

Monitoring of *Ambrosia artemisiifolia* L. Distribution in Meadow Phytocenoses of Kabardino-Balkarian Republic (Central Caucasus)

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Abstract—Common ragweed *Ambrosia artemisiifolia* L. is an aggressive adventive quarantine species that is widespread in the southern regions of Russia. In the Kabardino-Balkarian Republic, freshly-plowed meadows and fresh deposits after cereals in the foothill zone and weedy sites are the optimal conditions for the species spread. Common ragweed has recently actively penetrated into the mountain regions of the republic. On the basis of the study of the ecological—cenotic and ecological—biological features of *A. artemisiifolia*, a number of recommendations on limiting its distribution within Kabardino-Balkaria have been developed.

Keywords: *Ambrosia artemisiifolia*, Kabardino-Balkaria, meadow phytocenoses, invasion, cenopopulation

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INTRODUCTION

Synanthropic vegetation is a source of distribution of harmful and quarantine invasive species (Mirkin, 1998). Synanthropic plant species can have a great impact on local natural phytocenoses and agrocenoses. Therefore, the study of adventive plants is an important task that requires not only the record of a new species in a certain area but also a comprehensive study of its ecological—cenotic and ecological—biological features. Against the background of climate changes and an increase in anthropogenic impact on mountain ecosystems, it is particularly relevant to study the distribution of invasive species in mountains, including the mountains of the Central Caucasus.

The distribution of an aggressive quarantine species, *Ambrosia artemisiifolia* L., in the Kabardino-Balkarian Republic (KBR) may have a significant impact on the economic development of the republic, taking into account costs for the restoration of the biological diversity of indigenous meadow ecosystems, as well as costs for the liquidation of infestation of agricultural lands and health care costs. Therefore, the study of the ecological—cenotic and ecological—biological features of *A. artemisiifolia* for revealing the invasive potential (including its distribution in mountain meadow systems), determining the limiting factors, and developing recommendations on the limitation and liquidation of the foci of distribution of the species is relevant for maintaining the stable development of the region.

A. artemisiifolia is an annual plant of the family Asteraceae Dumort. (Compositae Giseke) with the North American range and is included in the list of quarantine weed plants in Russia. Its stem is high (up to 2.5 m), paniculate-branched, and 1 to 2.5 cm thick and its main root system penetrates into soil to a depth of up to 4 m or more. The plant is monoecious; however, it has been established (Zhaldak, 2011) that heads with monoclinal flowers can also be formed in the inflorescences of this plant. The mass distribution of the species to new territories is significantly determined by a number of its ecological—biological features. Common ragweed is quite drought tolerant (Almadi, 1976). The high regeneration capacity allows it to form additional roots and be successfully established after its shoots are covered with soil, as well as generate new shoots from the radical parts during cutting (Konyakin and Chemeris, 2013). One plant can produce 25000 to 100000 seeds, which can continue ripening after seeding even at the milky or wax ripeness stage and yield sound seedlings after wintering (Konyakin and Chemeris, 2013; Esipenko, 2015). The long period of afterripening of seeds (4 to 6 months) determines the impossibility of their germination immediately after seeding, which protects the sprouts from destruction during light frosts (Luchinskii and Makoveev, 2011). The high seed productivity and long-term biological dormancy period (from 5–14 to 40 years or more) (Vasil'ev, 1958) allow *A. artemisiifolia* to create a seedbank in soil. The species can exhibit

phenological expression (Luchinskii and Makoveev, 2011). Small, light, floating seeds enveloped in utricles are easily transferred by water flows, winds, car wheels, and animal hair. In addition, common ragweed is characterized by a high genetic variability (Chun et al., 2005), the allopathic effect, the resistance to many herbicides (Kazinczi et al., 2008), and the almost complete absence of effective natural enemies beyond its native land.

At the same time, the ecological–biological features of *A. artemisiifolia* significantly limit the distribution of the species. The plant is an annual. The prolonged vegetation with the development cycle of approximately 150 to 180 days, followed by the emergence of seedlings and fructification (short-day plant), does not allow the species to migrate farther north than 50° N (*Spravochnik po karantinny...*, 1970). According to the data of Reznik (2009), the boundaries of the mass distribution of the species are determined by the mean September temperature of no less than 15°C; seedlings emerge at a mean daily temperature of no less than 6–8 (8–10)°C and the pollen production is maximal at 22–28°C (Luchinskii and Makoveev, 2011; Esipenko, 2015). In colder areas, the shoots are nipped by light frosts and do not have time to complete fructification or the seeds lose their germinating capacity and die completely, especially when they are poorly deepened into the soil (Luchinskii and Makoveev, 2011). The presence of dense, undisturbed grass sod also prevents the emergence of seedlings and development of *A. artemisiifolia* plants, while the invasion of the species to forest, meadow, and steppe communities indicates their disturbance (Lebedeva, 2011). At the same time, climate warming promotes an early development of individuals and an increase in the efficiency of late fructification of the species, which enables it to spread to the north and upstream along the altitudinal profile of the northern macroslope in the Great Caucasus. According to the data of Komzha (2011), in North Ossetia–Alania, this distribution is particularly significant during years with stable warm weather in summer to autumn.

The main danger posed by common ragweed is that its pollen is highly allergenic. In addition, since *A. artemisiifolia* has a large habitus, consumes a large amount of water and mineral elements, and produces plant germination and growth inhibitors (chlorogenic and isochlorogenic acids and glucose and caffeic acid ester) (Esipenko, 2015), it severely suppresses agricultural crops, dries soils, and decreases their fertility. This plant affects the forage qualities of hay and limits the grazing potential (it is poorly eaten by livestock because of the content of bitter esters in its leaves (Glubsheva and Karpushina, 2009)).

In the Russian Federation, the greater part of the area occupied by *A. artemisiifolia* is in the North Caucasus, Rostov and Volgograd oblasts, Kalmykia, and Primorskii krai. In the Kuban, the species was

recorded for the first time in 1914 and occupied an area of over 4.6 million hectares by 2012, growing in all areas of Krasnodar krai (Esipenko, 2015). Common ragweed was recorded near the city of Stavropol in 1918 and in the vicinity of the city of Ordzhonikidze in 1929 (Dimitriev et al., 1994). At the present time, this is the most widespread quarantine weed of American origin in North Ossetia (Komzha, 2011). In Dagestan, the species was found for the first time in Khasavyurtovskiy raion near the village of Pokrovskoe in 1969; in 2014, the quarantine zone of *A. artemisiifolia* covered 664.31 ha of lands in the republic (Misrieva and Sharonova, 2014). In Kabardino–Balkaria, foci of the species were found in the postwar time, which is confirmed by archive materials: Resolution of the Council of Ministers of the Kabardinsky District for 1952, which recorded the spread of ragweed in the fields of individual farms; Resolution of the Government of the Kabardinsky District for Measurements on Eliminating All FOCI of Quarantine Weed Plants (including common ragweed) (*Resolution...*, 1952; *Decree...*, 1953); etc. However, *A. artemisiifolia* contaminated 8589 ha in the republic as early as 1957 (*Resolution...*, 1957).

The objective of the research was to study the ecological–cenotic and ecological–biological features of *A. artemisiifolia* and its distribution in Kabardino–Balkaria, including its first emergence in the mountain areas of the republic (1300–1700 m above sea level).

MATERIALS AND METHODS

The research was carried out in Kabardino–Balkaria (from 42°54' to 44°01' N and from 42°24' to 44°28' E) within the Elbrus and Tersk variants of zonation of the northern macroslope of the Central Caucasus (Sokolov and Tembotov, 1989). The features of the Elbrus zonation are expressed in the absence of a broad-leaved forest belt and in the pronounced xerophytization of landscapes. Its zonal spectrum within the KBR includes meadow steppes (forest–steppe zone), steppified meadows, and an subalpine belt, an alpine belt, a subnival belt, and a nival belt. The Tersk zonality is characterized by the mesophytization of landscapes. It includes a broad-leaved forest belt, a subalpine belt, an alpine belt, a subnival belt, and a nival belt. The mountain and foothill meadow phytocenoses, steppe deposits, plowlands, the outskirts of agricultural fields, urban lawns, and ruderal communities with the involvement of *A. artemisiifolia* (the gorges of the Malka, Baksan, and Cherek rivers; the Zolsky, Baksalsky, and Chegemsky administrative areas, Nalchik urban district (UD)) were studied.

A total of 13 geobotanical descriptions were made in the following sampling sites (SSs) (Fig. 1): SS1 (the 420th kilometer of the federal E50 highway, steppe deposit (2–3 years old) after cereals); SS2 (transport junction in the vicinity of the Baksan UD, fresh plowland for an apple garden); SS3 (the outskirts of the Baksan UD, steppe deposit (4–5 years old)); SS4 (the

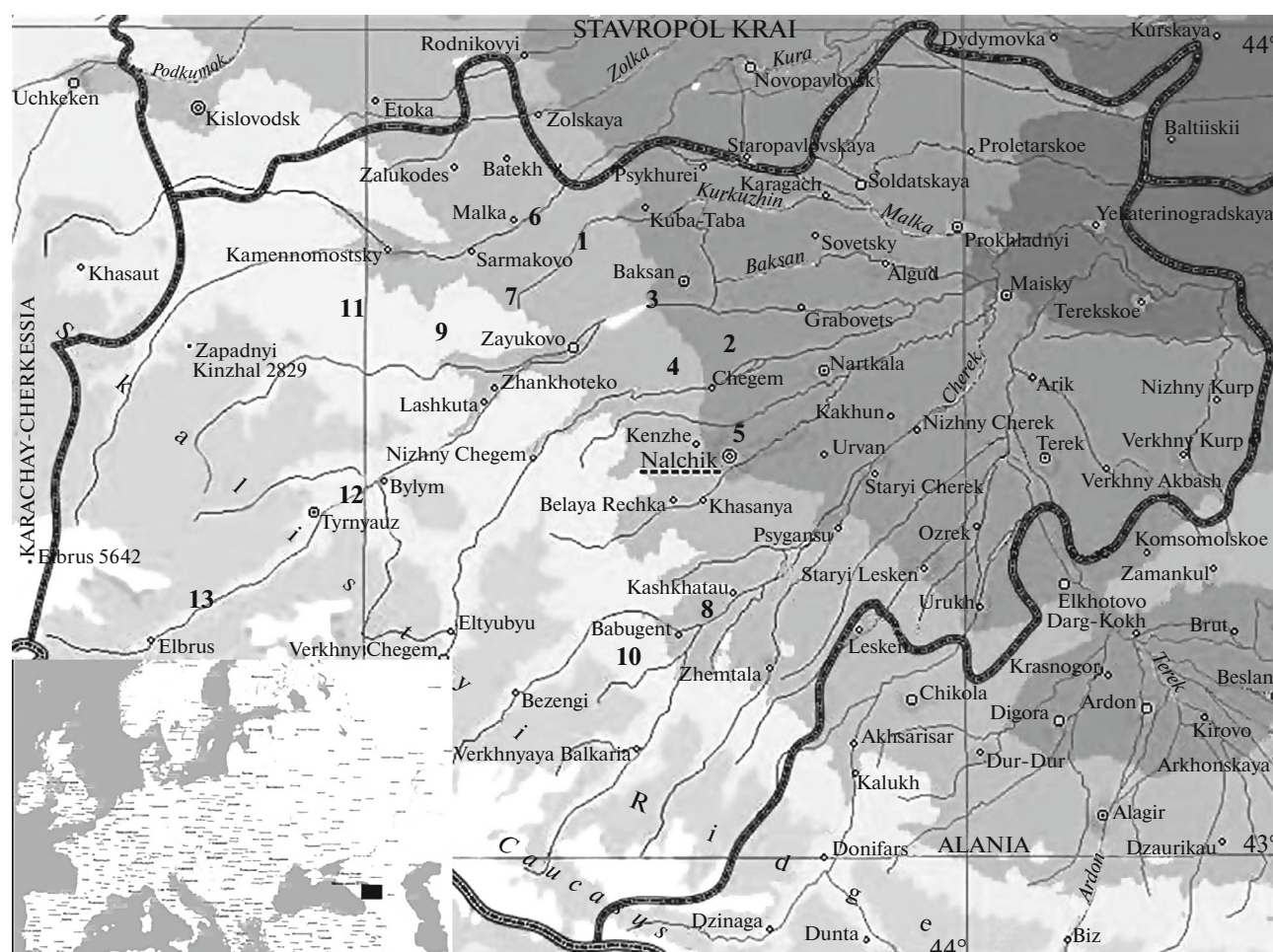


Fig. 1. Location and schematic map of the study area; localities of sampling sites. (1–13) numbers of samplings sites.

outskirts of the Chegem rural settlement (RS), grass stand between the road and agricultural field); SS5 (the Nalchik UD, unmanaged lawn along the pavement on ul. Lermontova); SS6 (the outskirts of the Malka RS, steppified meadow), SS7 (Sarmakovo RS, weedy sites); SS8 (the outskirts of Lake Verkhnee Goluboe, meadow vegetation in the vicinity of a yard); SS9 (Kamennomostsky RS, the border of a corn field); SS10 (Cherek gorge, observation areas); SS11 (the outskirts of the Kichmalka RS, steppified meadow in the river floodplain that is exposed to cattle grazing and recreational load), SS12 (Tyryauz urban settlement (US), unmanaged lawn along the pavement on Elbrus avenue); and SS13 (Elbrus RS, meadow vegetation in the vicinity of a yard).

The geobotanical descriptions included the determination of the total projective cover (TPC, %) of the grass stand and its mean height (H_{mean} , cm) in each SS. The projective cover and abundance of separate species were estimated according to the combined Brown–Blanke scale modified by Mirkin et al. (1989): (r) a very rare species (1–4 individuals) with an insig-

nificant cover; (+) the species occurs sparsely and covers less than 1% of the SS; (1) 1–5% projective cover, (2) 6–15% projective cover, (3) 16–25% projective cover, (4) 26–50% projective cover, (5) over 51%. In addition, the current state of the *A. artemisiifolia* cenopopulations (CPs) within the SSs under consideration (according to their numeration) was analyzed with respect to the following parameters: abundance and density of individuals, mean plant height and number of inflorescences per individual, and variability of these parameters (Cv, %). The demographic CP parameters were determined by generally accepted methods (Dyrenkov, 1984). The levels of variation of the characteristics were assumed according to Zaitsev (1973).

RESULTS AND DISCUSSION

The geobotanical studies showed that the projective cover of *A. artemisiifolia* in the land plot of the KBR foothill zone (SS2) that was plowed but was not sown was 50% during the first year of invasion. In total, 12 species grow in the community as carriers of

temporary phytocenosis; ruderal annual plants *Chenopodium album* L., *Stellaria media* (L.) Vill., and *Thlaspi arvense* L. are the most abundant among them (Table 1).

In SS1 (steppe deposit, 2–3 years old), the abundance of common ragweed and the height of its shoots are somewhat lower under similar soil and climate conditions. Against the background of an increase in the total projective cover of the grass stand, the number of species significantly increases in the phytocenosis; annual weed plants *Ch. album*, *S. media*, *Th. arvense*, *Poa annua* L., *Setaria pumila* (Poir.) Schult., and *Amaranthus retroflexus* L. are still widespread among them; however, perennial herbaceous species *Artemisia vulgaris* L., *Elytrigia repens* (L.) Nevski, and *Taraxacum officinale* F.H. Wigg., which are characteristic of the steppified KBR meadows, are also abundant.

The rather old steppe deposit (4–5 years old) in SS3 is characterized by a further increase in the number of species in the plant community with the simultaneous preservation of approximately 50% projective cover of *A. artemisiifolia*. The emergence and distribution of biennial and perennial mesophytes *Arctium lappa* L., *Cirsium incanum* (S.G. Gmel.) Fisch., *Galium verum* L., *Heracleum asperum* (Hoffm.) M. Bieb., *Trifolium pratense* L., *A. vulgaris*, and *E. repens* were recorded in the phytocenosis. At the same time, the abundance of annual *A. retroflexus*, *Ch. album*, and *P. annua* is still high. One should note the invasion of an aggressive adventive species, *Conyza canadensis* (L.) Cronquist, to the plot, which is a potential competitor for *A. artemisiifolia*.

The uncut section of the grass stand between the road and agricultural field (SS4) can be considered as a natural meadow phytocenosis that is exposed to the invasion of common ragweed from agrocenosis, which is characteristic of the foothill zone of the republic. In this area with 100% total projective cover of grass stand and a high species diversity, *A. artemisiifolia* is approximately 15% of the grass stand, which is presumably due to the periodic decrease in interspecific competition under irregular haying conditions, as well as to the colonization of the species from agricultural fields and the renewal of the population from the soil seedbank.

The minimum cover and abundance of *A. artemisiifolia* in the meadow phytocenoses of the foothill zone of the KBR was recorded in SS6 (natural steppified meadow at the outskirts of the Malka RS with a low degree of anthropogenic load). Under such conditions, the projective cover and abundance at the level of 1–2 points are generally provided by grasses and herbs: *A. vulgaris*, *Bromus arvensis* L., *E. repens*, *G. verum*, *Hordeum leporinum* Link, *Poa angustifolia*, *S. pumila*, *Taraxacum officinale* F.H. Wigg., *Vicia angustifolia* Reichard, etc., many of which are perennial plants. *C. canadensis* also occurs very frequently in the phytocenosis and generates a habitus during blooming.

An example of *A. artemisiifolia* distribution in the middle mountains due to the disturbance of meadow phytocenoses is the sparse steppified meadow in the floodplain of the Malka River that is exposed to cattle grazing and recreational load (SS11). Along with typically meadow species *P. annua* and *Lathyrus pratensis* L., common ragweed is the most common species here and has a projective cover of approximately 25%. The species diversity of the phytocenosis is low and *Achillea millefolium* L. and *Artemisia marschalliana* Spreng, which are resistant to trampling and grazing, are widespread under these conditions. There are species that are characteristic of anthropogenic habitats: *Cichorium intybus* L., *Convolvulus arvensis* L., *Dactylis glomerata* L., *Plantago media* L., etc.

In the middle mountains of the KBR, *A. artemisiifolia* also grows along the boundary with agricultural fields (SS9) under the conditions of severely disturbed phytocenoses in the observation areas of the Cherek Gorge (SS10). In the first case, ragweed with a projective cover of approximately 90% forms a monodominant community with a low share of weedy species: *Ch. album*, *E. repens*, *Polygonum aviculare* L., and *S. viridis*. In the second case (when the total projective cover is extremely low), it is one of a few ruderal species that can exist in the depressed state, being exposed to regular trampling, mechanical damages by automobile transport, and covering with road rubble. The vegetation of this species reaches a significant projective cover and abundance with a height of 130 cm in combination with *Urtica dioica* L. and *P. aviculare* in weedy sites at the outskirts of the Sarmakovo village settlement (SS7), where there are numerous unauthorized domestic waste landfills.

The expansion of *A. artemisiifolia* to the mountains of Kabardino-Balkaria is largely associated not only with climate warming but also with the transition of the local population from agricultural employment (in particular, animal husbandry employment) to recreation and tourism activity. This has resulted in a significant decrease in the volume of haying in the mountain areas, while the requirements of small livestock farms are covered by purchasing imported hay from lowland and foothill areas. This vegetable resource is probably infested with common ragweed seeds. For instance, it was sporadically found by Tsepkova at the outskirts of the Bezengi RS at an altitude of 1600 m above sea level (Tsepkova et al., 2014) as early as 2009. Rare findings of the species in the vicinity of the Elbrus RS at an altitude of 1800 m above sea level have been reliably known since 2007.

Let us consider the influence of the altitudinal factor on the phytocenotic characteristics of *A. artemisiifolia* based on the example of SS5 and SS12, which are confined to the urban ecosystems of the Nalchik UD (500 m above sea level) and the city of Tyznyauz (1300 m above sea level), as well as SS8 and SS13 as part of the meadow vegetation in the vicinity of yards

Table 1. Geobotanical characteristic of sampling sites occupied by *Ambrosia artemisiifolia* in the Kabardino-Balkarian Republic

SS no.	SS1	SS2	SS3	SS4	SS5	SS6	SS7	SS8	SS9	SS10	SS11	SS12	SS13
Altitude above sea level, m	440	450	450	480	500	645	686	800	820	900	1045	1300	1700
Description area, m ²	8000	4200	15000	900	60	700	600	200	400	15	3000	600	20
TPC, %	90	60	100	100	70	100	90	60	100	20	90	60	30
H_{mean} of grass stand, cm	60	65	70	70	50	65	120	90	80	10	40	25	40
Number of species in SS	31	12	42	44	20	43	19	20	4	8	19	13	17

Abundance and projective cover of species in sampling sites

<i>Achillea millefolium</i>	—	—	+	1	—	+	—	—	—	—	1	—	—
<i>Amaranthus retroflexus</i>	1	+	2	1	3	+	+	1	—	—	—	1	+
<i>Ambrosia artemisiifolia</i>	4	5	4	2	3	+	5	2	5	2	3	4	1
<i>Arctium lappa</i>	+	—	1	1	—	+	+	+	—	—	—	—	+
<i>Artemisia vulgaris</i>	2	—	2	2	2	1	r	+	—	r	—	1	—
<i>Bromus arvensis</i>	—	—	+	1	—	1	—	—	—	—	—	—	—
<i>Capsella bursa-pastoris</i>	+	+	—	+	+	+	+	+	—	—	—	+	+
<i>Cirsium incanum</i>	r	—	1	1	—	+	—	—	—	—	—	—	—
<i>Cichorium intybus</i>	+	—	+	+	—	+	r	+	—	—	+	+	—
<i>Chenopodium album</i>	2	1	2	1	3	1	+	2	+	+	—	2	1
<i>Centaurea diffusa</i>	—	—	+	+	—	+	—	—	—	—	—	—	—
<i>Convolvulus arvensis</i>	+	—	+	+	+	+	+	+	—	r	+	+	r
<i>Conyza canadensis</i>	+	—	1	2	—	3	r	+	—	—	—	—	—
<i>Dactylis glomerata</i>	—	—	+	+	+	r	—	—	—	—	1	—	—
<i>Elytrigia repens</i>	2	—	2	1	+	1	+	+	1	—	—	+	1
<i>Erigeron annuus</i>	+	+	1	2	—	2	—	—	—	—	—	—	—
<i>Galinsoga parviflora</i>	+	—	+	+	+	+	+	+	—	—	—	—	+
<i>Galium verum</i>	—	—	1	1	—	1	—	—	—	—	—	—	—
<i>Heracleum asperum</i>	—	—	1	+	—	+	r	—	—	—	—	—	—
<i>Hordeum leporinum</i>	—	—	+	+	—	2	—	—	—	—	—	—	—
<i>Hypericum perforatum</i>	—	—	r	+	—	+	—	—	—	—	—	—	—
<i>Lamium album</i>	+	—	r	—	+	r	r	+	—	—	—	—	2
<i>Lathyrus tuberosus</i>	+	—	+	+	—	+	—	—	—	—	—	—	—
<i>Lathyrus pratensis</i>	+	—	+	+	—	+	—	—	—	—	2	—	—
<i>Linum marschallianum</i>	—	—	r	+	—	+	—	—	—	—	+	—	—
<i>Medicago falcata</i>	—	—	+	1	—	—	—	—	—	—	—	—	—
<i>Phleum pratense</i>	—	—	+	+	—	+	—	—	—	—	1	—	—
<i>Plantago lanceolata</i>	—	—	+	+	+	1	—	—	—	—	—	—	—
<i>Plantago major</i>	+	r	+	1	+	+	+	+	—	+	+	1	+
<i>Poa angustifolia</i>	—	—	—	1	—	2	—	—	—	—	—	—	—
<i>Poa annua</i>	1	+	2	1	1	+	—	1	—	—	3	1	—
<i>Polygonum aviculare</i>	+	—	1	+	2	+	2	1	+	1	—	2	1
<i>Prunella vulgaris</i>	—	—	—	—	—	r	—	—	—	—	+	—	—
<i>Rumex confertus</i>	—	—	—	—	—	—	+	1	—	—	—	—	+
<i>Setaria pumila</i>	1	—	1	2	+	2	+	—	—	—	—	—	—
<i>Setaria viridis</i>	—	—	—	—	—	—	—	+	+	1	—	2	+
<i>Sisymbrium loeselii</i>	+	+	—	+	—	1	—	+	—	—	—	—	+
<i>Stellaria media</i>	1	1	+	+	—	+	+	+	—	—	—	—	+
<i>Taraxacum officinale</i>	1	—	+	1	+	2	—	—	—	—	—	+	—
<i>Thlaspi arvense</i>	1	1	2	—	—	—	+	—	—	—	—	—	—
<i>Trifolium arvense</i>	—	—	+	+	—	+	—	—	—	—	—	—	—
<i>Trifolium pratense</i>	+	—	1	1	+	1	—	—	—	+	+	—	—
<i>Trifolium repens</i>	+	—	+	+	—	1	—	+	—	—	1	+	+
<i>Urtica dioica</i>	+	—	r	r	—	—	3	3	—	—	—	—	1
<i>Verbascum laxum</i>	—	—	—	r	—	+	—	—	—	—	—	—	—
<i>Veronica polita</i>	+	+	—	—	—	—	—	—	—	+	—	—	—
<i>Vicia angustifolia</i>	—	—	+	1	—	2	—	—	—	—	—	—	—

Rarely encountered species: *Armoracia rusticana*, 5 (+); *Artemisia marschalliana*, 11 (1); *Allium rotundum*, 3 and 4 (+); *Echium vulgare*, 4 and 6 (+); *Fallopia convolvulus*, 1 (+); *Geum urbanum*, 5 (+); *Glechoma hederacea*, 13 (+); *Leonurus quinquelobatus*, 11 (+); *Lolium perenne*, 5 (1); *Melilotus officinalis*, 3 and 4 (r); *Plantago media*, 11 (1); *Salvia verticillata*, 6 and 1 (r and +); *Scabiosa caucasica*, 11 (+); *Seseli alpinum*, 11 (+); *Sonchus arvensis*, 1 (+); and *Thymus pastoralis*, 11 (+), where the figure indicates the number of the SS and the projective cover of the species in the SS is given in brackets.

near Lake Verkhnee Goluboe (800 m above sea level) and the Elbrus RS. SS5 and SS12 are characterized by the dominance of common ragweed; its projective cover on the roadside lawn of the Tynyaus US is even higher (40–50%) due to a decreased interspecific competition in the phytocenosis. The species composition of the sampling sites generally includes synanthropic ruderal species; their composition in the Nalchik UD corresponds to the previously described communities (Tsepkova et al., 2008). SS12 has a lower species diversity; the *A. retroflexus*, *A. vulgaris*, and *Ch. album* species, which are characteristic of urban phytocenoses, have a lower projective cover and abundance here than in the foothill zone of the republic.

In 2017, the number of records of *A. artemisiifolia* significantly increased along roads and in weedy sites, vegetable gardens, and yards at the outskirts of the Elbrus RS. According to local residents and employees of the Prielbrusye National Park (oral communications), whereas, previously, the species did not form generative shoots and/or the plants did not have time to generate seeds before light frosts, the stable abnormally high mean daily temperatures in July–September 2017 presumably contributed to the manifestation of phenological expression inherent in common ragweed. The plants came into the mass blooming stage on August 26–29, which is only one week later than its average blooming time for the entire foothill zone of the KBR. At the same time, the projective cover of *A. artemisiifolia* is lower in SS13 than in SS8 under similar conditions (nitrate-rich wet soils and a low level of interspecific competition) and with a similar species composition (3 and 10%, respectively).

Analysis of the demographic CP parameters of *A. artemisiifolia* showed that the maximum values of the parameters of physical density (22–28 individuals/m²) and abundance of individuals are observed under the conditions of overgrowing deposits (CP1 and CP3), in weedy areas (CP7), and along the boundaries with agricultural fields (CP9) in the foothill and middle-mountain belts of the KBR (Table 2).

Average values of the demographic parameters were recorded for the colonization of natural phytocenoses with disturbed shading (CP2 (steppified meadow plowing) and CP11 (grazing and recreation)). An increase in altitude above sea level does not significantly influence the values of the density of *A. artemisiifolia* individuals (3.47 and 6.78 individuals/m² in CP5 and CP12; 5.34 and 3.24 individuals/m² in CP8 and CP13).

According to the data on the emergence of *A. artemisiifolia* seedlings throughout the vegetation period (Zhaldak, 2011; etc.), we distinguished two groups of plants with early and late germination in most of the studied CPs that differed significantly ($p \leq 0.05$) with respect to the values of the mean shoot height: habitually larger individuals with early germination (group 1) and relatively short-growing plants with later germination (group 2).

Accordingly, we carried out a comparative analysis for separate groups of individuals rather than for the entire sample.

The growth parameters of the plants are influenced by a number of factors, including the altitude above sea level, interspecific competition, and the level and nature of anthropogenic pressure. There was no significant difference between CP1 and CP8, CP3 and CP13, CP5 and CP11, CP6 and CP11, and CP12 and CP13 with respect to the height of shoots (according to the Student's *t*-test), while the other CPs differed significantly with respect to this parameter. For instance, the minimum values of the shoot height are characteristic of the ruderal community with intense soil trampling (CP10) (Fig. 2). The low growth parameters of plants are characteristic of the group of natural meadow phytocenoses (CP6 and CP11): the evident interspecific competition leads to a decrease in the level of implementation of the growth potentials of the species. Presumably, anthropogenic pressure for CP11 in the form of grazing also has significance. The mean height of the individuals (62–76 cm for group 1 and 21–30 cm for group 2 with later plant germination) was recorded in the seminatural phytocenoses of the foothill zone of the KBR (CP1, CP2, CP3, and CP4: deposits after cereals, fallow land, and meadow vegetation along roads). With respect to the values of the growth parameters of the individuals, this CP group also includes the middle-mountain CP9, which develops under similar phytocenotic conditions within the meadow vegetation belt on the border of an agricultural field. The weedy sites (CP7) are distinguished by a significant increase in the height of *A. artemisiifolia* shoots. At the same time, the cenotic populations grouped with respect to the type of phytocenosis significantly differ in the height of plant shoots: 62 and 25 cm for CP5 and CP12 (urban ecosystems) and 52 and 27 cm for CP8 and CP13 (farm enterprises), respectively. The altitude above sea level has a greater significance for the implementation of the growth potentials of the species here.

Significant differences with respect to the mean number of female inflorescences per shoot were not revealed between CP4 and CP9, CP5 and CP10, CP3 and CP11, and CP1 and CP13. The mean number of inflorescences of pistillate flowers per individual is determined by the height of plants and is maximal for the large individuals of CP7. However, cutting (at a height of over 3 cm), grazing, and shoot damage lead to hyperbranchiness and an increase in the number of inflorescences: approximately 30 inflorescences per individual at a mean shoot height of 10 cm in CP10, approximately 60 inflorescences at a shoot height of 48 cm in CP11, and approximately 48 inflorescences at a shoot height of 25 cm in CP13. The lowest development of generative organs was recorded for the plants growing within the undisturbed meadow phytocenosis in CP6: on average, 12 and 6 inflorescences for

Table 2. Demographic parameters of cenopopulations and biometric parameters of *A. artemisiifolia* individuals under conditions of the Kabardino-Balkarian Republic

CP no.	N, thousand individuals	M, individuals/m ²	Mean plant height, cm		Mean number of female inflorescences per individual, pcs.	
			group 1	group 2	group 1	group 2
Disturbed ruderal communities						
10	0.09	6.13	10.2 ± 4.1/30.48	—	30.2 ± 6.8/11.09	—
Natural meadow phytocenoses						
6	0.05	0.07	45.3 ± 7.1/17.39	12.2 ± 3.1/17.48	12.5 ± 0.9/4.11	6.1 ± 0.3/4.58
11	55.38	18.46	48.4 ± 12.3/14.31	15.3 ± 3.4/24.07	60.5 ± 7.3/8.02	28.4 ± 7.2/13.47
Seminatural phytocenoses						
1	227.20	28.34	62.2 ± 5.1/4.21	23.1 ± 2.5/7.63	47.2 ± 2.5/3.02	15.2 ± 1.0/5.35
2	65.90	15.69	65.4 ± 3.5/3.09	20.6 ± 1.9/5.46	42.2 ± 2.2/3.48	10.9 ± 0.7/5.72
3	361.80	24.12	73.1 ± 6.2/4.48	37.3 ± 3.2/3.08	58.0 ± 5.8/6.44	20.5 ± 1.9/2.45
4	9.84	10.93	75.8 ± 10.8/8.13	30.2 ± 5.5/9.86	75.7 ± 12.3/13.25	48.3 ± 6.3/15.52
9	10.25	25.62	82.4 ± 6.4/2.12	32.6 ± 2.0/2.98	73.4 ± 5.5/3.87	23.1 ± 2.0/2.58
Weedy sites						
7	12.52	20.86	138.6 ± 12.9/5.21	56.2 ± 5.2/7.13	112.4 ± 9.3/5.12	76.8 ± 5.6/4.31
Farm enterprises						
8	1.07	5.34	62.4 ± 9.3/11.37	20.2 ± 3.1/12.34	65.3 ± 11.2/10.35	32.1 ± 6.6/11.41
13	0.07	3.24	25.4 ± 10.8/27.35	—	48.1 ± 8.4/11.21	—
Urban ecosystems						
12	4.07	6.78	27.4 ± 8.7/24.73	—	24.3 ± 2.1/5.35	—
5	0.21	3.47	52.5 ± 9.5/15.36	18.3 ± 4.3/15.41	32.3 ± 2.4/4.08	12.2 ± 1.8/5.64

N, number of individuals in CP; M, density of individuals in CP; the table shows the mean values of the morphological parameter and its deviation and variation coefficient ($\bar{x} \pm S\bar{x}/Cv$, %); group 1 and group 2 (habitually larger individuals with earlier germination and relatively short-growing plants with later germination, respectively) significantly ($p \leq 0.05$) differ from each other with respect to the mean shoot height values.

the individuals of the first and second groups, respectively.

The cenopopulations where there was no clear negative anthropogenic impact (CP1, CP2, CP3, CP7, and CP9) had low values of the coefficient of variation ($Cv_{\text{mean}} < 10\%$) of the mean shoot height and number of inflorescences per individual. For cenotic populations that grow in the city (CP5 and CP12), near farm enterprises (CP8 and CP13), and in the recreational zone (CP10 and CP11), an increase in the coefficient of variation of the shoot height to medium ($Cv_{\text{mean}} = 11\text{--}20\%$) and high ($Cv_{\text{mean}} > 20\%$) values is an adaptive response to adverse effects (trampling or shoot damage). This response is also induced by an increase in the level of interspecific competition in the phytocenosis (CP6). The variation in the number of inflorescences per shoot generally increases with increase in the number of generative shoots per individual (CP4, CP8, CP10, and CP13).

CONCLUSIONS

Thus, freshly plowed meadows, fresh deposits, and weedy sites at the outskirts of human settlements and agricultural fields are the optimal conditions for *A. artemisiifolia* distribution in the Kabardino-Balkarian Republic (high values of projective cover and abundance, density, and number of the species), which is in line with the previously established patterns for other regions (Zhaldak, 2011; Lebedeva, 2011; Esipenko, 2015; etc.). As the deposits are overgrown with perennial species, common ragweed continues to maintain its position in the phytocenosis for 4 to 5 more years.

The growth parameters of common ragweed shoots decrease with increase in the altitude above sea level from the foothills to the middle and high mountains, which is particularly evident when comparing the CPs of urban ecosystems and farm enterprises from different altitudes. Weedy sites at the outskirts of human settlements in the middle mountains are the exception; plants with a height of over 140 cm and a large repro-

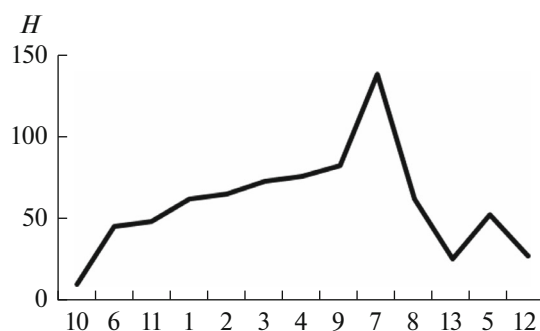


Fig. 2. Change in the mean height of *A. artemisiifolia* shoots (group 1) in cenopopulations depending on type of phytocenosis. *H*, shoot height, cm; (10–12) numbers of CPs: (10) disturbed ruderal community, (6 and 11) natural meadow phytocenoses, (1–4 and 9) seminatural phytocenoses (deposits after cereals, fallows, and meadow vegetation along roads and at the borders of agricultural fields), (7) weedy sites, (8 and 13) farm enterprises, (5 and 12) urban ecosystems.

ductive potential often develop here. Therefore, one of the measures of protection from *A. artemisiifolia* is to liquidate unauthorized landfills.

The species quite often colonizes anthropogenically disturbed meadow phytocenoses both at an altitude of approximately 500 m and at an altitude of approximately 1000 m above sea level. Under the effect of a strong anthropogenic pressure, *A. artemisiifolia* survives by saving resources for implementing growth potential and increasing the morphological variation in vegetative plant organs. In addition, the elimination and damage of shoots during cutting, grazing, and tourist trampling induce the branching of plants from a stem and an increase in the number of inflorescences per individual. Accordingly, one should correctly cut plants at the base of shoots.

Undisturbed meadow phytocenoses are resistant to the invasion of ragweed, which is indicated by the low indicators of the projective cover and abundance of the species and of the CP density and abundance. Along with an increase in altitude above sea level, a high interspecific competition leads to a decrease in the mean height of shoots and, accordingly, the number of inflorescences per individual. The undersowing of perennial plants of local flora that are resistant to technogenic pollution may become a method of handling lawns in human settlements.

Climate warming, bulk import of hay, and the growing traffic flow contribute to the successful invasion of *A. artemisiifolia* to the high-mountain areas of the KBR, including areas at the outskirts of the Elbrus RS, where there is a rehabilitation boarding house of the Center of Allergology of the Elbrus AST Ministry of Public Health of the KBR for asthmatic patients and patients with other allergic diseases. Being previously a quickly disappearing plant in areas of invasions, the species is currently well established in the

anthropogenically transformed meadow phytocenoses of the territory under study. It is necessary to perform careful monitoring and construct the relevant maps of *A. artemisiifolia* distribution in the republic, including the distribution of *A. artemisiifolia* in the mountain areas, as well as to popularize the knowledge on this problem. For instance, in the high mountains of Kabardino-Balkaria, where the abundance of common ragweed is at the level that still makes it possible to effectively control this plant on the basis of mechanical plant removal, many local residents do not know the characteristic morphological parameters of this previously rare species.

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