A PRELIMINARY LIST OF PROTOZOA IN BRITISH COLUMBIA TERMITES

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The presence of protozoa in the lower termites has long been known and was first recorded by Lespes in 1856. Since then, many genera and species have been discovered. The opinion formerly held by some entomologists was that there was some correlation existing between the presence of protozoa and the condition of the sexual organs. Recent researches would indicate that the majority of protozoa are symbiotic and that their presence has nothing to do with the sexual organs.

To get a clear understanding of the relationships of protozoa and termites, it is necessary to present a brief description of the digestive tract of those which contain these symbionts.

Embryonically, the gut is divisible into three well-defined regions; the fore-intestine or stomodeum, the mid-intestine, and the hind-intestine or proctodeum. The stomodeum and the proctodeum are formed embryonically as invaginations of the anterior and posterior body wall respectively. The lining, therefore, of the fore- and hind-intestine is of the same material as that of the exoskeleton, that is, chitin. The mid-intestine arises independently of the body wall and thus lacks this chitinous lining.

The thin-walled pharynx merges into the oesophagus and a large crop, followed by the gizzard. Posterior to the gizzard the foregut protrudes into the cavity of the mid-intestine, forming a large oesophageal valve. At the anterior end of the mid-intestine, which is tubular and of uniform size throughout, are four short enteric caeca. At the junction of the mid- and hind-intestines are a number of Malphigian tubules. Posterior to these tubules, and in the enlarged portion of the hind-intestine, are present large numbers of protozoa. The larger members of this protozoan population appear to live in a symbiotic relationship with their host. In return for food, protection and a suitable medium in which to live, they render the termite a service in the digestion of cellulose which the termite is unable to perform alone.

According to Beall's (2) and my own collection the following are the three species of termites in British Columbia:— **Zootermopsis angusticollis** (Hagen), **Z. nevadensis** (Hagen) and **Reticulitermes hesperus** (Banks). In the first two of these species the digestive tract is as described above. The protozoa occurring in these are as follows, those I have found being indicated by an asterisk:

Z. angusticollis, the common damp-wood termite.

* **Trichonympha collaris** (Kirby).
* **T. campanula** (Kofoid and Swezy).
* **T. sphaerica** (Kofoid and Swezy).
* **Streblomastix strix** (Kofoid and Swezy).
* **Trichomonas termopsidis** (Cleveland).
* **Tricercomitus termopsidis** (Kirby).
* **Hexamastix termopsidis** (Kirby).
* **Hirmocystis termitis** (Leidy).

Z. nevadensis, the small damp-wood termite, is believed to have the same species of protozoa as **Z. angusticollis** but as yet I have not examined any of this species.

R. hesperus (Banks), the western subterranean termite.
* **Trichonympha agilis** (Leidy).
Microjoenia ratcliffei (Brown).
* **Torquenympha octoplus** (Brown).
* **Spironympha porteri** (Koidzumi).
S. ovalis.
* **Spirotrichonympha flagellata** (Grassi and Foa).
* **Holomastigotes elongatum** (Grassi).
Dinenympha fimbriata (Kirby).
Dinenympha sp.
* **Pyrsonympha major** (Powell).
P. minor.
P. granulata.
* **Hirmocystis termitis** (Leidy).

Protozoa are not present in newly-hatched termites. They are fed for some time on material (stomodeal food) regurgitated by the parents but after a moult or two, proctodeal food is added and finally constitutes almost the entire food supply procured from another individual. As there are no protozoa in the fore-intestine of the parents, first instar termites receive no protozoa in stomodeal food. There are protozoa in all the older instars. Nymphs, soldiers and adults contain the same species of protozoa, but they differ in total population and possibly relative proportion in the different forms of termites. Adults contain fewer protozoa than do nymphs of the seventh instar. The total number of protozoa found in immature termites varies with the time since the last moult and the nearness to the next moult.

A month before the moult, the intestine appears normal in every way and possesses its usual content of food material and protozoa. From three to four weeks before the moult, the termite enters a period of self-starvation, so that the food content of the intestine disappears but the protozoa remain. However, with their food supply cut off, the wood-eating protozoa gradually starve and disappear. Of these, the three species of **Trichonympha** go first followed by **Trichomonas,** so that

all four are completely absent before the moult occurs. Of the other three species of protozoa present, **Streblomastix** may, or may not remain through the period of the moult and **Tricercomitus** and **Hexamastix** always persist in the intestine.

As was said before, the fore-intestine and hind-intestine walls are lined with chitin which is continuous, through the mouth and anus, with the exoskeleton of the insect; with the shedding of the exoskeleton, these chitinous linings are also shed. Having thus renovated its digestive tract, the termite must reacquire a protozoan fauna. The above three smaller, non-symbiotic species of protozoa may remain in the gut through the moult; the larger species must be reacquired from other termites. The exact method of refaunation is not definitely known. That refaunation does not take place by anal contact with protozoa or faeces is shown by the careful studies of Andrew (1). Refaunation does take place readily by feeding on material containing protozoa. The methods by which the protozoa can be normally obtained for this feeding were not definitely determined in Andrew's experiments. Faeces do not contain protozoa in motile condition or in cysts, though there is some indication that cystoid forms of **Trichomonas termopsidis** and **Trichonympha campanula** exist in the intestine under certain unfavorable conditions. Feeding termites on faeces does not refaunate them. Cannibalism leads to a transfer of protozoa but it is not the only agency that achieves this result. Protozoa have been found in some instances on the unextruded pellet and in the first drop of intestinal fluid, hence the transfer of protozoa during proctodeal feeding may be one of the normal methods of refaunation. Andrew states that in mixed groups of faunates and defaunates where cannibalism was prevented and no stomodeal feeding or dropping of liquids was observed, proctodeal feeding on the part of both faunates and defaunates continued as usual, but refaunation was not accomplished, indicating that this may not be the most effective method of refaunation. In a few cases, liquid droppings were found to contain living flagellates, so that feeding on these and on fresh nest structures in which intestinal fluid is used as a cement may probably account in part for normal refaunations. By using recently moulted individuals it was determined that in the normal colony, refaunation has usually taken place by the third or fourth day.

Careful studies of the number of protozoa in a large normal nymph have shown approximately 25,000 **Trichonymphs** and about 500,000 **Trichomonas** (1).

Gregarines are also present in **Z. angusticollis** at least, and probably in **R. hesperus.** These are purely parasitic and are located in the anterior part of the mid-intestine. Their population varies in a single individual from one or two to several hundred (8). In the development, the immature gregarines are first attached to the intestinal wall in the crevices

between two groups of cells. Later the epimerite of the young gregarine is lost and then the protozoa becomes free. These parasites have no apparent effect upon the cells of the intestine, nor is the termite visibly affected by the presence of large numbers of gregarines. **Hirmocystis termitis** is the common species I have found in **Z. angusticollis. Kofoidina ovata** (Henry), a second gregarine, is recorded in **Z. angusticollis** from the State of Washington. As yet, this species has not been found in any of the British Columbia specimens.

Spirochaetes and bacteria are fairly common in the intestine. Some spirochaetes and bacteria are normally found adherent to the surface of the flagellates.

Some of the flagellates have internal parasites of their own, generally bacteria.

From this work, it can be seen that the protozoa in British Columbia termites are similar to those existing in similar termites of California.

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