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Report of the Zoologist

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REPORT OF THE ZOOLOGIST.

HENRY B. WARD, PH.D.

In the report of last year was given a full summary of the present state of our knowledge concerning the parasites of man and the domestic animals. It is the intention of the following pages to review the parasitic fauna of the state of Nebraska so far as it is definitely determined, and also to include a list of some species reported but not accurately identified. The second section of this report presents a brief description of some important parasites not included in the group of worms, and hence not mentioned in last year's report. I shall omit all parasites, both internal and external, which are found in the group of insects, since these belong properly to the Entomologist of the Board, and are being discussed by Professor Bruner in another part of this volume. There remains, then, for consideration the group of microscopic parasites, the Protozoa, and the peculiar family of the Linguatulidae. The third section of the report will include a brief account of some of the most important parasites of domestic birds which were not mentioned last year. It is my intention at some later time to give a full account of the parasites peculiar to this important group of farm animals. But the species described here are so peculiarly important that they demand immediate attention.

I. Parasites Reported from Nebraska.

The number of parasites of man or some one of the domestic animals which up to the present time have been accurately identified and reported within the limits of this state, is noticeably small. In the report of last year I was able to cite but eight. Since then there have been nine others identified, making a total for the state of only seventeen. This small number is due in part to the extremely dry weather, which has been unfavorable to the development of parasites, but even under these conditions the list is yet far from a complete record for the state. In the first place, collections have been made only in a comparatively limited area, and, in the second place, I have received definite information of the abundant presence at various points of certain parasites, of which no specimens have been sent me, and which can hence be identified merely with some degree of probability. It should be remembered that no description is sufficient for the positive determination of a parasite, and that definite information with reference to the species can be given only on receipt and careful examination of specimens in alcohol. For such specimens, together with full information as to their source, I shall be

greatly indebted, and will gladly pay the expense connected with sending them to the University. The large majority of the parasites in the appended list were obtained in the immediate vicinity of Lincoln, and all but one were identified by me personally. Among the collections of parasites obtained within the year were those which represent particularly three important hosts: man, dog, and rabbit.

Several specimens of human tapeworms have been sent me, and have been subjects of careful investigation. There is among them one well-known species, the *Taenia saginata*, which according to the investigations of Stiles, of the U. S. Bureau of Animal Industry, is the most common tapeworm in this country. Among the specimens of tapeworm, however, were two—one of those were without the head—that evidently were the same form; these do not appear to belong to any known species, so far as can be seen at present. In general appearance this form resembles the *Taenia saginata*, although the ripe segments are much longer and more slender. At the same time the uterus presents a considerably different appearance from that offered in the other species. The number of lateral branches is less than in *T. saginata*, and their arrangement at the end of the segment is strikingly characteristic. The head, which was present in that one specimen only, is strikingly unlike that of either human *Taenia* previously known. The rostellum is armed with many small hooks, and can be entirely retracted within the head. The possible existence of a new species of human tapeworm is important enough to call for most careful investigation, and I hope at some later time to present a fuller description of this form with figures. It would be a great favor if human tapeworms could be sent to me for examination and comparison with the forms mentioned above.

In the last report attention was called to the extreme importance of the dog tapeworms, since this host harbors a considerable number of forms which are important for the stockraiser. In this connection I would again refer to what is said on page 277 of last year's report. A considerable number of dogs from Lincoln have been examined during the year, and four tapeworms positively identified. *Dipylidium caninum* was mentioned in last year's report. In addition to this *Taenia s rrata* is common in Lincoln, between fifty and sixty specimens having been taken from a single host. A new species of *Taenia*, somewhat like *Taenia marginata*, with which it was confused for some time, is also abundant. A single specimen of *Taenia coenurus* was also discovered. This is the adult of which the larva gives rise to the disease of "gid," or "staggers" in sheep. It is an unfortunate addition to our fauna, and it may well be hoped that the occurrence of this single specimen within the limits of Nebraska was accidental. No report of the disease caused by the larva has come from any part of the state.

In some rabbits examined a delicate thread worm, *Oxyurus ambigua*, was abundant in the blind intestine, and several hundred specimens were taken from a single host. It is probably a parasite of no great consequence. In the liver of a rabbit sent me by the kindness of Dr. A. T.

Peters, state veterinarian, was found in great numbers a microscopic parasite, which proved on examination to be *Coccidium oviforme.* The liver was almost filled by small nodules, which, in sections, were seen to be masses of Coccidia, and the tissue of the organ was almost entirely destroyed. A description of this parasite is given in the second section of the report.

I cannot leave the general discussion of parasites without calling attention to the fact of the probable increase of these forms with the recurrence of a moister season. Especial attention should be paid to the drinking places of stock as pointed out in the report of last year.

Accounts have been sent me of the occurrence in various regions of "horse worms." These are probably the *Ascaris equorum* mentioned on page 299 of the last report. In the same way the "kidney worms" reported are probably *Dioctophyme gigas*, (p. 302), of the last report. At least one instance has been reported in detail in which the liver flukes were the cause of considerable damage in sheep flocks in this state. The species was probably *Distoma hepaticum*, although I have not personally seen a specimen.

In the following list are included all the parasites taken from man and the domestic animals within the limits of the state of Nebraska which so far as I know have been accurately determined. The species starred is quoted from Stiles' monograph on the Cestodes of Cattle, Sheep, and Allied Animals; all other species have been subject to personal study and verification by myself. In connection with each parasite is noted the organ in which it occurred and the host or hosts actually found infected in this state. Reference to the check list of parasites printed at the close of the report of last year will indicate, so far as man and the domestic animals are concerned, in what other organs and hosts the parasites may occur.

PARASITES FOUND IN NEBRASKA.

PROTOZOA.

Coccidium oviforme, liver of tame rabbit.

TREMATODES.

Distoma felineum, biliary ducts of cat and coyote.

CESTODES.

Cysticercus fasciolaris, larva of *Taenia crassicollis*, in liver of rat.
pisiformis, larva of *Taenia serrata*, omentum of tame rabbit.
Dipylidium caninum, small intestine of dog.
Taenia coenurus, small intestine of dog.
crassicollis, small intestine of cat.
saginata, small intestine of man.
serrata, small intestine of dog.
sp., small intestine of dog.
sp., small intestine of man.
* *Thysanosoma actinoides*, duodenum and ducts of liver and pancreas in sheep.

NEMATODES.

Ascaris lumbricoides, small intestine of hog.
mystax, small intestine and stomach of dog and cat.
Oxyuris ambigua, caecum of tame rabbit.
Trichina spiralis, muscle of hog.

ACANTHOCEPHALA.

Gigantorhynchus gigas, small intestine of hog.

II. Microscopic Animal Parasites.

The Protozoa or single-celled animals are the lowest forms included in the animal kingdom and are, with rare exceptions, of microscopic size. They are of very simple structure and yet comprise a large number of different forms which may be conveniently grouped into four great subdivisions or classes, as follows:

1. Rhizopoda, without any cell membrane or covering, and moving by projections of the soft body.
2. Sporozoa, with a cell covering, without special organs of locomotion.
3. Flagellata, with a membrane and long whiplike organs of locomotion.
4. Infusoria, with a membrane, and very numerous fine short hair-like organs of locomotion.

It is only comparatively recently that the importance of these forms, as causes of disease, has been recognized; and the part which they play has not yet been thoroughly investigated. Their minute size and the ease with which they may be overlooked have, of course, contributed to this result. Within the last few years, however, a number of important diseases have been traced to parasites belonging to this group. There are important parasites in all of the various classes. Such for instance are the malaria parasite in the first class, and others less commonly known in the third and fourth, but it is the second group which contains the most as well as the most important protozoan parasites and to which attention is directed now.

According to Balbani, the Sporozoa may be divided into five distinct orders:

1. *Gregarinida*, which occur chiefly in invertebrates.
2. *Coccidia*, or *psorospermiae oviformes.*
3. *Sarcosporidia*, or *psorospermiae utriculiformes.*
4. *Myxosporidia*, or *psorposperms* of fishes.
5. *Microsporidia*, or *psorosperms* of articulates.

The group of Coccidia are distinguished as Sporozoa possessing a naked protoplasmic body in the early stage of the animal, but surrounding themselves after completion of growth with a resistant shell. The protoplasm in the interior is then converted into one or more spores and these into a variable number of sickle-shaped bodies. Under this group the single genus *Coccidium* will claim our attention. In it the entire body falls into four spindle-shaped spores in each of which two sporozoites are formed.

Coccidium perforans Lkt. 1879.

SYN.—*Cytospermium hominis* Riv. 1878.

According to some authors, this species is not to be distinguished from the following, but the work of Leuckart has demonstrated that in form, size, and dwelling place are definite differences which warrant the specific distinction. This species, which is shown in Fig. 1, is from 0.024 to 0.026 long, by 0.013 to 0.014, or even 0.020 mm. wide. The form is a short oval, and the contents of the cyst always show a protoplasmic remnant.

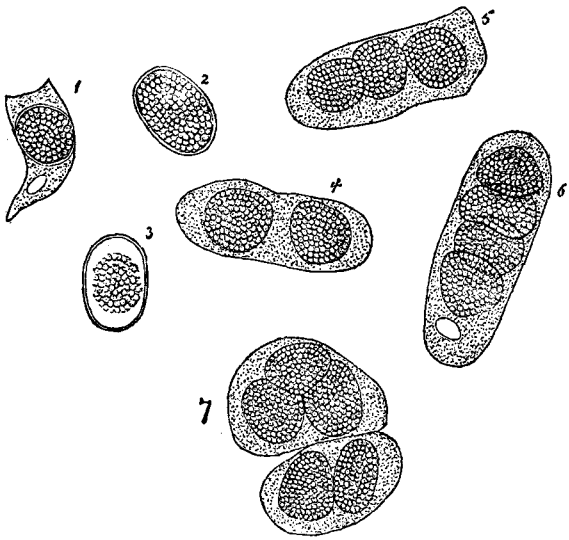

FIG. 1.—Sporozoa (probably *Coccidium perforans*) from the intestinal epitheluim of a sheep. 1. An epithelial cell containing a single parasite; 2. Free parasite; 3. The plasma has receded from the wall of the cyst; 4–7. Epithelial cells containing from two to four parasites each. [After Stiles.]

A case of the presence of the parasite was described by Curtice from the intestine of a sheep, and Stiles has published a detailed study of the specimens. The parasites appear as irregular whitish patches on the walls of the small intestines. In the spots the villi are much enlarged, and the cells contain one or more cysts of *Coccidia* with prominent membrane and coarsely granular contents. (Fig. 1^1). Such a *Coccidium* at an earlier period consists of a granular mass without membrane. The development of the membrane which is shown in figure 1^2, is followed by the contraction of the contents, leaving a clear space between the central mass and the wall of the cysts (Fig. 1^3). The central mass later divides forming four sporoblasts. The entire protoplasmic portion is not used in forming the sporoblasts, but a remnant is left. Later each of the sporoblasts gains a definite membrane of its own, and is known as a spore. Subsequently every spore produces within itself two sickle-shaped bodies, or sporozoites.

In this condition, the *Coccidia* may remain indefinitely, and the method of their transference to a new organism is not yet fixed. They probably reach the exterior and are introduced with the dust in the air, in drinking water or on various articles of food. It seems probable that the spores do not set the falciform bodies free until after being introduced into the alimentary canal of a new host.

In cases of slight infection it is probable that the effect of the parasite is inconsiderable, but under other circumstances death may result even at the end of a few days. A diagnosis can only be made by a microscopic examination of the feces.

This species develops in the intestinal epithelium of the rabbit, of man, and perhaps of other mammals. In the case from the sheep studied by Stiles it is by no means certain that the species present was *C. perforans*, since the measurements given for his specimens are smaller than the average for the species under consideration. Moreover, the single stage of the parasite described by him would not permit of a final determination.

The serious disturbance in the digestive functions caused by the parasites in the instance first cited is at once evident. Pröger and Zürn have described an attack of the same character which resulted fatally in four calves. The exact species is also here a matter of doubt. Enough has been said, however, to indicate the importance of this disease and the necessity of more extended information concerning it.

Coccidium oviforme Leuck. 1879.

SYN.—*Psorospermium cuniculi* Riv. 1878.

Oval in shape, with a minute depression at one pole; length 0.04–0.05 mm.; width 0.022–0.028 mm. It is found in the liver of various mammals, chiefly of the rabbit. Through the kindness of Dr. Peters, state veterinarian, I have received some pieces of rabbit liver badly infected with this parasite. On a cross-section of the liver one can detect even with the naked

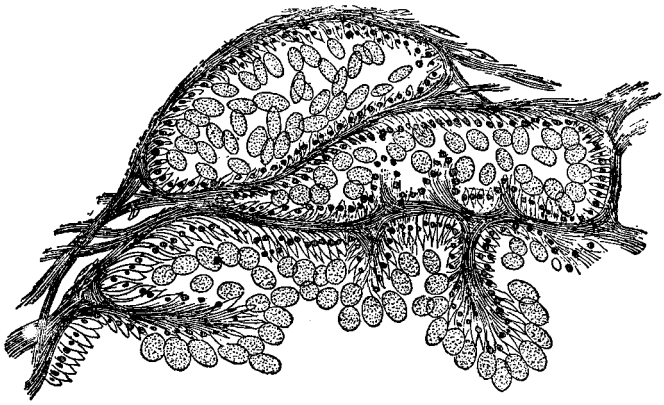

FIG. 2.—Section of rabbit liver invaded by *Coccidium oviforme*. The hepatic ducts are dilated by the oval parasites. [After Balbiani.]

eye little nodules, while under the microscope a fine section shows that the mass of the liver tissue has been destroyed, and that the spaces are occupied by enormous numbers of small bodies having a clear, highly refractive shell, which contains a single mass of protoplasm, or four spores. The early stage of the parasite, in which they consist of a protoplasmic mass without a wall, and not more than 0.009–0.010 mm. in diameter, was not present in this specimen. The cysts found averaged from 0.03 to 0.04

mm. by 0.02 to 0.025 mm. Their appearance is very much that of the egg of a parasitic worm, for which they have been frequently mistaken, but from which they may be distinguished by an examination of the contents.

The encysted *Coccidia* rupture the walls of the cells and accumulate in masses (Fig. 2) in the cavity of the biliary ducts, the microscopic appearance of which has already been described. These masses vary greatly in size, the largest being nearly equal in size to a walnut. In number they are in cases of serious infection extraordinarily abundant. The cysts contain a thick, yellow, cheesy mass in which are multitudes of encysted *Coccidia* among remains of degenerated cells and granulated matter.

The final stage of development in the liver shows a cyst with double contour in which the protoplasmic contents are massed at the center, leaving a clear space just inside the cyst. The stage is similar to that shown in Fig. 1 for *Coccidium perforans*. After these have broken into the biliary ducts, they are eventually carried into the intestines and thus reach the exterior. Here the further development proceeds with varying rapidity according to the exact circumstances, and in ten to twenty days is finished. There are formed first the four rounded masses or sporoblasts, each of which becomes elongated to a membrane-covered spore, and finally within the spore are produced two falciform bodies. In this condition the *Coccidia* are preserved without further change for long periods of time, and the further development is only a matter of conjecture. It is thought, however, that when introduced in some way into the alimentary canal of a new host the spores burst and set free the falciform bodies, and that these become amoeboid, ascend the gall duct into the liver, and finally invade the hepatic cells.

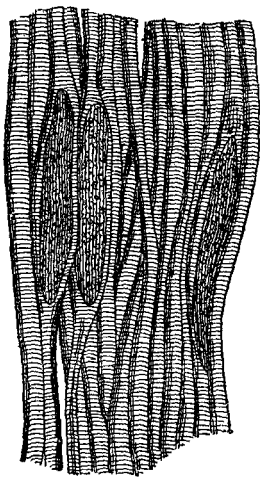

FIG. 3.—Sarcosporidia in the muscle fibres of pork. [After Railliet.]

The disease to which they give rise is known as hepatic coccidiosis, and resembles generally pernicious anaemia. Young animals are particularly liable to the attacks of this malady, which is extremely common in some parts of the world. In England, for instance, 92 per cent of the rabbits are said to be infected. Similar species have been met in the liver of man, and the source of infection is thought to be impure water or carelessly cleaned green food of some sort.

The disease may at times produce serious losses in rabbit colonies and should on all occasions be carefully watched and rooted out at the earliest possible moment. The diseased animals should be removed and, in other than exceptional cases, destroyed. The viscera especially should be burned or boiled a long time before being fed to other animals. The difficulty appears to be most common among animals kept in dark places, and it is also said to be frequent among those fed exclusively on green foods.

The third order of Sporozoa or Sarcosporidia, also known as the psorospermiae utriculiformes, are found as parasites in muscles and connective tissue (Fig. 3). They are commonly known as Miescher's or Rainey's corpuscles, and have been found in the majority of domestic animals, even including the domestic fowl. The most important species is:

Sarcocystis Miescheri (Kühn.)

SYN. *Synchytrium mescherianum* Kühn 1865; *Gregarina Miescheriana* Rivolta 1878; *Sarcoystis Miescheri* Ray Lankester 1882; *Miescheria utriculosa* Harz 1886.

These parasites are found as elongated bodies tapering toward both ends commonly, but more at one than at the other, two or three mm. in length, and not more than 0.2 to 0.3 mm. in greatest diameter. These spindles, which are somewhat granular in appearance, are covered by a thick, firm cuticula with close transverse striations. Under the influence of pressure this cuticula becomes broken up and resembles a hairy covering (Fig. 4*b*). Within this membrane are massed together many closely packed nodules which give the entire structure a granular appearance. These bodies are spherical and 0.025 to 0.050 mm. in diameter. They assume a polygonal shape by reciprocal pressure. In each of these spherical nodules are contained numerous corpuscles, at first rounded then semi-lunar, or kidney shaped. The internal structure of these bodies is still a matter of discussion. At the extremity of the spindle there is a small, open space occupied mainly by refractive granules.

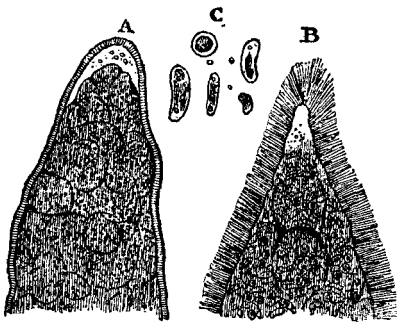

FIG. 4.—Sarcospoidia isolated and greatly magnified. A. End of one on which the cuticula is intact. B. Another with the cuticula crushed and having the appearance of a covering of fine hairs (cilia). C. Reniform corpuscles and granules separated. [After Railliet.]

These structures are found in muscles of the pig where they were discovered by Herbst and Rainey. Their presence is detected only by post mortem examination. The infected muscles have a darker color and at times one can distinguish, even with the eye, small points or lines of white. These are the sarcocysts, and are in the axis of the muscle fibers surrounded by a layer of muscle tissue which, at an advanced age, may suffer calcareous degeneration. The cysts may move about within the muscle-sheath according to Perroncito. In the cysts one may distinguish a surface zone of active growth and a central degenerate area, thus giving the mass a certain likeness to tubercular centers.

Commonly, the presence of sarcocysts cannot be detected during life. But in the extreme case weakness or even paralysis of the hind quarters

was attributed by Virchow to the presence of these parasites, without sufficient evidence of the interdependence of the two having been adduced.

The following figures with reference to the frequence of these forms are quoted from Railliet: "Koch estimates the infected animals at eight in 100, Perroncito at twenty-five in 100, Leuckart at twenty-eight in 100, Moulé at forty in 100, Herbst and Ruprecht at fifty in 100, and Kühn at ninety-eight and five tenths in 100." The experiments of Leuckart in artificial infection were the first to show the possibility of infection by eating flesh containing the sarcocysts. This single experiment does not suffice, as Leuckart remarks, to establish the possibility of direct infection and the consequent danger for man through eating the infected flesh. In any case the consumption of flesh badly infested should be prohibited, since Rabe has shown this to be a possible cause of intestinal catarrh, and more especially because of the diminished food value of the infected flesh. It is not known whether the infection is ordinarily direct. There is a closely related species which is found in the sheep, but they are not so abundant as to be a source of danger. A somewhat similar species is found in man as an occasional parasite.

Among the parasites of the nasal cavity there is one which, though not a worm, is ordinarily considered in connection with such forms as have been discussed in this and the preceding report although it belongs to a different subdivision of the animal kingdom. The Linguatulida are elongated, worm-like, with a ringed body; the mouth is without jaws and is surrounded by two pairs of hooks which are regarded as rudimentary legs. There are only a small number of genera and species, one of which, the most common form, may well receive attention here.

FIG. 5.—*Linguatula rhinaria*, female natural size. [After Neumann.]

Linguatula rhinaria (Pilger) Raill. 1885.

SYN.—*Taenia rhinaria* Pilger 1802; *Polystoma taenoides* Rud. 1810; *L. taenoides* Lamarck 1816; *Pentastoma taenoides* Rud. 1819; *L. rhinaria* Raill. 1885.

The body (Fig. 5) is much elongated, worm-like, being flattened on the ventral surface with rounded dorsum. The anterior extremity is the larger and broadly rounded, while the body becomes smaller towards the posterior end. About ninety rings occur on the integument with projecting margins armed with spines. The two pairs of buccal hooks are sharp, curved, and provided with two roots. Each of the hooks is capable of being retracted into a small sheath and is controlled by special muscles. The male is white, 18 to 21 mm. long, 3 mm. wide in front, and 0.5 mm. at the posterior end. The female is slightly grayish or brown, 80 to 100 mm. long, 8 to 10 mm. wide near the anterior end, and only 2 mm. at the posterior. The ovoid eggs measure 0.09 by 0.07 mm.

In the adult condition, this animal lives in the nasal cavities of various animals, particularly of the dog. The larval form of this species has been found in the viscera of a large number of mammals, including cattle, sheep, pigs, rabbits, cats, and even man.

The eggs are deposited by the adult female in large numbers in the mucous of the nasal cavity and are expelled with it. Especially during the attack of sneezing, which the presence of the parasites occasions, they are thus distributed over the grass of pastures. The grass or forage thus soiled brings the eggs into the stomach of some herbivorous animal, cattle or sheep, where the shell of the egg is dissolved and the young worm set free. At this time the embryo bears a certain resemblance to some of the mites, especially *Demodex*. It is oval, measuring 0.13 mm. long by 0.05 to 0.06 mm. wide. The oval body is prolonged into a short projection at the posterior end and is provided with two pairs of legs, each of which is bifid. At the anterior extremity is a boring apparatus consisting of a median stylet and a pair of hooks. With this stylet and hooks the wall of the intestine is perforated, and the embryo wanders into some organ in which it encysts, as the liver or lungs. Here it becomes transformed into a pupa without segments or hooks, and measures 0.25 to 0.30 mm. long by 0.18 mm. broad. After a number of moltings, the body becomes more elongate and divided into 80 or 90 rings. The alimentary canal and mouth are also well developed, and towards the end of the sixth month the larva is fully developed. In this stage it measures 6 to 8 mm. long and has received the name of *Linguatula denticulatum* (Fig. 6) from the considerable number of chitinous spines on the border of each ring.

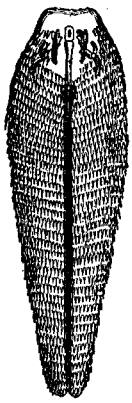

FIG. 6.—*Linguatula rhinaria*, larval condition known as *L. denticulata*, magnified 10 diameters. [After Railliet.]

These fully developed larvae soon start a migration by means of the hooks and the spines which prevent going backwards, and ultimately reach the peritoneal cavity, where the majority of them perish. But a few, however, are re-encysted at some second point. The further migration of the larva is passive, *i. e.*, depends upon their host being eaten; and in case this does not take place they perish. The viscera of such animals are frequently abandoned to the dogs, and so the larvae reach the nasal cavities in which they attain maturity. The method by which the final location is reached is at present uncertain, but in one way or another they attain the nasal cavity where they are ordinarily to be found at the sides, partly hidden under the projecting bone. Such a condition is shown by the figure (Fig. 7). Sexual maturity is reached after five or six months' growth in the nose. The females, which are very fertile, produce, according to the estimate of Leuckart, each 500,000 eggs.

In some regions as many as ten per cent of the dogs examined are found to be infected, and it is probable that the supposed rarity of the parasite

is really due to the ease with which it may be overlooked. They are naturally more common in butchers' dogs and street dogs than in ordinary household pets.

The presence of the parasites does not give rise to any very definite symptoms so far as is at present known. There is a re-occurence of fits of sneezing which becomes more frequent and longer, and occasionally appearances of asphyxia together with the effort to free the nose from

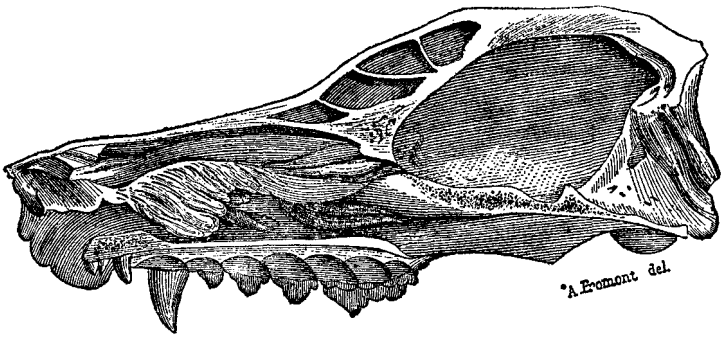

FIG. 7.—Head of dog, split longitudinally through the middle and showing indistinctly specimens of *Linguatula rhinaria* (two are side by side) under the turbinated bones of the nasal cavity. [After Colin.]

some object by rubbing with the paws. In these fits of coughing not only the mucous with eggs, but also even the worms themselves, may be expelled. The parasites may remain long in the nasal cavity, and with their disappearance comes relief from the trouble.

The preventive treatment, which consists in keeping the fragments of slaughtered animals away from the dogs, would hardly of itself be necessary for this slight malady alone, but it should be remembered that the same treatment is of extreme importance as protection against the parasitic diseases due to various worms. (See Rept. 94, p. 277.)

The larval worms are commonly found in a number of animals and are particularly frequent in sheep. Here they bring about a reduced condition and materially injure the value of the host. From the common seat of the larva in the mesenteric glands, which are altered and even largely destroyed, it is certain that nutrition must be very unfavorably affected.

In man the larva has been found encysted most frequently in the liver. They are rather common in Germany and Austria, rarer in Switzerland and France. Their presence is too occasional and the number too insignificant that they can have any appreciable effect upon the health of the host.

III.—Diseases of Poultry due to Parasitic Worms.

Among the various parasites, harbored in one organ or another by poultry in this part of the world, there are two of such importance that they deserve mention here. One of these is a newly discovered tapeworm

which gives rise to an affection similar in superficial appearance to tuberculosis and worthy of close attention both because of this similarity and because of the damage which it may do. The other is a nematode or thread-worm which is the cause of a wide-spread and important disease known as the "gapes." I shall take up the tapeworm disease at first.

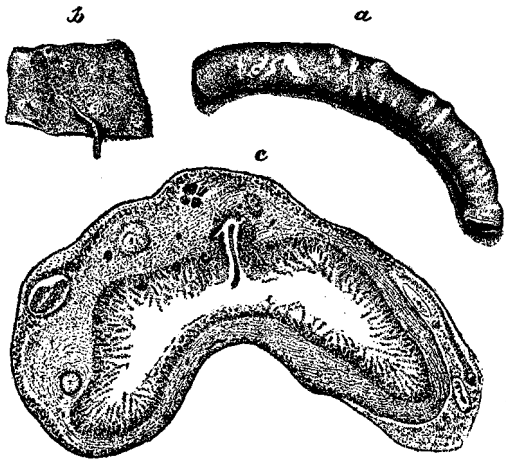

FIG. 8.—*a*, Portion of the intestine of a fowl showing the nodules (x⅓). *b*, The mucosa of the intestine showing ulcerated areas, also several small and one larger tapeworm attached to the wall (x⅓). *c*, Cross section of the intestine illustrating the thickening of the wall due to a large number of the nodules, also a portion of a tapeworm which has penetrated the mucous membrane (magnified). [After Moore.]

Within the past year there has been discovered a new disease of fowls which from its close resemblance to tuberculosis is of great significance, especially since it is of a character that has no deleterious effect upon the flesh of the fowl. This disease has been described at length in a circular of the Bureau of Animal Industry, by Dr. V. A. Moore, from whose report the following is prepared. It is the intestine which is the seat of the disease and which presents the appearance of being covered with nodules (Fig. 8*a*) or tubercle-like bodies most numerous in the lower third of the small intestine. A few such bodies occur sometimes in the beginning as well as near the end of the intestines. In size these nodules vary from minute areas scarcely perceptible to the naked eye to such as are 4 mm. in diameter. In shape they are round or oval, and are sometimes so closely crowded as to apparently overlap. They are more or less yellowish in tint, varying considerably according to the size. In the intestine near the nodules were attached a considerable number of tapeworms (Fig. 8*b*), and sections (Fig. 8*c*) demonstrate that the heads of the tapeworms had penetrated the mucous membrane and were found attached to different layers (Fig. 9) of the wall of the intestine. The worms attached to the inside of the walls were commonly of small size, but in the contents of the intestines a larger form of the same species was also encountered.

With reference to the species, Dr. C. W. Stiles, of the Bureau, was inclined to believe that the form is one known as *Taenia bothrioplitis*, which was described as the cause of a disease of fowls in Italy. It is probable that this name is synonymous with *Davainea tetragona* (Molin 1858) R. Bl. 1891. Only one fowl actually died of the disease, but others which were used for experiment and subsequently examined were found to be

affected by this complaint. According to Dr. Moore, the extent of the lesions in several of the fowls examined was sufficient to show that the host would soon have perished from the trouble. In the fowls used for experimenting, the disease could not be detected previous to *post mortem* examination by any symptoms which were noticed.

Tubercular lesions are said to occur frequently in the intestines of fowls, and it is of the greatest importance that a thorough examination of such cases should be made. In some cases of which the descriptions were quoted by Dr. Moore, it was not possible to tell whether the complaint was actually tubercular or a disease of the character just described. He calls attention to the analogous disease of sheep produced by the *Oesophagostoma columbianum* which led to the destruction of many animals, since it was thought that tuberculosis existed in the flock. A similar mistake in diagnosis would result in the unwarranted destruction of valuable poultry. Furthermore, the complaint is worthy of careful attention, since Dr. Moore estimates that in the region in which it occurs it occasions of itself a considerable annual loss. At present it is known to exist in the District of Columbia, North Carolina, and Virginia.

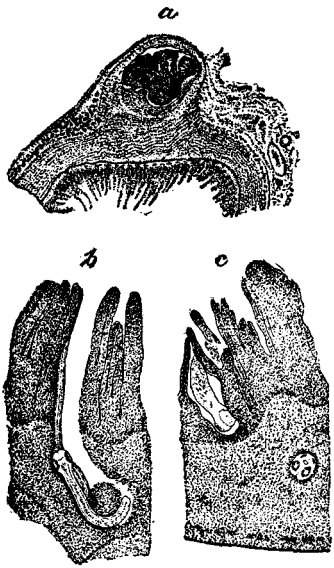

FIG. 9:—*a*, Cross section of a nodule containing a sequestrum situated in the outer or longitudinal muscular layer, circular layer of the muscular wall not affected. *b*, A section showing a tapeworm and a necrotic mass within the muscular wall. *c*, A portion of a cross-section of the intestine showing the head of a tapeworm within the muscle and one lying between the villi with its head resting on the basement membrane of the mucosa (magnified). [After Moore.]

With reference to the diagnosis of the disease, I take the following from Dr. Moore's circular: "The diagnosis has not in my experience been difficult, as in every case the attached tapeworms were readily detected upon a close examination of the intestinal contents or of the mucous membrane of the affected portion of the intestine. However, the worms are quite small and could easily be overlooked in a hurried or cursory examination. In case of doubt, if the affected intestine is opened, and the mucous surface washed carefully in a stream of water, the small worms will be observed hanging to the mucous membrane. This discovery, in the absence of lesions in the liver or other organs, would warrant the diagnosis of the tapeworm disease." *

One of the most general and unfortunate diseases of poultry is the

* For the figures 9 and 10 illustrating this topic I am indebted to the courtesy of Dr. D. E. Salmon, chief of the Bureau of Animal Industry, United States Department of Agriculture, Washington, D.C.

FIG. 10—*Syngamus trachealis*, natural size and enlarged ten times. [After Railliet.]

so-called "gapes," which is a form of bronchitis due to the presence in the trachea or bronchi of peculiar parasites belonging to the genus *Syngamus* which takes its name from the apparent double headed character of the animal. The disease was reported first from America at the end of the last century, and some years later made its appearance in England, France, and over the continent generally. It is probably, therefore, a native American parasite, though the most serious losses from its presence have been met in the Old World. The description of the worm is as follows:

Syngamus trachealis von Sieb. 1836.

SYN.—*Fasciola trachea* Montagu 1811; *Strongylus trachealis* Creplin 1846; *Sclerostomum syngamus* Dies. 1851; *Syn g primitivus* Molin 1860.

The body of the worm (Fig. 10) is elongated, of a reddish color, and possesses a broad, flat head. The mouth is circular with a hemispherical capsule in which are fixed seven sharp projections, arranged about the opening of the oesophagus; there are four membranous lips. The male is 2 to 6 mm. long, the female, 5 to 20 mm. The eggs are elliptical 0.085 mm. long, and .05mm. wide. The individuals of the two sexes become permanently attached at copulation so that they cannot be separated without mutilation.

Under the common name of the "red worm," "gap-worm," or "forked-worm," it is known to all poultry raisers. The disease attacks chiefly young birds or is certainly most fatal in such cases as also in certain years.

The life history of the worm is as follows: The eggs are developed to a certain extent before being laid, but they cannot be deposited except the body of the female be ruptured; this, of course, occurs after the worm has been ejected from the air passages, or on the decomposition of the host. The eggs falling on the damp ground, or in the water, require from seven to forty days for development. Ehlers has proved that no intermediate host is necessary, since birds which were fed on the eggs containing embryos were found after two weeks to contain adult individuals. On the other hand Walker, who held that an intermediate host was necessary, was able to show that embryos are not killed by being swallowed by earth worms and may reach new hosts in the body of the earth worm. Mégnin calls attention to the fact that the affected birds cough up worms which are seized and swallowed by other fowls with apparent relish, and in this way the disease is undoubtedly spread. It is worthy of note that at a temperature of 68°–77° F. the worms in the embryonic condition will remain alive in water for eight to ten days, while if the temperature is somewhat lower they can be kept about a year. In this way the possibility of infection remains some time after the removal of the source from which the parasite was originally introduced. The method in which the worms reach the air passages after the introduction of eggs, or embryos, into the alimentary canal is at present uncertain.

On the examination of birds which have died from this disease, the worms are found to be attached to the windpipe near its point of division and enveloped in a kind of foam. They adhere so firmly that removal is accomplished only by the tearing of the worm. The number found in any host is variable; twenty-five to thirty will suffocate a fullgrown bird, while even two or three may kill a young fowl.

For the prevention of this trouble the strictest quarantine regulations are necessary, and the destruction of all the eggs which may be coughed up by infected birds as well as of the bodies of fowls which have succumbed to the disease. Of the many different methods of cure which are recommended none is perfectly satisfactory, and emphasis must be laid upon the necessity of prevention. The following remedies are those recommended by Neumann and included perhaps the most successful of any heretofore published:

"Isolate the affected birds, and put those yet healthy on clean ground. Bury deeply, or burn the bodies of the dead birds; disinfect the ground of pheasanteries or poultry-yards by sprinkling over it a one per cent solution of salicylic or sulphuric acid; give uncontaminated food and water to the birds, adding to the water two or three drachms of salicylate of soda to the quart. Such are the preventive measures recommended by Mégnin.

"In America (and also in England) a feather from which all the barbules have been removed except those at the point, is introduced into the trachea and turned around there, with the object of detaching the worms; but this is an insufficient and dangerous proceeding, and can remove only a small number of the parasites which are situated on the upper part of

the trachea; and are exceptionally slightly attached to the mucous membrane; while it may cause suffocation that will lead to sudden death.

"Following Cobbold's advice, we may, in cases of imminent asphyxia, open the trachea and withdraw the worms.

"Montagu has been successful with a vulgar remedy in England, which consists in dampening with wine, instead of water, the grain with which the diseased birds are fed.

"Garlic has been employed with much success, first by Montagu, then by Mégnin. Montagu gave an infusion of rue and garlic, instead of water, to drink. Mégnin prescribed, as food, a mixture of hard-boiled eggs, ox-heart soup, stale bread and salad, all well mixed up with chopped garlic, and given in proportion of one clove of the latter daily to every six pheasants. He was also fortunate in the employment of powdered asafoetida with an equal part of gentian, these being incorporated in a cake and given in the proportion of five-tenths grammes per head every day. He also mixed in every quart of drinking water, a solution of one gramme of salicylic acid to 100 grammes of water.

"It is in being eliminated by the air passages that the volatile principles of garlic and asafoetida act as toxicants on the red worm of the trachea.

"Mégnin recommends, besides, fumigation with sulphurous acid; the fits of coughing to which it gives rise cause the expulsion of the parasites. But this means requires much watchfulness, in order to avert accidents from suffocation.

"The German breeder above mentioned advises the employment of an 8 to 10 per cent solution of salicylic acid, a few drops of which are to be carefully injected into the trachea by means of a straw stalk. And 'an English farmer says he has rarely lost an affected individual since he resorted to tobacco smoke. He places the pullets in a box, which he covers with a cloth, then puts a little tobacco in a pipe, lights it, puts some more tobacco on the top, introduces the pipe into the box and blows gently through the stem, until the birds fall over almost inanimate. He then restores them to the open air, where they soon recover their health—(Railliet).'"