HERPETOMONAS PARASITES IN FLEAS.

(Plate XIV.)

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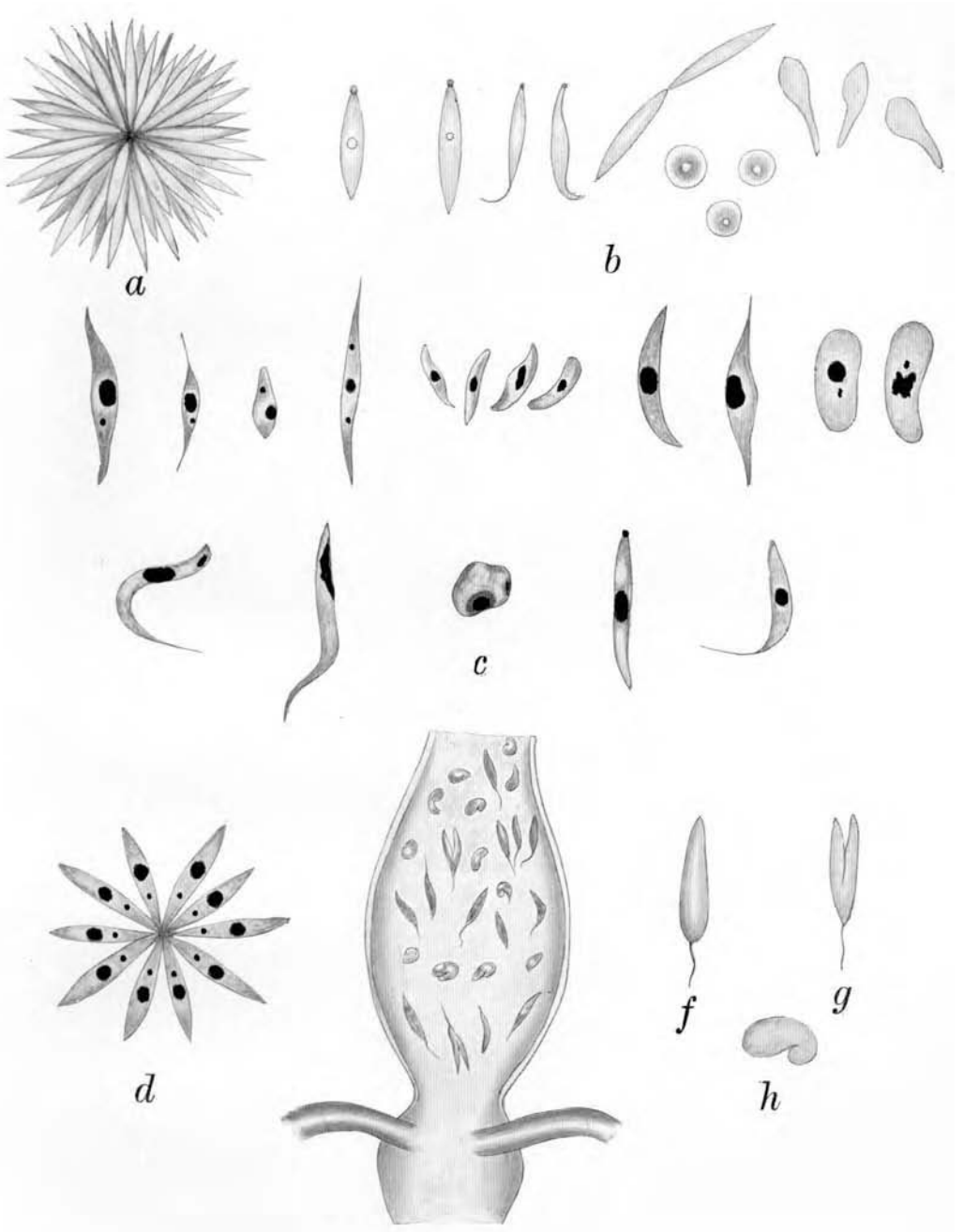
In the light of the controversy which is beginning to be waged in connection with Schaudinn's[1] researches into the life-history of *Halteridium noctuae*, and especially in view of the papers by Prof. Ross[2] which have been appearing in this *Journal*, the accompanying illustrations are likely to be of interest. They represent forms of parasite which I have found in the alimentary tract of the flea, *Pulex cleopatrae* Roths. and possibly other species, when searching for a cycle of development for *Haemogregarina balfouri* Laveran[3] in that insect which, along with mites, infests the Sudan jerboa (*Jaculus gordoni*). The illustrations were prepared by Mr Richard Muir from drawings which I made in Khartoum.

Plate XIV, *a* and *b* represent unstained forms of the parasite.

a will at once be recognised as one of the "*colonies radiées*" mentioned by Ross and which Léger[4] described in 1902 and 1903 as the rosettes of his "formes monadiniennes." It is composed of what looked like vermicule forms, but doubtless they possessed very minute flagella, though, if such existed, they were difficult to demonstrate as shown in *d*, which is a small rosette or cluster stained by Leishman's method. The large size of the micro-nuclei or blepharoplasts and the fact that they are probably situated at the same, *i.e.* anterior end, as the invisble flagella will be noted. Further it will be observed that there is no trace of undulating membranes.

b shows other unstained forms, amongst them some of more or less spherical shape which correspond to the *Amoebulae* of Ross and are probably identical with the "formes-gregariniennes" of Léger. True flagellated forms are shown which greatly resembled minute trypanosomes, besides these there are club-shaped and spindle-shaped parasites.



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I began to find these forms in the dissections of fleas which had fed on infected jerboas, and at first, curiously enough, only in female fleas which had derived blood from this source. Afterwards, however, I found very similar forms in male fleas; while my assistant, Mr Friedrichs, has more recently come across allied, if not identical, parasites in fleas fed on gerbils, the blood of which was quite normal.

To begin with, the parasites were only visible after pressure had been made on the cover-glass surmounting the flea dissection. This caused their expulsion from the alimentary tract, where they were found lying free in the neighbourhood of the easily recognised so-called rectal glands. In the salt or citrate solution employed for the dissection they exhibited very active movements, the individuals composing the rosettes being in violent agitation, while the vermicule forms swung to and fro with a motion like that of the agitated needle of a compass; and the flagellated forms, besides possessing a kind of Brownian movement, exhibited a marked though limited movement of translation.

The gregarine or amoebulae forms alone remained at rest. These parasites were kept under observation for 24 hours, but no special change was observed in them beyond a lessening, and in some cases a complete abolition of motility. At a later period a more careful dissection revealed the conditions shown in *e*, *f*, *g*, and *h*.

e represents the posterior part of the mid-gut of a female flea and shows gregarine forms which, as seen in *h*, approximate very closely to the haemogregarine type. This, together with the limitations in incidence above-mentioned, and the similarity of the appearances to those described by Schaudinn for *Halteridium noctuae* in *Culex pipiens* led me to think that I had found the freed trophozoites of *H. balfouri* undergoing a cycle of development and becoming flagellated. It was quite easy to watch these gregarine forms developing flagella (*e*, *f*) and marked motility, so that, attached by their short stalks to the intestinal epithelium, they could be seen lashing vigorously from side to side. Moreover, longitudinal division (*e*, *g*) could be observed taking place, and it is worthy of note that it began at the end opposite the flagellum and therefore presumably could not have been dependent on a binary division of the micro-nucleus unless, and this is interesting, these forms were identical with some of the stained forms to which *c* refers. There at least one parasite will be seen resembling a trypanosome in all but the absence of an undulating membrane, for, as will be noted, the micro-nucleus is at the opposite end from the flagellum. These stained parasites are from the same series of preparations as the unstained

forms. *Trypanoplasma* shapes will be seen and others not at all unlike Leishman-Donovan bodies. An extra chromatin spot is visible in one of the trypanoplasma-like bodies. The two small dots may represent the "displosome" of Prowazek [5].

It is evident that these parasites are of the nature of *Herpetomonas* and they are probably closely related to Léger's *Crithidia fasciculata.* I believe they are the first to be described in fleas, to judge from the list of invertebrates given by Birt [6], in which species of *Herpetomonas* have hitherto been found, a list by the way to which, in the light of recent work by Novy [7] and Minchin [8], several species of *Glossina* must be added.

Into the question of their exact significance and their possible relation to the haemogregarines of jerboas I do not propose to specially enter, beyond again pointing out that they have been seen (by Mr Friedrichs) in fleas which had not fed on infected blood; that recently I have found in a flea fed on an infected jerboa a condition of travelling vermicules and cyst formation, identical with that described by Christophers [9] in lice which had been fed on Indian gerbils harbouring the haemogregarine which he discovered in these rodents. That this is the true cycle in the insect there can be little doubt, for it was evident that a great multiplication had taken place, and the large, well-defined cysts contained equally well-marked sausage-shaped bodies (sporozoites ?) there being from four to six within each capsule. (See *Second Report, Wellcome Research Laboratories,* 1906.)

It is therefore probable that these illustrated forms are merely parasites of the flea itself, and it is interesting that some should so closely resemble the true *Trypanosoma* as, for instance, one of those indicated by *c.*

I append measurements of the different forms:

Unstained.

Form *f.*	Total length including flagellum	12μ
	Length of flagellum	3μ
	Greatest breadth	2μ
Form *h.*	In either diameter	about 6μ

Stained.

Trypanosome forms.

Total length including flagellum	10·5μ to 11·25μ
Length of nucleus	1·5μ
Length of body	6·75μ
Length of flagellum	3μ to 4·5μ

Stained.

Individuals composing rosette	
Length	7·5μ to 9μ
Greatest breadth	1·5μ to 2μ
Vermicule forms—no flagella visible	
Length	7·5μ to 12μ, a few 22·5μ
Greatest breadth	1·5μ to 2μ

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