Short-term standard litter decomposition across three different ecosystems in middle taiga zone of West Siberia

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Abstract. The method of standard litter (tea) decomposition was implemented to compare decomposition rate constants (*k*) between different peatland ecosystems and coniferous forests in the middle taiga zone of West Siberia (near Khanty-Mansiysk). The standard protocol of TeaComposition initiative was used to make the data usable for comparisons among different sites and zonobiomes worldwide. This article sums up the results of short-term decomposition (3 months) on the local scale. The values of decomposition rate constants differed significantly between three ecosystem types: it was higher in forest compared to bogs, and treed bogs had lower decomposition constant compared to Sphagnum lawns. In general, the decomposition rate constants were close to ones reported earlier for similar climatic conditions and habitats.

1. Introduction

1.1. Litter decomposition in ecosystems.

Litter decomposition determines the nutrient cycles in ecosystems and represents one of the largest fluxes in the global terrestrial carbon cycle [1]. In this context, the peatland ecosystems deserve special attention due to significant carbon storage and their real response to the changing environment.

In the recent past several litter decomposition studies using native litters were performed in the diverse peatland ecosystems in West Siberia [2, 3, 4, 5]. The basic method of litter bags with native substrates was implemented in these studies. About 30 litter types were studied in total (including dwarfshrubs, herbs, mosses and lichens; their above ground and belowground parts).

The decomposition rates of different litters were obtained along with evaluation of environmental parameters, such as temperature, micro-habitat conditions, elemental composition of the substrates and soils, depth below the surface and others. The dynamics of decomposition rates through the course of time were described for some of litter types.

Despite the importance of using native litter types in decomposition experiments, this approach does not allow to make comparisons across the sites and hence hamper the identification of the key drivers of litter decomposition on a global scale. A combined approach of local and standard litter was implemented in several large decomposition studies such as DECO and LIDET. In order to prove the possibility of using this technique, M. Didion with co-authors [6] compared long-term decomposition rates of local litter and tea (Lipton Rooibos and Green tea) in the Austrian Alps and found a similar responses in decomposition to the changing climatic conditions and associated shift in the vegetation.

In this context, recently started Global Litter Decomposition Study, TeaComposition, within the International Long Term Ecological Research (ILTER) aims to study the long-term litter C dynamics and its key drivers at the present and predicted climate scenarios worldwide by using standard substrate (tea).

1.2. Purpose of the study and hypotheses.

In the current study we aim to investigate the standard substrate (tea) to compare decomposition rate constants (k) between different peatland ecosystems and coniferous forests in the middle taiga zone of West Siberia. We hypothesize that 1) decomposition rate constant would be higher in coniferous forests compared to peatlands (due to better aeration conditions and better nutrient content of the soil), 2) within peatland ecosystems the waterlogged lawns would have lower decomposition constant compared to treed bogs, referring to series of experiments previously made under the same conditions.

1.3. Abbreviations.

MFS – Mukhrino Field Station; FS – Field Station; *k* – Decomposition constant; S – Stabilization factor [7]; a_r – Decomposable fraction of rooibos tea [7].

2. Materials and methods

2.1. Site description.

The experiment on tea decomposition was held in the vicinities of Mukhrino field station of Yugra State University [8] which is located in the middle taiga zone of West Siberia on the left terrace of the Irtysh River in 30 km South-West from Khanty-Mansiysk (60.8890°N; 68.7027°E). In the studied area, the vegetation is mainly characterized by coniferous forests and raised *Sphagnum* bogs. The forested areas develop on well-drained locations whereas large areas in the station vicinities are occupied by peatland landscapes. The oligotrophic peatlands are the most prevalent and represented by treed pine-dwarf shrubs-*Sphagnum* communities and graminoid-*Sphagnum* lawns. The water table may fluctuate between 0-15 cm depending on season and precipitation rate at the lawns, while the treed bogs have thicker acrotelm layer where the water level is 30-50 cm below the surface. The soil (*Sphagnum* peat) has nearly equal characteristics in the treed bogs and the *Sphagnum* lawns with low pH values (pH 3-4), high percentage of organic carbon (49-58%) and low ash content (1.2-2.6 %). The soil nutrients, calculated for the upper layer of peat in this bog were: K – 224, Na – 177, Ca – 1347, Mg – 278, P – 206, Fe – 791 mg/kg of dry weight (all soil characteristics are according to [20]).
The forests are made up of several coniferous trees and the undergrowth of various small herbs, ericoid shrubs and feather mosses. The coniferous forests are replaced by their secondary communities from *Betula* spp. and *Populus tremula*. The underlying soils are spodosols (= podzolic soils) formed on clayey loam parent material and are characterized by thin organic layer and low pH values [9].

2.2. Litter bag experiment.

The general scheme of TeaComposition project was implemented in the study [7]. Two plots (200 m^2) (waterlogged graminoid-Sphagnum lawn and relative dry pine-dwarf shrubs-Sphagnum treed bog) differing mainly in water regime and associated vegetation composition were located within the raised bog (figure 1). The third plot was located in well-drained coniferous-deciduous mixed forest (see table A1 in Appendix for details of vegetation, plots coordinates and soil properties). Lipton tetrahedron-shaped synthetic tea bags containing about 2 g of green or rooibos tea were prepared for incubation according to protocol described in [7]. At each site two replicas were established with 32 tea bags from each type buried inside a square 4 m^2 for incubation over the period of 3 years with the retrieval time after 3, 12, 24, and 36 months. Before the incubation, the tea was dried at 70°C for 48 hours and the initial weight was recorded. The tea was incubated in the aerated acrotelm layer (0-5 cm below the Sphagnum surface) at the two bog sites and under the litter layer (0-5 cm, approximately in organic layer as it is poorly distinguished in the podzolic soils) at the forest site in June 2016. After 3 months of incubation the first 8 bags from each plot were collected, cleaned from earth and roots, dried and weighed.

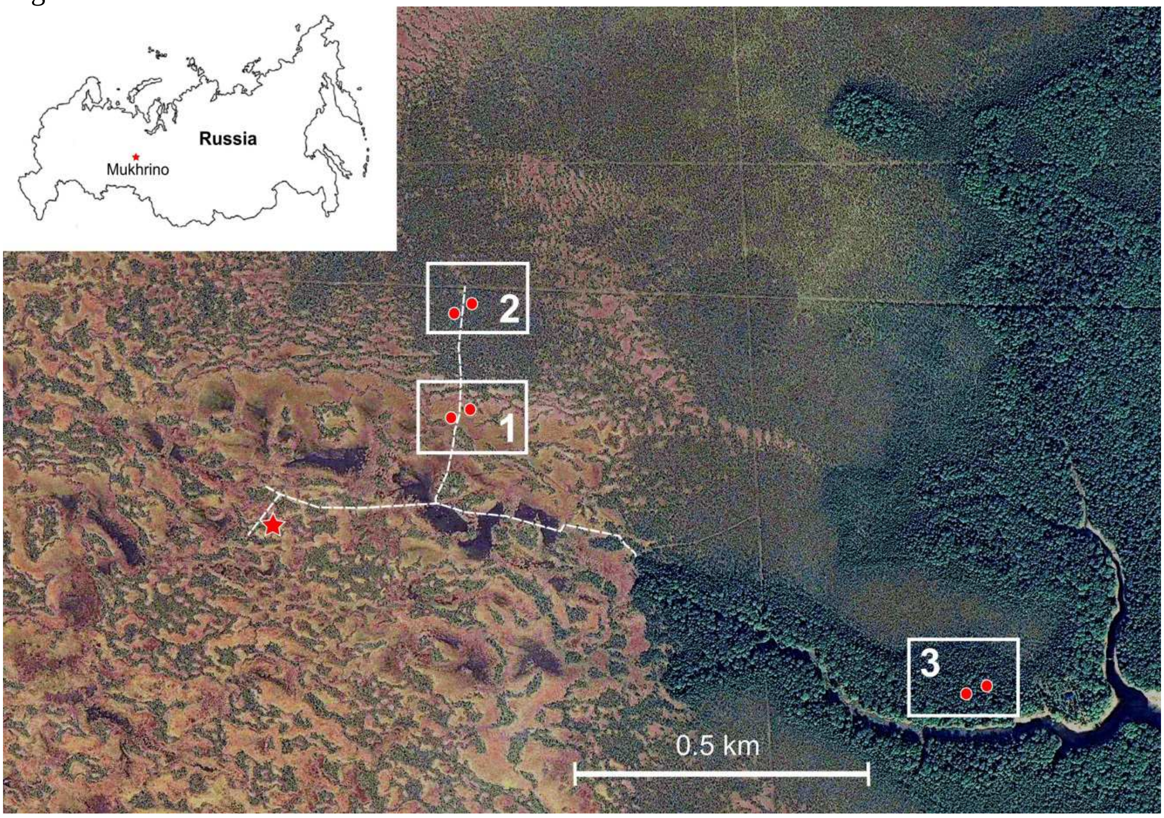

Figure 1. Location of plots and replicas in the vicinities of Mukhrino FS: Plot 1 – *Sphagnum* lawn of raised bog, Plot 2 – treed community of raised bog, Plot 3 – forest; the star marks the position of a micro-meteorological station MFS; the dotted line – a boardwalk through the experimental polygon of MFS in the bog

2.3. General climate characteristics and monitoring of climatic parameters.

The general climate characteristic in the Khanty-Mansiysk vicinities is continental subarctic or boreal with the average annual temperature being –1.3°C, the mean temperature of the coldest month (January) –19.8°C, the warmest month is July with its average of 18°C. The mean annual precipitation is 553 mm [10].

The weather conditions were measured by automatic micro-meteorological station of Mukhrino FS located in the bog, including Rotrinic Hygroclip S3 for measuring air temperature and HOBO rain gauge RG3-M for measuring liquid precipitation. The mean temperatures of May-September were higher by 2-4°C compared to the values of the average climate in Khanty-Mansiysk. The number of rains was 20-50% lower in summer (May-August) but September had 30% more rains compared to the average climate characteristics.

2.4. Data analysis.

The calculation of k (decomposition constant), S (stabilization factor) and a_r (decomposable fraction of rooibos or green tea) was made as described in [7]. The values of differences between three plots were calculated by Wilcoxon rank sum test [12] (this test is equivalent to the Mann-Whitney U test) using RANKSUM MATLAB-function.

3. Results

3.1. Visual characteristic of the decomposed tea.

The visual characteristics of the bags content differed significantly among the plots as it was seen by direct observation and using lens (table B1 in the Appendix). Generally, green tea was more decomposed, it had darker color and was more homogenized compared to rooibos. The tea bags in lawns had almost intact structure of soaked tea, no roots or fungal mycelium were observed (except for two bags in Lawn 1 and Lawn 2, which were buried on a small hummock under more aerated conditions). The bags in the treed bog had darker color, green tea was very dark, homogenous and slimy, all bags with green tea were covered abundantly by some species of Myxomycota (dark slimy mass on the surface and abundant spores and capillitium threads were seen under the microscope) and rooibos was in several cases covered abundantly by *Aspergillus* sp., no or minor roots were observed. The tea in forest was similar to treed bog but green tea was more intact compared to treed bog, abundant fungal mycelium and mycorrhizal roots were observed on the surface and inside the bags (roots were carefully removed).

3.2. Litter mass loss.

The mass loss after 3-months incubation of green tea was significantly higher (average 72%) compared to rooibos (average 27%) (figure 2A). With regard to the effect of the ecosystem type, there were significant differences between all three ecosystem types for green tea, and between forest/treed bog and lawn/treed bog for rooibos tea (table 1). The probability of overlap between median values of mass loss for forest and lawn was high (24%) and statistically insignificant. It is important to note that the mass loss of green and rooibos varied differently between the ecosystem types (e.g. mass loss for green tea decreased in a sequence lawn>treed bog>forest while for rooibos tea in a sequence lawn~forest>treed bog).

3.3. Stabilization factor and decomposition rate constant.

The stabilization factor and decomposition rate differed significantly between all three ecosystem types (figure 2B, table 2, table C1 in the Appendix). The highest probability of overlap between median values was only 0.3%. The largest stabilization was in forest, intermediate in treed bog and the lowest in the lawn. The decomposition rate constant was the largest in forest and the lowest in the treed bog.

Table 1. Wilcoxon rank sum test for mass loss of two tea types in different ecosystems.

Ecosystem type	Probability of overlap between median values	
	Green tea	**Rooibos tea**
Forest/Lawn	0.0002	0.2370
Forest/Treed bog	0.0002	0.0002
Lawn/Treed bog	0.0019	0.0002

Table 2. Wilcoxon rank sum test for *S* and *k* values in different ecosystems.

Ecosystem type	Probability of overlap between median values	
	S	***k***
Lawn/Treed bog	0.003	0.0006
Lawn/Forest	0.0002	0.0003
Forest/Treed bog	0.0002	0.0002

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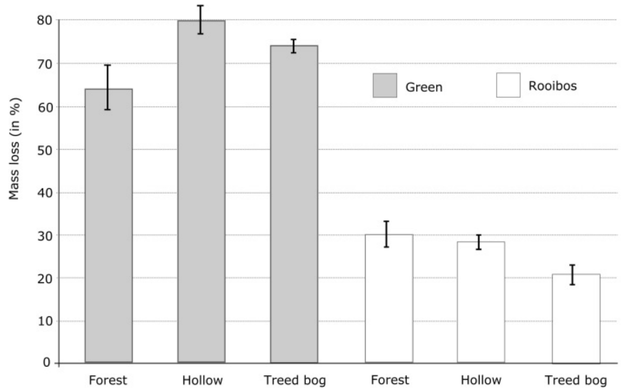

Figure 2A. Mean numbers of mass loss (in %) after 3 months of decomposition: two types of tea bags (rooibos, green) in three habitats (treed bog and hollow of raised bog and coniferous forest), black bars show standard deviations.

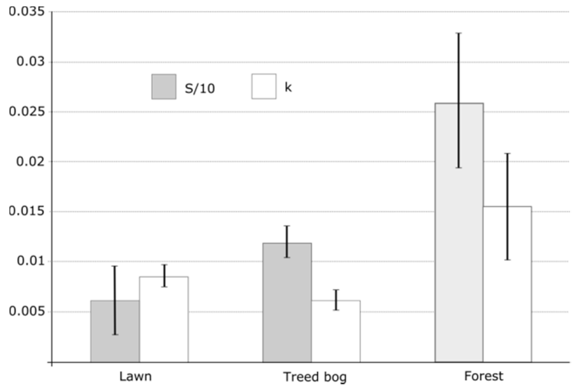

Figure 2B. Mean numbers of stabilization factor (S/10) and decomposition rate constant (k, day^{-1}) for three studied ecosystem types, black bars show standard deviations.

4. Discussions

According to general view, accumulation of peat is provided by an imbalance between slow rates of decomposition and rate of net primary production in peatlands. This is determined however by multiple factors, e.g. poor nutrient content, cool and anoxic conditions, high refractory content of peatland litters, and others [12, 13]. We tested the hypothesis of slower decomposition rates in bog compared to forest when the influence of litter content is reduced by the standard litter (tea).

We hypothesized that decomposition rate constant would be higher in coniferous forests compared to peatlands. This assumption was confirmed by the calculations of decomposition rate constant which was almost twice higher in forest compared to both bog sites. The higher decomposition rate in forest compared to peatland could be explained by better aeration conditions and better nutrient content of the soil and is consistent with the general rule of slow decomposition rates in peatlands. However, the forest site had also the highest stabilization factor, which is probably explained by unusually dry summer, which preserved high fraction of green tea (but not rooibos tea!) in forest. It is likely that the local weather conditions could significantly influence the short-term decomposition rates. We assume therefore that the experiment should be repeated in the following years to verify the decomposition rates in relation to weather conditions.

The literature review shows different estimates when comparing the decomposition rates between upland forest and peatlands. T. Moore and N. Basiliko [12] in a study of three tree leaf types in a temperate swamp and adjacent deciduous forest in Canada showed higher decomposition rate in forests in only half of the plots and the reverse in the other half. T. Moore with coauthors [14] made litter transplant experiment (using the same litters, e.g. 10 foliar litter types and wood, under different drainage classes) and showed no significant difference between decomposition rates in uplands and peatlands. However, they report significant differences for two litter types decomposing faster either in upland or peatland conditions. The authors suggest that longer term (>6 years) differences in decomposition rate (when the litter would become buried under anoxic conditions) and differences in litter quality account for larger accumulation of organic matter in peatlands compared to forest.

As we mentioned above, the mass loss sequences in three ecosystems varied for green and rooibos tea. The use of two litter types for estimation of k at a single point in time was based on assumption that both tea types will equally react to the environmental parameters [7]. As in our study this condition was not satisfied, it could cause incorrect calculation of a_r based on stabilization factor. However, these differences on short-time scale could be caused by insufficient decomposition time for slowly decomposable rooibos tea. The following retrieval of the next sequences of bags (after 1, 2 and 3 years of decomposition) could solve this problem.

Regarding the differences between the peatland habitats, our hypothesis was that the waterlogged lawns would have lower decomposition constant compared to treed bog. The calculation of decomposition constant showed the opposite: the lawns had higher decomposition rate compared to treed bogs. The stabilization factor corresponded to the decomposition rate: it was low in lawns and higher in treed bogs. According to the series of experiments in similar habitats in taiga zone of West Siberia the decomposition in lawns is slower compared to treed bogs due to high water level and consequently anaerobic conditions. This was shown in litter transplant experiments for several plant litters incubated in both habitats. N. Kosykh with coauthors [2] compared decomposition rates of a dwarfshrub leaves (*Chamaedaphne calyculata*) on hummocks and in lawns and showed higher decomposition rate in better aerated conditions of hummocks. The mass loss of peat samples was significantly higher on hummocks compared to hollows in peatlands in different zones of West Siberia [15]. The unusually dry summer could influence the opposite results in our case: the lawns were drier during this year which created thicker aerated layer and higher decomposition rates (and probably treed bogs were at the same time too dry for normal decomposition rate). Possible relationships between the decomposition rate and the water level in lawns and hummocks will be determined after three years of decomposition experiment using data on water level collected by Mini-Diver sensors installed in close proximity to the experimental plots.

There are many theoretical models to estimate the decomposition rate constant depending on humidity, for example [16, 17, 18, 19]. A simple relationship developed by A. Van der Linden with co-authors [16] shows, that decomposition rate constant is about 3 times higher under optimal conditions of humidity compared to the conditions of full moisture saturation. Considering the forest conditions being optimal, and the bog (lawn and treed bog) being fully saturated, the k values estimated in our experiment are consistent with this model.

The values of the decomposition rate constant (k) resulting from our work were compared with the values for boreal zone from literature. The mean values of k in forest, lawn and treed bog were 0.015, 0.008 and 0.006 day^{-1} respectively. T. Moore and N. Basiliko [12] report k values in peatlands (calculated on a 6 year basis) from 0.000027[3] day^{-1} (spruce needless) to 0.0012 day^{-1} (birch leaves) when litter decays rapidly. The values of slowly decomposing litters (*Sphagnum fuscum*, wood blocks) could range from 0.00 to 0.000027 day^{-1} and 0.000027 to 0.000082[4] day^{-1} respectively [12: table 7.1]. N. Kosykh with co-authors in a study performed in close vicinities to our experimental site recorded similar values of decomposition constant (based on two months of decomposition) for leaves of *C. calyculata* (k=0.0067 day^{-1})[5], but higher value for roots of the same plant (k=0.009 day^{-1}) [2]. The values of k and S estimated in our study correspond to similar ecosystem types measured by J. Keuskamp with co-authors [7: figure 3] (such as peatlands sites in Ireland and in the Netherlands, calculations based on 60-90 days of decomposition).

The significant difference (for 1-3 orders of magnitude) between our decomposition constants and reported by T. Moore and N. Basiliko [12] could be explained by difference in decomposition time (3 months vs. 6 years). The decomposition process is described by formula (1) and includes two stages of decomposition of labile and recalcitrant compounds:

$$W(t)=ae^{-k_1 t} + (1-a)e^{-k_2 t}$$

where $W(t)$ is the weight of the substrate after incubation time t, a is the labile, $(1-a)$ is the recalcitrant fraction of the litter, k_1 and k_2 are decomposition rate constants of the labile and recalcitrant fractions accordingly [7]. During the short-time experiments (90 days in our case) k_2 is very low and cannot be estimated. On the other hand, in long-lasting experiments (6 years) where the process is approximated by simple exponential decay model [12] the decomposition constant will either be equal k_2 (and

[3] The original values were in another dimension: 0.01 (spruce needless) and 0.45 (birch leaves) year^{-1}.
[4] The original values were 0.00 to 0.01 and 0.01 to 0.03 year^{-1}.
[5] The original values were: *C. calyculata* (k=0.08) and roots (k=0.11) month^{-1}.

therefore very low) or intermediate between k_1 and k_2. In contrast, the values of k estimated during the first months of decomposition [2] are very close to our 90-days estimates.

The mass loss of tea bags in our study was higher compared to earlier experiments in the Northern Limestone Alps of Austria in forest and grassland communities (subalpine to alpine climate zones) [6]. M. Didion with coauthors report the mean values being 30% for green tea and 7% for rooibos tea for a year of decomposition, while we measured mean values 72% for green tea and 28% for rooibos tea for 3 month of decomposition. We cannot explain these differences, considering seemingly harsher conditions in our region (lower mean annual temperatures and precipitation values). However, similar mass losses of approximately 70% for green tea and 30% for rooibos tea were also reported by J. Keuskamp with co-authors [8] in experimental conditions after 140 days of decomposition. The mean temperature of incubation period in our study was comparable to that of experimental conditions (15°C) without taking into account daily fluctuations in natural conditions.

The mass loss of standard litter (tea) was compared with estimates of native litters mass loss on a located nearby peatland [2]. The mass losses of *Sphagnum* were 7-15%, woody parts of dwarfshrubs – 18%, rhizomes of sedges – 15-30%, roots of dwarfshrubs – 20-40%, roots of sedges and herbs – 30-40%, green parts of herbs and dwarfshrubs – 50-86%, and rhizomes of *Menyanthes trifoliata* – 80% of their initial weight after 1 year of decomposition. Comparing to this native substrates, the mass loss of rooibos tea was close to slowly decomposing substrates such as wood and *Sphagnum*, and green tea mass loss corresponded to easily decomposable green parts of plants and rhizomes.

5. Conclusions

We estimated mass loss, decomposition rate constant and stabilization factor in three major ecosystem types in middle taiga zone of West Siberia using standard litter (tea) short-term decomposition experiment. The values of decomposition rate constants differed significantly between three ecosystem types (coniferous forest, treed *Sphagnum* bog and *Sphagnum* lawn). The decomposition rates in forest were higher compared to bog. Between bog sites, treed bog had lower decomposition rates compared to lawn, which could nonetheless be biased by unusually dry summer conditions. The experiment should be therefore repeated in future years to obtain unbiased data.

The mass loss and the decomposition rate constants were close to reported earlier for similar climatic conditions and habitats.

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Appendices

Table A1. Description of vegetation and soil properties of the experimental plots.

Plot / Replica	Coordinates	Vegetation	Dominant plants with % cover (only species with > 5 % of cover shown)	Soil type and description	pH
1/1	60.89325 N 68.68311 E	Graminoid-*Sphagnum* lawn bog	*Andromeda polifolia* (5), *Oxycoccus palustris* (3), *Carex limosa* (5), *Scheuchzeria palustris* (2), *Eriophorum russeolum* (3), *Sphagnum balticum* (30), *S. jensenii* (50), *S. papillosum* (10), *S. lindbergii* (5)	Sphagnum peat: 0-5 - aerated layer, penetrated by roots (could become anaerobic in spring and after heavy rainfall); 5-400 cm - anaerobic peat layer.	3-4
1/2	60.89307 N 68.68301 E				

2/1	60.89497 N 68.68335 E	Pine-dwarfshrubs-*Sphagnum* treed bog	*Pinus sibirica* (3), *P. sylvestris* (40), *Chamaedaphne calyculata* (10), *Ledum palustre* (30), *Vaccinium uliginosum* (6), *Oxycoccus microcarpa* (5), *Rubus chamaemorus* (20), *Sphagnum fuscum* (95), *S. angustifolium* (5)	Sphagnum peat: 0-30 (50) cm - aerated layer, penetrated by root; 50-400 cm - anaerobic peat layer	3-4
2/2	60.89507 N 68.68339 E				
3/1	60.88911 N 68.69941 E	Coniferous-deciduous mixed forest	*Populus tremula* (50), *Pinus sibirica* (20), *Picea obovata* (10), *Rubus saxatilis* (15), *Vaccinium vitis-idaea* (12), *Gymnocarpium dryopteris* (10), *Equisetum sylvaticum* (7), *Linnaea borealis* (6), *Hylocomium splendens* (15), *Pleurozium schreberi* (10)	Spodosols: A_0 - forest litter; 0-20 cm (A) clayey loam, penetrated by roots, light grayish color; 20-100 cm (B) clayey loam, dirty brown color; 100-200 cm - silt (loess), grayish, gleying.	4-5
3/2	60.88897 N 68.69887 E				

Table B1. Initial and final weight of tea and description of its characteristics, presence of roots, and fungal mycelium after 3 months of decomposition.

Bag #	Plot	Tea type	Initial weight	Final weight after 3 month	Mass loss %	Observations on tea quality, roots and fungal mycelium[a]
1	Lawn	green	1.7158	0.4051	76	Dark homogenous; weak roots; abundant Myxomycota
2	Lawn	green	1.7708	0.4689	74	Dark homogenous; weak roots; abundant Myxomycota
3	Lawn	green	1.7064	0.3121	82	Green slimy leaves; no roots; no mycelium
4	Lawn	green	1.7107	0.3251	19	Green slimy leaves; no roots; no mycelium
17	Lawn	rooibos	1.8282	1.3160	28	Sodden tea; no roots; no mycelium
18	Lawn	rooibos	1.8116	1.2552	31	Sodden tea; no roots; no mycelium
19	Lawn	rooibos	1.7637	1.3008	26	Sodden tea; no roots; no mycelium
20	Lawn	rooibos	1.7577	1.2761	27	Sodden tea; no roots; no mycelium
33	Lawn	green	1.7364	0.3938	77	Green slimy leaves; no roots; no mycelium
34	Lawn	green	1.6893	0.3283	81	Green slimy leaves; no roots; no mycelium
35	Lawn	green	1.7478	0.3317	81	Green slimy leaves; no roots; no mycelium
36	Lawn	green	1.6676	0.3385	80	Green slimy leaves; no roots; no mycelium
49	Lawn	rooibos	1.8186	1.3091	28	Sodden tea; no roots; no mycelium
50	Lawn	rooibos	1.5515	1.0996	29	Sodden tea; no roots; no mycelium
51	Lawn	rooibos	1.7774	1.2511	30	Sodden tea; no roots; no mycelium
52	Lawn	rooibos	1.8384	1.3030	29	Sodden tea; no roots; no mycelium
65	Treed bog	green	1.7200	0.4700	73	Dark homogenous; no roots; abundant Myxomycota
66	Treed bog	green	1.7567	0.4365	75	Dark homogenous; no roots; abundant Myxomycota
67	Treed bog	green	1.7410	0.4832	72	Dark homogenous; no roots; abundant Myxomycota
68	Treed bog	green	1.7993	0.4599	74	Dark homogenous; no roots; abundant Myxomycota
81	Treed bog	rooibos	1.8376	1.4062	23	Sodden tea; weak rooots; no mycelium

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82	Treed bog	rooibos	1.7647	1.4489	18	Sodden tea; weak rooots; no mycelium
83	Treed bog	rooibos	1.7909	1.4155	21	Sodden tea; weak rooots; no mycelium
84	Treed bog	rooibos	1.8479	1.4857	20	Sodden tea; weak rooots; no mycelium
97	Treed bog	green	1.7336	0.4792	72	Dark homogenous; no roots; abundant Myxomycota
98	Treed bog	green	1.7735	0.4418	75	Dark homogenous; no roots; abundant Myxomycota
99	Treed bog	green	1.6357	0.4247	74	Dark homogenous; no roots; abundant Myxomycota
100	Treed bog	green	1.7667	0.4372	75	Dark homogenous; no roots; abundant Myxomycota
113	Treed bog	rooibos	1.8340	1.3974	24	Sodden tea; some roots; *Aspergillum*
114	Treed bog	rooibos	1.7567	1.3924	21	Sodden tea; no roots; abundant *Aspergillum*
115	Treed bog	rooibos	1.8244	1.4720	19	Sodden tea; no roots; abundant *Aspergillum*
116	Treed bog	rooibos	1.7303	1.3186	24	Sodden tea; some roots*; Aspergillum*
129	Forest	green	1.7243	0.6056	65	Dark homogenous; many roots; abundant dark and white mycelium
130	Forest	green	1.8772	0.6354	66	Dark homogenous; many roots; abundant dark and white mycelium
131	Forest	green	1.7754	0.8796	50	Dark homogenous; some roots; abundant dark and white mycelium
132	Forest	green	1.7810	0.5750	68	Dark homogenous; some roots; abundant dark and white mycelium
145	Forest	rooibos	1.8247	1.2767	30	Sodden tea; many roots; mycelium and mycorrhiza
146	Forest	rooibos	1.8152	1.2788	30	Sodden tea; abundant roots; mycelium and mycorrhiza
147	Forest	rooibos	1.8131	1.2637	30	Sodden tea; many roots; some mycelium
148	Forest	rooibos	1.8212	1.2041	34	Sodden tea; many roots; some mycelium
161	Forest	green	1.7035	0.6595	61	Dark homogenous; some roots; Myxomycota
162	Forest	green	1.7837	0.7595	57	Dark homogenous; some roots; Myxomycota
163	Forest	green	1.7735	0.6245	65	Dark homogenous; some roots; Myxomycota
164	Forest	green	1.6799	0.6130	64	Dark homogenous; some roots; Myxomycota
177	Forest	rooibos	1.8100	1.3286	27	Sodden tea; some roots; some mycelium and mycorrhiza
178	Forest	rooibos	1.7763	1.2510	30	Sodden tea; some roots; some mycelium and mycorrhiza
179	Forest	rooibos	1.8328	1.1993	35	Sodden tea; some roots; some mycelium and mycorrhiza
180	Forest	rooibos	1.7585	1.3202	25	Sodden tea; some roots; some mycelium and mycorrhiza

[a] Observations of fungal mycelium in mass made by naked eye, not attempt to estimate exact biomass of fungal mycelium was done in this study

Table C1. Values of stabilization factor (S) and decomposition rate (*k*) for retrieved samples after 3 months of decomposition.

Plot	Replica	Vegetation Type	S	*k* day^{-1}
1	**1**	Lawn	0.091068	0.008792
1	**1**	Lawn	0.124600	0.010776
1	**1**	Lawn	0.028199	0.007181
1	**1**	Lawn	0.037577	0.007758
1	**2**	Lawn	0.081147	0.008663
1	**2**	Lawn	0.042113	0.008606

1	**2**	Lawn	0.036623	0.008643
1	**2**	Lawn	0.053024	0.008767
2	**1**	Treed bog	0.134633	0.007301
2	**1**	Treed bog	0.106768	0.004821
2	**1**	Treed bog	0.139254	0.006168
2	**1**	Treed bog	0.113912	0.005505
2	**2**	Treed bog	0.138426	0.007468
2	**2**	Treed bog	0.106388	0.005868
2	**2**	Treed bog	0.119012	0.005483
2	**2**	Treed bog	0.102855	0.007047
3	**1**	Coniferous forest	0.227974	0.013232
3	**1**	Coniferous forest	0.212233	0.012340
3	**1**	Coniferous forest	0.397756	0.026648
3	**1**	Coniferous forest	0.194095	0.015503
3	**2**	Coniferous forest	0.270107	0.011780
3	**2**	Coniferous forest	0.316074	0.016793
3	**2**	Coniferous forest	0.229166	0.018191
3	**2**	Coniferous forest	0.244673	0.009781

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