According to the common view peat types in which remains of Carex or Bryales dominate are of a better quality than those mainly composed of Sphagnum species. Thus within the Finnish classification in which the moss peats are divided into Sphagnum peat (Sp) and Carex-Sphagnum peat (CSp), and the fen peats into Sphagnum Carex peat (SCp), eutrophic Sphagnum-Carex peat (EuSCp), Carex peat (Cp) and Bryales-Carex peat (BCp), the quality of the peat is supposed to improve in this order. This, however, is not always the case when results of peat analyses are examined a marked variation within a certain peat group both in the nutrient content and other characteristics may be established (c.f. Kivinen 1933, Kaila et al. 1954, Kaila 1956 b). The differences between the mean values are often significant, but the individual data of one group are almost always overlapping the corresponding range of the other groups.

It was not likely to obtain markedly differing results when the cation content of various peat types was chosen as the object of the present study. In most of the papers dealing with the nutrient content of peat only the total amounts are reported. Yet, the authors found it desirable to get more information of the plant-available calcium, magnesium, and potassium in samples of virgin peat soils.

The problem of the availability of these nutrients to plants was conventionally solved. Considering the fact that the samples were air-dried and ground the results obtained by any method are likely to yield only an approximate estimate of the plant-available amounts under the natural conditions. Therefore, instead of the usual determination of exchangeable cations by washing with barium acetate the analytically more convenient extraction with ammonium chloride was employed.

**Material and methods**

The material of the present study was partly the same as in a previous work (Kaila 1956 b). It consisted of 208 samples of virgin peat soils collected mostly from Northern Finland. The samples originated both from the surface and the deeper layers.

The peat type and the degree of humification were estimated by direct examination of the fresh samples in the field. All the other analyses were performed
using samples which were air-dried and ground in a Wiley mill. The soil pH was determined in water suspension (1: 4) by a Beckman pH-meter with glass electrode. The volume weight was measured with an apparatus developed in this laboratory (cf. Kaila 1956).

The determination of the extractable cations was performed shaking 5 g samples of peat in 100 ml of 1 N ammonium chloride for two hours. The suspension was filtrated through paper without washing. Calcium, potassium and sodium in the filtrate were determined using a flame photometer by Lange. Magnesium content of the filtrate was calculated as the difference between the total calcium and magnesium content estimated by the versenate titration (Cheng and Bray 1951) and the calcium content obtained in the flamephotometric way.

**Origin and quality of the samples**

The results are reported in Table 1. The title «Bog type» means peat land vegetation type. The letter R = »räme» or pine bog, N = »neva» or treeless oligotrophic bog, K = »korpi» or spruce-broadleaved tree swamp, and L = »letto» or rich treeless fen. The column titled »Bo« represents the degree of land quality, estimated on the basis of the surface vegetation. The grading from 1 to 10, common in Finnish soil survey, is used. The classes from 5 to 10 are generally considered tillable.

There are 32 samples of Sp from treeless oligotrophic bogs or pine bogs with a low degree of land quality. The origin of the 31 samples of CSp is not markedly better. A large part of the 59 SCp-samples were collected from tillable peat lands, but among them are also samples particularly from the deeper layers of peat lands with a poor surface vegetation. Only 7 samples of EuSCp were available, all of them from rich treeless fens as well as all the 33 samples of BCp. The origin of the 46 samples of Cp is variable: several of them represent deeper layers of peat lands with a poor surface vegetation.

Owing to the fact that a large part of the moss peat samples originates from layers of a lower depth than those of the fen peats tend to do, also the degree of humification in the former samples appears to be lower than that in the latter ones. This may be illustrated by the mean values of the sampling depth and the degree of humification computed for the different peat groups. These were the following: (as a measure of variation the confidence limits at 95 % level are given):

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<th>H</th>
<th>Correlation coefficient between depth and H</th>
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<td>7.8 ± 2.5</td>
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<th>Ca</th>
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Samples of Sp

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V 23 a | N | 2 | 1—3 | 1 | 4.5 | 0.11 | 1700 | 1400 | 100 | 120 |
V 16 a | N | 3 | 1—3 | 1 | 4.4 | 0.12 | 3800 | 2000 | 410 | 250 |
69  | R | 2 | 0—2 | 2 | 4.2 | 0.09 | 2300 | 2200 | 2600 | 240 |
V 2 a | N | 3 | 1—3 | 2 | 4.3 | 0.15 | 2400 | 1200 | 450 | 60  |
K 38  | N | 1 | 2—4 | 2 | 4.6 | 0.23 | 4300| 750 | 360 | 40  |
107  | N | 3 | 0—2 | 3 | 4.4 | 0.16 | 2000| 2900 | 160 | 120 |
V 24 b | N | 2 | 5—7 | 3 | 4.8 | 0.17 | 800 | 1000 | 50  | 90  |
V 23 b | N | 2 | 5—7 | 3 | 4.9 | 0.19 | 1500| 600 | 30  | 10  |
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| V 3 a | N | 3    | 1—3  | 1    | 4.4  | 0.14 | 2900 | 2000 | 200  | 50   |
| A 19 | N  | 2    | 0—2  | 2    | 5.0  | 0.25 | 6000 | 1700 | 410  | 170  |
| A 12 | N  | 3    | 3—5  | 2    | 4.8  | 0.25 | 4600 | 1800 | 80   | 50   |
| A 13 | N  | 3    | 8—10 | 2    | 4.8  | 0.20 | 3800 | 1900 | 170  | 50   |
| A 23 | N  | 2    | 1—3  | 2    | 4.7  | 0.38 | 4400 | 1400 | 280  | 50   |
| V 19 a | N | 5    | 1—3  | 2    | 4.7  | 0.21 | 4600 | 2200 | 370  | 230  |
| V 5 a  | N | 4    | 1—3  | 3    | 4.6  | 0.24 | 4000 | 1000 | 60   | 40   |
| K 12 | N  | 4    | 0—1  | 3    | 4.4  | 0.27 | 5100 | 1300 | 160  | 130  |
| A 53 | N  | 2    | 1—3  | 3    | 4.2  | 0.42 | 1100 | 300  | 70   | 50   |
| 59 | N  | 5    | 0—2  | 3    | 3.6  | 0.23 | 1600 | 2100 | 610  | 250  |
| A 47 | R  | 2    | 2—4  | 3    | 4.6  | 0.23 | 2400 | 1200 | 120  | 160  |
| V 3 b | N | 3    | 5—7  | 3    | 4.3  | 0.25 | 2400 | 1200 | 60   | 50   |
| V 30 | N  | 5    | 2—3  | 3    | 5.1  | 0.26 | 3800 | 1200 | 130  | 40   |
| A 11 | N  | 3    | 0—2  | 3    | 4.9  | 0.26 | 2400 | 1100 | 180  | 30   |
| A 16 | N  | 2    | 6—8  | 3    | 4.5  | 0.30 | 1800 | 1300 | 20   | 30   |
| V 5 b | N | 4    | 5—7  | 3    | 4.9  | 0.30 | 4500 | 1100 | 60   | 50   |
| A 35 | N  | 6    | 0—4  | 3    | 5.5  | 0.31 | 13200 | 4700 | 280  | 30   |
| V 10 b | N | 3    | 5—7  | 3    | 4.9  | 0.24 | 1800 | 1600 | 180  | 150  |
| V 9 b  | N | 3    | 5—7  | 3    | 4.9  | 0.24 | 1800 | 1200 | 90   | 170  |
| V 13 a | N | 4    | 1—3  | 3    | 4.4  | 0.25 | 1800 | 1200 | 200  | 190  |
| K 18 | N  | 4    | 0—2  | 3    | 5.5  | 0.27 | 3300 | 700  | 60   | 20   |
| V 9 a | N  | 3    | 1—3  | 3    | 4.9  | 0.27 | 1900 | 1200 | 140  | 150  |
| V 10 a | N | 3    | 1—3  | 3    | 4.7  | 0.27 | 1700 | 1200 | 250  | 190  |
| V 14 a | N | 4    | 1—3  | 4    | 4.5  | 0.29 | 1500 | 1300 | 190  | 60   |
| V 20 a | N | 5    | 1—3  | 4    | 4.6  | 0.33 | 3000 | 1600 | 250  | 100  |</p>
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Samples of EuScp

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| K5  | L  | 8   | 4-6 | 3  | 5.4 | 0.27 |14000|2950| 420 | 310 |
| 63  | L  | 8   | 6-8 | 5  | 4.7 | 0.32 | 9550|2340| 170 | 210 |
| 117 | L  | 8   | 17-20|6  | 5.2 | 0.41 |13100|4500|  80 | 250 |
| 118 | L  | 8   | 20-23|6  | 5.4 | 0.47 |12400|4000|  30 | 200 |
| 64  | L  | 8   | 8-10| 7  | 4.3 | 0.38 | 5200|2370| 120 |160  |

Samples of Cp

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| A41 | N  | 3   | 3-5 | 3  | 4.8 | 0.25 |2400|1200 |  50 |  60 |
| A43 | N  | 3   | 2-6 | 3  | 4.5 | 0.24 |3000|1300 |  80 | 130 |
| A40 | N  | 3   | 0-2 | 3  | 4.7 | 0.30 |3550|1360 | 280 |  50 |
| A38 | N  | 2   | 3-5 | 3  | 4.5 | 0.29 |2100| 860 | 190 |  30 |
| A8  | K  | 5   | 0-2 | 3  | 4.7 | 0.32 |3970| 820 |  10 |  20 |</p>
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Samples of BCp
In this material distinct differences exist between the peat groups both in the degree of humification and in the sampling depth. It is worth noticing that in the BCp-group the average degree of humification is markedly lower than on the basis of the average sampling depth it could be supposed to be. In all the other peat groups the degree of humification tends to grow with the depth, although the total correlation coefficient between these quantities does not always appear to be very high.

In any case there are reasons to pay attention to this difference in the quality of the samples of the different peat groups when the results of this study are examined. It was found in connection with a previous work (Kaila and Kivekäis 1956) that in peat soil profiles generally a large part of extractable potassium is accumulated in the surface layers. The magnesium content, on the other hand, tended to be higher in the deeper layers.

*Extractable cations in the peat samples*

In Table 1 the amounts of cations extracted by 1 N ammonium chloride solution are reported as parts per million of the dry matter. According to the authors' opinion it is not justified to suppose that the results obtained by the present method

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<td>3</td>
<td>4.9</td>
<td>0.25</td>
<td>7600</td>
<td>3300</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>127</td>
<td>L</td>
<td>8</td>
<td>14—17</td>
<td>3</td>
<td>4.9</td>
<td>0.24</td>
<td>8700</td>
<td>3400</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>128</td>
<td>L</td>
<td>8</td>
<td>17—20</td>
<td>3</td>
<td>4.8</td>
<td>0.25</td>
<td>8800</td>
<td>3400</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>K 2</td>
<td>L</td>
<td>7</td>
<td>3—5</td>
<td>3</td>
<td>5.2</td>
<td>0.28</td>
<td>8600</td>
<td>1100</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>73</td>
<td>L</td>
<td>8</td>
<td>0—2</td>
<td>3</td>
<td>8.0</td>
<td>0.44</td>
<td>23500</td>
<td>4000</td>
<td>80</td>
<td>210</td>
</tr>
<tr>
<td>125</td>
<td>L</td>
<td>8</td>
<td>4—7</td>
<td>4</td>
<td>4.9</td>
<td>0.30</td>
<td>7300</td>
<td>4100</td>
<td>70</td>
<td>150</td>
</tr>
<tr>
<td>123</td>
<td>L</td>
<td>8</td>
<td>17—20</td>
<td>4</td>
<td>4.9</td>
<td>0.24</td>
<td>8600</td>
<td>3000</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td>114</td>
<td>L</td>
<td>8</td>
<td>7—10</td>
<td>4</td>
<td>5.4</td>
<td>0.29</td>
<td>13000</td>
<td>4100</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>141</td>
<td>L</td>
<td>7</td>
<td>0—2</td>
<td>4</td>
<td>5.6</td>
<td>0.45</td>
<td>14000</td>
<td>5100</td>
<td>200</td>
<td>270</td>
</tr>
<tr>
<td>75</td>
<td>L</td>
<td>7</td>
<td>0—2</td>
<td>4</td>
<td>5.4</td>
<td>0.24</td>
<td>10200</td>
<td>3500</td>
<td>30</td>
<td>120</td>
</tr>
<tr>
<td>130</td>
<td>L</td>
<td>8</td>
<td>24—27</td>
<td>5</td>
<td>5.0</td>
<td>0.36</td>
<td>8200</td>
<td>3400</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>142</td>
<td>L</td>
<td>8</td>
<td>0—2</td>
<td>5</td>
<td>4.8</td>
<td>0.53</td>
<td>11700</td>
<td>4000</td>
<td>360</td>
<td>220</td>
</tr>
<tr>
<td>115</td>
<td>L</td>
<td>8</td>
<td>10—13</td>
<td>5</td>
<td>5.4</td>
<td>0.37</td>
<td>12700</td>
<td>4100</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>135</td>
<td>L</td>
<td>8</td>
<td>10—13</td>
<td>6</td>
<td>5.8</td>
<td>0.44</td>
<td>13800</td>
<td>4000</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>116</td>
<td>L</td>
<td>8</td>
<td>14—17</td>
<td>6</td>
<td>5.3</td>
<td>0.39</td>
<td>12000</td>
<td>4100</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>140</td>
<td>K</td>
<td>10</td>
<td>0—2</td>
<td>6</td>
<td>5.1</td>
<td>0.58</td>
<td>14700</td>
<td>2200</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>134</td>
<td>L</td>
<td>8</td>
<td>4—10</td>
<td>6</td>
<td>5.7</td>
<td>0.43</td>
<td>11500</td>
<td>3400</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>136</td>
<td>L</td>
<td>8</td>
<td>14—17</td>
<td>7</td>
<td>5.7</td>
<td>0.42</td>
<td>15000</td>
<td>4500</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>K 3</td>
<td>L</td>
<td>7</td>
<td>7—9</td>
<td>7</td>
<td>5.3</td>
<td>0.34</td>
<td>6800</td>
<td>700</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>K 11</td>
<td>L</td>
<td>7</td>
<td>5—7</td>
<td>7</td>
<td>5.0</td>
<td>0.37</td>
<td>4000</td>
<td>700</td>
<td>10</td>
<td>200</td>
</tr>
</tbody>
</table>
would correspond to the exchangeable cations. Therefore, the results have not been reported as milliequivalents per 100 g.

In order to get a better survey of the data in Table 1, the means for the cation contents in the different peat groups were computed. Also the cation content expressed on the basis was calculated. This quantity does not, of course, correspond to the real amounts of these nutrients as kg/ha in the natural peat layers of a depth of 20 cm. Yet, it may be supposed to give a relative estimate of the amounts of these extractable cations.

First the means of the calcium content in the different peat types are examined. In addition to the means with their confidence limits at 95 per cent level also the minimum and maximum values are reported.

<table>
<thead>
<tr>
<th>Ca p.p.m.</th>
<th>Ca kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
</tr>
<tr>
<td>Sp (32)</td>
<td>3690 ± 720</td>
</tr>
<tr>
<td>CSp (31)</td>
<td>2680 ± 850</td>
</tr>
<tr>
<td>SCp (59)</td>
<td>3410 ± 590</td>
</tr>
<tr>
<td>EuSCp (7)</td>
<td>10240 ± 4090</td>
</tr>
<tr>
<td>Cp (46)</td>
<td>7070 ± 1780</td>
</tr>
<tr>
<td>BCp (33)</td>
<td>9720 ± 1510</td>
</tr>
</tbody>
</table>

According to these means there appears to be a distinct difference between the groups of Sp, CSp, and SCp and the groups of EuSCp, Cp and BCp. Thus in this material the SC-peat, generally counted among the fen peats, resembles more the moss peats known to be poor in calcium. In the material studied by KIVINEN (1933) the average content of total calcium in the different peat types was of the same order as in this paper the respective data for calcium extracted by 1 N ammonium chloride. The mean values reported by KIVINEN for calcium dissolved by 1 % citric acid were generally somewhat lower than our data, and the Cp group was surprisingly poor in calcium.

The mean quantities of magnesium extracted by the present method were the following:

<table>
<thead>
<tr>
<th>Mg p.p.m.</th>
<th>Mg kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
</tr>
<tr>
<td>Sp (32)</td>
<td>1310 ± 250</td>
</tr>
<tr>
<td>CSp (31)</td>
<td>1240 ± 200</td>
</tr>
<tr>
<td>SCp (59)</td>
<td>1460 ± 190</td>
</tr>
<tr>
<td>EuSCp (7)</td>
<td>3540 ± 1180</td>
</tr>
<tr>
<td>Cp (46)</td>
<td>2010 ± 440</td>
</tr>
<tr>
<td>BCp (33)</td>
<td>2950 ± 460</td>
</tr>
</tbody>
</table>

The variation in the magnesium content is marked as it also was in the calcium content. In regard to the magnesium content the SCp group belongs to the moss peats, although less distinctly than in regard to the calcium content.

Now, of course, arises the question whether the difference in the sampling depth plays any part in these results. The SCp samples were, on the average, col-
lected from layers which were far less deep than were the layers from which the Cp, EuSCp and BCp samples originated. In the mean degree of humification, on the other hand, the differences between SCp samples and samples of the BCp and EuSCp groups are insignificant. The correlation coefficients between the cation contents and the degree of humification or of the sampling depth are the following:

<table>
<thead>
<tr>
<th></th>
<th>Cap.p.m.</th>
<th>Mg p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Depth H</td>
<td>Depth H</td>
</tr>
<tr>
<td>Sp (32)</td>
<td>0.1130.020</td>
<td>0.3750.078</td>
</tr>
<tr>
<td>CSp (31)</td>
<td>0.3300.149</td>
<td>0.2860.141</td>
</tr>
<tr>
<td>SCp (59)</td>
<td>0.0480.052</td>
<td>0.385** 0.114</td>
</tr>
<tr>
<td>EuSCp (7)</td>
<td>0.281 — 0.165</td>
<td>0.0260.355</td>
</tr>
<tr>
<td>Cp (46)</td>
<td>0.568*** 0.393**</td>
<td>0.528*** 0.652***</td>
</tr>
<tr>
<td>BCp (33)</td>
<td>— 0.012 0.275</td>
<td>0.3200.216</td>
</tr>
<tr>
<td>All (208)</td>
<td>0.398*** 0.198*</td>
<td>0.433*** 0.219*</td>
</tr>
</tbody>
</table>

These total correlation coefficients do not reveal any connection between the calcium or magnesium content and the depth or the degree of humification, except in the Cp-group. The fact that the samples of Cp, BCp and EuSCp groups generally originated from deeper layers and contained higher amounts of these extractable cations is probably the reason for the significant correlations between the depth and the calcium and magnesium contents in all the material. As to the connection between the cation contents and the degree of humification only a low correlation can be demonstrated. Consequently, the differences found in the mean contents of calcium and magnesium in the various peat types probably do not arise only from the differences in the sampling depth.

The amounts of potassium extracted by 1 N ammonium chloride from these samples were far lower than those of calcium and magnesium. In connection with some other work it was found that almost all of the potassium in this kind of peat samples was extracted by the present method. This is in accordance with what is known of the occurrence of potassium in peat soils.

The mean content of potassium in the different peat types of this material was the following (the means expressed with the confidence limits at 95 per cent level):

<table>
<thead>
<tr>
<th></th>
<th>K p.p.m.</th>
<th>K kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean min. — max.</td>
<td>mean min. — max.</td>
</tr>
<tr>
<td>Sp (32)</td>
<td>260 ± 100 40 — 1 000</td>
<td>90 ± 30 10 — 390</td>
</tr>
<tr>
<td>CSp (31)</td>
<td>300 ± 180 10 — 2 600</td>
<td>140 ± 70 5 — 1 050</td>
</tr>
<tr>
<td>SCp (59)</td>
<td>160 ± 30 40 — 610</td>
<td>90 ± 15 10 — 300</td>
</tr>
<tr>
<td>EuSCp (7)</td>
<td>440 ± 500 30 — 1 600</td>
<td>210 ± 180 30 — 580</td>
</tr>
<tr>
<td>Cp (46)</td>
<td>180 ± 70 10 — 1 400</td>
<td>130 ± 55 5 — 790</td>
</tr>
<tr>
<td>BCp (33)</td>
<td>110 ± 30 30 — 300</td>
<td>80 ± 30 10 — 380</td>
</tr>
</tbody>
</table>

The variation in the potassium content is high in all the peat groups. Generally it appears to be even higher than the corresponding variation in the calcium and
magnesium content. Although no significant difference can be noticed between the mean values for the peat groups, a slight tendency to higher potassium content may be observed in the moss peats or groups of Sp and CSp as compared with the groups of BCp, Cp, and SCp. Some high numbers in the EuSCp group heighten the mean of these few samples. Probably the conclusion which can be drawn on the basis of these data is that there are no distinct difference in the content of extractable potassium in the peat types.

The amounts of sodium extracted by the present method also varies markedly within all the groups. The values are of the same order as those of potassium, and mostly far lower than the calcium and magnesium contents. The mean values and the variation limits for sodium are the following:

<table>
<thead>
<tr>
<th></th>
<th>Na p.p.m.</th>
<th>Na kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>min. — max.</td>
</tr>
<tr>
<td>Sp (32)</td>
<td>100 ± 30</td>
<td>10 — 400</td>
</tr>
<tr>
<td>CSp (31)</td>
<td>170 ± 90</td>
<td>10 — 1340</td>
</tr>
<tr>
<td>SCp (59)</td>
<td>110 ± 30</td>
<td>0 — 360</td>
</tr>
<tr>
<td>EuSCp (7)</td>
<td>490 ± 600</td>
<td>160 — 1930</td>
</tr>
<tr>
<td>Cp (46)</td>
<td>230 ± 90</td>
<td>10 — 1160</td>
</tr>
<tr>
<td>BC (33)</td>
<td>200 ± 20</td>
<td>100 — 300</td>
</tr>
</tbody>
</table>

The Sp and SCp groups are fairly low in extractable sodium. Also the CSp-samples contain less sodium than the EuSCp, Cp, and BCp groups, particularly as expressed on the volume basis. It looks as if the relations between the sodium content of these peat groups would be more like those of calcium content than those of potassium.

The connection between the depth or the degree of humification and the amounts of extractable potassium or sodium in the different peat groups were calculated and the following total correlation coefficients were obtained:

<table>
<thead>
<tr>
<th></th>
<th>K Depth</th>
<th>H</th>
<th>Na Depth</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sp (32)</td>
<td>0.566***</td>
<td>0.484**</td>
<td>0.254</td>
<td>0.217</td>
</tr>
<tr>
<td>CSp (31)</td>
<td>0.331</td>
<td>0.074</td>
<td>0.115</td>
<td>0.087</td>
</tr>
<tr>
<td>SCp (59)</td>
<td>0.205</td>
<td>0.207</td>
<td>0.047</td>
<td>0.191</td>
</tr>
<tr>
<td>EuSCp (7)</td>
<td>0.709</td>
<td>0.728</td>
<td>0.538</td>
<td>0.574</td>
</tr>
<tr>
<td>Cp (46)</td>
<td>0.211</td>
<td>0.029</td>
<td>0.696***</td>
<td>0.406**</td>
</tr>
<tr>
<td>BCp (33)</td>
<td>0.222</td>
<td>0.074</td>
<td>0.205</td>
<td>0.051</td>
</tr>
<tr>
<td>All (208)</td>
<td>0.211*</td>
<td>0.187*</td>
<td>0.249**</td>
<td>0.144</td>
</tr>
</tbody>
</table>

It was found in a previous paper (KAILA & KIVEKÄS 1956) that the content of extractable potassium in peat soil profiles tends to be higher in the surface layers than in the deeper ones. In this material a significant correlation between the sampling depth and the potassium values exist only in the Sp-samples. The very slight connection for all the material does not tell whether the differences in the sampling depth have any effect on the amounts of potassium in the samples of the different peat groups. The same holds true with the connection between potassium content and the degree of humification.
The latter characteristic is not at all correlated with the content of extractable sodium in these samples, except in the Cp-group. In this group also a high correlation with depth can be noted, the reason of which is not clear.

*Extractable cations and acidity of the samples*

It is a common knowledge that the composition of the cation system in the soil is the factor on which the acidity of the soil mostly depends. The authors found it desirable to study the relation of the content of these extractable cations and the soil reaction.

In this material the pH-values measured in a water suspension of air-dried samples were, on the average, the following for the various peat groups:

<table>
<thead>
<tr>
<th>Peat Group</th>
<th>pH Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sp</td>
<td>4.3 ± 0.2</td>
</tr>
<tr>
<td>EuSCp</td>
<td>5.0 ± 0.5</td>
</tr>
<tr>
<td>Csp</td>
<td>4.5 ± 0.1</td>
</tr>
<tr>
<td>Scp</td>
<td>4.7 ± 0.1</td>
</tr>
<tr>
<td>Cp</td>
<td>4.9 ± 0.1</td>
</tr>
<tr>
<td>Bcp</td>
<td>5.2 ± 0.2</td>
</tr>
</tbody>
</table>

These are typical means for the pH-values of the different peats and they are well in accordance with the data reported by Kivinen (1933). Only the pH in the Sp group is slightly higher and in the Bcp group somewhat lower than the corresponding results reported by Kivinen.

The correlation was calculated for the pH values and the cation contents of the peat groups and the following coefficients were obtained:

<table>
<thead>
<tr>
<th></th>
<th>Ca p.p.m.</th>
<th>Mg p.p.m.</th>
<th>K p.p.m.</th>
<th>Na p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sp (32)</td>
<td>0.475**</td>
<td>0.469**</td>
<td>0.048</td>
<td>0.062</td>
</tr>
<tr>
<td>Csp (31)</td>
<td>0.407*</td>
<td>0.284</td>
<td>0.388*</td>
<td>0.067</td>
</tr>
<tr>
<td>Scp (59)</td>
<td>0.542***</td>
<td>0.172</td>
<td>0.374**</td>
<td>0.207</td>
</tr>
<tr>
<td>EuScp (7)</td>
<td>0.927**</td>
<td>0.758*</td>
<td>0.374</td>
<td>0.472</td>
</tr>
<tr>
<td>Cp (46)</td>
<td>0.708***</td>
<td>0.458**</td>
<td>0.167</td>
<td>0.401*</td>
</tr>
<tr>
<td>Bcp (33)</td>
<td>0.833***</td>
<td>0.275</td>
<td>0.210</td>
<td>0.172</td>
</tr>
<tr>
<td>All (208)</td>
<td>0.692***</td>
<td>0.470***</td>
<td>0.245**</td>
<td>0.199*</td>
</tr>
</tbody>
</table>

As could be expected the correlation between the pH-values and the content of calcium is fairly high in most of the peat types. The positive correlation between pH and magnesium content is less distinct for all the samples and for several of the peat groups no correlation between these quantities exists. The potassium content, on the other hand, tends to show a slight tendency to decrease with decreasing acidity. No correlation, worth of notice occurs between the acidity and the sodium content of these samples, except in the Cp group.

There is in these peat groups no significant correlation between the depth or the degree of humification and the pH-value. Therefore, it is unnecessary to calculate the partial correlation coefficients by eliminating the effect of the sampling depth and the degree of humification between the pH and the cation contents.
**Extractable cations in the surface layers and the peatland quality**

In the present material a large part of the samples originated from fairly deep layers. So far as the cultivation of peat soils is in question, generally only the surface layers are of importance. Therefore, also an examination of this part of the material is desirable.

The samples down to a depth of 3 dm contain, on the average the following quantities of calcium and magnesium:

<table>
<thead>
<tr>
<th></th>
<th>Ca p.p.m.</th>
<th>Mg p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sp (18)</td>
<td>3,510 ± 970</td>
<td>1,120 ± 280</td>
</tr>
<tr>
<td>CSp (12)</td>
<td>2,690 ± 730</td>
<td>1,590 ± 400</td>
</tr>
<tr>
<td>Scp (26)</td>
<td>2,930 ± 590</td>
<td>1,260 ± 202</td>
</tr>
<tr>
<td>EuScp (2)</td>
<td>8,700</td>
<td></td>
</tr>
<tr>
<td>Cp (11)</td>
<td>4,380 ± 2,230</td>
<td>1,490 ± 620</td>
</tr>
<tr>
<td>BCP (11)</td>
<td>10,500 ± 4,370</td>
<td>2,680 ± 910</td>
</tr>
</tbody>
</table>

These mean values of the calcium content are equal to those calculated for the whole material, except in regard to the Cp group. These samples are markedly lower in calcium than the average of all the samples indicates. As to the magnesium content no significant difference appears to exist between the surface samples and the whole material.

The potassium content, on the other hand, seems to be somewhat higher in the surface samples than in the deeper layers. The extractable sodium occurs in equal amounts in the surface peat and in the older deposits. The following mean values for potassium and sodium content in the surface samples demonstrate this.

<table>
<thead>
<tr>
<th></th>
<th>K p.p.m.</th>
<th>Na p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sp (18)</td>
<td>385 ± 150</td>
<td>120 ± 65</td>
</tr>
<tr>
<td>CSp (12)</td>
<td>445 ± 435</td>
<td>190 ± 90</td>
</tr>
<tr>
<td>Scp (26)</td>
<td>220 ± 60</td>
<td>115 ± 35</td>
</tr>
<tr>
<td>EuScp (2)</td>
<td>1,145</td>
<td>1,120</td>
</tr>
<tr>
<td>Cp (11)</td>
<td>225 ± 155</td>
<td>185 ± 125</td>
</tr>
<tr>
<td>BCP (11)</td>
<td>190 ± 75</td>
<td>215 ± 55</td>
</tr>
</tbody>
</table>

The peatland quality estimated on the basis of the surface vegetation, mainly depends on the nutrient content and other conditions in the surface layers of peat. Therefore, when the contents of extractable cations and the degrees of land quality were studied, there was no cause to examine the whole material. The samples from layers not deeper than 3 dm were chosen to the object of this testing. The statistical treatment yielded the following results:

<table>
<thead>
<tr>
<th></th>
<th>Ca p.p.m.</th>
<th>Mg p.p.m.</th>
<th>K p.p.m.</th>
<th>Na p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sp (18)</td>
<td>0.034</td>
<td>-0.218</td>
<td>0.170</td>
<td>0.064</td>
</tr>
<tr>
<td>CSp (12)</td>
<td>0.788**</td>
<td>0.341</td>
<td>-0.147</td>
<td>0.374</td>
</tr>
<tr>
<td>Scp (26)</td>
<td>-0.183</td>
<td>0.222</td>
<td>0.370</td>
<td>0.569**</td>
</tr>
<tr>
<td>EuScp (2)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cp (11)</td>
<td>0.225</td>
<td>0.342</td>
<td>0.240</td>
<td>0.383</td>
</tr>
<tr>
<td>BCP (11)</td>
<td>0.206</td>
<td>0.055</td>
<td>0.167</td>
<td>0.269</td>
</tr>
<tr>
<td>All (80)</td>
<td>0.551***</td>
<td>0.369**</td>
<td>-0.025</td>
<td>0.149</td>
</tr>
</tbody>
</table>
It could be expected to find a fairly close connection between the calcium content and the land quality. This however, was not the case within the different peat types. For all the surface samples the correlation is significant, although not very high. The same holds true with the extractable magnesium for which the correlation is even lower. The scant supply of potassium in peat lands is not correlated with the land quality. The distribution of sodium in the surface samples does not correspond to the land quality.

**Connection between the amounts of extractable cations**

It seems possible that there exists some dependence between the quantities of these extractable cations in the peat samples. Indeed, a rather high correlation could be found for the contents of calcium and magnesium, as the following correlation coefficients indicate:

<table>
<thead>
<tr>
<th>Total correlation coefficients between the contents of</th>
<th>Ca and Mg</th>
<th>Ca and K</th>
<th>Mg and K</th>
<th>K and Na</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sp (32)</td>
<td>0.613***</td>
<td>0.142</td>
<td>— 0.075</td>
<td>0.238</td>
</tr>
<tr>
<td>CSP (31)</td>
<td>0.317</td>
<td>0.103</td>
<td>— 0.537***</td>
<td>0.329</td>
</tr>
<tr>
<td>SCp (59)</td>
<td>0.672***</td>
<td>— 0.013</td>
<td>0.039</td>
<td>0.059</td>
</tr>
<tr>
<td>EuSCp (7)</td>
<td>0.834*</td>
<td>— 0.585</td>
<td>0</td>
<td>0.295</td>
</tr>
<tr>
<td>Cp (46)</td>
<td>0.679***</td>
<td>0.109</td>
<td>0.201</td>
<td>0.247</td>
</tr>
<tr>
<td>BCp (33)</td>
<td>0.729***</td>
<td>— 0.105</td>
<td>— 0.491</td>
<td>0.646***</td>
</tr>
<tr>
<td>All (208)</td>
<td>0.782***</td>
<td>— 0.042</td>
<td>— 0.009</td>
<td>0.172</td>
</tr>
</tbody>
</table>

The data listed above show no connection between the contents of calcium and potassium on the one hand, or between the amounts of extractable magnesium and potassium, on the other hand. As to the potassium and sodium extracted by ammonium chloride, no significant correlation between them is to be found, except in the BCp group.

**Discussion**

This statistical study, the aim of which was to elucidate the nutrient conditions in regard to calcium, magnesium and potassium in different kinds of peat, gave results which emphasize the large variation of the nutrient content in every peat group. The individual data for one group are always overlapping the range of the other ones. Generally, even the means do not significantly differ from each other.

This large variation did not arise only from the fact that in the material analyzed the sampling depth varied from 1 to 60 dm. The extent of variation in the different groups of surface samples was as large as that for the whole material. No significant correlation was found to exist between the sampling depth and the content of the different cations, except in a few cases. This also shows that this variation must be attributed to some other reasons than the age of the deposit.

One factor which may be held liable for the variation in the contents of extractable cations in the different peat groups is the location of the sampling place in the peat land. It has been observed (KIVINEN 1933) that particularly in large peat lands moistened by waters from outside the peat deposits on the edge of the area
adsorb a large part of the cations in the running water and only water fairly poor in nutrients reaches the middle part of the peat bog. In the long run this, of course, brings about changes in the composition of the surface vegetation and further in the quality of peat. Meanwhile, this phenomenon may at least partly be held responsible for the large variation in the nutrient content within the same peat group.

Attention must also be paid to the fact that even each of these six peat groups may be composed of fairly different plant residues. The Sp group, for example, can be developed from residues of poor Sphagnum fuscum vegetation or from markedly richer residues of other Sphagnum species. Also the remains of Carex differ from each besides this, the nutrient content of plants depends on the nutrition conditions of the peat land and large variations even within the mineral composition of the same plant species may exist.

In any case, the results of this study emphasize that the determination of the kind of peat does not give any probable estimate of the nutrient content of the sample. An Sp sample may be richer in calcium, magnesium, and potassium than a Cp or a BCp sample.

**Summary**

An attempt was made to elucidate the content of plant-available calcium, potassium and magnesium in different kinds of virgin peat. The amounts of these cations extracted by 1 N ammonium chloride solution were supposed to give an estimate satisfactory for this purpose. Also the extractable sodium was determined.

The material consisted of 208 samples mainly collected from Northern Finland.

The variation in the content of extractable cations was high in all the peat groups. The individual values of one group were overlapping the range of other ones. The average calcium and magnesium contents of the Sp, CSp and SCp groups were somewhat lower than those of Cp, BCp and EuSCp groups. The same seems to be the case with the content of extractablesodium whereas the moss peats tended to be slightly less poor in potassium than the peats of better quality.

A more or less significant correlation existed in all the peat groups between the calcium content and the pH-values. The correlation was markedly lower for pH and extractable magnesium. A weak tendency to negative correlation could be noticed between pH and extractable potassium.

The land quality and the calcium and magnesium content of all the surface samples were correlated with each other, although not very strongly. Within the different peat groups no correlation between these quantities could be found, except in one case. The scant supply of potassium in the surface samples did not show any connection with the land quality.

The reasons responsible to the large variation of the nutrient content within a certain peat group were discussed. The fact was emphasized that on the basis of the identification of the kind of peat nothing reliable is known of the nutrient content of the sample.
REFERENCES

(3) Kaila, A. 1956 b. Phosphorus in virgin peat soils. Ibid. 28: 142—167
(4) Kivekäs, J. 1956. Extractable calcium, magnesium, potassium and sodium in different layers of peat soils. Ibid 28:

SELOSTUS:

UUTTUVASTA KALSIUMISTA, MAGNESIUMISTA, KALIUMISTA JA NATRIXMISTA ERI TURVELAJEISSA

Jaakko Kivekäs ja Armi Kaila

Yliopiston Maanviljelyshemian laitos, Helsinki

Tutkimuksessa tarkastellaan turvelajeittain ammoniumkloridilla uuttuvien kalsiumin, magnesiumin, kaliumin ja natriumin määriä ja näiden riippuvuutta toisistaan.

Tutkimusaineistona oli 208 luonnontilaisilta, lähinnä pohjois-Suomen soitaa otettua turvenäytettä. Ilmakuivista, jauhetuista näytteistä määritettiin kahden tunnin huiskutuksen aikana 1-n ammonium-kloridiluokseen uuttuneiden em. kationien määrät; määritykset tapahtuivat Langen liekki fotometrilla ja versenaattititrausta käyttäen.


Tarkasteltaessa erikseen pientanäytteiden (0—3 dm) kationipitoisuksia havaitaan, että kalsiumin ja magnesiumin määrät ovat samaa suuruusluokkakaa kuin muissakin näytteissä. Kaliumia sensijaan näyttäisi pintaturpeissa olevan keskimäärin runsaanmin kuin syvemmältä otetuissa näytteissä.


Kalsiumin ja magnesiumin välillä voidaan havaita selväkään positiivinen korrelaatio.