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A study of phenotypical diversity in wild narrow-leaved vetch (*V. angustifolia* L.)

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About 160 species of the genus *Vicia* are used for food and forage. In Lithuania, narrow-leaved vetch *V. angustifolia* L. is considered to be the progenitor of this genus. This species is quite common and grows on various soils, in dry grasslands, forests and in cereal crops as a weed. Nineteen *V. angustifolia* coenopopulations were investigated in the LUA collection under identical soil and plant management conditions during the period 2001–2003. Morphological plant assessment was based on measurements of stem height, branching point, the number of branches and pods, pod length and width, seed number per pod, 1000 seed weight, air-dried weight per plant. Crude protein content was determined in air-dried mass. A great intercoenopopulation diversity of *V. angustifolia* was determined. The greatest variation was found in the following parameters: branching, air-dried weight per plant, the number of productive stems. Four groups of vetch earliness were distinguished according to the date of the beginning of flowering. In terms of practical relevance, the group of medium earliness is considered to be the most valuable since it is characterised by the highest leafiness and protein content in air-dried mass.

Key words: *V. angustifolia,* coenopopulations, biodiversity, *ex situ*

INTRODUCTION

Since olden times, plants of *Fabaceae* the family as a source of energy and protein are one of the major plants used for food and forage. Legumes are valued for their ability to fix biological nitrogen and protect the soil from erosion. They are also used for phytoamelioration and as living mulches for alternative cropping systems [1, 2].

The genus vetch [*Vicia* L.] belongs to the family *Fabaceae*. *Vicia* subgenus *Vicia* contains several economically important food and forage legume species whose centre of distribution is the Eastern Mediterranean. Due to their current economic value and potential for future utilization, *Vicia* was ascribed a high priority by the International Board for Plant Genetic Resources (IBPGR) forage working group for collection, conservation and forage development [3]. About 160 species of *Vicia* are used for food and forage [4]. Narrow-leaved vetch *V. angustifolia* L. is considered to be the progenitor of this species [5] (its other name is *V. sativa* ssp. nigra L. (L.) [3]. Tests of phylogenic relationships between individual *Fabaceae* species revealed *V. angustifolia* to posses one of the highest genetic polymorphism levels [7], which partly proves the theory of the origin of the *Vicia* genus species.

V. angustifolia belongs to West Asian flora elements. It is distributed almost in all Europe, America, Australia, South Africa [7]. Narrow-leaved vetch is a terophyt, spring plant, which rarely overwinters [7]. A range of intermediate forms between *V. angustifolia* and *V. sativa* [5] was identified. In Lithuania, *V. angustifolia* is a fairly common plant which grows on various soils, in dry grasslands, dry forests and in cereal crops as a weed. It is a valuable forage crop containing 25% protein from absolutely dry mass [7].

The objective of the present study was to investigate and conserve the biological diversity of *V. angustifolia* growing on the territory of Lithuania.

MATERIALS AND METHODS

The experimental subject was *V. angustifolia* grown *ex situ* (2001–2003). Vetch was sown in the second half of April.

Morphological plant assessment was based on measurements of stem height, branching point, the number of branches and pods, pod length and width, seed number per pod, 1000 seed weight, air-dried weight per plant. Crude protein content was determined in air-dried mass (Kjeldahl method). Analysis of the collected material was done at the laboratory of Crop Production Department of LUA. Protein analyses were done at the Agrochemical Research Centre of LIA. The collections were grown and field trials were conducted at the LUA Experimental Station.

Meteorological conditions

In 2002 and 2003, the summer weather conditions were similar to the long-term mean (Fig. 1), however, the year 2002 was distinguished by hot and droughty weather in July–August. During the experimental years the air temperature in July and August was by up to 3.4 °C higher than the long-term mean, the air temperature in April to June being by 0.1–3.4 °C higher than the long-term mean.

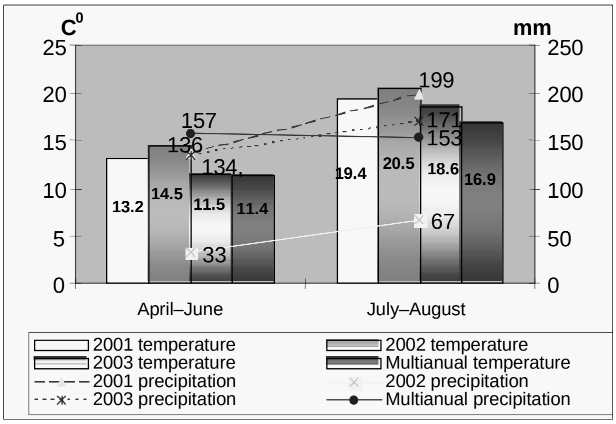

Fig. 1. Meteorological conditions (2001–2003)

In all experimental years, the amount of precipitation that fell during April–June was lower than the long-term mean (22.5–122 mm); the amount of precipitation in July–August (except for 2002) was by 18–46 mm higher. In 2002, especially droughty was the April–June period (the amount of precipitation was by 103 mm lower than the long-term mean) and the July–August period when the amount of precipitation was by 83 mm lower than the long-term mean.

RESULTS AND DISCUSSION

During the period 2001–2003, nineteen *V. angustifolia* coenopopulations were grown under identical soil and plant management conditions in the collection of the LUA Experimental Station. Accessions were collected in South-Eastern Lithuania (63%), Western Lithuania (26.3%), Central and Northern Lithuania (10.7%), agrophytocenoses of spring cereals (68%), dry grasslands and temporarily abandoned soils (32%).

Estimation of the phenological stages of *V. angustifolia* coenopopulations growing *ex situ* revealed four groups of earliness according to the beginning of flowering (Table). The largest number of coenopopulations (42%) were attributed to the early, 26.3% to the medium early, 16.3% to the late group. Only one coenopopulation was attributed to the ultra early group (5.4% of all coenopopulations).

Table. ***Vicia angustifolia* subpopulations according to the beginning of flowering**

Indices	Earliness group				$\bar{X} \pm s$	v%
	Ultra early $\bar{X}$	Early $\bar{X}$	Average early $\bar{X}$	Late $\bar{X}$		
Number of coenopopulations	1	8	5	5	19	
Beginning of flowering date	Jul 1	Jul 5–7	Jul 8–11	Jul 12–17	Jul 1–14	
Height of plant:						
first pod place	31.2	22.3	23.5	28.6	25.4 ± 3.5	29.0
at the beginning of flowering	30.0	30.0	28.4	32.0	30.1 ± 3.3	23.0
in the end of vegetation	60.9	48.7	60.1	58.2	58.4 ± 4.8	18.0
Number of branchings						
from enlobe	1.0*	2.2**	2.0**	2.0**	2.1 ± 0.4	34.7
from main stem	0	2.4	**3.1**	2.2	2.6 ± 0.7	60.5
Number of:						
pods	7.2	8.1	**10.1**	8.6	8.9 ± 2.7	31.0
seeds in the pod	**8.6***	6.5**	7.3**	**7.0****		
pod length, mm	37.0	31.8	37.3	**43.0**	36.6 ± 0.3	17.1
pod width, mm	4.0**	4.2**	4.4	**5.4***	4.5 ± 0.5	16.0
Weight of 1000 seeds, g	6.5	14.0	16.6	**20.0**	15.5 + 2.2	29.7
Dry matter of one plant, g	0.7**	0.9	1.1	1.1*	0.95 + 0.13	30.3
Foliage, %	54.7	60.3	**64.5**	55.8	60.7 + 6.7	26.7
Protein content, %	23.4	23.6	23.9	23.4	23.8 + 1.2	28.4

Means marked with* differ significantly ($P < 0.01$) from means marked with **.

Fig. 2. Different phenotypes of *V. angustifolia* L.: a) late, b) average early, c) early

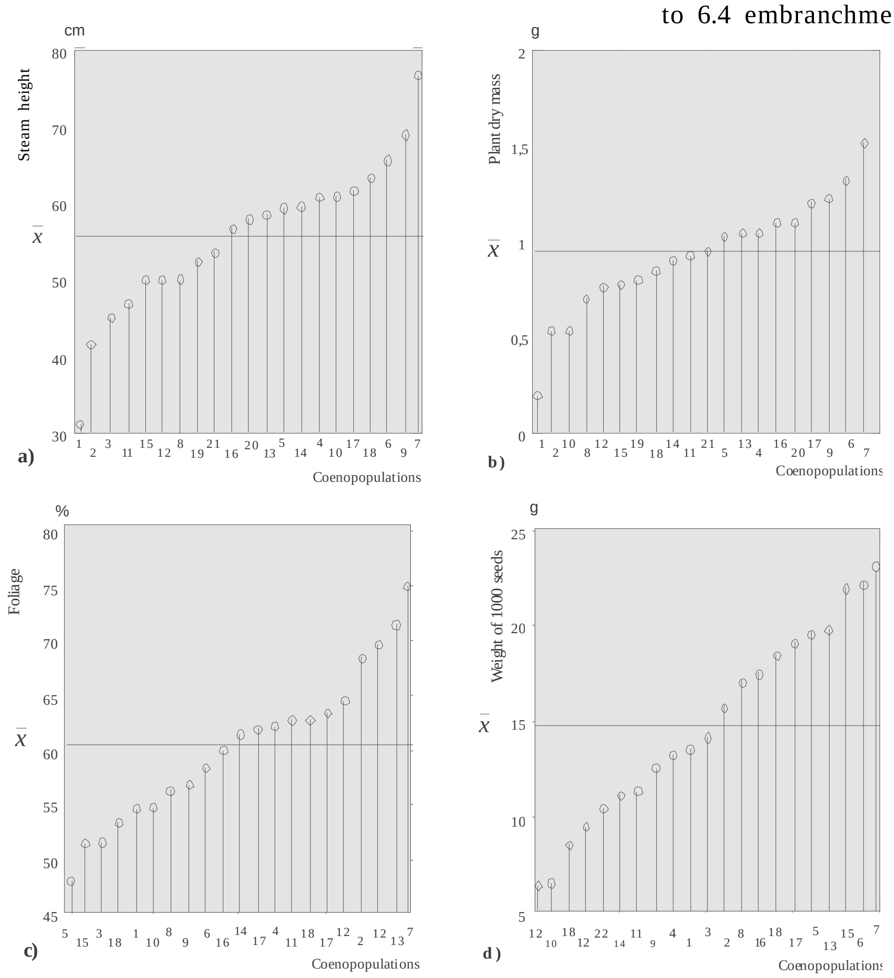

Fig. 3. Morphometric characteristics of main parameters of *V. angustifolia* L.

Vetch of the ultra early coenopopulation significantly differs in habit. It is a single-stemmed, non-branchy vetch form. The plants of this coenopopulation stood out by the highest seed number per pod (Table). Medium early coenopopulations were most valuable in terms of practical relevance: their average stem branchiness, leafiness, and protein content were found to be the highest. The coenopopulations attributed to the late group branched from enlobe more often than did the plants of the other groups; the parameters of their pods and 1000 seed weight were the highest.

Assessment of individual coenopopulations revealed a great diversity of their morphological parameters. The most stable and genetically determined were pod parameters, their variation coefficient being the lowest (v% = 16.0–17.1). The variation of branchiness was most pronounced: embranchment from enlobe v% was 34, and especially embranchment from the main stem v% was 60.5. Estimation of branchiness revealed coenopopulations of two types: branching from enlobe and having several (1–3.6) embranchments of the first row and those having embranchments of the first and second row (1.7 to 6.4 embranchments of the second row). A weak inverse linear correlation was determined between the embranchments of the first row from enlobe and leafiness (r = –0,432), as well as a positive correlation between embranchments of the second row and leafiness (r = +0.384).

Three types of coenopopulations were determined according to the shape of leaves: narrow with a pointed tip (the ratio of leaf length to width from 0.17 to 0.3), medium wide or wide, with an obtuse tip (0.24–0.4), wide, with a truncated tip (0.33–0.39). Narrow-pointed leaves were more frequent in early coenopopulations and medium wide and wide with obtuse and truncated tips to later coenopopulations characterised by a higher stem (secondary) branchiness, leafiness and mass (Fig. 2).

At different growth stages plant height in the coenopopulations varied differently (Table). A greater height diversity was determined at the beginning of flowering. At the end of the growing season plant stems of the tallest coenopopulations were more than twice taller than those of the shortest coenopopulations (Fig. 3a). The highest variation was identified for the attachment height of the pod. Attachment height of the first pod directly correlates with stem branchiness as well with plant light interception and flower formation conditions.

One thousand seed weight varied significantly. For some coenopopulations 1000 seed weight was 2.7 times higher (Fig. 3d)) than that of the coenopopulations producing the smallest seed. A positive linear correlation was determined between pod width and 1000 seed weight (r = +0.457), and an inverse linear correlation was determined between pod width and the number of seed per pod (r = –0.313).

Coenopopulations of *V. angustifolia* differed also by the colour of seed coat (Fig. 4), which varied from black to greenish grey with black pigment spots. One coenopopulation had yellowish brown seed with indistinct pigment spots. A lighter seed colour and a smaller number of pigment spots was more specific to medium-early and late branchy coenopopulations with wide leaves.

Fig. 4. Seeds of different *V. angustifolia* coenopopulations

The highest air-dry weight per plant for individual populations was up to three times higher than the lowest air-dry weight (Fig. 3b)). Leaves accounted for the largest share in the air-dry mass (Fig. 5). The leafiness of different coenopopulations varied from 48.7 to 75.6% (Fig. 3c)). A positive correlation was determined between leafiness and protein content in air-dried herbage (r = +0.596). Protein content in herbage for different populations varied from 19.5% to 26.6%. The highest protein content was identified in *V. angustifolia* flowers (Fig. 6) and the lowest in stems.

The chances for species survival are determined by its great biodiversity [8]. Results of *V. angustifolia* biodiversity investigation show its great adaptation and thus survival capacity.

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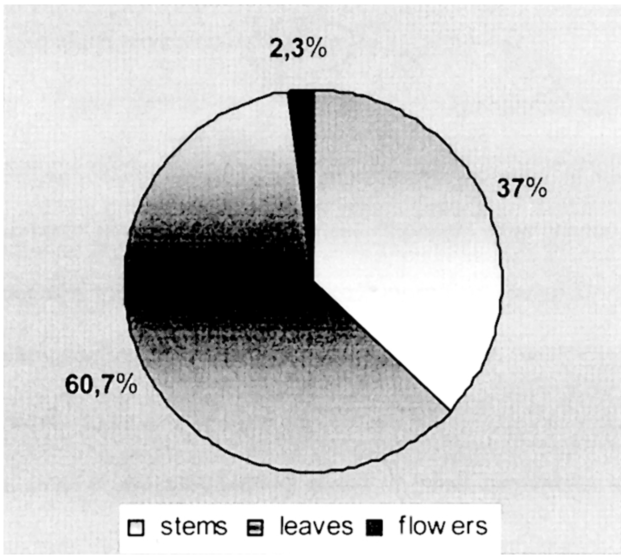

Fig. 5. Proportion of stems, leaves and flowers in air-dry vetch mass

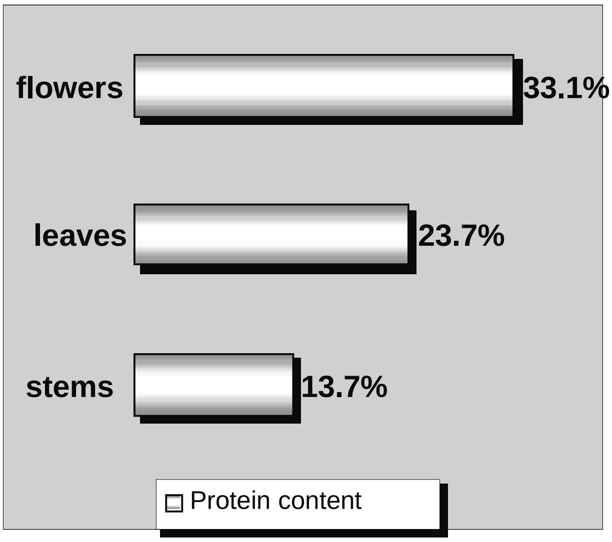

Fig. 6. Protein content in air-dry vetch mass

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LAUKINIO SIAURALAPIO VIKIO (*V. angustifolia*) FENOTIPINËS ÁVAIROVËS TYRIMAI

S a n t r a u k a

LÞÛU Bandymø stoties kolekcijoje 2001–2003 m. vienodos agrotechnikos sàlygomis buvo tirta 19 *Vicia angustifolia* L. cenopopuliacijø ir nustatyta didelë morfologiniø parametrø ávairovë. Skirtingø cenopopuliacijø augalø aukðtis skyrësi daugiau kaip du kartus, vieno augalo orasausë ir 1000 sëklø masë – tris kartus. Proteinø kiekis orasausëje þolëje svyravo nuo 19,5 iki 26,6%, lapuotumas – nuo 48,7 iki 75,6%. Daugiausiai proteinø rasta vikiø þieduose – 33,1% ir lapuose –23,7%. Labiausiai ávairavo stiebo ðakotumas (v% = 60,5). Nustatyta silpna atvirkðtinë tiesinë koreliacija tarp atsiðakojimø nuo þemës pavirðiaus ir lapuotumo (r = –0,432), taip pat teigiama tiesinë koreliacija tarp atsiðakojimø ið stiebo ir lapuotumo (r = = + 0,384). Stabiliausi buvo ankðties parametrai. Nustatytas tiesinis teigiamas ryðys tarp ankðties ploèio ir 1000 sëklø masës (r = +0,457), atvirkðtinis tiesinis ryðys tarp ankðties ploèio ir sëklø skaièiaus ankðtyje (r = –0,313). Pagal vikiø þydëjimo pradþios laikà iðskirtos 4 ankstyvumo grupës. Praktiniu poþiûriu vertingiausia vidutinio ankstyvumo grupë. Jai priklausanèios cenopopuliacijos iðsiskyrë ið kitø grupiø didesniu lapuotumu (64,%), baltymingumu (23,2%), didþiausiu produktyviø ankðèiø skaièiumi (10,1).