THE POTASSIUM AND WATER CONTENTS OF CAT NERVES AS AFFECTED BY STIMULATION

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A loss of potassium from unmyelinated crab nerve has been reported by Cowan ('34) and has been recently confirmed with somewhat improved technique by Young ('38). Vogt ('36) has reported losses of K from the cervical sympathetic ganglion during stimulation. No observations have apparently been made on myelinated nerves except two experiments (Fenn, '34) on frog nerves which showed only losses of K and of Cl too small to be significant. In this paper experiments are reported on the sciatic nerve of the cat. In part, the observations were incidental to other experiments on the loss of potassium from cat muscle (Fenn and Cobb, '36) when stimulated through its nerve.

METHODS

While details differed in the various experiments, the usual procedure consisted in cutting the sciatic nerve on both sides of the cat as far centrally as possible and stimulating on one side through shielded silver electrodes with either a continuous or intermittent tetanus for 30 minutes or more. The branch of the nerve supplying the hamstring muscles was cut. After stimulation, the animal was bled to death and both sciatic nerves were dissected out, omitting 2 cm. at the central end which had been between or just below the electrodes. The tibial branch was dissected out to the gastrocnemius muscle and the superficial peroneal to the ankle. Both nerves were treated as much alike as possible during the dissection, with care to avoid undue drying and inclusion of any of the surrounding tissues. The nerves were weighed fresh in weighing bottles, dried at 100°C. to constant weight, ashed in a muffle furnace at 500°C. and analyzed for potassium by a slightly modified Shohl and Bennett method. Each nerve weighed about 0.5 gram and contained about 0.8 mgm. of potassium, an amount well within the range of the method. The accuracy of the analyses for which I am mostly indebted to my assistant, Mrs. Doris Cobb Marsh, has been checked in many previous investigations. The average difference between the potassium contents of paired nerves has been found to be 2 per cent (Fenn and Cobb, '35). A single control experiment in which both nerves were unstimulated showed changes as large as those usually observed in stimulation experiments and indicated that nothing could be gained by a more extensive control series.

RESULTS

A total of twenty-four experiments were completed and the results are summarized in Table 1. The water and potassium contents of the resting nerves were quite variable, presumably because of varying amounts of myelin.
sheath, fat, and connective tissue. The potassium figures were equally variable, whether calculated per 100 grams of nerve water or per 100 grams of dry tissue, so that the variation was not all due to different amounts of non-aqueous solid material, but partly due, presumably, to varying amounts of axones.

**TABLE 1**

*Summary of twenty-four experiments*

<table>
<thead>
<tr>
<th></th>
<th>Normal content</th>
<th>Probable error of mean</th>
<th>Range</th>
<th>Change due to stimulation</th>
<th>Out of 24 cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water: cc. per 100 gms. dry</td>
<td>196.0</td>
<td>±2.1</td>
<td>164–240</td>
<td>+5.6 ±2.1</td>
<td>14 gains</td>
</tr>
<tr>
<td>Water: cc. per 100 gms. wet</td>
<td>66.2</td>
<td>±0.07</td>
<td>62–70</td>
<td>+1.9 ±0.7</td>
<td>14 gains</td>
</tr>
<tr>
<td>Potassium: m.-eq. per 100 gms. dry</td>
<td>14.1</td>
<td>±0.2</td>
<td>11–17</td>
<td>+0.09 ±0.19</td>
<td>10 gains</td>
</tr>
<tr>
<td>Potassium: m.-eq. per 100 gms. water</td>
<td>7.3</td>
<td>±0.09</td>
<td>6.4–8.5</td>
<td>−0.15 ±0.06</td>
<td>17 losses</td>
</tr>
</tbody>
</table>

The changes in water and potassium caused by stimulation were in general small, and none of the average changes shown in the table were really significant as indicated by the probable errors of the means which are included in the table. In general, about half of the nerves showed gains and half losses. The most nearly consistent result was obtained from the potassium changes calculated per 100 grams of nerve water. The figures showed that seventeen out of twenty-four nerves lost potassium but the average loss was only 2.5 times the probable error. If there is any loss of potassium, therefore, it amounts to less than 2 per cent and is too small to be detected with certainty by this method.

While a statistical study shows that the changes observed on stimulation were not significant, some of the changes were too large to be accounted for purely by the analytical error. The largest of these were losses of both potassium and water, or gains of both potassium and water (per 100 grams of dry weight) amounting to 15–25%. Such results might be due to the inclusion of more nonaqueous material with one of the nerves than with the other; they were particularly evident in the first few experiments where the dissection may have been less skillful. Moreover, the ratio $\Delta H_2O/\Delta K$ in these extreme cases was closely similar to the ratio of $H_2O/K$ in the original nerve. Other occasional variations were probably attributable to some experimental error. Many attempts were made to obtain more consistent results by varying the nature of the stimulation, or the condition of the animal, or by better preservation of the blood supply of the nerve, but the results were always disappointing.

It is necessary to conclude, therefore, that any mobilization of K or gain of $H_2O$ which may occur is so delayed by the medullary sheath that the net change is inappreciable. Or the change due to each impulse is so small that recovery is complete before the arrival of the next one. It is also possible that the electrolyte changes are purely secondary phenomena, dependent upon the
recovery processes so that conduction can occur in cat nerves without a loss of potassium.

**Summary**

Cat nerves stimulated continuously in situ for 30 minutes or more at a frequency of 50–100 per second show no consistent loss or gain of potassium or water.

**REFERENCES**


Young A. C. The effect of stimulation on the potassium content of Limulus leg nerves. This Journal, following paper.