FIFTEEN YEARS OF CHANGES IN THE REPRESENTATION OF ALIEN SPECIES IN CZECH VILLAGE FLORA

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Abstract

Floras of several villages in the Bohemian Karst Protected Area (Czech Republic) are compared over the time period of almost fifteen years and the trends in the performance of alien plant species are described. Floristic list from 1980-81 was compared with the recent situation in 1995. Alien species were divided into archaeophytes, consisting of species introduced before 1500, and neophytes, introduced after 1500. From 1982 to 1995, there was an increase in the total number of species recorded in the 10 villages studied by 26.3 % (from 407 in 1982 to 514 in 1995). The most remarkable increase (by 90 %) was recorded in neophytes. This group at present not only consists of higher number of species (95 in 1995 compared to 50 in 1982) but particular species are also more abundant than in the past. These trends may be explained by (i) an increase in tourism bringing more diaspores into the region, (ii) more plants available on the gardening market compared to the period 15 years ago, and (iii) boom of the building activity.

Introduction

The flora of human settlements harbours relatively high proportions of alien plant species (Sukopp and Werner 1983; Kowarik 1990; Reidl and Dettmar 1993). This is from the increased possibilities of dispersal and rather heterogeneous environment providing plant species with a variety of habitats (Gilbert 1989; Wittig 1991). Human-induced disturbances are also frequent in the city environment and although not unequivocally accepted, there is some agreement on the supporting role of disturbances for the establishment of alien species (Hobbs 1989; Rejmánek 1989; Kowarik 1995). Furthermore, high vegetation dynamics create a number of early successional stages in which type of environment increase the chances for alien species to establish (Rejmánek 1989).

Most of the floristic data available from human settlements in Europe concern towns and cities (Pyšek 1993). Such data in the majority of cases results of either a short-term record from a single vegetation period, or concern long-term research, in some cases covering more than a decade (e.g. Berlin, Germany – Kunick 1974, 1982; Kowarik 1990). In both cases, it is difficult to infer the changes in the flora composition in time; in the short-term studies because the records are unrepeated, in those long-term because the data are cumulative which makes it difficult to compare unless a very long time-interval is considered. However, historical data making it possible to draw quantitative conclusions are very rare (Klotz 1987; Kowarik 1990).

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The present paper concentrates on the representation of alien species in the flora of village settlements. With the villages, it is possible to make an up-to-date record of the flora present in a given time. The repetition of such a sampling enables analysis of changes in the floristic composition on a rather short time scale. The present study compares the floras of several central Bohemian villages over the time period of almost fifteen years and is aimed at describing the trends in the performance of alien plant species. Also, with the study area located within former Eastern block of Europe, the paper is concerned with the following question: Are the changes in life style which occurred in the Czech Republic as a consequence of political changes reflected in the features of human-associated flora?

Study area and methods

Field research was carried out in the Bohemian Karst Protected Area, central Bohemia, located approximately 30 km SW of Prague. The area has an annual temperature of 8.4°C, and an annual precipitation of 480 mm (50-years average, Beroun meteorological station). The following 10 villages were studied (with the number of inhabitants and number of inhabited houses given in the parentheses, data from 1980): Karlštejn (1082/249), Srbsko (535/144), Vysoký Újezd (337/101), Choteč (287/80), Bubovice (279/79), Chýnice (244/65), Lužce (132/33) Kuchař (116/34), Hostim (108/37), and Svatý Jan pod Skalou (78/20). The villages are located at the altitude of 225–432 m. A detailed phytosociological study on vegetation of the villages was carried out by Pyšek (1991, 1992).

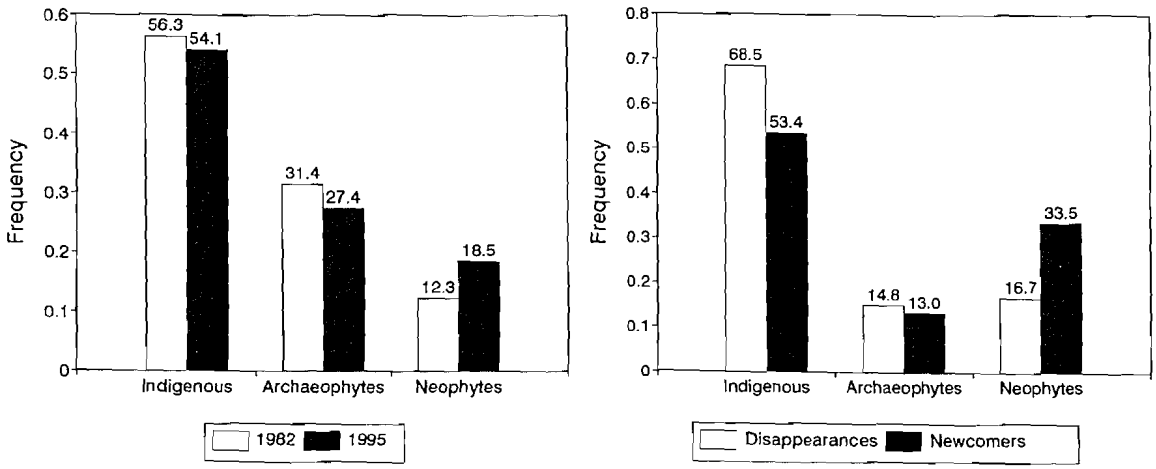
In 1980–81, the floristic list including all species of higher plants was compiled for the territory of each village by the first author (Pyšek 1982, 1985). The margin houses at the village periphery were considered as the limits of the territory studied, and the species beyond these limits were not included in the list. In 1995, the floristic research was repeated using the same methods and criteria.

Total floristic lists (i.e. the lists of all species present in the set of villages studied) were compiled for each period and compared with respect to the representation of alien species. The species matching the following definition were considered as alien (introduced, exotic, adventive): a species which reached the area as a consequence of the activities of neolithic or post-neolithic man or of his domestic animals (Webb 1985; Pyšek 1995). The term is opposite to indigenous (native), i.e. those species which evolved in the area or which arrived there by one means or another before the beginning of the neolithic period or which arrived there since that time by a method entirely independent of human activity (Webb 1985). Alien species were further divided into two groups: (a) archaeophytes, consisting of species introduced before 1500, and (b) neophytes, introduced after 1500 (Holub and Jirásek 1967). The species status was determined using local floras and data bases (Frank and Klotz 1990, Ellenberg *et al.* 1991; Hejný and Slavík 1988-1992; Slavík 1995).

Neophytes were further analysed from the viewpoint of the area of origin, life form and life strategy based on Grime *et al.* (1988).

Table 1. Comparison of species richness according to the status between the two records (1982, 1995). Total species numbers recorded in the ten villages studied are given. The term Disappearances is used for those species present in 1982 but not found in 1995. Those not present in 1982 but recorded in 1995 are termed Newcomers.

	1982	1995	Disappearances	Newcomers
Indigenous	229	278	37	86
Archaeophytes	128	141	8	21
Neophytes	50	95	9	54
Total	407	514	54	161



a *b*

Fig. 1. Comparison with respect to the origin status of (a) the taxa present in species lists 1982 versus 1995, and of (b) the disappearances versus newcomers. Disappearances are those species recorded only in 1982, newcomers are those present only in 1995. Percentages for particular groups are given at the top of the bars.

Results

From 1982 to 1995, there was an increase in the total number of species by 26.3 % (taking the species number from 1982 as 100 %). This was the result of an increase in each of the categories distinguished with respect to the origin status (Table 1). Native species increased in their number by 21.4 % and archaeophytes by 10.2 %. However, the increase which was by far the most remarkable was that of neophytes (by 90 %). Consequently, the floristic spectrum with respect to the origin status changed in favour of neophytes (Fig. 1a) and this trend was statistically significant ($P<0.05$, Table 2).

If the set of species present only in 1980s and not recorded in 1995 (termed as "Disappearances") is compared with those not present in 1982 but recorded in 1995 (termed as "Newcomers"), the trend of the neophyte increase is also obvious (Table 1, Fig. 1b).

The comparison of neophyte species sets from both periods did not reveal any

Table 2. Differences in species lists (1982 versus 1995) classified according to species status (native versus archaeophytes or neophytes), and comparison of neophytes present in 1982 and 1985 from the viewpoint of origin, life forms and life strategies. The null hypotheses tested were: (1) Species present in the villages studied in 1982 do not differ in their status from those present in 1995; (2) The set of neophytes present in 1982 does not differ from that recorded in 1995 in origin, life form and life strategy. χ^2 test on contingency tables was used. Regions of origin distinguished are as in Fig. 2. Life forms distinguished: chamaephytes, geophytes, hemicryptophytes, phanerophytes, therophytes. Only the C-, CSR-, and CR-strategies (according to Grime 1979) were used for the test because of a low number of species possessing other strategies. NS = the null hypothesis cannot be rejected on significance level less than 0.05.

	df	χ^2-value	P
Species status	2	6.99	<0.05
Neophyte origin	4	1.79	NS
Neophyte life form	4	1.92	NS
Neophyte life strat.	2	0.29	NS

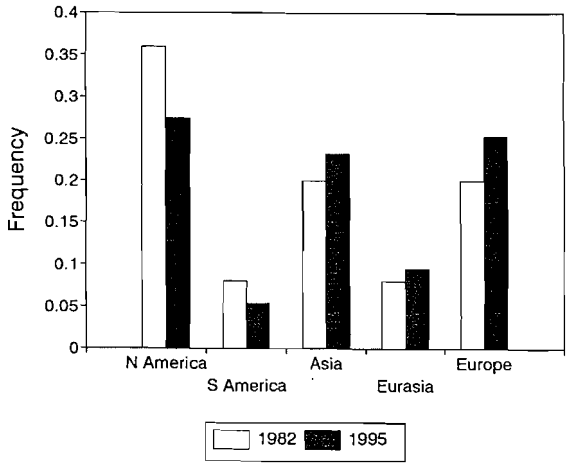


Fig. 2. Composition of the neophyte species sets according to the area of origin. Although there was a slight increase in representation of European and Asian species relative to those coming from North America, the difference between 1982 and 1995 was not significant (see Table 2).

significant differences in the frequency of life forms, life strategies or the area of origin (Table 2). In both periods, it was the North American species which were most strongly represented (Fig. 2).

The commoness of particular groups of species was analyzed on the basis of species occurrence in particular villages, i.e. their frequency (understood as the number of villages in which the species occurred). While the pattern has not actually changed for native species and archaeophytes (Fig. 3a, b), neophytes remarkably increased the frequency of their occurrence. In 1982, only 2.0 % of the total number of neophytes occurred in 9 or 10 villages whereas this is now 10.5 %. In the same vein, the percentage of neophytes occurring in at least 5 villages increased from 20.0 % to 36.8 % (Fig. 3c).

Fig. 4 indicates that those neophytes present in the villages studied in 1982 with high frequency had a better chance to be common in 1995. However, even among the newcomers, a principle group (35.2 %) became established in at least three villages. On the other hand, all the neophytes that disappeared between 1982 and

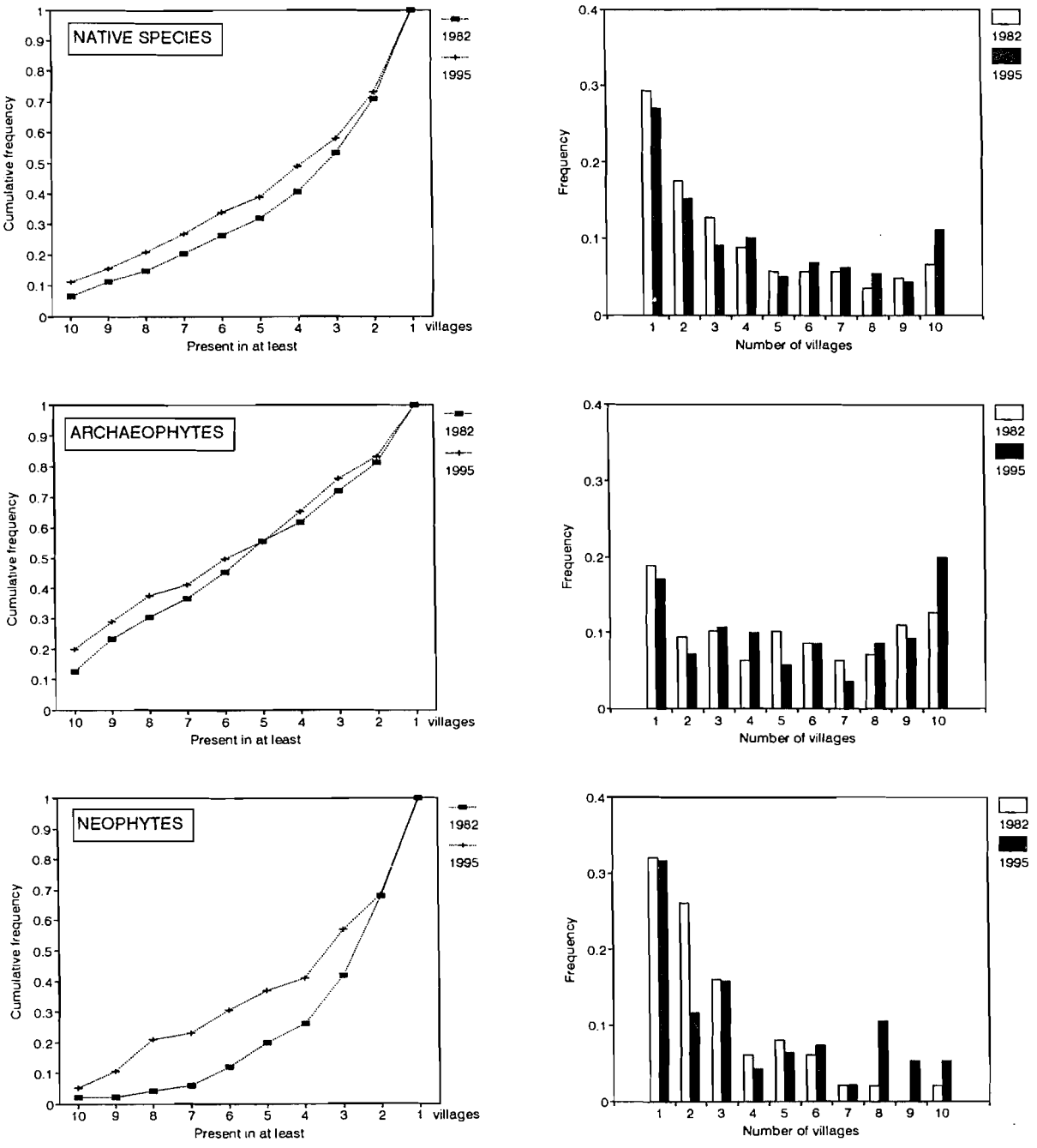


Fig. 3. Cumulative frequency of occurrences in the villages studied shown for (a) native species, (b) archaeophytes, and (c) neophytes. Frequency distribution of species with respect to the number of villages in which they occurred is shown in the left part of the diagram.

1995 were present with the lowest frequency (1–2 occurrences), or, put in another way, of those with the lowest frequency, 31.0 % disappeared.

Discussion

To explain the changes in the composition of village flora recorded in the present study, the changes in management and life style of Czech countryside (associated

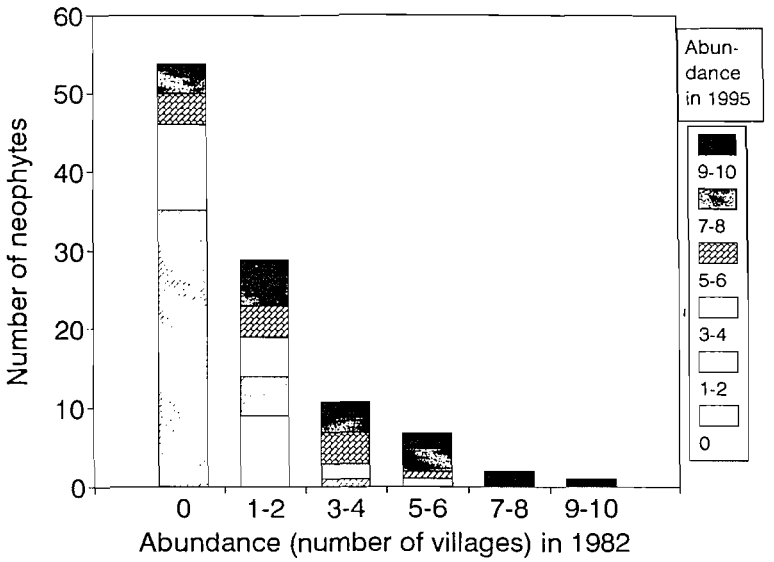


Fig. 4. Changes in abundance (expressed as the number of villages in which the species occurred) of neophytes from 1982 to 1995. Each bar representing the number of species with a given number of villages in which it occurred in 1982 is divided according to the number of villages these species occupied in 1995.

with the change of the political system at the end of the 1980s) must be taken into account.

In the 1980s, at the time of the first research period, there was no private agriculture, the arable land was managed by so-called cooperative farms and these farms were located mostly at the periphery of the village. The countryside was being overdosed with nutrients, especially nitrogen, coming from extensive fertilization – the average input of pure nutrients (N, P_2O_5, K_2O) was 255 kg per hectar per year (Moldan 1990).

At present, there is some return to private agriculture and the number of houses keeping cattle, poultry and waterfowl is increasing. Further, the input of fertilizers into the landscape has decreased remarkably and, as a consequence, quite a few weeds of oligotrophic sites, which used to be common in the past but diminished in the recent decades, are now present again. Also, the boom of building activity, though most remarkable in the big cities, is also obvious in the countryside and creates suitable disturbed habitats for ruderal flora. All these phenomena increase the diversity of habitats available in the villages and explain the increase in the species richness recorded by the present study.

But why was the increase in neophytes the most remarkable? The following reasons may serve as an explanation: (1) There is undoubtedly considerable increase in tourism as the area is one of the most attractive in the central Bohemian region. Although it is difficult to give an unequivocal evidence that a plant was brought in by tourism, more visitors coming undoubtedly mean more diaspores, often carried from very distant areas. (2) The variety of plant species and cultivars available on the gardening market is incomparably higher than 15 years ago. Numerous private companies were established in the last few years and the flow of germplasm into the country is practically uncontrollable. These plants, by escaping from cultivation, represent an important contribution to the neophyte pool, e.g. *Viola* × *wittrockiana, Sorbaria sorbifolia, Mahonia aquifolium, Papaver somniferum, Lychnis coronaria,*

Euphorbia lathyris, Alcea rosea and many others. (3) Neophytes, being mostly confined to man-made sites, are very much encouraged by building activity (Kowarik 1990), e.g. *Galinsoga parviflora, G. ciliata, Amaranthus powellii, Veronica persica* or *Conyza canadensis*, to mention those confined to disturbed areas.

The Bohemian Karts protected area is, by Czech standards, rather special area because of its natural beauty and nature conservation value (richness of flora and fauna). Its touristic attractivness, and proximity to Prague increase the possibilities of undesirable introductions of plant species. More data are therefore needed to allow broader generalization, but the present study undoubtedly indicates an increasing and disturbing importance of alien plant species in the contemporary Czech countryside. The increasing number of neophytes, the most dynamic and relatively recently introduced group of aliens, is especially alarming. The majority of them occur only temporarily, but on the other hand, some of the most noxious invaders are known to recruit from relatively recent introductions (Cronk and Fuller 1995).

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