Теоретичні та прикладні питання

Wild ornamental plants of the family *Asteraceae* from the northeastern part of Azerbaijan

PARVIN AGHAYEVA
PARVANA GARAKHANI
ARZU HUSEYNOVA
VALIDA ALI-ZADE

AGHAYEVA P., GARAKHANI P., HUSEYNOVA A., ALI-ZADE V. (2018). **Wild ornamental plants of the family *Asteraceae* from the northeastern part of Azerbaijan.** *Chornomors'k. bot. z.*, **14** (3): 204–212. doi: 10.14255/2308-9628/18.143/1

The article deals with wild species of ornamental herbs belonging to the family Asteraceae collected in Quba and Qusar districts of Azerbaijan during 2012–2017. In total, more than 120 specimens were collected and identified based on the main diagnostic morphologic characters. Altogether 49 species belonging to 28 genera and 11 tribes were registered, considering the latest taxonomic and nomenclatural changes. New localities of *Cyanus cheiranthifolius* and *Leontodon danubialis* were found in Quba district (the Great Caucasus). The relict species *Callicephalus nitens* and the Caucasus endemic species *Tanacetum leptophyllum* were also found in the studied region. The life forms and morphological types, diversity patterns of plants depending on altitude and soil humidity were reflected. Perennial plants, as compared to annuals, are dominant in the districts. *Erigeron acris* and *Lactuca serriola* may grow as both annual and/or biennials, while *Carduus nutans* is mainly biennial. *Senecio vernalis* may grow as an annual, biennial or perennial plant, depending on its habitats and local conditions. Morphological features, such as root systems, branching patterns, leaf outlines and flowers arrangement, are very variable and depend on the growing environment. Numbers of species occur both in forests and grasslands. Some of them grow along mountain slopes and also occur in meadows. Species variation and a consistent trend along the elevational gradient was observed starting from the low mountain zone. Abundance of species decreased in higher elevations. Results suggest that recent climate warming interacted in changes of habitats of some species. Species distribution patterns along the elevation gradients are affected by mountain range peculiarities, expositions of slopes, soil types, soil sliding processes, and climate warming. Numerous species have been recorded in more than one altitude zone. The number of ornamental wild herbs belonging to Asteraceae growing in these districts can be successfully used in horticulture in parks and gardens.

Keywords: plant diversity, Cyanus cheiranthifolius, Leontodon danubialis, morphology, life forms, growth elevation

АГАЄВА Р.Н., ГАРАХАНІ Р.Х., ГУСЕЙНОВА А.Ю., АЛІ-ЗАДЕ В.М. (2018). **Дикорослі види декоративних трав з родини *Asteraceae* північно-східної частини Азербайджану.** *Чорноморськ. бот. ж.,* **14** (3): 204–212. doi: 10.14255/2308-9628/18.143/1

У статті наводяться дані про види дикорослих декоративних трав'янистих рослин з родини Asteraceae, зібраних у 2012–2017 роках в Губинському і Гусарському районах Азербайджану (Великий Кавказ). У цілому зібрано і визначено більш ніж 120 гербарних зразків, встановлені діагностично важливі морфологічні ознаки з згідно з сучасною номенклатурою, виявлено 49 таксонів, що відносяться до 28 родів і 11 триб з урахуванням сучасної номенклатури. Вказана таксономічна структура, життєві форми, морфологічні типи та поширення в залежності від висоти зростання та

вологості грунту. Встановлено нове місце зростання видів *Cyanus cheiranthifolius* та *Leontodon danubialis* в Губі. У вивченому регіоні також відзначені реліктовий вид *Callicephalus nitens* і ендемік Кавказу *Tanacetum leptophyllum*. У зазначених районах переважають багаторічні рослини. *Erigeron acris* і *Lactuca serriola* можуть рости як однорічні, але *Carduus nutans*, в основному, дворічний. *Senecio vernalis* може рости як однорічна, дворічна або багаторічна рослина, в залежності від місця зростання. Такі морфологічні особливості як форма кореневих систем, розгалуження стебла, контури листків і розташування кольорів дуже різноманітні і залежать від середовища проживання. Деякі види трапляються як в лісових, так і в лучних угрупованнях, уздовж гірських схилів. Зміна видового різноманіття і послідовна тенденція зростання по градієнту висоти спостерігалися від нижнього до верхнього гірських поясів, в високогір'ях кількість видів зменшувалася. Отримані результати свідчать, що потепління клімату супроводжується зміщенням місця існування деяких видів. На розподіл видів з висотою впливають особливості гірського хребта, експозиції схилів, типи грунтів, процеси зсуву ґрунтів і потепління клімату. Деякі види були зареєстровані в більш ніж одному висотному поясі. Значне число декоративних дикорослих трав, що відносяться до *Asteraceae*, які ростуть в цьому регіоні, можна успішно використовувати в садівництві в парках і садах.

Ключові слова: різноманітність рослин, Cyanus cheiranthifolius, Leontodon danubialis, морфологія, життєві форми, висоти зростання

Агаева Р.Н., Гарахани Р.Х., Гусейнова А.Й., Али-Заде В.М. (2018). **Дикорастущие виды декоративных трав из семейства *Asteraceae* северо-восточной части Азербайджана.** *Черноморськ. бот. ж.,* **14** (3): 204–212. doi: 10.14255/2308-9628/18.143/1

В статье приводятся данные о видах дикорастущих декоративных травянистых растений из семейства Asteraceae, собранных в Губинском и Гусарском районах Азербайджана (Большой Кавказ), в 2012–2017 годах. В целом собрано и определено более 120 гербарных образцов, учтены диагностически важные морфологические признаки с учетом современной номенклатуры, выявлено 49 таксонов, относящихся к 28 родам и 11 трибам с учетом современной номенклатуры. Указаны таксономическая структура, жизненные формы, морфологические типы и распространение в зависимости от высоты произрастания и влажности почвы. Установлено новое место произрастания видов *Cyanus cheiranthifolius* и *Leontodon danubialis* в Губе. В изученном регионе также отмечены реликтовый вид монотипного рода *Callicephalus nitens* и эндемик Кавказа *Tanacetum leptophyllum*. Выявлены жизненные формы и морфологические типы видов, их распространение в зависимости от высоты произрастания и влажности почвы. В указанных районах преобладают многолетние растения. *Erigeron acris* и *Lactuca serriola* могут расти как однолетние, но *Carduus nutans*, в основном, двулетний. *Senecio vernalis* может расти как однолетнее, двулетнее или многолетнее растение, в зависимости от места произрастания. Морфологические особенности, такие как форма корневых систем, ветвление стебля, контуры листьев и расположение цветов очень разнообразны и зависят от среды обитания. Некоторые виды встречаются как в лесных, так и в луговых сообществах вдоль горных склонов. Изменение видового разнообразия и последовательная тенденция роста по градиенту высоты наблюдались, начиная с нижнего горного поясу, в высокогорьях количество видов уменьшалось. Результаты показывают, что наблюдаемое потепление климата сопровождается смещением среды обитания некоторых видов. На распределение видов влияют особенности горного хребта, экспозиция склонов, типы почв, процессы смещения почв и потепление климата. Некоторые виды были зарегистрированы в более чем одному высотному поясе. Значительное число декоративных дикорастущих трав, относящихся к *Asteraceae*, произрастающих в этом регионе можно, успешно использовать в садоводстве в парках и садах.

Ключевые слова: разнообразие растений, Cyanus cheiranthifolius, Leontodon danubialis, морфология, жизненные формы, высоты произрастания

Asteraceae (Compositae) is one of the largest families in terms of the species number and diversity, and taxonomy of that group is continuously discussed during recent decades. The family is monophyletic and includes nearly 1700 genera and about 24 000 species, of which 1600–1700 species are distributed almost worldwide [FUNK et al., 2009]. Many taxa have been clarified, changed or moved to various positions based on recent embryological [KAPİL, BHATHNAGER, 1999; GOTELLİ et al., 2008; FRANCA et al., 2015], karyological [INCEER, BEYAZOGLU, 2004; MEJÍAS, ANDRÉS, 2004; GEDİK et al., 2014], and molecular studies, which resulted in new data and new phylogenies that influences the classification schemes and nomenclature [OLMSTEAD et al., 1993, 2000; LUNDBERG, BREMER, 2003; FUNK et al., 2009; SHİ ZHU et al., 2011].

Asteraceae have been studied in Azerbaijan since the beginning of the last century, and 450 species belonging to 132 genera were recorded for the country in earlier publications [KARYAGİN, 1928; GROSSGEİM, 1946, 1949; SERDYUKOV, 1955; FLORA AZERBAYDZHANA, 1961; GADZHYEV, 1962; ASKEROVA, 1970]. Research on Asteraceae conducted during recent years involved taxonomic revisions of various genera, such as *Centaurea* L. [HUSEYNOVA et al., 2013, 2014], *Pyrethrum* Zinn (often included in *Tanacetum* L. *sensu lato*) [SAHMUROVA et al., 2010; MUSTAFAYEVA, 2013]; representatives of the family were also studied as part of plant diversity surveys of the country [ASGEROV, 2008; SHUKUROV et al., 2012; MEKHTİEVA, 2015]. Studies on the chemical composition of various species were also carried out by many authors [NOVRUZOV, SHAMSİZADE, 1998; CHOBANOV et al., 2004; SERKEROV, 2005; DZHAGANGİROVA, SERKEROV, 2014].

The interest in ornamental plants was growing exponentially over the last decades. Continued reduction of natural resources necessitates using hardy ornamental plants with low maintenance requirements for creating urban landscapes, especially those plants displaying inherent tolerance to environmental stresses [HEYWOOD, 2003; GRAY, BRADY, 2016]. The objective of the present study was to reveal the patterns of ornamental herb diversity of Asteraceae in the Quba and Qusar districts of Azerbaijan, to elucidate the taxonomic structure and bioecological positions of the taxa of the family in the growing environment for revealing species with potential uses.

Material and Methods

The Quba (2574 km^2) and Qusar (1542 km^2) districts are located at 500–4466 m above sea level (a.s.l.) in the northeastern part of Azerbaijan and are considered naturally floristically rich areas. Both districts are under the severe anthropogenic impact due to the recreational activities and tourism. Approximately 127 ornamental herb specimens of the family Asteraceae were collected in the territory during 2012–2017. Plants for our analysis were chosen based on phenological and morphological features (structure of flowers, stem, leaves) and overall aesthetic qualities. Each collected sample was characterized based on morphology and identified visually or by using a dissection microscope (stereomicroscope). Identification of samples were implemented based on available literature on the local flora, checklists, and recent literature on Asteraceae worldwide [FLORA AZERBAYDZHANA, 1961; TUTAYUK et al., 1961; FUNK et al. 2009; KONSPEKT FLORY KAVKAZA, 2008, 2012]. The species status was also checked following the "Global Compositae Checklist" (www.compositae.org), "The Plant List" (http://www.theplantlist.org), "Plants of the World Online" (http://www.plantsoftheworldonline.org) and other web resources. Plant life forms were determined according to C. Raunkiaer (1934) and I. Serebryakov [SEREBRYAKOV, 1964].

Results and Discussion

The Quba and Qusar districts spread along various altitude belts (foothills, low, middle and high mountain zones, subalpine and alpine habitats). Most of herbaceous plants occurring

here belong to the spring flora (i.e., flowering mainly in springtime). But there are also species blooming in summer and autumn. About 194 species of 69 genera of Asteraceae were reported from Quba and Qusar in Flora Azerbaijani [FLORA AZERBAYDZHANA, 1961], of which 8 species from 6 genera were recorded as ornamental plants. In this study we report 45 species and 4 other taxa belonging to 28 genera and 11 tribes (Table 1).

Fleabanes (*Erigeron acris, E. canadensis*), inulas (*I. aspera*, *I. conyza*, *I. helenium*, *I. orientalis*) and tansies (*Tanacetum coccineum, T. leptophyllum, T. niveum, T. parthenifolium, T. silaifolium*) dominate in a number of species. However, it should be noted that the genus *Inula*, as traditionally understood, has been recently split into several monophyletic genera, and most of *Inula* species occurring in Azerbaijan are now placed in the genus *Pentanema* Cass. [BOIKO et al., 2018]. The genera *Senecio* and *Anthemis* are represented by three species each, *Aster*, *Centaurea*, *Crepis* by two, and *Antennaria, Bellis, Callicephalus, Carduus, Cyanus, Eupatorium, Galatella, Helichrysum, Lactuca, Lapsana, Leucanthemum, Pojarkovia, Psephellus, Pulicaria, Pyrethrum, Symphyotrichum, Taraxacum, Tragopagon, Tussilago* and *Xeranthemum* by only one species each.

Of the identified species, *Cyanus cheiranthifolius* (Fig. 1) of the subtribe Centaureinae, collected in the July 2012, and *Leontodon danubialis* (Fig. 2) of the tribe Cichoriae collected in April, 2016 in Quba, represent the new records for the studied territory. *Cyanus cheiranthifolius* was previously reported from the Nakhchivan Autonomous Republic [FLORA AZERBAYDZHANA, 1961]. Among the recorded species, *Callicephalus nitens* represents a relict and *Tanacetum leptophyllum* an endemic taxon for the Caucasus.

Plant life forms. The originality of various life forms arises in ontogeny of plants as a result of more or less complicated and long chain of age and morphogenetic changes. Life forms indicate and even partly determine the functions of plants in ecosystems and display the adaptation ability of plants to the environment that could be achieved in a number ways [DVORYAKOVSKİY, 1983]. The studied species were classified according to their life forms, and the results are presented in Table 2.

Systematically closely related species may have different life forms. The same species may grow as annual or biennial, depending on elevations and ecological factors, such as the type of soil, light, temperature, and humidity. The total number of annual plants is minor in comparison with perennials, and the list of annuals includes only *Callicephalus nitens*, *Crepis micrantha*, *Erigeron canadensis*, *Lapsana communis*, and *Xeranthemum squarrosum*. *Carduus nutans* is mainly biennial. *Erigeron acris* and *Lactuca serriola* may grow as both annual and/or biennials. *Erigeron acris* is either a biennial or perennial plant. *Senecio vernalis* may grow as an annual, biennial or perennial plant, depending on its growth site. Other identified species found in the territory were perennials.

Morphological types. The plant phenology should be taken into consideration, especially those related to competition and growth rate, as they improve our understanding of adaptations leading phenological changes. Plant characteristics are important for understanding the species-specific growth form depending on surrounding environment and specific responses to climate changes. Numerous studies have reported variations on plant types in response of climate change and other ecological factors that affect plant survival, distribution, growth and reproduction [GRAY, 2016; KONİG et al., 2016; GUO et al., 2017]. Plant growth rates and development depend upon the environmental temperatures surrounding the plant, and each species has its specific minimum, maximum and optimum temperatures [HATFİELD, PRUEGER, 2015].

Morphological features, such as root systems, branching patterns, leaf outlines, and flowers arrangement, are very variable and depend on the environment conditions. Many species occur in both forests and grasslands. Some of them grow along mountain slopes, and also occur in meadows. Tansies, such as *Tanacetum niveum*, *T. leptophyllum*, *T. coccineum*, and *T. meyerianium*, are very common in the study territory.

Table 1.

Taxonomic structure of the studied plants

Tribes and subtribes	Genera	Species
Cardueae s. str. (=Cynareae subtribe Carduinae)	*Carduus* L.	*Carduus nutans* L.
Cynareae subtribe Centaureinae	*Centaurea* L., *Cyanus* Mill., *Psephellus* Cass.,	*Centaurea emiliae* Huseynova et Garakhani, *C. solstitialis* L. (Willd.) K. Koch, *Cyanus cheiranthifolius* (Willd.) Soyák, *Psephellus dealbatus* (Willd.) K. Koch.
Cichoriae	*Crepis* L., *Lactuca* L., *Lapsana* L., *Leontodon* L., *Tragopogon* L., *Taraxacum* F.H. Wigg.	*Crepis micrantha* Czerep., *C. sibirica* L., *Lactuca serriola* L., *Lapsana communis* L., *Leontodon danubialis* Jacq., *Tragopogon graminifolius* DC., *T. pratensis* L., *T. pusillus* M. Bieb., *Taraxacum officinale* (L.) Weber ex F.H. Wigg
Senecioneae (incl. subtribe Tussilagininae)	*Pojarkovia* Askerova, *Senecio* L., *Tussillago* L.	*Pojarkovia pojarkovae* (Schischk.) Greuter *Senecio patagonicus* Phil., *S. vernalis* Waldst. et Kit., *Tussilago farfara* L.
Astereae s. str.	*Aster* L., *Bellis* L., *Callicephalus* C.A. Mey., *Erigeron* L., *Galatella* Cass., *Symphyotrichum* Nees	*Aster alpinus* L., *A. amellus* subsp. *ibericus* (Steven) V.E. Avet, *Bellis perennis* L., *Callicephalus nitens* M.Bieb. ex M.Bieb.) C.A. Mey., *Erigeron acris* L., *E. canadensis* L. (= *Conyza canadensis* (L.) Cronquist), *E. caucasicus* Steven, *E. caucasicus* subsp. *venustus* (Botsch.) Grierson., *Galatella villosa* (L.) Rchb. f., *Symphyotrichum novae-angliae* (L.) G.L. Nesom
Anthemideae	*Anthemis* L., *Leucanthemum* Mill., *Tanacetum* L.	*Anthemis cretica* L. subsp. *iberica* (M. Bieb.) Grierson, *A. fruticulosa* M. Bieb., *A. marschalliana* subsp. *sosnovskyana* (Fed.) Grierson, *Leucanthemum vulgare* (Vaill.) Lam., *Tanacetum coccineum* (Willd.) Grierson, *T. leptophyllum* M. Bieb., *T. meyerianum* Sosn., *T. niveum* (Lag.) Sch. Bip., *T. parthenifolium* (Willd.) Sch.Bip., *T. silaifolium* (DC.) Sch. Bip., *T. vulgare* L.
Gnaphaliae	*Antennaria* Gaertn., *Helichrysum* Mill.	*Antennaria caucasica* Boriss., *Helichrysum rubicundum* (K. Koch) Bornm.
Inuleae	*Inula* L. *sensu lato* (incl. *Pentanema* Cass.), *Pulicaria* Gaertn.	*Inula aspera* Poir., *I. conyza* (Griess.) DC., *I. germanica* L., *I. helenium* L., *I. orientalis* Lam., *Pulicaria dysenterica* (L.) Gaertn.
Eupatorieae	*Eupatorium* L.	*Eupatorium cannabinum* L.
Cynareae	*Xeranthemum* L.	*Xeranthemum squarrosum* Boiss.

Fig 1. *Cyanus cheiranthifolius*: A – herbarium specimen; B – flower of the plant in nature.

Fig 2. *Leontodon danubialis*: A – herbarium specimen; B – plant in nature.

Table 2.

Life forms of the studied plants

Life forms	Number of species	%
Annual	5	10,2
Biannual	3	6,12
Perennial	37	75,5
Annual and biennial	2	4,10
Biennial and perennial	1	2,04
Annual, biennial and perennial	1	2,04
Total	49	100

The *Inula* species (*I. aspera*, *I. germanica*, *I. helenium*, *I. orientalis*, *I. conyza*) identified in this study possess thick, branching root, woolly-covered leaves and flower heads of narrow ray-florets.

They can be found from low mountain belts up to the subalpine zone. *Aster alpinus* prefers high meadows with clay, slit or clay loam. *Eupatorium cannabium* grows in forest, in humid places, such as around springs and rivers, but also observed along the car roads. In relation to humidity, among the identified species 14 were mesophytes, 15 mesoxerophytes, and 15 xerophytes.

Species such as *Senecio vernalis* are observed in early spring, but most of representatives of the family appear in April and May. Some of them flower and complete their life cycle in the beginning of summer, in May and June (*Anthemis fruticulosa, Cyanus cheiranthifolius, Crepis micrantha*), but there are species with longer flowering periods, which continue until the end of summer. Some species, such as *Erigeron acris*, *Galatella villosa*, *Helichrysum rubicundum*, all *Inula* species (except *I. orientalis*), *Senecio patagonicus*, *Tanacetum coccineum*, *T. vulgare*, and *Tragopogon pratensis* flower until September. *Senecio vernalis* was observed also in December.

Common daisy (*Bellis perennis*) forms mats on rocky slopes, which is perennial plant with creeping rhizomes and rosettes of small rounded spoon-shaped leaves. Fleabanes (*Erigeron acris*, *E. canadensis*, *E. caucasicus*, *E. caucasicus* subsp. *venustus*) grow in mountainous meadows, despite of tiny flower heads, not all, but some attract attentions by their white ray florets. They can be annual, biennial and perennial, depending on species. All asters (*Aster alpinus*, *A. amellus* subsp. *ibericus*) superficially look similar. They are perennial plants with thickened root, erect or branched stems, spread from the middle-mountain up to subalpine zone, bloom in spring and in summer, occasionally in autumn.

Most of plants are characterized by their slender, erect, branched (*Antennaria caucasica, Cyanus cheiranthifolius, Leucanthemum vulgare*) or mainly unbranched (*Aster alpinus, A. amellus* subsp. *ibericus*, *Inula orientalis* etc.) stems. There are also plants forming rosettes consisting of leaves of different shapes: small rounded leaves of *Bellis perennis* or large leaves with spines at the tips of the lobes (*Carduus nutans*) directly on the ground which gives rise to various types of stems. Plants in Asteraceae have various root systems, some have rhizomes (*Aster alpinus, Bellis perennis, Crepis sibirica* etc.), taproot (*Pyrethrum*), fibrous taproots (*Erigeron acris*), or fibrous taproots with woody rhizomes (*Tanacetum*), or woody rhizomes (*Tussilago*).

Elevation diversity. Most of species grow in foothills, lower and middle mountain zones. Distribution of species depending on elevation increase up to certain point (middle mountain zone), then a decrease in the number of taxa is observed along the higher elevations. Despite species-specific variation and a consistent trend along the elevational gradient was observed beginning from the low mountain zone. Abundance of species decreased in upper (higher) elevations. These results suggest that recent climate warming interacted in driving the observed dynamics. The results also show that species distribution patterns along the

elevation are affected by mountain range peculiarities, slope expositions, soil types, soil sliding processes, and climate warming. Numerous species have been recorded in more than one altitude zone (Table 3).

Crepis micrantha, *Inula aspera*, *Lactuca serriola* and *Xeranthemum squarrosum* grow from foothills up to the mid-mountain zone; *Inula helenium* and *Senecio vernalis* were observed up to the subalpine zone in these districts. *Anthemus cretica* subsp. *iberica* grows in the alpine zone, *A. marschalliana* subsp. *sosnovskyana*, *Aster alpinus*, *Cyanus cheiranthifolius* and *Erigeron caucausicus* subsp. *venustus* are distributed mainly in subalpine and alpine zones. *Inula orientalis*, *Tanacetum coccineum* are usual for subalpine zones. *Erigeron acris*, *Leucanthemum vulgare*, *Psephellus dealbatus* occur in the mid-mountain and subalpine zones. *Callicephalus nitens* is a single species of the genus that occurs in the middle and low mountains of the Caucasus. All other species mainly occur in the mid-mountain zone. Species are grouped as follows in Table 3.

Table 3.

Distribution of plants along altitudinal zones

Elevation levels	Number of species
Foothill (70–400 m d.s.h.)	34
Low and middle mountain zone (500–1000 m a.s.l.)	32
Middle and upper mountain zone (800–1800 m a.s.l.)	24
Subalpine and alpine zone (1900–2350 (2400) m a.s.l.)	7
Higher mountain zone (350–2400 (2500) m a.s.l.)	3

Application. Number of wild-growing plants of Asteraceae can be successfully used in horticulture in parks and gardens. Plants with growing ability at different altitudes and various soil types are more promising to be successful in their adaptation to various environmental conditions and habitats. For example, species of *Bellis*, *Crepis*, *Inula* may look attractive in urban areas. Tansies are widely used for ethnobotanical (medicinal, dye) properties. *Aster alpinus*, *Carduus nutans*, *Lapsana communis*, *Tanacetum parthenifolium,* are *Taraxacum officinale*, *Tussilago farfara* are widely used in traditional medicine. *Eupatorium cannabinum*, *Inula helenium*, *Serratula coronata* and *Taraxacum officinale* represent dye plants, also containing vitamins and alkaloids in leaves and stems. They are also known as honey plant attracting domestic and wild bees. Members of the family, such as *Tragopogon graminifolius*, are edible plants, and *Lactuca serriola* is a fodder plant.

Conclusions

This study represents an effort to examine ornamental diversity of herbs belonging to the Asteraceae recorded in Quba and Qusar districts of Azerbaijan (the Great Caucasus). During centuries, natural and artificial selection pressure shaped genetic and phenotypic basis of plants growing in this area. Adapted plant species of this area currently are also strongly affected by climate change and anthropogenic pressure, which makes important to study of the flora of these districts more thoroughly. The plant diversity has not been studied separately in these two districts, but earlier contributions elucidating various aspects of plants growing here have been published.

Obviously, both studied districts are rich with flowering plant species, even taking into account only the number (194) of Asteraceae species occurring in the area. Asteraceae species with ornamental features are considered (and some first reported) in present article. Investigation of plants was based on morphology only while ornamental features were considered for various applications, such as indoor planting, gardening, carpet bedding, borders for edging, and fence plantings. Further research will be conducted to elucidate ornamental plants belonging to other plant families. This will help in preparing a list of plants potential to be introduced into cultivation and suitable for urban areas within the country, depending on species-specific requirements to environmental conditions.

Acknowledgments

We are grateful to anonymous reviewers for their valuable comments and suggestions. Our thanks are also due to Prof. Sergei L. Mosyakin (M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, Kyiv, Ukraine) for his suggestions on taxonomy and editorial comments. The kind help and cooperation of the editorial team of this journal, who guided our manuscript through the editorial process, are greatly appreciated.

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Рекомендує до друку
Ходосовцев О.Є.

Отримано 16.10.2018

Адреси авторів:
Р.Н. Агаева, Р.Х. Гарахани, А.Й. Гусейнова, В.М. Али-Заде
Інститут ботаніки
НАН Азербайджану
Бадамдарское шоссе
Баку, AZ1004
Азербайджан
e-mail: apn_aghayeva@yahoo.com

Author's addresses:
P. Aghayeva, P. Qarakhani, A. Huseynova, V. Ali-Zade
Institute of Botany, Azerbaijan National Academy of Sciences
Badamdar highway 40,
Baku AZ1004
Azerbaijan
e-mail: apn_aghayeva@yahoo.com