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REVIEW ARTICLE

Structure and dynamics of populations of *Asclepias syriaca* (*Asclepiadaceae*) within the Left-Bank Forest-Steppe of Ukraine

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Abstract. *Asclepias syriaca* (*Asclepiadaceae*) is a clonal plant, a kenophyte native to North America, and it is known for its ability to form colonies. We present here a modern distribution map of *A. syriaca* in Ukraine based on extensive research, including data from numerous herbaria, literature, open biodiversity databases, and our own field observations. Our findings indicate that the highest concentration of this species is found within the Forest-Steppe region. We conducted a comprehensive population study using traditional methods, identifying the above-ground shoot as the main unit of measurement. Our research focused on four population sites in the Left-Bank Forest-Steppe (Poltava Region) and one site in Ukrainian Polissya (Kyiv Region) for comparison. The populations studied are thriving and continuously expanding. Our results indicate that intraspecific competition (self-thinning) plays a significant role in the species' territorial expansion. Under the influence of climate change trends (particularly, warming and a decrease in annual precipitation) observed over the past 14 years, a shift in phenophases has been recorded: shoots of *A. syriaca* emerge approximately three weeks earlier than before. However, other population parameters have not shown significant changes.

Keywords: alien species, *Asclepias syriaca*, common milkweed, invasive species, population structure, population dynamics

Introduction

Phytoinvasions are now recognized as a major destructive factor negatively affecting the environment, particularly the flora (Protopopova et al., 2002, 2003). This issue has become critical because invasions are significant drivers of non-native organisms that inflict irreversible damage on the survival of species and disrupt the normal functioning of ecosystems (Vitousek et al., 1997; Alien species..., 2002; Pejchar, Mooney, 2009; Sesay et al., 2024). The World Conservation Union has identified non-native organisms, particularly invasive plants, as the second most significant threat

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to biodiversity, following only the destruction of habitats. In certain countries, such as the USA and Australia, this issue is considered the most pressing current threat to biodiversity (Canada.ca., 2025–onward; Invasives Canada, 2025–onward). They also present a significant risk to human health (Denóbile et al., 2023). The global economic cost of phytoinvasions amounts to billions of dollars each year, with Europe facing annual losses of 12 billion Euros (Invasive Species Centre, 2025–onward; European Commission, 2025–onward).

Several countries have developed national strategies to prevent and control invasions (Genovesi, Shine, 2004; Ries et al., 2004; Reaser, 2013, etc.). In Europe, the Invasive Alien Species Regulation (Regulation (EU) 1143/2014) has been adopted, which includes measures that must be implemented across the EU regarding invasive alien species. In Ukraine, this issue remains largely unresolved. Currently, A Draft Decree from the Cabinet of Ministers of Ukraine has been developed, entitled "On the Approval of the National Strategy for Managing Invasive Alien Species of the Flora and Fauna in Ukraine for the Period Until 2030". This strategy aims to enhance the country's environmental policy in line with European regulations. Its goals are to prevent the entry and control the introduction of invasive alien species into natural ecosystems, as well as to eliminate or reduce the negative impacts of these species on ecosystems, economic activities, and human health. Such legislative acts address a range of issues, emphasizing, among other aspects, the comprehensive studies of populations. The specific actions for implementing the Strategy in Ukraine include reducing the density and population numbers of invasive alien species. This aims to contain their impact at an acceptable level over a long term, while also ensuring ongoing monitoring of their populations.

The impact of invasive species is often linked to their population size, but data on the size of these populations and the occurrence of high-abundance and expanding populations are frequently insufficient or unavailable (Hansen et al., 2013). Alien species require time to adapt to new environments, and characteristics such as taxonomy, biology, and other ecological factors of alien plants ultimately determine their success in the new habitat (Sakai et al., 2001).

This topic is widely discussed among scientists (Sakai et al., 2001). For example, researchers are studying the age structure and dynamics of *Heracleum mantegazzianum* Sommier & Leviev populations (Pergl et al., 2006, 2007). Some studies focus on seed productivity and germination dynamics, as well as the population structure of *Asclepias syriaca* L. (Sárkány et al., 2008; Pauková et al., 2013; Bacieczko, Borcz, 2015); structures of genomic diversity of *Reynoutria japonica* Houtt in populations (Guerrero et al., 2021; Kawai et al., 2023, etc.), among other examples.

Asclepias syriaca is a species that has been spreading across Ukraine in recent years and successfully occupying new habitats. This species is currently under active studies in Ukraine. The findings from these studies reveal various aspects, including the genetic diversity of the species, its history of cultivation, its past and current distribution, roles within plant communities, characteristics of coenopopulations, methods of utilization, and some data from population studies (Dvirna, 2014, 2015, 2018, 2020, 2021; Dvirna et al., 2023; Didenko et al., 2023; Pashkevich et al., 2023).

Our present research aims are to provide a comprehensive study of the structure and dynamics of populations of *Asclepias syriaca*, as well as the impact of climate on these populations in the Left-Bank Forest-Steppe of Ukraine.

Materials and Methods

Study area

The study is based on original data collected from our field research conducted between 2011 and 2024.

We selected populations of *A. syriaca* from the villages of Lelyukhivka, Sudivka, Kuntseve, and the former village of Pudly in Poltava District, Poltava Region (*Oblast*). This territory is located in the central and central-northeastern parts of Ukraine (Fig. 1). According to botanical and geographical zoning, the studied territory falls within the Left-Bank Forest-Steppe zone (Heluta, 1989). According to the physiographic zoning (Popov, 1968), it belongs to the Forest-Steppe zone. For comparison, a study was conducted in Mykolaivka village of Bucha (Buchanskyi) District, Kyiv Region (*Oblast*) (Fig. 1). It is located in northern Ukraine, in the Kyiv Polissya zone, which is part of Ukrainian Polissya (the northern forest zone).

A mix of highlands and lowlands, with lowlands being more prevalent, characterizes the relief of the Left-Bank Forest-Steppe. The Dnipro Lowland

Fig. 1. Distribution map of the studied *Asclepias syriaca* populations

covers a significant portion of this area, while the eastern foothills of the East European Upland (also sometimes referred to as the Central Russian Upland) rise in the far east. The locality of the village of Mykolaivka belongs to the Polissya Lowland (part of the East European Plain), where flat and slightly undulating relief prevails, with minor differences in elevation.

Soils in the Left-Bank Forest-Steppe exhibit substantial diversity. Chernozems, including both podzolized and typical types, are predominant, while gray forest soils are also common. Additionally, meadow-chernozem and meadow soils are found in the lowlands, while peat soils are present in certain areas (Balaev et al., 2005). The soils include black soil in Kuntseve and Lelyukhivka, while the others consist of sandy and sandy loam types.

The primary soil types in Kyiv Polissya include sod-podzolic (light sandy loam and sandy), sod-weakly podzolic sandy loam, swampy and peat-swampy, and alluvial soils found along river valleys and streams (Balaev et al., 2005). Gray forest soils characterize the research area in Mykolaivka.

The territory of the Left-Bank Forest-Steppe belongs to the temperate climatic zone (Khilchevskyi et al., 2014). Based on data from the Branch State Archive of Hydrometeorological Observation Materials at the Borys Sreznevsky Central Geophysical Observatory, we compiled a database that allowed us to create climate diagrams. These diagrams illustrate the average monthly air temperature, °C (Fig. 2) and the total monthly precipitation (mm) recorded at the weather stations closest to the studied localities. Thus, Lelyukhivka, Pudly, and Sudivka are closest to Kobelyaky; Kuntseve is closest to Poltava; and Mykolaivka is closest to Kyiv.

The climate of the studied region features moderately cold winters and warm summers. At the Poltava weather station (Fig. 2A, D), the average annual temperature from 2011 to 2016 ranged between 7 and 9 °C. Since 2017, a clear warming trend has emerged, with the warmest years being 2020 (about 10.4 °C) and 2023 (approximately 10.9 °C). The maximum temperature reached 24.5 °C in July 2023. Winters in 2015, 2019, and 2020 were unusually warm, with temperatures staying above zero, while winters in 2012, 2014, 2016, and 2017 were colder. Spring is typically warming; from 2019 onward, March averaged above zero, and May was notably warm in 2013 (20.1 °C). From 2016 to 2024, summers have consistently been warm, averaging 22–24 °C, with rising temperatures noted in July and August.

In Kobelyaky (Fig. 2B, E), the lowest average temperature was recorded in 2016 at approximately 7.3 °C, with a rising trend of about 2.5 °C over the past 14 years. Winters after 2018 became milder, with 2016 and 2017 being colder, and 2020 notably

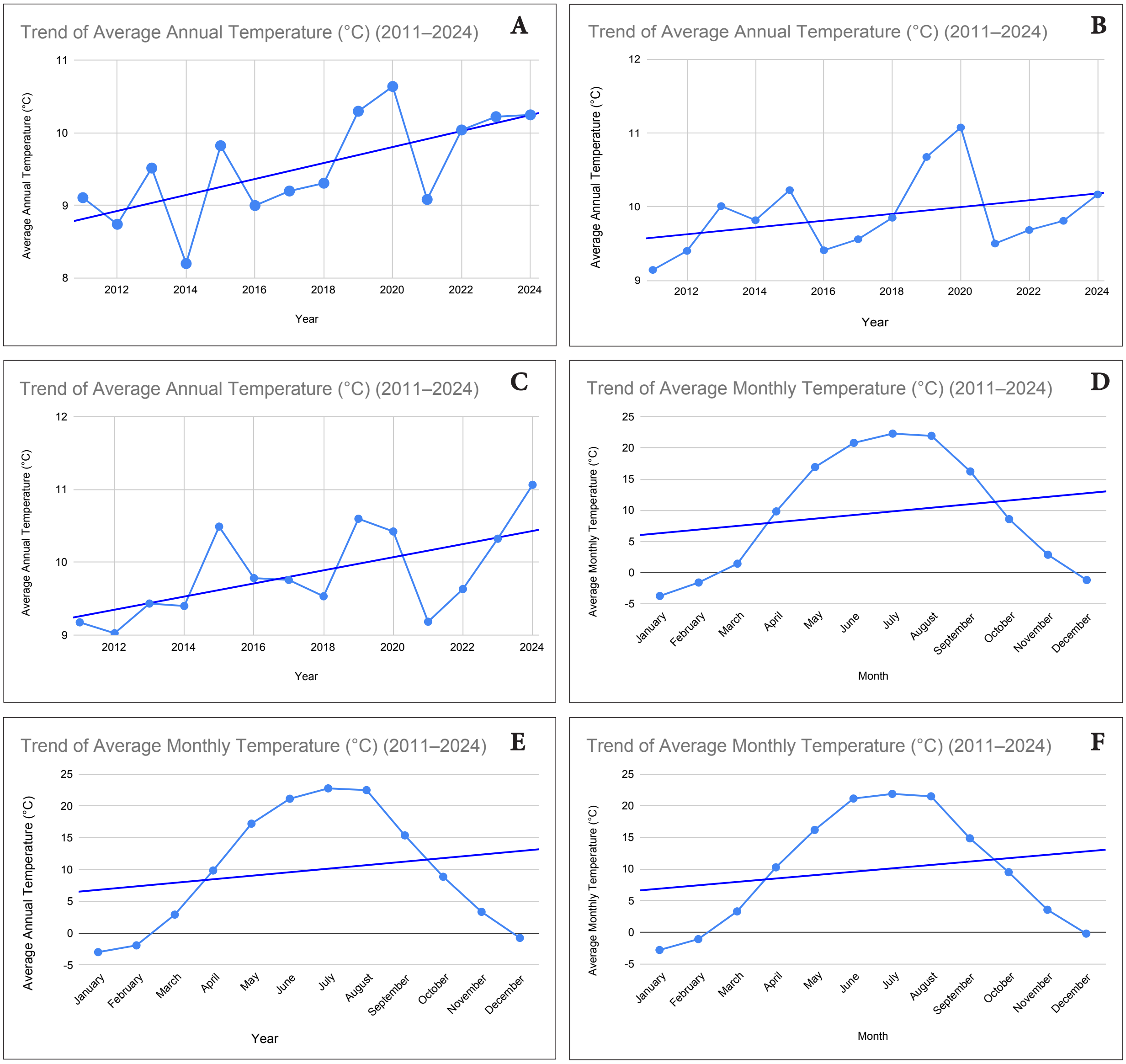

Fig. 2. Graphs of the trend of average annual temperature, and the trend of average monthly temperature (°C), 2011-2024. A, D: at the Poltava weather station; B, E: at the Kobelyaky weather station; C, F: at the Kyiv weather station

warmer. Summer temperatures reached 25.1 °C in July 2023, with trends showing a steady increase, especially since 2017.

At the Kyiv weather station (Fig. 2D, F), 2012 was the coldest year (≈ 9.03 °C), while 2023 was the warmest (≈ 11.04 °C). Since 2018, there has been a noticeable increase in the average temperature. January is the coldest month (around –2.81 °C), and July is the warmest (about 21.89 °C), with notable fluctuations including record lows in February 2012 and peaks in July 2021. The overall trend indicates ongoing climate warming.

Between 2011 and 2024, the climate has demonstrated a distinct warming trend. Winter months are becoming noticeably milder, with fewer frosty periods, while summers are experiencing more frequent heat peaks of 22–24 °C. Spring and autumn also show a gradual increase in temperatures, indicating a shift in climate norms toward overall warming. Consequently, winters are becoming shorter and warmer, and the annual temperature range is narrowing, with fewer severe frosts and more pronounced high-temperature peaks during summer.

One characteristic of the climate in the Left-Bank Forest-Steppe is its unstable moisture levels (Adamenko, 2014). According to the agro-climatic zoning, the area studied is classified as a weakly humidified zone (Adamenko, 2014). The highest peaks at the Poltava station occurred in June 2014 (134.3 mm), June 2021 (133.3 mm), and May 2016 (126 mm). The lowest values were recorded in September 2015 (4.4 mm), September 2016 (2.2 mm), and August 2018 (1.4 mm). The dynamics are highly variable, with sharp increases alternating with declines. For example, following the 2014 peak, values dropped significantly in 2015. After 2021, a tendency toward reduced fluctuations is observed, with no extreme values exceeding 100. The most "stable" years, showing moderate values, are 2019, 2022, and 2023. Data from the Kobelyaky station demonstrated a pronounced cyclical pattern, with distinct peaks recorded in 2016, 2018, and 2021. However, the subsequent period (2022–2024) indicates a downward trajectory. The variability of the series suggests a lack of stability, as values fluctuate considerably between 28 mm and 73 mm. Data from the Kyiv station exhibited a wave-like dynamic with pronounced peaks in 2013 and 2016, followed by an overall decline in 2024. Thus, the precipitation dynamics at the selected stations exhibit a wave-like pattern, where sharp increases alternate with declines. There is a noticeable trend of decreasing annual precipitation.

Analyzing archival climate data and literature (Adamenko, 2014), we observe that droughts are advancing into regions with sufficient moisture, increasingly covering wider areas. The area of the humid agroclimatic zone (Polissya) and the zone of unstable moisture (Forest-Steppe) is decreasing, while the arid zone (Steppe) is expanding. This shift is occurring alongside a steady increase in air temperatures throughout the year, particularly during the cold months and especially in July and August. Additionally, there is a rise in thermal resources in the region, though some areas are experiencing a slight decrease in annual precipitation.

This territory of Poltava Region is situated on the left bank of the Dnipro River. Numerous rivers drain the studied area, the largest being the basins of the Dnipro, Sula, Psel, and Vorskla rivers (Khilchevskyi et al., 2014).

Data and methods

Based on the original data of our field research, the analysis of herbarium specimens from CHER, CWU, DNU, KHER, KW, KWHA, KWHU, LW, LWKS, LWS, and PWU (Shiyan, 2011), together with data from open-access databases such as GBIF (2025-onward), UkrBin (2025-onward), and iNaturalist (2025-onward), and literature data, a comprehensive database documenting the distribution of the common milkweed has been compiled, and it currently contains over 2.500 localities. A distribution map was compiled using SimpleMappr (https://www.simplemappr.net/), and Google Maps (https://www.google.com/maps).

The populations studied inhabit various types of habitats. In segetal areas, we found *A. syriaca* in Lelyukhivka in a soybean field, and in Pudly and Kuntseve in areas which feature deserted private gardens. In Mykolaivka, we observed it in an abandoned field. In a semi-natural setting, the population in Sudivka is located at the forest edge within a *Pinus sylvestris* L. plantation.

We established randomly selected plots within the population field, each measuring 1 × 1 m. The number of plots varied based on changes in the population field, ranging from one plot (Sudivka, Lelyukhivka, Pudly) to 10 (Kuntseve) and 12 (Mykolaivka) plots.

Population studies were conducted according to the method of Zlobin (1989, 2009; Zlobin et al., 2013). Considering the biological characteristics of the studied species, we use the aboveground shoot as the accounting unit.

Among the ontogenetic periods, we distinguish three. Pre-generative is the period that encompasses the growth of the plants from seedlings to fully mature vegetative plants. The generative period pertains to individuals that are in the flowering and fruiting stages. Post-generative is a period of senescence, when individuals cease growth and reproduction and gradually die out.

During our study of the phenological phases of the species, we recorded the onset of emergence, flowering, fruiting, and seed dispersal, using Holdrege's image and data (Holdrege, 2010) as a reference.

The number of individuals in a population is defined as the total count of population units within it. For small plots, we conducted a complete count of shoots. In larger plots, we estimated the total size of the population area, determined the average

Fig. 3. Geographical distribution of *Asclepias syriaca* in Ukraine

population density by counting shoots in sample plots, and then calculated the average total number of shoots in the entire population. Population density is measured as the number of individuals per unit of area (e.g., 1 × 1 m). When studying the spatial organization of common milkweed populations, we recorded the locations of individuals within the population area, as well as in the sample plots.

The spatial structure, i.e., the nature of the individual's placement within populations, was defined following Kershaw (1964) and Zlobin (1989, 2009). This is the position of plant individuals (ramets / above-ground shoots) in the population area.

Based on the accounting method outlined by Minarchenko (2014), we measured the density of the stock by weighing the freshly harvested raw materials per unit area. The results are expressed in grams per square meter (g/m^2). Additionally, we conducted a second weighing of the dried raw materials.

Results and Discussion

The species is a kenophyte that was introduced to Europe during the late 17th and early 18th centuries (Bagi, 2008). In Ukraine, the wild-growing (escaped) plants were first recorded in Vinnytsia Region at the end of the 19th century: "*Asclepias syriaca* L. Mohileff. Dniester, Podolia gub. ... Montresor, 16 Aug." [sine datum, probably middle of the 1880-1890s]. Montresor" (KW, s.n.).

Common milkweed is native to North America (Woodson, 1954; Bhowmik, Bandeen, 1976; POWO, 2025–onward). The species is commonly found in a variety of habitats in the primary range, including plains, slopes, ridges, valleys, fields, meadows, pastures, ditches, and the banks of ponds and lakes. Additionally, it thrives in swamps, bogs, parks, urban areas, stream banks, hollows, precipices, sand hills, prairies, and forest clearings and edges, as well as in coastal forests (Fishbein, 2023). The species is found in many European countries (Follak et al., 2021). It is considered invasive in Hungary (Bagi, 2008; Zalai et al., 2017; Meinhardt et al., 2024; Tölgyesi et al., 2024), Romania (Sîrbu et al., 2021), Bulgaria (Petrova et al., 2013), Croatia (Boršić et al., 2008, 2018), Bosnia and Herzegovina (Maslo, 2016), Germany (Nehring, Skowronek, 2017), and potentially invasive in Widuchowa, Poland (Bacieczko, Borcz, 2015). The European Union, by Regulation (EU) No 1143/2014, lists the common milkweed as one of the invasive alien species. Since 2017, *A. syriaca* has been included in the Union List, which prohibits the keeping, importing, selling, breeding, and growing of this species within the European Union, as outlined in Article 7 of the Invasive Alien Species regulation (Commission Implementing Regulation (EU) 2017/1263). In the

Fig. 4. Rhizomes of *Asclepias syriaca*. A: gray forest soils; B: black soil

GBIF database (GBIF, 2025–onward), there are available entries for Mexico, Australia, and Kazakhstan. However, the records for Australia and Mexico are considered likely incorrect (Follak et al., 2021).

In recent decades, the species has rapidly spread and become naturalized in Ukraine. The highest density of its localities is found in the central region of Ukraine's Forest-Steppe (Fig. 3). It seems to be completely absent in Crimea, with isolated localities found in the southern, southeastern, and eastern regions of Ukraine. *Asclepias syriaca* is distributed in various types of habitats; ruderal and segetal habitats predominantly occupy roadsides of transport routes, areas near cultivation centers (such as botanical gardens, homesteads, and flowerbeds), and semi-natural areas (including forest edges and meadows).

Asclepias syriaca is a perennial rhizomatous plant with erect herbaceous, mainly unbranched, and annually dying off above-ground shoots up to 1.5–2.0 cm in diameter, 93–220 cm high. The rhizome of this species is plagio-orthotropic, highly branched (Fig. 4), which enables it to adapt to various types of soil.

The rhizomes of the plant from different localities show some variation (Fig. 4). In gray forest soils, the population is relatively young (established in 2012), and the plant rhizomes exhibit fewer branches (Fig. 4A) as compared to those of another population on black soils (Fig. 4B), which has existed for over 20 years. Nevertheless, in both cases, the populations are thriving.

This species is classified as an implicitly polycentric biomorph, as it possesses multiple growth centers that are located so closely together that distinguishing between them is quite challenging. The species under investigation is a typical polycarpic, characterized by a life cycle in which the generative phase lasts significantly longer than both the pre-generative and post-generative periods (Table 1).

Studying phenology reveals plant's biological characteristics, as examining its seasonal development and phenological phases helps identify patterns in its life cycle (Stupak, 2023). In addition, such studies help develop measures to manage invasive species, including common milkweed. Some

Table 1. **The ontogenetic periods for the studied *Asclepias syriaca* populations**

Ontogenetic period	Period in 2011	Period in 2024
Pre-generative	May 11 — June 9	April 20 — May 30
Generative	July 4 (by Holdrege) / June 10 — August 15	June 6 (July 10) — flowering and until September 5 fruiting
Post-generative	From August 28	From September 16

stages of phenological development of *A. syriaca* are depicted in Fig. 5.

The data from 2011 are consistent with the North American findings of Holdrege (2010). We have supplemented his data according to our observations. The time of sprouting depends on the temperature regime; the earlier the air temperature rises, the earlier the sprouts appear. At present, the first shoots (Fig. 5; April 10) typically appear in late April, when the air temperature is between 8 °C and 10 °C (Fig. 2), to early May, when the air temperature is between 12 °C and 20 °C (Fig. 2). Aboveground shoots develop over a month, leading to an increase in the plant's height and the number of leaves. The flowering phase begins in June and July, followed by fruiting from mid-July to September (Table 1, Fig. 5). Seed dispersal continues from September until the first frosts. After this period, the shoots die off and usually persist in a dry state until spring. Over 14 years of observation, we have noted a shift in the timing of phenophases, likely due to climatic factors, specifically warming. Consequently, minor shifts in phenological phases, such as the earlier emergence of seedlings and the somewhat earlier onset of flowering and fruiting, are indicative of warming.

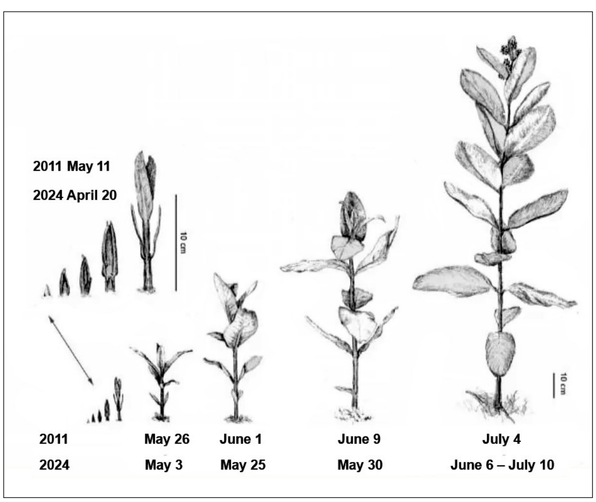

Fig. 5. Some stages of phenological development of *Asclepias syriaca* (based on Holdrege (2010), with dates from the present study)

Asclepias syriaca exhibits two primary growth forms, resulting in either the development of a composite individual or the establishment of a colony. The term "colony" is here synonymous with the term "clone", which is widely accepted. The components of an individual have closely arranged ramets, maintaining a consistent connection with the maternal individual and with each other. The type of clone we are discussing is classified as population-coenotic. In this context, a clone consists of a collection of ramets that share a common origin and occupy a specific area. These ramets do not necessarily exhibit morphological or physiological similarities with one another, but they collectively represent a distinct morphological and coenotic integrity. It is important to note that plants of the same species can produce multiple types of clones simultaneously. We believe this also applies to common milkweed. One possible variant of the clone type is genetic and physiological. However, we have not conducted studies to confirm the genetic similarity of individuals in a clone or the metabolic differences between ramets. Another type is morphostructural, which refers to a collection of ramets situated close to the mother plant and connected through underground or aboveground stem-root formations. One piece of evidence for the morphostructural type is an experiment that involves physically damaging shoots by completely cutting them. This leads to the formation of new shoots next to where the old ones previously grew.

We have examined the spatial structure of populations, which has significant ecological implications. The diversity of spatial organization enables populations to utilize environmental resources and minimize intraspecific competition efficiently. As a result, they can strengthen their positions within their habitats. Additionally, the spatial structure facilitates interactions among individuals within populations, a phenomenon commonly observed during the self-thinning process.

The spatial structure of populations is determined by the arrangement of individuals within a habitat, leading to typical distribution patterns. Our research has identified two types of horizontal

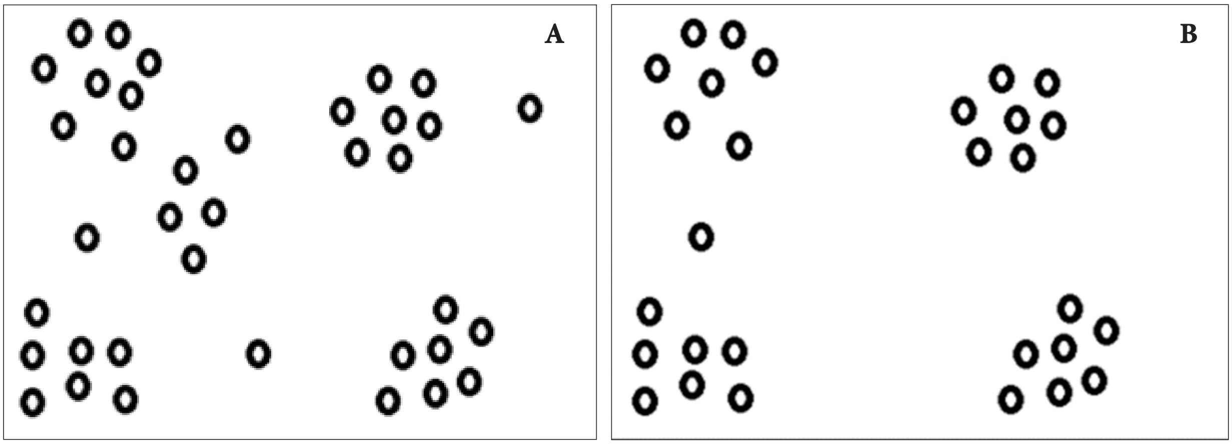

Fig. 6. Type of spatial arrangement of *Asclepias syriaca* individuals in the population field. A: random-contagious; B: contagious

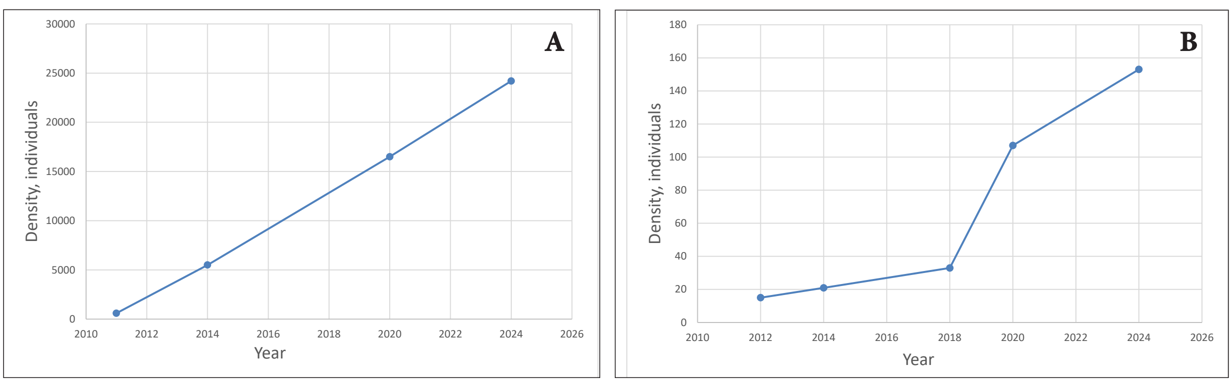

Fig. 7. The number of the *A. syriaca* individuals. A: in Kuntseve village; B: in Sudivka village

structures typical of common milkweed populations: random-contagious and contagious (Fig. 6).

In the random-contagious type of individual placement within a population field, individuals are randomly positioned, resulting in clusters of individuals. Most cases of randomness, or some distance from shoot accumulation centers, result from specific impacts, such as mowing, uprooting, or chemical treatment. The contagious type, or cluster of individuals — or a group, curtain, or mosaic — is influenced by their habitat, the unique characteristics of their ontogeny, and reproduction under specific conditions, as well as various external factors. It is important to highlight that most populations exhibit spatial heterogeneity. The populations of the *A. syriaca* exhibit a specific phytocoenotic pattern.

Population characteristics are commonly evaluated in terms of size and density. Within the 1 × 1 m sampling plot found in the village of Kuntseve (Poltava Region), shoot density ranged from 35 to 55. In 2011, the occupied area of the studied species was 3 × 4 m; by 2014, it had expanded to 10 × 10 m, further increasing to 15 × 20 m in 2020, and to 20 × 22 m in 2024. Consistent with this spatial expansion, the number of *A. syriaca* shoots increased from 600 in 2011 to 5 500 in 2014, 16 500 in 2020, and 24 200 in 2024 (Fig. 7). Overall, the number of shoots in this population increased nearly 40-fold over the 14-year observation period.

In the area near Sudivka village in Poltava Region, the species was first observed at the edge of an artificial plantation of *Pinus sylvestris*. In 2012, there were 15 shoots; by 2018, this number had increased to 33, occupying an area of 2 × 2 m. In 2020, the number of individuals increased to 107 shoots, covering 1.5 × 4.0 m. By 2024, the population had reached 153 shoots, occupying an area of 2 × 8 m (Fig. 7B).

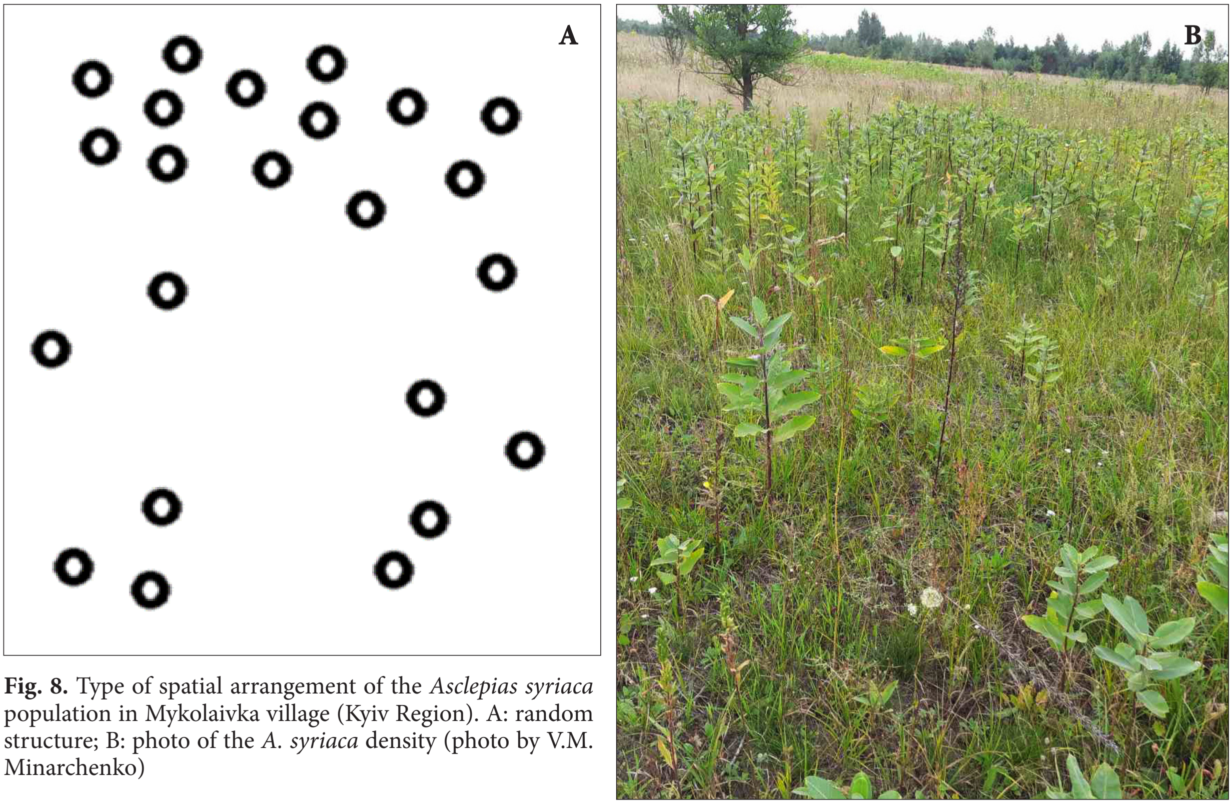

Fig. 8. Type of spatial arrangement of the *Asclepias syriaca* population in Mykolaivka village (Kyiv Region). A: random structure; B: photo of the *A. syriaca* density (photo by V.M. Minarchenko)

We observed a tenfold increase in the common milkweed population. Notably, shoots recorded in 2012 and 2013 did not produce fruits; by 2020, only nine shoots fruited, whereas by 2024, more than half had flowered. This delayed reproductive success is likely attributable to unfavorable microhabitat conditions, as the species occurred entirely beneath the canopy of *Pinus sylvestris* for several years. In 2014, however, 50% of the shoots fruited as most individuals expanded into illuminated areas, with only four remaining under the pine canopy. By 2024, the population was predominantly in well-lit habitats, with just eight shoots persisting in shaded conditions.

In 2023, the *A. syriaca* population was observed in Pudly. This population consisted of 101 shoots, occupying an area of 2.7 × 2.6 m, resulting in an average population density of 25 shoots per square meter. A notable characteristic of the species in this area is the curling of the leaves. By 2024, the population density had increased to 52 shoots per square meter. The total area is approximately 3.5 × 4.0 m with an estimated population size of about 200 shoots. A self-thinning process has been observed within the population. Shoots were also found emerging at a distance of 0.5 m from the main cluster. This year, it is observed that the lower leaves of all shoots have turned yellow and are gradually falling off during the flowering period. Over the year, the number of population individuals has doubled. The causes of the leaves' yellowing and curling remain unidentified.

In 2019, a new locality of common milkweed was recorded among soybean crops in Lelyukhivka. The population consisted of 17 individuals, occupying an area of 0.5 × 0.5 m. Of these individuals, five were flowering and six showed damage characterized by leaf twisting. In 2023, only four shoots were noted. However, systematic spot chemical treatments were applied to this site throughout the entire observation period, and by 2024, the population disappeared.

A somewhat different situation was observed in Mykolaivka village (Kyiv Region). The spatial structures of this common milkweed population are random (Fig. 8).

This population emerged around 2003 and is gradually expanding its area. In the plots, the number of individuals varies from five to 24. The species occupies an area of approximately one hectare, resulting in a population density of about 240.000 shoots per hectare. Based on our analysis of the data, we conclude that all studied populations of *A. syriaca* are growing and expanding. By the type of vitality, the populations are prosperous.

We also compared our data with similar existing data. We found that the number of shoots is a variant trait influenced by biotype types and both biotic and abiotic factors.

Populations of ruderal habitats in Western Slovakia exhibit a high density, with 45 shoots per square meter recorded. Similarly, an abandoned vineyard in Central Slovakia showed 33 shoots per square meter (Valachovič, 1987; Pauková et al., 2013). These high densities are also observed in populations from Poltava Region. In contrast, a lower density was noted in an abandoned vineyard in Hungary, ranging from 7.4 to 18.1 shoots per square meter in an abandoned field (Csontos et al., 2009). North American studies report even lower figures, with only 1.2 to 8.8 shoots per square meter (Bhowmik, Bandeen, 1976). These lower densities may occur either during the initial establishment of a species in a new area or because of self-thinning processes. Intraspecific competition likely leads to a gradual decrease in population density and range expansion. This phenomenon is a characteristic of *A. syriaca* populations.

Regarding the determination of stock density, we obtained the following results. In 2022, when weighing fresh raw materials (aboveground shoots) in the village of Kuntseve, the weight ranged from 3.5 to 4.0 kg, while the dry weight ranged from 2.8 to 3.0 kg. The number of shoots per square meter was 32–36.

Upon re-examination in 2024, the weight of freshly harvested raw materials ranged from 1.00 kg to 3.08 kg. Correspondingly, the weight of dry raw materials varied from 0.47 kg to 2.79 kg. The number of shoots observed during this period ranged from 20 to 45.

At the experimental site in Mykolaivka village, we recorded the weight of freshly harvested raw materials ranging to 1.530 kg, with dry raw material weights 0.80 kg. In this instance, the number of shoots ranged from 10 to 16.

In both locations, we noted that weight loss was minimal (up to 1 kg). Significant variations in weight can be attributed to the spatial structure of the population field and the density of the rafts. Importantly, climatic conditions do not appear to affect the resource density of *A. syriaca*. The relatively high indicators of stock density suggest promising potential for utilizing this species in industry, such as to produce biofuels or in the pharmaceutical industry.

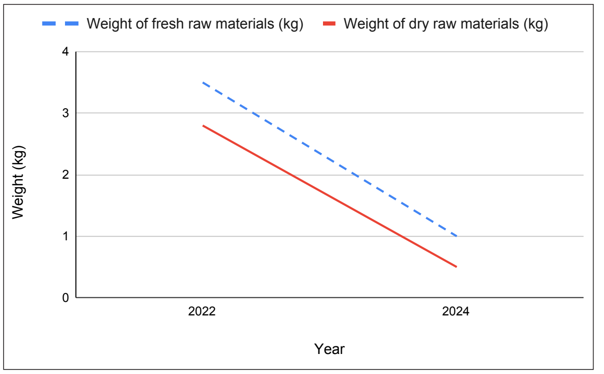

Fig. 9. The stock density of *Asclepias syriaca*

Conclusion

The monitoring studies described above were conducted for the first time in Ukraine. The analysis of selected climate data demonstrates a clear shift in climate over the past 14 years. A trend toward warming and a reduction in annual precipitation is observed. However, it is essential to consider local climatic conditions. For example, in 2018, a flood occurred in Ukraine, and the common milkweed population field was submerged. Therefore, the species can tolerate temporary waterlogging as well as dry periods.

Notably, climatic changes have influenced the phenology of *A. syriaca*, particularly the earlier emergence of seedlings. It was hypothesized that the prolonged lifespan of shoots would lead to increased biomass; however, this expectation was not supported. Despite consistently high shoot density, the stock of raw material did not differ substantially across sites. At the same time, other structural characteristics of the populations appeared unaffected by climate changes and trends.

Populations of the species are thriving and constantly growing due to their complex biology, ecological timing, and behavior. The gradual expansion of this species' range observed over the past decade is likely due not only to the methods of introduction, whether intentional by humans through seeds or unintentional during land cultivation, but also to competition within the species itself. We believe this is a regular characteristic of the species, observed not only in Ukraine but also throughout Europe and the USA.

Thus, conducting population monitoring studies of invasive species allows for their control and timely eradication, which are effective means of reducing their further spread. We saw this in one of the examples provided above.

ETHICS DECLARATION

The authors declare no conflict of interest.

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Структура та динаміка популяцій *Asclepias syriaca* в межах Лівобережного Лісостепу України

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Реферат. *Asclepias syriaca* — кенофіт північноамериканського походження, клональна рослина, що здатна утворювати колонії. На основі опрацювання значного масиву гербарних, літературних відомостей, відкритих баз даних з біорізноманіття та власних польових даних, нами складено сучасну карту поширення *A. syriaca* в Україні. Виявлено, що найвища концентрація локалітетів виду спостерігається в межах Лісостепу. Комплексне популяційне дослідження проведено із застосуванням класичних методів; обліковою одиницею був визначений надземний пагін. Основну увагу дослідження зосереджено на чотирьох популяційних полях виду у межах Лівобережного Лісостепу (Полтавська обл.) та, для порівняння, на одному в Українському Поліссі (Київська обл.). Досліджувані популяції є процвітаючими і постійно зростають. Дослідження показують, що внутрішньовидова конкуренція (самопроріджування) сприяє розширенню займаної території. Під впливом тенденцій змін клімату (зокрема, потепління та зменшення річної кількості опадів), зафіксованих упродовж останніх 14 років, спостерігається зсув фенофаз — відростання пагонів *A. syriaca* відбувається на три тижні раніше. Водночас інші параметри популяцій істотно не змінюються.

Ключові слова: *Asclepias syriaca*, адвентивний вид, інвазійний вид, структура та динаміка популяції