The effect of the mite *Myocoptes musculinus* (C. L. Koch 1840) on the skin of the white laboratory mouse and its control

By D. P. Watson, B.Sc., M.R.C.V.S.

Biology Department, Royal Free Hospital School of Medicine, London

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INTRODUCTION

The object of this work was to find the effect, if any, of the mite *Myocoptes musculinus* (C. L. Koch, 1840) on the skin of the white laboratory mouse by histological examination of normal and infected skins. It was undertaken because there is a good deal of research proceeding on mitotic activity using the malpighian layer of the skin of the mouse (Bullough, 1951, etc.). Previous work by Cook (1953), Stoner & Hale (1953), Madden, Tozloski & Sweetman (1954), Flynn (1955) and Davis (1957) gives no indication of the effect of the mite or of acaricides on the skin of the host.

**Spread of infection**

Infection of the bedding of the mouse rarely occurs or is accidental, and spread of the mite is from body to body in the nest.

*M. musculinus* has the third pair of legs in all stages modified for attachment to the hairs of the host by means of a specialized locking device (Watson, 1960). In the tritonymph and female, this device is also present on the fourth pair of legs. The mite is capable of rapid movement through the host hairs when this specialized limb is extended, but should the hairs be disturbed, it immediately attaches itself firmly. This reflex is a protective mechanism which prevents the mite being brushed off as the mouse travels through grass or bedding.

The young are infected from their mother at 4½ days, the mites clinging to the vibrissae on either side of the mouth.

When a mouse dies, its body temperature drops and the mites leave the deeper hair layer and migrate to the hair tips. Here they attach themselves by means of the modified hindlegs, whilst the front ones wave continuously in the air and make grasping movements. When another mouse sniffs inquiringly at the body, the mite transfers to its vibrissae and so gains a new host. The grasping motions are continuous and purely reflex; the mite will grasp a steel needle if one is placed within reach.

**Sites of infection**

The usual sites of infection are face, between the ears, inguinal region and base of tail. In heavy infections on untreated mice, these are increased to include the shoulders and may spread right down the back. In the adult mouse, the presence of large numbers of mites causes poor greyish coat, some skin reddening, hair
thinning or loss, and some irritation resulting in localized skin bleeding (see Fig. 1). This is followed by increase in size of the affected areas, weight loss, marked emaciation, debility and eventually death of the mouse.

**Histological examination of skin**

An histological examination of the skin was made to determine the effect of the mite on the rate of cell division of the malpighian layer, and to see if this differed between young (6–8 weeks) and adult (6 months and older) mice. The mice used were all male and, as far as possible, were litter-mates, as Bullough & Johnson (1951a) found that the oestrus cycle and phase of hair growth affected mitotic activity.

Samples of skin from snout, head and base of tail were treated with colchicine using the technique of Bullough & Johnson (1951b). The effect of the colchicine is to bring up the mitotic divisions of the cells in the malpighian layer to the metaphase stage and then arrest it. The samples were taken from three young clean and infected mice and three adult clean and infected animals. After embedding, the skin was sectioned at 5 and 8 μ and the sections stained in haematoxylin and eosin. The sections were examined histologically, and eighteen fields of view were selected at random from each sample and the number of metaphases counted in each. The results were subjected to statistical analysis. The skin was also examined to see if the mite had any other effect, for example, on the superficial layers of the epidermis and on the dermis.

**Effect of *Myocoptes musculinus* on the skin**

On examination of the sections, it was seen that, unlike *Sarcoptes scabiei*, which burrows into the skin, *M. musculinus* is purely a surface dweller. It feeds on the superficial epidermal layers and at no stage of its life cycle does it penetrate the deeper layers of the skin, or ingest blood or serum.

On comparing samples of skin from adult normal and infected mice, it was found that the infected skin had increased in depth (Fig. 2) and was twice as thick

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**Fig. 1.** Adult clean male mouse, coat white and glossy (left), adult male mouse showing signs of mange; note grey appearance of coat (right).
**Effect of M. musculinus on the mouse**

as the normal in the region of the malpighian layer. There was no increase in thickness of the deeper layers, but there was, however, some cellular infiltration in the zone just below the malpighian layer. The cells which had invaded this region were mainly macrophages and some lymphocytes. Furthermore, the number of cells in the metaphase stage in the malpighian layer were found to be approximately four times as numerous in the infected as in the normal mouse (Table 1, para 1). In contrast to these results, the effect of *M. musculinus* on the actively dividing skin of clean and infected mice of 6–8 weeks, is negligible. The skin desquamation is quite marked at these ages and seems to more than supply the needs of the mite without having any pathological effect on the skin of the mouse. There is no increase in number of mitotic divisions and no noticeable cell infiltration (Table 1, para 2).

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**Table 1. To show mitotic rate in clean and infected skin of mice of various ages**

<table>
<thead>
<tr>
<th>Paragraph</th>
<th>Type</th>
<th>Mean mitotic count</th>
<th>S.E. of count</th>
<th>Dif. of means</th>
<th>S.E. of difference of means</th>
<th>Value of 't' test</th>
<th>Significance (positive if <em>P</em> &lt; 0.01)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Clean adult</td>
<td>2.16</td>
<td>0.0960</td>
<td>5.54</td>
<td>1.878</td>
<td>&lt; 0.01</td>
<td>Significant</td>
</tr>
<tr>
<td></td>
<td>Infected adult</td>
<td>7.7</td>
<td>1.876</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Clean young</td>
<td>6.5</td>
<td>0.0707</td>
<td>0.25</td>
<td>0.2572</td>
<td>&gt; 0.3</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td>(6 weeks)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Infected young</td>
<td>6.25</td>
<td>0.2474</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(6 weeks)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Control of Myocoptes musculinus**

The following drugs were tested in an attempt to control the mite: benzene hexachloride (0.015 %), dieldrin (0.015 %), arsenic and sulphur (0.018 %), piperonyl butoxide (5 %) and dimethylphthalate (100 %).

Dimethylphthalate, an oily liquid, was found to be most efficacious, as it also controlled *Myobia*: a prostigmatid mite which also occurs on mice and is found
with the anterior half of its body buried in the superficial epidermal layers. Usually only one or two of these mites are present on a *Myocoptes*-infected mouse, but if only non-oily drugs are used to control the *Myocoptes*, the *Myobia* is unaffected by these and rapidly multiplies to become the chief parasite. Belozerov (1957) found that dimethylphthalate acted as a repellent against *Bdellonyssus bacoti*, rather than as an acaricide.

It seemed important to ascertain whether or not the drugs used had any effect, themselves, on the skin of uninfected mice. Histological examination of normal uninfected skin was carried out: (1) after one application of the drug; (2) after two applications, with a week’s interval between them. It was then found that the acaricides did not affect the mitotic count in the malpighian layer (Table 2).

### Table 2. To show that the drugs used have no appreciable effect on the mitotic rate in the malpighian layer of the skin

<table>
<thead>
<tr>
<th>Type</th>
<th>Mean mitotic count</th>
<th>S.E. of count</th>
<th>Difference of means</th>
<th>S.E. of difference means</th>
<th>Value of ‘t’ test</th>
<th>Significance (positive if P &lt; 0-01)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean undipped Adult</td>
<td>2-3 (1) 0-01</td>
<td></td>
<td>(1, 2) 0-22</td>
<td>0-08</td>
<td>&gt; 0-0</td>
<td>These differences are therefore not significant</td>
</tr>
<tr>
<td>B.H.C. dipped, × 2</td>
<td>2-08 (2) 0-0793</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dieldrin dipped, × 2</td>
<td>2-46 (3) 0-0844</td>
<td></td>
<td>(1, 3) 0-16</td>
<td>0-09</td>
<td>&gt; 0-01</td>
<td></td>
</tr>
<tr>
<td>Piperonyl butoxide dipped, × 2</td>
<td>2-07 (4) 0-0437</td>
<td></td>
<td>(1, 4) 0-23</td>
<td>0-26</td>
<td>&gt; 0-01</td>
<td></td>
</tr>
<tr>
<td>Dimethylphthalate dipped, × 2</td>
<td>2-6 (5) 0-1054</td>
<td></td>
<td>(1, 5) 0-3</td>
<td>0-1054</td>
<td>&gt; 0-01 &lt; 0-02</td>
<td></td>
</tr>
</tbody>
</table>

### Effect of diet on symptoms of myocoptic mange

Laboratory mice are usually fed exclusively on rat cubes, which contain a concentrated diet. In infected mice fed on green food as well as cubes, symptoms of mange are delayed for periods of up to a year, although the mite population carried is as heavy or heavier than on those showing actual symptoms and fed cubes only.

This suggests that there is a precursor for protection in fresh green food, and several authors (György, 1938; Kartman, 1943; Kelemen & Tenyi, 1949) have suggested that vitamins, such as vitamin A and riboflavin, which are more abundant in fresh food, may help to protect animals from parasites and disease. That this protection is not merely a matter of acquired immunity is shown by the fact that adult mice infected with *Myocoptes* and deprived of green food, show symptoms of mange, and continue to do so at subsequent infections, the symptoms becoming more pronounced with each additional attack. Also, trace elements, such as iron, are found in soil-splashed Brassicas and are essential for the proper function of the thyroid, which also plays a part in combating disease (Reitler, 1947; Todd, 1949) and in preventing anaemia. Greens must be available for the mice at weaning time and supplied regularly each day, as the mice will nibble inquiringly at almost anything at this time. If greens are given to older mice previously fed only cubes, they refuse to eat them, their feeding pattern having been already fixed.
Effect of M. musculinus on the mouse

The rat cubes contain insufficient roughage for the proper functioning of the gut and post-mortem examination shows it to be always distended with gas. Thus the health of the laboratory mouse is very near the border-line and pathological symptoms may easily develop as a result of mite attack or even of treatment with acaricides.

Carriers of Myocoptes musculinus

Specimens of Mus musculus L. and Microtus agrestis, from various parts of the country, were examined for parasites. Only a few Myocoptes were found among the numerous parasites (other mites and lice) carried by the mice and no symptoms of mange were seen. It is thought that this may be due to the fact that these mice are harder and, on an average, younger than the laboratory mouse. They also have access to a more balanced diet. No Myocoptes were found on Apodemus sylvaticus, and this confirms the observations of Elton, Ford, Baker & Gardner (1931).

SUMMARY

1. The means of attachment of the mite Myocoptes musculinus to the hair of the host, the mouse, and the sites where it is located are given.
2. Normal and skin infected with M. musculinus of young (6–8 weeks) and adult (6 months) mice is treated with colchicine and examined histologically.
3. Infected skin shows a mitotic count of approximately four times that of normal skin in the adult; there is no appreciable difference in the young.
4. Acaricides used to control the mite were benzene hexachloride (0.015%), dieldrin (0.015%), arsenic and sulphur mixture (0.018% arsenic), piperonyl butoxide (5%) and dimethylphthalate (100%); the latter being the most efficacious.
5. It is established that the drugs had no effect on the rate of division of the cells of the malpighian layer of the skin.
6. The number of Myobia present increases as the Myocoptes are killed unless dimethylphthalate, an oily liquid, is used at intervals.
7. Diet in conjunction with signs of mange is discussed.
8. Carriers of M. musculinus are given.

I wish to thank Cooper McDougall for supplying the materials used in dipping and swabbing, and the Infestation Control Laboratory of the Ministry of Agriculture for supplying me with a number of specimens of wild mice from different parts of the country. I am also grateful to the Council of the Royal Free Hospital School of Medicine for facilities for carrying out the work; and to Dr A. M. Hughes for her helpful guidance at all stages of the work and especially for reading the paper.

REFERENCES


