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DIMENSIONAL FEATURES OF CENOPOPULATIONS OF SOME SPECIES OF MEDICINAL PLANTS IN THE CONDITIONS OF NORTH-EAST UKRAINE

Inna ZUBTSOVA, Larysa PENKOVSKA, Viktoriia SKLIAR, Iurii SKLIAR

Sumy National Agrarian University, 160 Herasym Kondratiev, Sumy, 40021, Ukraine,
Phone/Fax: +380542701055, Email: i_zubtsova@ukr.net, lara_penkovskaya@ukr.net,
skvig@ukr.net, sul_bio@ukr.net

Corresponding author email: skvig@ukr.net

Abstract

The article presents the results of the study of the size characteristics of cenopopulations Hypericum perforatum L. (Hypericaceae) and Saponaria officinalis L. (Caryophyllaceae), which are formed in different phytocoenoses of North-East Ukraine. We have studied six cenopopulations Hypericum perforatum from softwood, mixed and broadleaf forests and seven cenopopulations of Saponaria officinalis from meadows with domination of Elytrigia repens (L.) Nevski. During the research there were used a morphometric analysis, a complex of methods of statistical and mathematical processing of data, as well as the original approach to assess the dimensional structure of populations. We show that the implementation of morphological variability (variation of morphological parameters of plants within a single population) and morphological plasticity (the change in mean values of morphological parameters in the "transition" from population to population) is an integral part of the complex of processes and transformations that ensure the existence of cenopopulations of Hypericum perforatum and Saponaria officinalis in the north-eastern part of Ukraine. Cenopopulations of each species there has been erected phytocoenoses in which the greater (or significant) share of the values of the leading morphological parameters reaches the largest or the smallest values. These phytocoenoses can be considered as potential centers of procurement of medicinal raw materials. The results of the morphometric analysis provide an opportunity to determine the characteristic dimensions plants of Hypericum perforatum and Saponaria officinalis in each of the phytocenoses and to define the identification tags of their model individuals. An analysis of the dimensional structure of Hypericum perforatum and Saponaria officinalis cenopopulations has shown that they are mostly formed from plants whose size corresponds to 3-4 adjacent dimensional classes of height and leaf area and, respectively, 6-11 and 4-10 variants of the combination of dimensional classes of height and leaf area surfaces with IDSS values varying from 24.0-44.0% and from 16.0 to 40.0%.

Key words*: cenopopulation, morphometric analysis, dimensional structure, Hypericum perforatum L., Saponaria officinalis L.*

INTRODUCTION

The size of plant organisms, to a great extent due to the attached way of life, is their extremely important basic characteristic. Many plant properties are closely related to the size: life expectancy, place in the biogeocoenosis of the species, role in the food chain of the eco-system. Individuals of different sizes contribute unevenly to bioproducts, differ in the nature of intra-ecosystem bonds, and have different degrees of resistance (Law, 1983; Toshihiko, 1988; Marba et al., 2007; Zlobin, 2009).

Of particular significance, morphometric studies have been obtained after the elaboration of the method of vitality analysis (Zlobin, 1989; 2018) was developed and adjusted. The scientist considers plants as multi-indicative organisms and makes it possible to set morphometric features that are the most informative from a biological point of view for their various life forms.

Analysis of literary sources shows that despite the fact that the study of dimensional characteristics of plants has been one of the most important components of particular areas of botanical research for a long time (Karmanova, 1976; Hunt, 1978), and morphometric analysis is used in the study of different levels of organization of living (individuals, populations, phytocenoses), on the background of the presence of a very large number of works, which provide information on the size of the objects of study, the proportion of developments with the data on the size structure of certain sets of plants is relatively insignificant. Although the expediency of the analysis of the plants phytocoenoses ratio of various size groups, as well as the informative value of this indicator, was proved in classical botanical works several decades ago (Ipatov, 1968; Dyrenkov, 1984; Weiner, 1985). Recently, the data on the size structure of the plant's cenopopulations are most often given in works devoted to the study of competitive relationships (Gordon B. Bonan, 1988; Hara et al., 1993; Schwinning, Weiner, 1998; Kotov, 2001), the state of forest phytocoenoses and their natural reforestation (Buzun, 2004; Lebkov, 2008; Skliar, 2013; 2015a; 2015b).

Studying plant size and the dimensional structure of their populations is promising in terms of determining the stock of phytomass and assessing the resource potential of certain species within certain territories (Zlobin et al., 2013). Accordingly, the usage of such studies is appropriate and necessary for plants characterized as medicinal.

Ukraine is distinguished by significant species richness of plants, which has inherent healing properties (Minarchenko, 2002; Kislichenko, Lenchik, Musienko, 2015). A significant number of medicinal species are also presented in the flora of the North-Eastern Ukraine (Reserve Treasures, 2001). However, nowadays this region is insufficiently covered by research aimed at clarification of the features and patterns of composition, the functioning of the cenopopulations of plants in this group, assessment of their resource potential, and on the whole, it is focused on the definition of scientifically-based approaches to ensure their sustainable and non-exhaustive economic usage.

In this paper, we aimed to estimate the size of the dimensional parameters of individuals and the dimensional structure of cenopopulations of two species of medicinal plants (*Hypericum perforatum* L. and *Saponaria officinalis* L.) which are one of the most widespread in the North-East of Ukraine.

MATERIALS AND METHODS

Hypericum perforatum (Hypericaceae) is called a remedy for 99 diseases. This plant belongs to the pharmacopeia of many countries and according to the European Scientific Association of Herbal Medicine, it is one of the most popular medicinal plants in the world. *Hypericum perforatum* contains more than 10% of tannins, essential oils, resinous substances, vitamin C, carotene and some other substances. Modern medicine uses *Hypericum perforatum* to treat many diseases. Very valuable medicines are imanin and novoimanin. They kill more than 40 types of microbes and are used to treat many infectious diseases, burns (Zlobin, Bondareva, 2000)

Saponaria officinalis (Caryophyllaceae) is a perennial herbaceous rhizome plant of 30-90 cm high. The stalk is bare or swollen. The rhizome of the plant is creeping, branched, outwardly reddish-brown. Leaves are opposite, narrowed at the base into short petioles, elongated-elliptic with three longitudinal relief veins. The flowers are correct, pale pink, collected in the tartan droop, on short peduncles. It blossoms from June till August. Its fruit is a box. It is widespread throughout the territory of Ukraine - on flood plains, forest glades, and edges, with the exception of the Pinnacle Steppe. Sometimes *Saponaria officinalis* is grown as a decorative plant. Rhizomes and roots are picked up in late autumn. It is applied as a diuretic, slightly diaphoretic and expectorant. *Saponaria officinalis* contains saponins (saporubrin - in the roots of about 5%), triterpene hipsogenin, flavonoid glycoside (in the grass), saponarin (Safonov, 2008).

The research was carried out within the northern and central parts of North-Eastern Ukraine which belong to two geobotanical districts: Shostkinsky and Krolevets-Glukhivsky. The first of these is a part of the Polissya geobotanical province, and the second is a part of the Middle Russian forest province.

The study covered six cenopopulations of *Hypericum perforatum* and seven of *Saponaria officinalis*. All of them grow in phytocoenoses typical of the region. The investigated cenopopulations of *Hypericum perforatum* are represented in such phytocenoses as:

1. *Pinetum (sylvestris) coryloso (avellanae)-pteridiosum (aquilinae);*
2. *Pinetum (sylvestris) coryloso (avellanae)-chelidoniosum (majus)*;
3. *Pineto (sylvestris)-Aceretum (platanoiditis) fragariosum (vescae);*

4. *Quercetum (roboris) coryloso (avellanae)–chelidoniosum (majus);*
5. *Quercetum (roboris) coryloso (avellanae)–urticosum (dioici);*
6. *Querceto (roboris)-Aceretum (platanoiditis) fragariosum (vescae)*.

Cenopopulation of *Saponaria officinalis* is a part of the following phytocoenoses:
1. *Elytrigietum (repentis) subpurum;*
2. *Elytrigietum (repentis) artemisiosum (absinthium);*
3. *Elytrigietum (repentis) artemisiosum (vulgariosum);*
4. *Elytrigietum (repentis) alchemillosum (submillefolium);*
5. *Elytrigietum (repentis) alchemillo (submillefolium)-artemisiosum (absinthium);*
6. *Elytrigietum (repentis) urticoso (dioici)-alchemillosum (submillefolium);*
7. *Elytrigietum (repentis) variaherbosa.*

In order to determine the dimensional parameters of the plants of the studied species, we carried out a morphometric analysis. For this purpose, in the studied phytocoenoses, randomly, there were taken 25-50 generative plants of each of the two species under study. We evaluated a series of static metric and static allometric indices (Zlobin, 1989; Zlobin et al., 2009) (Tables 1, 2).

There were determined nine metric and eight allometric indices in *Hypericum perforatum*, and 13 metric and seven allometric indices in *Saponaria officinalis*.

To assess the statistical validity of the quantitative data obtained and their generalization, we used spot evaluation and dispersion analysis (Tsarenko et al., 2003).

This was provided by using statistic computer packages STATISTICA and PAST.

The dimensional structure was established on the basis of two morphoparameters (the total of the leaf surface area (A) and height (H)) based on the use of the original method which provided the implementation of the following algorithm of action:

Table 1. List of static metric morphoparameters, which were used to assess the state of plants of the studied species

The name of the morphoparameter	Symbols	Unit of measurement
Total weight of plants	W	g
Total phytomass leaves	WL	g
Phytomass of the stalk	Wst	g
Phytomass of one leaf	W1L	g
The total surface area of leaves	A	cm^2
The surface area of one leaf	A1L	cm^2
Total number of leaves	NL	pcs.
Number of side shoots of the first order	B	pcs.
The height of the plant	H	cm
Diameter of a stalk	D	cm
The total mass of reproductive organs	Wgen	g
Weight of one reproductive organ	Wgen1	g
Total number of generative organs	Ngen	pcs.

Table 1 and Table 2 show symbols and calculation formulas submitted by Karmanova I.V. (1976), Hunt R. (1978), Zlobin Yu.A. (1989)

Table 2. List of static allometric morphoparameters which were used to assess the state of plants of the studied species

The name of the morphoparameter	Symbols and calculation formulas for morphological parameters	Unit of measurement
Leaves area per unit of phytomass	LAR = A/W	cm^2/g
Photosynthetic effort	LWR = WL/W	g/g
Relative growth	HWR = H/W	cm/g
The ratio of the total leaf area to the diameter of the stalk	ADR=A/D	cm^2 /mm
The proportion between the height of the plant and the diameter of the stalk	HDR = H/D	cm/cm
Leaves area per unit of phytomass	SLA = A WL	cm^2/g
Reproductive effort	RE1=(Wgen/W)×100	%
	RE2=(Wgen/A)×100	%

1. The minimum and maximum values of H and A are determined for the whole population of individuals.
2. Taking into account the minimum and maximum values of the selected morphological parameters classes of dimension were determined for each of them.
3. A matrix of dimensional classes was made.
4. In the cenopopulation the position of each plant in the matrix field was determined.
5. The percentage of individuals representing different dimensional classes was estimated for the cenopopulation.
6. The dimension of index of the diversity of the size structure (IDSS) was determined by Skliar V.G. (2016) for cenopopulation (1):

$$IDSS = (Nf/Nt) * 100\% \qquad (1)$$

where: Nf is the number of combinations of different dimensional classes A and H found among plants of a certain cenopopulation; Nt is the theoretically calculated number of possible combinations between plants of dimensional classes A and H.

RESULTS AND DISCUSSIONS

The results of the estimation of the dimensional value of the plants *Hypericum perforatum* and *Saponaria officinalis* in different phytocoenoses of the North-Eastern Ukraine are shown in Tables 3 and 4. They confirm that in each of the locations individuals with a specific complex of values of the leading morphological parameters are formed. For the absolute majority of dimensional variables, all registrations of differences in the values of morphological indices in plants of different phytocenoses are statistically significant (at $p<0.05$). *Hypericum perforatum* has the only exception in the weight of one leaf, the total number of leaves and relative growth, and *Saponaria officinalis* has the exception in relative increase and the ratio of the total leaf area to the diameter of the stem. In addition, all morphological parameters show their peculiarities in terms of changes in the quantities of phytocoenoses under study (Figures 1, 2).

This indicates that each of the dimensional indicators has individual characteristics and plays a specific role in the formation of a complex of morphological adaptations in plants *Hypericum perforatum* and *Saponaria officinalis* to the conditions of specific locations. However, they are characterized by the manifestation of certain general tendencies. So in *Hypericum perforatum*, the highest values of nine morphoparameters (out of 17 evaluated) are recorded to the cenopopulation of the phytocoenosis *Quercetum (roboris) coryloso (avellanae)–chelidoniosum (majus).* In *Saponaria officinalis*, out of the 20 indicators covered by the study, the largest of the eight belong to the phytocoenosis *Elytrigietum (repentis) artemisiosum (vulgariosum)*, while the biggest indices of eighth (at four in each cenopopulation) are the *Elytrigietum (repentis) urticoso (dioici)–alchemillosum (submillefolium)* and *Elytrigietum (repentis) variaherbosa*. In *Saponaria officinalis*, unlike *Hypericum perforatum*, a fairly clear pattern and distribution of the smallest values appeared: eight of them were observed in the cenopopulation of the phytocoenosis *Elytrigietum (repentis) alchemillosum (submillefolium)* and seven in the *Elytrigietum (repentis) subpurum.*

In general, the results of the studies show that the existence of the plant and the cenopopulation of *Hypericum perforatum* and *Saponaria officinalis* are accompanied by the active implementation of them as morphological plasticity (according to Zlobin Yu.A., 1989), its sign is the presence of differences in mean values of morphological parameters cenopopulations for different phytocenoses, and morphological variability (manifested in the variation of absolute values of dimensional characteristics plants within a specific phytocoenosis).

On the implementation of the level of cenopopulations of both types of morphological variability, in particular, clearly demonstrate the mean arithmetic mean error, given in Tables 3 and 4. Actually, the manifestation of morphological variability proves the expediency and necessity of a thorough study of the dimensional structure of cenopopulations.

Table 3. Average values of plant morphometric parameters in the cenopopulations of *Hypericum perforatum*

Morphoparameters	Phytocoenoses					
	Pinetum (sylvestris) coryloso (avellanae)− pteridiosum (aquilinae)	*Pinetum (sylvestris) coryloso (avellanae)− chelidoniosum (majus)*	*Pineto (sylvestris)− Aceretum (platanoiditis) fragariosum (vescae)*	*Quercetum (roboris) coryloso (avellanae)− chelidoniosum (majus)*	*Quercetum (roboris) coryloso (avellanae)− urticosum (dioici)*	*Querceto (roboris)− Aceretum (platanoiditis) fragariosum (vescae)*
	$\overline{X} \pm S_{\bar{x}}$	$\overline{X} \pm S_{\bar{x}}$	$\overline{X} \pm S_{\bar{x}}$	$\overline{X} \pm S_{\bar{x}}$	$\overline{X} \pm S_{\bar{x}}$	$\overline{X} \pm S_{\bar{x}}$
	Static metric morphoparameters					
H	67.5±2.128	68.7±2.33	71.2±1.84	76.1±1.85	71.7±2.10	68.21±2.25
W1L	0.01±0.002	0.04±0.001	0.04±0.002	0.07±0.019	0.04±0.002	0.04±0.001
WL	1.40±0.025	1.47±0.017	1.40±0.034	1.25±0.036	1.51±0.037	1.46±0.037
D	0.50±0.015	0.40±0.016	0.42±0.014	0.52±0.014	0.43±0.014	0.38±0.011
B	26.9±0.96	26.1±0.99	22.2±0.83	28.0±0.92	24.3±0.93	22.1±0.73
A	4.30±0.241	5.23±0.186	4.74±0.216	4.92±0.255	5.64±0.133	4.55±0.239
W	7.30±0.232	6.97±0.144	7.48±0.195	8.45±0.264	7.27±0.140	7.36±0.221
Wg	0.90±0.068	0.96±0.040	0.86±0.045	1.06±0.039	0.89 ±0.031	0.75±0.047
NL	115.4±2.3	111.7±1.98	112.5±1.73	117.9±2.25	114.3±1.93	115.9±2.19
Static alometric morphoparameters						
LAR	0.60±0.031	0.74±0.019	0.63±0.026	0.60±0.037	0.78±0.020	0.62±0.027
LWR	0.20±0.007	0.21±0.004	0.18±0.005	0.15±0.004	0.20±0.003	0.20±0.005
HWR	9.40±0.260	9.79±0.203	9.59±0.226	9.10±0.185	9.82±0.171	9.30±0.213
HDR	133.3±5.10	172.3±4.53	170.4±5.34	146.7±3.13	168.8±7.04	178.6±3.09
RE1	13.1±0.93	13.9±0.56	11.6±0.52	13.0±0.62	12.4±0.50	10.3±0.59
RE2	23.2±2.13	19.0±1.06	18.8±1.02	23.7±1.66	16.2±0.88	17.0±0.88
SLA	3.1±0.18	3.5±0.11	3.4±0.14	4.1±0.26	3.8±0.12	3.1±0.14
ADR	8.5±0.47	13.1±0.43	11.3±0.48	9.70±0.61	13.4±0.60	12.0±0.54

Table 4. Average values of plant morphometric parameters in the cenopopulations of *Saponaria officinalis*

Morphoparameters	Phytocoenoses						
	Elytrigietum (repentis) subpurum	*Elytrigietum (repentis) artemisiosum (absinthium)*	*Elytrigietum (repentis) artemisiosum (vulgariosum)*	*Elytrigietum (repentis) alchemillosum (submillefolium)*	*Elytrigietum (repentis) alchemillo (submillefolium)- artemisiosum (absinthium)*	*Elytrigietum (repentis) urticoso (dioici) - alchemillosum (submillefolium)*	*Elytrigietum (repentis) variaherbosa*
	$\overline{X} \pm S_{\bar{x}}$	$\overline{X} \pm S_{\bar{x}}$	$\overline{X} \pm S_{\bar{x}}$	$\overline{X} \pm S_{\bar{x}}$	$\overline{X} \pm S_{\bar{x}}$	$\overline{X} \pm S_{\bar{x}}$	$\overline{X} \pm S_{\bar{x}}$
	Static metric morphoparameters						
W	34.7±1.05	42.1±1.11	46.4±1.01	35.7±1.53	42.4±1.33	49.3±1.63	47.3±1.63
WL	7.9±1.27	11.1±1.53	13.5±1.45	4.3±0.56	4.2±0.71	8.6±1.20	9.4±1.32
Wst	25.5±1.08	26.4±2.13	24.9±2.67	29.7±1.58	36.2±1.86	37.3±0.99	34.9±2.31
W1L	0.39±0.040	0.39±0.049	0.50±0.045	0.26±0.028	0.21±0.028	0.41±0.040	0.48±0.069
A	184.3±13.54	189.5±12.41	190.7±9.70	135.6±4.50	213.3±12.58	219.1±9.52	244.7±7.98
B	8.9±0.67	5.33±0.513	7.9±0.81	3.5±0.31	3.7±0.45	6.1±0.73	3.5±0.50
NL	19.6±1.51	28.3±1.66	26.6±1.21	16.2±0.87	18.1± 0.98	20.3±1.06	18.5±0.86
A1L	9.8±0.75	7.4±0.65	7.5±0.50	8.6±0.37	11.9±0.48	11.2±0.63	13.6±0.72
H	35.1±1.11	41.9±1.11	47.7±0.88	34.4±0.72	44.7±1.44	55.1±1.26	46.1±1.23
D	0.5± 0.03	0.6± 0.04	0.6±0.03	0.3±0.03	0.5±0.03	0.7±0.03	0.5±0.03
W gen	1.3± 0.37	4.6±0.80	7.9±1.23	1.7±0.21	2.0±0.24	3.4±0.42	3.0±0.39
W gen1	0.1±0.02	0.3±0.04	0.4±0.05	0.2±0.02	0.1±0.01	0.2±0.02	0.2±0.02
N gen	12.2±0.81	17.0±0.66	21.3±1.21	10.1±0.52	15.3±0.54	19.1±0.67	16.3±0.64
Static allometric morphoparameters							
LAR	5.4±0.47	4.5± 0.34	4.2±0.27	3.9±0.26	5.1±0.39	4.5±0.29	5.2±0.20
LWR	0.2±0.03	0.2±0.03	0.3±0.04	0.1±0.02	0.1±0.02	0.2±0.02	0.2±0.03
HWR	1.02±0.038	0.99±0.024	1.02±0.028	0.98±0.046	1.06±0.045	1.12±0.038	0.99±0.053
ADR	386.4± 38.50	354.6±34.57	307.3±24.42	528.9±62.85	448.2±40.89	349.9±24.91	532.0±29.57
HDR	72.2±3.78	79.1±8.14	76.7±4.80	136.1±18.21	92.5±4.54	87.4±4.52	101.5±6.78
RE1	3.1±0.87	11.3±2.10	17.4±2.94	4.8±0.49	4.7±0.60	6.78±0.87	6.6±0.92
RE2	0.6±0.16	2.6±0.46	4.4±0.73	1.3±0.16	0.9±0.11	1.6±0.22	1.3±0.16

According to the results of the estimation of the largest and the lowest morphological parameters in each of the studied species, five-dimensional classes of height and area of the leaf surface were allocated.

However, taking into account the features of the general morphostructure of plants *Hypericum perforatum* and *Saponaria officinalis*, the ranges of dimensional classes of selected morphoparameters in these species were slightly different (Tables 5, 6).

In general, the theoretically allocated number of combinations of different classes of dimension (Nt) for the cenopopulation of the studied species is equal to 25 variants.

In the *Hypericum perforatum* cenopopulation, IDSS varies from 24.0 to 44.0%.

That is, in the composition of cenopopulations, plants representing the sizes of magnitudes corresponding to 6-11 variants of the combination of dimensional classes of height and the area of the leaf surface are represented.

The highest level of IDSS (44% - 11 variants of the combination of dimensional classes) is distinguished by the population from the grouping *Pinetum (sylvestris) coryloso (avellanae)-pteridiosum (aquilinae).*

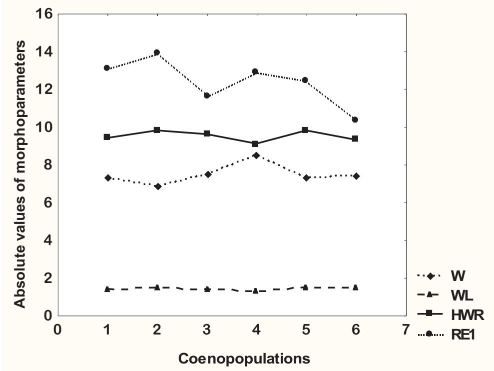

Figure 1. Changes in the mean values of morphoparameters in *Hypericum perforatum* cenopopulations by the investigated phytocenoses (numbering of cenopopulations corresponds to the numbering of the phytocenoses given in the text)

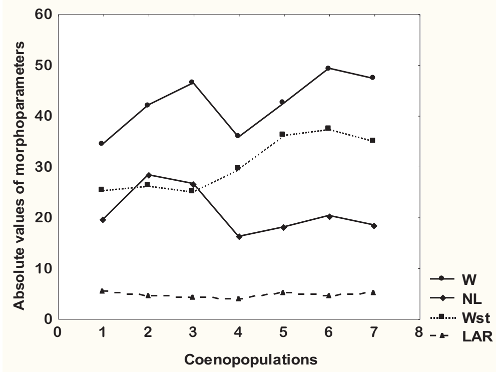

Figure 2. Changes in the mean values of morpho-parameters in *Saponaria officinalis* colonies for the investigated phytocenoses (numbering of cenopopulations corresponds to the numbering of the phytocenoses, given in the text)

Table 5. Representation of *Hypericum perforatum* plants of different classes of dimension in the investigated phytocenoses

Morphoparameters				The proportion of individuals of different sizes in the price of populations (the numbering of the cenopopulations corresponds to the numbering of the phytocenoses given in the text)					
height (H)		the area of the leaf surface (A)							
class	amplitude of absolute values, sm	class	amplitude of absolute values, sm^2	1	2	3	4	5	6
I	90.0–115.0	II	6.0–7.5	6.66		3.33			
I	90.0–115.0	IV	3.0–4.5	3.33			3.57		
II	75.0–90.0	I	7.5–9.0					23.0	20.0
II	75.0–90.0	II	6.0–7.5	13.3	20.68	20.0	21.42	23.0	24.0
II	75.0–90.0	III	4.5–6.0	20.0	10.34	3.33	10.71	7.69	
II	75.0–90.0	IV	3.0–4.5	23.3	3.44	13.33	3.57		
II	75.0–90.0	V	1.5–3.0	3.33			7.14		
III	60.0–75.0	I	7.5–9.0					11.5	12.0
III	60.0–75.0	II	6.0–7.5	10.0	3.44			23.0	16.0
III	60.0–75.0	III	4.5–6.0	3.33	6.89	13.33	10.71		12.0
III	60.0–75.0	IV	3.0–4.5	10.0	27.58	33.33	25.0		
III	60.0–75.0	V	1.5–3.0		10.34	3.35			
IV	45.0–60.0	II	6.0–7.5	3.33	3.51			11.81	4.0
IV	45.0–60.0	III	4.5–6.0				3.6		8.0
IV	45.0–60.0	IV	3.0–4.5		10.34	10.0	14.28		
IV	45.0–60.0	V	1.5–3.0	3.42					
V	30.0–45.0	III	4.5–6.0						4.0
V	30.0–45.0	IV	3.0–4.5		3.44				
Index of the diversity of the size structure (IDSS),%				44.0	40.0	32.0	36.0	24.0	32.0

Table 6. Representation of *Saponaria officinalis* plants of different classes of dimension in the investigated phytocenoses

Morphoparameters				The proportion of individuals of different sizes in the cenopopulations (the numbering of the cenopopulations corresponds to the numbering of the phytocenoses given in the text)						
height (H)		the leaf surface area (A)								
class	amplitude of absolute values, sm	Class	amplitude of absolute values, sm^2	1	2	3	4	5	6	7
I	65.0–75.0	III	190.0–230.0						3.33	
II	55.0–65.0	I	270.0–310.0						3.34	20.0
II	55.0–65.0	II	230.0–270.0						6.67	20.0
II	55.0–65.0	III	190.0–230.0						13.33	13.33
II	55.0–65.0	IV	150.0–190.0						13.33	6.67
III	45.0–55.0	I	270.0–310.0					13.33		
III	45.0–55.0	II	230.0–270.0			13.33		6.67	20.0	26.67
III	45.0–55.0	III	190.0–230.0			6.67		6.67	26.67	13.33
III	45.0–55.0	IV	150.0–190.0		6.67	40.0		13.33	13.33	
III	45.0–55.0	V	110.0–150.0		20.0	13.33		6.67		
IV	45.0–35.0	I	270.0–310.0	6.67	6.67			6.67		
IV	45.0–35.0	II	230.0–270.0	6.67	13.33	6.67		6.67		
IV	45.0–35.0	III	190.0–230.0	13.33	26.66	6.67		20.0		
IV	45.0–35.0	IV	150.0–190.0		20.0	13.33	6.67	13.33		
IV	45.0–35.0	V	110.0–150.0	20.0	6.67		40.0	6.66		
V	25.0–35.0	II	230.0–270.0	13.33						
V	25.0–35.0	IV	150.0–190.0				13.33			
V	25.0–35.0	V	110.0–150.0	40.0			40.0			
Index of the diversity of the size structure (IDSS),%				24.0	28.0	28.0	16.0	40.0	32.0	24.0

It is formed from plants, the size of which according to the appearance corresponds to the I-IV classes, and the leaf surface area is of II-V classes. The largest share (23.3%) of this cenopopulation has plants of the II class of height and IV class of leaf surface area.

The high values of IDSS (40.0%) are also distinguished by the cenopopulation of *Pinetum (sylvestris) coryloso (avellanae)-chelidoniosum (majus).* In its composition, plants are represented in which the values of both the height and the leaf surface area corresponding to the II-V classes. The largest (27.58%) is the share of plants of the III class of height and the IV class of the leaf surface area.

In the cenopopulation of *Quercetum (roboris) coryloso (avellanae)-chelidoniosum (majus),* IDSS is reduced to 36% that corresponds to the representation of the population of plants whose size represents the nine variants of the combination of dimensional classes of height and leaf surface area. Here grow plants of the I-IV classes of height and II-V classes of the leaf surface area (Figure 3). The largest (25.0%), as in the previous cenopopulation, is the proportion of plants of the III class height and the IV class of leaf surface area.

Sufficient indicators of IDSS (32.0% is eight variants of the combination of dimensional classes) are common to populations *of Pineto (sylvestris) - Aceretum (platanoiditis) fragariosum (vescae)* and *Querceto (roboris) - Aceretum (platanoiditis) fragariosum (vescae).*

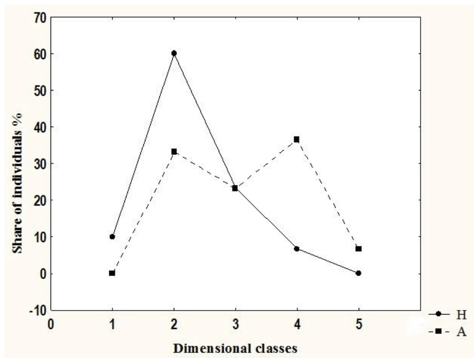

Figure 3. Dimensional spectra of *Hypericum perforatum* cenopopulation in the phytocoenosis *Quercetum (roboris) coryloso (avellanae)-chelidoniosum (majus)*

The population from the first phytocoenosis is formed from plants whose height corresponds to the I-IV classes, and the leaf surface area corresponds to the II-V classes. The largest (33.33%) here is the proportion of plants, the size of which corresponds to the III class of height and the IV class of leaf surface area. In the second phytocoenosis, the plants are slightly smaller in height (II-V classes), but larger in the area (I-III classes). The largest (24.0%) is the proportion of plants, in which both height and leaf surface area correspond to the II class.

Cenopopulation of *Hypericum perforatum* from the phytocoenosis *Quercetum (roboris)* *coryloso (avellanae)-urticosum (dioici)* has the least IDSS (24.0%). It presents six variants of combining dimensional classes. Here, plants of II-IV classes of height and I-III classes of the area grow (Figure 4). The largest (by 23.0%) is the proportion of plants, the size of which corresponds to three combinations of classes of height and area: II-I, II-II, III-II.

In the cenopopulations of *Saponaria officinalis* compared to *Hypericum perforatum* cenopopulations IDSS indices are somewhat lower and vary in the range of 16.0-40.0%. That is, in the composition of cenopopulations, plants are represented the dimensional size of which correspond to 4-10 variants of combining dimensional classes of height and leaf surface area (Table 6).

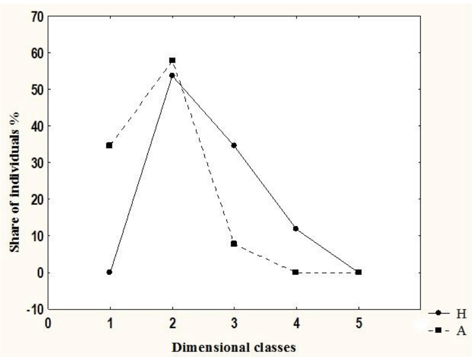

Figure 4. Dimensional spectra of the concentration of *Hypericum perforatum* in the phytocoenosis of *Quercetum (roboris) coryloso (avellanae)-urticosum (dioici)*

The highest level of IDSS (40% is 10 variants of the combination of dimensional classes) is distinguished by the cenopopulation from phytocenosis *Elytrigietum (repentis) alchemillo (submillefolium)-artemisiosum (absinthium).* It is formed from plants, the size of which according to the appearance corresponds to the III-IV classes, and the leaf surface area of the I-V classes. The largest share (20.0%) of this cenopopulation consists of plants of the IV class of height and III class of leaf surface area.

Sufficient indicators of IDSS (32.0% - eight variants of the combination of dimensional classes) are typical of the cenopopulation of *Saponaria officinalis* from the phytocenosis of *Elytrigietum (repentis) urticoso (dioici) - alchemillosum (submillefolium).* It is formed from plants, the size of which corresponds to the I-III classes, and the leaf surface area is of the I-IV classes (Figure 5). The largest share (26.67%) of this cenopopulation consists of plants of the III class of height and III class of leaf surface area.

In two cenopopulations of *Saponaria officinalis* (from the phytocenoses of *Elytrigietum (repentis) artemisiosum (absinthium)* and *Elytrigiteum (repentis) artemisiosum (vulgariosum)*, the values of IDSS are 28.0%. In both of these cenopopulations, there are represented plants whose elevation value correspond to the III-IV classes, and the leaf surface area corresponds mostly to the II-V classes.

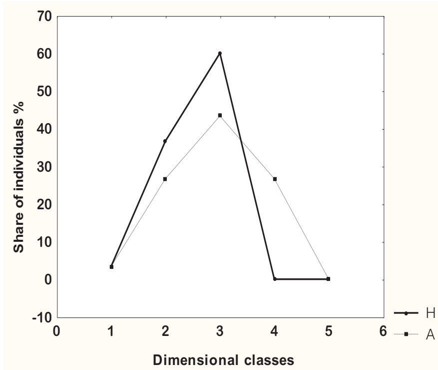

Figure 5. Dimensional spectra of the cenopopulation of *Saponaria officinalis* in the phytocoenosis of *Elytrigietum (repentis) urticoso (dioici)-alchemillosum (submillefolium)*

However, in the first of 26.66% of the largest part, the plants are of the IV class of height and the III class of leaf surface area, while in the second cenopopulation the highest is the specific gravity (40.0%) of the plants of the III class of height and the IV class of leaf surface area.

In two other cenopopulations, *Saponaria officinalis* (from the phytocenoses *Elytrigietum (repentis) subpurum* and *Elytrigietum (repentis) variaherbosa)*, the IDSS rates are reduced to 24%. In the first of these phytocenoses, plants of the I-III classes of height, as well as I-III and V classes of the leaf surface area are represented (Figure 6). The largest (40.0%) is the specific gravity of plants corresponds to class V as height, so as the leaf surface area. On the contrary, the second of these cenopopulations is formed from plants of II-III classes of height and I-IV classes of leaf surface area. The largest (26.67%) is the proportion of plants that reach the III class of height and the II class of the leaf surface area.

In the cenopopulation with the smallest IDSS (16.0% - 4 variants of the combination of dimensional classes), plants of two classes of height and two classes of leaf area are presented. The largest (40%) is the proportion of plants, the size of which corresponds to the IV class of height and the class V of the leaf surface area, as well as the height class V and the class V of the leaf surface area.

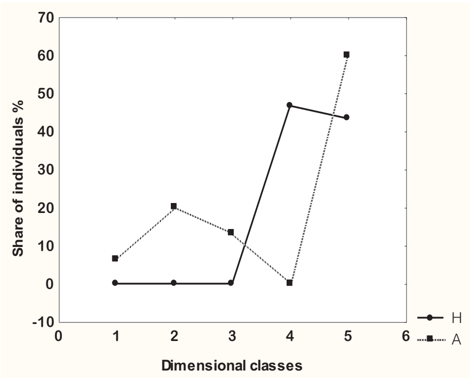

Figure 6. Dimensional spectra of the cenopopulation of *Saponaria officinalis* in the phytocoenosis of *Elytrigietum (repentis) subpurum*

In cenopopulations of *Saponaria officinalis*, the value of IDSS increases in the following sequence of phytocenoses: *Elytrigietum (repentis) alchemillosum (submillefolium)* (16.0%) → *Elytrigietum (repentis) subpurum, Elytrigietum (repentis) variaherbosa* (24.0%) → *Elytrigiteum (repentis) artemisiosum (absinthium), Elytrigiteum (repentis) artemisiosum (vulgariosum)* (28.0%) → *Elytrigiteum (repentis) urticoso (dioici)-alchemillosum (submillefolium)* (32.0%) → *Elytrigietum (repentis) alchemillo (submillefolium)-artemisiosum (absinthium)* (40.0%). In the cenopopulations of *Hypericum perforatum* the value of IDSS increases in the following phytocenoses: *Quercetum (roboris) coryloso (avellanae)-urticosum (dioici)* (24.0%) → *Pineto (sylvestris)-Aceretum (platanoiditis) fragariosum (vescae), Querceto (roboris)−Aceretum (platanoiditis) fragariosum (vescae)* (32.0%) → *Quercetum (roboris) coryloso (avellanae)−chelidoniosum (majus)* (36.0%) → *Pinetum (sylvestris) coryloso (avellanae)−chelidoniosum (majus)* (40.0%) → *Pinetum (sylvestris) coryloso (avellanae)−pteridiosum (aquilinae)* (44.0%). In other words, the cenopopulation of *Hypericum perforatum* which exists under the tent of pinnacle forests, is higher than in 1.1-1.8 times the IDSS values (40.0-44.0% vs. 24.0-36.6% in comparison with the cenopopulations of mixed and broadleaf forests).

CONCLUSIONS

The results of the analysis show that the implementation of morphological variability (variation of morphological parameters of plants within a single population) and morphological plasticity (the change in mean values of morphological parameters in the "transition" from population to population) is an integral part of the complex of processes and transformations that ensure the existence of cenopopulations of *Hypericum perforatum* and *Saponaria officinalis* in the north-eastern Ukraine.

Despite the fact that the average values of the leading morphoparameters in one way or another show their peculiarities of dynamics at the cenopopulations, as the result there erects phytocenoses in each species in which the greater (or significant) share of the values of the leading morphological parameters reaches the largest or the smallest values. The identification of such places should be an obligatory part of the research aimed at determining the parameters of the eco-coenotic optimum (passimum) regarding the existence and development of cenopopulations. So from all the studied phytocoenoses, the most favorable for the formation of plants that are quite large in size and with well-developed morphological structures, for *Saponaria officinalis*, was the phytocoenosis *Elytrigietum (repentis) artemisiosum (vulgariosum)*, and for *Hypericum perforatum - Quercetum (roboris) coryloso (avellanae)-chelidoniosum (majus).* These phytocoenoses can be considered as potential centers of procurement of medicinal raw materials of *Saponaria officinalis* and *Hypericum perforatum,* respectively, provided that they are enriched here with high population density values (number of plants per unit area).

The results of the morphometric analysis provide an opportunity to determine the characteristic dimensions plants of *Hypericum perforatum* and *Saponaria officinalis* in each of the phytocenoses and to define the identification tags of their model individuals. For example, the distinctive features plants of *Hypericum perforatum* from *Pinetum (sylvestris) coryloso (avellanae)-chelidoniosum (majus)* are the lowest phytomass (6.97±0.144 g) in the complex with the highest values of reproductive effort (RE1 = 13.9±0.56%). In turn, plants of the cenopopulation of *Saponaria officinalis* from the *Elytrigietum (repentis) artemisiosum (absinthium)* are characterized by the largest number of leaves (28.3±1.66 pcs.), with some of the smallest indices of the area of one leaf (7.4±0.65 cm^2).

An analysis of the dimensional structure of *Hypericum perforatum* and *Saponaria officinalis* cenopopulations has shown that they are mostly formed from plants whose size corresponds to 3-4 adjacent dimensional classes of height and leaf area and, respectively, 6-11 and 4-10 variants of the combination of dimensional classes of height and leaf area surfaces with IDSS values varying from 24.0-44.0% and from 16.0 to 40.0%. In general, it is quite high indices. In other cenopopulations species where IDSS have already been evaluated (different cohorts of the younger generation of *Pinus sylvestris* L., *Quercus robur* L., *Acer platanoides* L. (Skliar, 2014), as well as *Ledum palustre* L., *Chimaphila umbellata* (L.) W. Barton and *Oxycoccus palustris* Pers. (Sherstiuk, 2018), this indicator varies in the range of 5-25%.

Relatively significant IDSS indices registered in cenopopulations of *Hypericum perforatum* and *Saponaria officinalis* are yet another objective evidence that these types of morphological adaptations are an important part of the complex of adaptation to environmental conditions, and this kind of adaptation there needs further careful and thorough study both in these species and in other medicinal plants.

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