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Article

Composition and seasonal dynamics of tree litterfall in oak forests of the southern part of Primorsky Krai

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Abstract
Litterfall is an important component of nutrient cycling in forest ecosystems. Data on its periodicity and amount in oak forests are crucial for understanding tree–soil interactions, assessing the successional status of forests, as well as for proper forest management and fire prevention. The aim of this study was to evaluate the variation in mass and fractional composition of tree litterfall, taking into account its seasonal dynamics in a secondary oak forest. Litterfall, including leaves, branches and bark, reproductive organs, and other fractions, was collected on five permanent plots from September 2023 to September 2024. Each plot was equipped with 10 litterfall traps (0.71 × 0.71 m). The average annual litterfall mass in the studied biogeocenosis amounted to 6.49 ± 0.20 t ha^{-1}. The fractional composition of litterfall differed among plots and reflected stand composition. For four of the plots, litterfall was dominated by leaves of Mongolian oak, Manchurian linden, Amur linden, and mono maple. The lowest litterfall input was recorded in the winter–spring period (0.26 ± 0.04 t ha^{-1}), while the highest occurred in autumn (4.93 ± 0.18 t ha^{-1}). Leaves accounted for 71.1% of the total litter mass; reproductive organs – 14.5%; bark and branches – 14.0%. From winter to autumn, leaf litter mass increased sharply, bark and branch fractions grew gradually, while reproductive organs were shed mainly in summer.

Key words tree litterfall, oak forest, seasonal dynamics, fractional composition, Primorsky Krai, *Quercus mongolica*.

Introduction

Oak forests of Primorye cover 1,995 thousand hectares (17.5%) of the forested area, have great economic importance, and play an exceptionally important ecological role. Compared with other forest formations, they are the most affected by recurrent fires, which have a significant impact on the state and dynamics of their biogeocenoses. This is especially true for oak forest stands adjacent to relatively densely populated areas of southern Primorye, which for nearly 150 years have been exposed not only to fire but also to unregulated logging.

At present, a vast body of factual material has been accumulated on oak forests of the Russian Far East. Various aspects of their biology, origin, distribution, typology, and phytomass structure have been addressed in the works of B.A. Ivashkevich, V.L. Komarov, K.P. Solovyov, D.P. Vorobyev, V.N. Vasiliev, V.N. Smagin, V.A. Rozenberg, N.A. Popov, N.G. Vasiliev, Yu.F. Zheleznikov, A.N. Prilutsky, and many others (Manko, 2007). However, studies on nutrient cycling in the forest–soil system of oak forests in the Far East have been virtually absent. A.A. Druzin (1963) studied the return of mineral nutrients to the soil through litterfall in oak–Korean pine forest of the Suputinsky Reserve (now "Ussuriysky"). A.F. Kostenkova (1973) investigated the composition and mass of tree litterfall in oak and Abies holophylla stands of the "Kedrovaya Pad" Reserve. Therefore, understanding the characteristics of litterfall formation in oak forests during their natural development remains highly relevant.

Litterfall of woody plants is one of the key components in the functioning of forest biogeocenoses. It affects forest vegetation through the soil environment, determines the features of soil-forming processes, and plays an important role in nutrient cycling and biogeochemical processes, including the carbon cycle (Lukina et al., 2020).

The amount of litterfall and the timing of its deposition on the soil surface largely determine the decomposition rate of the forest floor and the input of nutrients into the soil. L.O. Karpachevsky (1981) proposed distinguishing two fractions of litter according to their decomposition rate: active and inactive (conservative). The active fraction includes photosynthesizing organs (leaves, needles) and reproductive organs, while the conservative fraction includes branches and cones, the mass of which varies most strongly.

The aim of this study was to identify the patterns of mass and fractional composition of tree litterfall in oak forests, taking into account its seasonal dynamics.

Material and methods

The study area is located in the southern part of Primorsky Krai, within 43° N latitude and 132° E longitude (Fig. 1).

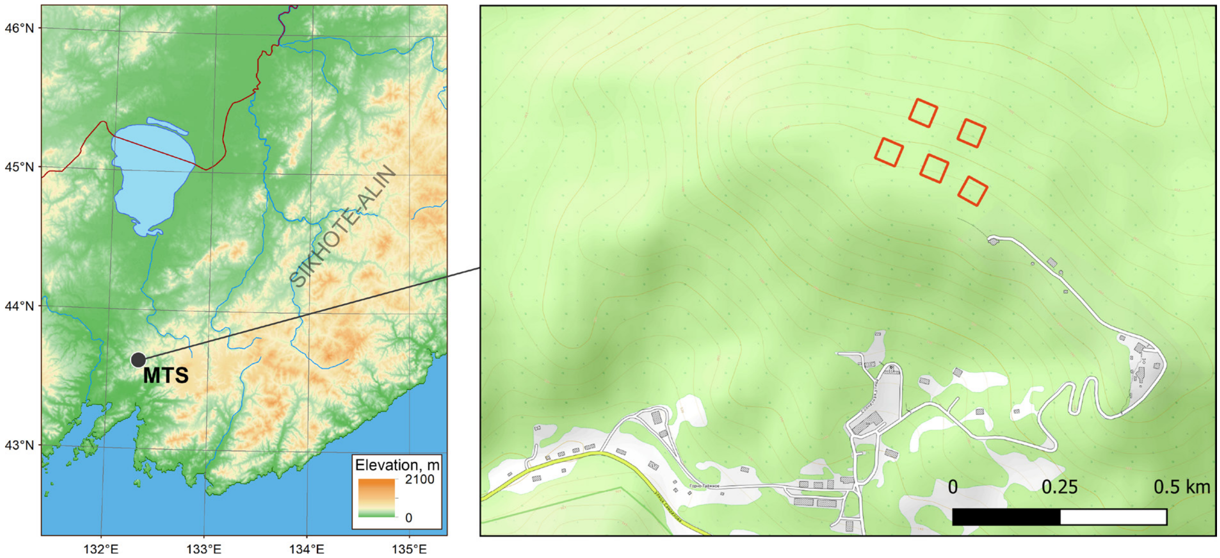

Figure 1. Location of the study area

The climate of the V.L. Komarov Mountain-Taiga Station of the Federal Scientific Center of Biodiversity, Far Eastern Branch, Russian Academy of Sciences (MTS) is classified as continental with monsoon features (Vitvitsky, 1969). According to S.K. Malysheva (2018), the mean annual air temperature is 4.9 °C; the absolute minimum is –37.7 °C, and the absolute maximum is +39.0 °C. Soil freezing depth ranges from 60 to 180 cm depending on snow cover. The length of the growing season is 190 days, and the period of active vegetation (daily mean T > 10 °C) averages 160 days. Mean annual precipitation is about 710 mm.

The research was carried out within the framework of the state project “Development of a system for ground-based and remote monitoring of carbon pools and greenhouse gas fluxes in the Russian Federation…”. In accordance with the project program, a forest biogeocoenosis (BGC) was selected at the Gornotayozhnaya Station within the regional mountain biome of southern Sikhote-Alin (Map…, 2018). In the Degtyarev stream basin, at an elevation of 230–250 m a.s.l., on the mid-part of a gentle slope (5–15°) of northern–northeastern exposure (transeluvial elementary landscape according to B.B. Polynov), five permanent sample plots (PSP) of 50 × 50 m were established at 50 m intervals; their total area was 1.25 ha. Two of the PSPs are partly located along the ecological profile “Gornotayozhny” (Moskaluk, 2022). The soil is classified as Haplic Cambisols on eluvo-deluvium basalt.

When establishing sample plots in the secondary herb–shrub oak forest with linden and maple, basic forest-ecological methods were used (Sukachev, Zonn, 1961; Methodological approaches…, 2010; etc.), which allow a comprehensive characterization of all vegetation components (tree stand, undergrowth, shrub–herb layer, regeneration). A geobotanical description was made for each plot. However, it was generally impossible to meet the requirements for the number of main tree species needed to obtain statistically reliable results in multi-species stands under strongly dissected relief conditions. The main forest-forming species in mature and overmature stages were represented by a small number of usually large individuals and dominated the stand not by stem count but by growing stock. Stand characteristics such as basal area, timber stock, and mean diameter were calculated using regional forest inventory handbooks (Handbook…, 2010).

Characteristics of the BGC. The secondary oak forests in the study area developed in place of primary conifer–broadleaf forests that were subjected to clear-cutting, selective logging, and fires in the 1940s–1950s (Moskaluk, 2022). The stand in the BGC is multi-species and open, with no clear stratification into layers; 18 tree species were recorded (Table 1). Stand density is 0.3–0.4; the mean age of *Quercus mongolica* is about 110 years, and of *Tilia mandshurica* and *T. amurensis* about 80 years. Stand composition differed slightly among the five PSPs. In four plots, *Q. mongolica* prevailed, while in one plot *T. mandshurica* and *T. amurensis* dominated. On different plots, at least 10% of the stand composition included *Acer mono, Betula davurica, Ulmus, Populus tremula, Juglans mandshurica, Fraxinus rhynchophylla, Maackia amurensis* (Tables 1, 2).

Table 1. Tree species composition and dominance in Mongolian oak forests.

Acronyms	Scientific name	Tree species volume, %					Average
		Plot number					
		1	2	3	4	5	
QM	*Quercus mongolica*	42.2	61.7	49.8	20.4	75.0	49.5
TM TA	*Tilia mandshurica* *T. amurensis*	37.0	15.1	32.3	49.2	14.3	29.6
AM	*Acer mono*	10.2	8.3	4.0	12.3	3.1	7.5
UL	*Ulmus laciniata*	2.7	–	0.6	5.7	–	3.1
UJ	*U. japonica*	–	3.2	–	–	3.3	
BD	*Betula davurica*	3.9	5.1	0.4	3.5	2.5	3.4
JM	*Juglans mandshurica*	2.1	-	8.3	0.7	–	1.5
MA	*Maackia amurensis*	1.1	0.9	0.3	4.1	0.9	1.2
FR	*Fraxinus rhynchophylla*	0.4	–	3.5	1.7	–	2.3
FM	*F. mandshurica*	–	–	–	–	–	
APS	*Acer pseudosieboldianum*	–	–	0.7	2.0	<0.1	0.6
LA	*Ligustrina amurensis*	–	–	<0.1	0.4	–	<0.1
PT	*Populus tremula*	–	5.7	–	–	–	<0.1
KS	*Kalopanax septemlobus*	0.3	–	–	–	–	0.1
AT	*Acer tegmentosum*	–	–	–	–	0.5	1.1
CC	*Carpinus cordata*	–	–	<0.1	<0.1	0.1	0.1
MAL	*Micromeles alnifolia*	–	–	0.1	–	0.1	0.1

Note. Here and in Tables 2, 4, 5 a dash means that this component is missing.

Table 2. Characteristics of observed Mongolian oak stands (per 1 ha).

Plot number	Age, year		Number, pcs ha^{-1}		Basal area, m^{-2} ha^{-1}	Volume, m^{-3} ha^{-1}		Average	
	oak	lime	live trees	dry trees		live trees	dry trees	DBH, cm	height, m
1	120	100	452	20	27.548	222.6	4.9	27.8	17.5
2	80	60	578	16	31.224	246.9	8.8	26.2	16.8
3	110	70	512	20	35.120	280.8	30.4	29.9	17.8
4	127	72	580	–	34.692	280.6	–	27.6	17.5
5	120	90	436	24	34.076	268.9	6.9	31.6	17.8
Average	110	80	512	16	32.532	260.0	10.2	28.6	17.5

The undergrowth comprised all tree species present in the stand, but their proportions varied among PSPs. In addition, *Pyrus ussuriensis* occurred in the undergrowth, though not in the tree layer. Conifer regeneration was absent.

The shrub layer was well developed, especially in small canopy gaps, and included 10 species. *Corylus mandshurica* dominated, reaching 3–4 m in height; also well represented were medium-sized shrubs such as *Eleutherococcus senticosus, Philadelphus tenuifolius, Euonymus pauciflorus, Berberis amurensis, Ribes manshuricum, Lonicera praeflorens, L. chrysantha,* and others. The liana vegetation, which rarely exceeded shrub layer height, was represented by *Schisandra chinensis, Actinidia kolomikta, A. arguta,* and occasionally *Vitis amurensis*, usually found within the shrub–herb layer.

The shrub–herb layer was mosaic, covering 60–70% of the soil surface. Under a closed canopy and shrub–liana cover it was sparse, but under an open canopy it had medium density. A total of 118 species were recorded in the shrub–herb layer across the five PSPs, while individual plots had between 61 and 79 vascular plant species. The herbaceous cover was highly diverse, including both small herbs and mesophilous tall herbs. The most constant and characteristic species included ferns (*Adiantum pedatum, Athyrium sinense, Lunathyrium pycnosorum, Matteuccia struthiopteris, Dryopteris goeringianum*); sedges (*Carex campylorhina, C. reventa, C. drymophila*); and mesophilous herbs (*Actaea asiatica, Arisaema amurense, Prenanthes tatarinowii, Asarum sieboldii, Cardamine leucantha, Cimicifuga dahurica, Lamium barbatum, Dioscorea nipponica, Galium davuricum, Circaea cordata*). Common throughout were *Thalictrum filamentosum, Corydalis ambigua, Paris manshurica, Lilium distichum, Phryma asiatica,* and others.

Mosses and lichens occupied no more than 3% of the surface, occurring on tree trunks and buttresses, old stumps, decaying logs, and stones. The bryoflora was forest, nemoral, and typical of southern Primorye. Mosses were represented by the genera *Brachythecium, Fissidens, Homalia, Myuroclada, Plagiomnium, Trachycystis,* and others.

On the plots, species listed in the Red Data Book of the Russian Federation and Primorsky Krai were found: *Paeonia oreogeton, Kalopanax septemlobus, Trillium rhombifolium.*

Litterfall collection methodology. At the BGC, 50 litter traps were installed across five permanent plots (10 per plot). Each permanent plot measured 50 × 50 m and was subdivided into a grid of 10 × 10 cells (5 × 5 m each). For every plot, 10 cells were randomly selected using a random number generator. Within each selected cell, a litter trap was placed at an arbitrary point, avoiding locations immediately adjacent to large tree stems, dense sapling clusters, or under impenetrable shrub cover to prevent strong local bias. As a result, approximately 20% of traps were located in inter-canopy spaces and about 80% under tree crowns. This restriction was introduced to avoid overrepresentation of highly localized conditions that do not reflect the general litterfall of the plot. This procedure ensured that the traps were spatially independent and evenly covered the plot area while maintaining a randomized design. Each trap had an area of 0.5 m² (0.71 × 0.71 m). Litter was collected over one year: September–October 2023 (autumn), November–April (winter–spring), and May–August 2024 (late spring–summer).

In the laboratory, litterfall was sorted according to species into the following fractions: leaves of the 18 tree species (*Quercus, Tilia, Acer, Juglans,* etc.); leaves of the undergrowth and "others," which included unidentified, broken and leaves of species represented by a small number, such as, for example, *Ligustrina amurensis, Maackia amurensis*, *Micromeles alnifolia*; reproductive organs (flowers, fruits, seeds) of tree species; bark and branches (d ≤ 1.5 cm); and miscellaneous (mosses, lichens, insects, mollusks). Litterfall mass and its fractions were expressed as oven-dry weight.

Results

The distribution of litterfall by fractions and seasons in the BGC is presented in Table 3 and Fig. 2. On PSPs differing in stand composition (Table 1), the mean annual litterfall mass during the study period was 649.2 ± 20.2 g m^{-2}, or 6.49 ± 0.20 t ha^{-1} (mean ± standard error). The coefficient of variation of annual litterfall mass among sample plots was low (7%), but its seasonal values increased from autumn to the winter–spring season and were of moderate magnitude.

The lowest litterfall input occurred in the winter–spring period – 25.6 ± 1.8 g m^{-2} (3.9 ± 0.3% of annual litterfall mass), while the highest occurred in autumn – 493.3 ± 18.1 g m^{-2} (76.0 ± 1.1%). The mass of late spring–summer litterfall was only 130.3 ± 6.3 g m^{-2} (20.1 ± 0.8%), although in some years it can be higher, since a significant portion of oak leaves (especially young ones) may remain on trees almost until late May. According to A.P. Dobrynin (2000), this serves as additional evidence that the ancestors of *Quercus mongolica* were evergreen.

Table 3. Average seasonal mass and main fractions of litterfall.

Litterfall components	XI–IV	V–VIII	IX–X	I–XII
	M±SE – average ± standard error			
Total litterfall mass per season	25.6±1.8	130.3±6.3	493.3±18.1	649.2±20.2
	3.9±0.3	20.1±0.8	76.0±1.1	100
Coefficient of variation, %	15.8	10.7	8.2	7.0
Mass of leaves	2.7±0.5	34.6±3.6	424.6±13.4	461.9±12.9
	0.4±0.1	5.4±0.6	65.4±0.4	71.2±0.8
Mass of reproductive organs	1.9±0.2	63.2±4.3	29.4±4.4	94.9±5.2
	0.3±0.03	9.7±0.5	4.5±0.6	14.5±0.4
Mass of bark and branches	21.1±1.8	30.9±2.8	38.9±3.1	90.9±5.7
	3.3±0.3	4.7±0.4	6.0±0.4	14.0±0.7

Note. Values above the line: mass (g m-2); values below the line: % of annual litterfall mass.

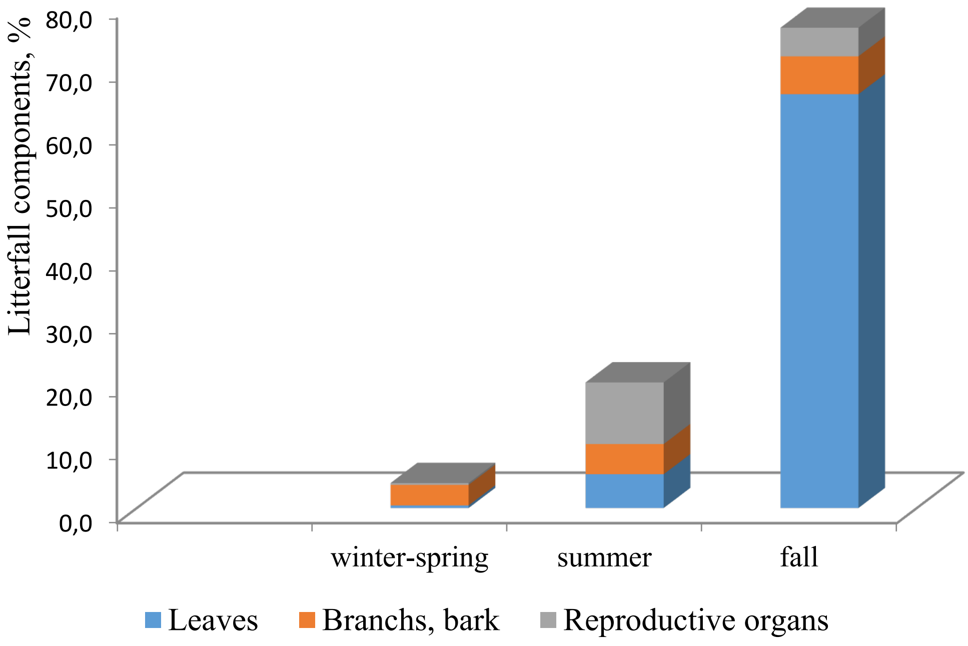

Figure 2. Distribution of litterfall components by season.

Most of the litterfall was deposited on the soil surface during the two autumn months (September and October): 65.4 ± 0.4% leaves, 4.5 ± 0.6% reproductive organs, and 6.0 ± 0.4% branches and bark. In the winter months, branches and bark dominated litter input: from November to May they accounted for 3.3 ± 0.3% of the annual mass of all fractions. Most reproductive organs fell in the summer months – 9.7 ± 0.5%, in autumn – 4.5 ± 0.6%, and the smallest amount was in the winter–spring period – less than 1%.

The study showed uneven input of all litterfall fractions during the year. For all PSPs of the BGC, the litterfall was dominated by leaves, mostly shed during the first two autumn months (Fig. 2).

Leaves in the litterfall were attributed to 18 tree species, while in the undergrowth they were mainly from *Corylus mandshurica, Philadelphus tenuifolius, Lonicera praeflorens,* and three species of lianas representing the extracohort vegetation (Table 4).

Table 4. Fractional composition and annual mass of leaf litterfall in sample plots (g m-2 and %).

Tree species	Plot number										M±SE
	1		2		3		4		5		
	g m^{-2}	%	g m^{-2}	%	g m^{-2}	%	g m^{-2}	%	g m^{-2}	%	g m^{-2}
QM	226.9	55.2	276.4	59.0	212.2	45.7	112.3	24.2	361.7	72.2	238±36,5
TM+TA	64.9	15.8	37.6	8.0	100.3	21.6	181.8	39.2	36.7	7.3	84.3±24.2
AM	51.1	12.4	59.2	12.6	32.9	7.1	50.4	10.9	40.1	8.0	46.7±4.1
UL+UJ	17.5	4.3	11.6	2.5	5	1.1	12.5	2.7	19.1	3.8	13.1±2.2
BD	12.7	3.1	18	3.8	–	–	8.5	1.8	0.6	0.1	9.9±3.2
JM	0.5	0.1	0.4	0.1	41	8.8	1.8	0.4	0.3	0.1	8.8±7.2
FM+FR	2.5	0.6	0.0	0.0	3.5	0.8	3.4	0.7	6.8	1.4	4.1±0.8
PT	–	–	8.6	1.8	–	–	–	–	–	–	nc*
KS	–	–	0.3	0.1	0.8	0.2	0.1	–	–	–	nc
APS	–	–	0.1	<0.1	1.7	0.4	11.5	2.5	0.6	0.1	nc
AT	–	–	–	–	0.1	0.0	2.9	0.6	0.9	0.2	nc
CC	–	–	–	–	0.7	0.2	5.5	1.2	1.7	0.3	nc
Undergrowth	0.6	0.1	0.1	<0.1	4.7	1.0	1.6	0.3	1.2	0.2	1.6±0.7
Other leaves	34.4	8.4	56.3	12.0	61.7	13.3	71.5	15.4	31.6	6.3	51.1±7.0
Total	411.1	100.0	468.6	100.0	464.6	100.0	463.8	100.0	501.3	100.0	461.9±12.9

Note. *nc – not calculated; the mean ± standard error was not calculated, as these tree species were not present in all sample areas. The abbreviations of the tree species here and in Table 5 are given in Table 1.

The bulk of annual leaf litterfall in the BGC came from *Q. mongolica* – more than 50% of total leaf mass (24.2–72.2%). Linden leaves (*T. mandshurica* and *T. amurensis*) together accounted for about 18% (7.3–39.2%); on average, *T. amurensis* contributed less (about 40%) than *T. mandshurica* (about 60%) due to its smaller and lighter leaves. The share of *Acer mono* leaves averaged 10% across the BGC (7.1–12.6%). Leaf litter of other tree species forming ≤10% of stand composition contributed no more than 9%. The leaves of such species as *Populus tremula, Ulmus, Betula, Acer tegmentosum, A. pseudosieboldianum, Carpinus,* and others are represented insignificantly (Table. 3). The "other leaves" fraction averaged about 11%. It includes small species, difficult to identify the remains of leaves of all tree species, which turned out to be in the fall traps mainly in the late spring and summer period. Due to the frequent intense summer rains, since the summer seasons of 2023 and 2024 were extremely humid and warm (the average annual precipitation was exceeded by more than two times), the leaves were quickly exposed to the destructive effects of moisture, insects and fungi.

The average annual mass of reproductive organs collected in litterfall traps at the BGC (Table 2) was 94.9 ± 5.2 g m^{-2} (14.5 ± 0.4% of total litterfall mass). Most reproductive organs were shed during the late spring–summer period – 63.2 ± 4.3 g m^{-2} (over 65% of the annual mass of this fraction), mainly represented by undeveloped linden nuts, oak fruits, maple flowers, elm samaras, etc. The peak oak acorn fall occurred in late August – early September. The average acorn mass in the BGC was 31.0 ± 4.6 g m^{-2}, which was about one-third of the total reproductive organ mass (Table 5). Acorn yield in the 2023/2024 season falls within the range reported by S.V. Gorokhova (1999) for similar BGCs near the GTS. According to Gorokhova (1999), acorn counts are underestimated because part of the crop is consumed by squirrels, chipmunks, and birds while still on trees; this likely applies also to fruits of *Juglans mandshurica* and *Corylus mandshurica.*

In autumn, 29.4 ± 4.4 g m^{-2} of reproductive organs were collected in traps, mainly maple and ash samaras, acorns, fruits of *Juglans mandshurica,* linden nuts, and birch seeds. The lowest input of this fraction was recorded during the winter–spring period – 1.9 ± 0.2 g m^{-2}.

Table 5. Fractional composition and annual mass of reproductive organs (g m-2 and % of total reproductive organ mass).

	Plot number									
	1		2		3		4		5	
Seeds & fruits	g m^{-2}	%	g m^{-2}	%	g m^{-2}	%	g m^{-2}	%	g m^{-2}	%
QM	26.7	33.4	45.8	48.9	17.9	20.7	25.0	25.8	39.8	34.7
TM+TA	0.7	0.9	0.3	0.3	0.9	1.0	12.6	13.0	0.02	<0.1
AM+APS+AT	<0.1	<0.1	0.3	0.3	0.7	0.8	0.2	0.2	–	–
BD	<0.1	0.1	0.1	0.1	–	–	–	–	–	–
JM	–	–	–	–	6.8	7.9	–	–	–	–
FR+FM	–	–	–	–	5.1	5.9	–	–	–	–
Other organs*	52.5	65.6	47.2	50.4	55.2	63.7	59.2	61.0	72.7	63.3
Total	80.0	100	93.7	100	86.6	100	97	100	114.8	100

Note. *This fraction mainly includes underdeveloped and damaged nuts of lime trees, hornbeam, elm, maple, birch catkins, maple flowers, etc.

The mass of branches and bark in 2023/2024 was 90.9 ± 5.7 g m^{-2} (14.0 ± 0.7% of annual litterfall mass). For this fraction, a gradual increase from winter to autumn was observed. More than 40% of branches and bark were collected in autumn – 38.9 ± 3.1 g m^{-2}, 34% in summer, and 23% in winter–spring (Fig. 2, Table 3).

The "other" fraction was insignificant – 0.2–7.7 g m^{-2} – and was not recorded on all PSPs. This fraction mainly consisted of mosses and lichens, which entered traps along with bark of old trees, as well as mollusks and insects.

Discussion

Litterfall is an important carbon component in forest ecosystems (Zhao et al., 2022). Its assessment is necessary for calculating the carbon balance (Matala et al., 2008). The amount of litterfall in Eurasian forests is increasing in response to climate change: some authors argue that in broadleaved forests this occurs more rapidly with changes in mean annual temperature (Liu et al., 2004; Li et al., 2010; etc.), while other researchers point out that precipitation has a stronger influence on forest plant growth than temperature (Yue et al., 2018). Still others, in addition to climatic factors, consider biotic ones such as basal area increment and species richness (Sun et al., 2021). J. Novák et al. (2014) found a positive correlation between annual litterfall and precipitation and a negative correlation between annual litterfall and summer temperature in oak young stands. D.E. Harvey et al. (2020) emphasize the temporally unstable and spatially uneven response of tree growth to climate variability, as well as the existence of geographically coherent regions where these changes are similar.

The total amount of litterfall in the studied fresh oak–linden–maple BGC in the 2023/2024 season varied from 587.9 to 724.2 g m^{-2}. These values are almost 1.5 times higher than the litterfall mass reported by A.F. Kostenkova (1973) in dry oak forests of the Kedrovaya Pad Reserve, and 1.5–1.8 times higher than the average annual values reported for oak young stands in the Czech Republic (Novák et al., 2014). Our obtained mean values (649.2 ± 20.2 g m^{-2} $year^{-1}$) fall within the range given for Italian mesophytic evergreen oak forests (Bussoti et al., 2003) and temperate and subtropical forests of Asia (Liu et al., 2004). Such a significant amount of litterfall in the studied BGC is apparently associated with the extremely wet and warm summer seasons of 2023 and 2024.

The proportions of leaves (70%), branches (16%), and other elements (14%) reported for China (Jia et al., 2018) are close to our data but differ markedly from those presented by A.F. Kostenkova (1973), who reported very high leaf content (about 90%), low bark and branch fractions (6.7%), and minor other fractions (3.5%).

Fallen leaves (primarily oak) not only return nutrients to the soil but also perform an important function in oak regeneration: they cover acorns, thereby protecting them from consumption by animals and improving germination by preventing acorn desiccation (Suh & Lee, 1998).

Annual litterfall formation also affects the amount of fuel accumulated in forests, which serves as an indicator of forest fire risk (Jia et al., 2018). Although *Q. mongolica* belongs to fire-resistant species, forests with its participation are often damaged by spring and autumn surface fires.

Conclusions

The seasonal input and fractional composition of tree litterfall were studied in an oak–linden–maple BGC. The mean litterfall mass was 6.49 ± 0.20 t ha^{-1} $year^{-1}$. The study revealed uneven input of all litter fractions throughout the year. The number of fallen leaves, as well as the total litterfall, showed a pronounced seasonal pattern: the highest levels were observed from September to October.

Individual litterfall components displayed different seasonal dynamics: the mass of total litter, leaves, bark, and branches increased from the winter–spring period to autumn. The maximum input of reproductive organs occurred in the late spring–summer period. Bark and branches were shed throughout the year, increasing in mass from winter to autumn.

Our study showed that one season is insufficient to obtain accurate data on the amount and seasonal features of litterfall. After two extremely wet years, 2025 turned out to be very dry and hot, which can be expected to affect the dynamics of litterfall mass and its fractional composition.
Significant accumulation of litterfall associated with warming may increase forest fire hazard, which is especially important in dry years, when litter has a major impact on fire development. The obtained data will be useful for assessing the contribution of representative oak–broadleaved forests of the southern Russian Far East to the carbon balance and nutrient cycling in forest ecosystems.

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