

## On the richness of Central European urban flora

K druhové bohatosti flóry středoevropských měst

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Relation between the number of species and number of inhabitants in Central European towns and cities is presented. Factors influencing numbers of species reported to occur in urban floras are discussed.

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Floristic investigation of European towns is receiving more and more attention (e.g. KRAWIECOWA et ROSTAŃSKI 1976, KORNAŚ 1983, KLOTZ 1987, SUKOPP et al. 1987). Studies of this type usually include as basic data the total number of species found in a given locality. This paper aims to summarize accessible data from Central Europe and pays attention to the factors influencing floristic richness of urban areas.

Data on the number of species reported from some European towns are presented in Table 1. As a characteristic of the town the number of inhabitants was used which is supposed to be closely related to the anthropic pressure and the size of the town area. The number of inhabitants was obtained from the statistical year-books from the years 1980–83. Geographical location of towns is shown in Fig. 1.

Relation between the number of species and number of inhabitants is presented in Fig. 2. In the case of smaller towns, approximately up to 200 thousands inhabitants, the number of species found does not usually markedly exceeds 500. In cities up to ca 1 million inhabitants, the number of species varies from 500 to 1200, while in cities with 1,5 to 2 millions of inhabitants the total number comes to 1500.

This generalization should be taken with a caution, however. There are exceptions that can be explained if specific conditions are considered. The low species number in Amsterdam can be ascribed undoubtedly to the fact that the local oceanic flora is poor in species. On the contrary, an increase in the number of species is seen in some Polish ports (remarkable in Gdańsk, less pronounced in Szczecin) or in Halle, a town situated within the reach of the Elbe migration route of adventitious plants (JEHLÍK et HEJNÝ 1974).

The obvious increase of species number in urban areas inhabited by more than 50 thousand was pointed out by HAEUPLER (1974). SUKOPP et WERNER (1983) gave evidence for a frequently higher number of species in towns when compared to the surrounding landscape. They related the number of species not only to the number of inhabitants, but also to the area of the

town. They mentioned Hannover, West Berlin, Warsaw, and Vienna; their survey (SUKOPP et WERNER l.c., Table 2) does not include smaller towns, however. When we include more recent data on species number (in the case of Warsaw e.g., SUDNIK-WÓJCIKOWSKA 1988), we can see (Fig. 2) that the number of species is, with the exception of Hannover, in all these cities almost equal. This is in conformity with their comparable areas and sizes of population.

According to my opinion, numbers of species reported to occur in urban floras are influenced by the following factors:

### 1. Geographical location

In general, the floristic richness of a region is ruled by its geographical location and climatic conditions. This is reflected mainly in the number of apophytes that occur in man-made habitats. Spreading and establishment of anthropophytes from warmer regions is very closely connected with the temperature conditions of a given territory, of a given town (SUKOPP et WERNER 1983, PÝŠEK 1989). The geographical location itself, however, is apparently not decisive for the total amount of species in urban areas. Both species rich and species poor cities occur all over Central Europe (Fig. 1).



Fig. 1. — Location of European towns for which data on the number of species were published. Floristic richness is indicated by points (up to 500 species), empty circles (from 500 to 1000 species), and full circles (more than 1000 species).

Table 1. — Number of species related to the number of inhabitants in European towns and cities. Symbols indicate data reported by: ○ — KRAWIECOWA et ROSTAŃSKI 1976, ! — KUNICK 1982, + — KOWARIK 1985

	town	geographical co-ordinates		number of inhabitants (thousands)	number of species	source
		latitude	longitude			
less than 200 thousands	Sieradz	51.36	18.44	30	498	SOWA et WARCHOLIŃSKA 1984
	Zduńska Wola	51.37	18.57	38	418	SOWA et WARCHOLIŃSKA 1984
	Opole	50.39	17.57	87	802	○ MICHALAK 1970
	Erlangen	49.36	11.00	102	268	+ NEZADAL 1974
	Würzburg	49.48	9.55	129	454	+ HETZEL et ULLMAN 1981
	Bremerhaven	52.32	8.35	137	518	+ KUNICK 1979
	Brussel	50.51	4.21	150	458	! HOLLAND 1976—77
	Plzeň	49.46	13.24	171	530	PYŠEK et PYŠEK 1988
200 thousands — 1 million	Halle	51.29	11.58	235	946	KLOTZ 1984
	Braunschweig	52.16	10.31	256	800	+ BRANDES 1977
	Szczecin	53.26	14.36	337	871	○ CWIKLIŃSKI 1970
	Brno	49.11	16.36	344	764	GRÜLL 1979
	Gdańsk	54.22	18.38	373	1030	○ SCHWARZ 1967
	Wrocław	51.06	17.00	517	1177	KRAWIECOWA et ROSTAŃSKI 1976
	Hannover	52.23	9.44	523	914	+ HAEUPBER 1976
	Duisburg	51.26	6.45	539	1036	! DÜLL et KUTZELNIGG 1980
	Poznań	52.24	16.55	558	539	KRAWIECOWA 1951
	Stuttgart	48.49	9.11	568	1080	+ KREH 1951
	Amsterdam	52.22	4.54	717	390	! BOLMAN 1976
	Lodz	51.47	19.28	753	547	○ SOWA 1962
more than 1 million	Warszawa	52.14	21.01	1290	1416	SUDNIK-WÓJCIKOWSKA 1988
	Wien	48.12	16.22	1600	1348	! FORSTNER et HÜBL 1971
	Hamburg	53.33	10.00	1672	1387	+ MANG 1981
	Berlin (West)	52.30	13.20	1930	1396	SUKOPP et al. 1981

## 2. City's size

Larger cities are characterized by a greater intensity of the anthropic pressure and higher diversity of habitats. The typical urban biotopes are combined with the suburban areas of rural character, which contributes to the flora enrichment. This is further influenced by fringe areas (*sensu* HÄUPLER 1974) between cities and surrounding landscape, where the species of semi-natural communities can find suitable life conditions. The opportunity for the occurrence of apophytes is further enhanced by extensive areas of planted greenery in cities.

## 3. Possibilities of immigration

Numbers of anthropophytes introduced both intentionally and unintentionally are influenced by this factor. The percentage representing anthropophytes in those European cities for which corresponding data have been published so far, was summarized by PYŠEK (1989, Table 10). The values he

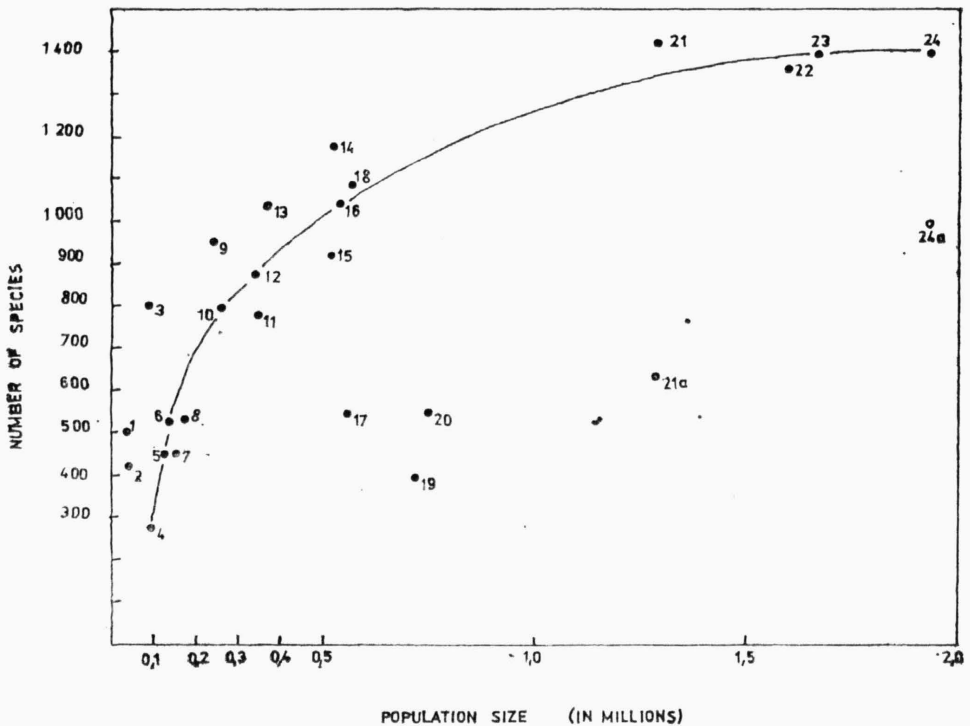


Fig. 2. — Relation between the number of species and the population size for European towns. West German cities were used to construct the curve.

1 — Sieradz, 2 — Zduńska Wola, 3 — Opole, 4 — Erlangen, 5 — Würzburg, 6 — Bremerhaven, 7 — Brussel, 8 — Plzeň, 9 — Halle, 10 — Braunschweig, 11 — Brno, 12 — Szczecin, 13 — Gdańsk, 14 — Wrocław, 15 — Hannover, 16 — Duisburg, 17 — Poznań, 18 — Stuttgart, 19 — Amsterdam, 20 — Łódź, 21 — Warszawa (1988), 21a — Warszawa (1964), 22 — Wien, 23 — Hamburg, 24 — West Berlin (1981), 24a — West Berlin (1974).

stated varied from 40 to 56 %, but an apparent increase corresponding with increasing city size has not been proved. Possibilities of immigration and the richness of urban flora in general are influenced by economical and geographical conditions of a given territory (cf. JEHLÍK 1982).

#### 4. Authors' approach

Conceptions of different authors vary as the boundaries of the investigated area are concerned. It is important whether the fringe area of the town is included into the research or not.

Methodological discrepancies evoke further differences in the number of species recorded. This holds especially for the range of taxonomic concept of the species and the way of species registration in the field, e.g. whether the species escaping cultivation only rarely are included into floristic lists or are omitted. A recent study carried out in the town of Brno (GRÜLL 1979) was restricted to anthropogenous habitats. The floristic list compiled by this author lacks species growing at semi-natural localities in the city area, as JEHLÍK (1983) remarked.

Another important aspect is the research duration. Due to the remarkable dynamics of ruderal flora we will get a considerably higher number of species after investigating the flora of a certain area over a long time. For example, the increase of number of species in the flora of West Berlin was indicated by comparing the original amount of 994 species (KUNICK 1974) with later sum of 1396 species (SUKOPP et al. 1981 sec. SUKOPP et WERNER 1983). Similarly, for Warsaw, ZANOWA (sec. KRAWIECOWA et ROSTAŃSKI 1976) reported 604 species in the year 1964, then, resulting from the research carried out by SUDNIK-WÓJCIKOWSKA (1987, 1988) during the years 1977—82, the number was more than doubled: 1416 species.

In spite of these above-mentioned specific conditions, which can vary in different cities, as the case may be, it can be concluded that the number of species in Central European urban flora increases with the increasing number of inhabitants. This relation can be seen best when considering only cities of a certain geographical area. West German cities were used to construct the curve in Fig. 2. The floristic differences are minimized because the area is, from the phytogeographical point of view, less heterogeneous than when considering the whole of Europe. The cultural and economical differences are also minimized as the comparison concerns one state only. It is possible to expect that also differences in authors' approaches within one scientific school, in W. Germany concentrated around the personality of prof. Sukopp, are minimized.

#### SOUHRN

Práce se v rámci střední Evropy zabývá vztahem mezi počtem druhů v městské flóře a velikostí města. Ta je vyjádřena počtem obyvatel, který zároveň vypovídá o předpokládané intenzitě antropického tlaku a úzce souvisí s rozlohou města. U menších měst do 200 tisíc obyvatel zpravidla počet zjištěných druhů výrazně nepřesahuje 500, u měst do ca. 1 miliónu obyvatel se pohybuje mezi 500 a 1200 a u velkoměst s 1,5 až 2 milióny obyvatel se blíží 1500 (tab. 1, obr. 2).

Počet druhů ve flóře určitého města je ovlivněn geografickou polohou, klimatickými poměry a s tím související floristickou bohatostí území. Dále se na něm podílí velikost města (a z ní vyplývající intenzita antropického tlaku a stanovištní heterogenita) a možnosti zavlékání antropofyt. Výsledky mohou být ovlivněny pojetím jednotlivých autorů; to se liší přístupem ke zpra-

covávanému území (zahrnutí nebo vynechání okrajových zón) i přístupem floristickým (pojetí druhu, evidence ojediněle zplaňujících druhů).

Závislost mezi počtem druhů a velikostí populace je nejlépe patrná, srovnáme-li pouze města na území jednoho státu (např. NSR). Tím eliminujeme geografické a hospodářské rozdíly a navíc můžeme očekávat v rámci určité výzkumné školy více méně obdobný přístup autorů.

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