Medicago falcata L. Population State and Prospects for Use in North-Western Region

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Abstract. Meadows play an important role in maintaining the floristic diversity of regional floras. The phytocenotic allocation of the *Medicago falcata* L. population has not been sufficiently studied, as well as patterns of distribution of its units and unit groups, viability in a specific habitat under various anthropogenic influences. The growth and development of *Medicago falcata* L. populations under optimal conditions are becoming increasingly relevant and are promising in theoretical and applied aspects.The purpose is to study morphological characteristics and search for valuable forms of *Medicago falcata* L. to create varieties with high seed and feed productivity in the process of breeding work. The morphological characteristics of plants were studied depending on the age state and distribution of units in the territory they occupied. We have established that the total number of plants in the juvenile state in the population varies little from year to year, although the quantitative ratios of young plants of individual species can fluctuate significantly. This indicates that units in the juvenile state occupy a common ecological niche in the cenosis. The population of *Medicago falcata* L., growing in the Shelon meadow in the Soltsydistrict, differ in the methods of vegetation resumption, with numerous well-leafed shoots and high ecological plasticity. The formed meadow ecosystems depend not only on the natural conditions in their locations, but also on the influence of anthropogenic factors, which in turn affects the biogeocenosis (living organisms and their interaction with the environment) and, accordingly, the species composition of the meadow. There are rosette-free monocyclic vegetative and generative shoots, with a well-developed root system vertically and horizontally in the soil profile.

1 Introduction

Sickle alfalfa (*Medicago falcata* L.) is a native species with a perennial form of development; it grows in one place for more than 10 years with a high percentage of self-renewal of the grass stand. Species of *Medicago* L. are valuable vitamin-containing, high-protein forage plants [1, 5, 7, 10]. The most ancient source of alfalfa plants was the irrigated oases of Central Asia, and they were the source material for the creation of breeding varieties. Armenia was an equally ancient second center of alfalfa cultivation.

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Varieties of folk selection gradually spread in Western Europe, the Mediterranean countries, as well as in North and South America.

The distribution area of *Medicago falcata* L. is the northern regions of Europe and Asia. Its high plasticity allows adaptation to a variety of growing conditions, so it is distributed almost everywhere, especially in the southeast of the region [8; 9].

On the territory of the Russian Federation, there are about 50 species of alfalfa, which plant scientists combined into related species based on origin, morphological characteristics, biological characteristics of growth and development into certain groups [13]. In the natural conditions of the Novgorod region, the native species of sickle-shaped alfalfa(*Medicago falcata* L.), strangerhop medick (*M. lupulina* L.) andpurple alfalfa (*M. sativa* L.) [2].

Currently, there is a great need for high-protein feed for highly productive breeds of animals and birds [3, 4, 12]. *Medicago falcata* L. plants contain biologically complete protein with essential amino acids, which is necessary for the animal body [6, 11]. In addition, the biotechnology of protein concentrates is being widely introduced into production, both for farm animals and in the food industry for humans.

2 Material and Methodology

The experiments were carried out on the Msta meadow in the Borovichi and Novgorod districts and the Shelon meadow in the Soltsy district. The surveyed meadows differed in species composition and wide ecological amplitude. Meadows were formed on soddy-carbonate podzolized soils, with a deeper occurrence of carbonate rock and are confined to the slopes of river valleys or elevated plain spaces. The water regime is determined mainly by the moisture of atmospheric precipitation.

Biometric measurements and observations of plant growth and development were carried out according to generally accepted methods and recommendations (Program and Methodology..., 2011). Structural analysis was carried out on 50 plants during the harvesting period: the length of the shoot was measured, the number of shoots in the bush, the number of first-order branches, the length of the internode, the number of internodes, the length and thickness of the main shoot were also measured. The alfalfa harvest was recorded using the cut-sample method.

To preserve the species in places of natural growth, using the methods of T.A. Rabotnova, A.A. Uranova and M.S. Snagovskaya the number and age structure of the coenopopulation of *Medicago falcata* L were studied. Different ratios of ontogenetic groups in the population were taken as the ontogenetic structure of the cenopopulation. One individual was taken as a counting unit. Seed productivity was determined according to the method of I.V. Vainagina.

The chemical composition and nutritional value of the samples were determined according to generally accepted methods for analyzing feed on the basis of the Novgorod Scientific Research Institute of Agriculture.

3 Results and Discussion

The vegetation cover of meadows was formed as a result of the influence of environmental factors on plants, as well as a result of the evolution of the plants themselves, which made it possible to compete with adventive species introduced into their communities in a certain area.

The study of the biological diversity of plant species at the regional level is the basis for providing feed, food and raw materials in the future. The threat to resource-significant

species is their gradual depletion in specific floras and the destruction of their habitats. To preserve the genetic diversity of organisms, it is necessary to ensure the rational use of species and ecosystems.

An objective assessment of existing ecosystems can be given by comprehensive geobotanical and ecological studies of the characteristics of the phytocenotic occurrence of populations and the identification of mechanisms of their resistance to the effects of various environmental factors [15; 16]. This approach is one of the components of modern environmental forecasting of the development of landscape systems [14; 16]. Field floristic research on the territory of the Novgorod region has been carried out since 2000; during this period, sufficient information has been accumulated about the current state and places of growth of resource-significant plant species (Fig. 1).

A large coenopopulation of *Medicago falcata* L. grows in the meadows of the river Msta in the Borovichi and Novgorod districts, on the Prishelon lands of the villages of Zapolye, Nikolskoye, Ilemno, Dorogostitsy of the Soltsydistrict. This species was known from the collections of V. L. Komarov and other plant scientists from the end of the 19th century to the present day.

It is still important not only to identify a particular species in the study area, but also to monitor its dynamics. The state of the *Medicago falcata* L. population and its age development in natural cenosis is promising, since intrapopulation polymorphism is well preserved.

	A	B	C	D	E	F	G	H	I	J	K
129	Medicago		Falcata	L		Novgorodsky	The city of Novgorod	Ravine	herbarium	Kolmovsky A.	29.07.1893
130	Medicago		Falcata	L		Okulovsky	Near	Floodplain	herbarium	Borodin I.	18.08.1896
131	Medicago		Falcata	L		Borovichesky	Along the bottom of the shore	Floodplain	herbarium	Antonov A.	12.06.1896
132	Medicago		Falcata	L		Borovichesky	The banks of the Msta River	Dry meadow	herbarium	Antonov A.	21.06.1896
133	Medicago		Falcata	L		Valdaisky	The outskirts of the village	Meadow	herbarium	Dobropistsev	18.07.1901
134	Medicago		Falcata	L		Kretsky	Ust Volma	Meadow	herbarium	Borodin I.	05.06.1906
135	Medicago		Falcata	L		Kretsky	The sand is near	Meadow	herbarium	Klopov S.	09.06,1905
136	Medicago		Falcata	L		Kretsky	On the river bank	Rocky places	herbarium	Alekseevsky	
137	Medicago		Falcata	L		Old Pussian	Between	Roadside	herbarium	Censorship	11.06.1917
138	Medicago		Falcata	L		Novgorodsky	The left bank of the river	Coastal rampart	herbarium	Stepanov	06.07.1923
139	Medicago		Falcata	L		Novgorodsky	On the left bank of the river	The coastal zone	herbarium	Stepanov	06.07.1923
140	Medicago		Falcata	L		Novgorodsky	The village of Priluki	The indigenous coast	herbarium	Ganeshin S.S.	19.09.1923
141	Medicago		Falcata	L		Novgorodsky	Ate Bronnitsa	Flood meadow	herbarium	Ganeshin S.S.	11.07.1962
142	Medicago		Falcata	L		Novgorodsky	The outskirts	Floodplain	Cadastre	Korenovnina	02.08.1938
143	Medicago		Falcata	L		Mstinsky	The Msta River	Floodplain	Cadastre	Voskanyan	10.07.1962
144	Medicago		Falcata	L		Lyubytinsky	The right banks of the river	Coastal slope	herbarium	Valma V.P.	27.07.1967
145	Medicago		Falcata	L		Borovichesky	Borovichi city	Above-the-floodplain terrace	herbarium	Minyaev M.A.	02.08.1968
146	Medicago		Falcata	L		Borovichesky	Borovichi city	Above-the-floodplain terrace	herbarium	Minyaev M.A.	09.08.1968
147	Medicago		Falcata	L		Soletsky	Near the village of M.	Pine forest	herbarium	Neujmina I.Ya.	17.06.1976
148	Medicago		Falcata	L		Soletsky	1.5 km to the west	Coastal slope	herbarium	Neujmina I.Ya.	27.06.1976
149	Medicago		Falcata	L		Kretsky	Highway	Alder and birch forests	herbarium	Vargina N. E.	17.07.1979
150	Medicago		Falcata	L		Malovihersky	The bank of the Msta River	Secondary meadow	Own	Ivanov I.A.	21.07.1989
151	Medicago		Falcata	L		Kretsky	Neighbourhood	The deposit	Own	Abdushaeva	08.07.2006
152	Medicago		Falcata	L		Borovichesky	500m from the village	Meadow	Own	Abdushaeva	13.07.2006
153	Medicago		Falcata	L		Borovichesky	The left bank of the Msta rivers	Coastal slope	Own	Abdushaeva	11.07.2006
154	Medicago		Falcata	L		Borovichesky	Neighbourhood	Dry meadow	Own	Abdushaeva	11.07.2006

Fig. 1. Information about places of growth of *Medicago falcata* L.

Root shoot plants of Medicago falcata L in the Msta meadow of the Borovichi and Novgorod districts, and rhizomatous forms in the Shelon meadows of the Soltsy district were identified and described.

We have found that the resistance of *Medicago falcata* L. plants in the studied meadows depended on the age structure, the method of renewal and the impact of external factors on them. To create a model of a variety for mowing use, the morphological characteristics of *Medicago falcata* L. plants were studied (Table 1).

Plants growing on the Msta meadow had anascendingbush shape, and in the Shelon meadow with moderate moisture, semi-erect forms with large bushes predominated. The number of shoots is one of the indicators characterizing plant growth and affecting the yield and quality of the resulting feed. In the population of *Medicago falcata* L. on the Shelon

meadow in the Soltsy district, middle-aged generative units predominated. The number of vegetative shoots prevailed over generative ones, which were formed from the buds of rhizome renewal, which occurs due to vegetative propagation.

Table 1. Morphological characteristics of *Medicago falcata* L. plants

Characteristics	Mstameadow		Shelonmeadow Soltsydistrict
	Borovichidistrict	Novgoroddistrict	
Bushshape	ascending	semi-loose	semi-erect
Size, cm	12.7±0.23	11.6±0.34	24.9±0.19
Height of plants in the budding phase, cm	73.0± 1.84	90.4± 1.60	83.3± 0.22
Number ofshoots, pcs.	53.2± 0.39	19.7± 0.74	88.8± 2.99
Leafcover, %	46.8	54.4	50.5

Depending on the shape of the bush, age and growing conditions, bushiness varies within a very wide range from 53.2 to 88.8 pieces per plant. Shoots of varying lengths from 73 to 90.4 cm, glabrous and with numerous, from 8 to 10 pieces, internodes. This is the most important morphological characteristic in breeding practice since it is closely related to resistance to lodging. Based on the results of the studies, it was established that the range of variation in the length of shoots indicates the possibility of selecting for the characteristic of stem height and the formation of a pasture or hay type of grass stand.

The basis for selection for elements of seed productivity was the shape of the bush, since it affects the formation of generative shoots, which makes it possible to regenerate the herbage by seed under natural growing conditions (Table 2). Plants growing on the Shelon meadows in the Soltsy region formed shoots with numerous inflorescences and flowers. In terms of the number of beans, the population on the Msta meadow in the Novgorod region distinguished itself, with 4.2 units more compared to the Shelon meadow, but the plants on the latter formed large seeds, the weight of 1000 seeds was 2.14 g.

Table 2. Elements of seed productivity of *Medicago falcata* L. plants

Population	Total inflorescences on shoot, pcs.	Flowersininflorescence, pcs.	Beansininflorescence, pcs.	Seedsperbean, pcs.	Weight of 1000 seeds, g.
Mstameadow Borovichidistrict	12.5±0.2	18.4±0.1	10.5±0.7	5.5±0.2	1.78 ±0.3
Msta meadow Novgorod district	14.9±0.4	16.1±0.4	12.1±0.2	4.6±0.6	1.86 ±0.4
Shelonmeadow Soltsydistrict	22.4±0.2	19.7±0.3	7.9±0.1	4.9±0.2	2.14 ±0.7

We have found that changes in the studied characteristics of seed productivity are associated with the age state of the population and their growing conditions. The number of individuals of the species per unit area did not have a significant effect on the formation of seed yield. In addition, to create high-yielding varieties, selection must be carried out according to the number of beans on the cluster, the number of clusters on the shoot and the number of seeds in the bean; the seed productivity of the varieties depends on all of this.

According to the results of correlation analysis, a positive average relationship was revealed between seed yield and the number of beans on the stem ($r = 0.44$), with the number of seeds in a bean ($r = 0.57$) and with the weight of 1000 seeds ($r = 0.58$).

According to the biochemical composition, *Medicago falcata* L. plants are rich in plant protein, which is well balanced in amino acid composition, so this plant is a valuable high-protein forage crop. In studies conducted by N. A. Karnaukhova et al. [10], in Siberian conditions, *Medicago falcata* L. plants accumulate protein from 17.7 to 18.0%, and in the Novosibirsk region, according to data, its content is about 14.9%. Crude protein is the main source of essential amino acids, the content of which determines the vital activity of farm animals and their productivity. The protein content in dry matter and feed units varies greatly depending on the environmental conditions of growth (Table 3).

Table 3. Dynamics of the chemical composition of the *Medicago falcata* L. plant by vegetation phases

Population	Vegetationphase	Content, % CM			
		crudeprotein	crudefiber	crudeash	crudefat
Mstameadow Borovichidistrict	budding	16.0	14.4	7.3	2.5
	budding-beginningofflowering	15.4	16.6	7.2	2.9
	flowering-formationofbeans	14.1	18.0	7.0	2.3
Msta meadow Novgorod district	budding	18.2	22.0	9.2	2.8
	budding-beginningofflowering	17.4	30.0	8.8	3.1
	flowering-formationofbeans	16.8	38.5	8.0	2.5
Shelonmeadow Soltsydistrict	budding	22.1	19.4	8.6	2.8
	budding-beginningofflowering	17.1	25.2	7.5	3.3
	flowering-formationofbeans	15.7	34.6	6.9	2.9

A high crude protein content of 22.1% was noted in the dry above-ground mass of plants growing On the Shelon meadow in the Soltsy district during the budding phase and 15.7% in the flowering-bean formation phase, which indicates a high protein supply of feed. In the population from Msta meadows, the crude protein content varied from 16.0% to 18.2%, which is higher than the accepted values in domestic practice of feeding farm animals.

A slight increase in the content of crude fiber was noted during the growing season in plants of the Msta meadow in the Borovichi district. Feeding green material high in crude protein and low in crude fiber can cause disease such as tympania in cattle. No significant changes in the content of crude ash and crude fat in the dry above-ground mass of plants were noted.

4 Conclusions

The annual renewal of the *Medicago falcata* L. population was noted on the Shelon meadow, due to the predominance of individuals with root suckers. Root shoots develop from adventitious buds on the lateral roots, with the help of which the selfclone spread and occupied a new territory.

The number of shoots and the percentage of their foliage influenced the chemical composition and quality of the prepared feed. The nutritional value of feed decreases during the phases of plant vegetation, which is associated with an increase in crude fiber content and a decrease in crude protein content. In the population of the Msta meadow in the Borovichi district, the number of vegetative shoots prevailed over generative ones, therefore, a high content of crude protein and a low content of crude fiber were noted, which affects the nutritional value and digestibility of feed in the diet of animals. Therefore, selection for nutritional value must be carried out during the budding phase of *Medicago falcata* L. plants, which will make it possible to prepare more complete and highly nutritious feed for animals.

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