Thaiszia - J. Bot., Košice, 8: 141-146, 1998

THAISZIA
JOURNAL OF
BOTANY

Ant herbivory - a significant factor in population dynamics of *Veronica* and other temperate plant species?

PAVEL KOVÁŘ [1] & MARCELA KOVÁŘOVÁ[2]

[1]Department of Botany, Faculty of Science, Charles University, Benátská 2, 128 01 Prague 2, Czech Republic, fax: (02)21953125, e-mail: kovar@prfdec.natur.cuni.cz
[2]Institute of Botany, Czech Academy of Science, 252 43 Průhonice near Prague, Czech Republic, e-mail: mkovar@mbox.cesnet.cz

KOVÁŘ P. & KOVÁŘOVÁ M. (1998): Ant herbivory - a significant factor in population dynamics of *Veronica* and other temperate plant species? – Thaiszia – J. Bot. 8: 141-146. – ISSN 1210-0420.

ABSTRACT: Up to 960 seeds of *Veronica officinalis*, 131 seeds of *V. chamaedrys*, and 732 seeds of *Agrostis capillaris* were found in the upper 10 x 10 x 10 cm soil segments, and 770, 50 and 833 seeds, respectively, in the lower 10 x 10 x 20 cm segments sampled from the *Tetramorium caespitum* mounds at 950 m a.s.l. (formerly a hill pasture, Slovenske rudohorie Mts., Slovakia). The seed collecting activity of this ant species might help to explain the extremely low seed bank and seedling recruitments reported in the literature, especially of the *Veronica* species. In the field research, we should be aware of this phenomenon which is largely neglected in the temperate zone, and design the field work and experiments accordingly.

KEYWORDS: ants, grassland vegetation, seed collection, seed bank, *Veronica* species, *Lasius flavus, Tetramorium caespitum*

Introduction

There is an extense literature on seed collecting activity of harvesting ants from semi-desert and other warm areas (e. g. OSTER & WILSON 1978, CAMPBELL & GILMOUR 1979, RISSING 1986 and 1988, ANDERSEN 1988, COFFIN &

LAUENROTH 1990, MILTON & DEAN 1993). However, from temperate grasslands, we have only limited evidence of such an impact of ants on vegetation (WALOFF & BLACKITH 1962, KING 1977a, 1977b, 1977c, 1981).

This paper brings data suggesting that ant seed collection might represent an important factor in population dynamics of some species of temperate grasslands, namely those of the genus *Veronica.* Number of excellent studies was published on population dynamics of the *Veronica* species, e. g., that of BOUTIN & HARPER (1991) who aimed "to determine and quantify the life history patterns of five *Veronica* species, in order to assess and compare the processes that influence their survivorship and reproductive success in the field". They found that *V. chamaedrys* was the rarest in the seed bank of all the *Veronica* species involved in the study, with seed density of 80 seeds.m^{-2}, and only five seedlings were observed within the two seasons studied. It produced 401 seeds.m^{-2}, with 6.3 ± 3.4 seeds per capsule (0-220 seeds per plant). They report "heavy mortality in the seed population before seedling emergence", and "virtually no seed bank of this species in the soil". *V. chamaedrys* seeds are reported to produce 0.37 % seedlings in the field.

We believe that our contribution could help to explain the very low reproductive success of *V. chamaedrys.*

Differences in species spectra and amounts of the burried seeds among two types of ant-hills and the surrounding grassland were in the focus of our study. Our data suggest significant irregularities in the seed distribution pattern which coincides with the heterogeneity caused by the ant-hills. This implies that higher concentration of seeds of several species, namely those of the genus *Veronica* in ant nests, are due to ant activity which seems to be an important factor which must be taken into account in balance studies.

Material and methods

Site

Sampling was done in July 1979 on the 30 x 30 m flat area of a pasture on a mountain ridge 0.3 km SE of the point Obrubovanec (1020.4 m a.s.l.) approx. 950 m a.s.l., Slovenské rudohorie Mts., Slovak Republic, 48°41' latitude, 19°39' longitude, extensely covered by ant-hills in a density exceeding 1 mound per square meter, inhabited mainly by two ant species, *Lasius flavus* F. and *Tetramorium caespitum* L. The latter occupies drier, more "open" hills with only sparse plant cover, while the former prefers wetter mounds, usually covered by vegetation, namely mosses (*Polytrichum* sp. div.). Apart from these ant species, *Camponotus ligniperda* LATR., *Formica fusca* L., *Formica lemani* BONDROIT, *Formica rufa* L., *Formica pratensis* RETZ., *Lasius niger* L. and *Myrmica ruginodis* NYLANDER were found in the area studied though in much smaller quantities.

Plant community

Vegetation covering the area of interest belongs to the alliance *Nardo-Agrostion tenuis* SILLINGER 1933 (sensu BRAUN-BLANQUET 1964). Plant species recorded in the studied plot are listed in Table 1.

Seed and soil analysis

In the second half of July 1979, 10 x 10 x 30 cm samples were taken in four replicates from the two types of ant-hills and four 10 x 10 x 10 cm blocks were excised from the surrounding meadow grassland. The ant-hill samples were divided horizontally into two parts, 0-10 and 10-30 cm. The material was washed, according to the method of KROPÁČ (1966), through a set of sieves (mesh size 3.0, 2.0, 1.0, 0.5, 0.2 mm). The organic remains retained were dried at 85°C and the seeds separated and determined, using comparative samples of the seeds produced by the plant species collected from the same locality. Some of the material was lost and the reslts are thus given as singular data (Table 1).

Simultaneously with sampling the soil material for the seed bank content, additional soil samples were taken for the soil moisture content assessment. Total nitrogen content (by KJEHLDAHL's method) and pH (after 10 min. shaking and filtration through blue filter of 5 g soil in 25 ml of distilled water) were also determined (Table 2).

Results

Table 1 lists plant species recorded in the plot studied, presence of their seeds in the soil samples taken from the *Tetramorium caespitum* and *Lasius flavus* mounds and from the grassland samples, and soil water content measured in the mounds. Table 2 shows chemical soil characteristics, pH and total N content.

Discussion

Our data show that the seed collecting activity of the two ant species is obvious, namely that of *Tetramorium caespitum* which prefers the seeds of *Agrostis tenuis, Veronica chamaedrys* and *V. officinalis* (the reproductive success of the two *Veronica* species could be explained by the interesting comparative study of DALE & CAUSTON 1992a, 1992b, 1992c, 1992d). Increased soil heterogeneity of the seeds of *V. officinalis* was also found in the nests of *Lasius flavus*, even though in smaller quantities than in the nests of *Tetramorium caespitum*. Both ant species are common in temperate areas (e. g. OSTER et al. 1978). Niche differenciation between the two ant species is remarkable though they inhabit the same biotope. The niche differentiation is revealed in vertical pattern of their nests - *Tetramorium* prefers open, sunny and drier patches and its mounds often occur on the older ones. It transfers the soil particles to the top in effort to escape from the reach of growing vegetation, while *Lasius* inhabits the space deeper under the soil surface, with higher organic matter content and covered by dense, often moss vegetation cover.

Table 1. List of plant species found in the plot and number of their seeds retained in the seed bank (plant species growing on the particular ant-hills are marked by asterisk; upper part - "u", lower part - "l")

Plant species	ant-hills inhabited by *Tetramorium caespitum* (T)						*Lasius flavus* (L)					meadow (M)			
	T1u	T2u	T3u	T1l	T3l	T4l	L3u	L4u	L2l	L3l	L4l	M1	M2	M3	M4
vascular plants															
- grasses and sedges															
Agrostis capillaris	732	143*	121*	833	35*	80*	3	0	12	19	2	23	13	22	10
Anthoxanthum odoratum	1	10	10	0	2	0	0	1	2	1	1	12	5	3	2
Briza media	0	0	0	0	0	0	0	0	5	0	0	0	1	0	0
Danthonia decumbens	7	0	13	0	0	0	4	0*	0	0*	0	2	3	5	0
Deschampsia flexuosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Festuca rubra	0*	0*	8*	0*	19*	1	0*	0*	0*	0*	0*	5	2	1	0
Nardus stricta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex ovalis	0	0	0	0	0	0	0*	1	0	0*	0	0	2	0	1
Carex pilulifera	13	2	12	10	1	5	0	35	3	3	1	9	162	1	6
Luzula campestris	0	4	0	3	0	0	0	0	0	1	0	0	0	0	0
- herbs															
Achillea millefolium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ajuga genevensis	0	0	0	0	0	0	1	1	2	0	1	0	0	0	1
Alchemilla sp.	0	2	2	1	18	3	0	2	1	0	20	6	5	5	0
Antennaria dioica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carlina acaulis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carum carvi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerastium fontanum vulgare	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Cruciata glabra	0	0	0*	0	0*	0	0	0	0	0	0	1	0	0	0
Dianthus deltoides	9	6	0	6	5	1	0	0	1	0	0	1	0	1	0
Hieracium pilosella	0*	0*	0	0*	0	0	0	0	0*	1	0	0	0	0	0
Hypericum maculatum	0	0	0	3	0	2	0	0	0	0	0	0	0	0	0
Hypochaeris radicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leontodon hispidus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lotus corniculatus	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Lychnis viscaria	0	0	0	2	1	0	0	0	1	1	0	0	0	1	0
Pimpinella saxifraga	0	0	1*	0	0*	0	0	0	0	0	0	0	0	0	0
Plantago lanceolata	0	0	0	0	0	0	0*	0	0	0*	0	1	0	0	0
Polygala sp.	2	2	0	1	0	5	0	9	0	5	0	4	0	5	0
Potentilla erecta	57	9	11	23	13	24	21	61	53	8	7	126	65	81	120
Prunella vulgaris	0	0	12	0	0	9	1	0	0	8	0	0	0	0	0
Ranunculus acer	0	6	2	0	0	0	0	0	0	0	0	0	3	1	5
Rumex acetosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thymus pulegioides	1	0	0*	0	0*	0	0*	0	0*	0*	0	0	0	0	0
Trifolium pratense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium repens	1	0	3	3	1	0	0	8	4	0	2	11	1	3	6
Veronica chamaedrys	131	59	25	50	12	7	0	0	9	0	0	0	0	0	3
Veronica officinalis	960	31	419	770	115	42	3	39*	58	25	37*	0	6	2	0
Viola reichenbachiana	0	0	5	0	10	0	12	0	3	8	3	4	16	44	3
mosses															
Pleurozium schreberi, Polytrichum formosum, Rhytidiadelphus squarrosus															
water content (%)	5.6	7.9	7.5	13.6	14.8	14.1	14.8	14.5	19.6	15.5	18.5		17.9‡		

‡ - Average sample of the meadow soil

Table 2. Soil characteristics

	ant-hills inhabited by		meadow
	Tetramorium caespitum	*Lasius flavus*	
pH (n=8)	5.46±0.063	5.12±0.048	4.70±0.115
N (%)	2.53	1.98	3.76

It is worth to assume that these (or other) ant species largely affect the population dynamics of certain plant species, such as the *Veronica* ones recorded in our plot. It is interesting to note that *V. officinalis* was not present in a close vicinity of the ant-hills and was not involved in the relevé recorded there. The ants had to transport its seeds from quite a long distance from the forest margins. Moreover, since we did not sample the whole of the ant-hill for the seed content, we have presumably missed some of the seeds collected by the ants and the total seed amounts retained by one ant-hill would thus be much higher. It is reported (e.g. by OSTER et al. 1998) that this kind of seed herbivory is fulfilled in a process beginning with seed collection and storage inside the ant mounds, followed by consuming the attractive tissues, and by the active release of the rest of the inactive seeds by ants to the surrounding of their nests at the end. This may explain no occurrence of the *Veronica* seedlings on the microlocalities harvested by seed-collecting ants.

Since BOUTIN et al. (1991) assessed the viable seed bank in the soil collected from the field sites in December and some of the species shed their seeds already in the first half of the growing season, there was time enough for the seed collectors (being it ants or other harvesters) to fulfill their job and deplete the seed bank. We thus suggest, especially for the studies on population dynamics of *Veronica* species, that the plant (population) ecologists be aware of this phenomenon, and that some restrictions be used to prevent the access of seed harvesters, mainly ants, in quantitative field studies of those plant species whose seeds are collected by them.

Acknowledgement

We are grateful for our honeymoon which we partly devoted to the field work, to Dr P. WERNER from the Research Institute of Plant Production in Prague who kindly determined the ant species, and for the amazing activity of ants who have prepared such a nice gift for us.

References

ANDERSEN A. N. (1988): Immediate and long-term effects of fire on seed predation by ants in sclerophyllous vegetation in south-eastern Australia. – Aust. J. Ecol. 13: 285-293.

BOUTIN C. & HARPER J. L. (1991). A comparative study of the population dynamics of five species of *Veronica* in natural habitats. – J. Ecol., 79: 199-221.

BRAUN-BLANQUET J. (1964): Pflanzensoziologie. – Wien.

CAMPBELL M. H. & GILMOUR A. R. (1979): Reducing losses of surface-sown seed due to harvesting ants. – Aust. J. Exp. Agric. Anim. Husb. 19: 706-711.
COFFIN D. P. & LAUENROTH W. K. (1990): Vegetation associated with nest sites of western harvester ants (Pogonomyrmex occidentalis CRESSON) in a semiarid grassland. – Am. Midl. Nat. 123: 226-235.
DALE M. P. & CAUSTON D. R. (1992): The ecophysiology of Veronica chamaedrys, V. montana and V. officinalis. I. Light quality and light quantity. – J. Ecol. 80: 483-492.
DALE M. P. & CAUSTON D. R. (1992): The ecophysiology of Veronica chamaedrys, V. montana and V. officinalis. II. The interaction of irradiance and water regime. – J. Ecol. 80: 493-504.
DALE M. P. & CAUSTON D. R. (1992): The ecophysiology of Veronica chamaedrys, V. montana and V. officinalis. III. Effects of shading on the phenology of biomass allocations - a field experiment. – J. Ecol. 80: 505-515.
DALE M. P. & CAUSTON D. R. (1992): The ecophysiology of Veronica chamaedrys, V. montana and V. officinalis. IV. Effects of shading on nutrient allocations - a field experiment. – J. Ecol. 80: 517-526.
KING T. J. (1977a): The plant ecology of ant-hills in calcareous grasslands. I. Patterns of species in relation to ant-hills in southern England. – J. Ecol. 65: 235-256.
KING T. J. (1977b): The plant ecology of ant-hills in calcareous grasslands. II. Succession in the mounds. - J. Ecol. 65: 257-278.
KING T. J. (1977c): The plant ecology of ant-hills in calcareous grasslands. III. Factors affecting the population sizes of selected species. – J. Ecol. 65: 279-315.
KING T. J. (1981): Ant-hills and grassland history. – J. Biogeogr. 8: 329-334.
KROPÁČ Z. (1966). Estimation of weed seeds in arable soil. – Pedobiologia 6: 105-128.
MILTON S. J. & DEAN W. R. J. (1993): Selection of seeds by harvester ants (Messor capensis) in relation to condition of arid rangeland. – J. Arid Environ. 24: 63-74.
OSTER G. F. & WILSON E. O. (1978): Caste and ecology in the social insects. – Princeton, New Jersey.
RISSING S. W. (1986): Indirect effects of granivory by harvester ants: plant species composition and reproductive increase near ant nests. – Oecologia 68: 231-234.
RISSING S. W. (1988): Dietary similarity and foraging range of two seed-harvester ants during resource fluctuations. – Oecologia 75: 362-366.
WALOFF N. & BLACKITH R. E. (1962): The growth and distribution of the mounds of Lasius flavus (Fabricus) (Hym: Formicidae) in Silwood Park, Berkshire. – J. Anim. Ecol. 31: 421-437.

Received: 22 June 1998
Accepted: 24 September 1998