

REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy in Biology

**BIOECOLOGICAL FEATURES AND EFFECTIVE
USE OF THE SPECIES OF VETCH GENUS (*VICIA* L.)
DISTRIBUTED IN AZERBAIJAN**

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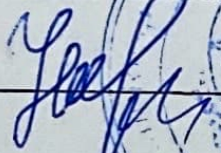
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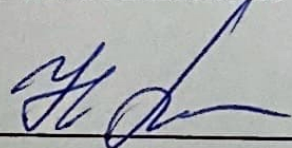
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INTRODUCTION

Relevance and degree of development of the topic. Up to 210 species of the genus *Vicia* L. are distributed in the world flora. Although 41 wild and 1 cultivated species of the vetch plant are reported in the multi-volume work “Plant kingdom of Azerbaijan”¹, and 43 wild and 1 cultivated species in A. Asgarov’s book “Flora of Azerbaijan”², the intraspecies systematics and biomorphological diversity of the genus have not been widely studied, and the species of the genus have not been monographically studied. Herbarium and seed materials for many of these species have not been collected for almost the last 70-80 years.

Considering that the species of the genus are valuable fodder plants and they are included in the list of valuable genera for plant genetic resources by FAO (Food and Agriculture Organization of the United Nations), also, the presence of medicinal, decorative, rare and endangered species among them makes the study of this genus relevant in the territory of the republic.

There is a great need to study the systematics of the genus *Vicia* L. in the flora of Azerbaijan, to determine the effective use of many species of the genus on scientific grounds. The ongoing research work aims to determine the habitat of these species in nature, collect them and find out their biomorphological characteristics, as well as eliminate gaps in the botanical description of the species. For this purpose, expeditions covering more than 30 different regions of Azerbaijan were organized in 2012-2021. During these expeditions, herbarium and seed samples of 22 species were collected, they were determined and their morphological characteristics were analyzed. Since the distribution of some species (*V. caucasica* Ekvtim., *V. amphicarpa* Lam., *V. pilosa* Bieb., *V. serratifolia* Jacq., *V. larissae* Prima.) with inaccurate localities requires clarification, it was considered appropriate to carry out floristic work.

¹ Флора Азербайджана: [в 8-х т.] / -Баку: АН Азерб. ССР, – т. 5, –1954. - 579 с.

² Əsgərov, A. M. Azərbaycanın bitki aləmi: / A. Əsgərov. - Bakı: Teas press, - 2016. -444 s.

Goals and objectives of the research. The purpose is to study the systematics and bioecological features of the species of vetch (*Vicia* L.) of the flora of Azerbaijan, and discovery of ways of their effective use.

For this purpose, the following tasks were performed:

- Identification of morphological and diagnostic features of the genus *Vicia* L.
- Study of the taxonomy of the genus *Vicia* L.
- Determination of bioecological characteristics of the genus *Vicia* L. (distribution depending on the main biotopes, mountain ranges, environmental factors)
- Botanical-geographical analysis of the genus *Vicia* L.
- Ecological assessment of rare and endangered species and study of ways to restore them
- Preparation of proposals on the economic importance of the *Vicia* L. genus species and their effective use.

Research methods. Classical (comparative-morphological, taxonomic, floristic, experimental), as well as modern (statistical) methods were used in the study of species systematics and phylogeny.

Provisions submitted to the defense:

- The new diagnostic signs discovered in the morphological structure (seed) of species and subspecies of the genus are of systematic importance;
- Since the species of the genus are of high feed quality, it is advisable to cultivate them for the organization of an alternative feed base;
- The results and assessments of the 13 rare and endangered taxa of the genus can provide a basis for further research in the conservation and maintenance of the gene pool.

Scientific novelty of the research. For the first time in Azerbaijan, an intraspecific taxonomic synopsis of the genus *Vicia* L. were developed. In the modern flora of Azerbaijan, the genus vetch (*Vicia* L.) consists of 52 taxa belonging to 2 subspecies, 14 sections, including 36 wild and 1 cultural species, 7 subspecies, 8 species

diversity; of these, 7 subspecies were added to the taxonomic composition of the genus given in “Flora of Azerbaijan”. New distribution areas of 2 species and 1 subspecies were identified. The nomenclature of the studied species, range types have been specified, their electronic maps were compiled. Monitoring data obtained on the coordinates and ecological indicators of these species, as well as phytocenological characteristics of the species were used in the comparative-morphological analysis. Phenetic (taximetric) analyzes were performed on the vetch samples using the cluster analysis method. Micromorphological structural features of seeds of 17 species and subspecies were analyzed, diagnostic structural elements important for the systematics of species with disputed status were identified and photographed.

Biochemical indicators were studied in the seeds of selected vetch taxa due to their economic importance, and it was found that the biochemical indicators in 6 seed samples have higher values. The seeds of vetch taxa collected from different areas of Azerbaijan were planted in the experimental area of the Institute of Genetic Resources, phenological observation and structural analysis were carried out on the plants, and the samples were evaluated according to quantitative and qualitative characteristics

Theoretical and practical significance of research. The innovations obtained as a result of the micromorphological, systematic and statistical study of 22 species and subspecies (*Vicia abbreviata* Fisch. ex Spreng. (*V. truncatula* Fisch. ex Bieb.), *V. bithynica* (L.) L., *V. sativa* subsp. *cordata* (Wulfen ex Hoppe) Batt., *V. elegans* Guss., *V. grandiflora* Scop., *V. hirsuta* (L.) S. F. Gray, *V. hybrida* L., *V. lutea* L., *V. monantha* Retz. (*V. cinerea* Bieb.), *V. narbonensis* L. (*V. johannis* Tamamsch.), *V. nissoliana* L. (*V. variegata* Willd.), *V. pannonica* Crantz, *V. peregrina* L., *V. sativa* subsp. *nigra* (L.) Ehrh., *V. sativa* subsp. *sativa* L., *V. sepium* L., *V. tetrasperma* (L.) Schreb., *V. tenuifolia* subsp. *variabilis* (Frey et Sint.) Dinsm., *V. villosa* subsp. *varia* (Host) Corb. (*V. dasicarpa* auct.), *V. loiseleurii* (*V. meyeri*), *V. villosa* subsp. *villosa* Roth) of the vetch genus (*Vicia* L.) can be used in the preparation of a monograph

on this genus, in the development of the morphological description of those species in the new edition of the multivolume “Flora Azerbaijan”, as well as in textbooks and teaching aids on botany.

13 species of the genus were identified as rare and endangered, their ecological assessment was carried out, and electronic maps were compiled. Proposals prepared on their protection can be submitted to the Ministry of Ecology and Natural Resources of Azerbaijan, as well as to the next new edition of the “Red Book of the Republic of Azerbaijan”.

Herbarium samples of vetch genus collected during field research were handed over to the Herbarium Funds of the Institute of Botany and Institute of Genetic Resources of MSE RA and seed samples handed over to the Genbank of the Institute of Genetic Resources of MSE RA which played a certain role in their enrichment.

Approbation and application. The main provisions of the dissertation work and important scientific results obtained are presented in a number of republican and international scientific practical conferences: at the II International Scientific Conference on “Problems of Nature and Society” of Baku State University (Baku, 2012); at the international scientific conference “Actual problems of modern natural and economic sciences” of Ganja State University (Ganja, 2018); at the VIII International scientific conference on “Autumn Scientific Readings” held in Ukraine (Kiev, 2019), at the general meeting of the Institute of Genetic Resources MSE RA and the scientific seminar of the Institute of Botany, MSE RA.

10 scientific articles and 2 theses reflecting the main provisions of the dissertation were published, of which 3 articles (2 included in international indexed databases) and 1 thesis were published abroad.

The organization where the dissertation work was performed. It was carried out in the Department of Ecobotany and Systematics of the Institute of Genetic Resources, MSE RA.

Structure and scope of the dissertation. The total volume of the work is 185 pages of computer writing, written in the Azerbaijani language. The dissertation consists of an introduction, 8 chapters, results, suggestions and recommendations, appendices, and a list of

165-titled literature. The total volume of the dissertation with characters is 217733 characters (introduction-6843, Chapter I - 21596, Chapter II -6688, Chapter III - 26557, Chapter IV-114308, Chapter V-6611, Chapter VI-2999, Chapter VII-15531, Chapter VIII- 13622, results- 2152, recommendations - 826). The work contains 17 tables, 44 map-schemes and 53 figures.

CHAPTER I. LITERATURE REVIEW ON THE STUDY OF *VICIA L.* GENUS

Vetch (*Vicia L.*) is one of the most widespread genera of the legume family (*Fabaceae* Lindl) of dicotyledonous class (*Dicotyledonae*). Species included in the genus are distributed in the northern temperate hemisphere, including in Azerbaijan from the lowlands to the middle mountain belt.

Although the idea of systematizing plants dates back to ancient times (Plant Studies, Theophrastus, circa 372-287 BC), it emerged as a science after the work of D. Ray (1686-1704) and C. Linnaeus (1735 and later). The genus *Vicia* was first described by C. Linnaeus (1735).

Although the classical botanists of the Caucasus like M. Bieberstein, F. Hohenacker, K. F. Ledebour, K. Koch, E. Boissier, G. Radde, V. I. Lipskij as well as A.M. Askerov expressed interesting views on the genus of *Vicia L.*, its classification, Azerbaijani species, B. Fedchenko gave the first comprehensive system of this genus in the "Flora of the USSR"³.

The only taxonomic study on the whole genus at the global level was conducted by F. K. Kupicha^{4,5}.

CHAPTER II. MATERIAL AND METHODS OF RESEARCH

³ Флора СССР: [в 30 - х т.] / - Л: Изд. АН СССР, - т.13. - 1948. - 588 с.

⁴ Kupicha, F.K. Observations on the vascular anatomy of the tribe *Vicieae* (*Leguminosae*) // - London: Botanical Journal Linnean Society, - 1975.V.70, p. 231-242.

⁵ Kupicha, F.K. The infrageneric structure of *Vicia* // - Edinburgh: Notes Royal Botanic Garden, - 1976. Vol. 34, - pp. 287-326.

The material for the research was herbarium and embryonic plasma materials collected in 2012-2021 under special expedition routes organized in different regions of Azerbaijan under the leadership of A.M. Asgarov.

During the research, materials related to 22 species and subspecies of the genus vetch were collected. The collected herbarium materials are stored in the Herbarium fund of the Institute of Genetic Resources of MSE RA. In addition, as a research material, the collections stored in the Herbarium funds of the Institute of Botany (BAK), the Institute of Genetic Resources (AGRI) of MSE RA and Institute of Botany (TBI) of the Republic of Georgia (Tbilisi) to clarify the status of some taxa were studied. Extensive literature and internet data were analyzed.

The methodology of the Union for the Protection of the Environment was used in the assessment of rare and endangered species, the categories and criteria given in the International "List List"⁶ are taken as a basis.

Classical (comparative-morphological, taxonomic, floristic, phytocenological, experimental), as well as modern (statistical) methods were used in the study of species taxonomy.

During the bioecological analysis, the structure of biotopes, ecological groups of species were studied, I. Serebryakov's⁷ system were used to determine the life forms of the species and L.I. Prilipko's⁸ division to study the regularity of distribution depending on the altitude.

Vetch species collected from different areas of Azerbaijan were planted in the experimental field of the Institute of Genetic Resources, biomorphological observation and structural analysis

⁶ Red List of the endemic vascular plants of the Caucasus. Plant life of South West Asia, 2013, 8 p. 21.

⁷ Серебряков, И.Г. Жизненные формы высших растений и их изучение (Полевая геоботаника): [в 3 - х т.] / И.Г.Серебряков, – М.- Л.: Изд. АН СССР, – 1964. - т. 3, - 181 с.

⁸ Прилипко, Л.И. Лесная растительность Азербайджана / Л.И. Прилипко. - Баку: АН Аз. ССР, - 1954. - 488 с.

were carried out on plants, samples were evaluated for quantitative and qualitative characteristics (Experimental method).

Phenetic (taximetric) analyzes were carried out on the vetch samples collected during the expeditions in 2015-2017 using the cluster analysis method.

The analysis were performed using the SPSS Win (SPSS ver. 16.0) program (Statistical method).

Information on the amount of annual precipitation and temperature in the study areas (minimum temperature for T_{\min} -month, maximum temperature for T_{\max} -month and average annual temperature for T_{aa}) was obtained through the PAST program.

Hypsometric height and range coordinates were measured with a Garmin eTex 20 model GPS device.

The recommendations of the latest version of the Higher Plant Taxonomy “APG IV”⁹ and the International Congress of Botany (Austria, Vienna, 2005) have been taken into account in clarifying the nomenclature issues (the Code was published in 2009).

In the definition of species and clarification of their nomenclature the books “Flora of Azerbaijan”¹, “Flora of the Caucasus”¹⁰, “Flora of the USSR”³ and A. Asgarov’s books² were used.

The distribution of vetch species is shown on the botanical-geographical regions of Azerbaijan, adopted in the works “Flora of Azerbaijan”¹ and A. Asgarov’s “Flora of Azerbaijan”². Ranges were specified on the basis of herbarium fund materials.

CHAPTER III. MORPHOLOGICAL CHARACTERISTICS OF SPECIES OF *VICIA* L. GENUS

3.1. General morphological structure of vetch species. The stem is slender or filamentous, dense or sparsely hairy on the outside,

⁹ An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV // Botanical Journal of the Linnean Society, - 2016. 181 (1). - p. 1–20.

¹⁰ Флора Кавказа: [в 7 - х т.] / - Москва-Ленинград: Изд. АН АЗССР, - т.5. – 1952. - 453 с.

and sometimes almost bare, straight rising or creeping on the ground. The leaves are bipinnate, ending with a more or less branched tendrils or a acuminate (*V. abbreviata*, *V. ervilia*), sometimes ending with a single leaf. The shape of the leaflet is important for classification. The species of vetch genus have 5 different leaflet shapes: oblong, elliptical, linear, ovate and obovate.

The flowers of the representatives of the genus are butterfly-shaped. These flowers consist of three types of petals: one petal at the back (standard, called a banner), two at the side (wing) and two at the front (keel).

Calyx has different forms in different species. The calyx is 5 dentated, usually the lower 3 dentates are significantly longer than the upper 2 dentates. This is the inclined shape of the calyx (uneven dentates).

The shape of the calyx is of diagnostic importance in the grouping of the species of genus *Vicia* L., as well as in the development of determinant keys.

The corolla resembles the structure of an ordinary butterfly. 9 adjacent stamens form a tube, and 1 is free. The banner is not clearly described unguiculate, the wings are almost equal to the calendula, the keel is blunt, shorter than the banner, sometimes the same length. The tube formed by the stamens and the pistil inside it are located inside the keel, which causes the pollen to spread through the insects. The presence of colorful flowers attracts insects.

In many species of the genus, the legume is elongated – linear (*V. cappadocica*, *V. ervilia*, *V. narbonensis*, *V. monantha*). Other groups have narrow oblong (*V. abbreviata*), oblong-rhombic (*V. hybrida*) and oblong-semi-rhombic (*V. anatolica*); wide-linear (*V. grandiflora*) and linear (*V. lathyroides*, *V. sativa*) legume forms. Another distinguishing feature is that the legume is smooth or hairy.

Cytological studies show that different species of the genus have $2n = 10, 12, 14, 16, 18, 28$ sets of chromosomes.

3.2. Micromorphological structure of seeds of vetch genus species and its taxonomic importance. Seeds can be used as an important trait in the grouping of species. Two main characteristics

of the seed are important in the intrageneric classification of vetch genus. One is the length of the hilum (seed navel) and the other is the sculpture of the seed surface. The length of the hilum varies in size in vetch species: 1/16 to 3/4 of the seed¹¹. Perennials have long and annuals have a short navel-hilum. However, some annuals (for example, *V. grandiflora*) have long hilum.

In 2011-2017, the micromorphological structural characteristics of seeds of 17 species and subspecies of vetch (*V. bithynica*, *V. sativa* subsp. *cordata*, *V. elegans*, *V. hirsuta*, *V. hybrida*, *V. loiseleurii*, *V. lutea*, *V. monantha*, *V. narbonensis*, *V. pannonica*, *V. peregrina*, *V. sativa* subsp. *nigra*, *V. sativa* subsp. *sativa*, *V. tenuifolia* subsp. *variabilis*, *V. tetrasperma*, *V. villosa* subsp. *varia*, *V. villosa* subsp. *villosa*) collected from different regions of Azerbaijan were analyzed, diagnostic structural elements important for the systematics of species with disputable status were identified and photographed¹².

Vicia sativa subsp. *cordata* Wulf. ex Hoppe subspecies - seeds black, round, size 1.991 x 1.614 mm; the seed surface is papillate, the papilla is densely located, the shape of the papilla is conical, multi-sectioned, the top is waxy, the shape of the hilum is oblong-oval, the size is 0.938 x 0.298 mm (fig. 1. a-b-c). *V. sativa* subsp. *nigra* (L.) Ehrh. subspecies, the shape of the seed is spherical, the size is 2.422 mm in diameter, dark brown, spotted; the seed surface is papillate, the papillae is closely arranged, the shape of the papilla is conical, multi-sectioned, the top is waxy, the shape of the hilum is oblong-oval, the size is 1.503 x 0.437 mm (Fig. 1. d-e-f). *V. sativa* subsp. *sativa* L. subspecies - seed flat globose, size 4.150 x 2.678 mm; brown, velvety; the seed surface is papillate, the papilla is densely located, the shape of the papilla is conical, multi-sectioned, the top is

¹¹ Asadova, K.V., Asgarov, A.M. Micromorphological structure of seeds in some taxa of *Vicia* L. (*Fabaceae*) occurring in Azerbaijan // - Baku: Plant & Fungal Research, - 2018, 1(1), - p. 43-51.

¹² Asadova, K.V., Asgarov, A.M. Micromorphology of seed in some *Vicia* taxa belonging to section *Crassa* from Azerbaijan // - Крым: Бюллетень ГНБС, - 2020. Вып. 134, - с. 17-23.

waxy, the shape of the hilum is oblong-oval, the size is 1.961 x 0.425 mm (Fig. 1. g-h-j).

All three samples (*V. sativa* subsp. *cordata*, *V. sativa* subsp. *nigra* and *V. sativa* subsp. *sativa*) belong to *Sativa* section.

Vicia hybrida L. species – seeds are circular, brown- marble-like, with dark spots, size 4,946 x 3,768 mm; the seed surface is papillate, the papilla is densely located, the shape of the papilla is conical, multi-sectioned, the shape of the hilum is elliptical, the size is 2.977 x 0.591mm (fig. 2. a-b-c).

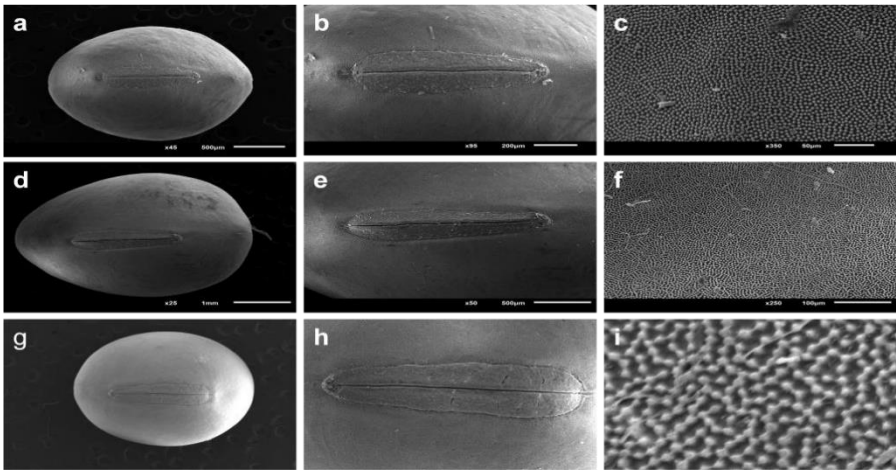


Figure 1. General view of vetch seeds, shape of hilum and structure of seed surface under SEM microscope a-b-c: *V. sativa* subsp. *cordata*; d-e-f: *V. sativa* subsp. *nigra*; g-h-i: *V. sativa* subsp. *sativa*

V. lutea L. species - the shape of the seeds is compressed, black-brown, slightly marble-shaped, the size is 4,017 x 2,325 mm; the seed surface is papillate, the papilla is densely located, the shape of the papilla is conical, multi-sectioned, the top is waxy, the shape of the hilum is elliptical, the size is 1.923 x 0.522 mm (Fig. 2. d-e-f). *V. pannonica* Crantz. species seeds spherical, the size is 4.138 mm in diameter, black-velvet in color, the seed surface is papillate, the papilla is densely located, the shape of the papilla is conical, multi-

sectioned, the shape of the hilum is elliptical, the size is 2.243 x 0.569 mm (Fig. 2. g-h-i).

All of three samples (*V. hybrida*, *V. lutea*, *V. pannonica*) belong to *Hypechusa* section.

The dissertation provides detailed micromorphological analyzes of seeds of all other taxa.

The results of the study showed that the microscopic examination of the seed surface plays an important role in systematics and can be used to clarify the status of subgenus and sections. General seed characteristics (shape, color, seed size) are considered valuable in identifying other taxa.

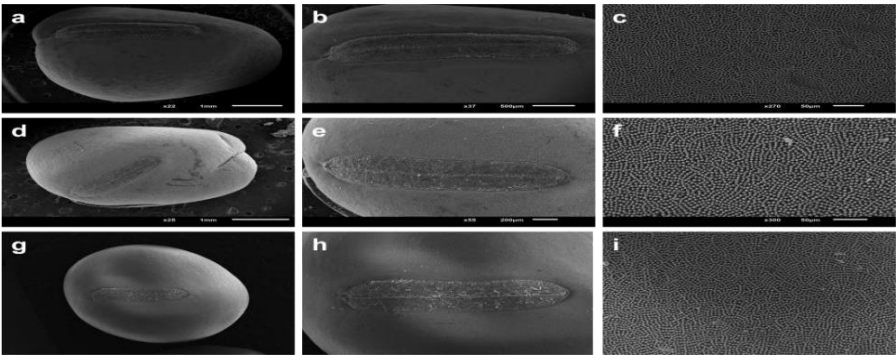


Figure 2. General view of vetch seeds, shape of hilum and structure of seed surface under SEM microscope a-b-c: *V. hybrida*; d-e-f: *V. lutea*; g-h-i: *V. pannonica*

CHAPTER IV. SYSTEMATICS OF SPECIES OF VETCH (*VICIA L.*) GENUS IN AZERBAIJAN

4.1. General information about the systematics of vetch species. The exact number of vetch genus (tribe *Fabeae* Rchb.= *Vicieae* Bronn, family *Fabaceae*) species has not yet been determined. This is due to the lack of a complete monograph in recent years, as well as due to the existence of different types of concepts that differ in flora and regional changes.

The comprehensive classification of the genus was done according to the different signs: the relative length of the peduncle (flower axis) and the number of flowers in the inflorescence, as well

as the location of the hilum on the seeds, the ratio of the location of the hilum around the seed to the micropyle, the size of the seed, the color of the hilum, the structure of the leaflet margins, the presence or not of nectaries on the base of the leaves, etc.

The genus vetch is distributed in temperate regions of Europe, Asia, North America, South America and tropical Africa. The greatest species diversity of the genus can be found in the Caucasus and Mediterranean regions.

4.2. Taxonomic review of genus. It was determined that in the flora of Azerbaijan, the genus *Vicia* L. is represented by 2 subgenera, 14 sections and 52 taxa (36 wild and 1 cultivated species, 7 subspecies, 8 variations)^{13, 14}.

This section describes the general morphological characteristics of genus and subgenera; nomenclature, description, nomenclature type, distribution in Azerbaijan and map, biotope, distribution in the Caucasus, general distribution, range type and number of chromosome of each species and subspecies are noted.

Sect. *Hypechusa* (Alef.) Aschers & Graebner

Lectotypus (Gunn, 1969): *V. lutea* L. Sp. Pl. 736 (1753).

V. pannonica Crantz, *V. pannonica* Crantz, 1769, Stirp. Austr., ed. 2, 2: 393; Fedchenko 1948, in Fl. USSR, XIII: 470; Grossheim 1949, Definition of Plants of the Caucasus: 154; Grossheim. 1952, Flora of Caucasus, 5: 384; Tamamshyan 1954, Flora of Azerbaijan, 5: 483; Tamamshyan 1962, Fl. Arm., 4: 289; P. W. Ball, 1968, Fl. Europ. 2:134; Plitmann 1970, in Davis, Fl. Turkey, 3: 314; Stankev. 1976, News of taxonomy of higher plants 13:204; Galushko 1980, Flora of the North Caucasus 2: 168; Khintibidze 1981, Flora of Georgia 7: 451; Tsvelev 1987, Fl. European parts of the USSR, 6: 142; Asgerov 2006, Higher plants of Azerbaijan, 2: 124; same, 2011,

¹³ Əsədova, K.V. Böyük Qafqazın mərkəzi hissəsinində yayılan Lərgə (*Vicia* L., *Fabaceae* Lindl) cinsi növlərinin taksonomiyası və bioekoloji xüsusiyyətləri //Ekologiya: Təbiət və cəmiyyət problemləri mövzusunda II Beynəlxalq Elmi Konfrans, - Bakı: *Bakı Universiteti*, - 7 noyabr - 8 noyabr, 2012, - s. 384-385.

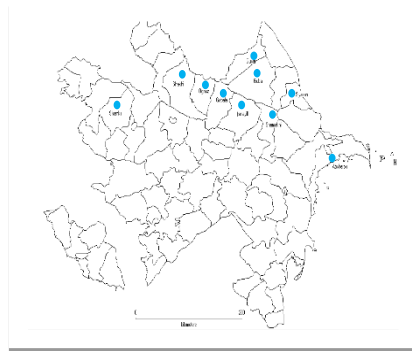
¹⁴ Əsədova, K.V. Azərbaycan florasının *Vicia* L. cinsi haqqında // Bakı: AMEA Genetik Ehtiyatlar İnstitutunun elmi əsərləri, - 2015. C.V, - s. 158-161.

Conspectus of Azerbaijan Flora: 99; same, 2016, Plant kingdom of Azerbaijan: 261. - Pannon 1. (Fig. 3; map-scheme 1)

Botanical description: Annual, 60-70 cm tall, is a soft-hairy plant. The stem is branched at the base, creeping or straight rising. There are 6-9 pairs of leaflets in leaves, ends with tendrils. The leaflets are linear or oblong, narrowed below, cut at the top, slightly deep hollowed and sharply protruding, 12-20 mm long and 2-4 mm wide. The surface of young leaflets is very hairy. In mature forms, the hairiness of the upper surface is reduced. The stipula is small, 3-4 mm in size and semi-axial. The flowers locate in bents, on a short stalk, 2-4 in number. The calyx is curved, with uneven dentated. The corolla is 20-22 mm long, yellowish, brighter yellow than the lower part. The banner is dark-veined, covered with dense, long fibrils. The beans are bent down, stretched at both ends, brown, dense, appressed soft fibrilous, 3-8 seeded. The seeds are spherical, slightly faceted, black-velvety, hilum is narrow and short.^{15, 16}



Figure 3. *V. pannonica*
(Pannon 1.)



Map-scheme 1. Distribution of
V. pannonica

¹⁵ Əsədova, K.V. Abşeronda yayılan Lərgə (*Vicia* L.) növlərinin taksonomik tərkibi, yayılması və istifadəsi imkanları // Bakı: AMEA Genetik Ehtiyatlar İnstitutunun elmi əsərləri, - 2017. C.VI, №1-2, - s. 167-173.

¹⁶ Əsədova, K.V. Azərbaycanda Lərgə (*Vicia* L.) cinsinin *Cracca* yarımcinsinin taksonomik icmalı // Bakı: Azərbaycan Milli Elmlər Akademiyasının Gəncə bölməsinin “Xəbərlər” məcmuəsi, - 2018, - s. 3-8.

Phenology: Flowering in May-June, fruiting in July.

Biotope: Up to the middle mountain ranges. It grows among crops, meadows and forests, grassy slopes, bushes, at an altitude of 15-2000 m above sea level.

Nomenclature type: Austria (“Ex confinio Austriae versus Hungariam ad vinearum aggeres crescentem”).

Distribution in Azerbaijan: Gobustan-Alazan-Ayrichay-Kura plain- West of the Greater Caucasus- North of the Lesser Caucasus- Center of the Lesser Caucasus- South of the Lesser Caucasus - Nakhchivan mountain- Lankaran mountain.

During the expeditions, herbarium and seed material were collected from Absheron, Gobustan, Siyazan, Guba, Gusar, Shamakhi, Oguz, Sheki, Gabala and Ismayilli districts.

Distribution in the Caucasus: Around the Kabris

General distribution: Crimea, southern Europe, Central Europe (south), Mediterranean, Balkan-Asia Minor, Arm.-Kurd., Iran. $2n = 12, 14$

Geographical area type: Pannon

CHAPTER V. BIOCEOLOGICAL CHARACTERISTICS OF SPECIES OF *VICIA* L. GENUS

5.1. Distribution of species by height. Vetch species are distributed in different mountain ranges - low, medium, high, subalpine and alpine. Annual and biennial species are found in the lower mountain belts, while perennials are found in different belts. Depending on the altitude, during the study of the regularity of distribution, L.I. Prilipko's division was used⁹ (Tab. 1.).

Table 1.

Distribution of species depending on altitude

Belts	Number of species	by %
Plain (up to 400 m)	9	15
Low mountain belt (500-1000 m)	11	19
Middle mountain belt (800-1800 m)	24	41
Subalpine and alpine belt (1900-2400 m)	7	12
High mountain belt (2400-3400 m)	8	14

Vetch taxa are found from the lowland (Lankaran lowland, Samur-Shabran lowland, etc.) to the high mountain belt (at an altitude of 2500 m above sea level).

As can be seen from the table, most taxa are distributed in the middle mountain range (41%). It should be noted that one taxon can be distributed in several mountain belts.

According to I.G.Serebryakov system⁸ vetch species are considered to be annual, biennial and perennial herbs. Most taxa belong to the annual group (27 taxa).

5.2. Ecological groups of taxa. According to the degree of humidity of biotopes, vetch taxa of the Azerbaijani flora are divided into 3 ecological groups: 1. Mesophytes - vetch that love moisture. 2. Xerophytes - drought-loving vetch. 3. Mesoxerophytes - vetch that occupy an intermediate position. The species of vetch (*Vicia* L.) distributed in Azerbaijan are mainly forest plants.

The distribution of vetch taxa by ecological groups is summarized in the diagram below (Fig. 4.).

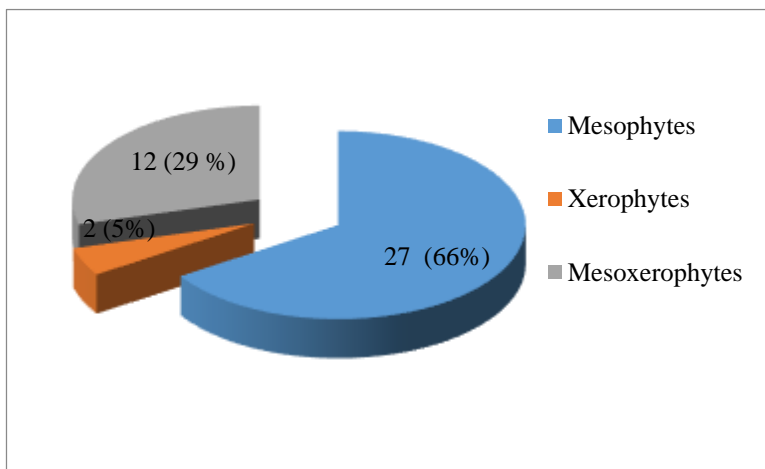


Figure 4. Distribution of taxa by ecological groups

As can be seen from the diagram, most taxa belong to the mesophyte group (22 taxa, 66%).

5.3. Assessment of biomorphological diversity of species.

Significant changes in the biomorphological structure of the species were observed under the influence of environmental factors. For phenetic (taximetric) analysis of vetch, samples belonging to 18 species and subspecies collected by us on 38 routes in 2015-2017 were selected. At least 2-3 samples were taken from each population and the average value was calculated by measuring the parameters. Each population is referred to as the Operational Taxonomic Unit (OTU). For biomorphological analysis, 33 quantitative and qualitative characteristics (plant height, number, length, width of leaflets; number, length, width of beans; number of seeds, flower color, bean shape, seed color and shape, etc.) were selected. Based on the results obtained, taximetric analysis was performed using the Cluster Analysis method (Fig.5).

The analyzes were performed using SPSS Win (SPSS ver. 16.0)¹⁷.

During studies *V.sativa* subsp. *sativa* was collected from Masallı district, Sharafa village area (-15 m) on *min* height, *V. peregrina* from Lerik district, Mıstan village (1723 m) and *V.elegans*, *V.loiseleurii*, *V.Nissoliana* from Ordubad district, Paragha village (1644 m) on *max* height.

Species are grouped into 4 main clusters:

The first main cluster is divided into 12 groups: *V. tenuifolia* subsp. *variabilis* (Z02, Z7, E8) belong to *Cracca* section (according to Radji, Fedchenko systems); *V. narbonensis* (K20) to *Faba* section, *V. villosa* (Z3), *V. sativa* subsp. *sativa* (Q2, K14, A1-1) to *Vicia* section, *V. lutea* (C4, K18), *V. pannonica* (Z4) - *Hypochusa* and *V. abbreviata* (Z11) - *Atossa* section (according to Kupicha).

The second main cluster included 4 samples: *V. monantha* (A1, A1-2, K9), *V. nissoliana* (E1-2) belong to *Cracca section* (according to Rajji and Kupicha).

¹⁷ Асадова, К.В., Аскеров, А.М. Биоморфологическая оценка некоторых таксонов вики (*Vicia* L., *Fabaceae* Lindl.), распространенных в Азербайджане // Крым: Ученые записки Крымского федерального университета имени В. И. Вернадского Биология. Химия, - 2021. Т. 7 (73), № 1, - с. 14–25.

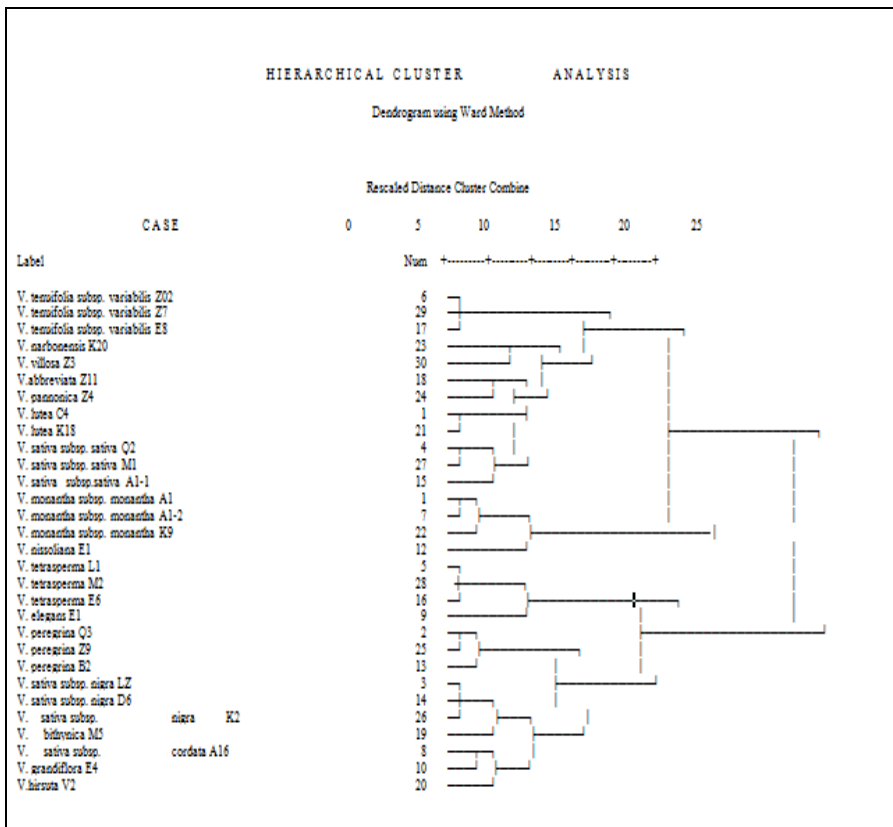


Figure 5. Single Correlated Cluster analysis of morphological characters in *Vicia* L. taxa

Four samples are grouped in the third main cluster: *V. tetrasperma* (L1, M2, E6) belong to *Ervum* section; *V. elegans* (E1-1) - *Cracca* section (according to Rajji and Kupicha).

The fourth main cluster included 10 samples: *V. peregrina* (Q3, B2, Z9) belong to *Peregrinae* section, *V. sativa* subsp. *nigra* (LZ, D6, K2) to *Vicia* section; *V. bithynica* (M5) - *Faba* section; *V. sativa* subsp. *cordata* (A16), *V. grandiflora* (E4) – *Vicia* section and *V. hirsuta* (V2) - *Cracca* section (according to Kupicha).

Species are also grouped according to their morphological and ecological parameters. Some samples located in the first cluster are

mesophytic and annual: *V. narbonensis* (K20); *V. villosa* (Z3); *V. sativa* subsp. *sativa* (Q2, K14, A1-1); *V. lutea* (C4, K18), *V. pannonica* (Z4); others are mesoxerophytic and perennial: *V. abbreviata* (Z11), *V. tenuifolia* subsp. *variabilis* (Z02, Z7, E8).

Some samples grouped in the second cluster are xerophytes and annuals: *V. Monantha* subsp. *monantha* (A1, A1-2, K9), but another sample is mesoxerophytic and perennial - *V. nissoliana* (E1-2).

In the third cluster, 3 samples are mesophytic and annual - *V. tetrasperma* (L1, M2, E6), another example is xerophyte and perennial - *V. elegans* (E1-1).

In cluster 4, 7 samples are xerophytic and annual - *V. eregrina* (Q3, B2, Z9), *V. sativa* subsp. *nigra* (LZ, D6, K2), *V. hirsuta* (V2); the other 3 samples are mesophytic and annual - *V. bithynica* (M5), *V. sativa* subsp. *cordata* (A16), *V. grandiflora* (E4).

It was determined that 4 main clusters differ from each other according to 4 characteristics: plant height, number of leaflets, number of seeds in a bean and ecological groups of species.

CHAPTER VI. BOTANICAL-GEOGRAPHICAL ANALYSIS OF SPECIES OF GENUS VETCH (*VICIA L.*)

6.1. Distribution characteristics of vetch species (*Vicia L.*)

General distribution features of vetch species are carried out according to the scheme "Botanical-geographical zoning of Azerbaijan": 1. Greater Caucasus (within Azerbaijan), 2. Lesser Caucasus, 3. Kur-Araz, 4. Lankaran-Astara, 5. Nakhchivan. Distribution in the Caucasus is given based on the zoning scheme adopted in A. Grossheim's "Caucasian flora"¹⁴, and its distribution in the world based on the zoning scheme shown in the flora of the European part of the USSR¹⁸.

The results of our research show that vetch species are more common in the Greater Caucasus region of Azerbaijan (34 species). There are 27 species in the Lankaran-Astara region, 26 in the Lesser Caucasus, 24 in Nakhchivan and 12 in the Kur-Araz region.

¹⁸ Флора Европ. части СССР: [в 10 - х т.] / - Л: Наука, - т. 6. - 1987. - 254 с.

In determining the geographical types of vetches of the flora of Azerbaijan, geographic types from “Flora of Caucasus”¹⁴ by A.A.Grossheim and “Flora of Turkey”¹⁹ were used.

The International Legume Database Information Service and et c. (ILDIS) was used to clarify the general distribution of species²⁰.

New distribution areas of 2 species and 1 subspecies were identified: *V. lutea* (Absheron district, Novkhani village, miscellaneous herbs), *V. loiseleurii* (Ordubad, Paraga village, around the mountain). A new distribution area of *V. pannonica* subsp. *striata* subspecies for Azerbaijan were discovered: *V. pannonica* subsp. *striata* (M.Bieb.) Shmalh.- Purple-flowered pannon vetch. Shamakhi district, Mirzandiya village, meadow (23.V. 2017. Leg.: K. V. Asadova) N 40°34'737; E 48°43'648; H 584 m. (Fig.6).



Figure 6. *V. pannonica* subsp. *striata* (M.Bieb.) Shmalh.

CHAPTER VII. RARE, ENDEMIC SPECIES OF VETCH GENUS (*VICIA* L.), PROPOSALS FOR THEIR PROTECTION

7.1. General information about rare, endangered and endemic species. The main threat to biodiversity is the destruction

¹⁹ Davis, P.H., Plitmann, U. *Vicia* L. Flora of Turkey and the East Aegean Islands // - Edinburgh: Edinburgh University Press, - 1970. Vol. 3. - pp. 274- 325.

²⁰ ILDIS. International Legume Database and Information Service, 2010, <http://www.ildis.org/>

and fragmentation of habitats. For this reason, many species are at risk and their numbers are declining.

As a result of the rapid population growth in our country, many natural habitats have been destroyed and their area reduced. According to the latest research, currently about 20 percent of the flora of Azerbaijan, ie 800-900 plant species need protection⁶. The “Red Book of Azerbaijan” does not contain many rare and endangered species²¹.

The most important way to conserve biodiversity is to assess the conservation status of plant species.

7.2. Ecological assessment of vetch species. Based on our observations, some assessments have been made about the susceptibility of the species of genus *Vicia* L. A 9-point category developed by the International Union for Environmental Protection (IUCN) is used⁶ to identify rare and endangered species, and the works of foreign and local authors were analyzed²².

As a result of the study of the genus vetch in Azerbaijan in 2012-2019, information on rare and endangered species of this genus was collected. As a result of the study, the conservation status of 13 species of the genus vetch was assessed. A range map was developed using the DIVA-GIS program (map-scheme 2).

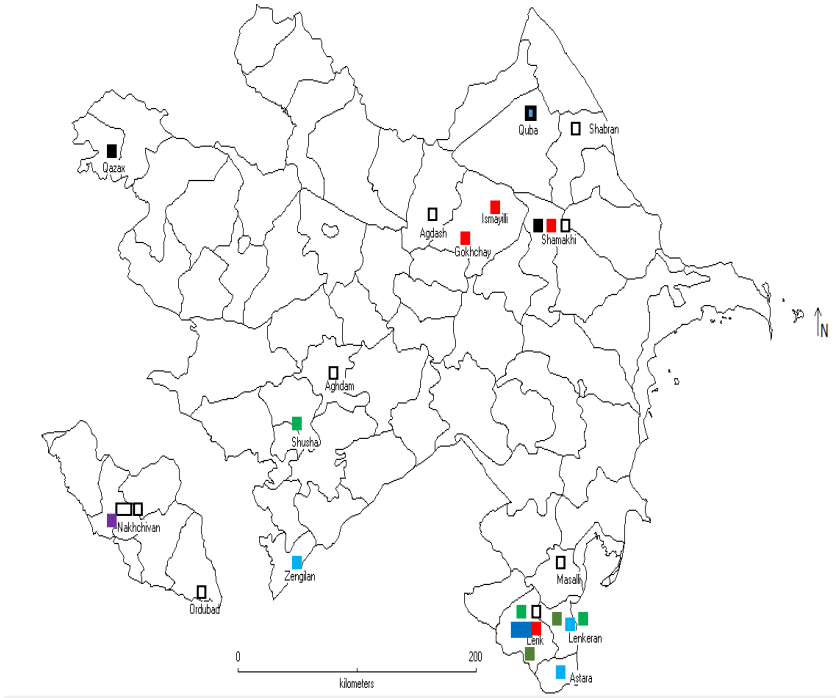
It was determined that 5 taxa under critical threat belong to DD, 3 to CR, 1 to EN and 4 to VU category. Grazing, constructions, land clearing and urbanization have been identified as the main threats to this genus.

V. ciceroidea Boiss. (*V. rafigae* Tamamsch.) – (subendemic). It is a perennial herb with a height of 40-50 cm. Flowering occurs in July and fruiting in July-August months. It is known to occur in the mountainous area of Nakhchivan in the upper mountain belt, on the southern stony slope. Described from Nakhchivan (Paragha). Herbarium information: Collected from Ordubad district, Paragha

²¹ Azərbaycan Respublikasının Qırmızı kitabı. Nadir və nəsli kəsilməkdə olan bitki və göbələk növləri: [2 cilddə] / Bakı: - İlc., - 2013, - 673 s.

²² Binzat, O.K.. Revision of *Vicia* L. (*Leguminosae*) in the Central Anatolia // - Turkey: PhD thesis, - 2012. - p. 81-84

village by I. Hajiyeu in 12.07.1939. The type is preserved in the Herbarium fund of the Institute of Botany. The search for the species during the expeditions did not give positive results. Due to the distribution of the population of this species in a limited range and the disturbance of the territory due to the influence of the anthropogenic factor, it belongs to the VU category.



Map-scheme 2. Habitat map of rare, endangered and endemic species based on literature and reserve data

- /- *V. ampicarpa*; /- *V. anatolica*; ○ *V. antiqua*; ● *V. ciliatula*;
 ◆ - *V. ciceroides*; ◇ - *V. iberica*, ■ - *V. johannis*, □ - *V. loiseleurii*,
 △ - *V. hyrcanica*, ▲ - *V. lathyroides* ★ - *V. pilosa* ✦ - *V. larissae*,
 ✕ - *V. hololasia*

CHAPTER VIII. IMPORTANCE, EFFICIENT USE, PRODUCTIVITY OF VETCH GENUS SPECIES IN AZERBAIJAN

8.1. Chemical composition, economic importance and possibilities of use of species of vetch genus (*Vicia* L.). In order to meet the food needs of the world's growing population in recent years, there is a need for a comprehensive study of agricultural crops. This need also falls on grain legumes. The representatives of vetch genus are one of the most widespread grain legumes in the world. It is considered expedient to study the chemical composition of some important species of genus, to determine their economic significance and to study the ways of their use.

Species of vetch genus are distinguished by nitrogen fixation properties. Thus, the roots of the vetch plant contain nitrogen-fixing bacteria that form root nodules, which absorb free nitrogen from the air and convert it into a mineral form that plants can use. During the vegetation period, vetch plant secrete these minerals into the soil through their roots, which enriches the soil microflora and gives it fertility. Due to this, the productivity of plants planted in the soil after the end of the vegetation period increases and the quality of the product rises. This is a valuable fodder plant, the dry and green mass of which is readily eaten by animals.

Because vetch seed is a very rich source of protein, the biochemical characteristics of some important vetch seeds have been studied (Tab. 2) .

As can be seen from the table, the biochemical parameters had different values depending on the growing conditions and genotypes.

The results showed that vetch samples distinguished with high biochemical characteristics can be used as a starting material for future breeding work due to their economic value.

Table 2.

Biochemical indicators in vetch seeds collected from different areas

N	Sample code	Sample collection location	in% of dry matter		In mg in 100 g
			Total nitrogen	Protein	Tryptophan
1	<i>V. sativa</i> subsp. <i>nigra</i> (L.) Ehrh. – Black vetch				
	AZE17Z3	Gabala district, Kichik Pirali village	3,99	24,93	210
2	<i>V. sativa</i> subsp. <i>sativa</i> L. – Spring vetch				
	AZE17KS18	Shamakhi district, Madrasa village	4,11	25,68	215
3	<i>V. pannonica</i> Crantz- Pannon vetch				
	AZE17K20	Shamakhi district, Mirzandiya village	4,29	26,81	220
4	<i>V. bithynica</i> (L.) L.- Bithynian vetch				
	AZE17M6	Masalli district, Gizilaghaj village	4,37	27,31	155
5	<i>V. lutea</i> L.- Yellow vetch				
	AZE17Z9	Gabala district, Amirvan village	3,69	23,06	145
6	<i>V. monantha</i> Retz.- One-flower vetch				
	AZE16D6	Shamakhi district, Shamakhi-Agsu road	4,52	28,25	180

8.2. Assessment of productivity of vetch (*Vicia* L.) samples collected from different eco-geographical regions. In 2015-2017, research works were carried out in the Absheron experimental field of the Institute of Genetic Resources of MSE RA on samples of vetch (*V. sativa* subsp. *nigra*-2 samples, *V. ciliatula*-1, *V. cinerea*-1, *V. hirsuta*-1, *V. loiseleurii*-1, *V. sepium*-1, *V. pannonica*-3, *V. sativa* subsp. *sativa*-2, *V. villosa* subsp. *villosa* -1, *V. tenuifolia* subsp. *variabilis*-2 samples) collected from different territories of Azerbaijan during expeditions.

During the 3-year research, biomorphological observation and structural analysis of plants were carried out, samples were evaluated for quantitative and qualitative characteristics. Biomorphological indicators of the samples were noted, the percentage of flowering and bean formation was calculated.

The results of the study show that it is expedient to use samples of vetch growing in different eco-geographical conditions and with different biomorphological features as donor forms in the creation of new productive varieties in future breeding works.

RESULTS

1. For the first time, a synopsis of the genus vetch (*Vicia* L.) distributed in Azerbaijan was developed. It was determined that in the modern flora of Azerbaijan, the genus vetch (*Vicia* L.) is represented by 2 subgenera, 14 sections and 52 taxa (36 wild and 1 cultivated species, 7 subspecies, 8 species diversity).

The micromorphological structural characteristics of the seeds of 17 species and subspecies belonging to the vetch genus were analyzed (SEM), diagnostic structural elements important for the systematics of the species with disputable status were identified and photographed.

2. Vegetative and generative organs of the collected 22 taxa were studied and diagnostic signs were revealed. The nomenclature, phytocenological characteristics, habitat types of 44 taxa (species and subspecies) belonging to the genus vetch (*Vicia* L.) distributed in Azerbaijan were clarified, and map-scheme reflecting their distribution were drawn up.
3. Phenetic (taximetric) analyzes were carried out using the Cluster method on the samples of vetch belonging to 18 species and subspecies collected on 38 routes. It was determined that the taxa were grouped into 4 main clusters and subclusters according to the corresponding morphological characters and ecological parameters.
4. An ecobotanical analysis of species of the genus *Vicia* L. was carried out, based on their life form (most of them belong to the

annual group - 27 taxa), their relation to humidity (mostly belong to the mesophytic group (22 taxa, 66%)) and distribution in zones (mostly distributed in the middle mountain zone (24 taxa, 41 %) were grouped. A new distribution area of 2 species and 1 subspecies was discovered: *V. lutea* (Absheron district, Novkhani village, different grass), *V. loiseleurii* (Ordubad, Paragha village, mountain surroundings). *V. pannonica* subsp. *striata* (Shamakhi district, Mirzandiya village, meadow).

5. The conservation status of 13 taxa was assessed, and a map-scheme of their distribution was drawn up. It was determined that 5 taxa under critical threat belong to DD, 3 to CR, 1 to EN and 4 to VU category.
6. Biochemical indicators were studied in the seeds of selected vetch taxa due to their economic importance, and it was found that the biochemical indicators in 6 seed samples have higher values.
7. The seeds of vetch taxa collected from different areas of Azerbaijan were planted in the experimental area of the Institute of Genetic Resources, phenological observation and structural analysis were carried out on the plants, and the samples were evaluated according to quantitative and qualitative characteristics

SUGGESTIONS AND RECOMMENDATIONS

1. Most of the vetch species studied are valuable fodder plants. The structural elements we found during morphological analysis of some species (*V. narbonensis*, *V. lutea*), which are more promising as fodder plants, can be used as markers.

2. Thirteen taxa were identified as endangered, their assessment was made according to the international categories, on this basis a number of conservation methods were recommended for their protection and is planned to be submitted to the Ministry of Ecology and Natural Resources of the Republic of Azerbaijan.

3. Innovations obtained as a result of systematic, macro and micromorphological research of 22 species and subspecies of the vetch genus (*Vicia* L.) can be used in the preparation of a monograph on this genus, in the new edition of multi-volume "Flora of

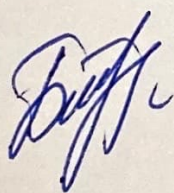
Azerbaijan”, and “Red Book of the Republic of Azerbaijan”, as well as textbooks and teaching aids on botany.

**List of published scientific works on the subject of the
dissertation:**

1. Əsədova, K.V. Böyük Qafqazın mərkəzi hissəsinə yayılan Lərgə (*Vicia* L., *Fabaceae* Lindl) cinsi növlərinin taksonomiyası və bioekoloji xüsusiyyətləri // Ekologiya: Təbiət və cəmiyyət problemləri mövzusunda II Beynəlxalq Elmi Konfrans, - Bakı: Bakı Universiteti, - 7 noyabr - 8 noyabr, 2012, - s. 384-385.
2. Əsədova, K.V. Azərbaycan florasının *Vicia* L. cinsi haqqında // Bakı: AMEA Genetik Ehtiyatlar İnstitutunun elmi əsərləri, - 2015. C.V, - s. 158-161.
3. Asadova, K.V., Asgarov, A.M. Evaluation of biomorphological diversity and distribution of Vetch (*Vicia* L.) species in Azerbaijan // - Bakı: Proceedings of ANAS (Biological and Medical Sciences), - 2017. V. 72, №. 3, - p. 140-147.
4. Əsədova, K.V. Abşeronda yayılan Lərgə (*Vicia* L.) növlərinin taksonomik tərkibi, yayılması və istifadəsi imkanları // Bakı: AMEA Genetik Ehtiyatlar İnstitutunun elmi əsərləri, - 2017. C.VI, №1-2, - s. 167-173.
5. Əsədova, K.V. Azərbaycanda Lərgə (*Vicia* L.) cinsinin *Cracca* yarımcinsinin taksonomik icmalı // Bakı: Azərbaycan Milli Elmlər Akademiyasının Gəncə bölməsinin “ Xəbərlər” məcmuəsi, - 2018, - s. 3-8.
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7. Əsədova, K.V., Əsgərov, A.M. Azərbaycanın nadir, endem və nəslə kəsilməkdə olan Lərgə (*Vicia* L.) növləri // “Müasir təbiət və iqtisad elmlərinin aktual problemləri”, Beynəlxalq elmi konfrans, - Gəncə: Gəncə Dövlət Universiteti, - 04 may - 05 may, - 2018, - s. 29-32.

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9. Asadova, K. V., Asgarov, A. M. Micromorphological structure of seeds in some taxa of *Vicia* L. (*Fabaceae*) occurring in Azerbaijan // - Baku: Plant & Fungal Research, - 2018, 1(1), - p. 43-51
10. Asadova, K.V. Genus *Vicia* L. in the flora of Azerbaijan // VIII Міжнародна Конференція «Осінні Наукові Читання», - Київ: Велес, - 31 жовтня, - 2019, –с. 17-19
11. Asadova, K.V., Asgarov, A.M. Micromorphology of seed in some *Vicia* taxa belonging to section *Crassa* from Azerbaijan // - Крым: Бюллетень ГНБС, - 2020. Вып. 134, - с. 17-23.
12. Асадова, К.В., Аскеров, А.М. Биоморфологическая оценка некоторых таксонов вики (*Vicia* L., *Fabaceae* Lindl.), распространенных в Азербайджане // Крым: Ученые записки Крымского федерального университета имени В. И. Вернадского Биология. Химия, - 2021. Т. 7 (73), № 1, - с. 14–25.

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12. Асадова, К.В., Аскеров, А.М. Биоморфологическая оценка некоторых таксонов вики (*Vicia* L., *Fabaceae* Lindl.), распространенных в Азербайджане // Крым: Ученые записки Крымского федерального университета имени В. И. Вернадского Биология. Химия, - 2021. Т. 7 (73), № 1, - с. 14–25.



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Dissertation is accessible at the Library of the Institute of Botany of Ministry of Science and Education of the Republic of Azerbaijan.

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