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ARCTOSTAPHYLOS UVA-URSI IN ESTONIA

1. DISTRIBUTION AND GROWTH

The bearberry (*Arctostaphylos uva-ursi* (L.) Spreng.) is a valuable and required medicinal plant; however, data about its resources in the Estonian SSR have been lacking so far. While assessing forest stands forest estimators estimate visually, besides other berry and medicinal plants, also the bearberry but on the basis of these data conclusions can be drawn only about the distribution of the bearberry and not about its resources. The aim of the present paper is to study some aspects of the bearberry biology, to estimate its resources and to elaborate the principles of its rational utilization which would secure restoring. During this work the bearberry was studied in 51 forest districts of 20 forest enterprises out of all 210 forest districts of 22 forest enterprises of the Estonian SSR. The total number of analyses is 359.

Methods

The whole forest allotment (from 0.1 to 5—7 (20) ha) together with its bearberry coenopopulation formed one analysis. In order to estimate the mean cover of the bearberry, its cover was determined on 30 sample squares of 1 m². Thus, the cover of the beaberry was determined altogether on 10770 sample squares. The sample squares were located systematically, i. e. at equal distances on 2—4 (6) parallel imaginary transects depending on the shape and size of the forest allotment, so that the whole allotment was evenly covered with squares. The 1 m² frame was covered with a net of 10×10 cm, so that every 1 dm² corresponded to 1% of the cover. That enabled one to estimate the cover of the bearberry precisely and quickly. Ramets of a bearberry clone were cut on the area of 1 dm² on each sample square; the fresh weight was determined (with the 0.1 g accuracy), the yearly increment of 10 plagiotropic ramets of the same clone was measured. In order to characterize the clone, two of its crossing diameters were also measured. The above data were determined on 1—5 sample squares of each forest allotment depending on the distribution frequency of the bearberry on the sample squares. The increment of ramets of the previous year was measured in the course of field work in the middle of the vegetation period, while the increment of the current year was determined at the end of the vegetation period. Each forest allotment was analysed geobotanically while forest estimation results provided data characterizing the tree stand, the site type, the formula of the stand, its age, height, fullness and the quality class. The ordination scale indices of soil moisture and soil fertility after E. Lõhmus (Lõhmus, 1984) were used for the quantitative characterization of the site type. The forest allotments to be analysed in each forest district were selected in different site types, so that their age, fullness and estimates were also different.

In each analysis the mean cover of the bearberry ($\bar{x}$, %), the mean fresh weight of ramets on 1 dm² ($\bar{y}$, g), the air-dry weight and their ratio (p) were determined, as well as the mean increment of ramets ($\bar{j}$, cm per year). Since the bearberry drug is dried at temperatures up to 30 °C

(Tammeorg et al., 1975), the absolute dry weight was not used in this work.

By means of the correlation method the correlation coefficients were first determined between 20 parameters, resulting in statistically significant correlations with the soil moisture content and fertility characterizing different forest site types. Therefore new correlation coefficients were found for four basic site types separately (between 18 parameters). The number of analyses and critical correlation coefficients (level of significance 0.05) were the following: in the *Cladonia* site type $n = 149$, confident $r > 0.10$, in the *Rhodococcum* ($=$ *Vaccinium*) site type $n = 119$, $r > 0.18$, in the *Calluna* site type $n = 42$, $r > 0.31$ and in *Arctostaphylos*-alvar and *Calamagrostis*-alvar site types together $n = 27$, $r > 0.39$. Use was made of parameters characterizing the growth of the bearberry (mean cover (%), the weight of ramets on 1 dm² (g), the ratio of air-dry and fresh weights, the mean yearly increment of ramets (cm), the biomass of ramets (kg/ha)) and habitat conditions including geobotanical parameters characterizing the tree stand (age, fullness, quality class, height and the proportion of the pine in the stand) and the lower layers (the number of species and total cover of the shrub-layer, excluding the bearberry, herb-layer, moss-layer and lichen-layer).

The distribution and cover of the bearberry

The total area of forest allotments registered for the bearberry in the Estonian SSR is 2185 ha, which makes up to 0.14% of the forest area. Since the climate and habitat conditions are, despite the small territory, very different, the key sample area technique was not used and the bearberry was studied all over the territory of the Republic.

Habitats of the bearberry, a stenotopic species, comprise dry pine forest on low-fertility sandy soils (quality class III—Vᵃ) which belong to the *Cladonia* ($=$ *Clad.*), *Calluna* ($=$ *Call.*), *Rhodococcum* ($=$ *Vaccinium* $=$ *Vacc.*), *Calamagrostis*-alvar and *Arctostaphylos*-alvar ($=$ alvar) site types (Lōhmus, 1974; Lōhmus, 1984; Katus, Tappo, 1965). The bearberry occurs infrequently also on *Vaccinium uliginosum* and *Myrtillus* site types but in this case only on sandy eskers or mineral islands in bogs. As a heliophilous species it prefers gaps in a stand, forest vistas and paths, while in the case of a sufficiently sparse forest it grows evenly over the whole stand. The bearberry grows well also on entirely open habitats: in pits, on dunes and other places devoid of vegetation.

Table 1 characterizes the distribution of tree stands on forest allotments studied according to the site type, age, fullness and quality class. It can be seen that the *Clad.* and *Vacc.* site types are represented more often while *Call.* and alvar site types are less frequent. The other tree site types are non-typical and of less importance, and will be neglected in further analysis. According to the age structure, tree stands of I—III age classes appear to be more frequent, older age classes are represented to a smaller extent. Most abundant are tree stands of medium fullness (0.6—0.7) which are not especially favourable for the growth of the bearberry. According to the quality class classification medium- and low-fertility III—IV quality class stands are more widespread. Most stands consist of pines while the average proportion of the pine in the tree stand formula is slightly greater in the *Clad.* site type (9.88), in others it is practically the same (see Table 2). The average height of tree stands is greatest in the *Clad.* site type (9.9 m) and smallest in the *Call.* site type (5.6 m). That results from the age structure of the analysed stands, since in the *Call.* site type the mean age of stands is only 37 years, in the *Clad.* site type 74 years.

Bearberry habitats are floristically relatively poor in species and have

Table 1

The distribution of tree stands analysed
(359 analyses altogether)

Site type	%	Tree stand					
		age	%	full-ness	%	quality class	%
Cladonia	41.5	0—20	28.9	0.3	1.9	1	0.3
Calluna	11.7	21—40	24.2	0.4	6.2	2	4.1
Vaccinium	33.2	41—60	10.8	0.5	4.6	3	32.3
Arctostaphylos- and	7.5	61—80	6.7	0.6	57.7	4	42.3
Calamagrostis-alvar		81—100	6.1	0.7	22.5	5	16.0
Others	6.1	101—120	4.1	0.8	5.9	5a	5.0
		121—140	7.6	0.9	1.2		
		141—160	7.0				
		161—180	2.6				
		>180	2.0				

a low total cover. The distribution frequency of the most widespread species accompanying the bearberry is given by layers in Fig. 1. In the shrub-layer the bearberry occurs together with 3—4 species while their number is rarely over 5—6 (Table 2); the total cover of species is mostly under 20—30%. In the herb-layer the total number of species was about 170. By the distribution frequency *Melampyrum pratense* (65.7%), *Festuca ovina* (63.5%), *Lerchenfeldia flexuosa* (51.2%) and *Chamaenerion angusti-*
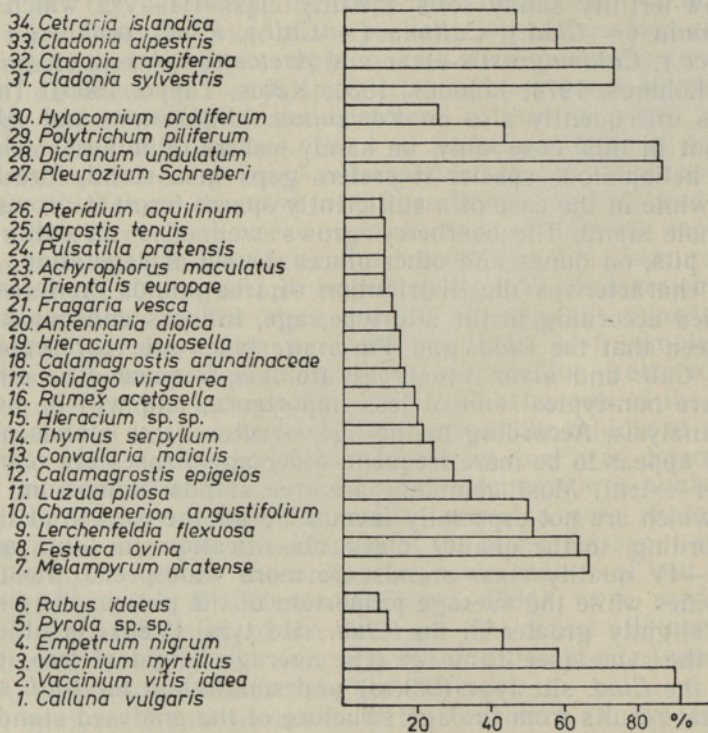
34. *Cetraria islandica*
33. *Cladonia alpestris*
32. *Cladonia rangiferina*
31. *Cladonia sylvestris*

30. *Hylocomium proliferum*
29. *Polytrichum piliferum*
28. *Dicranum undulatum*
27. *Pleurozium Schreberi*

26. *Pteridium aquilinum*
25. *Agrostis tenuis*
24. *Pulsatilla pratensis*
23. *Achyrophorus maculatus*
22. *Trientalis europae*
21. *Fragaria vesca*
20. *Antennaria dioica*
19. *Hieracium pilosella*
18. *Calamagrostis arundinaceae*
17. *Solidago virgaurea*
16. *Rumex acetosella*
15. *Hieracium* sp. sp.
14. *Thymus serpyllum*
13. *Convallaria maialis*
12. *Calamagrostis epigeios*
11. *Luzula pilosa*
10. *Chamaenerion angustifolium*
9. *Lerchenfeldia flexuosa*
8. *Festuca ovina*
7. *Melampyrum pratense*

6. *Rubus idaeus*
5. *Pyrola* sp. sp.
4. *Empetrum nigrum*
3. *Vaccinium myrtillus*
2. *Vaccinium vitis idaea*
1. *Calluna vulgaris*

20   40   60   80   %

Fig. 1. The distribution frequency (%) of more widespread species analysed in shrub- (*1—6*), herb- (*7—26*), moss- (*27—30*) and lichen-layers (*31—34*).

folium (50.1%) considerably exceed all others. The number of herb-layer species in the analyses ranges from 0 to 26 while the mean number is

The mean growth parameters (1) of the tree stand, lower layers and bearberry, variation coefficient, % (2), variation ranges (3) in different site types

		Clad.	Call.	Vacc.	Alvar
Age of tree stand, years	1.	74±5	37±6	46±5	77±13
	2.	72.6	96.3	100.4	83.6
	3.	5−191	5−154	2−188	4−208
Fullness of tree stand	1.	0.65±0.02	0.65±0.04	0.66±0.02	0.61±0.04
	2.	23.2	34.6	31.1	33.8
	3.	0.1−0.9	0.1−1.0	0.1−1.0	0.1−0.8
Quality class of tree stand	1.	4.3±0.1	4.2±0.1	2.9±0.1	5.1±0.2
	2.	13.0	10.5	12.6	18.9
	3.	3−5[a]	4−5[a]	1−4	3−5[a]
Proportion of pine in tree stand	1.	9.88±0.04	9.57±0.18	9.60±0.09	9.55±0.33
	2.	5.2	12.0	10.6	17.7
	3.	7−10	4−10	4−10	2−10
Height of tree stand, m	1.	9.9±0.6	5.6±1.0	9.0±0.8	8.4±1.3
	2.	69.4	105.9	96.7	77.8
	3.	0.5−22.0	0.5−20.0	0.5−27.0	0.5−20.0
Cover of shrub-layer, %	1.	16.6±1.5	22.0±2.9	16.8±1.7	6.0±1.7
	2.	106.6	83.8	105.5	140.5
	3.	0—98	2−80	0.1−90	0.1−35
Number of species in shrub-layer	1.	3.7±0.2	3.7±0.3	3.8±0.2	3.9±0.4
	2.	42.0	39.9	35.0	44.1
	3.	0−8	2−7	1−8	1−8
Cover of herb-layer, %	1.	3.3±0.3	6.0±2.1	6.0±0.9	6.0±1.2
	2.	103.0	215.8	149.4	104.0
	3.	0.1−16.0	0−70.0	0.1−63.0	1−32.0
Number of species in herb-layer	1.	6.3±0.4	5.7±0.5	8.5±0.5	13.8±0.9
	2.	75.2	53.5	57.4	33.8
	3.	1−24	0−14	1−26	6−25
Cover of moss-layer, %	1.	48.9±2.2	41.6±4.2	46.9±2.7	34.3±5.1
	2.	53.5	64.5	61.1	76.0
	3.	5−96	0−97	0−97	0−85
Number of species in moss-layer	1.	2.8±0.1	2.5±0.2	2.9±0.1	3.0±0.3
	2.	34.4	40.8	39.3	43.4
	3.	1−6	0−4	0−5	0−6
Cover of lichen-layer, %	1.	9.1±1.0	6.1±1.6	3.1±0.7	12.8±3.1
	2.	132.1	160.1	236.9	121.7
	3.	0−70	0−50	0−51	0−50
Number of species in lichen-layer	1.	2.8±0.1	2.5±0.2	2.3±0.2	2.0±0.3
	2.	40.4	53.2	61.1	70.1
	3.	0−4	0−4	0−5	0−4
Mean cover of bearberry, %	1.	1.9±0.3	1.8±0.4	1.8±0.3	4.7±0.9
	2.	169.7	137.1	157.7	90.9
	3.	0.1−22.1	0.1−14.0	0.1−15.8	0.1−16.3
Mean annual increment of bearberry ramets, cm	1.	3.46±0.07	3.55±0.11	3.85±0.08	3.24±0.11
	2.	24.2	21.1	24.1	18.2
	3.	1.47−6.25	1.65−5.05	1.80−7.47	2.32−4.71
Mean fresh weight of 1 dm² of bearberry, g	1.	12.3±0.3	12.4±0.6	11.8±0.3	11.1±0.6
	2.	25.3	28.0	25.6	25.2
	3.	4.5−23.0	6.1−22.2	3.9−20.1	6.7−16.2
Bearberry biomass, kg/ha	1.	120.2±17.4	104.3±22.6	110.5±17.0	263.7±50.6
	2.	176.6	140.6	167.9	99.7
	3.	0.6−1632.2	1.8−827.0	0.7−992.6	1.1−899.1

Table 3

Statistically significant $p=0.05$ correlation coefficients between parameters characterizing bearberry growth and site type conditions in different site types (in hundredths)

Parameter	Cover of bearberry				Fresh weight				Air-dry/fresh weight				Increment of bearberry				Biomass of bearberry			
	CL	CA	VA	AL	CL	CA	VA	AL	CL	CA	VA	AL	CL	CA	VA	AL	CL	CA	VA	AL
Fresh weight of 1 dm²	20	*	33	*	*	*	*	*	14	*	*	*	*	*	*	*	*	*	*	*
Air-dry/fresh weight	*	*	*	*	18	58	-18	-50	*	*	*	*	*	*	*	*	*	*	*	*
Increment of ramets	*	*	*	*	48	*	33	*	*	*	*	*	*	*	*	*	*	*	*	*
Bearberry biomass	98	96	99	96	27	*	39	54	*	*	*	*	*	*	*	*	*	*	*	*
Age of tree stand	*	*	*	*	20	*	*	*	20	*	*	-41	*	*	*	*	*	*	*	*
Fullness of tree stand	-18	*	-20	*	*	*	-29	*	*	*	*	*	*	*	*	*	-17	*	-21	*
Quality class of tree stand	29	*	*	*	*	*	*	*	*	*	*	*	-12	*	-26	*	30	*	*	*
Height of tree stand	-11	*	*	*	17	*	*	*	21	*	*	*	29	*	*	*	*	*	*	*
Proportion of pine	*	*	*	-60	*	*	*	*	*	*	*	*	*	*	*	-46	*	*	*	-52
Cover of shrub-layer	-17	*	*	*	26	*	*	*	29	*	21	*	16	*	*	*	-15	*	*	*
N of species in shrub-layer	-17	-35	*	*	13	*	*	*	13	*	-56	*	23	*	24	*	-15	*	*	*
Cover of herb-layer	*	*	*	*	-12	*	*	*	*	*	*	*	*	*	19	*	*	*	*	*
N of species in herb-layer	24	*	31	*	-12	*	20	55	*	*	*	-52	*	*	*	40	21	*	29	*
Cover of moss-layer	-28	*	-35	*	*	*	-19	*	*	*	*	*	29	*	*	-42	-24	*	-34	*
N of species in moss-layer	-21	*	-28	-45	-12	*	*	*	-12	*	*	*	*	*	*	-60	-19	*	-29	*
Cover of lichen-layer	*	*	*	*	14	*	-19	*	14	*	-28	*	-18	*	-28	*	*	*	*	*
N of species in lichen-layer	*	*	*	*	25	*	-24	*	*	*	-25	*	13	*	-25	*	13	*	-19	*

* — statistically significant linear correlation is lacking.
CL — *Cladonia*, CA — *Calluna*, VA — *Vaccinium*, AL — alvar site type.

significantly greater in alvar site types — 13.8 species. The cover of the bearberry is greater in the case of fewer herb-layer species; only in high soil fertility alvar site types are the average cover and biomass of the bearberry relatively great also in the case of the species-rich herb-layer.

In lower layers 2—3 species dominate in the moss-layer with the average cover 40—50%, which is somewhat lower in alvar site types. The total cover of the moss-layer can even exceed 90% but at the same time the total cover of the lichen-layer is small. The total cover for the lichen-layer is mostly smaller than for the moss-layer and reaches sometimes 50—60% but may lack altogether in damp sites. The mean cover of the lichen-layer is minimum in the damp *Vacc.* site type while variability is greatest here; the maximum cover is observed in the dry alvar site type where variability is lowest.

The bearberry as a species with a weak competitive ability, grows well in areas where vegetation is damaged as a result of fire, clear cutting or ploughing, and also on low fertility soils where other species cannot survive. The bearberry tolerates also lower soil moisture than most other species, owing to its long main root and numerous adventive roots (Шимкунайте, 1970; Борисова, 1974). In forest allotments where other vegetation is practically lacking, the bearberry grows especially well under favourable light conditions and its cover and biomass can be quite significant.

The mean cover of the bearberry for a forest allotment ranges between 0.03 and 22.1%. Data of the mean cover by forest types are presented in Table 2. The greatest mean cover is found in the alvar site type (4.7%), in other site types it is considerably smaller and relatively uniform (1.8—1.9%). The maximum cover (22.1%) occurs in the *Clad.* site type where also variability is highest ($V = 169.6\%$). Over 20% cover was observed only in two cases. In general, the cover of the bearberry is small, since in more than a half of the analyses the mean cover was below 1%; its distribution is shown in Fig. 2. In our conditions forest allotments with the mean cover over 3% should already be regarded as productive, i. e. only 1% of registered bearberry habitats. This fact leads to the conclusion that bearberry resources cannot be abundant in our republic.

In the course of geobotanical analyses the cover of the bearberry was also visually estimated. The correlation coefficient between the value of the visual cover and the one obtained by means of the 1 m² frame was quite high, $r = 0.76$ (level of significance 0.05). Hence, the visual estimation of the cover may prove quite accurate in the practical determination of bearberry resources. In order to acquire more experience and greater accuracy it is desirable that forest estimators should undergo a short practice before fieldwork on areas with different bearberry covers. Such a practice gave good results in a short time, so that while working in the first forest district the correlation coefficient obtained by us was even greater ($r = 0.88$) than the mean one.

The correlation analysis of the data shows (see Table 3) that the mean cover of the bearberry has a larger number of significant, though weak correlations in the *Clad.* site type. Stronger correlations can be noticed with the biomass ($r = 0.98$) and among other parameters, also with the absolute value of the tree stand quality class ($r = 0.29$) and with the cover of the moss-layer ($r = 0.28$). In the *Vacc.* site type the cover of the bearberry correlates with the fresh weight of 1 dm² ($r = 0.33$), with the biomass ($r = 0.99$) and in the geobotanical aspect with the number of herb-layer species ($r = 0.31$), with the cover and number of species of the moss-layer ($r = 0.35$ and $r = -0.28$, respectively). In the alvar site type the cover of the bearberry has quite a strong negative correlation with the proportion of the pine in the tree stand formula ($r = -0.60$) and with the
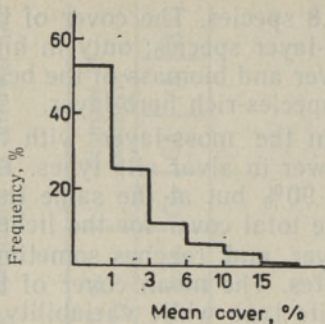
Fig. 2. The distribution of the
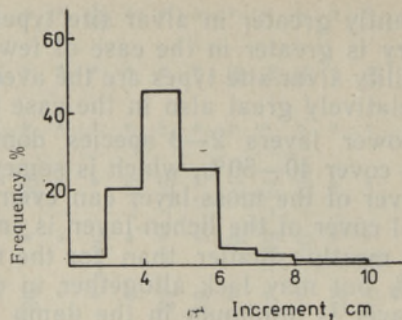mean cover of the bearberry.

Fig. 3. The distribution of the mean
annual increment of bearberry ramets.

number of species in the moss-layer, which shows that the bearberry grows
better in alvar site types with the poor-in-species moss-layer where the
tree stand includes other species besides the pine. The smallest number
of correlations is found in the *Call.* site type where the mean cover of the
bearberry correlates with the biomass of the bearberry ($r = 0.96$) and with
the number of species in the shrub-layer ($r = -0.35$). The last correlation
is evidently due to the fact that *Calluna vulgaris*, dominating in the shrub-
layer of this site type, considerably inhibits the growth of the bearberry.

Increment of bearberry ramets

The increment of bearberry ramets depends on a large number of
factors. Thus, the increment of horizontal plagiotropic ramets at the edge
of the clone is much greater than the increment of vertical orthotropic
ramets in the centre of the clone. According to literature data, e. g. the
yearly increment of plagiotropic ramets in the Ukraine is 7—9 cm, of
orthotropic ramets 4—5 cm (Бумар, Попович, 1985); in Yakutia the
increment in the case of plagiotropic ramets in the forest is 3.8—5.7 cm
and in cut-over areas 8.0—11.7 cm, in the case of orthotropic ramets
2.0—4.0 cm and 3.0—5.0 cm, respectively (Поздняков et al., 1978), i. e.
about two times smaller. In the present work only the increment of pla-
giotropic ramets was measured since the increase of the area of the clone
and biomass depends on this value. In optimal growth conditions the
annual increment of ramets can be considerably great. According to the
data from Lithuania the increment of ramets for viable clones is 15—
20 cm; the value below 7 cm is considered to indicate the degradation
of the clone (Пясецкене, 1973). According to literature data the maximum
increment of bearberry ramets can reach even 50—80 per year (Шимку-
найте, 1970; Атлас ареалов ..., 1976). We have observed the maximum
increment in the case of a few ramets to be 20—30 cm. The increment of
bearberry ramets is also related to climatic conditions and is greater in
southern regions (Шимкунайте, 1970).

According to our data the mean annual increment of bearberry ramets
ranges from 1 to 8 cm; its distribution is given in Fig. 3. Ramets with the
mean increment of 2.1—5.9 cm make up a predominant part of all ana-
lyses, i. e. 91%. Thus, the mean annual increment is quite small in our
republic, and judging by the Lithuanian data, our pure bearberry stands
are in a considerably bad condition. Data on the mean increment of
ramets by forest types are presented in Table 2; it can be seen that the
increment of ramets is minimum in the alvar site type (3.24 cm) and
maximum in the *Vacc.* site type (3.84 cm).

The size of bearberry clones can vary greatly. In young stands the
diameter of clones is small, 0.2—2(3) m, because in most cases the bear-
berry starts growing only after clear-cutting. The number of leaves on

Fig. 4. The dependence of the geometrical mean increment of bearberry ramets on the clone diameter.

bearberry ramets is then abundant, the leaves are large and the increment of ramets is notable. The diameters of clones in older and thicker tree stands can be rather large, even over 10 m, so that separate clones grow together and it is sometimes difficult or even impossible to distinguish between them. However, the general appearance of the clone is not favourable; the clone is thin, the density of leaves is low and the increment of ramets small. Very often the centre of older clones consists of mere stems covered partly with litter and sand as a result of which the clone has a circular form. Under very sparse older tree stands ramets can be densely-leaved and the clone itself thick but the increment of plagiotropic ramets for older clones is significantly smaller than for younger ones. So, in a young stand of the same site type the average number of leaves on a ramet is 12.7—20.7, the length of leaves 1.67—2.07 cm, the width 0.67—0.69 cm and the increment of ramets 7.0—13.2 cm. In the case of bearberries growing under trees the corresponding parameters are 8.4—10.5 cm, 1.48—1.55 cm, 0.60—0.63 cm and 4.0—5.0 cm, respectively (Pihlik, 1980). The correlation between the diameter of the bearberry clone and the mean annual increment of ramets is shown in Fig. 4. One can see that in the case of very young clones with the diameter less than 1 m the increment is smallest, then increases to a certain extent in the case of clones with diameters of 1—5 m, and decreases again in the case of older clones with larger diameters. The great variability of the mean increment of ramets for medium-sized clones is due to the fact that the increment of ramets depends, besides the age of the clone as related to its size, also on a number of environmental factors. The decrease in the increment of older large clones is caused by the aging of the clone itself, on the one hand, and on the deterioration of growth conditions caused by the aging of the tree stand, on the other hand. The increment of ramets decreases also as a result of the joining of clones.

The correlation between the age of the tree stand and the mean annual increment of bearberry ramets is depicted in Fig. 5. Since the correlation analysis showed a significant but weak correlation between the mean increment of bearberry ramets and the soil moisture content, the correlation with the age of the tree stand was found separately for all forest site types. In *Clad.* and *Call.* site types the mean increment of bearberry ramets is similar: small in young stands and greater with the increasing age of the tree stand. Increment is evidently restricted by the small soil moisture content in the young stands of these site types. The smallest soil moisture content is found in the *Clad.* site type (Lõhmus, 1984) while here the increment values are also considerably lower than in the *Call.* site type. The inhibiting effect of the moisture deficit is observed especially
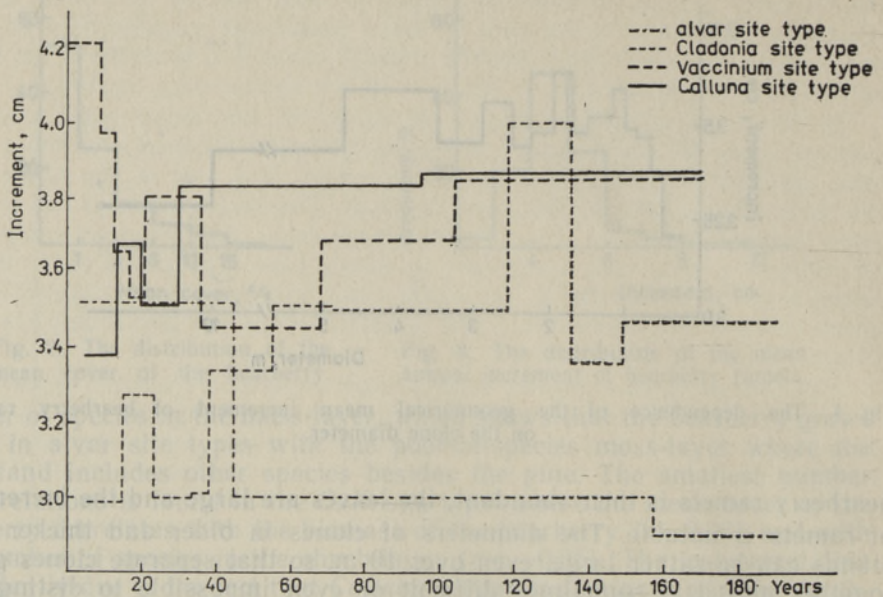
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Fig. 5. The dependence of the geometrical mean increment of bearberry ramets on the age of the tree stand.

in areas with the continental climate where it may prove to be the main factor restricting the growth (Мухина, 1986). A great rise in the increment of ramets in the *Clad.* site type tree stands of the age of 120—130 years probably results from the great variability of our data as nature does not provide any special cause for that phenomenon. In the *Vacc.* site type both the soil moisture content and fertility are somewhat higher. Here the increment is most intensive namely in young stands, decreases in medium-aged tree stands and increases again to some extent in older tree stands. Due to the sufficient soil moisture and the lack of competition from the tree stand and ground vegetation the increment of bearberry ramets in the young stands of this site type is greater. Owing to the scarcity of analyses in the case of *Arctostaphylos*-alvar and *Calamagrostis*-alvar sites both types are considered together. The increment of bearberry ramets in the alvar site type is greater in younger tree stands and decreases steadily with aging tree stands. It can be supposed that on the fertile soils of the alvar site type other species will further restrict the growth of the bearberry, which has a low competitive ability.

The correlation analysis (Table 3) again reveals the largest number but very weak correlations in the *Clad.* site type. A weak positive correlation is found between the increment of bearberry ramets and the age and height of the tree stand ($r=0.25$ and $r=0.29$), and in the geobotanical aspect between the increment of ramets and the cover of the moss-layer ($r=0.29$). In the *Vacc.* site type the value of the increment of bearberry ramets is in a negative correlation with the cover of the moss-layer ($r=-0.27$). In the alvar site type the increment of ramets has a relatively strong negative correlation with the proportion of the pine in the tree stand formula ($r=-0.46$) and with the cover and number of species of the moss-layer ($r=-0.42$ and $r=-0.60$). A positive correlation was observed with the number of the herb-layer species ($r=0.40$). Consequently, the increment is somewhat greater on better soils, which is connected also with the occurrence of other species in the tree stand. In the *Call.* site type no correlations were found between the increment of ramets and the parameters studied.

Weight of bearberry ramets

All bearberry ramets were cut on a random 1 dm² sample square; their mass will further be called the fresh weight of 1 dm², which varies very greatly. Even the mean value of an analysis varies from 3.9 to 23.0 g, since it depends on the thickness of ramets in a clone, on the size and density of leaves on ramets, on the clone age as well as on habitat conditions. The fresh weight of 1 dm² is greater for clones growing in optimal conditions. Data about the fresh weight of 1 dm² in various site types are presented in Table 2. Lowest values are observed in the case of the alvar site type (11.1 g) and highest in the *Call.* site type (12.4 g) where also the maximum value was registered (23.0 g).

To eliminate the effect of weather conditions the air-dry weight of ramets cut from 1 dm² was determined in all analyses, and in further calculations only this value was taken into account. The air-dry weight of 1 dm² varies from 1.82 to 11.81 g. The distribution of fresh and air-dry weights of ramets from 1 dm² is depicted in Fig. 6. The ratio of the fresh and air-dry weight of bearberry ramets was also determined, which ranges from 33.7% to 67%, while the mean value of all analyses was 46.3%.

Since the large number of analyses were carried out all over the Republic's territory, 0.46 can further be considered as the determination coefficient of the air-dry weight for stocking the drug in our region. Because the bearberry grows in dry habitats and there exists a number of xeromorphic features in its structure, this ratio is relatively similar in geographically different habitats. E. g. in Yakutia the ratio is 45% and in Central Siberia 49% (Поздняков et al., 1978), which corresponds to our results.

Fig. 6. The distribution of the mean fresh (g) and air-dry weight (g) of bearberry ramets on 1 dm².

There exists a relatively good positive correlation between the fresh weight of ramets of 1 dm² and their mean increment in all site types except the alvar site type (Table 3). The strongest correlation occurs in the *Call.* site type ($r=0.58$) while it is weaker in *Clad.* ($r=0.48$) and *Vacc.* ($r=0.33$) site types. In the *Clad.* site type the fresh weight of bearberry ramets of 1 dm² correlates with the biomass ($r=0.25$); weaker correlations are observed with a number of other parameters. In the *Vacc.* site type correlations with the bearberry biomass ($r=0.39$), the mean cover ($r=0.33$) and the fullness of the tree stand ($r=0.29$) are stronger. In alvar forests the fresh weight of 1 dm² correlates with the number of species of the herb-layer ($r=0.55$), the bearberry biomass ($r=0.54$) and with the ratio of the air-dry and fresh weights of ramets ($r=-0.50$). In the *Call.* site type the fresh weight of 1 dm² is in correlation with the increment of ramets ($r=0.58$).

As it becomes clear from the above data there exists a linear dependence between the fresh weight of bearberry ramets per square unit and the mean yearly increment of ramets in all site types except the alvar site type. The relation between the weight of ramets of 1 dm² and the mean increment is presented in Fig. 7. It is evident that the determination of weight during fieldwork is considerably more troublesome and time-consuming than the measurement of increment. Therefore we were inter-
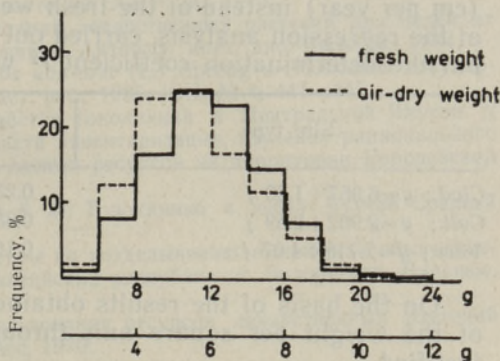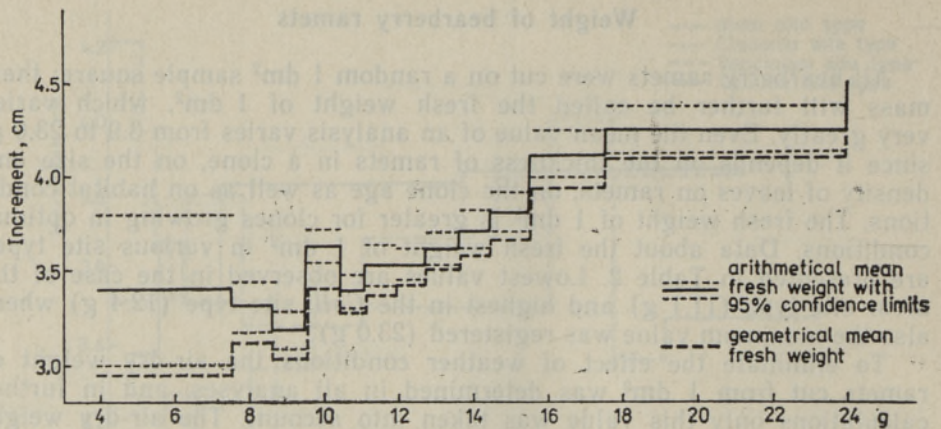
Fig. 7. The correlation between the mean fresh weight (g) of bearberry ramets on 1 dm²
and the mean annual increment.

ested in the possible use of the mean increment of bearberry ramets $\bar{j}$ (cm per year) instead of the fresh weight of 1 dm² y (g/dm²). The results of the regression analysis, carried out by site types, proved to be confident but the determination coefficient r^2 was too low in all cases.

Site type	r^2	$T / T_{0.95}$	$F / F_{0.95}$
Clad.; $y=6.057+1.80\ j$	0.235	6.72 / 1.96	45.21 / 3.84
Call.; $y=2.902+2.69\ j$	0.332	4.46 / 2.02	19.90 / 4.08
Vacc.; $y=7.718+1.07\ j$	0.107	3.75 / 1.98	14.09 / 3.92

On the basis of the results obtained it can be said that the derivation of the weight per square unit through the increment of ramets is not justified.

Conclusions

In conclusion it can be said that the distribution of the bearberry in our republic is rather insignificant; it grows on 0.14% of the whole forest area, mainly in *Cladonia, Calluna, Rhodococcum* (= *Vaccinium*) and *Arctostaphylos*-alvar and *Calamagrostis*-alvar site types where vegetation is floristically poor in species and has a small total cover. In more than a half of analyses the mean cover of the bearberry itself is below 1%, and forest allotments with the mean cover over 3%, which make up only 1/5 of the total number, should be considered productive in our republic.

The mean annual increment of plagiotropic bearberry ramets is small, since in more than 90% of analyses this value is only 2—6 cm. Among forest types this parameter is greatest in the *Rhodococcum* (= *Vaccinium*) site type and smallest in the *Arctostaphylos*-alvar and *Calamagrostis*-alvar site type. The increment of bearberry ramets depends on the site type as well as on the age of the clone itself and that of the tree stand.

The weight of the bearberry per square unit is a very variable parameter both in the case of the fresh and dry weight. The mean ratio of the air-dry and fresh weight is 0.46 which can be practically considered while stocking the drug. Although there exists a linear correlation between the fresh weight per square unit and the increment of ramets (excl. in alvar forests), the regression analysis has shown that due to its great variability the mean increment of bearberry ramets cannot evidently replace the fresh weight per square unit.

The number of linear correlations between the parameters characterizing the bearberry growth and its habitat conditions is greatest in the *Cladonia* site type; however, these correlations are mostly very weak. Relatively stronger correlations are found in alvar site types; the number of correlations in the *Calluna* site type is very small.

Consequently, the bearberry is a species with a relatively small distribution, a medium cover and increment of ramets in Estonia. Therefore, the determination of its distribution and resources should be exact; the stocking should be carefully planned in strict accordance with the increment of mass.

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Ulve PIHLIK

LEESIKAS EESTIS

1. Levik ja kasv

Leesika kui hinnatud ravimtaime varude kohta siiani andmed puudusid. Käesoleva töö eesmärk oli uurida leesika bioloogia mõningaid aspekte, et nende põhjal välja töötada alused taastumist tagavaks ratsionaalseks kasutamiseks. Leesika levikut ja kasvu uuriti Eesti NSV 20 metsamajandis (22-st), kus tehti kokku 359 analüüsi.

Leesikas on meil lokaalse levikuga liik. Puistute pindala, kus kasvab leesikat, on ainult 0,14% metsafondi pindalast. Leesikas kasvab põhiliselt kuivades III—Vᵃ boniteedi männikutes väheviljakatel liivmuldadel, mis kuuluvad sambliku, kanarbiku, pohla, leesika- ja rohuloo metsakasvukohatüüpi. Floristiliselt on leesika kasvukohad liigivaesed ja väikese üldkatvusega; puhmarindes kasvab enamasti 3—4 liiki üldkatvusega alla 20—30%, rohurindes 6—8 liiki (v. a. loometsad, kus liike on rohkem) üldkatvusega alla 10%, sambla- ja ka samblikurindes esineb enamasti 2—3 liiki, mille üldkatvus on esimesel juhul 40—50% ja teisel 10—15%.

Leesika enda katvus on väike, rohkem kui pooltes analüüsides on keskmine katvus alla 1% ja maksimaalne katvus ulatub ainult kuni 22%. Keskmine katvus on suurem loometsades (4,7%), teistes metsakasvukohatüüpides on see ühesugune (1,8—1,9%). Meie oludes tuleb puistueraldused, milles leesika keskmine katvus on üle 3%, lugeda juba produktiivseteks.

Leesika plagiotroopsete võrsete keskmine aastane juurdekasv varieerub analüüsides 1—8 sentimeetrini, kusjuures rohkem kui 90% analüüsides on juurdekasv 2,1—5,9 cm. Võrsete keskmine juurdekasv on suurim pohla metsakasvukohatüübis (3,85 cm) ja väikseim loometsades (3,24 cm). Võrsete juurdekasvu suurus sõltub nii puhma enda kui ka puistu vanusest ja metsakasvukohatüübist. Sambliku ja kanarbiku metsakasvukohatüübis on võrsete juurdekasv noorendikes väiksem kui vanemates puistutes, loometsades aga on juurdekasv suurem nimelt noorendikes. Pohla metsakasvukohatüübis on juurdekasv maksimaalne noorendikes, väheneb keskealistes ja suureneb uuesti vanemates puistutes.

Leesika võrsete toormass pinnaühikul (1 dm²) varieerub 3,9—23,0 g piires, õhukuiv mass 1,82—11,81 g piires, õhukuiva ja toormassi keskmine suhe on 0,46. Kuigi pinnaühiku massi ja võrsete keskmise aastase juurdekasvu vahel on olemas lineaarne korrelatsioon kõigis metsatüüpides peale loometsade, ei ole regressioonanalüüsi põhjal alust kasutada pinnaühiku massi määramiseks võrsete keskmist juurdekasvu.

Kõige rohkem on leesika kasvunäitajatel statistiliselt usaldusväärseid (p=0,05) korrelatiivseid seoseid sambliku metsakasvukohatüübis, kuigi need on enamasti väga madalad; loometsades on korrelatsioonikordajad suuremad ning kanarbiku metsakasvukohatüübis esineb neid kõige vähem.

Ульве ПИХЛИК

ТОЛОКНЯНКА В ЭСТОНИИ

1. Распространение и рост

Толокнянка обыкновенная (*Arctostaphylos uva-ursi* (L.) Spreng.) является ценным лекарственным растением, но данные о ее запасах в Эстонии до сих пор отсутствовали. Для разработки основ возобновления и рационального использования изучали распространение и рост толокнянки в 20 лесхозах (из 22) Эстонской ССР, где было проведено 359 анализов.

Толокнянка является малораспространенным видом, занимая только 0,14% площади гослесфонда. Она растет в сухих сосняках III—Vᵃ класса бонитета на малоплодородных песчаных почвах, которые относятся к лишайниковым, вересковым, брусничным, толокнянково-альварным и вейниково-альварным лесам. Флористический состав местопроизрастания толокнянки маловидовой, суммарное проективное покрытие низкое. В кустарничковом ярусе встречается 3—4 вида с общим проективным покрытием менее 20—30%, в травянистом — 6—8 видов (кроме альварных лесов, где видов значительно больше) с общим проективным покрытием менее 10%, в моховом и лишайниковом ярусе — 2—3 вида с общим проективным покрытием соответственно 40—50% и 10—15%.

Максимальное покрытие толокнянки достигало 22%, но в общем оно низкое — в более чем 50% анализов среднее покрытие составляло менее 1%. В альварных лесах оно больше (4,7%), чем в других типах леса (1,8—1,9%). Так в наших условиях выделы леса со средним проективным покрытием толокнянки более 3% уже следует считать продуктивными.

Средний годичный прирост плагиотропных побегов толокнянки варьирует в анализах от 1 до 8 см и более чем в 90% — от 2,1 до 5,9 см; он больше в брусничных (3,85 см), а самый низкий в альварных лесах (3,24 см). Величина годичного прироста побегов зависит как от возраста кустарничка, так и от возраста древостоя и типа леса. В лишайниковых и вересковых типах местопроизрастаний прирост побегов меньше в молодняках и возрастает в более старых древостоях. В альварных лесах прирост больше в молодняках, в брусничном типе местопроизрастания — максимальный в молодняках, уменьшается в средневозрастных и вновь повышается в более старых древостоях.

Средняя масса побегов толокнянки варьирует от 3,9 до 23,0 г/дм², и воздушносухая масса — от 1,8 до 11,81 г/дм², а среднее соотношение их равняется 0,46. Хотя между сырой массой (1 дм²) и средним годичным приростом побегов имеется линеарная коррелятивная связь во всех типах леса кроме альварных, по данным регрессионного анализа нет основания для выражения массы на единицу площади через годичный прирост побегов.

Корреляционным анализом выявлены статистически достоверные (p=0,05) коррелятивные связи между ростом толокнянки и условиями местопроизрастаний. Связи теснее для альварного и слабее для лишайникового, а наименьшие для верескового типа местопроизрастаний.