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Stress as a Factor in Parasitism

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Stress as a Factor in Parasitism
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The basic problem under investigation may be stated as follows: Does stress make an individual less resistant to parasitic infection?

Under a New York Zoological Society grant during the summer of 1959, I was able to show that when ground squirrels were subjected to the stress of heat, constant light, fear, crowding, annoyance, noxious stimulants, hunger, constant darkness or narrow confinement, the numbers of protozoa in the cecum increased as compared to control animals. The latter were trapped in the field, brought to the laboratory and examined immediately. A group of squirrels was placed in a large cage but was not subjected to any type of stress. It was found that in these animals the cecal protozoa increased in numbers as readily as in the stressed groups.

Four major problems presented themselves for study during the summer of 1960.

1. Could the numbers of cecal protozoa in the control squirrels be increased by the stress of capture, transportation to the laboratory, and preparation for examination, all of which sometimes required several hours?

This summer I trapped 39 animals in various locations during June, July and August, sacrificed them immediately and made blood smears and collected cecal samples to be examined in the laboratory later. The protozoa count was thus a more accurate representation of field conditions and therefore my control figures were more accurate.

2. Was the increase in numbers of protozoa in the caged animals due to a change in diet and not to stress factors?

One hundred and fourteen squirrels were trapped at various localities during this summer and were divided into several groups. Some were fed dandelions only (a "natural" food), some received rabbit pellets only, others were fed dandelions in the morning and pellets in the afternoon, and one group was fed both types of food but was kept in constant light and increased temperatures. Resulting protozoa count is summarized below. The figures should be compared with the average control number of 66.

<table>
<thead>
<tr>
<th>Food</th>
<th>Protozoa Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dandelions only</td>
<td>76</td>
</tr>
<tr>
<td>Pellets only</td>
<td>118</td>
</tr>
<tr>
<td>Dandelions and pellets</td>
<td>99</td>
</tr>
<tr>
<td>Both types of food but animals kept in constant light and heat</td>
<td>114</td>
</tr>
</tbody>
</table>
Although the results do not rule out diet as the only factor in protozoa increase, the evidence indicates that stress favors the protozoa. In the animals living under the stress of light and heat, the numbers of cecal protozoa increased about 15 per cent over those in animals living at environmental temperatures and fed the same diet. Even in animals fed dandelions only, one of the plants on which the squirrels feed normally in the field, there was a 15 per cent increase in numbers of protozoa over the controls.

3. Does caging alone really produce sufficient stress to bring about an increase in numbers of cecal protozoa, or was the single cage used in 1959 subjected to unnoticed stress factors?

Ninety-three squirrels were placed in cages of two sizes and various degrees of crowding from one animal in one cage to 10 animals in a cage of similar size. Protozoa increased in numbers in practically all animals. These results indicate strongly that caging alone produces conditions within the cecum which encourage the development of protozoa.

4. How does one measure stress?

According to Hans Selye, John Christian, and other workers, one of the main indications of stress is an increase in the weight of adrenal glands. Accordingly, I weighed these organs in all control and caged animals. The results are summarized below.

<table>
<thead>
<tr>
<th>Weight of adrenals</th>
<th>Control animals</th>
<th>Stressed animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight in mg.</td>
<td>28.5</td>
<td>22.5</td>
</tr>
<tr>
<td>Per cent weight (adrenals/body wt.)</td>
<td>.0095</td>
<td>.0090</td>
</tr>
</tbody>
</table>

There was thus about 21 per cent decrease in total adrenal weights in the caged animals and almost a 5 per cent decrease in the percentage adrenal weights. These results are at variance with those reported by other workers studying stress.

An analysis of this summer's work must still be made to compare protozoa counts in the following groups of animals: males only, females only, young animals, mature animals, animals from each isolated locality and animals placed in various special groups in the laboratory. An analysis of the weights of the right and the left adrenal glands of each of these groups must also be made. There are also about 150 blood smears waiting for differential blood counts. A reduction in the white blood cell count is another indication of stress.

Assisted by Mrs. Glenn Noble.
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