ISSN 0039 — 5471

SUO

Vol. 33

1982, N:o 2

1. 7. 1982

Julkaisija — Publisher:
SUOSEURA — FINNISH PEATLAND SOCIETY

Toimitus—Office:
Unionink. 40 B
00170 Helsinki 17
Finland

Tilaushinta, 40 mk
Subscription price
40 Finnish marks

Kirjoituksia lainattaessa pyydetään mainitsemaan lehden nimi

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Suo 33, 1982 (2): 33—42

COMPARISON OF TWO PEAT SAMPLERS USED IN ESTIMATING THE DRY PEAT YIELD IN FIELD INVENTORIES

TURVESAANNON ARVIOINTIIN KÄYTETYN KAHDEN SUOKAIRAN VERTAILU

1. INTRODUCTION

The utilization of peatlands for moss peat and fuel peat production has enormously increased during the past few years in different countries. Consequently, the need for estimation of resources is understood as an important part of ''peat projects'' established in different parts of the world. It is well known that calculation of the dry peat yield cannot be done in any type of peatland without great risks of error on the basis of total area and depth as well as the degree of decomposition data of peat deposits due to the great variation in the moisture content (total porosity) of peat *in situ* (e.g. Samsonova *et al.* 1954 p. 115, Tolonen & Saarenmaa 1979, Korpijaakko *et al.* 1981, see, however, Scott *et al.* 1980).

The dry peat yield of a particular peatland area can be reliably estimated only either by means of direct volumetric sampling for bulk density data or indirectly using the relationship between moisture content and bulk density of peat.

In practical peat inventories the Russian peat sampler designed in Kalinin in early 1940s (Belekopytov & Berechnevich 1955, see Jowsey 1966 and Tolonen 1968) and its wider and longer modifications have been used for obtaining volumetric samples in many parts of the world. In Canadian and American literature (e.g. Day *et al.* 1979) the McCayley sampler is used as a synonym for the Russian peat sampler. A 150 cm long and 10 cm wide motor operated version of this sampler was demonstrated for the participants of the 6th International Peat Congress in Duluth, Minnesota, USA in late August 1981.

In the Geological Survey of Finland a modification of piston sampler (see Korpijaakko 1981) has been used for taking volumetric samples (e.g. Mäkilä 1980, Korpijaakko *et al.* 1981).

In Finland there was an apparent need to compare these two different samplers, because Lappalainen (1981) and Toivonen (1981) claimed that a piston sampler is required for obtaining acceptable volumetric samples from peat.

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2. METHODS

A piston sampler (80 mm in diam.) as described in Korpijaakko (1981) was made of stainless steel at a metal workshop (Reijo Nieminen) in Kuopio, Finland. It was used in field in accordance with the instruction given by Korpijaakko (1981).

From the same sampling sites, core profiles were taken by means of a Russian

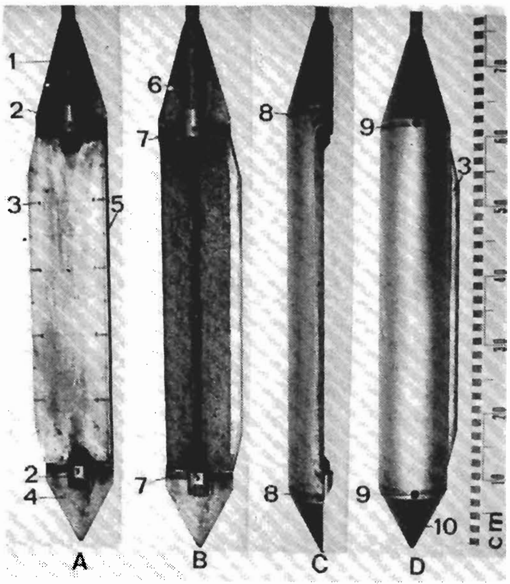

Fig. 1. Russian peat sampler as used in this study in the position when pushed down (A and C) and when lifted up with the sample (B) as well as in the back view (D). The main parts are head (I), pivots (2) with adjusting screws, anchor (3), nose (4), shuttle (5), hole for safety wire, thresholds, protecting the anchor (7), brazes (8), screws fixing the pivots (9) and groove for testing the soil type below the sample through (10). Photo J. Meriläinen 1982.

Kuva 1. Tutkimuksessa käytetty venäläinen turvekaira kuvattuna näytteenotto- (A ja C) sekä ylösnostoasennossa (B) jolloin näyte on sisällä sekä takaa (D). Tärkeimmät osat ovat runko ja kärki (1 ja 4), akselit pyöreiden teräsholkkiensa sisässä (2) säätöruuveineen, siipi, jonka leikkuupinta varustettu 10 ja 5 cm asteikolla (3), näytekouru jonka leikkaava reuna on hyvin terävä (5), varavaierin kolo (6) siiven ylä- ja alareunaa suojaavat kynnykset (7), kourun runkoon yhdistävät hitsaussaumat (8), akseliston kiinnitysruuvit (9) sekä pohjamaanäytteen ottoon tarkoitettu n. 1 cm syvyinen ura (10).

peat sampler (chamber 500 mm long, 100 mm in diam.) as modified by K. Tolonen (Fig. 1.). The sampler was used so that half cylindrical samples were obtained. The cutting edge of the chamber was sharpened in the field, if, necessary using a file and a whetstone. A sharp, long knife and scissors were used for slicing the 10 cm long subsamples. Water inside the core chamber was carefully preserved during the slicing.

The sampling spots were chosen to be near each other within less than one square meter, and they were located on mire surfaces as similar as possible. The same anchored zero level was used for each spot.

Samples were dried at 105°C. Dry bulk density is expressed as kg/m³ without ash correction. It is known, however, from the previous data of these peat deposits that the ash content is fairly low. Most commonly it is between 1 and 2 % for the Sphagnum peats and 2—4 % for the others.

3. STUDY SITES AND MATERIAL

Our data comes from five peatlands in Central Finland (Table 1).
The sites represent different main peatland vegetation (Table 2) and stratigraphy as well as different peat types (Fig. 3).

All the peatlands studied are drained for forestry. The efficiency of drainage has, however, been very low in all the sampling sites except at Lamminsuo 3.

Our material consists of 86 piston corer samples and equal number of 20 cm long Russian corer samples. Besides, in Lamminsuo 3 and Nuijasuo 2 we took altogether 74 samples by means of on open cylinder from open peat faces. The sampling by cylinder took place in the 140 cm deep roundish pits which were dug on those sites. Cylinder samples were taken in three replicates both in horizontal and vertical directions using a very thin walled and

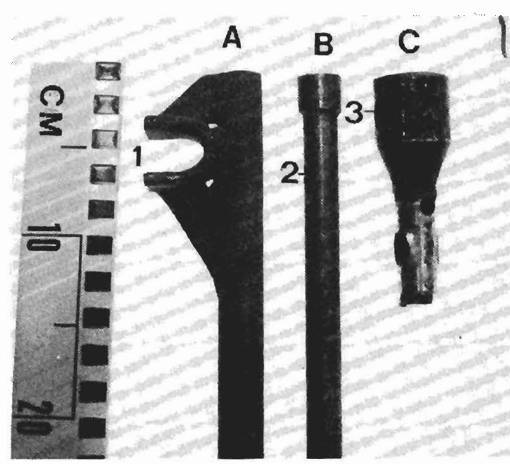

Fig. 2. Supplies of Russian peat sampler: lifting tool (A), lower end of an extension rod (B) and the head of the turning handle (C). Crasping jaws (1) are smoothed in order to prevent damages in extension rods, which are joined together by 10 mm bolts going through holes (2), hole (3) for turning handle. Photo J. Meriläinen 1982.

Kuva 2. Venäläisen turvekairan varusteita: nostovarsi (A), jatkovarsi (B) ja kääntövarren runko-osa (C). Puruleuat (1) ovat pyöristetyt, jolloin jatkovarsiin ei synny painaumia, jatkovarret liitetään toisiinsa varsien läpi menevien (2) 10 mm pultein. Nuijittavassa kääntöpäässä kääntövarren reikä (3).

Table 1. Location of the study sites.
Taulukko 1. Tutkimusalueiden sijainti.

No	Mire	Site	Abbr.	Parish	Basic map & coordinates
1	Suolamminneva	14	SL14	Ähtäri	224109:694651/52048
2	Viheriäisneva	1	Vih	Ruovesi	223104:686047/51136
3	Lamminsuo	3	Lam3	Juupajoki	214206:685969/51595
4	Riitasuo	1	RiitL	Ähtäri	224105:693740/51420
5	Nuijasuo	2	Nui2	Juupajoki	214209:686380/51950
6	Nuijasuo	1	Nui2	Juupajoki	40 m NE from Nui2

Table 2. Mire complex types and site types (Heikurainen 1979) of the mire sites studied.
Taulukko 2. Tutkimusalueiden kompleksi- ja suotyypit.

Site	Mire complex type	Nutritional hydrology	Site type
Suol. 14	aapa mire	slightly minerotr.	small sedge pine bog
Vih 1	raised bog	ombrotrophic	S. fuscum pine bog
Lamm 3	not classified	minerotrophic	ordinary spruce swamp
Riit L	raised bog	ombrotrophic	cotton grass pine bog
Nuij. 2 & 1	aapa mire	slightly nimerotr.	cotton grass pine bog

asymmetrically toothed steel cylinder, 12 cm in diameter. For vertical cylinder samples the lowermost cylinder of our piston sampler (cf. Korpijaakko 1981 Fig. 1) was applied.

The whole peat strata of all the peatlands studied were sampled using the Russian peat sampler, to investigate the spatial variation in the studied parameters (dotted parts in profiles in Fig. 3). Several additional peat profiles were also taken, for instance, in Suolamminneva the number of laboratory samples were about 2000 from 15 coring sites along a 850 long transect.

4. RESULTS

4.1. **Bulk density**

In Fig. 3 the bulk density values of samples obtained by Russian peat sampler and piston sampler are plotted against depth in all the five peatlands. In Lamminsuo and Nuijasuo there are also results of the samples taken by open cylinder (see methods).

According to our field observations, peat stratigraphy is not uniform, but changes may occur horizontally even over short distances. That kind of mosaic structure of peat layers is well documented in all the detailed studies so far regarding open peat faces (e.g. Ruoff 1934, Walker & Walker 1961, Casparie 1969, Aaby 1971, Tolonen 1971, Barber 1981).

Further evidence for this fact is provided by numerous corings in Suolamminneva (altogether 15 sites) with three replicates only 30 cm from each other using always the same sampler. The range of the bulk density values of samples from the corresponding depths was often as high as 10 kg m^{-3}. Results from site 5 are presented as an example. The average range of the bulk density values (excluding the four uppermost samples with greatest variation) was 10.70 $\pm$ 6.29 kg m^{-3} (n = 27) in this data.

Hence, it is not possible to compare correctly the sample pairs by different corers on the depth basis due to the inhomogenity of the peat strata.

Table 3. The average dry bulk density (kg/m³) (with S.D.) in six Finnish coring sites as obtained by means of piston sampler and Russian peat sampler as well as comparison of results by t-test, ns = statistically not significant, d.f. = degrees of freedom.

Taulukko 3. Turpeen tiheyden keskiarvo ja normaalipoikkeama (S.D.) kuudessa kairausprofiilissa "tilavuustarkan putkikairan" (Piston s.) ja venäläisen suokairan (Russian s.) näytteiden perusteella ja tulosten t-testi.

	Russian s.	Piston s.	t	n	d.f.
1. Suol. 14	68.19 $\pm$ 10.22	65.69 $\pm$ 10.54	0.742 ns	19	36
2. Vih. 1	75.03 $\pm$ 13.87	73.72 $\pm$ 15.66	0.287 ns	21	40
3. Lamm. 3	79.67 $\pm$ 15.40	80.98 $\pm$ 27.45	0.172 ns	17	16
4. Riit. L	96.69 $\pm$ 16.14	96.02 $\pm$ 22.74	0.099 ns	17	32
5. Nuij. 2	76.90 $\pm$ 16.23	71.59 $\pm$ 22.14	0.670 ns	12	22
6. Nuij. 1	74.60 $\pm$ 23.81	—	—	25	—

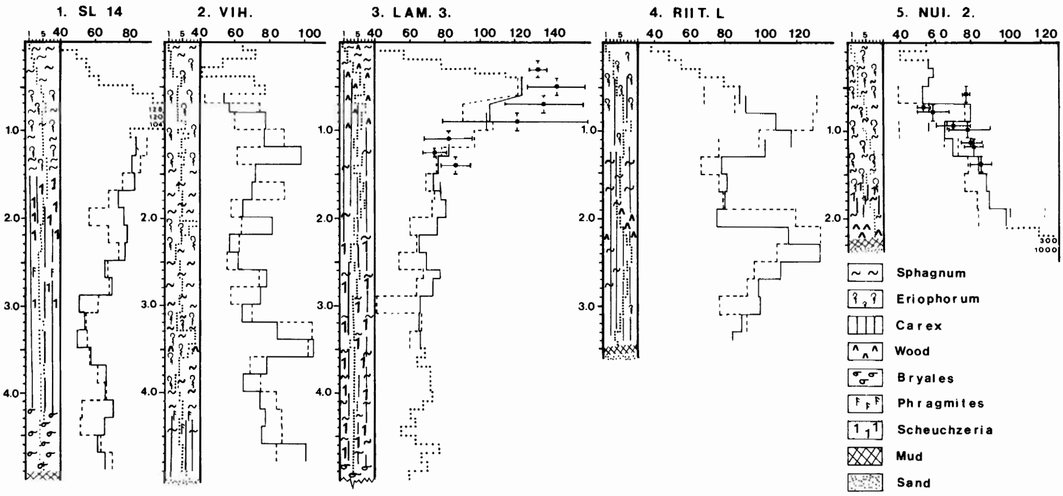

Fig. 3. Dry bulk density (kg/m³) vs. depth (m) in five Finnish peatlands as obtained by Russian peat sampler (solid and dotted line), by piston sampler (broken line) and by open steel cylinder from excavated pit (asterix for mean with single S.D. given). Dotted line in peat type column denotes the degree in decomposition in v. Post's ten grade scale (H 1—10). Abbr. in Table 1.

Kuva 3. Turpeen tiheyden (kg/m³) vertikaalijakauma viidellä Keski-Suomen suolla venäläisen turvekairan (ehyt ja pisteviiva), putkikairan (katkoviiva) ja kuopan seinämistä otettujen sylinterinäytteiden perusteella (keskiarvot merkitty tähdellä ja normaalipoikkeama janoin). V. Post'in maatumisaste merkitty turvelajipylväisiin.

The samples taken by the open cylinder from the pits gave statistically significantly higher bulk density values at most sampling depths. This is natural because the structural inner tension of the peat layers and considerable amount of water were lost during the excavation resulting in compression of peat.

Besides, wide range in the bulk density values was found also in the data of cylinder samples. Therefore we cannot be sure either, which if any of our samples represent the precisely correct bulk density values for the peat layers studied.

The statistical analysis of our data (Table 3) on a core profile basis did not reveal significant differences in dry bulk density values between Russian peat sampler and piston sampler. The reason for this was the negligible differences in the means, not the large variation in the data.

4.2. Water content on weight basis

From the vertical profiles (Fig. 4) one can get an impression that in the very wet peat layers the piston sampler generally gives slightly higher water contents that does the Russian peat sampler. Only in one case, however (in Nuijasuo), the difference was statistically significant (at 5 % risk level). The difference in the means of the whole core profiles was 1.66 % units (Table 4). One possible explanation for the difference in this case, and perhaps in all the peat deposits, was the fact that sampling by the piston corer took place some days after the coring by the Russian sampler, and because the holes were very close to each other (four holes altogether) the peat was wetter during the latter sampling. That might be true in the layers where water occurs in "pockets and veins" (cf. Tolonen et al. 1982). Such is the case in the site Nuijasuo 2 where several water veins were found being associated with pine roots as observed in a 180 cm deep pit excavated by spade after the sampling.

The variation in water contents of three replicates from each level taken by Russian peat sampler in Suolamminneva site 5 (very similar to SL 14 and only 20 m N from it) was clearly greater (range 2.03 ± 2.47 % units, n = 26) than the average range in water content values of site SL 14 taken both by piston sampler and Russian sampler (0.86 ± 0.74 % units; Fig. 4).

The average water contents and their standard deviations from the cylinder samples (3 to 6 replicates from each level) of the sites Lamminsuo 3 and Nuijasuo 2 are presented in Fig. 4. In the woody peat of the uppermost meter of the Lamminsuo profile several "water veins" were observed being associated with the roots of trees and

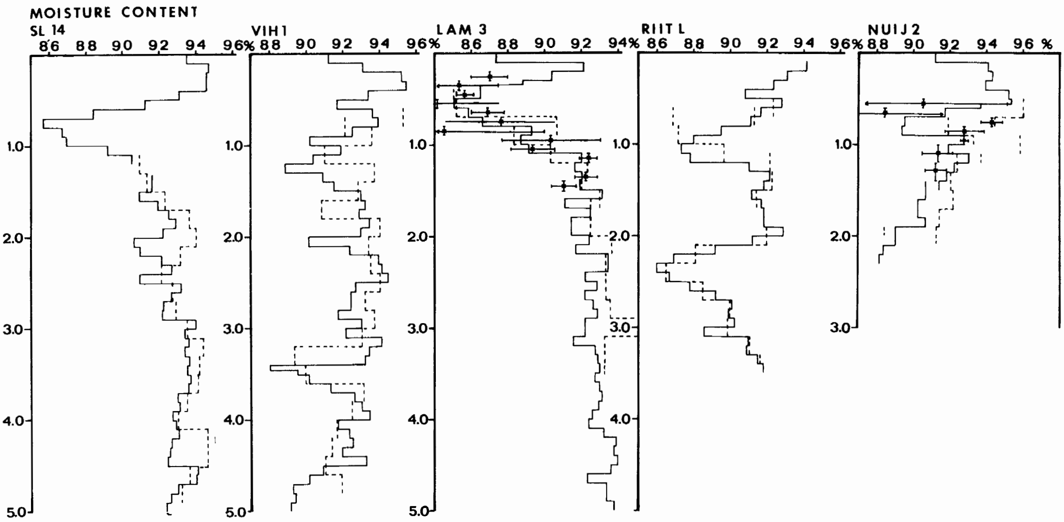

Fig. 4. Moisture content of peat, % of wet weight vs. depth (m) in five Finnish peatlands. Symbols for the different peat samplers as well as the cores used are equal to those in Fig. 3.

Kuva 4. Kosteussadannes märkäpainosta kuvan 3 viidessä keskisuomalaisessa turvekerrostumassa. Käytetyt kairat esitetty samoin merkein kuin kuvassa 3.

other burrows in the peat layers. This explains why water content of the samples obtained by open cylinder from the 140 cm deep pit was in general one or several percentage units lower than in samples taken by peat corers before the excavations of pits. The same is true in Nuijasuo 2 for the two uppermost and two lowermost layers, whereas in 0.7—1 m layer the results by piston corer and open cylinder are very near each other. For some unknown reason the water content in the samples by Russian peat corer in the last mentioned peat layers was up to four percentage units lower.

The average water content from adjacent Nuijaneva 2 siten (a similar site in terms of vegetation, hydrology and peat depth) obtained by Russian peat sampler (92.26 ± 2.23) was very close to the piston sampler value (92.70 ± 2.09).

4.3. Water content on volume basis

The water content of peat has often been expressed on volume basis instead of weight basis and this is preferable for several purposes (see e.g. Päivänen 1969). There are, however, great difficulties in obtaining correct water contents at sampling deeper peat layers by peat corers.

Considerable amounts of water were lost from our samples as expressed on volume basis (Table 5) and consequently the correlation coefficients for bulk density vs. water per volume are very low. In the case of Viheriäisneva, for instance, both the corers produced a correlation: r = —0.090 (n = 21). In the same samples of Viheriäisneva the r values using water content per weight as the independent variable were —0.995 by piston sampler and —0.961 by Russian peat sampler, respectively. The

Table 4. The average moisture content of peat (% of wet weight) and S.D. in six Finnish coring sites as well as comparison of results by t-test. * = statistically significant at 5 % risk level.

*Taulukko 4. Kosteuspitoisuuden (vesisadannes märkäpainosta) vertailu taulukon 1 kuuden näytesarjan näytteissä t-testin avulla. * = tilastollisesti merkitsevä 5 prosentin riskitasolla, ns = tilastollisesti ei merkitsevä.*

	Russian s.	Piston s.	t	n	d.f.
1. Suol. 14	92.58 ± 0.98	93.24 ± 1.04	2.013 ns	19	36
2. Vih. 1	92.09 ± 1.26	92.41 ± 1.51	0.536 ns	21	40
3. Lam. 3	91.30 ± 1.97	91.38 ± 3.20	0.094 ns	17	16
4. Riit. L	90.20 ± 1.79	90.31 ± 2.19	0.160 ns	17	32
5. Nuij. 2	91.04 ± 1.58	92.70 ± 2.09	2.195*	12	22
6. Nuij. 1	92.26 ± 2.23	—	—	25	—

Table 5. The average moisture content of peat (% of fresh volume) and its S.D. in six Finnish coring sites with t-test from paired samples (or from same levels in adjacent cores: Nuij. 1) and linear correlation coefficients for dry bulk density (kg/m^3) vs. moisture content of peat (volume basis) in the same material. ns = not statistically significant, * = significant at 5 % risk level, *** = significant at 0.1 % risk level.

Taulukko 5. Kosteuspitoisuuden (vesisadannes maastotilavuudesta) vertailu taulukon 1 kuuden näytesarjan näytteissä t-testin avulla sekä lineaarikorrelaatiokertoimet turpeen tiheyden (y) ja tilavuuspohjoisen vesiprosentin välisessä regressioyhtälössä samojen näytteiden perusteella.

Site	Russian s.	Piston s.	t	n	r(D_b vs water/vol %) Russian s.	Piston s.
1. Suol 14	88.90 ± 4.14	90.83 ± 2.22	2.533*	19	—0.177	—0.108
2. Vih 1	88.40 ± 5.47	89.49 ± 1.79	1.258^{ns}	21	—0.034	—0.083
3. Lam 3	86.51 ± 6.64	86.45 ± 7.99	0.033^{ns}	17	—0.635	—0.645
4. Riit L	90.39 ± 2.31	90.31 ± 2.45	0.069^{ns}	16	—0.602	—0.523
5. Nuij. 2	84.44 ± 4.17	90.76 ± 3.14	5.931***	12	—0.133	—0.134
6. Nuij. 1	89.01 ± 4.49	(90.76 ± 3.14)	(1.492^{ns})	12	—0.128	—

corresponding regression coefficients (—10.302 and —10.859, Table 6) clearly indicate that the gas content in the layers sampled, very likely lies below 5 % of volume (cf. Scott et al. 1980, Laine & Päivänen 1982). The water loss in this example apparently took place in the cutting or filling phase of the sampling in the peat layers, because we most certainly prevented any later water losses.

The average water percentages by the two peat samplers (Table 5) didn't statistically differ from each other in other peatlands except in Suolamminneva and in Nuijasuo. In Nuijasuo 2, however, the difference can be due to some technical error within sampling, because figures derived from the adjacent Nuijasuo 1 core by Russian peat sampler deviated very little from those by piston sampler.

The water loss was greater by Russian sampler than by piston sampler in the most fibrous and wettest peats. In the moisture area below 90.5 % (on volume basis) the difference between the corers was negligible.

4.4. Bulk density vs. moisture content regression

Because the density of solids of the organic dry matter of peats varies in quite a narrow range (from about 1.3 to 1.6), the dry bulk density of peat with low ash content is closely correlated with the moisture content (Fig. 5—7). The residual variation in the bulk density is due to the content of different gases (like methane), the occurrence of holes and furrows, and very possibly also due to the errors in

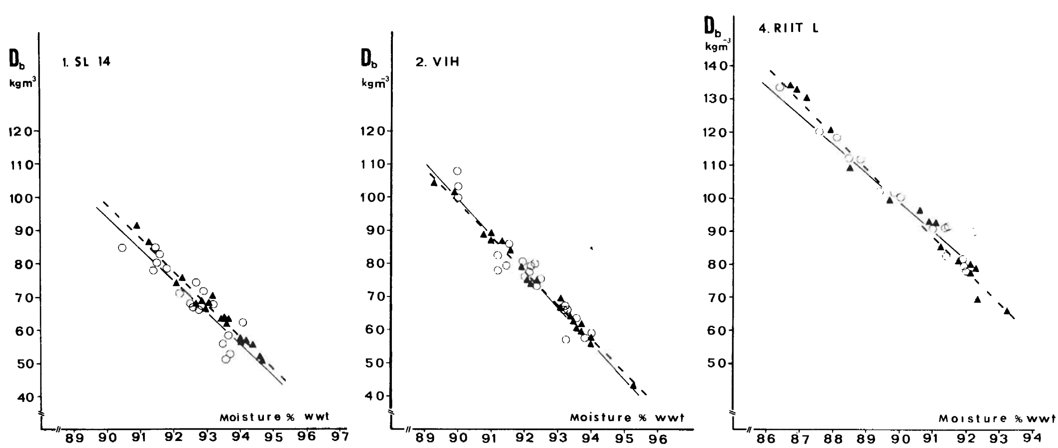

Fig. 5. Dry bulk density vs. moisture content in a Finnish sedge peat deposit (SL 14) and in two raised bogs (VIH and RIIT L) as derived from samples by Russian peat sampler (solid line and open circles) and by Piston sample used in this study (broken line and triangles), confer Table 5.

Kuva 5. Turpeen tiheyden riippuvuus turpeen maastokosteudesta samoista turvekerroksista kahdella eri kairalla kolmesta Keski-Suomen suosta otettujen näytteiden perusteella (ympyrät ja kokoviiva venäläisen kairan ja kolmiot sekä katkoviiva käytetyn putkikairan mukaan). Vertaa taulukko 5.

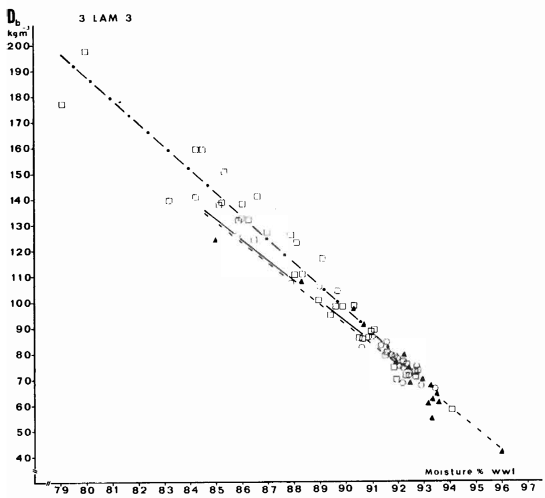

Fig. 6. Dry bulk density vs. moisture content of wet weight as obtained from the same depths in drained peat deposit of Lamminsuo by Russian peat sampler (solid line and circles) by Piston sampler used in this study (broken line and triangles) and by open cylinder from pit (broken line with dots and qudrangles). Confer Table 5.

Kuva 6. Turpeen tiheyden riippuvuus maastokosteudesta ojitetussa Lamminsuon turvekerrostumassa eri kairoin. Merkit muuten samat kuin kuvassa 3 paitsi neliöt ja pistekatkoviiva esittävät kairatusta kuopasta sylinterinäytteiden avulla saatuja tuloksia. Vertaa taulukko 5.

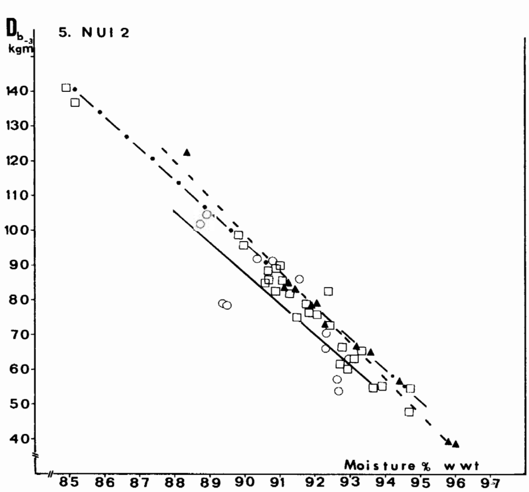

Fig. 7. Dry bulk density vs. moisture content by wet weight in peat deposit of Nuijasuo, site 2. Symbols as in Fig. 4.

Kuva 7. Turpeen tiheyden riippuvuus maastokosteudesta Nuijasuon turvepatsaassa 2. Selitykset kuvassa 4.

sampling and laboratory procedure. Weakly decomposed wet *Scheuchzeria* and *Phragmites* peats, in particular, are usually very rich in gases. The regression analysis between water content and bulk density, in the data of the above mentioned peat types obtained by the Russian peat sampler, resulted in lower regression and correlation coefficients, compared to the other peat types. This was especially clear in the data from Nuijasuo and Suolamminneva sites.

Comparison of the regression equations for piston sampler and Russian peat sampler was carried out by covariance analysis (Table 6). The differences in the slopes were not statistically significant in the data of any of the coring sites. Only in the material of Nuijasuo 2 and Suolamminneva 14 the differences in the elevations were statistically significant (at 1 % risk level, and at 5 % risk level, respectively). Our interpretation of the result is that in these cases the piston sampler might have taken a slightly too large volume for some samples and slightly too high water content for the samples below 100 cm in Nuijasuo as discussed before. Also the fact that the regression curve from the data by piston sampler in Nuijasuo lies higher than that by open cylinder offers further support for the above presented explanation.

In view of all the 25 peat samples cored from Nuijasuo 2 by Russian peat sampler the second last equation in Table 6 was resulted. Together with the corresponding equation from Nui 1 (Russian peat sampler; core hole 40 m nearby) it is, in fact, very close to the equation by piston sampler (cf. also Tables 3—5).

It is known from the literature (Schneider 1974) that a corer of piston type readily can fail to obtain certain sediment layers. Hongre & Erlandsen (1979) observed that the tube type corer caused bending of varves and compression up to 50 % of the original volume. In a corer like Russian peat sampler one can always see if any layers are absent as well as the primary structure of the sediment (including gas pockets and holes) in more or less undisturbed condition preassuming that the sampler is sharp enough. In piston sampler this is not possible because the 50 cm long sample is inside a nontransparent tube and must be pushed out during the sampling.

Table 6. Linear regression equations (y = bx + a) for dry bulk density (kg/m³) vs. moisture content of peat (% of wet weight) in some peatlands in Finland by means of piston sampler (P), Russian peat sampler (R) and by open cylinder (S) as well as comparison between the regression equations obtained for P and R by covariance analyses (F for slopes and F for elevations). ns = not significant, ** significant at 1 % risk level, * = significant at 5 % risk level.

*Taulukko 6. Turpeen tiheyden (kg/m³) regressioyhtälöt (y = bx + a) eräissä Suomalaisissa soissa kun x = kosteussadannes märkäpainosta "tilavuustarkalle" putkikairalle (P), venäläiselle suokairalle (R) ja teräslieriölle (S) sekä putkikairan ja venäläisen kairan regressioyhtälöiden vertailu kovarianssianalyysin avulla, myös esitetty (F). Merkitsevyystasot: ns = ei tilastollisesti merkitsevä, ** = tilastollisesti merkitsevä alle 1 % riskillä, * = tilastollisesti merkitsevä alle 5 % riskillä.*

		b	a	r	n	F slopes P/R	F elev. P/R	d.f.
1. Suol.	14 P	—9.958	994.2	—0.986	19	0.086 ns	4.824*	1,35
»	R	—9.614	959.6	—0.901	19			
2. Vih.	1 P	—10.302	1025.7	—0.995	21	0.625 ns	0.062 ns	1,39
»	R	—10.859	1076.8	—0.961	21			
3. Lam.	3 P	—7.898	802.6	—0.978	17	0.192 ns	1.137 ns	1,31
»	R	—7.938	807.0	—0.966	17			
»	S	—9.146	919.6	—0.976	47			
4. Riit.	L P	—10.303	1026.4	—0.992	16	3.327 ns	0.380 ns	1,30
»	R	—8.996	910.4	—0.973	16			
5. Nui.	2 P	—10.495	1044.5	—0.993	12	1.024 ns	8.373**	1,21
»	R	—8.793	879.3	—0.838	12			
»	S	—9.234	924.7	—0.984	27			
»	2 R	—10.740	1058.4	—0.981	25			
6. Nui	1 R	—10.490	1042.5	—0.983	25			

5. DISCUSSION

One can judge from the results presented in this paper that there were fairly small and relatively insignificant differences between the bulk density and moisture contents obtained by piston corer or Russian peat sampler in our examples.

The linear regression equations for moisture content (weight basis) vs. bulk density obtained from the data by piston sampler had slightly steeper slopes than those from the corresponding data by Russian sampler, in three of the testing sites. Our interpretation was that the piston sampler omitted the natural pockets, holes and veins of the peat layers due to the slight compession of samples typical of any tube corer.

The corresponding regression equations derived from the peat data from New Brunswick, Canada and Maine U.S.A. using Russian peat sampler (Tolonen *et al.* 1981, David Keys & Veijo Klemetti pers. comm., April 1981) were very close to those derived from the data by piston sampler as presented in Korpijaakko (1975) and in Korpijaakko *et al.* (1981).

Consequently, in accordance with the results obtained, the two samplers do not seem significantly to differ from each other. Of course, this does not necessarily mean that they provide correct volumes or moisture contents for peat deposits. In fact, the evaluation of our moisture data on volume basis revealed a considerable and irregular loss of water within sampling by both the corers. Our comparison with the cylinder samples from open pit walls in two coring sites suggests that at least the order of magnitude of the results by both peat samplers discussed might be right as far as bulk density figures are concerned. Further evidence is supported by the fact that our dry bulk density results came, indeed, fairly close to the theoretical ones calculated by Scott *et al.* (1980) for peats in different moisture content both in maximum and minimum gas content.

For practical inventories the piston sampler modification as used in this study cannot be preferred to the Russian peat sampler for several reasons. Because of the rather complicated design of the piston sampler it is fairly exposed to damage. Secondly, the staff required in operation is three or four persons and the sampling is very time consuming: often up to five or ten times slower than sampling by the Russian peat sampler.

Russian peat sampler (50 × 10 cm) has been used successfully by two persons equipped with special lifting tools. Two people can easily carry both the instruments and the samples also for long distances in field. The sampler is not sensitive to damage, measurement of the depth is easy and precise and the subsampling can be done in field using desired sample sizes (very often the fixed 20 cm high sample by piston corer is too large due to the inhomogenity of peat layers). The sampling is very easy and rapid. The only accessories needed in addition to lifting tool are file and whetstone for sharpening the cutting edge and scissors plus a long knife for subsampling.

More care is needed in sampling to preserve water in very wet samples taken by Russian peat sampler than in those by the piston corer. The only real disadvantage we found in Russian peat corer is that the samples very nearest to the bottom are sometimes difficult to obtain if the subsoil is hard.

REFERENCES

Aaby, B. 1976: Cyclic climatic variations in climate over the past 5500 yr, reclected in raised bogs. — Nature 263: 281—284.

Barber, K.E. 1981: Peat stratigraphy and climatic change. — A.A. Balkema. Rotterdam, 219 pp.

Casparie, W.A. 1969: Bult- und Schlenkenbildung in Hochmoortorf (Zur Frage der Moorwachstum, Mechanismus). — Vegetatio 19: 146—180.

Day, J.H., Rennie, P.J., Stanek, W. & Raymond, G.P. (Eds.) 1979: Peat testing mannual. — National Res. Counc. Canada Ass. Comm. on Geotechn. Res. Techn. Mem. 125: 1—193.

Hongve, D. & Erlandsen, A.H. 1979: Shortening of surface sediment cores during sampling. — Hydrobiologia 65 (3): 283—287.

Jowsey, P.C. 1966: An improved peat sampler. — New Phytol. 65 (2): 245—248.

Korpijaakko, M. 1975: Studies on the hydraulic conductivity of peat. — Ph.D. thesis 121 pp. University of New Brunswick, Canada.

Korpijaakko, M. 1981: Uusi kairatyyppi tilavuustarkkojen turvenäytteiden ottamiseen. (Summary: A piston sampler for undisturbed peat samples.) — Suo 32 (1): 7—8.

Korpijaakko, M., Häikiö, J. & Leino, J. 1981: Vesipitoisuuden ja maatuneisuuden vaikutus turpeen kuivatilavuuspainoon. (Summary: Effect of water content and degree of humification on dry density of peat.) — Suo 32: 39—43.

Laine, J. & Päivänen, J. 1982: Water content and bulk density of peat. Proc. of the Int. Symp. on Peat, Its Properties and Perspectives of Utilization, Minsk, USSR, Sept. 20—24, 1982. (in print).

Lappalainen, E. 1980: Peat resource estimation. — Report on Energy use of Peat. United Nations Conference on new and renewable sources of energy, 1981. The Ministry of Trade and Industry of Finland, Helsinki, Annex 1, 14—23.

Päivänen, J. 1969: The bulk density of peat and its determination. — Silva Fennica 3: 1—19.

Mäkilä, M. 1980: Tutkimus Toholammin turvevarojen käyttökelpoisuudesta ja turpeen eri ominaisuuksien välisistä riippuvuuksista. (Summary: The peat resources of Toholampi municipality and their potential use both correlations between different peat factors.) — Geol.tutkimuslaitos, maaperäosasto, Raportti P 13.6/8015 1—137.

Ruoff, S.F. 1934: Morfologija i vozrast prosloek v verhnej tolsce stagnovogo torfa srednerrusskih bolot. — Trudy Nauk-issled. torfjanogo in-ta vip. 14. Moskva—Leningrad.

Samsonova, N.N., Belekopytova, I. & Varenzova, V.S. 1954: Cpravotsnik po torfu. (Handbook of Peat). — Gosenergoitzdat. Moskva—Leningrad, 722 pp.

Scott, J.B., Korpijaakko, E.O. & Tibbetts, T.E. 1980: Development of conversion factors for expressing peat resource estimates. — Symposium Papers, Peat as an Energy Alternative, Arhington, Virginia, U.S.A., December 1—3, 1980, pp. 37—49. Institute of Gas Technology.

Schneider, S. 1974: Vergleich der Bohrenmethoden Hiller und Livingstone. — Pollen ét Spores 16: 489—492.

Toivonen, T. 1980: Turpeen tilavuuspainon ja eräiden muiden fysikaalis-kemiallisten ominaisuuksien merkityksestä sekä suon energiasisällön laskemisesta Pulkkilan Kaivosnevalla. (Summary: The significance of the bulk density and some other physico-chemical properties of peat, and the calculation of the energy content of the mire Kaivosneva, Pulkkila. — Pro gradu —tutkielma. Turun yliopiston geologian ja maantieteen laitos, Maaperägeologia, joulukuu 1980, 75 s. (M.Sc. thesis, 75 p. University of Turku, Finland, Dept. of Quaternary geology).

Tolonen, K. 1968: Soiden kehityshistorian tutkimusmenetelmistä. II. Turvekairoista. (Summary: On methods used in studies of the peatland development. II. On the peat samplers.) — Suo 18: 86—92.

Tolonen, K. 1971: On the regeneration of northeuropean bogs. I. Klaukkalan Isosuo in South Finland. — Acta Agralia Fennica 123: 143—166.

Tolonen, K. & Saarenmaa, L. 1979: The relationship of bulk density to three different measures of the degree of peat humufication. — Proc. Int. Symp. Classification of Peat and Peatlands. Hyytiälä, Finland. International Peat Society, Helsinki, pp. 227—238.

Tolonen, K., Keys, D. & Klemetti, V. 1982: Predicting energy content of *in situ* peats by means of their moisture content and bulk density. (Tiivistelmä: luonnontilaisen turvekerrostuman energiasisällön ennustamisesta maastokosteuden ja todellisen tilavuuspainon avulla.) — Suo 32 (1): 00—00.

Walker, D. & Walker, P.M. 1961: Stratigraphic evidence of regeneration in some Irish bogs. — J. Ecol. 49: 169—185.

TIIVISTELMÄ

TURVESAANNON ARVIOINTIIN KÄYTETYN KAHDEN SUOKAIRAN VERTAILU

Luonnontilaisten turvekerrostumien kuiva-ainemäärien arviointia ei voida luotettavasti tehdä turvelaji- ja maatumisastetietojen nojalla (esim. Tolonen ja Saarenmaa 1979, Korpijaakko *et al.* 1981), vaikkakin myös vastakkaisia käsityksiä on esitetty (Scott *et al.* 1980). Turvesaannon arvioinnin täytyy perustua joko tilavuusnäytteisiin tai turpeen maastokosteuden tietämiseen, sillä edellinen voidaan varsin luotettavasti laskea jälkimmäisen avulla (esim. Korpijaakko *et al.* 1981).

Tässä kirjoituksessa verrataan kahta tilavuusnäytteiden ottoon turvekerrostumista käytettyä kairamallia ns. tilavuustarkkaa putkikairaa (Korpijaakko 1981) ja venäläisen turvekairan (ks. Tolonen 1968) parannettua muunnosta (sisähalkaisija 10 cm, pituus 50 cm) (kuvat 1 ja 2).

Tutkimus tehtiin viidellä suolla Keski-Suomessa, jotka valittiin edustamaan erilaisia suotyyppejä ja turvekerrostumia (taulukot 1 ja 2). Vertailu perustuu 86 putkikairanäytteen kairaamiseen mahdollisimman läheltä kairauspisteitä, joista näytteet oli otettu pohjasta pintaan venäläisellä turvekairalla. Käytännössä kairausreiät olivat halkaisijaltaan yhden metrin laajuisen ympyrän sisällä. Kahdessa tutkimuspisteessä kaivettiin lopuksi n. 2 metrin syvyinen kuoppa ja vertailunäytteitä otettiin kuopan seinämistä erilaisilla terävillä sylintereillä.

Tulokset on laskettu +105°C:ssa kuivatuista näytteistä, eikä turpeen tiheysarvoihin ole tehty tuhkakorjausta. Aineistoon ei kuitenkaan sisälly turpeita, joiden tuhkapitoisuus olisi yli 10 % (havainnot lähipisteistä samoilta soilta ja päätelmät turvelajin perusteella).

Maastohavainnot tutkimuskohteissa venäläisen kairan näytteistä, kokemuksemme avointen turveleikkausten parissa ja turvegeologinen kirjallisuus pakotti tekemään vertailut turvepatsaiden keskiarvotulosten pohjalla. Näin siksi, että kerrosrajat turpeessa usein ovat vinoja eikä samalta syvyydeltä vieri vierestäkään otetun kahden näytteen samanlaisuudesta osoittautunut valitsemillamme soilla olevan mitään takeita.

Kahdella kairalla saadut todelliset turpeen tiheydet (ent. tilavuuspaino) eivät viidessä koeprofiilissamme poikenneet tilastollisesti merkitsevästi toisistaan. Sekä keskiarvot että hajontaluvut olivat varsin lähellä toisiaan (taulukko 3). Vastaavasti vain yhdessä profiilissa oli näytteiden kosteuspitoisuus (painoprosenttina) tilastollisesti merkittävästi (5 % riskitasolla) suurempi putkikairanäytteissä kuin venäläisen kairan näytteissä. Tosin putkikairan näytteiden kosteussadannekset olivat kautta linjan hiukan korkeampia (taulukko 4). Enemmän toisistaan poikkesivat eräissä kohteissa kahden kairatyypin antamat regressioyhtälöt vesipitoisuuden ja turpeen tiheyden väliselle riippuvuudelle samassa turvepatjassa, vaikkakin tämä ero vain muutamassa kohdassa oli tilastollisesti merkitsevä tehdyn kovarianssianalyysin valossa (taulukko 6).

Siellä missä eroja oli, putkikairan antaman yhtälön regressiosuora oli jyrkempi kuin venäläisen kairan tullen lähelle vedenkyllästämän turpeen teoreettista (maksimi) regressiosuoraa (vrt. Scott *et al.* 1980). Alustavana tulkintana esitämme, että putkityyppinen verrattain paksuseinäinen (n. 8 mm) ja alaspäin lyömällä (ei kiertämällä) työnnettävä kaira työnsi kasaan tietyissä turvekerroksissa esiintyviä onkaloita. Tätä vahvistavat maastohavaintomme etenkin Suolamminnevalta ja eräät kirjallisuudessa esitetyt tulokset. Joka tapauksessa molemmat kairat antavat oikeaa suuruusluokkaa olevat tiedot turpeen saannosta luonnossa tavattavalla kosteusalueella ja sopivat siten tätä tarvetta varten kerättävän tiedoston hankintaan.

Käytännön näkökohdat eivät aseta putkikairaa venäläisen kairan edelle sikäli, mikä koskee kairan kestävyyttä, kairauksen helppoutta, nopeutta ja vaadittavaa henkilökuntaa. Käytännön kokemuksemme mukaan putkikaira vaatii noin kaksinkertaisen miehistön ja jopa viisi tai kaksitoista kertaa niin paljon aikaa kuin venäläinen kaira saman kerrostuman näytteenottoon. Venäläisen kairan parissa ilmennyt ainut todellinen epäkohta, (kun käytetään asianmukaista lujaa kalustoa ja nostovarsia sekä näytteen käsittelytekniikkaa) on, että kairan periaatteesta johtuen aivan pohjimmaisista tiukoista kerroksista on toisinaan vaikeaa saada näytettä.