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ARCTOSTAPHYLOS UVA-URSI IN ESTONIA

2. Biomass resources and their rational exploitation

Besides the parameters characterizing the growth of the bearberry (*Arctostaphylos uva-ursi* (L.) Spreng.), i. e. its cover, the mean increment of ramets and the fresh weight per square unit (1 dm²), also the biomass appears to be essential. The aim of the present work is to consider the dependence of the bearberry biomass on several habitat conditions, the possibilities for prognosticating the biomass, the yearly increment of biomass and the resources and perspective stocking regions in the Estonian SSR. In order to protect bearberry resources it is necessary to elaborate the principles for drawing up stocking plans of the drug in accordance with both its distribution and the amount of resources in a certain district.

Methods

The biomass of the bearberry (B, kg/ha) and resources (W, kg per forest allotment) were calculated as the air-dry weight in every analysis, altogether for 359 forest allotments according to the following formula

$$B=\bar{x}\cdot\bar{y}\cdot p,$$
$$W=B\cdot s,$$

where $\bar{x}$ is the mean cover of the bearberry, $\bar{y}$ — the fresh weight of bearberry ramets on 1 dm², p — the ratio between the air-dry and fresh weight of bearberry ramets, s — the area of the forest allotment.

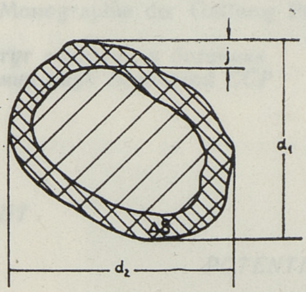

Fig. 1. Finding the annual increment of the biomass of bearberry ramets. d_1 and d_2 — diameters of the bearberry clone, j — annual mean increment of bearberry ramets, ΔS — annual increment of the bearberry clone area.

When calculating the annual increment of the dry weight of bearberry ramets, we proceeded from the assumption that bearberry clones have a circular or elliptical form; the relative yearly increment of mass ($\Delta M/M$), mentioned further also as the coefficient of the increment of mass, was found for each analysis. On the basis of this value the annual increment of the dry weight of the bearberry (Fig. 1) was found per forest allotment (ΔW, kg)

$$\Delta S=(\pi/2)\cdot(d_1+d_2)\cdot j,$$
$$\Delta M=\Delta S\cdot k,$$
$$M=(\pi/4)\cdot d_1\cdot d_2\cdot k,$$
$$\Delta W=W\cdot\Delta M/M,$$

where ΔS — the annual increment of the bearberry clone area, j — the annual mean increment of bearberry ramets, d_1, d_2 — diameters of the bearberry clone, ΔM — the annual increment of the fresh weight of the bearberry clone, k — the fresh weight of the bearberry on a 1 dm^2 sample square, M — the total fresh weight of the bearberry clone.

Biomass of bearberry ramets

The biomass of the bearberry, determined on the basis of its cover and the fresh weight of ramets on 1 dm^2, is very variable. In our conditions the biomass over 100 kg/ha should be considered a good quantity since in more than a half of the analyses the biomass is under 50 kg/ha (Fig. 2). An exclusively great biomass was found in two cases: 1144 kg/ha in the Pidula forest district on the island of Saaremaa, and 1632 kg/ha in the Tornimäe forest district on the island of Hiiumaa. In both cases the *Clad.* site type (Pihlik, 1988) in the 90—100 year-old pine forest of quality class V^a was involved. The mean biomass for various site types of the forest allotments analysed was smallest in the *Call.* site type (104.3±22.7, V=140.5%) followed by the *Vacc.* site type (110.5±17.1, V=167.9%), *Clad.* site type (120.2±17.4, V=176.6%) and alvar site type (236.7±50.6, V=99.7%).

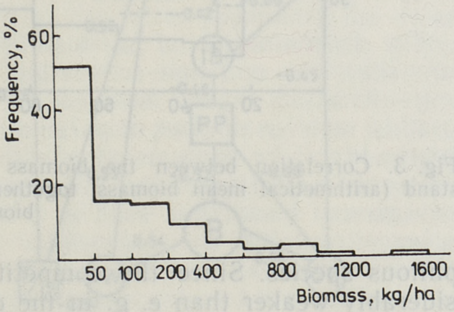

Fig. 2. Distribution of the biomass of bearberry ramets.

The growth of the bearberry as a heliophilous species depends to a great extent on light conditions of the site type (Шимкунайте, 1970; Пясецкене, 1969; Поздняков et al., 1978; Сотник, 1968, 1969; Борисова, 1974; Будрюнене, 1983; Мухина, 1986; et al.). It is known that light conditions in a tree stand depend also on its age; in young and old stands light conditions are better than in thick medium-aged tree stands. The correlation between the biomass and the age of a tree stand can be seen in Fig. 3. Due to the great variance of biomass values the graph presents both the arithmetical mean of the biomass together with confidence limits and the geometrical mean. This clearly shows that the biomass of bearberry ramets decreases sharply in 15—20-year-old tree stands, reaching the value of only 50 kg/ha in medium-aged tree stands. This can be accounted for by the deterioration of light conditions in medium-aged forest stands. During the further 40 years tree stands are non-productive for the bearberry; starting from 60-year-old forest stands the biomass of the bearberry starts increasing again. At this age pine-trees are already disbranched, pine stands themselves have become sparser as a result of cutting, and, therefore, light conditions are more favourable for the bearberry. However, the biomass of the bearberry does not reach the level it has in young stands and even starts decreasing in older tree stands. The decrease in the biomass is also connected with the aging of bearberry clones. In older clones leaves on orthotropic ramets are smaller than on plagiotropic ramets (Шимкуните, 1970). Since orthotropic ramets make up a larger part of the clone, the total biomass decreases as well. The rise in the biomass in 80—100 year-old tree stands (depicted on the graph) may be caused by the great variation of the collected data, and also by the fact that in tree stands of the age of 100 years or more the improvement of light conditions leads to the competition by other helio-

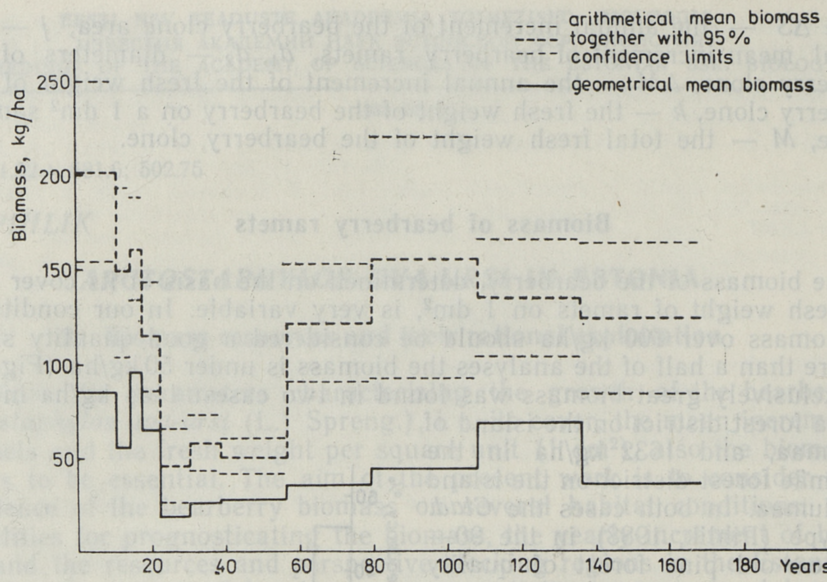

Fig. 3. Correlation between the biomass of bearberry ramets and the age of the tree stand (arithmetical mean biomass together with confidence limits, geometrical mean biomass).

philous species. Since the competitive ability of the bearberry is considerably weaker than e. g. in the case of *Calluna vulgaris*, which needs similar ecological conditions, or the species of genus *Cladonia*, its biomass decreases to some extent. Thus, one can draw the conclusion that the biomass of the bearberry is related to the age of the tree stand via light conditions, and that the stocking of the drug can be suggested in young stands up to 15(20) years and in older tree stands starting from the age of 60(70) years.

The biomass of the bearberry has correlations with the cover in all main site types (Pihlik, 1988). In the *Clad.* site type the biomass of the bearberry is in a positive correlation with the bearberry cover ($r=0.98$), the fresh weight of the bearberry ramets on 1 dm^2 ($r=0.27$), the absolute value of the quality class of the tree stand ($r=0.30$) and the number of species of the herb-layer ($r=0.21$); in a negative correlation with the fullness of the tree stand ($r=-0.17$) and the cover and number of species of the shrub-layer ($r=-0.24$; $r=-0.19$). Thus, the biomass of the bearberry in this site type is greater in sparse tree stands of a low quality class, accompanied by the shrub- and moss-layer which are poor in species and have a small cover, and a herb-layer which is somewhat richer in species; here the cover of the bearberry itself and its mass per square unit are great. In the *Vacc.* site type the biomass has a positive correlation with the cover ($r=0.99$) and the fresh weight of 1 dm^2 ($r=0.39$). The biomass of the bearberry is greater in sparse tree stands of a small fullness ($r=-0.21$), where the cover and the number of species of the moss-layer and the number of species of the lichen-layer are small ($r=-0.34$, $r=-0.29$, $r=-0.19$, respectively), while the number of species of the herb-layer is greater ($r=0.29$). In alvar site types the biomass of the bearberry is in a positive correlation with the cover ($r=0.96$) and the fresh weight of 1 dm^2 ($r=0.54$), and in a negative correlation with the proportion of the pine in the tree stand formula ($r=-0.52$). In the *Call.* site type the biomass of the bearberry has a significant correlation with the mean cover only ($r=0.96$). The number of correlations between the biomass of the bearberry, the mean cover and the fresh weight per square

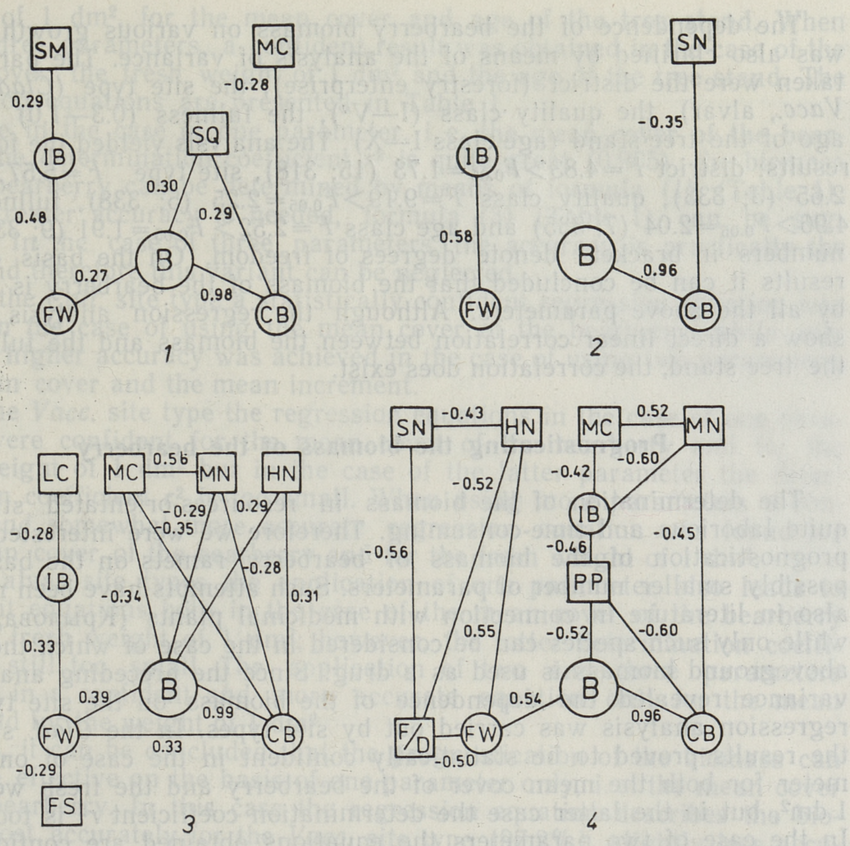

Fig. 4. Correlations between the basic growth parameters of the bearberry and site type conditions in different site types ($r>0.27$, significance level 0.05); 1 — *Clad.*, 2 — *Call.*, 3 — *Vacc.* and 4 — alvar site type, *B* — biomass of bearberry ramets, *CB* — cover of bearberry, *FW* — fresh weight of ramets of 1 dm^2, *IB* — meam annual increment of bearberry ramets, *SM* — mean height of tree stand, *SQ* — quality class of tree stand, *FS* — fullness of tree stand, *PP* — proportion of the pine in the tree stand formula, *F/D* — ratio of the air-dry and fresh weight of ramets, *SN* — number of species in shrub-layer, *HN* — number of species in herb-layer, *MC* — cover of moss-layer, *MN* — number of species in moss-layer, *LC* — cover of lichen-layer.

unit is greatest in the alvar site type and smallest in the *Call.* site type (Fig. 4).

Data on a strong dependence between the biomass of the bearberry and the fullness of the tree stand are also presented in literature (Будрюнене, 1983; Бумар, Попович, 1985). The correlation analysis of our data shows a statistically significant but weak correlation between the biomass of the bearberry per forest allotment and the fullness of the tree stand only in the *Clad.* ($r=-0.17$) and *Vacc.* ($r=-0.21$) site types, while in the *Call.* and alvar site types our data revealed no linear correlation. At the same time it can visually be observed that the biomass of ramets depends also on the fullness of the tree stand. That can be explained by the fact that it does not reflect light conditions in the bearberry habitat according to forest estimation data. The bearberry may grow on a forest allotment where the fullness of the tree stand is relatively great in case there exist a number of habitats favourable for its growth: hollows, sparse areas with damaged vegetation, forest paths. The biomass of the bearberry ramets can then be quite abundant while the same applies also to the biomass on the whole forest allotment.

The dependence of the bearberry biomass on various growth factors was also clarified by means of the analysis of variance. The parameters taken were the district (forestry enterprise), the site type (*Clad.*, *Call.*, *Vacc.*, alvar), the quality class (I—V^a), the fullness (0.3—1.0) and the age of the tree stand (age class I—X). The analysis yielded the following results: district $F=4.83>F_{0.05}=1.73$ (15; 318), site type $F=5.57>F_{0.05}=2.65$ (3; 333), quality class $F=9.19>F_{0.05}=2.25$ (5; 338), fullness $F=4.96>F_{0.05}=2.04$ (7; 335) and age class $F=2.52>F_{0.05}=1.91$ (9; 333). The numbers in brackets denote degrees of freedom. On the basis of these results it can be concluded that the biomass of the bearberry is affected by all the above parameters. Although the regression analysis did not show a direct linear correlation between the biomass and the fullness of the tree stand, the correlation does exist.

Prognosticating the biomass of the bearberry

The determination of the biomass in resources-orientated studies is quite laborious and time-consuming. Therefore we were interested in the prognostication of the biomass of bearberry ramets on the basis of a possibly smaller number of parameters. Such attempts have been reported also in literature in connection with medicinal plants (Крылова, 1975), while only such species can be considered in the case of which the whole aboveground biomass is used as a drug. Since the preceding analysis of variance revealed the dependence of the biomass on the site type, the regression analysis was carried out by site types. In the *Clad.* site type the results proved to be statistically confident in the case of one parameter for both the mean cover of the bearberry and the fresh weight of 1 dm^2, but in the latter case the determination coefficient r^2 is too small. In the case of two parameters the equations obtained are confident for the mean cover and the mean increment, for the mean cover and the fresh

Table 1

Prognostication of the bearberry biomass on the basis of its cover (x, %), increment (j, cm), fresh weight of 1 dm^2 (y, g) and age of the tree stand (z, year) in different site types

Regression equation	r^2	$T/T_{0.05}$	$F/F_{0.05}$
Cladonia			
$B=-2.755+64.297x$ (1)	0.965	64.13 / 1.96	4112.27 / 3.84
$B=-42.128+64.250x+11.418j$ (2)	0.968	65.81 / „ 3.01	2173.72 / 3.00
$B=-62.144+63.339x+4.979y$ (3)	0.971	66.82 / „ 5.04	2409.86 / 3.00
$B=-66.196+63.498x+4.500y+0.130z$ (4)	0.972	67.78 / „ 4.52 2.30	1665.78 / 2.60
Calluna			
$B=1.375+56.983x$	0.926	22.43 / 2.02	503.92 / 4.08
$B=-45.173+56.761x+13.222j$	0.931	22.74 / „ 1.60	262.78 / 3.23
Vaccinium			
$B=-5.860+64.146x$	0.972	63.51 / 1.98	4033.90 / 3.92
$B=-60.776+62.442x+4.902y$	0.978	65.12 / „ 5.42 /	2521.49 / 3.07
Alvar			
$B=-15.331+59.561x$	0.932	18.45 / 2.06	340.32 / 4.24
$B=-224.813+54.681x+20.980y$	0.975	25.61 / „ 6.43	465.92 / 3.40

weight of 1 dm^2, for the mean cover and age of the tree stand. When using three parameters, a confident result was obtained in the case of the mean cover, the fresh weight of 1 dm^2 and the age of the tree stand. The regression equations are presented in Table 1.

Since in the case of one parameter, i. e. the mean cover of the bearberry, the determination coefficient r^2 is quite great (0.965), the biomass of the bearberry can be determined by means of formula (1) (Table 1). When greater accuracy is needed, formula (3) (Table 1) can be suggested. In the case of three parameters the accuracy is practically the same and therefore this variant can be neglected.

For the *Call.* site type a statistically confident regression equation was found in the case of using the mean cover of the bearberry, while only slightly higher accuracy was achieved in the case of using two parameters, the mean cover and the mean increment.

In the *Vacc.* site type the regression equations in the case of one parameter were confident for the mean cover of the bearberry and for the fresh weight of 1 dm^2 but in the case of the latter parameter the determination coefficient r^2 is too small. When using more parameters a confident and somewhat more accurate regression equation was found for the mean cover of the bearberry and for the fresh weight of 1 dm^2.

For alvar site types the application of one parameter also leads to confident equations both in the case of the mean cover of the bearberry and the fresh weight of 1 dm^2; however, the latter determination coefficient is still too small. The application of two and three parameters resulted in a confident and more accurate equation only for the mean cover and for the weight of 1 dm^2.

Thus, it can be concluded that the prognostication of the biomass can be quite effective on the basis of one parameter only, i. e. the mean cover of the bearberry. In this case the regression equation describes the biomass most accurately for the *Vacc.* site type (97.2%), slightly less accurately for *Clad.* (96.5%), alvar (93.2%) and *Call.* (92.6%) site types. The accuracy of the determination increases somewhat but not considerably in the case of using two parameters for *Vacc.*, *Clad.* and *Call.* site types, and still more for alvar site types. The fresh weight of 1 dm^2 serves as another parameter, except for the *Call.* site type where the mean increment of ramets should be used instead. The increment of ramets is also fit as another parameter for the *Clad.* site type but in this case the accuracy of the equation increases less than in the case of using the fresh weight of 1 dm^2.

Resources and stocking regions of the bearberry

To determine bearberry resources an inventory was made of 2172 ha in all forestry enterprises where the occurrence of the bearberry had been registered by the forestry management, i. e. about a half of the registered area. For areas where the inventory was not made bearberry resources were determined in the indirect way using the geometrical mean biomass of every forest district and the mean coefficient of the biomass increment. In the case of the geometrical mean of the increment of bearberry ramets the effect of a few very great biomass parameters on the mean value is smaller than in the case of the arithmetical mean, and therefore the values are somewhat lower. To avoid the overestimation of resources we consider it proper to use the geometrical mean of the biomass when extrapolating data to the areas where the inventory was not carried out.

Under the biological resources of the bearberry we mean its total aboveground biomass on a certain area. The annual increment of the bearberry

Table 2

Distribution and resources of the bearberry in the Estonian SSR

Forest district	Area, ha	Biological resources, t	Annual increment of biomass, t	Economic resources, t	Maximum annual resources of drug, kg
Aegviidu	254.4	12.50	0.847	0.68+(0.13)	125+(25)
Alutaguse	99.2	16.00	0.996	0.99	180
Elva	47.3	2.00	0.181	0.16	30
Hiiumaa	106.1	25.51	0.332	0.33	65
Jõgeva	3.2	0.23	0.020	0	0
Järvamaa	19.8	4.85	0.333	0.33	55
Kilingi-Nõmme	117.7	4.95	0.139	0+(0.09)	0+(15)
Kohtla-Järve	428.9	43.60	3.341	3.34	660
Läänemaa	16.0	0.75	0.058	0+(0.06)	0+(10)
Pärnu	29.1	1.22	0.042	0	0
Rakvere	246.5	10.87	1.430	1.35+(0.08)	240+(10)
Räpina	154.2	30.26	0.986	0.90	180
Saaremaa	346.1	71.01	2.450	2.45	445
Suure-Jaani	22.4	0.26	0.017	0	0
Tallinna	52.7	8.33	0.388	0.39	75
Tartu	18.4	0.17	0.015	0	0
Tudu	29.9	6.25	0.506	0.50	95
Valgamaa	140.0	11.70	1.269	1.27	250
Viljandi	3.5	0.22	0.029	0	0
Võru	38.2	1.18	0.123	0+(0.08)	0+(15)

In brackets resources of *R* (reserve) category forest districts.

biomass depends on the annual increment of bearberry ramets. In the case of the economic resources of the bearberry the drug stocking economy is considered. In forest destricts where the annual increment of biomass is less than 50 kg either due to the scarcity of habitats or the small annual increment of biomass, the economic resources of the bearberry are lacking. All the above-mentioned parameters are presented as the air-dry biomass by forest districts in Table 2. Figs 5 and 6 show the biological resources of the bearberry and the annual increment of biomass in forest districts.

The total biological resources of the bearberry in the Estonian SSR comprise 252 tons. Biological resources are greater in the forestry enterprises of Saaremaa (71.0 t), Kohtla-Järve (43.6 t), Räpina (30.3 t) and Hiiumaa (25.5 t), medium in the forestry enterprises of Alutaguse (16.0 t), Aegviidu (12.5 t), Valgamaa (11.7 t) and Rakvere (10.9 t). As it is seen in Table 2 the growth area of the bearberry and its biological resources are not always in accordance, and therefore one cannot draw conclusions about bearberry resources on the basis of its area distribution only.

The total yearly increment of biomass for the bearberry in the Estonian SSR is 13.5 t, economic resources are 12.7 t. Greatest economic resources are found in the forestry enterprises of Kohtla-Järve (3.34 t), Saaremaa (2.45 t), Rakvere (1.35 t), Valgamaa (1.27 t), Alutaguse (1.27 t), Räpina (0.9 t) and Aegviidu (0.68 t). It can be seen that both the biological and economic resources of the bearberry are great in the forestry enterprises of Saaremaa and Kohtla-Järve. As to economic resources, however, the forestry enterprises of Rakvere and Valgamaa are ahead of the others. That is caused by the circumstance that the bearberry occurs there in young tree stands where the increment of its ramets and, consequently, the annual increment of biomass is greater than in older tree stands which prevail in the forestry enterprises of Räpina and Hiiumaa.

It can be see in Figs 5 and 6 that the distribution and resources are not even all over the territory of the Republic, which should be taken into

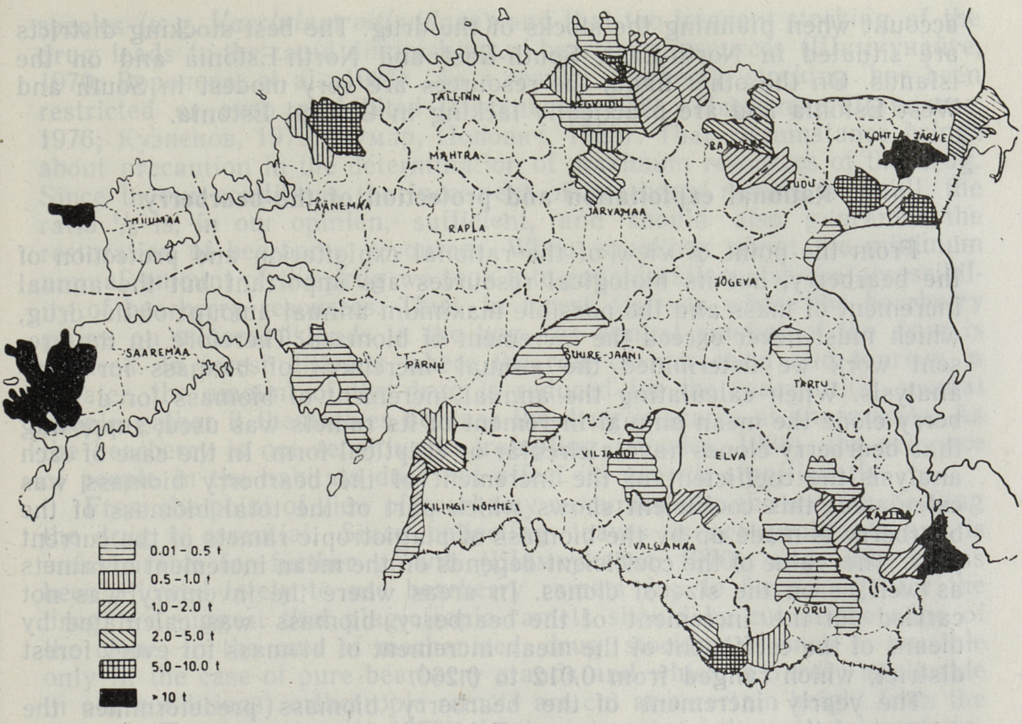

Fig. 5. Biological resources (t) of the bearberry biomass per forest district.

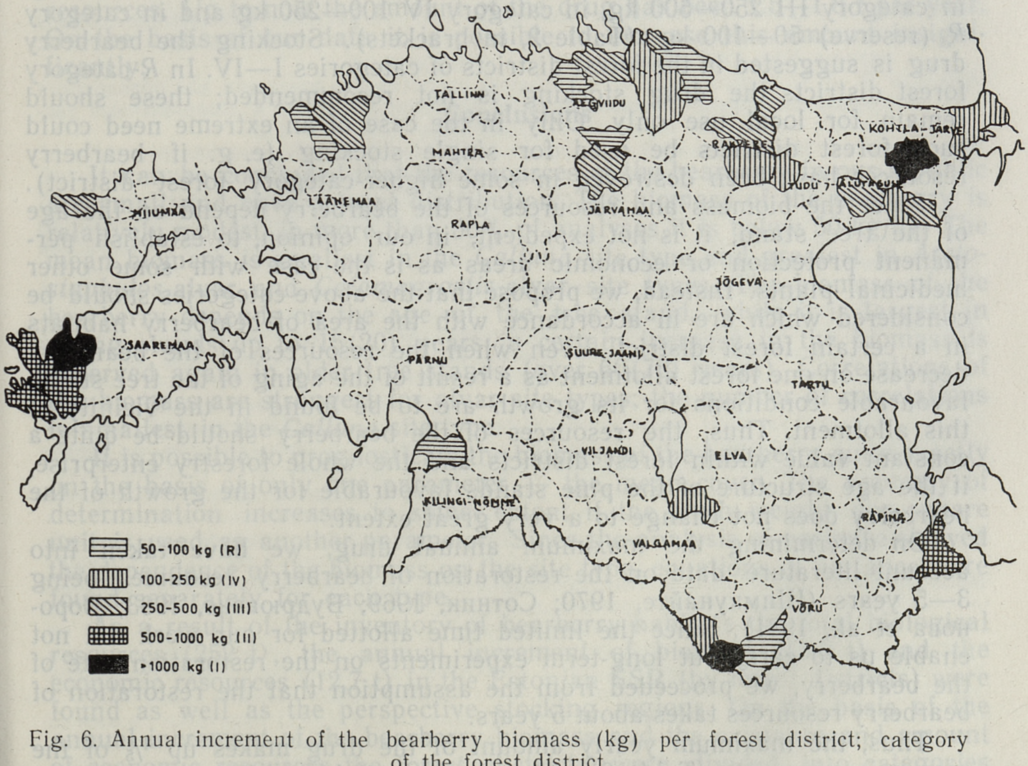

Fig. 6. Annual increment of the bearberry biomass (kg) per forest district; category of the forest district.

account when planning the stocks of the drug. The best stocking districts are situated in North-East, South-East and North-Estonia and on the islands. On the other hand, the resources are very modest in South and West Estonia and are practically lacking in Central Estonia.

Rational exploitation and protection of the bearberry

From the point of view of the rational exploitation and protection of the bearberry, not its biological resources are important but the annual increment of mass and the possible maximum annual amount of the drug, which must never exceed the increment of biomass. Therefore, in the present work we determined the annual increment of biomass for every analysis. When calculating the annual increment of biomass for a bearberry clone the mean annual increment of its ramets was used, supposing that bearberry clones have a circular or elliptical form. In the case of each analysis the coefficient of the increment of the bearberry biomass was calculated; this coefficient shows which part of the total biomass of the bearberry is made up by the biomass of plagiotropic ramets of the current year. The value of the coefficient depends on the mean increment of ramets as well as on the size of clones. In areas where the inventory was not carried out the increment of the bearberry biomass was calculated by means of the coefficient of the mean increment of biomass for every forest district, which ranged from 0.012 to 0.260.

The yearly increment of the bearberry biomass predetermines the amount of its economic resources (Table 2). According to the amount of economic resources the forest districts were divided into categories. In category I the yearly increment of the bearberry biomass exceeds 1000 kg per forest district, in category II the yearly increment is 500—1000 kg, in category III 250—500 kg, in category IV 100—250 kg and in category *R* (reserve) 50—100 kg (Table 2, in brackets). Stocking the bearberry drug is suggested in the forest districts of categories I—IV. In *R*-category forest districts the drug stocking is not recommended; these should remain for local use only. Only in the case of an extreme need could such forest districts be used for single stocking (e. g. if bearberry resources have been destroyed in some higher-category forest district).

Since the biomass and resources of the bearberry depend on the age of the tree stand, it is not expedient, in our opinion, to establish permanent protection or economic areas as is the case with some other medicinal plants. Instead, we propose that the above categories should be considered which are in accordance with the area of bearberry habitats in a certain forest district. Even when the resources of the bearberry decrease on one forest allotment as a result of the aging of the tree stand, favourable conditions for its growth are to be found in the vicinity of this allotment. Thus, the resources of the bearberry should be quite a constant value within forest districts and the whole forestry enterprise, if the age structure of the pine stands favourable for the growth of the bearberry does not change to a very great extent.

On determining the maximum annual drug, we have taken into account literature data on the restoration of bearberry resources being 3—5 years (Шимкунайте, 1970; Сотник, 1969; Будрюнене, 1983; Воронова et al., 1981). Since the limited time allotted for our work did not enable us to carry out long-term experiments on the restoration rate of the bearberry, we proceeded from the assumption that the restoration of bearberry resources takes about 5 years.

Thus, the maximum yearly amount of the drug makes up $1/5$ of the economic resources (Table 2). The data available in literature suggest that the restoration of the bearberry is slower than that of other similar species (e. g. *Vaccinium vitis-idaea*) and that too frequent stocking of the drug leads to the rapid diminishing of bearberry resources (Шимкунайте, 1970; Воронова, et al., 1981). As a result, bearberry stocking has been restricted or even prohibited (Пясецкене, 1969; Пясецкене, Шляпятис, 1976; Кузнецов, 1979; Бумар, Попович, 1985). That circumstance brings about precaution in the determination of maximum resources of the drug. Since in our conditions the increment of bearberry ramets is small, the ratio $^{1}/_{5}$ is, in our opinion, sufficient, and should also guarantee the restoration of bearberry resources. When speaking about the minimum annual amount of the drug we took into consideration also the accessibility of bearberry resources. Thus, in forest districts where the bearberry grows on mineral islands in the bog, the annual amount of the drug is reduced. In forest districts where the role of recreation and tourism is greater, the amount of the drug is reduced for the reason that several people gather it themselves because the drug is scarce at pharmacies. As the bearberry is not sensitive to trampling (Bowles, 1983), the presence of people in the habitats does not affect its growth significantly.

From the point of view of bearberry resources also the way of stocking the drug is essential. Since collecting leaves is not profitable and is unfavourable for further growth (Шимкунайте, 1970), and since it has been allowed lately to use bearberry ramets (up to 5 cm long) for the drug, we suggest that plagiotropic ramets should be cut at the edge of the clone. In the case of mechanized drug stocking (which is possible only in the case of pure bearberry stands and which is hardly applicable in our conditions) orthotropic ramets are cut at a certain height from the ground (Поздняков et al., 1978). In the interests of the rational exploitation of bearberry resources the drug should be gathered, first of all, from young stands and from older stands before clear-cutting, cutting off the larger part of the clone, avoiding in this way the useless loss of available resources. Up to now the amount of the drug has been 1.5—1.8 t per year. On the basis of our data it is possible to increase this amount insignificantly.

Conclusions

It can be concluded that the resources of the bearberry in our republic are small and have a local distribution. The biomass of the bearberry is relatively modest, in more than 50% of analyses it is below 50 kg/ha. The mean biomass is smallest in the *Calluna* site type and greatest in *Arctostaphylos*-alvar and *Calamagrostis*-alvar site types. The biomass of the bearberry depends on the age of the tree stand, while it is largest in young stands up to 15(20) years; a certain increase in the biomass is observed again in older tree stands (over 60(70) years). Correlations of the biomass are strongest for alvar site types; the number of correlations is smallest in the *Calluna* site type.

It is possible to prognosticate the biomass of the bearberry quite exactly on the basis of only one parameter — the mean cover. The accuracy of determination increases to some extent if the fresh weight per square unit is used as another parameter. Since the analysis of variance showed the dependence of the biomass on the site type, equations of variance were found separately for each type.

As a result of the inventory of bearberry habitats the total biological resources (252 t), the annual increment of biomass (13.5 t) and the economic resources (12.7 t) in the Estonian SSR (by forest districts) were found as well as the perspective stocking regions. On the basis of the annual increment of the bearberry biomass and the existence and amount of economic resources the forest districts were divided into categories (I—IV+*R*) which should be taken into account when planning the amount of the drug, so that the restoration of resources would be guaranteed. The maximum annual resources of the drug comprises 1/5 of the economic resources which amounts to 2.4 tons in the Estonian SSR.

Since the biomass and resources of the bearberry depend on the age of the tree stand, it is not expedient to establish permanent protection on economic areas. To protect bearberry resources it is necessary to take into account the above-presented categories and the maximum annual resources of the drug per forest district. Rational exploitation should consider the dependence of the bearberry biomass on the age of the tree stand and take advantage of the few available stands in time. A considerable increase of bearberry resources would be feasible only by creating favourable conditions for its growth or by cultivating the plant.

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LEESIKAS EESTIS

2. Biomass ja varud ning nende ratsionaalne kasutamine

Leesika kasvu iseloomustav tunnus on tema biomass. Käesoleva töö eesmärk oli selgitada leesika biomassi sõltuvust mõnedest kasvukohatingimustest, aga ka biomassi prognoosimise võimalusi, määrata massi aastane juurdekasv ning leesika varud ja perspektiivsed kogumisrajoonid (kokku 359 analüüsi alusel).

Kuigi leesika biomass muutub väga suurtes piirides, on rohkem kui pooltes analüüsides see alla 50 kg/ha. Keskmine biomass on kõige suurem loo kasvukohatüübis (236,7 kg/ha), kanarbiku, pohla ja sambliku kasvukohatüübis aga võrdlemisi lähedane (vastavalt 104,3, 110,5 ja 120,2 kg/ha). Leesika keskmine biomass on sõltuvuses puistu vanusest. Suurim on see noorendikes vanusega alla 15(20) aasta, väheneb tunduvalt keskealistes puistutes ja suureneb mõnevõrra vanemates puistutes. Andmete ekstrapoleerimisel inventeerimata aladele kasutati biomassi geomeetrilist keskmist, et vältida varude ülehindamist. Dispersioonanalüüs näitab, et leesika biomassi mõjutavad niihästi rajoon, metsatüüp, puistu boniteet, täius kui ka vanus. Leesika biomassi korrelatiivsed seosed on tugevamad loo kasvukohatüübis, ning kõige vähem on neid kanarbiku kasvukohatüübis.

Leesika biomassi võib kõigis metsatüüpides küllalt hästi prognoosida ka ainult ühe tunnuse — leesika keskmise katvuse — alusel, kusjuures hindamise täpsus on kõigis metsatüüpides üle 90%. Kahe tunnuse kasutamine tõstab määramise täpsust, kuid mitte väga oluliselt.

Leesikavarude inventeerimise tulemusel määrati leesika bioloogiline varu (252 t), leesika massi aastane juurdekasv (13,5 t) ja majanduslik varu (12,7 t) Eesti NSV-s (kõik õhukuiva massina). Leesika bioloogilise varu ja massi aastase juurdekasvu kohta koostati kaardid, mis näitavad, et parimad kogumisrajoonid on meil Kirde-, Kagu- ja Põhja-Eestis ning saartel.

Leesika ratsionaalse kasutamise ja kaitse eesmärgil on vastavalt massi aastasele juurdekasvule ja olemasolevale majanduslikule varule jagatud metskonnad kategooriatesse (I—IV + reserv) ning määratud maksimaalne aastane droogi kogus (kokku 2,4 tonni). Leesika droogi kogumiseks tuleb kasutada noorendikke vanusega alla 15(20) aasta, vanemaealisi puistuid üle 70 aasta ja kindlasti puistuid enne lageraiet, et ära kasutada meie tagasihoidlikud leesikavarud.

Улве ПИХЛИК

ТОЛОКНЯНКА В ЭСТОНИИ

2. Биомасса и запасы сырья толокнянки и их рациональное использование

Рост толокнянки (*Arctostaphylos uva-ursi* (L.) Spreng.) определяется ее биомассой. Целью настоящей работы было выяснение зависимости биомассы толокнянки от некоторых условий местопроизрастания, прогнозирование биомассы и годичного прироста, а также перспективных районов заготовки сырья. Определение этих показателей проводили на основе 359 анализов по всей территории Эстонской ССР.

Биомасса толокнянки варьирует в очень больших пределах, в более чем 50% анализов она низкая — менее 50 кг/га. Средняя биомасса самая высокая в альварных лесах (236,7 кг/га), в вересковом, брусничном и лишайниковом — ниже (104,3, 110,5 и 120,2 кг/га соответственно). Средняя биомасса толокнянки зависит от возраста древостоя. Она больше в 15—20-летних молодняках, уменьшается в результате ухудшения световых условий в средневозрастных и повышается в какой-то мере в старших древостоях. Во избежание переоценивания запасов сырья использовали геометрическую среднюю биомассу. Влияние условий местопроизрастаний (район, тип леса, бонитет, полнота и возраст древостоя) определяли дисперсионным анализом. Корреляционные связи биомассы толокнянки для альварных лесов более тесные, чем для лишайниковых и вересковых типов лесов.

Биомассу толокнянки можно прогнозировать довольно точно (более 90%) на основе лишь одного признака — среднего проективного покрытия. Использование двух признаков увеличивает точность прогнозирования только в некоторой мере.

На основе инвентаризации запасов сырья определяли общий биологический запас (252 т), годичный прирост биомассы (13,5 т) и эксплуатационный запас сырья толокнянки (12,7 т) в Эстонской ССР (воздушно-сухой массой) и составляли карты для двух первых показателей по лесничествам. Перспективные районы запасов сырья толокнянки находятся в северо-восточной, юго-восточной и северной частях Эстонии и на островах.

Для рационального использования и охраны запасов сырья лесничества ЭССР разделены на категории (I—IV и запасной) соответственно годичному приросту биомассы и эксплуатационным запасам толокнянки. Определен объем возможных ежегодных заготовок сырья по лесничествам — суммарно 2,4 т воздушно-сухой массой. Для заготовки сырья толокнянки подходят прежде всего молодняки в возрасте 15—20 лет, древостои возрастом выше IV класса и выделы леса перед сплошной рубкой.