OBSERVATIONS ON THE MOBILIZATION OF PEAT NITROGEN IN INCUBATION EXPERIMENTS

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Peat lands contain considerable amounts of nitrogen, which for the main part however, occurs in such organic compounds as are not easily soluble and are slow in mobilizing, being thus scarcely or not at all available to plants. The mobilization of the natural supply of nitrogen into a form available to plants would thus be of considerable economic advantage in the cultivation of peat lands. KAILA, SOINI and KIVINEN (3) have investigated the effects of calcium, fertilizers, and ash on the mobilization of nitrogen, and state that calcium as a rule stimulated the nitrification, but on the amount of mineral nitrogen calcium has in general a negative effect. The effect of ash was, according to them, apparent mainly as a neutralizing quality. They did not observe any clear effect of trace elements, nor of calcium or phosphorus fertilizers. Having investigated the effect of lime on the accumulation of mineral nitrogen in incubation experiments with peat soils KAILA and SOINI (5) states that liming does not always enhance the accumulation of mineral nitrogen, nor does it always cause an increase in the nitrate nitrogen. KIVINEN (7) has in some experiments noted that liming and fertilizing clearly enhances the mobilization of peat nitrogen. KAILA, KÖYLIJÄRVI and KIVINEN (2) found that a higher temperature increased the amounts of ammonium nitrogen, though they might be caused by purely chemical phenomena. Since all the above mentioned investigations into the mobilization of peat nitrogen have been carried out with only comparatively few samples, it was decided to continue research by using more extensive material.

Material and methods

The material of this study consisted of 60 samples from peat soils in North Finland. All the samples were air-dried and ground with a Willey-mill.

The pH was measured in water and N KCl suspensions (1:4) using a Beckman pH-meter with glass electrode.

The ammonium nitrogen was extracted with an 0.1 N HCl. The ammonium nitrogen was determined by shaking samples of fresh incubated peats weighing 20 grams in 100 ml of 0.1 N HCl for one hour, and by filtrating and washing the peat twice with 25 ml of the extractant. The ammonia in the extract was determined by distillation with MgO (5).

The soluble organic nitrogen was determined from the original samples by burning, in accordance with the Kjeldahl-method, a part of the solution obtained in determining the ammonium nitrogen and by distilling the nitrogen from this. The obtained amount of nitrogen minus the amount of ammonium nitrogen was taken as representing organic nitrogen.

The nitrate nitrogen was extracted from fresh samples of 20 g with 100 ml of a $CaSO_4$ solution in which the samples were shaken for ten minutes. The determination was made from the filtrate by the phenoldisulphonic acid method (1) using an EEL-colorimeter.

The presence of nitrite nitrogen was determined with Griess' reagent.

Also the amounts of calcium and potassium extractable with a N NH_4Cl solution were determined by adding 100 ml of this solution to 2 g of air-dried peat. The liquid was filtered through paper and the determination was made by using a Lange flamephotometer (4).

Some characteristics of the peat samples are reported in Table 1. There are 20 samples in which the Sphagnum remains are dominant; the other 40 samples represent peat where the Carex remains are dominant.

Table 1. Peat samples.

No	H	Depth dm	Weight of volume	Ash %	pH_{H_2O}	pH_{KCl}	1 N NH_4Cl exchange-able Ca %	Total N %	NH_4-N g/kg	NO_3-N g/kg	Min. N g/kg
					Samples of BCp						
9	0—1	0—2	0,16	9.9	4,9	4.1	0.52	1.95	0.20	0.33	0.53
1	1	0—2	0.14	9.0	5.5	4.5	1.05	2.52	0.13	0.35	0.48
10	1—2	2—4	0.24	15.6	5.2	4.1	0.37	2.97	0.11	0.21	0.32
2	3	3—5	0.28	7.5	5.2	4.3	0.86	2.75	0.14	0.38	0.52
3	7	7—9	0.34	4.4	5.3	4.2	0.68	2.76	0.12	0.10	0.22
11	7	5—7	0.37	10.6	5.0	3.9	0.40	3.62	0.14	0.20	0.34
					Samples of Cp						
29	1—2	5—7	0.20	5.1	4.6	3.9	0.37	1.99	0.17	0.15	0.32
44	3	1—2	0.34	16.4	4.5	3.9	0.45	3.12	0.26	0.18	0.44
13	3—4	1—3	0.28	5.1	4.9	4.0	0.39	3.47	0.13	0.25	0.38
14	3—4	5—7	0.26	4.9	5.1	4.1	0.34	2.67	0.19	0.17	0.36
25	3—4	1—3	0.21	4.5	4.6	3.7	0.34	2.33	0.17	0.25	0.42
26	3—4	5—7	0.20	3.1	4.2	3.7	0.35	2.40	0.18	0.24	0.42
40	3—4	1—3	0.29	10.9	5.8	4.6	0.39	3.06	0.09	0.17	0.26
43	3—4	0—1	0.35	11.1	4.9	4.1	0.50	3.12	0.22	0.29	0.51
45	3—4	0—1	0.31	5.6	4.9	4.2	0.71	3.60	0.25	0.56	0.81
46	3—4	1—2	0.33	2.3	4.1	3.6	0.60	3.20	0.24	0.36	0.60
51	3—4	0—2	0.27	5.3	4.8	3.7	0.46	2.94	0.23	0.17	0.40
52	3—4	0—2	0.29	4.7	4.4	3.8	0.54	2.98	0.18	0.37	0.55
36	5	4—6	0.34	6.1	4.9	3.8	0.37	2.54	0.10	0.08	0.18
55	5	0—2	0.23	8.8	4.8	4.0	0.56	3.62	0.15	0.16	0.31
56	5	0—2	0.27	8.4	4.7	3.7	0.55	3.78	0.19	0.15	0.34
41	5—6	2—6	0.28	3.5	4.2	3.7	0.39	3.61	0.21	0.09	0.30
20	6	6—8	0.30	4.8	5.4	4.3	0.38	2.88	0.18	0.16	0.34
4	6—7	3—6	0.35	6.6	5.2	4.1	1.35	2.73	0.14	0.09	0.23
19	7—8	3—5	0.46	8.1	5.4	4.3	0.34	3.52	0.24	0.15	0.39
60	8—9	10—14	0.53	7.0	4.9	3.7	0.36	2.56	0.33	0.29	0.62

No	H	Depth dm	Weight of volume	Ash %	pH_{H_2O}	pH_{KCl}	1 N NH_4Cl exchange-able Ca %	Total N %	NH_4-N g/kg	NO_3-N g/kg	Min. N g/kg
					Samples of SCp						
28	1	0—3	0.20	6.5	4.5	3.9	0.45	1.74	0.19	0.12	0.31
12	2—3	0—1	0.27	9.8	4.4	3.9	0.51	3.40	0.14	0.72	0.86
35	2—3	4—6	0.26	5.0	4.4	3.6	0.34	1.03	0.19	0.08	0.27
18	3—4	0—2	0.27	15.4	5.5	4.4	0.33	4.51	0.25	0.46	0.71
24	3—4	6—8	0.35	2.2	5.1	4.0	0.66	2.51	0.17	0.03	0.20
59	5—6	0—5	0.45	9.6	5.3	4.1	0.30	5.07	0.34	0.14	0.48
					Samples of EuSCp						
57	3	0—2	0.25	8.5	5.5	4.5	1.40	2.56	0.15	0.16	0.31
58	3	0—2	0.28	5.9	5.3	4.5	1.25	3.20	0.16	0.18	0.34
47	3—4	0—2	0.24	7.1	5.9	5.3	2.35	3.00	0.17	0.26	0.43
48	3—4	0—2	0.27	7.2	5.9	5.4	2.40	3.24	0.22	0.91	1.13
5	3—4	4—6	0.27	5.3	5.4	4.9	1.40	2.53	0.17	0.20	0.37
					Samples of LC- and LSCp						
27	4	11—14	0.23	5.3	4.4	3.7	0.29	2.04	0.22	0.27	0.49
23	4—5	4—6	0.32	2.0	5.0	4.0	0.79	2.37	0.17	0.05	0.22
30	5—6	2—5	0.34	4.7	4.8	3.9	0.36	2.73	0.18	0.10	0.28
					Samples of CSp						
15	1—2	0—2	0.26	10.3	4.4	3.5	0.30	2.44	0.29	0.40	0.69
16	1—2	0—2	0.21	8.5	4.3	3.6	0.30	2.67	0.10	0.38	0.48
17	1—2	0—2	0.18	6.5	4.4	3.6	0.34	2.11	0.16	0.51	0.67
38	2	2—4	0.23	5.0	4.6	3.0	0.43	2.23	0.62	0.21	0.83
49	2—3	0—2	0.18	4.8	4.5	3.6	0.49	3.03	0.20	0.27	0.47
50	2—3	0—2	0.22	4.3	4.3	3.6	0.50	3.25	0.12	0.25	0.37
53	3	0—2	0.23	5.6	4.6	3.8	0.46	3.26	0.18	0.12	0.30
54	3—4	0—2	0.26	4.1	4.6	3.8	0.50	3.03	0.16	0.13	0.29
39	3—4	4—6	0.25	4.3	4.6	3.1	0.35	2.12	0.28	0.21	0.49
8	4—5	3—4	0.39	5.5	4.6	3.9	0.39	2.41	0.09	0.23	0.32
33	5	6—8	0.25	5.8	4.5	3.3	0.44	2.61	0.21	0.08	0.29
42	6—7	2—4	0.39	12.4	3.9	3.3	0.30	2.37	0.13	0.09	0.22
					Samples of Sp						
6	0—1	1—2	0.11	4.2	4.5	3.6	0.70	1.19	0.12	0.47	0.59
21	0—1	0—2	0.09	8.0	4.3	3.1	0.62	0.85	0.21	0.08	0.29
31	0—1	0—2	0.08	5.9	4.2	2.9	0.41	2.44	0.21	0.14	0.35
32	0—1	4—6	0.08	3.9	4.4	3.0	0.47	1.46	0.23	0.16	0.39
34	0—1	0—2	0.09	5.0	4.2	3.4	0.34	1.03	0.20	0.37	0.57
37	1	0—2	0.11	4.9	4.5	3.1	0.49	1.45	0.21	0.17	0.38
7	1—2	2—4	0.17	4.5	4.6	3.8	1.06	1.49	0.19	0.20	0.39
22	1—2	2—3	0.14	2.8	5.0	4.1	0.68	1.15	0.17	0.09	0.26

The samples came from the surface layers of bogs as well as from layers deeper down. Consequently the degrees of humification differed relatively much. The volume weights and the amounts of ash indicate that there were no notable amounts of mineral matter in the samples, which is natural enough since the main part of the samples came from bogs in natural state situated rather far from roads etc. Most of the samples were clearly acid and the amounts of exchangeable calcium were low.

The amounts of total nitrogen were the same as are common in Finnish peats (6). The amounts of mineral nitrogen were rather high in most of the samples. The drying and grinding of the samples may be a reason for this, as has heen shown possible by Kivekäs (8) expressly where ammonium nitrogen is concerned.

No nitrite was found in the samples.

All the results have been calculated in relation to dry matter as mg/kg or kg/ha (to the depth of 20 cm).

The incubation experiments

The object of the investigation was to elucidate the phenomena that appear in peat nitrogen under favourable conditions with regard to moisture and other circumstances. It is hardly necessary to emphasize that in a laboratory the conditions are considerably more favourable and regular than in the field, and since the samples had been dried and ground the results obtained are certainly not applicable to the natural processes in the field. Moreover, the arrangement of the experiments was such as to give an indication of the interaction between the different phenomena like ammonification, nitrification, and denitrification at the moment of analysis, but not to give any idea of the leaching or the influence of plants, etc. that take place in the field.

Each sample was ground and mixed and placed into four glass jars, each jar containing 50 g. Of the four jars two were limed with an amount of lime correspond-

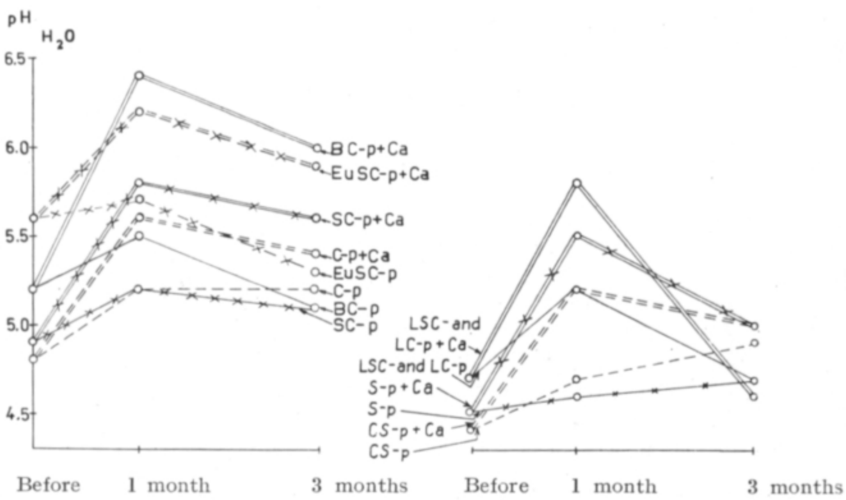

Figure 1. The effect of the incubation on the acidity of peat samples.

Table 2. The effect of incubation on the pH_{H_2O} of peat samples

No	before incubation	1 month of incubation		3 months of incubation	
		unlimed	limed	unlimed	limed
Samples of BCp					
9	4.9	5.8	6.7	4.9	5.6
1	5.5	4.9	6.6	4.6	6.4
10	5.2	5.7	6.4	6.1	6.8
2	5.2	5.3	6.1	4.8	5.7
3	5.3	5.8	6.4	4.8	5.3
11	5.0	5.6	6.0	5.4	6.2
average	5.2	5.5	6.4	5.1	6.0
L.S.D. 95 %		0.2	0.3	0.5	0.5
Samples of Cp					
29	4.6	5.1	5.9	4.8	5.5
44	4.5	5.0	5.2	5.9	6.1
13	4.9	5.4	5.3	5.1	5.9
14	5.1	5.6	6.4	6.0	6.3
25	4.6	5.3	5.8	4.3	4.2
26	4.2	4.8	5.5	4.9	5.2
40	5.8	6.0	6.4	5.1	5.6
43	4.9	5.0	5.4	5.9	6.2
45	4.9	5.2	5.6	5.9	6.1
46	4.1	4.4	5.0	4.9	5.1
51	4.8	5.0	5.2	5.1	4.7
52	4.4	5.1	5.4	5.1	4.6
36	4.9	5.3	5.4	5.2	5.4
55	4.8	5.6	5.9	4.2	5.0
56	4.7	5.3	5.7	5.3	5.0
41	4.2	4.2	4.7	4.6	5.2
20	5.4	4.8	5.4	5.7	5.9
4	5.2	5.6	6.1	4.4	4.9
19	5.4	5.2	5.5	5.7	5.0
60	4.9	5.5	5.8	5.3	4.9
average	4.8	5.2	5.6	5.2	5.4
L.S.D. 95 %		0.2	0.2	0.2	0.3
Samples of SCp					
28	4.6	5.1	5.9	4.8	5.5
12	4.4	5.0	6.2	5.1	5.7
35	4.4	4.8	5.4	5.2	5.4
18	5.5	4.2	5.0	4.4	5.6
24	5.1	5.9	6.3	4.8	5.0
59	5.3	6.1	5.9	6.0	6.3
average	4.9	5.2	5.8	5.1	5.6
L.S.D. 95 %		0.6	0.5	0.5	0.1
Samples of EuSCp					
57	5.5	5.8	6.0	5.2	5.7
58	5.3	5.7	6.2	5.2	5.6
47	5.9	6.0	6.6	5.5	6.2
48	5.9	5.8	6.4	5.7	6.2
5	5.4	5.4	6.0	5.0	5.7
average	5.6	5.7	6.2	5.3	5.9
L.S.D. 95 %		0.1	0.1	0.1	0.1
Samples of LSC-and LCp					
27	4.4	4. 9	5.4	4.7	4.7
23	5.0	5.7	6.4	4.1	4.0
30	4.8	5.1	5.6	5.2	5.2
average	4.7	5.2	5.8	4.7	4.6
L.S.D. 95 %		0.2	0.2	0.2	0.5
Samples of CSp					
15	4.4	4.7	5.2	5.5	5.0
16	4.3	4.5	5.1	5.0	4.4
17	4.4	4.5	5.2	4.9	4.7
38	4.6	4.8	5.4	4.3	5.2
49	4.5	4.8	5.5	5.1	4.7
50	4.3	4.4	5.3	5.0	4.8
53	4.6	5.2	4.7	4.4	4.7
54	4.6	5.2	5.6	5.0	5.0
39	4.6	4.8	5.3	4.3	4.7
8	4.6	5.0	5.8	5.8	6.2
33	4.5	4.7	5.5	4.8	5.4
42	3.9	3.6	4.1	4.3	4.8
average	4.4	4.7	5.2	4.9	5.0
L.S.D. 95 %		0.3	0.3	0.3	0.3
Samples of Sp					
6	4.5	4.9	4.9	4.8	5.4
21	4.3	4.7	5.6	4.0	4.1
31	4.2	4.2	5.3	4.7	5.3
32	4.4	4.0	5.8	4.7	5.2
34	4.2	4.5	5.7	4.9	5.5
37	4.5	5.0	5.8	4.7	5.5
7	4.6	4.7	5.5	5.6	4.6
22	4.3	4.7	5.6	4.0	4.1
average	4.5	4.6	5.5	4.7	5.0
L.S.D. 95 %		0.1	0.1	0.2	0.2

ing to 4 tons per hectare. The samples were moistened to a moisture degree of about 70 per cent. Water evaporating during the time of incubation was replaced by moistening performed at intervals. The moistened and well mixed samples were incubated at a mean temperature of about 17—18° C. Although the optimal temperature for the nitrification organisms is higher, the above mentioned temperature was considered suitable mainly because it is easily available, and because it corresponds, at least to some extent, to conditions in nature. The contents of the jars were analysed after one month and three months of incubation. The pH, the ammonium and the nitrate nitrogen were determined from a fresh sample. In Table 2 and in Figure 1 the effects of the incubation on the acidity are reported, the mean values are calculated per peat type, as well as the significant difference at 95 per cent level. In order to facilitate comparison the values determined before incubation have also been given in the tables.

The figures in Table 2 show that incubation during one month has in most cases caused a decrease in the acidity, although also a few contradictory cases are noted. In the limed samples the rise in the pH was greater than in the unlimed ones. After three months of incubation in part of the samples an increase in the acidity was to be seen, although the pH continued to be higher than the original pH value. On examining the effect of incubation on the acidity of the peat samples on the basis of the mean values it is evident that in all peat groups there was a rise in the pH during one month of incubation. The rise varies in unlimed samples by 0.1—0.5 while in the limed samples it was 0.6—1.2 pH degrees.

After three months of incubation the pH had sunk, although it was still higher than the original pH values in all the peat groups except the limed LC- and LSC peats. In the limed samples, with the exception of the LC and LSC peats, the pH was higher than in the unlimed samples.

In general the changes in the pH are very similar in all peat groups. Any clear differences between the different peat groups cannot be noted. The rise in the pH that occurs during the first month of incubation can probably be attributed to the ample formation of ammonia during the first stages of incubation, as Kaila and others (3) and Kaila and Soini (5) have stated. Later, when the ammonia has changed into nitrate the pH sinks again.

Table 3 shows the effect of incubation on the amounts of ammonium and nitrate nitrogen. Examining the figures in this Table, one finds that this effect was very variable.

Since the variations are big even within one and the same type of peat, it is difficult to get a clear view of the matter by examining the values of the single samples. For this reason the mean values of the different types of peat have been calculated in Table 3. On the basis of these figures it can be stated, that an incubation of one month increased the amount of ammonium nitrogen in all peat groups except the SC peat groups, and that liming in some cases enhanced the forming of NH_4-N. A considerable decrease in the nitrate nitrogen can be noted, this being greater in the unlimed samples than in the limed ones.

If the amounts of ammonium nitrogen and nitrate nitrogen in the original samples and those in the incubated ones are compared, it will be found that in

Sample	Before incubation				1 month of incubation unlimed			1 month of incubation limed			3 months of incubation unlimed			3 months of incubation limed		
	Sol.org. N	NH_4-N	NO_3-N	Min. N	NH_4-N	NO_3-N	Min. N	NH_4-N	NO_3-N	Min. N	NH_4-N	NO_3-N	Min. N	NH_4-N	NO_3-N	Min. N
Samples of BCp																
9	470	200	330	530	555	0	555	625	125	750	715	490	1 205	155	880	1 035
1	415	135	350	485	90	300	390	75	485	560	160	475	635	105	590	695
10	505	110	210	320	220	45	265	325	55	380	560	50	610	825	105	930
2	395	140	380	520	80	105	185	65	125	190	435	280	715	360	270	630
3	495	120	100	220	230	20	250	290	10	300	340	230	570	180	325	505
11	385	140	200	340	215	5	220	370	10	380	610	5	615	835	20	855
average	445	140	295	435	230	80	310	290	135	425	470	255	725	410	365	775
Diff.					90	—215	—125	150	—160	— 10	330	— 40	290	270	70	340
L.S.D. 95 %					180	120	145	215	190	210	210	215	340	350	335	210
Samples of Cp																
29	590	165	150	315	50	5	55	55	5	60	125	15	140	105	10	115
44	975	255	175	430	460	70	530	460	40	500	650	225	875	65	655	720
13	590	130	250	380	440	75	515	210	285	495	185	335	520	150	445	595
14	385	190	170	360	420	15	435	370	15	385	530	100	630	480	345	825
25	625	165	250	415	330	30	360	240	85	325	445	30	475	140	265	405
26	515	175	240	415	300	35	335	290	35	325	420	35	455	380	45	425
40	660	90	165	255	345	35	380	235	60	295	140	270	410	220	115	335
43	790	215	285	500	330	35	365	335	20	355	485	110	595	30	440	470
45	935	250	555	805	505	80	585	520	80	600	655	65	720	30	455	485
46	900	240	360	600	310	15	325	295	20	315	420	10	430	5	390	395
51	645	225	170	395	375	20	395	290	105	395	320	15	335	95	305	400
52	650	175	365	540	395	20	415	435	25	460	455	15	470	105	430	535
36	635	100	80	180	250	10	260	285	10	295	270	10	280	290	15	305
55	745	145	160	305	455	20	495	375	100	475	150	310	460	85	410	495
56	540	185	150	335	405	15	420	385	20	405	445	25	470	50	405	455
41	455	210	90	300	585	10	595	500	10	510	595	10	605	15	505	520
20	435	180	160	340	265	10	275	275	15	290	460	10	470	520	15	535
4	615	140	85	225	310	30	340	310	35	345	410	305	715	210	520	730
19	500	240	150	390	340	15	355	365	10	375	585	85	670	260	315	575
60	600	325	290	615	400	25	425	385	15	400	455	35	490	215	145	360
average	640	190	220	410	350	30	380	405	50	455	405	110	515	170	315	485
Diff.					160	—190	—30	215	—170	45	215	—110	105	— 20	95	75

Samples of SCp

28	720	185	115	300	110	5	115	150	5	155	365	15	380	140	105	245
12	480	720	140	860	435	20	455	515	15	530	270	395	665	190	495	685
35	675	190	80	270	225	10	235	200	20	220	270	15	285	210	15	225
18	545	250	460	710	50	370	420	25	470	495	160	410	570	190	540	730
24	425	165	30	195	395	20	415	375	25	400	465	30	495	455	45	500
59	655	325	290	615	400	25	425	385	15	400	455	35	490	215	145	360
average	585	305	185	490	270	75	345	275	90	365	330	150	480	235	225	460
Diff.					—35	—110	—145	—30	— 95	—125	25	— 35	—10	—70	40	—30
L.S.D. 95 %					175	150	140	190	195	155	125	205	140	115	240	230

Samples of EuSCp

57	535	145	160	305	330	40	370	145	160	305	65	310	375	40	280	320
58	590	160	175	325	420	15	435	335	10	345	90	340	430	55	330	385
47	765	165	260	425	430	60	490	350	95	445	90	360	450	335	80	415
48	625	220	905	1 125	100	340	440	100	370	470	90	470	560	365	85	450
5	470	170	200	370	50	305	355	40	325	365	310	585	895	460	670	1 130
average	595	170	340	510	265	155	420	195	190	385	130	415	545	250	290	540
Diff.					95	—185	— 90	25	—150	—125	—40	75	35	80	—50	30
L.S.D. 95 %					225	190	75	175	185	85	125	140	260	235	300	410

Samples of LSC- and LCp

27	525	215	270	485	340	25	365	275	35	310	405	35	440	330	45	375
23	605	165	45	210	470	20	490	460	30	490	355	160	515	90	415	505
30	575	175	95	270	255	5	260	320	5	325	415	10	425	455	30	485
average	570	185	135	320	355	15	370	350	25	375	390	70	460	290	165	455
Diff.					170	—120	50	165	—110	55	205	— 65	140	105	30	135
L.S.D. 95 %					270	25	285	235	35	250	75	200	125	460	550	175

					Samples of SCp											
15	470	290	395	685	550	50	600	610	145	755	1 070	80	1 150	350	655	1 005
16	505	100	380	480	300	15	315	400	40	440	580	25	605	160	480	640
17	455	160	510	670	395	35	430	475	65	540	560	35	595	340	360	700
38	695	620	205	825	985	30	1 015	930	50	980	1 330	15	1 345	1 260	10	1 270
49	725	200	270	470	420	15	435	490	35	525	575	15	590	390	145	535
50	810	120	250	370	335	15	350	455	45	500	495	5	500	245	255	500
53	700	180	120	300	340	20	360	100	405	505	195	145	340	70	500	570
54	605	155	130	285	360	20	380	355	30	385	300	10	310	190	130	320
39	690	275	205	480	520	45	565	510	50	560	700	5	705	710	25	735
8	510	85	230	315	245	60	305	245	25	270	560	50	610	480	85	565
33	545	210	80	290	260	15	275	380	20	400	365	20	385	590	40	630
42	580	125	90	215	400	5	405	430	10	440	480	25	505	20	545	565
average	605	210	240	450	425	25	450	450	75	525	600	35	635	400	270	670
Diff.					215	—215	0	240	—165	75	390	205	185	190	30	220
L.S.D. 95 %					125	10	125	125	70	120	200	25	195	215	145	160
					Samples of Sp											
6	515	120	470	590	360	50	410	340	55	395	285	55	340	245	55	300
21	375	210	75	285	470	30	500	570	70	640	670	65	735	205	470	675
31	640	210	140	350	455	20	475	445	55	500	635	50	685	410	250	660
32	580	230	155	385	435	35	470	535	65	600	650	60	710	255	440	695
34	685	200	365	565	310	20	330	385	15	400	465	40	505	335	175	510
37	745	210	165	375	1 230	70	1 300	1 365	140	1 505	1 380	10	1 390	1 655	15	1 670
7	540	190	200	390	615	70	685	755	85	840	1 355	85	1 440	480	85	565
22	490	165	85	250	470	40	510	275	115	390	155	205	360	135	130	265
average	570	190	205	395	540	40	580	585	75	660	700	70	770	465	200	665
Diff.					350	—165	185	395	—130	265	510	—135	375	275	—5	270
L.S.D. 95 %					245	20	260	295	35	320	380	50	365	420	145	365
Carex domin. peats		200	235	435	295	70	365	305	100	405	345	200	545	270	270	540
Diff.					95	—165	—70	105	—135	—30	145	— 35	110	70	35	105
L.S.D. 95 %					45	30	35	45	40	40	55	55	55	60	70	65
Sphagnum domin. peats		200	220	420	480	30	510	515	75	590	650	50	700	430	235	665
Diff.					280	—190	90	315	—145	170	450	—170	280	230	15	245
L.S.D. 95 %					110	10	115	215	40	125	170	25	170	185	95	150

Carex-dominated peats, except in forest peats and limed Carex-dominated peats, a reduction in the amount of nitrogen has taken place. On the other hand, the amounts of ammonium nitrogen and nitrate nitrogen in Sphagnum peats are bigger in the incubated samples than in the original ones owing to the rich formation of ammonium nitrogen.

After three months of incubation it can be established that in the unlimed samples there is more ammonium nitrogen than in the original ones, excepting the EuSC-peats. In general there has been an increase also in comparison with the samples that have been incubating for one month only. There is still less nitrate nitrogen than in the original samples, although the amount is greater than in samples incubated for one month excepting again the EuSC-peats. In the limed samples that have been incubating for three months there is more ammonium nitrogen than in the original samples, with the exception of the C and SC peats, but in general the ammonium nitrogen content is smaller than in the unlimed samples. Of nitrate nitrogen there was found more in the limed samples after three months of incubation than in the original ones, excepting the EuSC and S peats. On examining the total amounts of ammonium nitrogen and nitrate nitrogen after three months of incubation it is found that they have increased in all peats except the SC peats. Liming has in some instances stimulated the mineralization.

In order to establish the effect of incubation on the Carex- and Sphagnum-dominated samples the mean values of these two groups are given in Table 3. The BC, C, EuSC, SC, LSC, and LC peats (altogether 40 samples) have been considered Carex-dominated, and the CS and S peats (altogether 20 samples) have been considered Sphagnum-dominated. In addition the possible increases or decreases in the amounts of mineral nitrogen as compared to the amounts in the original samples are also given. The results show that one month of incubation has in the Carex-dominated samples caused an increase in the amount of ammonium nitrogen, the increase being slightly greater in the limed samples than in the unlimed ones. The amount of nitrate nitrogen has decreased considerably after one month of incubation, the decrease being slightly larger in the unlimed samples than in the limed ones. After three months of incubation the formation of ammonium nitrogen in the unlimed samples has continued. In the limed samples, again, there is now less ammonium nitrogen than in the samples that had been incubating only one month, nevertheless they still contain more ammonium nitrogen than the original samples. After three months of incubation the amount of nitrate nitrogen shows an increase as compared to what it was after one month, however, it is still slightly lower in the unlimed samples than in the original ones. In the limed samples, on the other hand, there is already slightly more nitrate nitrogen than in the original samples; accordingly liming has to some extent enhanced the forming of nitrate.

On the basis of these results it would seem that after one month of incubation the amount of ammonium nitrogen and nitrate nitrogen together in the Carex-dominated samples, limed as well as unlimed, is slightly smaller than in the original samples. After three months the amount is greater than in the original samples. Liming has neither caused a distinct increase, nor a decrease in the amount, to some extent it has, however, enhanced the formation of nitrate. In the Sphagnum-dominated samples one month of incubation has doubled the amount of ammonium nitrogen compared to the amount in the original samples; the increase is slightly larger in the limed samples. The amount of nitrate nitrogen has decreased considerably in the Sphagnum-dominated samples after one month of incubation. The decrease was smaller in the limed than in the unlimed samples. After three months the amount of ammonium nitrogen had further increased in the unlimed samples. In the limed samples, on the other hand, a decrease in the amount of ammonium nitrogen had taken place, although the amount is not nearly as small as in the original samples. The amount of nitrate nitrogen had increased also in the Sphagnum-dominated peats, true, only slightly in the unlimed samples, while in the limed ones the amount by now exceeded the amount of nitrate in the original samples. The total amount of ammonium nitrogen and nitrate nitrogen is clearly higher in the incubated samples, especially after three months of incubation, than in the original ones.

If the changes in the nitrogen compounds of these two peat types are compared, it will be seen that they very much resemble each other. It is interesting to note that in the original samples there were on an average, equal amounts of ammonium nitrogen and nitrate nitrogen in both groups. It is also interesting to find that after three months of incubation the total amounts of ammonium and nitrate nitrogen are distinctly higher in the Sphagnum-dominated than in the Carex-dominated samples. It should be noted, however, that in this connection the results have been counted on the basis of the weight units. If the volume units are taken as the means of comparison, for instance the mobilization in kilograms per hectare (Fig. 2), the Carex peats are found to be better mobilizers of nitrogen.

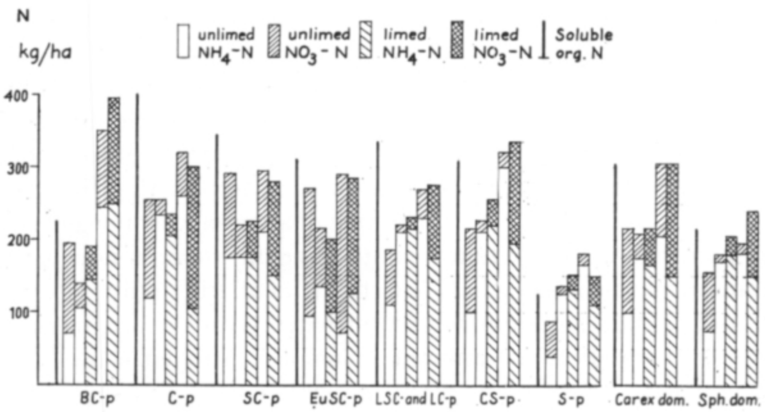

Figure 2. Mineral nitrogen in kg/ha in different peat types. At each peat type the first pilars represent the orginal samples, the second and third pillars the situation after one month of incubation, and the fourth and fifth the situation after three months of incubation.

As regards the mobilization of nitrogen expressed in kg per ha as shown in Fig. 2 it is apparent that the mobilization is very similar in all peatgroups except the S-peats, whose mobilization ability is rather less than that of the other groups. On comparing Carex-dominated and Sphagnum-dominated peats it is found that slightly more nitrogen is mobilized from the Carex-dominated peats, the difference is noticeable especially after an incubation period of three months.

Since the material was fairly large and diverse it was considered justifiable to examine, using the correlation coefficient, to what extent the mobilization of nitrogen is dependent on other qualities in the samples. The coefficients were calculated only for the Carex- and the Sphagnum-dominated peats. In a few cases, only, a significan correlation was obtained. Between the soluble organic nitrogen and the ammonium nitrogen in the limed Carex-dominated samples that had been incubating for three nonths a clear correlation was obtained (0.553***). A correlation was also obtained between the soluble organic nitrogen in the original samples and the mobilized nitrogen in the limed Carex-dominated samples that had been incubating for three months (0.425**).

Discussion:

On the basis of the results it can be stated that in these experimental conditions the differences between the various peat types in the mobilization of nitrogen are fairly small. To draw a clear line between the different peat types is difficult, in part even impossible. The same observation has earlier been made by KAILA, SOINI and KIVINEN (3). They have presumed that e.g. the low degree of humification in the peats could possibly account for the similarities. In this investigation, however, peats in many different stages of humification have been used, nevertheless no clear differences have been obtained. In addition the dispersions have been so great that even if there were in some cases differences between the mean values, the great dispersion makes them unreliable.

It is interesting to note that in samples that have been incubating for one month there is in many cases a smaller amount of mineral nitrogen than in the original samples. It is possible that there are many reasons for this, one of them might be the original great amount of extractable mineral nitrogen in the dried and ground samples. When the samples are moistened anew and are incubating, the effects of the drying and grinding might gradually disappear. The results obtained by KIVEKÄS (8) with regard to the effect of drying and grinding on the results of analyses, are an indication of this.

Liming seems in general to stimulate the nitrification. KAILA, SOINI and KIVINEN (3) have reached the same conclusion. This was particularly apparent in the samples after three months of incubation. On the other hand liming has seldom an increasing effect on the total amount of mineral nitrogen, even if one can not speak about a decreasing effect of liming, as has been stated by KAILA and SOINI (5).

A relatively interesting point is the fact that by dividing the peats into only two groups, the Carex-dominated and the Sphagnum-dominated peats, the total amount of mineralized nitrogen is found to be higher in the Sphagnum-dominated than in the Carex-dominated peats. This, however, holds good only if the results are calculated on the basis of the weight unit; if the volume unit is used the Carex peats seem to mobilize more nitrogen.

Among the reasons for the similarity in the results obtained from different peats, the effect of the artificial conditions in a laboratory may be considered the most important one. The incubation experiments were carried out with dried and pulverized samples in room temperature and constant moisture conditions, in which the possible harmful effects of the physical differences in the peats were unable to exercise any influence. Moreover, in experiments of this kind the effects of plants and the washing down of nutrients are excluded; and, what is most important, in this kind of experiment only the final results of the phenomena are stated (3 and 5). Thus the results obtained from these experiments are not directly applicable to conditions in the field.

Summary

60 peat samples from northern Finland representing different types of peat were incubated in a laboratory at a temperature of 17—18° C. The ammonium nitrogen, the nitrate nitrogen and the pH in the samples were determined after one month of incubation as well as after three months of incubation. The results were compared to results from determinations made before incubation. An attempt was made to elucidate the factors that influence the mobilization of nitrogen.

On the basis of the above results it is evident that the differences between the various peat types as mobilizers of nitrogen are under these circumstances not very distinct, nor do these differences seem to be dependent on the types of peat. The following facts can, however, be established:

In the amounts of ammonium nitrogen an increase takes place in most groups of samples during the first month. This increase is fairly big in the Sphagnum-dominated peats.

The increase in ammonium nitrogen continues in the unlimed samples in most peat groups during all three months of incubation.

After three months of incubation the amount of ammonium nitrogen in the limed samples is smaller than in the unlimed samples, although it is usually bigger than in the original samples.

After the first month of incubation the amounts of nitrate nitrogen in all types of peat have decreased compared to the amounts in the original samples. In the limed samples the decrease is not as great as in the unlimed ones.

After three months of incubation the amount of nitrate nitrogen has considerably increased as compared to the amount after one month of incubation. In the limed samples it might to some extent exceed the original amount of nitrate nitrogen, however, this is seldom the case in the unlimed samples.

If the results are calculated on the basis of weight unit, it can be stated that the ability to mobilize nitrogen is greater in the Sphagnum peats than in the other peat groups.

Working out the results in kg per ha it will be noted that somewhat more nitrogen is mobilized in the Carex-dominated than in the Sphagnum-dominated peats.

The results obtained by experiments in the laboratory are not directly applicable to conditions in the field.

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SELOSTUS:

HAVAINTOJA TURPEEN TYPEN MOBILISAATIOSTA MUHITUSKOKEISSA

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Laboratoriossa muhitettiin 60 pohjois-Suomen soilta otettua turvenäytettä 17—18° C lämpötilassa ja n. 70 % kosteudessa, sekä seurattiin turpeessa NH_4-N ja NO_3-N määrien vaihteluja 1 ja 3 kk pituisten koejaksojen kuluessa. Turpeiden välillä todettiin eroavaisuuksia, mutta ne eivät noudattaneet turvelajeja.