Set-aside plots – source of small mammal pests?

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A b s t r a c t . Succession of weeds and small mammal species was studied and compared on alfalfa field in two periods (cultivated 1996–1998 and set-aside 2001–2003). Composition of the plant community changed between the two periods of study. In the first period high biomass of green alfalfa biomass was available to the common vole which dominated small mammal community (88.7 %) and pronounced variation in maximal autumnal densities, typical of cyclic vole populations. Massive invasion of seed bearing weeds was stated after the field was set-aside and alfalfa biomass lowered. With the succession of weeds other rodent species such as *Apodemus* sp. increase their relative abundance (RA) and that of the pygmy field mouse was higher in the abandoned field compared with the common vole. The trend toward increasing RA was quite distinct (Z = 1.883; P = 0.060). Diversity of herb species and the small mammal species increased with abandonment. The monthly RA of the common vole was, on average, lower in the abandoned field than in the former period (Z = 2.353, P = 0.019). Also the cyclicity disappeared and RA of the population exhibited only seasonal oscillations. Biomass of the small mammal community decreased after the field was set-aside (Z = 3.021, P = 0.002).

Introduction

One of the most important large-scale environmental changes to occur in European arable landscapes in recent years has been the introduction of set-aside land (F i r b a n k et al. 1993). The set-aside scheme, whereby land is removed from arable production, is primarily aimed at manipulating agricultural surplus within the European Community, but has potentially great consequences for biodiversity and wildlife management (S o t h e r t o n 1998). In central Europe, the area sown with cereals rapidly increased, while those with leguminous, fodder crops decreased (Ministry of Agriculture Report 2000). With introduction of set-aside, some fodder crop fields were left abandoned. The cessation of regular farming leads to changes of vegetation structure of fields and, as a consequence, to both qualitative and quantitative changes in animal communities. Abandoned fields increase diversity of habitats in agricultural landscape and they are considered as a spatial and trophic refuge for many animal species. Higher diversity of food supply is conditioned by non arable regime, and elimination of herbicide and pesticide

treatment. Thus, animal populations on set-aside plots are not so drastically influenced by agricultural works being thus comparable with other elements in agricultural landscape, such as windbreaks, small forests, riparian strips, road verges and balks (S c h w a r t z & W h i t s o n 1987, S o t h e r t o n 1998). More diversified vegetation might provide more variable food resources, especially for mice species by providing seeds over a longer fruiting period, and by harbouring more invertebrates (T a t t e r s a l l et al. 2001). On the other hand, they can function as spatial refuges for animal pests after termination of farm activities (ploughing) or trophic storehouses when food is limited in the cultivated fields (mainly in winter and spring) (S k ř i v a n & A n d ě r a 1987, Y l ö n e n et al. 1991, M a i s o n n e u v e & R i o u x 2001). In central Europe, however, insufficient research has been done to establish the effects of set-aside for wildlife and for mammals in particular.

The succession of communities of small mammals in set-aside plots was extensively studied in Great Britain, where most of the research was concentrated on the bionomy of wood mouse (*Apodemus sylvaticus*) as a dominant species and indicator of changes in the agro-ecosystem (T e w & M a c d o n a l d 1993, T a t t e r s a l l et al. 1999a,b, M a c d o n a l d et al. 2000, T e w et al. 2000, T o d d et al. 2000). The succession of small mammal populations in set asides was found to be related to the type of previous crop, the method of set-aside establishment, and the resulting vegetative composition and structure (T a t t e r s a l l et al. 1999a,b). All these properties affect factors such as food availability and predator pressure (T e w et al. 2000, T o d d et al. 2000). Initial stage of set-aside is usually characterized by low density of ground coverage of plants and presence of some weed species bearing seeds. First invaders in such a type of biotope were *Apodemus* mice (Z e j d a 1965, C h u r c h f i e l d et al. 1997), in England particularly *Apodemus sylvaticus* exhibiting often high densities at the first stage of succession (T a t t e r s a l l et al. 1997, 1999a,b). In subsequent years of succession, voles exploited the denser canopy condition (F i r b a n k et al. 1993, R o g e r s 1992, R o g e r s & G o r m a n 1995).

In contrast to the majority of the published set-aside succession schemes, many plots in the Czech Republic set-aside recently are assumed to have a different succession of small mammal communities. For example, on the perennial alfalfa plots with well developed high density population of the common voles, one can imagine very different processes. Together with the increase of the proportion of weeds the abundance of granivorous species would rise too. To our knowledge, no description of succession stages on this type of set-aside plots has been provided in the central Europe.

In the present paper, we study the temporal variation in the composition of small mammal community in an intensively cultivated alfalfa field with high primary production. After a period of three years, this field was abandoned and set aside. Following a two years lasting gap we studied changes in plant structure together with those in small mammal community on the same plot for another three years. The main aim was to describe the composition of small mammal communities in both habitat types and to assess the potential of abandoned field as (1) a source of rodent pests and/or (2) stabilizing landscape element increasing mammal diversity. We tested the hypothesis that changes in management of the field affect primarily food supply for small mammals and that changing trophic conditions subsequently lead to the proportional increase in abundance of seed-eating species and decrease of grass-eating species.

Material and Methods

Study area

The study was conducted on an alfalfa field (five ha plot) near the village Drnholec in southern Moravia, Czech Republic (48°53'30''N, 16°27'30''E). The study plot has been chosen in a typical agricultural landscape with 91% of area composed by arable land, while woodland represented less than 4% of the area (quadrant of about 46 km^2). Besides several woods (with the area of 0.2 to 0.8 km^2), windbreaks are among the most typical landscape elements. Our study was divided into two 3-year periods. In the first three years (1996–1998), the regular sampling was done on a newly established and intensively culti-vated alfalfa field. The sampling was repeated in 2001–2003, one year after the field was set aside and vegetation was left to develop by natural regeneration. In 2001 alfalfa was therefore 6 years old and was only mown in July 2001 but the dry alfalfa biomass was left on the field.

Habitat structure and food supply

We recorded the species richness of plants on the studied plot (R o t h m a l e r 1982, Table 1). Yearly mean coverage of every species on the plot was expressed by B r a u n - B l a n q u e t (1964) method (* – scattered; 1: lower than 5 %; 2: 5–25 %; 3: 25–50 %; 4: 50–75 %). We divided plant species into three groups according to their life cycles as these are important for specifying diet supply during the winter. The annual plants (a) provide only seeds as food for rodents during the winter, while the perennial plants (p) provide roots, buds and some leaves as well. The biannual plants (b) have merely vegetative organs the first year, with some green leaves during the winter. Generative organs grow the second year and then the individual dies.

Food supply was estimated as the above-ground biomass four times a year (March, May, July, October) in both periods of the study according to J a k r l o v á (1987a). Nine to 20 samples (in accordance to the homogeneity of the plant cover) of the above-ground biomass were taken by clipping complete vegetation at the soil surface (0.5 × 0.5 m plot per sample). The biomass was then transported to the laboratory, sorted into different plant species, dried at 70°C to a constant weight, and then the dry weight and proportions of individual species were measured. Special attention was paid to the seed biomass (J a k r l o v á 1987b). For fur-ther analyses, the plant biomass was divided into four groups: ALFALFA (green parts of the alfalfa), WEEDS (all herb weeds), SEEDS (all seeds), and GRASSES (green parts of grasses). The Shannon-Weaver index of diversity of the herb layer was calculated from the dry biomass of each plant species using natural logarithm.

$$\bar{H} = -\sum_{i=1}^{s} \left(\frac{ni}{N}\right) \ln \left(\frac{ni}{N}\right) \ (\text{S h a n n o n } \& \text{ W e a v e r } 1 9 4 9),$$

n$_i$ is weight of biomass of each species and N is total weight of biomass of all species. To com-pare the index of diversity of small mammals and the vegetation cover, the Shannon-Weaver index of diversity was computed from collections in May, July and October and the proportion of each species from the total biomass was used.

Community of small mammals

Mammalian (rodents and insectivores) communities were snap-trapped monthly during both study periods (1996–1998, 2001–2003). Snap-traps were baited with fried wicks (soaked in fat and flour) and exposed for one night in lines of 100 traps 3 m apart. In all captured individuals we recorded species, body mass, sex, and reproductive condition obtained through dissection.

The abundance of small rodent species was expressed as the number of individuals captured per 100 trap-nights (index of relative abundance; RA). In order to restore the original variation lost due to „saturation effect", the index was transformed assuming random (Poisson) distribution of animals, i.e.

transformed index = [–ln (1–index/100)]100 (C a u g h l e y 1977).

The RAs for the two dominant species (the common vole and the pygmy field mouse) were recalculated as the monthly means (usually from three values) per type of management. These values were compared by a Wilcoxon nonparametric two-sample test to examine whether the type of management affected the pattern of changes in abundance. We assumed that the removal of individuals from the population had no essential effect on the demography of small mammal populations. This assumption is justified by the fact that densities of the common vole regularly exceeded 1000 individuals per hectare (J á n o v á et al. 2003). Moreover, the position of trapping lines was not kept fixed, but it changed among the trapping sessions. The dominance of the common vole in mammal community was also expressed as Simpson index of dominance from May to September (when the trapping in all years was done)

$$D_S = \sum_{i=1}^{i=n} (\frac{N_i}{N})^2 \text{ (O d u m 1977),}$$

where N_i is the number of captured individuals for each species in the whole period and N is the total number of all individuals of all species. We calculated the Shannon-Weaver index of small mammal diversity for the period from May to September using natural logarithms (formula see herb layer diversity).

The relative biomass of each species expressed in g/100 trap-nights was calculated for each trapping session. The nibbled individuals (72 common voles, 32 pygmy field mice and 5 specimens of other species over the whole research period) were not included in the biomass analyses. The seasonal changes in the mean monthly biomass of the entire small mammal community were compared between two periods of the study in a way similar to that for seasonal changes in relative abundance (i.e. Wilcoxon matched pair test). All statistical tests were computed using the program Statistica for Windows 6.0 (Statsoft 2000).

Results

Changes in habitat structure and food supply

Composition of the plant community changed dramatically between the two periods of study (Table 1). In the period of intensive production (1996–1998) the plant biomass consisted almost exclusively of the cultivated alfalfa and species diversity of plant community was very low (Table 2). The seasonal dynamics of alfalfa biomass was influenced mainly by regular harvesting (Fig. 1). During the vegetation period a great amount of green diet supply for herbivores

Table 1. Composition of weed community at intensively cultivated alfalfa field (year 1998) and in three years after its abandoning in the year 2000 (2001–2003). Type of the life cycle: a – annual, b – biannual, p – perennial, a–b – species growing both annually and biannually (the type of life cycle was dependent on the weather conditions). Mean coverage for every year and species on the plot was expressed by B r a u n - B l a n q u e t (1964) method (* – scattered individuals; 1 – lowest; 4 – highest coverage).

Name of plant	1998	2001	2002	2003	life cycle
Achillea millefolium				1	p
Alopecurus pratensis				1	p
Amaranthus chlorostachys				1	a
Amaranthus retroflexus	1	2	3	1	a
Anagalis arvensis			*	1	a
Arctium minus		*	*	*	b
Artemisia vulgaris				*	p
Atriplex nitens				1	a
Atriplex patula			1	1	a
Ballota nigra				*	p
Bromus commutatus		1	1	2	a–b
Bromus sterillis				3	a–b
Bromus tectorum				3	a–b
Calamagrostis epigeios				1	p
Cannabis ruderalis				*	a
Capsella bursa-pastoris	1	2	3	1	b
Carduus acanthoides		*	1	1	b
Carduus crispus				1	a
Cirsium arvense				*	p
Conyza canadensis	2	2	2	3	a
Cynoglossum officinale				*	b
Dactylis glomerata				1	p
Datura stramonium			*	*	a
Echinochloa crus-galli		1	2		a
Elytrigia repens				1	p
Fallopia convolvulus		1	1		a
Fumaria officinalis			*		a
Galium aparine			*	1	a
Galium mollugo				1	p
Geum urbanum				1	p
Hordeum murinum				1	a
Hyoscyamus niger			*		b
Chenopodium album		1	2	2	a
Chenopodium hybridum				1	a
Chenopodium polyspermum				1	a
Chenopodium rubrum			1		a
Kochia scoparia				2	a
Lactuca serriola				1	a
Lolium perenne				1	p

Matricaria maritima	1	1	2	2	a
Medicago sativa	4	3	3	2	p
Melica transsilvanica				*	p
Panicum miliaceum			*		p
Poa pratensis			*	1	p
Polygonum aviculare				1	a
Reseda lutea				*	p
Rumex obtusifolius			1	1	p
Senecio vulgaris			*		a
Setaria viridis				1	a
Silene pratensis			1	1	p
Solanum nigrum			*		p
Sonchus oleraceus			1		a–b
Stellaria media	1	2	2	2	a
Taraxacum officinale	1	1	2	2	p
Thlapsi arvense			1		a
Tragopogon sp.				1	p
Urtica dioica		*	*	*	p
Veronica hederifolia				1	a
Viola tricolor			*		a
Species richness	7	14	30	48	

was available (mean 203 g/m^2 of dry biomass from March to October). After the regular harvesting of alfalfa, roots and buds persisted as an underground diet supply. Winter food supply was also represented by buds and roots (15.5 g/0.3m^2 of buds and 43.5 g/m^3 of roots). Additionally, some weedy species occurred in the alfalfa crop. These were present in the field in low numbers, usually only in spring and autumn and amounted to 14 g/m^2 in October 1998 (six species from which four were annual; Table 1).

Massive invasion of the weeds started to infest the field. In the first year the plot was set aside, 13 weedy species were present, 7 (53 %) of which were annual, 1 (8 %) annual-biannual, 3 (23 %) biannual and 2 (15 %) perennial. The last year of observation 47 species of weeds were present, with 21 (45 %) species being annual, 3 (6 %) annual-biannual, 4 (9 %) biannual and 19 (40 %) perennial (Table 1). After the field was set-aside the most dominant weeds were *Capsella bursa pastoris* and *Stellaria media*. These two species composed a large proportion of the total green biomass (mean 81.75 g/m^2) from October 2001 through winter to March 2002. Already in spring 2002 these species produced seeds (30 g/m^2), an increasing food supply for granivorous species. Invasion of other annual weeds, such as *Amaranthus* sp. or *Chenopodium* sp. started. In autumn 2002 weeds produced as much as 368 g/m^2 of biomass from which 82 g/m^2 were various seeds. In 2003 the greatest species diversity of weeds occurred (Fig. 1). In May 2003, grasses dominated in the biomass (170 g/m^2) producing a large amount of seeds at this time (98 g/m^2). Other weed species such as *Chaenopodium* sp., *Atriplex* sp., *Matricaria* sp. and *Coniza* sp. increased their biomass later. However, they produced as much as 200 g/m^2 of seeds in autumn. As the succession of weeds progressed, biomass of alfalfa was lowered. During the set-aside period mean biomass of alfalfa (3 years) was 66.58 g/m^2. In 2003 the mean biomass of alfalfa was only 36 g/m^2 (7.4 % of the total plant biomass).
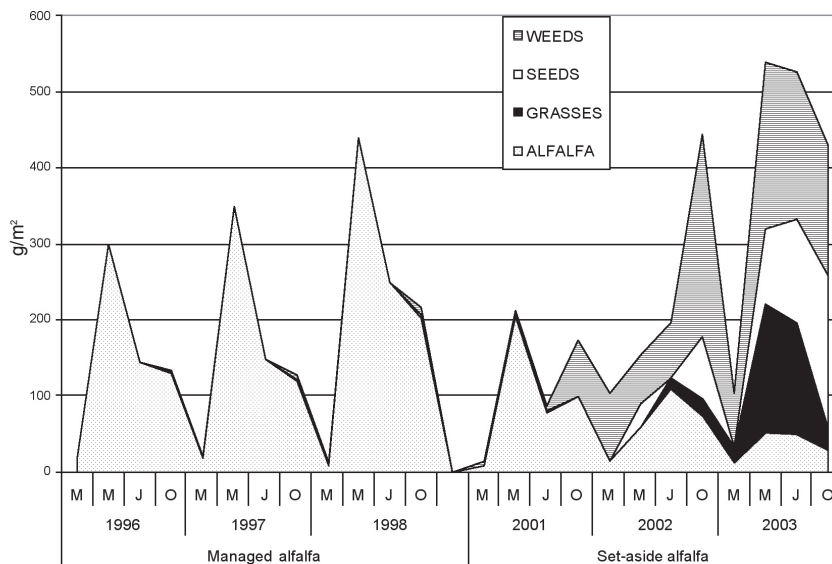
Fig. 1. Changes in biomass of plants on experimental field (g/m^2). Plant biomass was divided into four groups: ALFALFA (green parts of the alfalfa), WEEDS (all herb weeds), SEEDS (all seeds), and GRASSES (green parts of grasses).

Pattern of changes in small mammal community

During six years of the study, we obtained the material consisting of 1249 common voles (*Microtus arvalis* Pallas, 1778), 514 pygmy field mouse (*Apodemus microps* Kratochvíl et Rosický, 1952), and 53 wood mouse (*Apodemus sylvaticus* Linnaeus, 1758). In addition, yellow-necked mouse (*Apodemus flavicollis* Melchior, 1834), bank vole (*Clethrionomys glareolus* Schreber, 1780), bicolor white-toothed shrew (*Crocidura leucodon* Hermann, 1780), lesser white-toothed shrew (*Crocidura suaveolens* Pallas, 1811), harvest mouse (*Micromys minutes* Pallas, 1771), common shrew (*Sorex araneus* Linnaeus, 1758), and pygmy shrew (*Sorex minutus* Linnaues, 1766) were occasionally caught (together comprising 0.98% of individuals). Furthermore, hamster burrows and mole hills were observed on the study plot. However, neither hamsters nor moles have been captured and their abundance was not analysed.

The common vole dominated small mammal community in the alfalfa field between 1996–1998 (Table 2). In total, we captured 924 small mammals and 88.7 % from these (820 individuals) were the common voles. The abundance of the vole population exhibited

Table 2. The Shannon-Wiever index of diversity of plant species and small mammal community. The individuals of each species of small mammals were counted in the period from May to September and the Shannon index was calculated from proportion of all captured individuals each species and the total number of captured mammals in this period using natural logarithm. The weight of biomass of vegetation was counted from May, July and October collections for each herb species and proportion of total biomass of each species and the biomass of all herbs in all these sessions together was used as in the case of small mammals for setting the Shannon-Wiever index.

Community	1996	1997	1998	2001	2002	2003
Vegetation	0	0.009	0.061	0.614	1.794	1.916
Small rodents	0.194	0.350	0.721	0.815	0.765	0.830

apparently both within- and between-year variation. The abundance of voles increased from spring to autumn in 1996 and 1997 but strong summer decline was observed in 1998. Within the first part of the study, we observed pronounced variation in maximal autumnal densities typical of cyclic vole populations. The population underwent an increase phase of the population cycle in 1996 (max RA 56.6 individuals in November), reached its maximum in October 1997 (max RA 72.8 individuals) and declined dramatically in 1998 reaching almost zero numbers (Fig. 2). These multi-annual changes in density were accompanied by biological attributes of cycling populations such as shifts in the age structure and mean body mass (J á n o v á et al. 2003). The second dominant species in this period was the pygmy field mouse (9% from the total number of small mammals). Its RA was low throughout the first study period (up to 2). However, the numbers suddenly increased up to 11.3 individuals and 12.9 individuals in November and December 1997, respectively. The proportion of other species in the community was very low (2.5%) leading to very high values of the dominance index (Table 3).

The community composition and patterns of variation in population density of dominant species were quite different after the field was abandoned. The average proportion of common voles in trapping sessions decreased and the proportion of pygmy field mouse increased (Table 3). The presence of other species in the study area remained still very sporadic, with the exception of the wood mouse, the density of which temporarily
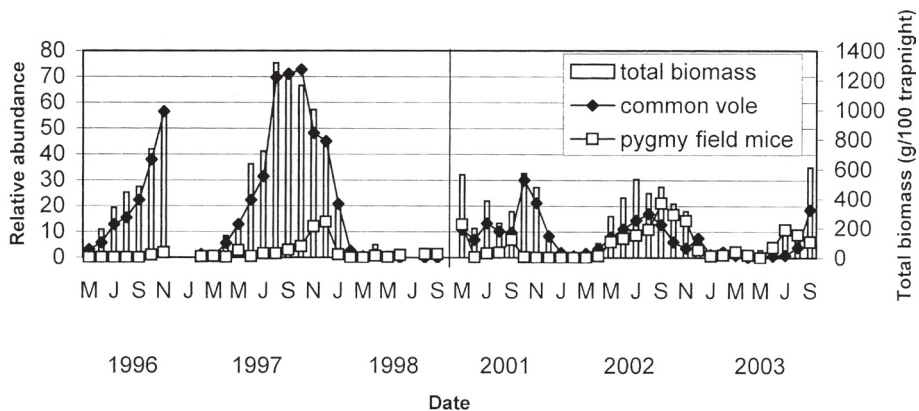

Fig. 2. Changes in the total biomass of the small mammal community, the relative abundances of the common vole, the pygmy field mouse of the community in managed alfalfa field (1996–1998) and in set-aside plot (2001–2003). Abundance were expressed as number of individuals captured per 100 trap-nights corrected for trap saturation.

Table 3. The Simpson index of dominance (Ds) in each year in period May–September and average proportion of individuals common vole (Marv), pygmy field mouse (Amic) and members of other species during this part of the year in regular managed and abandoned field.

	Year	Ds	Mean Marv	Mean Amic	Mean Others
Cultivated	1996	0.918	0.963	0.006	0.037
	1997	0.836	0.912	0.065	0.023
	1998	0.597	0.165	0.750	0.083
Abandoned	2001	0.506	0.647	0.290	0.063
	2002	0.486	0.530	0.453	0.017
	2003	0.491	0.319	0.621	0.060

increased in November 2001 (to 14.93%). The decreased proportion of voles caused that species diversity of the whole mammal community conspicuously increased (Table 2). The maximum autumnal abundances of the common vole were lower than in the first part of the study (2001: 30.1 individuals; 2002: 17.0 individuals; 2003: 18.6 individuals). The monthly RA was, on average, lower in the abandoned field than in the former period (Wilcoxon pair test n = 12, Z = 2.353, P = 0.019). The cyclicity of the population disappeared on the set-aside field, i.e. abundance of the population exhibited only seasonal oscillations and it was not possible to recognize any phase of population cycle from the density pattern (Fig. 2). Abundance of the pygmy field mouse was consistently higher in the abandoned field. Its population reached the maximal yearly numbers in May 2001 (12.8 individuals), September 2002 (21.1 individuals), and July 2003 (10.8 individuals) which are comparable with that of the common vole. The trend toward increasing abundances after change of management is quite distinct (Wilcoxon pair test n = 12, Z = 1.883; P = 0.060). The rapid crash down of the entire small mammals community was observed in spring 2003 being associated with alternatination of freezing and warmer temperatures coupled with rains and taws. The total monthly RAs computed for all small mammal species were higher in the managed alfalfa field than in the abandoned area (Wilcoxon pair test n = 12, Z = 3.059, P = 0.002).

The total biomass of the small mammal community exhibited the similar seasonal pattern: low values at the beginning of reproduction in spring, increase during summer and early autumn and decrease in winter. Very low values of biomass were recorded in 1998 when the common vole entered the decrease phase of population cycle and in the first half of 2003 because of unfavourable weather and delayed start of reproduction in all species. Biomass of the entire small mammal community significantly decreased after the field was abandoned (Wilcoxon pair test n = 12, Z = 3.021, P = 0.002).

Discussion

Succession of set – aside plots

We observed that changes in agricultural management led to conspicuous changes in the structure of small mammals' community. The abandoning of alfalfa field caused the increase of both diversity and biomass of weeds leading to shifts in the structure of rodent community towards higher proportions of seed-eating species, in our case mainly the pygmy field mouse. It has been often documented that changes of habitat structure affect small mammal community in agricultural landscape (M a c k i n – R o g a l s k a 1981). Habitat type is thought to affect population dynamics of rodents (and subsequently the structure of their communities) through differences in food availability (e.g. C o l e & B a t z l i 1979, M o n t g o m e r y & M o n t g o m e r y 1990, W i l s o n et al. 1993, B u t e t 1996). H a n s s o n (1979) also suggested that herbivore rodents may be affected by a several-year rhythm in the food from plants. It is thus highly predictable that field set-aside will lead to changes in small mammal community through changes in food supply. The changes in proportions and presence of small mammal species are strongly associated with the time of succession and nitrogen content in changing vegetation (H u n t l y & I n o u y e 1987). Succession is also related to the type of previous crop, the method of set-aside establishment, and the resulting vegetative composition and structure (T a t t e r s a l l et al. 1999a,b). These affect factors such as food availability

and predator pressure (T e w et al. 2000, T o d d et al. 2000). Initial stage of set-aside is usually characterized by low density of ground coverage of plants and presence of some weed species bearing seeds. First invaders in such a type of biotope were *Apodemus* mice (Z e j d a 1965, C h u r c h f i e l d et al. 1997, T a t t e r s a l l et al. 1997, 1999 a,b) followed by voles that can exploit the denser canopy conditions in subsequent years of succession (F i r b a n k et al. 1993, R o g e r s 1992, R o g e r s & G o r m a n 1995).

To our knowledge, however, we are the first to describe the succession of both habitat structure and small mammal community in abandoned highly productive fields with perennial leguminous, fodder plants. We suggested that the pattern of vegetation (and subsequently small mammal community) succession would be different from that described in annual, each year ploughed crops with production of seeds. Perennial crops such as alfalfa are known to be very suitable habitat for the common vole populations (S p i t z 1968, M a r t i n e t & S p i t z 1971, H e r o l d o v á et al. 2004). The voles consume preferably green parts of plants (H o l i š o v á 1959) that are produced by alfalfa almost all over the vegetation season. During the winter it supplies buds and roots. Moreover, the burrow systems in voles are well preserved in multi-annual perennial crops in the absence of yearly ploughing. Burrowing activities of voles, however, support weed invasion to the alfalfa fields leading to the ruderalisation of such plots that are not regularly managed (K o k e š 1976). In those fields, the proportion of green parts of plants in food rapidly decreases which can influence population dynamics of voles. We observed that the variation of autumnal densities decreased in the set-aside plot, that multi-annual fluctuations present in managed alfalfa field disappeared and population density exhibited only seasonal oscillations. This observation is in accordance with the results of H u n t l y & I n o u y e (1987). They sampled various riparian communities in various succession stages in Iowa and found the decrease in multi-annual variation of density in small mammal populations with the time of succession. Changes in the pattern of vole population dynamics in our study area were accompanied with changes in individual quality (J á n o v á et al., in prep.). In the second part of the study (set-aside plot), the individuals were smaller than before; the decrease in body length was obvious much more in males than females. There were fewer females in breeding condition on abandoned field at the end of reproduction season than on cultivated alfalfa plot with high density population (J á n o v á et al., in prep.). The proportion of reproductively active females affects natality and consequently growth rate of population density of the common vole. These results suggest that after the finishing of regular farming on the alfalfa plot, the habitat became very quickly less suitable for herbivorous species.

Other rodent species, such as mice of the genus *Apodemus*, were found only occasionally in regularly managed alfalfa fields, due perhaps to low food supply as they are mainly granivorous (H o l i š o v á & O b r t e l 1984). After the vegetation has been left to develop by natural regeneration, the proportion of alfalfa biomass decreased. Subsequently, we observed significant increase in dominance and diversity of weeds associated with extensive production of seeds. More diverse vegetation might provide more food resources especially for mice species, by providing seeds over a longer fruiting period, and by harbouring more invertebrates (T a t t e r s a l l et al. 2001). Even in southern Moravian agricultural landscape, the fallow plots with the presence of weeds were found to be suitable habitats for *Apodemus* mice (H o l i š o v á et al. 1962, Z e j d a 1965). The ruderalisation in our plot began immediately after it was abandoned. Thereafter annual weeds have been replaced by perennial ones and grasses soon prevailed. Here we document that increasing diversity and biomass of weeds could result very quickly in the increase of abundance of seed-eating rodent species. The

pygmy field mouse was present on the alfalfa field throughout the whole period of the study but its abundance increased dramatically after the plot was set aside. It appears to be the species which is absent from all types of forest in the study area (H o l i š o v á et al. 1962), however, it seems to be very adaptable to changing conditions in field habitats. In southern Moravian agriculture landscape, it inhabits various crop fields, preferably the corn, oily crops and root crops (H o l i š o v á at al. 1962). Based on the results of the diet analysis, it is clear that the distribution of this species in agricultural landscape is bounded to the presence of weeds in various crops. Its food is composed preferably of small seeds of various weeds (75.5% of relative weight). Nevertheless, it prefers seeds with starchy contents and in any corn fields this species readily consumes crops and thus can acts as a pest (H o l i š o v á et al. 1962, O b r t e l & H o l i š o v á 1982, H o l i š o v á & O b r t e l 1984). The second numerous mouse species, the wood mouse *A. sylvaticus*, shows very broad ecological valence in southern Moravian agricultural landscape. It is present in all habitat types; however, it inhabits most frequently cereal ricks, vineyards, arable land, windbreaks and shrubberies (Z e j d a 1965). The wood mouse is granivorous species consuming a great variety of seeds and it moves to corn at the time of ripening (H o l i š o v á 1960, H e r o l d o v á 1994).

We conclude that great changes in habitat structure, such as massive ingrowths by weed species after abandonment promptly lead to changes in the structure of small mammal communities. The most conspicuous change was the increase of the proportion of the granivorous species and their abundance which can lead to strong impact on surrounding seed crops.

Are abandoned fields risky for agricultural production?

Pest and weed problems are often cited as the main risks of set-aside field management (F i r - b a n k et al. 1993). However, to date there are only limited data about the impact of mammal pests on surrounding plantations. The common vole is considered to be the main mammal pest species in central Europe (R y s z k o w s k i & M y l l y m ä k i 1975, T r u s z k o w s k i 1982, Z e j d a & N e s v a d b o v á 2000) and its occurrence and abundance is regularly checked by Plant Protection Administration (D e l a t t r e et al. 1992, Z a p l e t a l et al. 2001). Grassy set-aside plots in agricultural landscape can be a source of pest species for surrounding crop fields in several ways. D e l a t t r e et al. (1992) compared land use patterns and types of the common vole population dynamics. Its major predator, weasel (*Mustela nivalis*), can use grassy landscape elements as refuges and easily disrupt population dynamics from low abundance and smooth variations to large amplitude cycles. Thus major shift in land use patterns toward a dominance of grassland can enhance the abundance of a pest species such as the common vole (D e l a t t r e et al. 1992). However, we have found the opposite direction of changes in population dynamics, i.e. the abandoned alfalfa field seems to have a stabilizing effect on the common vole populations.

Another risk of set-asides and other uncropped land (including natural boundary between them and crop fields) is that they provide stable and sufficient food supply. They can lodge many rodents, especially during the period between harvest and coming of new vegetation on near fields, i.e. they can function as temporary refuges of field pests (M a i s o n n e u v e & R i o u x 2001).This is especially true for granivorous species, such as *Apodemus* mice (B r y j a & Z u k a l 2000). These species are usually neglected as pests. However they can successfully colonize adjacent crop fields (T a t t e r s a l l 2001) and became important pest species in seed bearing crops (H e r o l d o v á et al. 2004). We have demonstrated that abundance of mice increase in set-aside plots very rapidly. Our preliminary results of the study of

their diet preferences show that they could invade more the field of their preferred crop (they prefer wheat against barley – H e r o l d o v á et al., in preparation) and have stronger impact on these plots.

The set-aside plots with higher diversity of plant and animal species could also function as stabilizing elements in an agricultural landscape like windbreaks, small forests, riparian strips, road verges and balks. These also act as a refugee in time of winter after ploughing and after harvesting in agricultural land. The wider food spectrum is suitable for both herbivorous and granivorous and also insectivorous species (H i r t h 1959, G o l l e y et al. 1973, S o u t h w o o d et al. 1979, Y l ö n e n et al. 1991, G i r a u d o u x et al. 1994, T e w et al. 1994, S o t h e r t o n 1998).

Set-aside of leguminous fodder fields has some peculiarities in plant and animal succession. The dominant voles make the coverage of alfalfa plants to be more open by their burrowing activities, and then the annual weeds start to invade the fields. With the succession of weeds other rodent species such as *Apodemus* sp. increase their abundance there. The succession proceeds further towards the perennial plants and finally the predominance of grasses which makes the set-aside field again more suitable for voles (D e l a t t r e et al. 1996).

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