

of the alimentary tract cause very definite and often very fatal diseases, and to diminish this cause of death the parasites must be eliminated or their access to the body of the bird prevented. Consideration of the diseases thus set up will come elsewhere, and here it should only be remarked that the expression "*the* grouse-disease" is a misleading one. As if a Grouse or any other living creature suffered from only one disease! What is usually meant by "*the*" disease is a somewhat sudden and very virulent disorder which sweeps through a district and in a very short time carries off a very large percentage of birds. Such a disease was investigated by Dr Klein some twenty years ago, and it is proposed that this disease—if it be a distinct disease—be called Klein's Disease of the Grouse. Since the Committee was appointed there seems to have been no definite outbreak of Klein's disease, but innumerable Grouse have been examined which were said by the game-keepers and moor-owners to be affected with or killed by "*the*" disease, which further investigation has shown to have been done to death by worms or Protozoa. The symptoms of "*the*" Grouse Disease are not readily apparent, especially to the unclinical eye.

Leslie A.S. & Shipley A.E. (1912)
Pub. J. Murray.

ECTOPARASITES

INSECTS.

A. MALLOPHAGA.—Bird-lice or Biting-lice.

I.—*Goniodes tetraonis*, Denny.

The Broad Bird-louse of the Grouse.

The bird-lice comprise a number of forms, sometimes also termed biting-lice, which in the great majority of cases live on the skin of birds. A few, such as the dog-louse,¹ live amongst the hairs of mammals. As this is the alternate host of a common tape-worm,² which passes its

¹ *Trichodectes latus*, Nitzsch.

² *Dipylidium caninum* (L.).

adult state in the dog, there was some justification for our hope of finding the larval stage of at least one of the Grouse tapeworms in these insects, but so far we have not succeeded in doing so. The biting-lice form a rather isolated group of insects; but there is, apart from the fact that their mouth organs are adapted for biting and not for sucking, much resemblance between some of their organs and those of the true lice; with these but not so closely allied, are the fleas.¹

Biting-lice are as a rule minute flattened little insects, with poorly developed eyes, a chestnut-brown body, and a generally well-groomed appearance. Five distinct species infest the domestic fowl, and unless the host be unhealthy, they seem rarely to do much harm.

In 1842 Denny² described and figured the broad bird-lice, which he calls the "Louse of the Black and Red Grouse." He states that it is "common upon both the Black and Red Grouse."³ "Upon the Willow or Hazel Grouse⁴ I find a similar but distinct species, rather broader in the abdomen, and of much darker colour."

Andrew Murray, in his book on Economic Entomology,⁵ writing of the broad bird-lice, says: "This is the insect which sometimes, especially in the bad seasons, does so much harm to the young Grouse when they are feeble and unhealthy."

Goniodes tetraonis is the commonest of the insects which infest the skin of Grouse, crawling about amongst the bases of the feathers and on the vanes of the feathers themselves. It occurs more commonly than the narrow bird-lice of the Grouse,⁶ which is often associated with it. It is comparatively rare to find a bird free from these "biting-lice," but perhaps 10 per cent. is about a fair estimate of the number of uninfested Grouse. The number on each bird is to some extent an inverse measure of their health. Careful search will discover but two or three on a healthy Grouse, but on a "piner" hundreds may be met with.

The broad bird-lice is usually found on the smaller feathers, crawling about half-way between their insertion and the tip of their vanes. When disturbed they hurry away into the brushwood of the small feathers, like small deer seeking cover, and they are by no means so easy to catch as one at first thinks. They eat the finer barbules of the feathers, which, accumulating in the crop, gives the dark, curved marking in their rather transparent bodies. On this meagre and arid diet they seem to flourish, actively produce young, and pass through several ecdyses or changes of skin.

The eggs are very beautiful objects; in badly infested Grouse they may be numerous, but as a rule they are none too easy to find. Usually

¹ Bird-lice, true lice, and fleas are now placed together in the modern group *Anapterygata*.

² "Monographia Anoplurorum Britannicæ," published by H. G. Bohm, London, 1842, p. 161, Pl. xiii. Fig. 3.

³ *Tetrao tetrix* and *Lagopus scoticus*.

⁴ *Tetrao saliceti* (sic).

⁵ Chapman and Hall, London, 1877.

⁶ *Nirmus cameratus*, Nitzsch.

they occur in small groups attached to the base of the after-plume and between it and the shaft of the plume. The specimen figured was on one of the feathers from the flank. (See Pl. xvii. Fig. 4.)

The eggs are elongated, some three or four times as long as they are broad. They are fixed by some adhesive secretion at the end corresponding to the hinder end of the embryo they shelter. At the other end is a well-marked cap or operculum which always points to the free end of the feather. The beauty of the marking on the egg-case is shown best in another but allied genus,¹ and we figure one, which we found² on the feathers of a partridge. Under the pressure of a coverslip the egg-case gradually ruptured along a circular line below the well-marked thickened edge or rim of the cap. The contained egg then began to emerge, carrying off with it the cap. The resemblance of this structure to a cap was emphasised by the long process which stands out like a feather borne on its apex. The eggs of the broad bird-louse of the Grouse show the network markings less well, but they are conspicuous on the cap, which bears a long tapering filament, longer than the egg itself. These markings also occur just below the cap, but fade away towards the fixed end. The general appearance of the eggs on the after-plume is shown in Pl. xvii. Fig. 3. They were found on the 27th July 1908, and they seem to be laid throughout the summer.

There is no metamorphosis, the young leaving the eggshell as miniatures of their parents.

Lagopoecus

II.—*Nirmus cameratus*, Nitzsch.

The Narrow Bird-louse of the Grouse.

This insect seems to have been first named by Nitzsch³ in the year 1818, but with no description. It is figured and described, and a bibliography is given by Denny⁴ under the name of *Nirmus cameratus*. Denny found it on the Red Grouse, the Black Grouse, "and I expect also upon the Ptarmigan." Grube describes it in Middendorf's "Siberian Travels" as existing on the Willow Grouse⁵ and the Ptarmigan,⁶ thus confirming Denny's surmise.

This narrow bird-louse is mentioned in Giebel's article⁷ on bird-lice at Halle, and described and figured in his great monograph.⁸ Piaget in his "Les Pediculines," states his conviction that *N. cameratus* is specifically identical with the *N. quadrulatus* of Nitzsch, from the Capercaillie.⁹ This opinion is also held by Kollogg.¹⁰

¹ *Menopon*.

² This egg is almost certainly the egg of *Menopon pallescens*, Nitzsch.

³ Germar's *Magazin der Entomologie*, Halle, iii., 1818, p. 291.

⁴ "Monographia Anoplurorum Britannia," London, 1842, p. 112.

⁵ *Lagopus albus*, Lin. = *L. sub alpinus*, Nils.

⁶ *Lagopus mutus*, Leach = *L. alpinus*.

⁷ "Zeitsch. Ges. Naturwiss.," xxviii., 1866, p. 370.

⁸ *Insecta Epitoca*.

⁹ *Tetrao urogallus*.

¹⁰ Wytsman's *Cerura Insectorum*, 66th Fasc. Mallophaga.

GONIODES TETRAONIS.

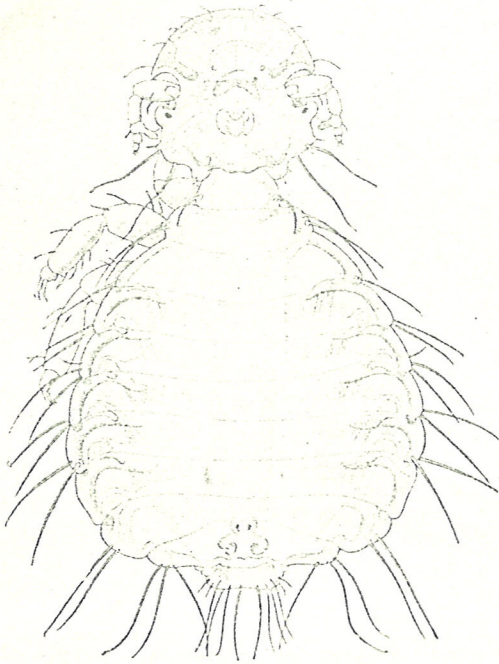


FIG. 1. *Goniodes tetraonis*. Denny. Male seen from above. The legs are shown on the left side only. The forked character of the antennae of the male and the male genital plates in the abdomen are shown.

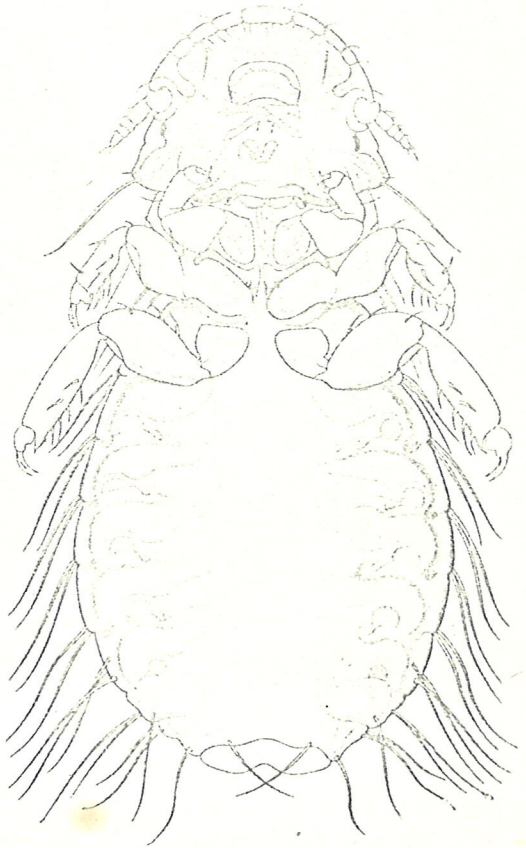


FIG. 2. *Goniodes tetraonis*. Denny. Female seen from below. The unbranched antennae and biting jaws are well shown.

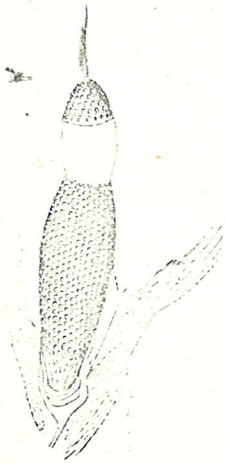


FIG. 3. Egg of *Menopon pallescens*. Nitzsch. Highly magnified. Under the pressure of the cover-slip the operculum has come away and the egg is squeezing its way out of the egg-shell.



FIG. 4. Four eggs of *Goniodes tetraonis* attached to the base of an after-plume. The operculum has fallen off one of them.

Nirmus is a more slender animal than *Goniodes*, and appears to be longer. It is rarer than the latter, though in the great majority of cases the two are found together. Most of what has been said above about the broad bird-louse applies also to the narrow form, as their habits are very similar, except that the latter lives more on the skin and upon the base of the shaft of the feather than does the former. It also seems to frequent the feathers under the wing, where the broader form is seldom seen. Both species appear to be able to wander all over the body; and though they seem rather more common upon the head, neck, and back, the old view that these biting-lice occur chiefly or exclusively on those parts of the body inaccessible to the beak has not been borne out by recent investigations (Pl. XVIII. Fig. 1).

Some eggs of this form have been found. These were for the most part empty, but from one or two full ones specimens of the insect have been hatched out. The eggs are white, and transparent when empty, just visible to the naked eye, 0.6 mm. in length, and about four times as long as they are broad. Each egg-case is beautifully marked with a network of ridges, the areas between the ridges being six-sided. At one end the egg has a cap which is pushed off when the young emerges. The eggs are laid between the barbules of the feather-vanes or near the bases of the filoplumes or short hair-like feathers, and adhere to their supports by means of some sticky excretion (Pl. XVIII. Fig. 2).

The eggs appear to be laid during the summer; the first time they were found (some of them were empty) was on 2nd July 1907, they were found again later in the season.

There is no metamorphosis or change of the larva into a chrysalis, and then into the adult form, as for instance in butterflies. The young emerge from the egg-case as small miniatures of their parents. They seem to cast their skin several times, but the exact number of times is not known. Dead specimens and cast skins were frequently met with.

In no case were either of the two species found in the crop of the Grouse, though, as we have just stated, they are fully exposed to being snapped up by the bird's beak if the bird cared to notice them. It is not known exactly how clean birds get infected; probably the bird-lice simply crawl from one bird to another when the latter are contiguous. There is evidence, however, that in some cases, probably rare ones, they cling to the Grouse-fly and are by it transported to a new host.

B. SIPHONAPTERA.—Fleas.

(i.) Fam. PULICIDÆ.—Fleas.

III.—*Ceratophyllus gallinulae*, Dale.¹

We are indebted to Mr N. C. Rothschild for identifying this flea, which is here recorded for the first time from the Grouse. It is a

¹ N. C. Rothschild, *Ent. Mag.*, 2nd Ser., xiv., 1903. In the *Ent. Rev.* xiii., 1901, No. 10, Rothschild described this under the name—synonym—of *Ceratophyllus (Trichopsylla) newsteadii*.

NIRMUS CAMERATUS.

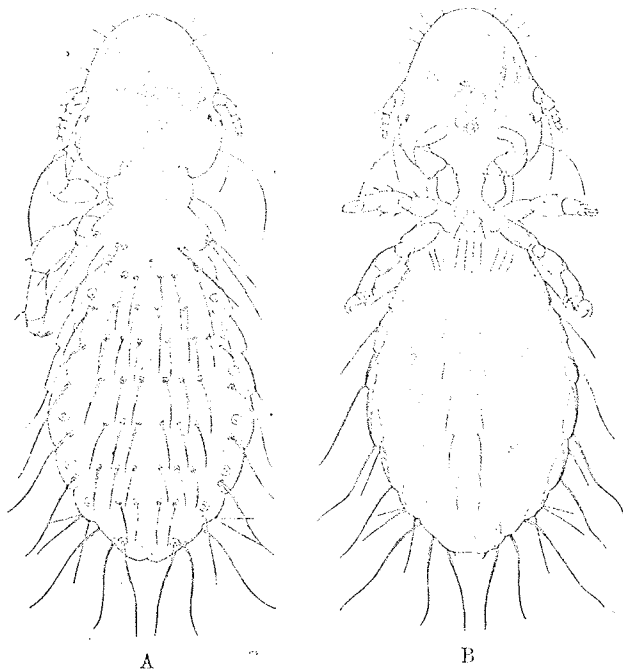


FIG. 1. *Nirmus cameratus*. Nitzsch. Magnified. Female. A seen from above; B seen from beneath.

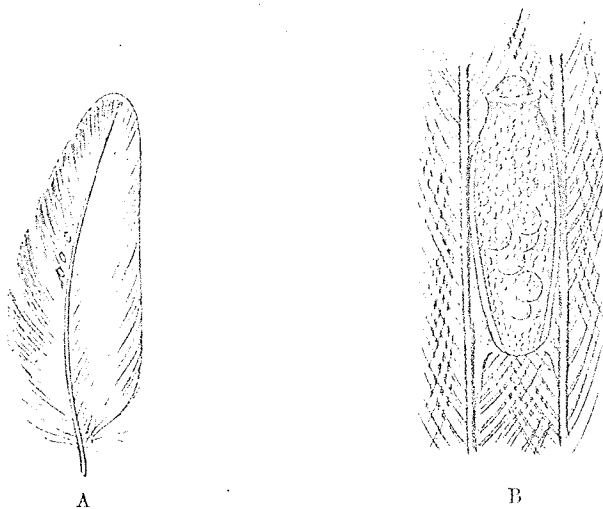


FIG. 2. Eggs of *Nirmus cameratus* on the feathers of a young Grouse about three weeks old. A, very slightly magnified, three eggs on one of the wing-covers; B, very highly magnified to show reticulations.

well-known bird-flea, having been found in the nest of the hawfinch, in that of the dipper, in that of the blackbird, the moor-hen, and others. In the thousands of Grouse which passed through the hands of the Committee only one or two specimens of this flea were found (all in 1906), and none were found in the crop. Hence, although the dog-flea, *Pulex serraticeps* Ger., is said to be the intermediate host of the dog tapeworm,¹ it does not seem at present very possible that the Grouse-flea could play any part in the life history of the Grouse tapeworms. On the other hand a flea may easily escape notice in the crop contents, and this species is probably much commoner in the nests than on the birds when flying. It has been suggested that there may be a connexion between the seasonal occurrence of the transparent tapeworm and the life history of the flea. The view is strengthened by Minchin's recent discovery of the larval form (cysticercus) of a tapeworm² in an allied species of flea³ which lives on the rat. As this species of Grouse-flea had not hitherto been accurately figured, Mr Edwin Wilson drew both male and female, and the drawings were reproduced in the original report. Now that the rôle of the flea in carrying certain human diseases is recognised, it is well to have them accurately delineated, as in a flea every hair tells. (Pl. XIX. Fig. 2.)

IV.—*Ceratophyllus garei*, Rothsch.

This second species of flea was found in a Grouse in 1907; but only one or two specimens were taken. It is recorded by Evans⁴ from the nest of the lapwing, and of the ring-dove. Rothschild⁵ has found it in the nest of a water-hen, and he records that it has been taken from the stoat, the weasel, the shrew, the vole, and the water-rat, and from hedge-clippings.

C. DIPTERA.—Flies.

(i.) Fam. HIPPOBOSCIDÆ.—Horse-flies.

V.—*Ornithomyia lagopodis*, Sharp.—The Grouse-fly.

This family includes besides the Grouse-fly, the horse-fly, sometimes known as the forest-fly, the sheep-keed, which has lost its wings and burrows in the wool of the fleece, and a third species which infests red-deer. This last has wings when young, but when the flies find a suitable host they get rid of their wings and nestle among the fur. Most, however, of the members of this family live on birds, and they seem particularly to frequent the swallows and allied species.

¹ *Dipylidium caninum*.

² Thought by Mr Nicoll to be *Hymenolepis diminuta* (Rud.), a tapeworm of the rat.

³ *Ceratophyllus fasciatus*.

⁴ "Ann. Scot. Nat. Hist.," 1906, p. 163.

⁵ *Ent. Mag.*, 2nd Ser., xiii., 1902, p. 225.

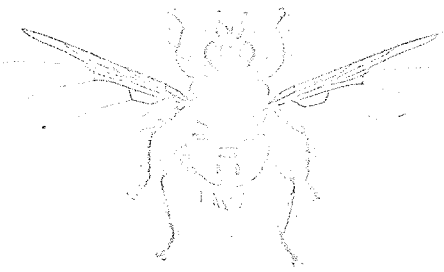


Fig. 1. The Grouse-fly *Orallthungia lagopodis*. Magnified about nine times.

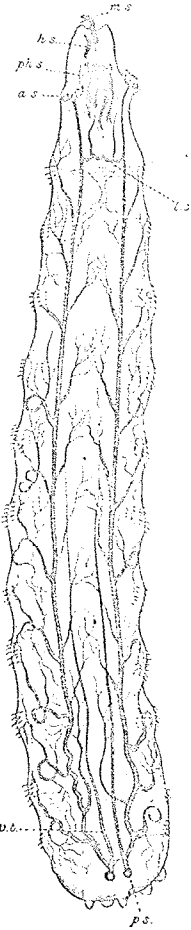
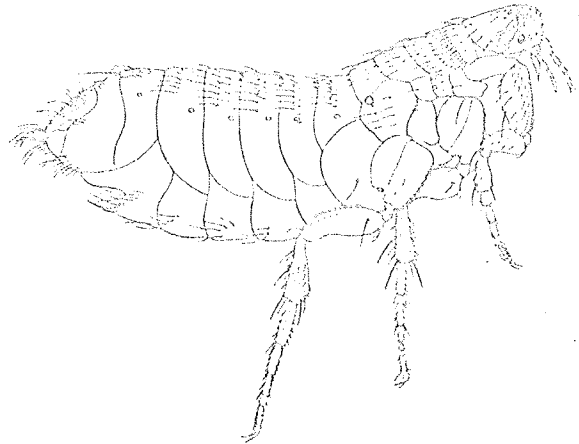
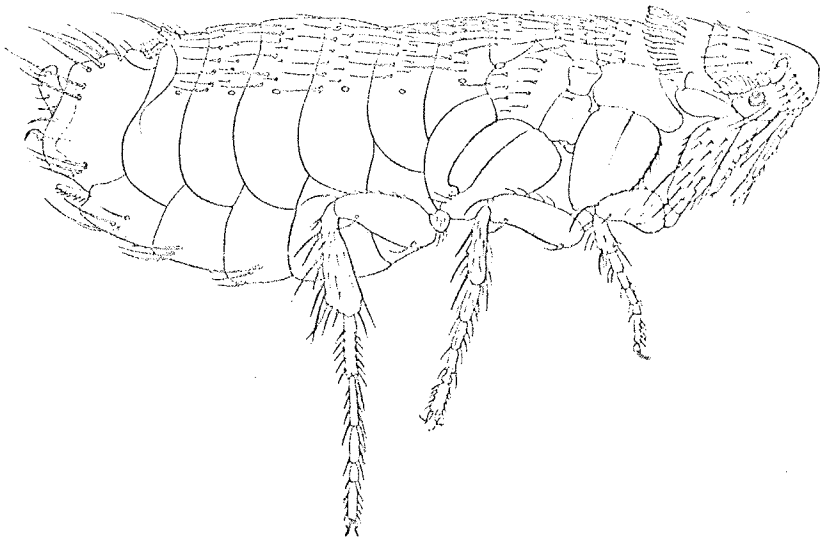


FIG. 3. Larva of *Scotomyza stercoraria* L. From a Grouse-dropping. Magnified.
a.s. anterior spiracle.
p.s. posterior spiracle.
h.s. hypostomal sclerite.
ph.s. pharyngeal sclerite.
v.t. viseral trachea.
l.c. transverse commissure.



A



B

FIG. 2. Side view of *Ceratophyllus gallinulae*. Dale. Highly magnified. A, Male; B, Female drawn to the same scale and showing the relative difference and size.

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⁴ "Ann. Scot. Nat. Hist.," 1906, p. 163.

⁵ *Ent. Mag.*, 2nd Ser., xiii., 1902, p. 225.

Till recently it had been thought that the Grouse-fly was the same species as the common bird-fly,¹ but recently Mr D. Sharp has pointed out that it is a distinct species. It is distinguished from the common bird-fly by its "peculiar lurid blackish colour, without any trace of green even on the feet or legs," and by other characters which have been quoted in the more anatomical portion of the Committee's Report. Recently yet another species² has been separated off from the common bird-fly, so that we now have three species of *Ornithomyia* in this country, and probably more will be added as the group is further studied.

We do not know the exact relations of the Grouse-fly to the Grouse. It is believed to suck its blood,³ and it certainly bites human beings. For a time it seems to burrow amongst the feathers of the bird, and any one handling Grouse during the summer is likely to disturb a fly or two. They come buzzing out, and are apt to crawl up one's sleeve. The feet, although large, are very beautiful. They are provided with a pair of very large hooks (Pl. XIX. Fig. 1). Altogether, these insects have a sinister aspect, and to people who do not like flies they are very repellent. They occur freely in larders where freshly killed Grouse have been placed, and after a short time they leave their dead host and accumulate upon the windows.

The earliest month in which the Grouse-fly has been found is in June, towards the latter end. The latest is in October. They are most plentiful in August.

The females seem to be commoner than the males, or, it may be that in August they are more readily caught. Like other horse-flies, forest-flies, and sheep-ticks, the Grouse-fly does not lay eggs, but the ovaries produce one large egg at a time, and this passes into a dilated oviduct which acts as a uterus, and here the egg develops. After attaining a certain stage of development, the larva surrounds itself with a pupa or chrysalis skin and is extruded. The chitinous or horny covering of the larva hardens and blackens with exposure to the air, and forms the so-called pupa-case; in fact, one may almost say the young are hatched as pupæ. At no time is the larva exposed, though there is a larval stage free in the uterus of the mother wrapped first in the egg-shell and then in the pupa-case.

The pupæ were found during August and September. They are black, shiny, seed-like looking objects, and appear to be deposited amongst the feathers, from which they are easily detached. The few we have found either dropped on some paper over which we were handling birds, or lay loose at the bottom of the cardboard boxes in which Grouse travel. Probably they take some eight or nine months before they give rise to the adult fly, and the latter very likely disappear altogether from about October till June. Further research is needed to throw light on these questions.

Three specimens of the Grouse-fly, all of them taken from one bird,

¹ *Ornithomyia avicularia*, Lin.

² *O. fringillina*, Bezzi.

³ *Proc. Zool. Soc. Lond.*, 1910, p. 704.

were themselves markedly infested with an ectoparasite, a species of mite. Here we refrain from quoting Dean Swift. The mite¹ belongs to a sub-family all of which are parasitic upon insects; these are regarded as harmless. Our specimens existed in considerable numbers, clustered round the hinder end of the fly's abdomen on the ventral surface, with their snouts or proboscides plunged into the body of the insect. Many were laying eggs, and many cast-off cuticles were lying around them. Eggs from which the larvæ had escaped presented a spindle-shaped outline; others contained eggs in various stages of differentiation; others fully formed larvæ.

We have in no single case found a Grouse-fly in the crop of a Grouse, nor have yet found any cestode larvæ or cysts in the bodies of the flies which we have cut into sections or dissected.

(ii.) Fam. SCATOPHAGIDÆ—SCATOMYZIDÆ.—Dung-flies.

This family contains species many of which produce their larvæ alive and deposit them in the bodies of other insects, or on open sores, or in organic material. The Grouse dung-fly cannot be looked upon as an ectoparasite of the Grouse, but it lays its eggs in Grouse-droppings, and its maggots live on and in these dejecta. The maggots must therefore constantly be in close contact with and certainly eat the eggs of the tapeworms which exist in such vast numbers in the Grouse droppings; and hence it was thought a profitable object to investigate for the second state of the cestode. It may be recalled that each Grouse dropping consists of two parts—(1) the dejecta from the intestine strictly speaking, and (2) the more fluid dejecta from the caeca. The latter pass last and lie like a cap upon the former. The two lateral diverticula or pouches of the bird's intestine known as the caeca are unusually large in the Grouse, and in them the absorption of the digested food takes place. The fly-maggots are only found in numbers in the "caecal" part of the dropping.

VI.—*Scatophaga stercoraria*, Lin.—The Grouse Dung-fly.

The Grouse dung-fly is first found commonly in April. In June it is not so common, owing perhaps to the rain having washed the caecal part of the droppings away. A large number of the larvæ have been examined both by crushing them and by cutting them into sections, but no trace of tapeworm cysts have been found, although many weeks were spent in carefully searching through the tissues of this and an allied species of dung-fly.² No specimen of either dung-fly or of their larvæ has been found in the crop of the Grouse (Pl. XIX, Fig. 3).

¹ Mr C. Warburton has kindly identified the mite as belonging to the genus *Cuneistrinia* and probably to a new species.

² *Scatophaga squattida*, Meigen.

ARACHNIDA.

ACARINA.—Mites and Ticks.

(i) Fam. IXODIDÆ.—Ticks.

The ticks are now known to carry certain unicellular animal parasites (Protozoa), capable of setting up virulent disease in man, cattle, dogs, etc. They may therefore be of importance in an inquiry into Grouse Disease. It is possible that their presence on the skin may be connected with some of the internal protozoal parasites mentioned below.

Severe outbreaks amongst fowls of a disease named "spirillosis" and of another obscure but very often fatal disease have been described by Balfour¹ in the Sudan. The organism which causes the former disease, a spirochaete² is transferred from one fowl to another by a tick.³ The second, and as yet rather obscure, disease is recognised by the natives, and by them associated with the presence of the same or allied ticks. We have found little trace of such disease in Grouse, and the recorded number of ticks taken in the Grouse is, except locally, so small that they can hardly play any part in Grouse Disease.

VII.—*Ixodes ricinus*, Lin.—The Common Sheep-tick.

This species of tick (the "castor-bean tick," as it is called in America) is common in many parts of the world. It is reported from sheep, goats, cattle, horses, deer, dogs, cats, foxes, ferrets, hedgehogs, hares, rabbits, bats, birds, and man. It occurs most frequently during the spring and early summer, but disappears after the beginning of July.

The sheep-tick is one of the commonest and one of the oldest known ticks of Europe. In the British Isles it often occurs on hunting dogs, and is sometimes called the "dog-tick"; the adult stage is especially frequent on sheep, goats, and oxen; less common on horses, dogs, and men. On the other hand, the larvæ and the nymphs are common enough on birds, lizards, and small mammals—in fact, on animals which live among and brush through grass or heather. It is only in the larva and nymph state that we find these ticks on the Grouse. On each of the infested birds the specimens were fixed on the chin or round the eyelids—in fact, in such positions as the Grouse cannot reach with its beak. In parts of Ross-shire, especially in certain woods, these ticks swarm in enormous numbers, and the keepers declare that they kill large numbers of young blackgame. Hence there is nothing remarkable in finding this species from time to time

¹ *British Medical Journal*, 9th November 1907, No. 2445, p. 1320.

² Probably *Spirochaeta gallinarum*.

³ *Argas persicus*.