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STRUCTURE AND POPULATION DYNAMICS OF *ASCLEPIAS SYRIACA* L. IN THE AGRICULTURAL LAND

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This paper evaluates the selected population-biological characteristics and size structure of invasive neophyte *Asclepias syriaca* in three habitat types (abandoned vineyards, grassland and road side) in the district of Veľký Krtíš in Central Slovakia. Three permanent research plots (1 m × 1 m) were established and monitored during the growing season in 2012. The density of the population at the end of the growing season ranged from 15 to 29 stems per m^2. The greatest average plant height was recorded in the roadside plot (129 cm) and the lowest in the abandoned vineyard (92 cm). Main stem thickness reached 1.5–2.0 cm at the base. The highest number of main stem leaves was recorded at the end of June and July (from 24 to 27). The number of inflorescences varied from 1.6 to 3.4 and the number of fruits ranged from 1.2 to 3.8 per generative stem. Statistically significant differences were found in the plant height, thickness of the main stem and the number of fruits at the three different locations.

Key words: *Asclepias syriaca*, population-biological properties, size structure, agricultural land

The expansion of potential invasive plant or expansive plant species from urban areas into abandoned vineyards, neglected fields, degraded habitats and other areas in agricultural land is possible and can threaten biodiversity and their removal can cause expense to farmers and land owners. Such species include Common Milkweed (*Asclepias syriaca* L.). Common Milkweed (*Asclepias syriaca* L., *Asclepiadaceae*) is a dicotyledonous perennial weed, native to Canada, north, central north-eastern and south-eastern United States (Bhowmik & Bandeen 1976; Cramer & Burnside 1982). The species is characterised by erect stems with large leathery leaves and well-marked pink flowers. It blooms from June to July. Fruits are oblong-ovate shaped pods with a white pericarp. Seeds with plumes of white shiny hairs ripen in August and September. *Asclepias syriaca* reproduces by seed and by adventitious buds on its roots (Bhowmik & Bandeen 1976; Valachovič 1989, 1991). The species was introduced to Europe from the eastern part of Northern America as an ornamental plant in the 19th century (Bhowmik & Bandeen 1976; Cramer & Burnside 1982). Medvecká *et al.* (2012) state that the first occurrence of this taxon in Slovakia was in 1917. Due to its spread in Slovakia, it is considered as a potential invasive neophyte (Gojdičová *et al.* 2002; Medvecká *et al.* 2012). The most common habitats are hot and dry sites in southern Slovakia, namely habitats along railways, ditches, fields adjacent to roads and in agroecosystems. The species can cause yield losses to farmers. Many authors have previously studied the biology and distribution of this species in the world (Bhowmik 1978; Bhowmik & Bandeen 1976; Cramer & Burnside 1982; Campbell 1984; Hartzler & Buhler 2000; Csontos *et al.* 2009 and others); as well as in Slovakia Ružička (1952), Valachovič (1987, 1988, 1989, 1991), Medvecká *et*

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al. (2012) and others. This paper presents the results of the evaluation of selected population-biological characteristics and size structure of potentially invasive neophyte *A. syriaca*, which is currently spreading in some localities of Central Slovakia. However, according to Act No. 543/2002 on Protection of Nature and Land in Slovakia and the Decree of the Ministry of the Environment No. 173/2011, Common Milkweed does not belong to the invasive plant species that need to be removed. Expansively spreading plants of Common Milkweed represent a great threat to the agricultural land, especially near cultivated land. It was demonstrated that the values of several reproductive traits of the studied populations exceeded the values reported for the native populations (Bhowmik & Bandeen 1976). It forecasts that *A. syriaca* could become an invasive plant in Slovakia.

MATERIAL AND METHODS

Three study sites were selected in the Ipeľ valley in the region of its tributaries: the Krtíš and the Plachtinský, in the vicinity of villages Selešťany, Sklabiná and Nová Ves in the district Veľký Krtíš, Banská Bystrica County, Central Slovakia. The altitude of the villages is approximately 160 m above sea level. It belongs to the hot and dry climate zone. The annual rainfall is around 600 mm. Soils are brown, illimerised, alluvial and floodplain (Michal 2003). Climadiagrams that present the average air temperature (°C) and total monthly precipitation (mm) in the village of Dolné Plachtince in the observed district are shown in Figure 1.

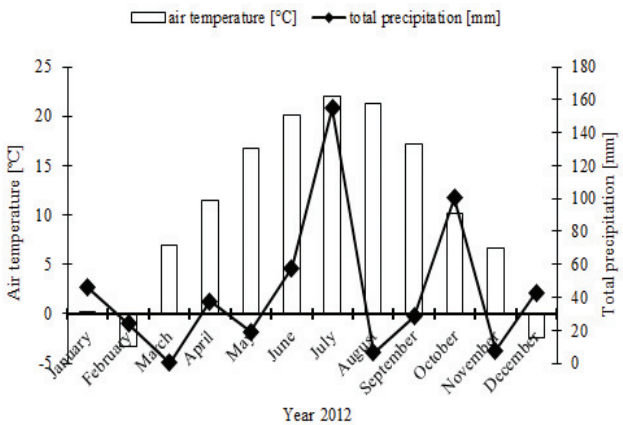

Figure 1. Climadiagrams for the year 2012 at the research site in the district of Veľký Krtíš (SHMÚ 2013, processed by the authors)

Selected populations of *A. syriaca* were studied in three different habitats: an abandoned vineyard (A) in the village of Selešťany, grassland (B) in the village of Sklabiná and along the roadside (C) in the village of Nová Ves. The observations were done in three non-destructive plots (1 m × 1 m) in each habitat by the random plot selection method. The investigated plots were located in the interior of the stands to avoid edge effect. Population density (stem per m^2) was determined by the method of repeated census of stem (ramet). The height of the main stem (cm) was measured from the soil surface to the apical part of the stem by folding rule. The thickness of the main stem in the base (cm) was measured by calliper (16FN Mahr). The number of leaves of the main stem, the number of inflorescences and the number of fruit per generative stem were monitored using the repeated census method. After obtaining the variables, the following parameters were calculated: the average density of populations, the average height of plants, the average thickness of the stem base, the average number of the main stem leaves, the percentage of generative stems, the percentage of stems with fruits, the average number of inflorescences and fruits per stem and per generative stem (Table 4). The size structure was evaluated on the basis of size classes with the same range of values. The nomenclature of accompanying species was adjusted according to Marhold *et al.* (1998). Field measurements were carried out at regular monthly intervals from April to September during the growing season in 2012 (29 April, 26 May, 28 June, 30 July, 31 August and 29 September). The comparison of the means of population-biological characteristics and size structures among the three study sites was done by statistical analysis ANOVA in Statgraphics Centurion by Kruskal–Wallis Test and LSD test. Significant differences were accepted at $P < 0.05$.

RESULTS AND DISCUSSION

Site A (abandoned vineyard) was covered by *Centaurium erythraea* Rafn, *Rubus fruticosus* L.,

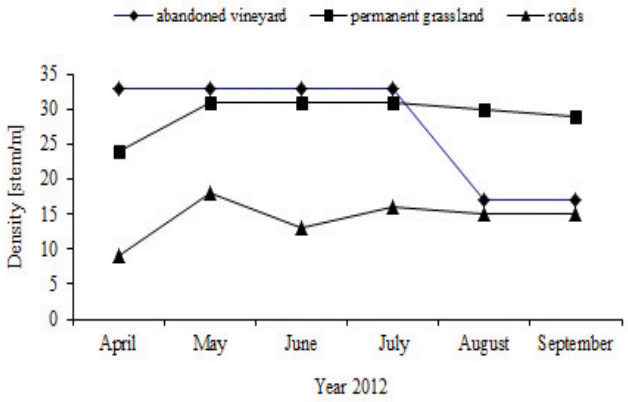

Figure 2. Dynamics of the number of stems of *Asclepias syriaca* in different habitats during the growing season of 2012 in Central Slovakia

Sambucus ebulus L. and *Verbascum densiflorum* Bertol. with vegetation coverage of 20%. Here, *A. syriaca* colonised a 1260-m^2 area. Site B (grassland) colonised area was 4508 m^2 and site C (roadside) colonised area was approximately 120 m^2. The major accompanying species at sites B and C consisted of *Achillea millefolium* L., *Centaurea jacea* L., *Cichorium intybus* L., *Cirsium arvense* (L.) Scop., *Convolvulus arvensis* L. and *Rubus fruticosus* L. with a coverage of 30–40%. Valachovič (1987) states that *A. syriaca* dominates in ruderal stands accompanied by *Artemisia vulgaris*, *Galium aparine*, *Solidago gigantea*, *Stenactis annua* and *Urtica dioica* in West Slovakia.

The highest population density was found in the abandoned vineyard (33 stems per m^2) until the end of July, then it decreased by the self-thinning process to 17 individuals in August, when the total rainfall was only 6.3 mm. The density dynamics of the population growing along the roadside (site C) resulted with the maximum value in May (18 stems per m^2; Figure 2). In comparison, Valachovič (1989) observed higher density (45 stems per m^2) of the population in ruderal stands in West Slovakia. Csontos e*t al.* (2009) indicate lower density of Common Milkweed in Hungary that varied between 7.4 (in abandoned vineyard) and 18.1 stems per m^2 (in neglected field). The number of individuals of *A. syriaca* recorded by Bhowmik and Bandeen (1976) in North America was only 1.2–8.8 stems per m^2.

The assessment of the size structure of *A. syriaca* populations at the end of the growing season showed that about 79% of the plants on grassland reached heights from 102.3 to 113.3 cm. The maximum height of plants was observed along the roadside, where 20% of the stems varied from 146.7 to 157.7 cm (Figure 3).

In general, we can conclude that our study confirmed statistically significant difference in the median value of the main stem height (P = 0.005), stem thickness (P = 0.00038) and the number of fruits (P = 0.0000025) at the three different locations. The summary statistics of these characteristics are shown in Tables 1–3. The values with different letters (A,

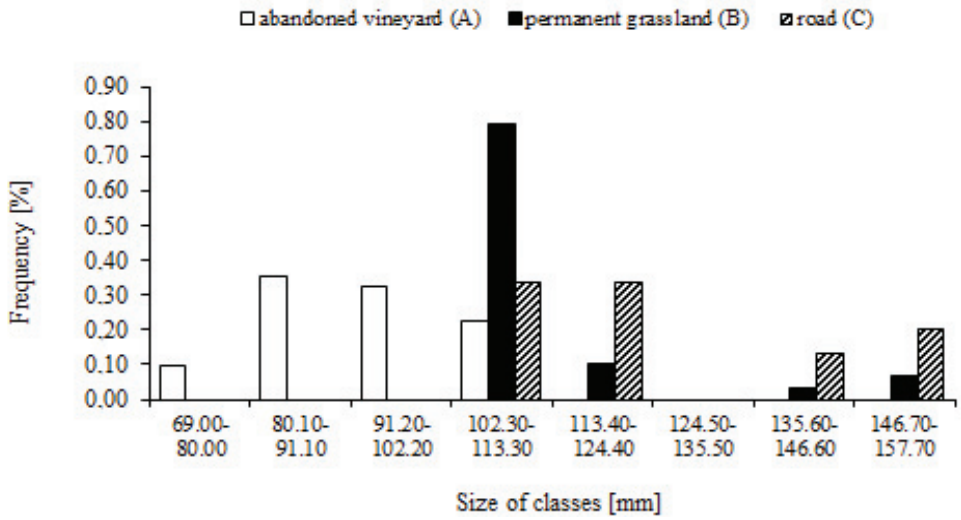

Figure 3. Size structure of *Asclepias syriaca* in different habitats at the end of September, 2012, in Central Slovakia

B, C) in columns indicate statistically significant differences according to the Kruskal–Wallis test ($P < 0.05$). The statistically significant difference was not confirmed in the number of leaves of the main stem and the number of inflorescences at the three observed habitats.

Shannon and Wyatt (1986) discussed the life strategy of *Asclepias exaltata*. After seed germination, the seedlings spent several years as non-flowering plants and stored photosynthetic resources in the roots. When the plants stored certain resources, they produced inflorescences but no mature fruits. These plants produced only pollen for pollination of older plants. After having accumulated enough resources, the plants produced mature fruits. In our study, the percentage of generative stems of

T a b l e 1

Summary statistics of the main stem height of *Asclepias syriaca* in the district of Veľký Krtíš in July 2012 ($P < 0.05$)

Habitats/statistic characteristics	Count [stems/m^2]	Average [m]	Median [m]	Standard deviation	Coefficient of variation [%]	Minimum [m]	Maximum [m]	Range [m]	Standard skewness	Standard kurtosis
Vineyard	33	0.92	0.96^a	0.13	14.15	0.46	1.10	0.64	–3.53	4.12
Grassland	31	0.94	0.95^a	0.09	10.30	0.69	1.13	0.44	–0.71	0.14
Roadside	16	1.08	1.07^b	0.16	14.74	0.84	1.37	0.53	0.40	–0.53
Total	80	0.96	1.01	0.14	14.28	0.46	1.37	0.91	–0.32	4.25

Values with different letters (a, b) in column indicate statistically significant difference

T a b l e 2

Summary statistics of the main stem thickness of *Asclepias syriaca* in the district of Veľký Krtíš in July 2012 ($P < 0.05$)

Habitats/statistics characteristic	Count [stems/m^2]	Average [cm]	Median [cm]	Standard deviation	Coefficient of variation [%]	Minimum [cm]	Maximum [cm]	Range [cm]	Standard skewness	Standard kurtosis
Vineyard	33	1.68	1.70^a	0.15	8.95	1.00	1.80	0.80	–6.99	14.70
Grassland	31	1.68	1.70^a	0.11	6.70	1.50	2.00	0.50	1.78	0.83
Roadside	16	1.82	1.80^b	0.11	6.16	1.70	2.00	0.30	1.18	–0.63
Total	80	1.71	1.70	0.14	8.23	1.00	2.00	1.00	–4.56	13.49

Values with different letters (a, b) in column indicate statistically significant difference

T a b l e 3

Summary statistics of the number of fruits of *Asclepias syriaca* in the district of Veľký Krtíš in July 2012 ($P < 0.05$)

Habitats/statistic characteristics	Count [stems/m^2]	Average [piece]	Median [piece]	Standard deviation	Coefficient of variation [%]	Minimum [piece]	Maximum [piece]	Range [piece]	Standard skewness	Standard kurtosis
Vineyard	33	1.96	2.00^b	1.93	97.89	0.00	6.00	6.00	0.63	–1.63
Grassland	31	0.77	1.00^a	0.92	118.89	0.00	3.00	3.00	2.34	0.37
Roadside	16	4.19	4.50^c	1.79	42.91	0.00	6.00	6.00	–1.94	0.71
Total	80	1.95	2.75	1.99	102.53	0.00	6.00	6.00	2.14	–1.85

Values with different letters (a, b, c) in column indicate statistically significant difference

T a b l e 4

Population-biological characteristics of *Asclepias syriaca* in the villages of Selešťany (A), Sklabiná (B) and Nová Ves (C) in Central Slovakia in 2012

Habitats/population-biological characteristics	Abandoned vineyard (A)	Grassland (B)	Roadside (C)
Density [stems/m^2] in June	33.0	31.0	13.0
Percentage of reproductive stems [%] in June	79.4	46.9	71.4
Percentage of stems with pods [%] in July	58.8	25.0	62.5
Number of inflorescences per reproductive stem [piece]	3.4	1.6	1.9
Number of inflorescences per stem [piece]	2.7	0.7	1.2
Number of pods per reproductive stem [piece]	2.5	1.2	3.8
Number of pods per stem [piece]	2.0	0.5	2.3
Number of pods per number of inflorescences on a stem [piece]	0.7	0.7	2.1

Common Milkweed varied from 46.9 to 79.4 in Central Slovakia (Table 4). Csontos *et al.* (2009) observed higher values for both the percentage of reproductive stems (89–98%) and the number of inflorescences per reproductive stem (from 3.1 to 5.1) in two neglected fields and one abandoned vineyard in Hungary. Valachovič (1989) reported 0.5 pods per stem in populations growing along railways in Western Slovakia. This corresponds to our results obtained on the grassland (site B). Higher values were observed on the abandoned vineyard (site A) and on roadside (site C) (2.0 and 2.3, respectively; Table 4).

CONCLUSIONS

The assessment of the size structure and population dynamics of neophyte *A. syriaca* in Central Slovakia showed statistically significant differences in the stem height, main stem thickness and number of fruits in three different habitats: abandoned vineyard, grassland and roadside. The highest population density was reached in May and in June, after which the intraspecific competition leads to a gradual decrease in the density. Optimal flowering was in June. Maximum number of leaves was observed in June and July. Significant foliage decrease occurred at the end of the growing season. Expansively spreading plants of Common Milkweed represent a great threat to the agricultural land, especially near cultivated land. It was demonstrated that the values of several reproductive traits of the studied populations exceeded the values reported for the native populations. It forecasts that Common Milkweed could become an invasive plant in Slovakia. Its sporadic occurrences recognised to date, most probably, do not correspond to the final range of distribution of Common milkweed in Slovakia, but instead the currently existing populations represent the third stage of establishment in a staircase model of invasion. Therefore, we recommend further surveying of the structure and dynamics of *A. syriaca* populations in Slovakia, including studies on seed production, seed dispersal, soil seed bank and biological control of the species.

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