POPULATION DYNAMICS OF RAMETS *ALLIUM URSINUM* L. IN SOUTH-WESTERN SLOVAKIA

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ABSTRACT

Allium ursinum (*Liliaceae*) is bulbiferous spring ephemeroid and geophyte with underground organs bulbs. Population dynamics of *Allium ursinum* ramets were studied in woodland communities (with *Acer campestre, Acer pseudoplatanus, Fraxinus excelsior*) in park in Hlohovec (SW Slovakia) on four permanent plots (025 x 025 m) during growing seasons (2001-2003) in 14-days interval. Field measurements we realized with usual methods of population biology (Harper, 1977). Analyzed plots were selected by random selection. Observed characteristics were – density of populations (individual.1m^{-2}) and size structure of population. Self-infilling was observed to second census (in March) and than decrease density ramet between 5. and 6. census (in May). In April 2003 we observed the highest average densities (720 i.). Maximum average plant size was observed in 2002 (275 mm), this years was externally humid and minimum in 2003 (229 mm). In April 2003 we noted 53% seedling of total number ramets (1056 i) on fourth permanent research plots.

1. INTRODUCTION

There are two conceptions how to regulate the size of clonal plants populations. The first one supposes the control of shoots production (and therefore the lack of self-thinning). These populations are able to regulate the speed of shoots growing up and to synchronize their growth through the mutually connected shoots (forming the polycormon). The second conception supposes the overproduction of shoots and their regulation through the self-thinning as in the case of no-clonal species because of the successful competition with other plant species for space and nutrient resources, protection of survival in the unit, as well as the colonization of adjacent habitats. According to this vision, the clonal species don't have the ability to control the meristem activity and the production of above-ground shoots. A lot of authors have dealt with the regulation mechanisms in the developing of the overgrowth yet (Harper, 1977; Begon et al., 1996, Ricklefs, 2001) and in Slovakia (Eliáš, 1998; Končeková, 2003; Fehér, Končeková, 2005), but still we don't have detailed information on many species.
Population dynamics of spring geophytes is characterized by short duration of above-ground shoots, which rapidly grow, bloom and produce seeds. Only underground organs hibernate (rhizomes, bulbs, etc.). (Shorina, Smirnova, 1995; Skripčinskij, Skripčinskij, 1976). *Allium ursinum* L. (*Liliaceae*) is a typical spring ephemeroid geophyt growing in eutrophic parts of the deciduous forests. There are two subspecies: *Allium ursinum* subsp. *ursinum* and *A. ursinum* subsp. *ucrainicum* KLEOP. et OXNER (Marhold, Hindák, 1998). It is a perennial with triangular stem from 0.2 to 0.5 m high. The umbel inflorescence is on stem, which height varied from 0.3 to 0.5 meters. The inflorescence consists of 10-30 white flowers (Egger, 1992). The onion is a reduced basal part of stem with one or more thickened stock scales, cone and spindle-like shaped. The daughter-bulb arises inside the mother-bulb. Both bulbs have the same size. The intensity of vegetation reproduction is small (from 0 to 12.5%), but even though is important in

forest edge habitats (Pauková, 2004a). According to the clonal growth of bear's garlic, it belongs to the *Galanthus nivalis* type (Klimešová, Klimeš, 1997).

2. MATERIALS AND METHODS

The number of above-ground shoots (ramets, individuals - i) were studied by the method of repeated census during three growing seasons (2001-2003) (Table 1). Population densities were observed regularly at two-week intervals from February till June. Reported data have been recalculated into one square meter ($1m^2$). The first and the second permanent researched plot were established on the edge of the prime floodplain with western exposure. The third permanent researched plot was situated on the light side of a slope with southern exposure. The fourth researched plot was established on the shady side of a slope with western exposure.

Table 1. Terms of measuring the populations of plants Allium ursinum in woodland communities in park in Hlohovec in 2001-2003

census/years	2001	2002	2003
1.	9.3.	3.3.	8.3.
2.	23.3.	17.3.	22.3.
3.	6.4.	31.3.	5.4.
4.	20.4.	14.4	19.4.
5.	4.5.	28.4.	3.5.
6.	18.5.	12.5.	17.5.
7.	1.6.	26.5.	31.5.

The obtained results were statistically evaluated by using the Statgraphics Plus program. To test the differences between the observed factors, we used the Multi-factorial analysis of variance and statistically significant differences were tested by LSD test. The size structure of the population was made by measuring the ramets with ruler on permanent researched plots. The data were again recalculated into one square meter. Size classes were determined on the base of minimum and maximum values and the results were evaluated. The precipitation and average daily air temperatures of the three-year period are illustrated in fig. 1-3 (distance from Nitra to Hlohovec 25 km).

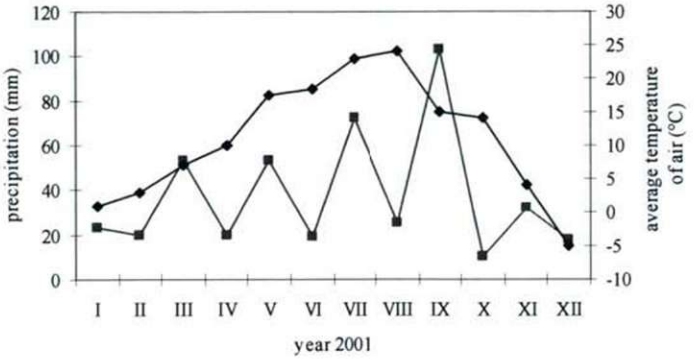

Figure 1 Average precipitation (mm) (pink color) and temperature of air (°C) (blue color) in Nitra in 2001 (Repa, Šiška 2002; processed by the author)

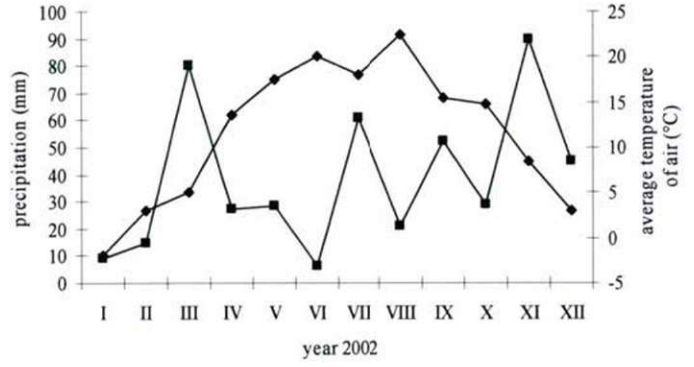

Figure 2 Average precipitation (mm) (pink color) and average temperature of air (°C) (blue color) in Nitra in 2002 (Šiška, Repa, 2003; processed by the author)

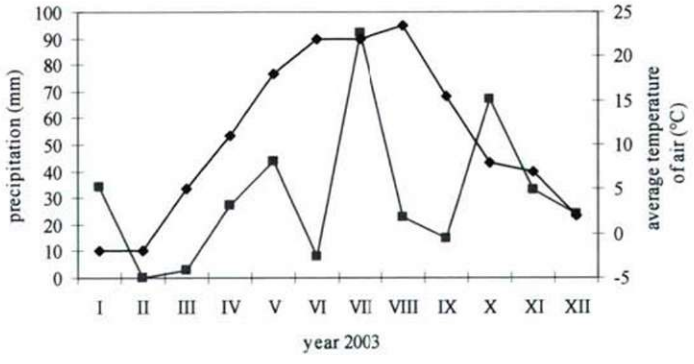

Figure 3 Average precipitation (mm) (pink color) and average temperature of air (°C) (blue color) in Nitra in 2003 (Repa, Šiška, 2004; processed by the author)

3. RESULTS AND DISCUSSION

By inter-annual assessment of the density of ramets of *A. ursinum* we haven't found differences in the number of shoots until the end of April (in the 4th census) during the growing season in 2001. In the next growing season, there was a significant decline with self-thinning to 89,7% (on the 560i at the end of vegetative season) (Fig. 4). In this studied year was the greatest variability in the number of individuals - the highest density of ramets (624i) and the lowest density of individuals (64i) on researched plot.
Population dynamics in 2002 were similar as in 2001. The number of ramets remained constant with a density of 480 individuals till the fourth census (at the end of April). In the next growing season the density of the ramets population due self-thinning mechanisms decreased less markedly than in the previous year.
Minimum initial density of individuals on the researched plot was recorded in 2003 (240i). This was connected with longer winter (February was cold with an average temperature only -1,8°C) and a later coming of warmer days than in previous years of research (Fig.3). Number of bear's garlic ramets increased sharply in the process of self-infilling in March (between the first and the second census, on 496i). We found a small reduction of individuals at the end of the growing season, which is related to the weather behaviour in that year (Fig. 3, 10).

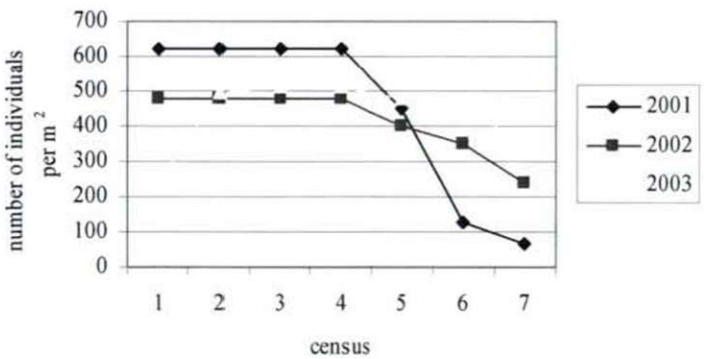

Figure 4 Population density of Allium ursinum on the 1st permanent researched plot in woodland communities in park Hlohovec in 2001-2003 [N. m^2]

In 2001, the population dynamics on the second permanent researched plot had a form of curve with one peak. (Fig. 5). In the last year of assessment, we saw the highest density of 832 individuals in April (the 2nd census), again as on the first research plot, the number of ramets increased sharply (about 384) between the first and the second measurement in March. Due to the self-thinning process decreased the number of individuals by 83,3% (560i). At the end of vegetative season, ramets had yellow aging

leaves and down bent (diffractive) flower stalks with round black seeds.

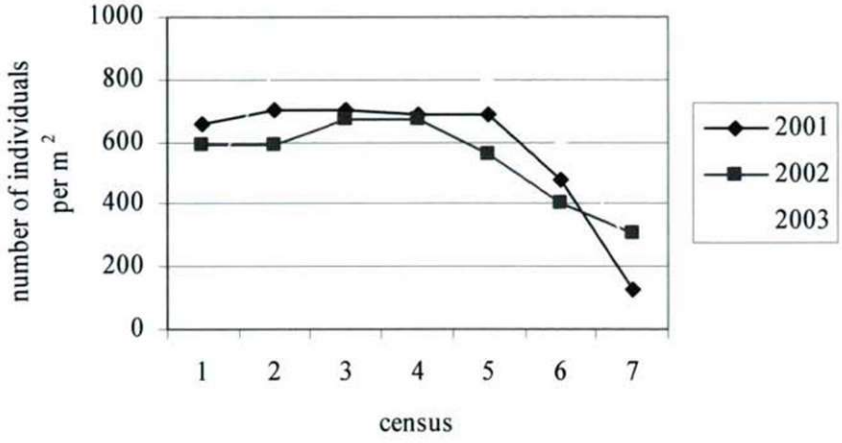

Figure 5 Population density of Allium ursinum on the 2nd permanent researched plot in woodland communities in park in Hlohovec in 2001-2003 [N. m²]

By inter-annual comparison of ramets density on the third permanent researched plot during the vegetative period 2001 and 2003, we found that the number of individuals between the second and the fifth census was approximately the same (Fig.6). Maximum number of ramets was 704 individuals in the first year of research, while the maximum number of individuals in the last year was only 480i per m^2. The whole year 2002 declined the number of individuals.

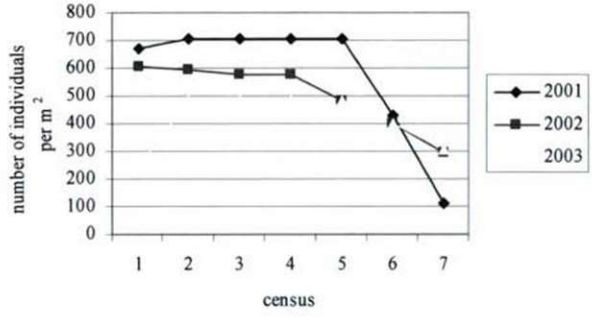

Figure 6 Population density of Allium ursinum on the 3rd permanent researched plot in woodland communities in park in Hlohovec in 2001-2003 [N. m²]

For all researched plots was found the lowest mortality of ramets *A. ursinum* to 48,25% at the end of the growing season in early June 2002 (the 7th census) (Fig.8), which is related with the highest rainfall during the growing season (March-May) (135,8 mm), the highest average temperature of air in February and March (3,5°C; 6,3°C) and the highest soil moisture (Fig.2). High soil moisture and soil fertility are indispensable for *A. ursinum* because the carbon gained during photosynthesis has to cover both the energy

demand for aboveground biomass production and respiration loss during the dormancy period in summer, autumn and winter (Jandl, Kopeszki, Glatz, 1997).

The most significant mortality of bear's garlic ramets to 27,3%, was found in early June 2001, because the end of vegetative season was very dry (Fig.1). February and March were very wet, the average temperature of air was normal (Fig.1), which initiated earlier start of growth of plants as well as the highest population density at the beginning of vegetative season 2001. On the contrary, February and March 2003 were extremely dry (February cold too) (Fig.3) causing a delayed start of phenophase of leaf growth *A. ursinum* in all plots.

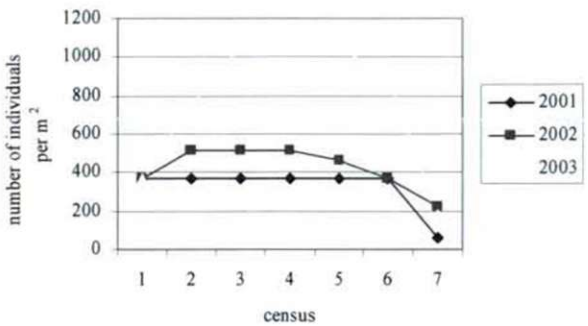

Figure 7 Population density of Allium ursinum on the 4th permanent researched plot in woodland communities in park in Hlohovec in 2001-2003 [N. m^2]

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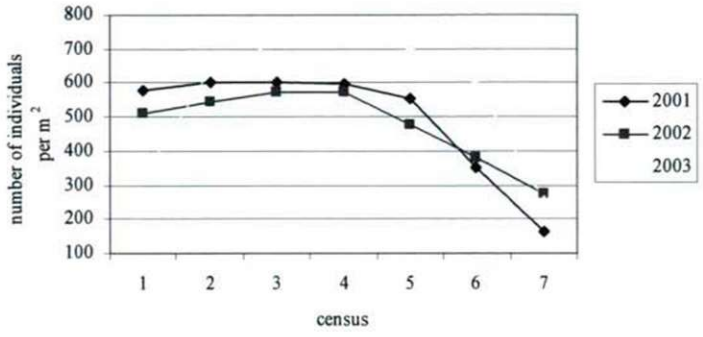

Figure 8 Population density of ramets Allium ursinum in all permanent researched plots in woodland communities in park in Hlohovec in 2001-2003 [N. m^2]

Population density was statistically highly evidentially dependent on the degree of developing phase, while there was a mortality of ramets especially at the end of the growing season. In assessing of the interaction density x developing phase of plants was the most significant difference between the third and the seventh and between the fourth and the seventh measurement (LSD $_{0,05}$ ± 125 test; LSD $_{0,01}$ ± 164 test) (Fig.9).

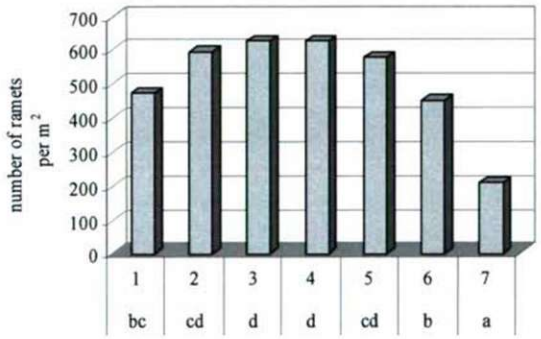

Figure 9 Statistical evaluation of significant differences in the number of ramets Allium ursinum depending on phenology. Values with different letters (a, b, c, d) in columns indicate statistically significant difference according to LSD test (P <0, 05)

Population density of *A. ursinum* was statistically significantly affected by the first and the second as well as by the first and the final year of monitoring (LSD $_{0,05}$ test ± 82,1;

LSD $_{0,01}$ test ± 113,2) (Fig.10). This means, that the weather behaviour significantly affected the number of individuals on researched plots. According to our observations mortality of ramets is indicated by environmental stress - dry soil (Fig.1, 2, 3). Self-thinning, as a mortality caused by the high density of vegetation, have observed many authors already on clonal species such as *Helianthus tuberosus* (Končeková, 2003), *Fallopia* x *bohemica* (Pauková, 2004b), *Sambucus ebulus* (Šranková, 2008).

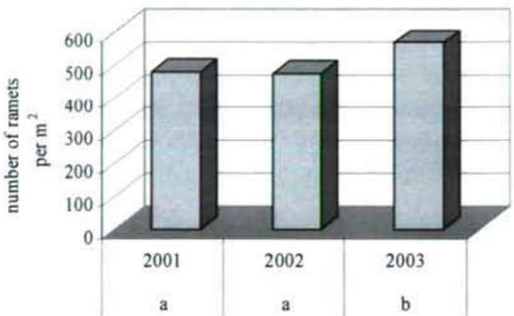

Figure 10 Statistical evaluation of significant differences in the number of ramets Allium ursinum depending on the season. Values with different letters (a, b) in columns indicate statistically significant difference according to LSD test (P <0, 05)

The population density of bear's garlic in the deciduous forest in the park in Hlohovec varied from 368 to 1056 i.m^2 in the main reproductive period at the end of April 2001-2003. According to Šmanova, Kričfalušij (1995), the density of *A. ursinum* varied from 371 to 840i.m^2 in the deciduous forests in the Carpathians in Ukraine. In mixed forests in north-western Germany at the end of the main reproductive period (mid May) were found 939 ramets, of this 260 seedlings per m^2 (Eggert, 1992). The number of individuals varied from 320 to 3350 i.m^2 in the beech forest in northern Germany (Ernst, 1979). Rychnovská and Bednář (1998) stated that the density of ramets was 700-900 per m^2 in floodplain forest in the Czech Republic. These data are comparable with our results and they correspond mainly with the values measured in Ukraine. Vice versa, Kuklová, Kukla (2006) recorded at average only 92 individuals of *A. ursinum* per m^2 in the Nature reservation Chynoriansky luh.

The number of plants on the permanent researched plots was statistically high significant between the first and the second and between the third and the fourth plots (LSD $_{0,05}$ ± 107 test; LSD $_{0,01}$ ± 142 test) (Fig.11). That means that the population density was influenced through the place of establishment of the researched plots. High significant interaction was between the permanent plots established in the plains of the prime floodplain with western exposure and the permanent plot based on the light side of a slope with southern exposure.

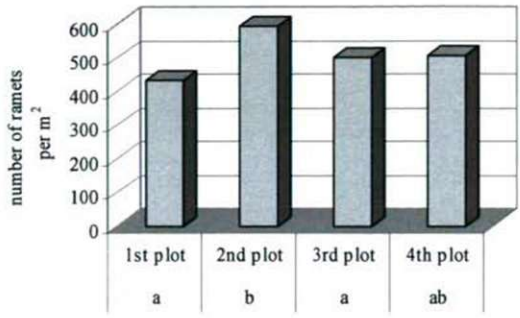

Figure 11 Statistical evaluation of significant differences in the number of ramets Allium ursinum depending on the permanent plots. Values with different letters (a, b) in columns indicate statistically significant difference according to LSD test (P <0, 05)

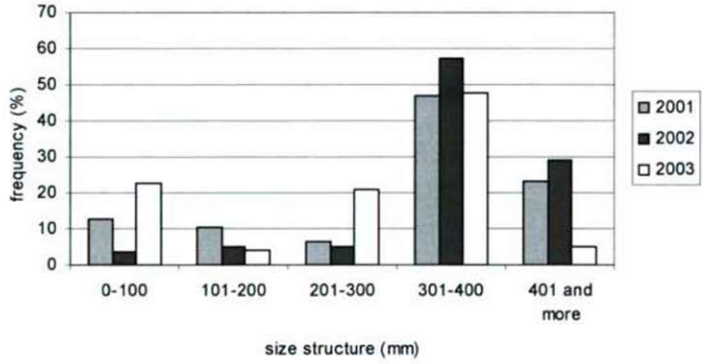

Figure 12 Size structure of populations Allium ursinum in woodland communities in Hlohovec at the end of growing season 2001 (752i), 2002 (1 312i) and 2003 (1 984i) (data represent totality for all permanent researched plots)

In general, we found out that during assessment years the population of *A. ursinum* at the end of the growing season mainly from individuals over 301 mm high (at average 78,1% of all the ramets). The highest average height of ramets 358 mm was recorded in 2002 and the lowest average height 309 mm were observed in 2001.

4. SUMMARY

At the beginning of the growing season self-infilling of ramets of *Allium ursinum* in woodland communities in the park from Hlohovec (SW Slovakia) was observed reaching the maximum density in March (the second census) 2001-2003. The density of individuals in the next growing season remained the same until April (up to the fifth census). The population density decreased mainly at the end of the growing season at the end of May (between the fifth and the sixth census). At the end of the vegetative season firstly the

overshadowed ramets (seedlings and juvenile plants) have been decayed, afterwards we observed decaying of generative plants with one or two inflorescences. According to our observation, *Allium ursinum* avoided self-thinning and in fact, it fails in applying the rule of self-thinning in natural conditions. Mortality of ramets was indicated by environmental stress - dry soil.

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