Monstrosities in Siphonaptera III

by

F. G. A. M. SMIT

Castration in a male Ceratophyllus gallinae (Schrank).

Dr. C. J. M. WILLEMSE, of Eygelshoven, Holland, sent me some fleas which were collected from a nesting-box of a Great Tit (Parus m. major L.) at Heerlen (Holland) by Dr. S. J. DIJKSTRA in March 1951. All specimens, 8 ♂, 24 ♀, though dried up, could be identified without previous maceration as belonging to *Ceratophyllus gallinae* (Schrank). Since Dr. WILLEMSE asked me to send some of the specimens to the Natuurhistorisch Museum of Maastricht, I mounted them all. Whilst corroborating the identity of the mounted specimens, I noticed in 4 of the males and in 21 of the females strange objects in the body-cavity; moreover, one of the males showed a very interesting anomaly, being extremely strongly castrated. *

Fig. 1 shows the terminalia of the castrated male. The exoskeleton remained virtually unchanged, with the exception of the 8th tergum (T VIII), which has a more pronounced dorso-apical angle than is normal (cf. Fig. 3), which causes the shape of the area spiculosa (a.s.) to be atypical. The modified segments are separately shown in Fig. 2. The 8th sternum (St VIII) is quite normal, though its membranous apical process (a.p.) is shortened, not broken as might be thought from its appearance. The spiculose membrane of this sternum (s.m.) is normally developed, as is also the case with Wagner's organ (W.o.). Sternum IX (St IX) has undergone a considerable change: the basal non-setiferous arm is very strongly malformed and the basal arms of each side are fused, not separated as they are in normal specimens. There is no apodemal rod running forward from the angle where the basal and apical arms are normally joined, but at some distance above this angle there is a short blunt process (p), which presumably represents a rudiment of the normal apodemal rod. The apical setiferous arms of sternum IX (which are not fused, like the basal arms are), are also malformed, though not very greatly; they are less slender than usual and their apices are not spatulate, but instead they have subparallel margins and therefore resemble those of *Ceratophyllus fringillae* (Walker). The clasper (which is a modified tergum IX) is extremely reduced; it has a much malformed manubrium (m) and a well-developed tergal apodeme (t.a.), but there is neither a body of the clasper nor a movable process. Most remarkable however is the fact that the phallosome, constituting the whole of the male intromittent organ, has not developed at all — there is no trace of it. The absence of the clasper and of the phallosome gives the castrated flea a rather "empty" appearance (cf. Fig. 1 with Fig. 3).

The only paper dealing with castration of fleas that is known to me,

---

* This is another example of the desirability of mounting large series of a species. If I had not mounted the above mentioned material of the very common *Ceratophyllus gallinae* (the so-called European hen- or chicken-flea) I would not have seen the interesting features of these specimens and the material would have gone into the alcohol collection, probably remaining there undisturbed for many years.

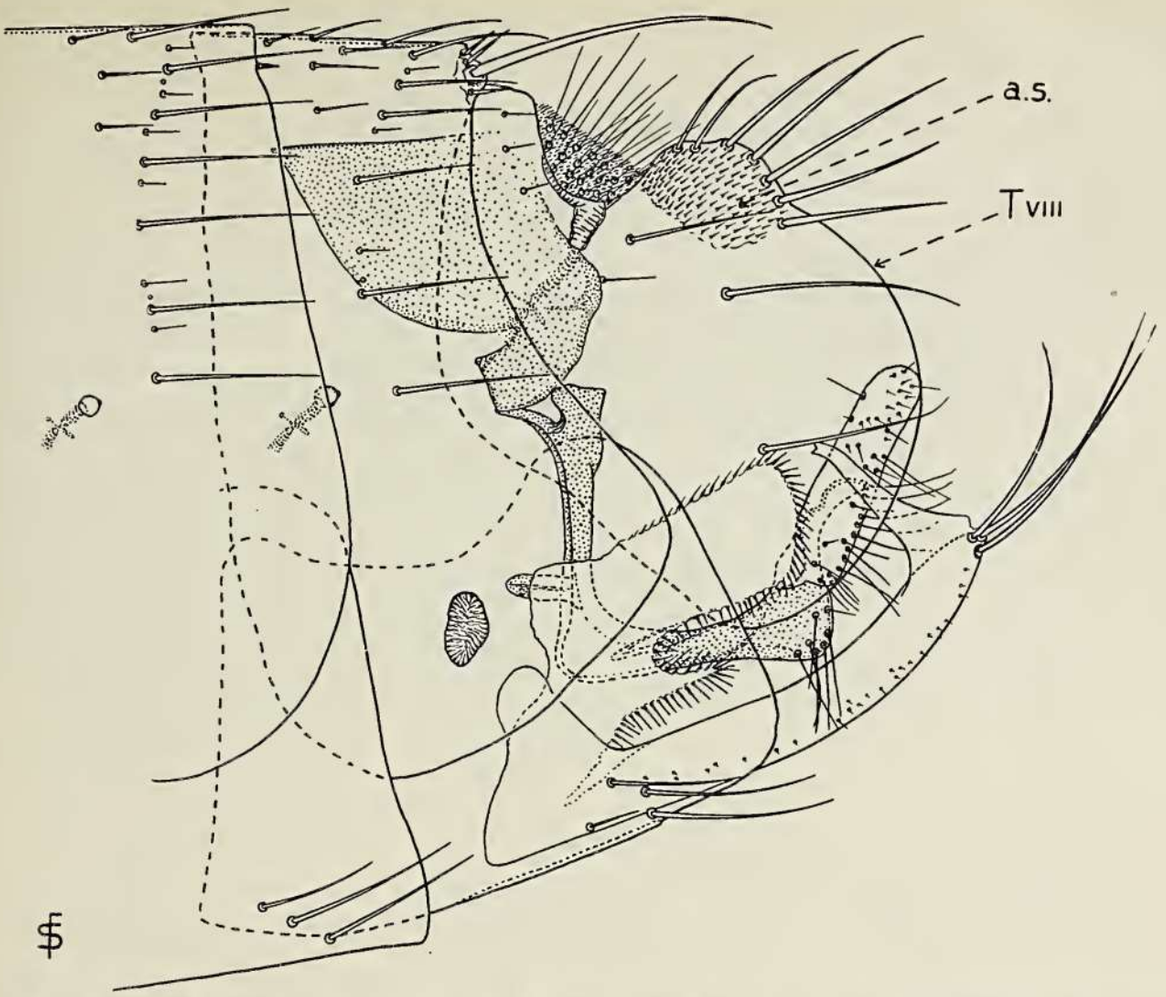

Fig. 1. *Ceratophyllus gallinae* (Schr.). Terminalia (anal segment omitted) of castrated male (from Heerlen, Holland).

is one by I. G. Ioff and V. E. Tiflov *. These authors found that a fairly high proportion of specimens of the 3 subspecies of *Coptopsylla lamellifer* (*C. l. lamellifer* (Wagner), *C. l. ardua* Jordan & Rothschild and *C. l. rostrata* Ioff & Tiflov), and also a specimen of *Coptopsylla olgae* Argyropulo, were infected with Nematodes, which had not been identified at the time of publication of their paper. It is interesting to note that anomalies were found only in the males, though the females were also parasitized, but the authors correctly point out that it might be possible to disclose anomalies of the female sexual organs if mounts were made without previous maceration with potash, or if the specimens were dissected. Out of 68 males of *Coptopsylla lamellifer* from Turkmenistan (Ashkhabad and Imam Baba), Western Kazakstan (Ust' Yurt and the lower part of the Volga region) and Eastern Kazakstan (Dzharkent), 14 were found to be castrated. In some places, however, not a single example of parasitic castration occurred among the considerable number of *C. lamellifer,* which Ioff and Tiflov examined, e.g. from the Kara-Kalpak and Uigur districts in Eastern Kazakstan. As for *Coptopsylla olgae,* 1 male (out of 12) from Imam Baha, Turkmenistan, was found to be castrated. (In the Rothschild Collection of Siphonaptera in the Zoological Museum, Tring, 3 out of 7 mounted males of *Copto-*

*) I. G. Ioff & V. E. Tiflov, 1940, Materials for the study of fleas. IV. Additional notes concerning the genus *Coptopsylla*. Flea castration by parasitic Nematodes. (Rev. Microbiol., Saratov, **19** (1): 98—103, fig. 1—2. [In Russian]).

psylla lamellifer ardua are castrated). Because the castration of the specimens of *Coptopsylla* was not as drastic as in the above-mentioned specimen of *Ceratophyllus gallinae,* the anomalous males had previously been considered to be subspecifically different from normal ones. The type of castration in *Coptopsylla* is as follows :

a) Manubrium and tergal apodeme are completely or partly undeveloped.
b) Frequently the fixed process of the clasper is narrow.
c) The movable process of the clasper is usually slightly narrower than normally and the apex is blunted, while its setae are often much reduced in number and in size.
d) Complete absence of the greater part of the penis-plate and the penis-rods.
e) The ninth sternum is malformed and its chaetotaxy is abnormal.

If we compare the effects of castration on the morphology of male *Coptopsylla*'s with the case of *C. gallinae*, as described above, we notice that in *Ceratophyllus gallinae* :

a) The manubrium is also reduced in size and distorted, but the tergal apodeme is well developed.

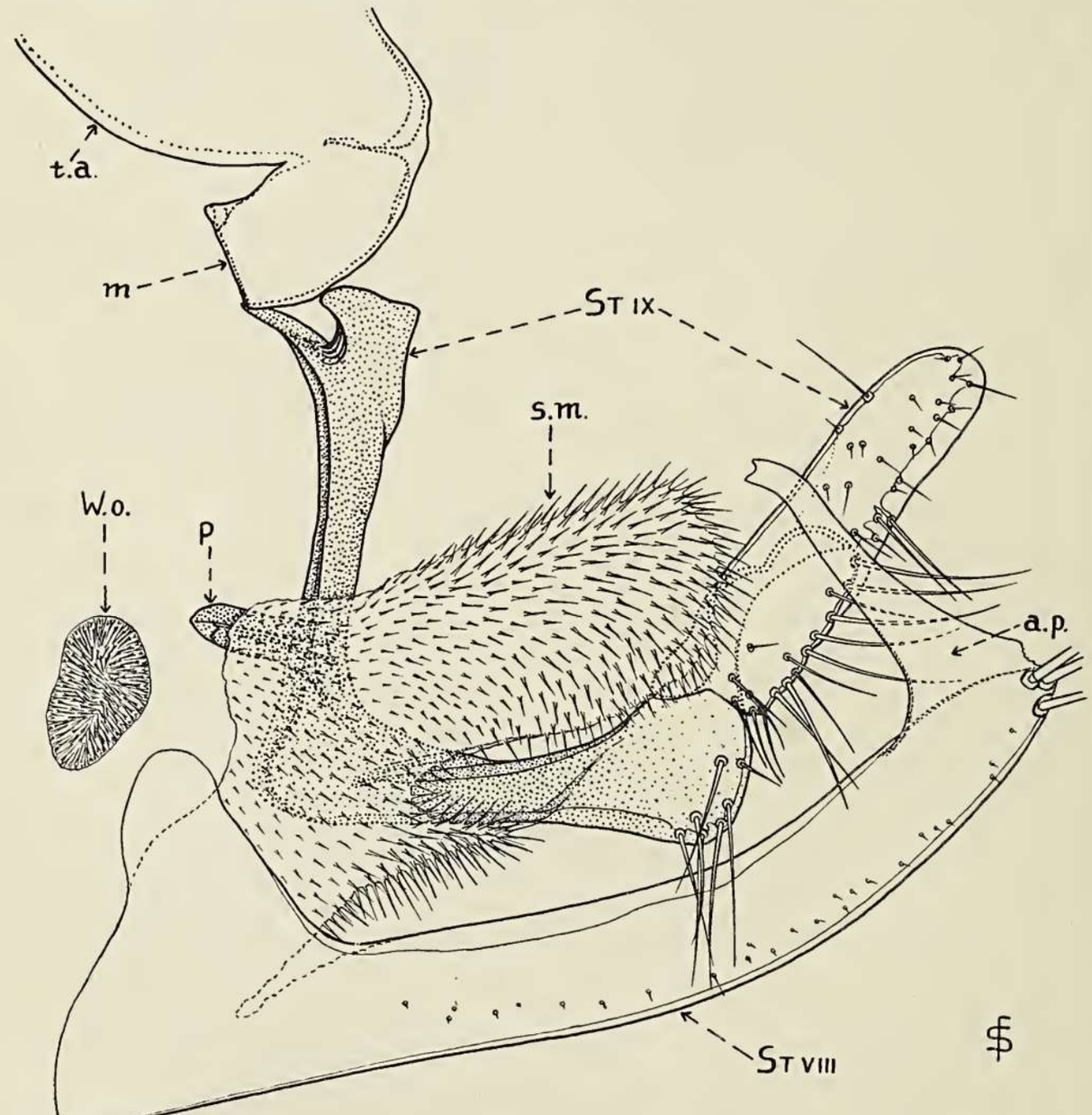

Fig. 2. *Ceratophyllus gallinae* (Schr.). Modified abdominal segments of castrated male.

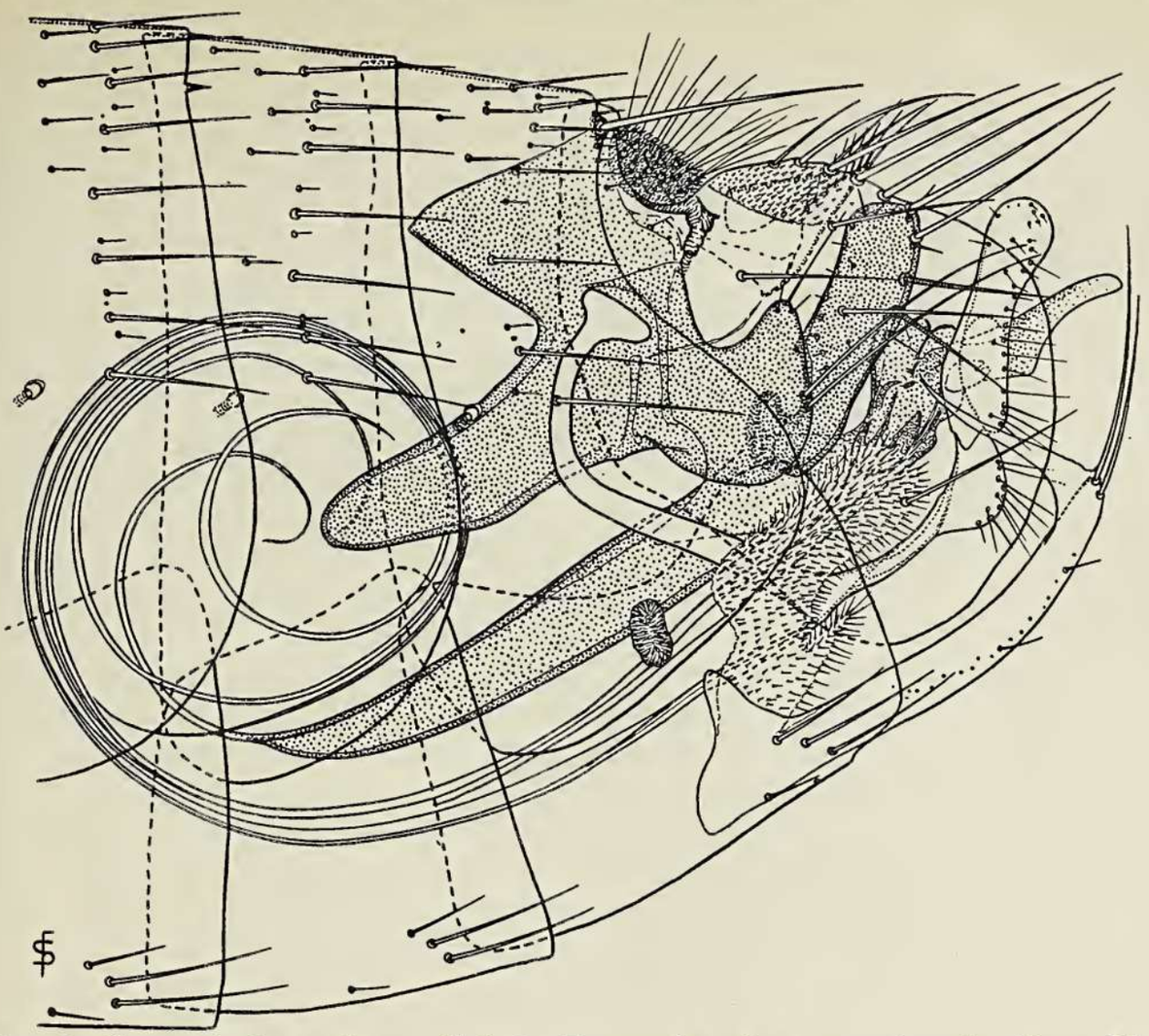

Fig. 3. *Ceratophyllus gallinae* (Schr.). Terminalia of a normal male (from Mook, Holland).

b) and c) Fixed and movable processes of the clasper are completely absent.
d) The entire phallosome is absent.
e) This is the same as in the males of *Coptopsylla*.

It is quite clear that the castration of the specimen of *Ceratophyllus gallinae,* described above, is an extreme case.

As regards the nature of the causative agent of castration, Ioff & Tifov found that in *Coptopsylla* it was caused by (unidentified) Nematodes, the total number of which per flea was estimated to be many dozens, if not hundreds. In the specimens of *C. gallinae,* two sorts of "micro-organisms" are visible in the mounted specimens : in each flea there are numerous small, somewhat circular, transparent bodies that are often attached to or inside tracheae (Fig. 4), and there may be a few larger dark, spongy-looking accumulations, which are mostly situated in the head and/or thorax. Are these bodies — I will call them corpuscles * — really the cause of the described castration ? One may assume this to be so, but what about the normal males which are also infested ? Possibly the castration and the presence of the corpuscles are in no way related, though it is not necessary that a certain cause should always have the same effect. Or perhaps the castrated male may have been infested in an earlier stage.

*) A term used only for convenience, and not to suggest any analogy with the corpuscles of the blood.

The difficulty is that the true nature of these corpuscles is unknown. Since I could not place them in any group if living organisms, I sent some slides for examination to the well-known insect-pathologist Prof. E. A. STEINHAUS of the University of California, at Berkeley. After considerable study of the specimens, for which kind service I am greatly indebted to him, he came to the conclusion that "the bodies in question appear to be collections of some crystalline material" and "It is possible they may represent some response to injury or infection but the nature of such is not apparent nor am I familiar with any particular physiological disturbances which may be responsible for these malformations. They certainly do not correspond to any known protozoan, fungus, bacterium, or virus." Professor STEINHAUS was kind enough to ask several other specialists for their views, and it appears that they all concur with the professor's opinion. Dr. C. TOUMANOFF of the Institut Pasteur, Paris, and his colleague Dr. PEREZ, also obliged me by studying some specimens with the aid of a polarizing microscope ; they, too, came to the conclusion that at least the small corpuscles are of a crystalline nature. Moreover, Dr. TOUMANOFF submitted some specimens for examination to Prof. J. WYART, specialist of crystallography at the Laboratoire de Minéralogie à la Sorbonne. Professor WYART reported that "L'examen de deux insectes au microscope polarisant, avec Monsieur TOUMANOFF, a décelé 2 formations biréfringentes fort probablement cristallisées : (a) une formation [the large type of corpuscle from the anterior part of the body] provient d'une cristallisation à partir d'un centre, avec l'apparence de fibres dont la direction de vibrations optiques seraient à 45° de la direction d'allongement des fibres ; la biréfringence est très faible, (b) des formations [the small circular corpuscles] fortement biréfringentes abondantes, avec les croix noires caractéristiques des sphérolites. Elles sont de nature différente de celles de la première." — I am most grateful to Professor WYART and to all other scientists mentioned above for their study of specimens and their opinions, which all agree with each other.

Since dissection of unmacerated specimens could doubtless throw more

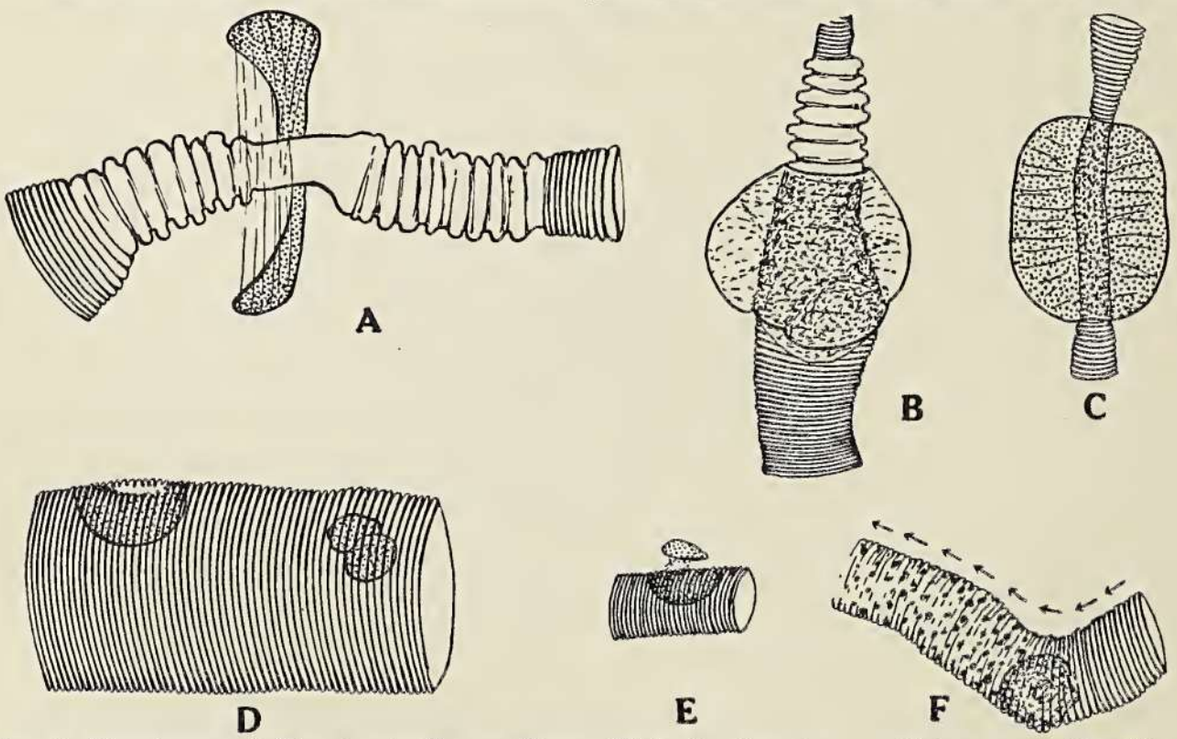

Fig. 4. Tracheae of *Ceratophyllus gallinae* (Schr.), showing malformation (A, B) and the corpuscles attached to or inside the tracheae (B—F).

light upon the nature of the corpuscles *, I asked Dr. DIJKSTRA whether he would try to obtain more fleas from the same nesting-box. I am very grateful to him for responding to my request, but unfortunately, his efforts were in vain : no more fleas were to be found in the nesting-box.

Since the question of whether the corpuscles are a cause of the castration remains undecided in the absence of a well-defined causative agent, it is better to look at some other facts, namely at the affected tracheae. These show, under high power, malformations at or near the place where small corpuscles are attached. The malformation consists in the taenidia being exceptionally coarse over a short distance, as is shown in Figs. 4 A and B. The corpuscles may more or less surround a branch of a trachea as in Figs. 4 B and C, or (even more interesting) they may lie inside the tracheae, as shown in Figs. 4 D—F. In Fig. 4 D, one can be seen attached to the tracheal wall and at the place of attachement the trachea is punctured ; more to the right two smaller ones are visible. Fig. 4 E represents a corpuscle similar to that in Fig. 4 D, and here too the trachea appears to be punctured, and in addition, there is an outgrowth at the puncture ; it is possible that a similar outgrowth may have been present in the corpuscle shown in Fig. 4 D, too, but if so it has become detached and removed during the process of preparation. Finally, Fig. 4 F shows the most interesting feature : here we see a corpuscle in a bend of a trachea ; the trachea to the left of it has many little black dots on its inner surface, while to the right of the corpuscle the trachea appears to be clean and normal. The intake-stream of air is in the direction of the arrows, and it is possibly a fair assumption that the black specks originated from the corpuscle. This seems more likely than the alternative — that the corpuscle is moving in the opposite direction to the air-intake, so that it simply leaves the black dots behind. More important is now the question of the nature of this particular corpuscle. That the corpuscles are to some extent crystalline in nature seems to be established, but this does not necessarily exclude the possibility that the crystals are inclusions within an organism (the organic part of which having been destroyed by maceration). Can a crystalline body form and excrete little black granules ? Surely not ; it seems more probable that the black granules are either spores or excrements. The phenomenon as shown in Figs. 4 D—F has a curious resemblance to the effects of the Isle-of-Wight disease of the honey-bee, which disease is caused by the mite *Acarapis woodi,* living inside the tracheae. This mite causes the tracheal trunks to be spotted with faeces, and it also punctures the tracheal walls, whilst it feeds on the blood of the bee. Are the corpuscles of Fig. 4 D—F also Acarina, which are malformed by maceration ? I do not know ; it seems improbable.

Very little is known about the tracheal diseases of insects and in presenting this note I hope to attract attention to such phenomena so that future workers may be induced to make a special study of them and provide answers to the queries mentioned in this paper.

British Museum (Natural History),
The Zoological Museum, Tring (Herts.). December 1951.

*) Any characteristic organic matter, that was part of the corpuscles, would have been destroyed by KOH ; if in unmacerated specimens the corpuscles should have the same appearance as in macerated ones, then their inorganic nature would be obvious.