striated masses, having a strong ammoniacal odor and a sharp salty taste.

Action—A heart and respiratory stimulant.

Indications—Acute bronchitis, pneumonia or in colds.

Dose—For an adult fowl, 20 grains given in capsule.

ARECA NUT (Betel nut)

Source—From the seed which resembles nutmeg in shape and color.

Properties—A brownish powder.

Action—Destroys intestinal parasites.

Indications—Infestation of intestines with worms, and acts as a cathartic.

Dose—For adult fowl, 5 to 10 grains, given in wet mash.

ARGENTI NITRAS FUSUS (Lunar caustic)

Source—Melted silver nitrate, 3 parts, and potassium nitrate, 6 parts, cast in suitable moulds.

Properties—White, hard, solid pencils which appear finely granular at a broken end.

Action—A caustic.

Indications—The pencil lunar caustic may be used to lightly burn ulcers in the mouth or head as in roup or sorehead.

BARBADOES ALOES

Source—The dried or inspissated juice of the *Aloe vera*.

Properties—A hard mass, orange brown and opaque. Odor, saffron-like and bitter taste.

Action—A cathartic.

Indications—Constipation.

Dose—For adult fowl, 10 to 20 grains.

BELLADONNA FLUID EXTRACT (Deadly Nightshade)

Source—An extract of the leaves of *Atropia belladonna*.

Properties—Blackish-brown liquid of characteristic odor.

Preparations—Extract; fluid extract and tincture.

Action—A stimulant. Lessens mucous secretions. Small doses do not affect respiration but large doses make breathing quicker and deeper.

Indications—Acute inflammation of the air passages as bronchi and lungs.

Dose—To adult hen, five drops, repeated every three hours. May be dropped in mouth by aid of medicine dropper.

CARBO LIGNI (Wood Charcoal)

Source—Soft wood is charred by piling it in a heap, igniting, and covering it with sand and dirt to prevent rapid combustion.

Properties—A black, odorless and tasteless powder or bits, free from gritty matter.

Action and Indications—It is indicated in indigestion, chronic gastritis, and intestinal catarrh and diarrhea.

How Given—May be kept in compartment of dry mash hopper where the birds have access to it. Use large size pieces for adult fowls and chick size for smaller ones.

CASTOR OIL

Source—A fixed oil expressed from the castor oil bean.

Properties—A pale, yellowish and almost odorless, transparent viscid fluid and possessing an offensive taste.

Use—A cathartic.

Indications—Constipation.

Dose—One tablespoonful to each four fowls. May be given in wet mash.

CHLOROFORM

Source—Alcohol and water are heated in a still to 37.7° C., when chlorinated lime is added and chloroform is evolved.

Properties—A heavy, clean, colorless, mobile and diffusible liquid of a characteristic ethereal odor, and a burning sweetish taste.

Action—Anesthetic.

Use—It is used as an anesthetic in preparing birds for operation. Chloroform and ether are an excellent combination for anesthetic purposes.

COAL-TAR DISINFECTANT DIPS (Standardized)

Source—Coal tar distillation products, the active principles of which are cresols and hydrocarbons.

Properties—They are a rather thick, black tarry liquid which turns the water a milky color, due to the soapy emulsion that results upon the addition of the water.

Use—A destroyer of germs and parasites.

How Used—If the product so standardized has a coefficient of 5, then a two per cent solution in water (one ounce or two table-spoonfuls to each two quarts of water) should be used for spraying purposes for parasites and germs.

CONVALLARIA (Fluid Extract) (Lily of the Valley)

Source—An extract of the plant.

Preparations—Extract, fluid extract and tincture.

Action and Indications—Similar to digitalis.

Dose—For adult fowl, ten to twenty drops.

CREOLIN

Source—Obtained from soft coal by dry distillation, its composition is very complex. It is said to contain cresol and higher homologues of phenol.

Properties—A dark-brown syrupy, alkaline liquid of a tarry taste and odor.

Action—A powerful disinfectant, antiseptic and parasiticide.

Use—As a spray for poultry houses and equipment use one to five ounces to each gallon of water.

DIGITALIS (Fluid Extract) (Fox Glove)

Source—From the leaves of digitalis.

Preparations—Extract, fluid extract and tincture.

Action—It strengthens the heart beat.

Indications—It has a tendency to correct the rapid, weak, irregular pulse.

Dose—For adult hen ten to twenty drops.

ETHER (Sulphuric Ether)

Source—Obtained by distillation of alcohol with sulphuric acid.

Properties—A transparent, colorless, mobile liquid, having a characteristic odor and a burning, sweetish taste.

Action—To produce anesthesia.

Use—It is used as an anesthetic in preparing for operations on birds.

EUCALYPTUS, OIL OF

Source—A volatile oil distilled from the leaves of the eucalyptus tree.

Properties—A colorless or faintly yellowish liquid. It has a characteristic aromatic odor, and a pungent, spicy and cooling taste.

Action—It is an antiseptic and disinfectant, being three times as effective as carbolic acid.

Indications—Catarrhal conditions of the nasal mucous membranes, and mucous membranes of trachea and bronchi.

Use—As a steam inhalation or as a spray or injection in catarrh and roup combined with other drugs, as follows:

Oil of eucalyptus.....	20 drops
Oil of thyme.....	1 dram
Menthol	10 grains
Oil petrol.....	2 ounces
Mix and inject into nasal passage.	

FERROUS SULPHATE (Copperas, green vitriol)

Source—Iron wire is dissolved by boiling in diluted sulphuric acid.

Properties—Large, pale, bluish green, monoclinic prisms, without odor and having a salty taste. Changes to a fine powder on being exposed to air.

Action—Externally it is an astringent and stimulant.

Indications—In a solution of one ounce to one gallon of water for wounds of any kind in the fowl.

FORMALDEHYD (Formic aldehyd)

Source—Obtained by partial combustion of wood alcohol, without ignition, by evaporation of the spirit in contact with a hot, platinized, asbestos plate.

Properties—A pungent gas. Sold in aqueous solution (40 per cent gas in water). It is very volatile.

Uses—A strong disinfectant. Used in about the same dilution as lysol for disinfecting purposes.

GENTIAN, POWDERED

Source—Obtained from the gentian roots.

Properties—A yellowish brown powder possessing a bitter taste.

Action—Improves the appetite and stimulates digestion.

Indications—Indigestion, loss of appetite and malnutrition.

Dose—Same as for ginger, which see.

GINGER, POWDERED (Zingiber)

Source—From the roots of the Zingiber officinale.

Properties—A yellowish-brown powder with bitter taste.

Action—A bitter tonic.

Indication—Indigestion, loss of appetite, malnutrition.

Use—Combined for tonic with other drugs, as follows:

Powdered ginger.....	2 ounces
Powdered gentian.....	2 ounces
Powdered nux vomica.....	2 ounces

Mix one teaspoonful to each twelve fowls. Given twice daily in wet mash.

GLYCERIN

Source—A liquid obtained by the decomposition of vegetable or animal fats or fixed oils.

Properties—A clear, colorless liquid of a thick, syrupy consist-

ency, oily to the touch, odorless, very sweet and slightly warm to the taste.

Action—Its affinity for water causes it to keep moist the surface to which it is applied.

Indication—Inflammation or injury of the mouth, pip, stomatitis.

HYDROCHLORIC ACID (Muriatic acid)

Source—From a distillation of sulphuric acid, sodium chlorid and water. The resulting gas is passed into distilled water.

Properties—A colorless, fuming liquid of pungent odor, and an intensely acid taste.

HYDROCHLORIC ACID (Dilute)

Made by taking 100 parts concentrated hydrochloric acid, 219 parts distilled water.

Action—It aids digestion by stimulating the formation of secretin in the stomach and intestines and excites the activity of all the glands giving rise to the secretions concerned with digestive activity.

In concentrated form is caustic.

Indication—Indigestion.

Dose—One tablespoonful to each gallon of drinking water.

LINSEED OIL

Source—A fixed oil expressed from linseed or flaxseed.

Properties—A yellowish, oily liquid, peculiar odor and bland taste.

Use—A cathartic.

Indication—Constipation.

Dose—One tablespoonful to each six fowls. May be given in wet mash. Raw oil must be used.

LYSOL

Source—From that part of tar oil which boils between 190° and 200° C., by dissolving in fat and saponifying in alcohol.

Properties—A clear, brown, oily liquid of a feeble creosote-like odor.

Action—Destroys germs and parasites.

Use—One-half to two per cent solution in water to disinfect water or feed containers and to spray houses.

MAGNESIUM SULPHATE (Epsom Salts)

Source—It is obtained from native dolomite, a double carbonate of magnesium and calcium.

Properties—Small, colorless, rhombic prisms, without odor, and having a cooling, saline and bitter taste. Slowly becomes a fine powder in dry air.

Action—A hydrogogue cathartic. A feeble diuretic.

Indications—Constipation.

Dose—For adult as a mild laxative, one tablespoonful to each twelve fowls. Best given in solution in water and this mixed with dry mash. One teaspoonful given by the mouth in solution will produce action in about four hours.

MENTHOL (Peppermint Camphor)

Source—Obtained from the official oil of peppermint.

Properties—Colorless, acicular or prismatic crystals. It possesses a strong, pure odor of peppermint.

Action—Allays irritation.

Indication—Catarrh of the head.

Use—Same as oil eucalyptus, which see.

MERCURIC CHLORID, CORROSIVE (Corrosive Sublimate)

Source—A heated mixture of mercuric sulphate 20 parts, sodium chlorid 16 parts, manganese dioxid 1 part.

Properties—Heavy, colorless, rhombic crystals, odorless, and having an acrid or persistent metallic taste. Permanent in air.

Action—A severe caustic.

Indications—May be used in contagious bowel diseases in fowls in drinking water. To each gallon of water add 6 grains mercuric bichlorid and 3 grains citric acid. It may be used in a solution of one, to one-thousand, as a disinfectant.

MERCURIC CHLORID (Mild) (Calomel)

Source—Heat mercurous sulphate and sodium chlorid. Calomel sublimes.

Properties—A white, impalpable powder; odorless and tasteless. permanent in the air. Insoluble in water.

Action—A cathartic.

Dose—For adult fowl, 3 to 5 grains.

NAPHTHALENE (Naphtalin)

Source—A hydrocarbon obtained from coal tar by distillation between 356° F. and 482° F. The impure naphtalin resulting is treated with sulphuric acid and sodium hydroxid, and is further purified by distillation with steam, and then by a mixture with strong sulphuric acid and finally by distillation.

Properties—Colorless, shining, transparent laminae, having a strong characteristic odor resembling that of coal tar, and a burning aromatic taste. It is slowly volatilized on exposure to air.

Action—An excellent destroyer of parasites.

Uses—As a powder in nests to destroy lice. Dissolved in kerosene (from 5 to 10 per cent) to saturate perches to kill mites. Five per cent in vaselin as an ointment in scaly legs. This ointment gives good results in sore head.

NUX VOMICA (Powdered)

Source—From the seed of the *Nucis vomicae*.

Indications—Indigestion, paralysis, loss of appetite.

Action—Powdered nux vomica is a bitter tonic, increasing the appetite, gastric secretion, and motion. A nerve stimulant.

Dose—For adult fowl, ten to twenty grains, repeated three times a day. May be given in capsule or doughball. As a tonic, one-half ounce in mash to each 12 hens. Twelve "stroke measure" teaspoonfuls of nux vomica make one ounce.

PETROL OIL

A neutral thick oil used as a vehicle in which to mix liquid preparations.

PETROLATUM (Vaselin, cosmolene)

Source—A mixture of hydrocarbons, chiefly of the marsh gas series, obtained by distilling off the higher and more volatile portions from petroleum and purifying the residue when it has the desired consistency.

Properties—A colorless or more or less yellowish, oily transparent liquid, without odor or taste; or giving off when heated, a faint odor of petroleum.

Use—As a vehicle for other drugs in the preparation of ointments.

PHENOL (Carbolic Acid)

Source—Obtained from crude carbolic acid by agitation with caustic soda, heating to 338° F. and adding hydrochloric acid; then by agitation with sodium chlorid, digestion with calcium chlorid and distillation at a temperature between 336° and 374° F. and finally by crystallization, phenol results.

Properties—Colorless, interlaced or separate, needle-shaped crystals, or a white crystalline mass, sometimes acquiring a reddish tint. It has a characteristic and somewhat aromatic odor and when it is greatly diluted with water has a sweetish taste. It goes into solution with a very small amount of water.

Action—An antiseptic, and in five per cent solutions it is a parasiticide.

Use—As an intestinal antiseptic, use one to two teaspoonfuls to each gallon of water. As a spray for poultry houses, use one to five ounces to the gallon of water.

PODOPHYLIN (May apple)

Source—Obtained from the roots of the may apple.

Properties—A fine non-crystallizable powder. It is yellowish in color and possesses a peculiar, faintly bitter taste.

Action—A powerful, though slow, acting cathartic. In experiments on baby chicks, one-eighth grain doses proved fatal in 42 out of 43 tests.

Indications—Constipation.

Dose—For adult fowl, one-fourth grain.

POTASSIUM DICHROMATE

Properties—It is a reddish-yellow crystalline potash product.

Use—A pale, straw-colored solution in water is astringent and is indicated in sore throat or sore mouth.

POTASSIUM PERMANGANATE

Source—Caustic potash, chlorate of potassium and black oxid of manganese are fused together.

Properties—Slender, monoclinic prisms, of a dark purple color, odorless, and having a taste first of sweet but afterwards disagreeable and astringent. Permanent in dry air.

Action—An intestinal antiseptic.

Indications—In contagious bowel diseases, as fowl cholera. Make drinking water lightly purple. About one ounce to four gallons of water.

PYRETHRUM (Persian insect powder)

Source—The powdered flowers of *Pyrethrum roseus*.

Properties—A coarse, greenish-yellow, pungent powder.

Use—Destroys fleas and lice.

Indication—May be used to dust in nests and on birds for lice. Only the pure product will give satisfactory results, and too liberal quantities should not be employed. Some depressing results have been observed when used too freely upon birds.

QUININ SULPHATE

Source—Obtained by boiling cinchona bark with hydrochloric acid and adding lime to the filtered decoction.

Properties—White, silky, light and fine needle-shaped crystals, with bitter taste.

Action—Retards metabolism and thus lessens the production of heat in the tissues. It dilates the vessels of the skin and therefore induce loss of heat.

Indications—Cold, bronchitis and pneumonia.

Dose—For adult fowl, 2 to 3 grains three times daily.

SANTONIN

Source—A neutral principle obtained from santonica. Santonica is derived from worm seed.

Properties—A colorless, flattened, prismatic crystal, odorless and almost tasteless.

Action—Destroys intestinal parasites.

Indications—Infestation of intestines with worms.

Dose—For adult fowls, one-fourth grain.

SODIUM CHLORID (Common or table salt)

Source—Mined in native state or obtained by evaporation of brine, spring or sea water.

Properties—Colorless, transparent, cubical crystals or a white crystalline powder with salty taste, permanent in dry air.

Action—Essential constituent of the food, since it is necessary to the composition of hydrochloric acid in the gastric juice and of blood plasma, from which it is constantly eliminated in the urine. Herbivorous and grain-eating animals require sodium chlorid in addition to that contained in their food. While the blood is rich in sodium salts, vegetables are particularly rich in potassium salts.

Birds deprived of salt suffer from anemia and general weakness. Birds cannot tolerate large doses of table salt.

Use—The mash should contain from one-half to one pound to each one hundred pounds of mash, and this should be thoroughly mixed.

SODIUM SULPHATE (Glauber, salts)

Source—The neutralized residue left in the manufacture of hydrochloric acid from salt with sodium carbonate.

Properties—Large, colorless, transparent monoclinic prisms or granular crystals, odorless and possessing a bitter, salty taste. Upon exposure to the air it gradually becomes a fine powder and loses its water of crystallization.

Action—A cathartic producing a watery stool.

Dose—One tablespoonful to each 12 adult fowls. Younger birds in proportion. It is best given dissolved in water and this mixed with mash. It is dangerous to attempt to pour liquids down the throat of birds, as there is great danger of their passing into the superior larynx and lungs. By looking into the throat of a bird while holding the mouth open one can observe the entrance into the air passage open and close.

Indications—Constipation.

STRYCHNIN SULPHATE

Source—The alkaloid (an active principle of nux vomica). Strychnin sulphate is formed by the action of sulphuric acid on strychnin.

Properties—Colorless, transparent, octohedral or prismatic white crystalline powder. Odorless and with an intensely bitter taste.

Action—A nerve stimulant.

Indications—Paralysis.

Dose—For adult fowl, one-fifth grain twice to three times daily.

SULPHOCARBOLATES OF CALCIUM, ZINC AND SODIUM

Source—The action of sulphuric acid and carbolic acid on metallic zinc, sodium or calcium.

Properties—A white, crystalline powder.

Use—In diarrhea, as an intestinal antiseptic.

Dose—Of the mixture of equal parts of sulphocarbolate of calcium, sodium and zinc, dissolve thirty grains in a pint of water and use as drink or with which to mix mash.

SULPHUR SUBLIMATUM (Sulphur)

Source—Obtained from native sulphur by sublimation.

Properties—A fine, yellow powder, having a slightly characteristic odor and a faintly acid taste.

Action—Dissolved sulphur as in the lime and sulphur dip (7 pounds unslaked lime, 21 pounds sulphur, 100 gallons water) is an excellent destroyer of parasites. In a dry state it has no effect upon mites and perhaps none on lice.

THYME OIL

Source—A volatile distillate from the *Thymus vulgaris*; source of thymol.

Properties—A thin liquid of characteristic odor.

Use—In catarrhal conditions.

THYMOL

Source—A phenol occurring in the volatile oil of thyme.

Properties—Large, colorless, translucent crystals of the hexagonal system.

Action—Destroys intestinal parasites.

Indications—Infestation by round worms.

Dose—For adult fowl, three grains, followed by a physic.

TOBACCO

Properties—From a golden yellow to a chestnut brown, containing an active principal, nicotin.

Use—Nicotin is very destructive to parasites, as lice and mites. Tobacco stems and leaves have no effect upon them. Dry leaves and stems in nests are useless. A decoction made by boiling tobacco stems or leaves in water is destructive to parasites and contains nicotin in solution. As a spray, nicotin in one-fourth of one per cent solution will destroy parasites.

WORM SEED, OIL OF

Source—Obtained from santonica.

Properties—A volatile oil, yellowish in color with characteristic odor.

Action—Destroys worms.

Indications—Intestinal worms.

Dose—For adult fowls, one teaspoonful to each twelve birds.

ZINC SULPHATE

Source—Prepared by dissolving metallic zinc in sulphuric acid.

Properties—Colorless, transparent, rhombic crystals, without odor and having an astringent, metallic taste. Changes to a fine powder when exposed to dry air.

Indications—One per cent solution in distilled water and two or three drops in the eye in case of inflammation (conjunctivitis).

INDEX

A		Page		Page
Abdomen, purulent inflammation			Appetite depraved	106
of the	130		Argas miniatus	82
Abdominal cyst	162		Arsenic, poisoning from	227
Abdominal tumor	161		Arthritis, infectious	189
Abnormal eggs	155		Articular inflammation, infec-	
Abortion in birds, epizootic	157		tious	189
Abscess of the foot	190		Ascaris inflexa	87
Abscesses of the liver	151		Ascites	129
Acanthia inodora	83		Aspergillosis	85, 152, 172
Acanthocephala	98		Aspergillus fumigatus	85, 152, 172
Achorion schoenleinii	84		Aspergillus glaucus	85
Actinomycosis	147		Asthenia	141
Adenoma	164		Asthma	169
Adrenal glands, anatomy of the	32		Asthma of canaries	185
Air sac disease	74		Auditory nerve, paralysis of the	198
Air sacs, anatomy of the	31		Autopsy, mode of performing	63
Air sacs, inflammation of the	182			
Ameba meleagridis	111		B	
Amyloid degeneration	152		Bacillus avisepticus	106
Anatomy of the adrenal glands	32		Bacillus botulinus	230
Anatomy of the air sacs	31		Bacteria of eggs	203
Anatomy of the carotid glands	32		Bacteria of the intestinal tract	201
Anatomy of the circulatory sys-			Bacterium asthene	141
tem	32		Bacterium pullorum	119
Anatomy of the cloaca	26		Bacterium sanguinarium	134
Anatomy of the digestive tract	22		Baldness of canaries	86
Anatomy of the esophagus	23		Beak, broken	219
Anatomy of the eyes	38		Beak, obstruction of the	101
Anatomy of the female repro-			Bedbug of poultry	83
ductive organs	42		Bee stings	84
Anatomy of the gizzard	24		Bile ducts, inflammation of the	151
Anatomy of the head	17		Birds, lice of	65
Anatomy of the kidneys	50		Blackhead	111
Anatomy of the large intestine	25		Blastomycosis of geese	128
Anatomy of the larynx	29		Blood diseases	133
Anatomy of the liver	26		Blood of normal fowl	34
Anatomy of the limbs	20		Blood tumors	160
Anatomy of the lungs	30		Blood vessels, rupture of the	140
Anatomy of the male reproduc-			Bone, reparative processes of	212
tive organs	48		Bones, structure of	211
Anatomy of the mouth	22		Botulism	229
Anatomy of the nasal cavities	28		Brain, diseases of the	195
Anatomy of the neck	17		Brain, hemorrhage of the	195
Anatomy of the nervous system	35		Bronchitis	169
Anatomy of the organs of hear-			Buildings and runs	54
ing	39		Buildings, disinfection of	57
Anatomy of the organs of smell	40			
Anatomy of the organs of special			C	
sense	38		Calculi	130
Anatomy of the organs of taste	40		Canaries, asthma of	185
Anatomy of the organs of touch	40		Canaries, baldness of	86
Anatomy of the pancreas	28		Canaries, cholera of	135
Anatomy of the pharynx	23		Canaries, infectious necrosis of	135
Anatomy of the respiratory tract	28		Canaries, intestinal diseases of	131
Anatomy of the small intestine	25		Canaries, intestinal worms of	99
Anatomy of the spleen	28		Canaries, respiratory troubles of	184
Anatomy of the stomach	24		Canaries, septicemia of	135
Anatomy of the thymus gland	32		Canaries, septicemic diseases of	135
Anatomy of the trachea	30		Canaries, typhoid of	135
Anatomy of the trunk	19		Canary louse, gray	67
Anatomy, visceral	22		Canary mite	68
Anesthesia of the fowl	215		Caponizing	221
Angiocholitis	151		Carotid glands, anatomy of the	32
Aphtha	84		Castration	221
Apoplectiform septicemia	133			

	Page		Page
Catarrh	167	Dispharagus nasutus	94
Catarrh, nasal	182	Dispharagus spiralis	94
Catarrh of the crop	105	Disposal of sick and dead birds ..	62
Cercomonas hepatis	127	Dizziness	195
Cercomoniasis	152	Drepanidotaenia infundibulifor-	
Chick, umbilical hernia of the ..	209	mis	96
Chicken cholera	106	Ducks, coccidiosis in	126
Chickenpox	173	Ducks, infectious articular in-	
Chickens, apoplectiform septi-		flammation in	189
cemia in	133	Ducks, inflammation of the eyes	
Chickens, sleeping sickness of ..	135	in	180
Chigger infestation	76	Ducks, lice of	67
Choanota infundibuliformis	96	Dwarf eggs	156
Cholecystitis	151	Dysentery	117
Cholera	106		
Cholera of canaries	135		
Circulatory system, anatomy of			
the	32		
Cloaca, anatomy of the	26		
Cloaca, prolapse of the	155		
Cloacitis	128		
Coccidiosis in wild ducks	126		
Coccidiosis, renal	127		
Coccidium avium	127		
Coccidium tenellum	119		
Cochlear nerve, paralysis of the ..	198		
Colds	167		
Comb, white scale of the	85		
Combs, frozen	218		
Congestion of the liver	150		
Congestion of the lungs	170		
Conjunctivitis	183		
Constitutional diseases	141		
Contagious epithelioma	163		
Contagious inflammation of the			
air sacs	182		
Contagious nasal catarrh	182		
Copper, poisoning from	228		
Cornea, ulceration of the	184		
Coryza avium contagiosa	182		
Crop, catarrh of the	105		
Crop bound	103		
Crop, enlarged	105		
Crop, gangrene of the	105		
Crop, gaseous	104		
Crop, impaction of the	103		
Crop, pendulous	105		
Crop, tympany of the	104		
Croupous inflammation of the			
pigeon	124		
Curvature of the spine	217		
Cuticular surface, horny growths			
on the	166		
Cyst, abdominal	162		
Cystic ovary	160		
Cytodites nudus	75		
D			
Davainea echinobothrida	98		
Davainea tetragona	97		
Dermanyssus avium	79		
Dermanyssus gallinae	79		
Diarrhea, non-specific	117		
Diarrhea, white	119		
Digestive tract, anatomy of the ..	22		
Digestive tract, diseases of the ..	101		
Diphtheric inflammation of the			
eyes	180		
Diphtheric roup	174		
Dipygus tetrabrachium	207		
Disinfection	57		
Disinfection of buildings	57		
Disinfection of yards	61		
Dispharagus laticeps	94		
		E	
		Echinorhynchus polymorphus	98
		Egg bound	153
		Egg, composition of the	203
		Egg shell, composition of the	203
		Eggs, abnormal	155
		Eggs, animal parasites in	203
		Eggs, bacteria of	203
		Eggs, dwarf	156
		Endocarditis	139
		Enteritis	117
		Enterohepatitis	111
		Epilepsy	195
		Epithelioma	165
		Epithelioma, contagious	163
		Esophagus, anatomy of the	23
		Eversion of the oviduct	153
		Eyes, anatomy of the	38
		Eyes, diphtheric inflammation of	
		the	180
		F	
		Face, white scale of the	85
		Fatty degeneration of the liver ..	149
		Fatty infiltration of the liver ..	149
		Feathers, anatomy of the	40
		Filaria tite	94
		Fleas	80
		Flukes	99
		Foods poisonous to fowls	227
		Foot, abscess of the	190
		Foot mange	72
		Fowl cholera	106
		Fowl pest	136
		Fowl typhoid	134
		Fracture of bones, repair of the ..	211
		Fractures	211
		Fractures, treatment of	214
		Frozen combs	218
		Fungi affecting birds	84
		G	
		Gangrene	218
		Gangrene of the crop	105
		Geese, blastomycosis of	128
		Geese, infectious articular in-	
		flammation in	189
		Geese, inflammation of the air	
		sacs in	182
		Geese, lice of	67
		Geese, renal coccidiosis of	127
		Geese, septicemia of	133
		Gizzard, anatomy of the	24
		Gizzard, suppurative inflamma-	
		tion of the	130
		Going light	141
		Goniocotes gigas	66

	Page
Goniocotes hologaster	66
Goniodes dissimillia	66
Goniodes stylifer	66
Gout	191

H

Head, anatomy of the.....	17
Hearing, anatomy of the organs of	39
Heart, hypertrophy of the.....	140
Heart, rupture of the.....	140
Hematoma	160
Hemorrhage of the brain.....	195
Hepatitis, protozoal	127
Hernia of the baby chick, um- bilical	209
Heterakis compressa	93
Heterakis differens	93
Heterakis maculosa	94
Heterakis papillosa	89
Heterakis perspicillum	87
Honey-comb ringworm	84
Horny growths on the cuticular surface	166
Hypertrophy of the heart.....	140

I

Impaction of the crop.....	103
Impaction of the intestines.....	104
Infectious leukemia	134
Infectious necrosis of canaries.....	135
Inflammation, articular	189
Inflammation of the abdomen.....	130
Inflammation of the air sacs.....	182
Inflammation of the bile ducts.....	151
Inflammation of the eyes in ducks	180
Inflammation of the gizzard.....	130
Inflammation of the liver.....	151
Inflammation of the lungs.....	171
Inflammation of the oil gland.....	157
Ingluvitis	105
Injury to the sternum.....	217
Intestinal tract, bacteria of the.....	201
Intestines, anatomy of the.....	25
Intestines, impaction of the.....	104

J

Jaundice	152
Jigger or red mite.....	76

K

Kidneys, anatomy of the.....	50
Kidneys, coccidiosis of the.....	127

L

Large intestine, anatomy of the	26
Larynx, anatomy of the.....	29
Lead, poisoning from.....	228
Leg weakness.....	187
Legs, scaly	72
Leukemia, infectious	134
Leukemia, myeloid	134
Lice, life history of.....	68
Lice of birds.....	65
Lice of canaries.....	67
Lice of ducks.....	67
Lice of geese.....	67

	Page
Lice of pigeons.....	67
Lice of turkeys.....	66
Limber neck	229
Limbs, anatomy of the.....	20
Lipeurus baculus	67
Lipeurus infuscatus	66
Lipeurus jejunos	67
Lipeurus polytrapezius	67
Lipeurus squalidus	67
Liver, abscesses and tumors of the	151
Liver, anatomy of the.....	26
Liver, congestion of the.....	150
Liver, diseases of the.....	149
Liver, fatty degeneration of the.....	149
Liver, fatty infiltration of the.....	149
Liver, inflammation of the.....	151
Liver, rupture of the.....	150
Louse infestation, dealing with.....	69
Louse infestation, effects of.....	69
Lungs, anatomy of the.....	30
Lungs, congestion of the.....	170
Lungs, inflammation of the.....	171
Lymph vessels	35

M

Macroductylus subspinosus Fab.....	227
Malformations	207
Mange, foot	72
Materia medica	231
Menopon biseriatum	65
Menopon obscurum	67
Menopon pallidum	65
Monocercomonas gallinarum.....	152
Mouth, anatomy of the.....	22
Mouth, sore	103
Mycosis of pigeons.....	85
Myelitis	196
Myeloid leukemia	134

N

Nasal catarrh, contagious.....	182
Nasal cavities, anatomy of the.....	28
Neck, anatomy of the.....	17
Nephritis	129
Nerves, diseases of the.....	195
Nervous system, anatomy of the	35
Nodular tapeworm disease.....	97
Notocotyle verrucosum	99

O

Obstruction of the beak.....	101
Obstruction of the oviduct.....	153
Obstruction of the trachea.....	167
Oidium albicans	84
Oil gland, inflammation of the.....	157
Organs of locomotion, diseases of the	187
Organs of special sense, anat- omy of	38
Osteoma	165
Ovariectomy	225
Ovary and oviduct, diseases of the	153
Ovary, cystic	160
Ovary, multiple tumors of the.....	160
Oviduct, broken eggs in.....	155
Oviduct, obstruction of the.....	153
Oviduct, prolapse or eversion of the	153
Oviduct, rupture of the.....	154

Unable to display this page

V

	Page
Vertigo	195
Vestibular nerve, paralysis of the	198
Visceral anatomy	22

W

Warts	166
Water supply	56
Wattles, white scale of the.....	85
White diarrhea	119
White scale of the comb, face and wattles	85
Wild ducks, coccidiosis in.....	126

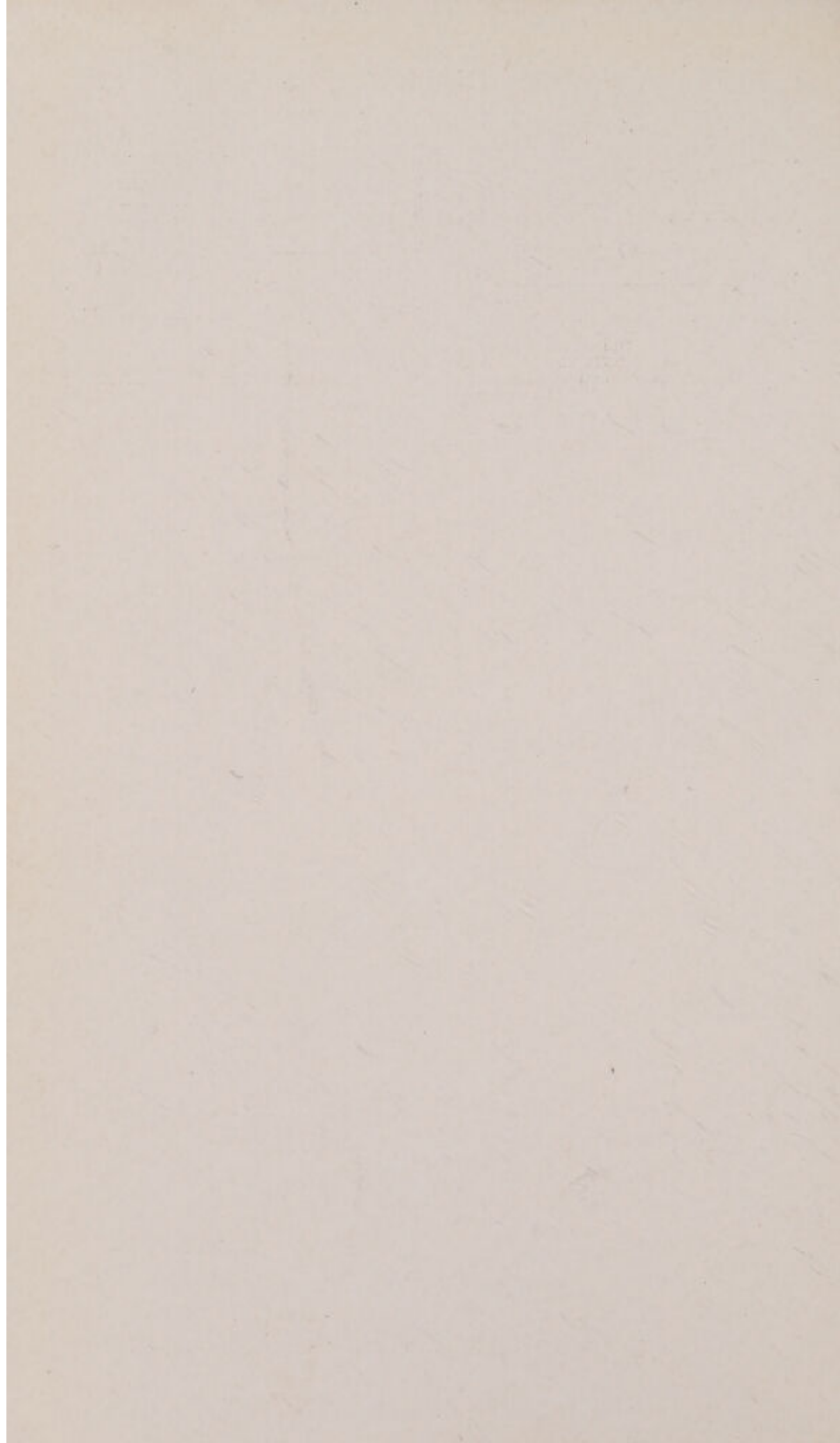
	Page
Wings, paralysis of the.....	189
Worms, eradication of.....	91
Worms, flat segmented.....	94
Worms of canaries.....	99
Worms, round.....	87
Worms, thorn-headed.....	98
Wounds.....	215

Y

Yards, disinfection of..... 61

Z

Zinc, poisoning from.....228





Unable to display this page

