Elektronische Aufsätze der Biologischen Station Westliches Ruhrgebiet 5 (2005): 1-16
Electronic Publications of the Biological Station of Western Ruhrgebiet 5 (2005): 1-16

Non-established adventive plants in the western and central Ruhrgebiet (Northrhine-Westphalia, Germany) – a preliminary overview[1]

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Abstract

A list of non-established (casual or not definitely established by now) adventive plant taxa found in the western and central Ruhrgebiet (Germany, Northrhine-Westphalia) since 1980 is given. A compilation of the investigation results of 100 years of adventive floristics in the Ruhrgebiet shows a decline of casuals by about 70 % since the period between the World Wars. Nowadays, the number of casuals in the Ruhrgebiet area is approx. 350.
Keywords: Spontaneosynanthropic, Ephemerophytes, Adventive plants, Xenophytes, Ergasiophygophytes, Ruhrgebiet, Northrhine-Westphalia

Nicht eingebürgerte Adventivpflanzen im westlichen und zentralen Ruhrgebiet – ein vorläufiger Überblick

Die seit 1980 im westlichen und zentralen Ruhrgebiet nachgewiesenen nicht eingebürgerten (unbeständigen und noch nicht sicher etablierten) Adventivpflanzensippen werden aufgelistet. Eine Zusammenstellung der Untersuchungsergebnisse aus 100 Jahren adventivfloristischer Arbeit im Ruhrgebiet belegt einen Rückgang von etwa 70 % der Unbeständigen seit der Zwischenkriegsperiode. Aktuell liegt die Zahl der unbeständigen (und noch nicht sicher eingebürgerten) Taxa bei gut 350.
Schlüsselwörter: spontaneosynanthrop, Ephemerophyten, Adventivpflanzen, Xenophyten, Ergasiophygophyten, Ruhrgebiet, Nordrhein-Westfalen

Introduction

The adventive flora of the former most important German industrial area, the Ruhrgebiet (situated in the western part of the federal land Northrhine-Westfalia), has been a subject of floristic investigations since 1881. The most important studies on adventive plants of the Ruhrgebiet were published within the period between the

[1] Updated draft of a poster contribution on the 6th International Conference – Ecology and Management of Alien Plant Invasions - EMAPi, 12-15 September 2001, Loughborough University, UK. Veröffentlicht auf der Internetseite www.bswr.de im Oktober 2005

World Wars. The works of HÖPPNER & PREUß (1926) and of BONTE (e.g. 1916, 1930) and SCHEUERMANN (e.g. 1928, 1929, 1934, 1941, 1942, BONTE & SCHEUERMANN 1937) including studies of some collaborators should be mentioned. After a period of stagnation (especially in publishing investigation results) nowadays the adventive flora of the Ruhrgebiet is studied more systematically (cf. KEIL & LOOS 2001). At least two Floras including large parts of the Ruhrgebiet are in preparation (principal aspects of the flora of the Ruhrgebiet are pointed out by DÜLL & KUTZELNIGG 1980, DETTMAR 1992, BÜSCHER et al. 1997, KEIL 1999 and LOOS 1999a; to the investigation of adventive plants at the riparian habitats at Rhine river in the westernmost part see the works of U. SCHMITZ, e.g. 2002).

Time-point and way or mode of introduction or immigration as well as the degree of naturalisation of alien plants are of special interest because a lot of changes from past to present could be recognized in this case. To classify adventive plants in this context, it is necessary to use well-defined terms. In central Europe the terminology of SCHROEDER (1969) has been widely adopted (cf. TREPL 1990). As HAEUPLER (2000) stated, the classifications founded by SCHROEDER are clear-cut and any deviating terminologies are not useful. But the separation of introduction mode, time and degree of naturalisation and their treatment as three separated systems is very complicated and lot of information is lost if one of the systems is neglected. In some cases a combination of the three systems could be useful to obtain most information on an alien plant species within a defined region (cf. LOOS 1999a and b, KEIL & LOOS 2001).

Additionally, the recognition of the degree of naturalisation can be problematic. At first, the status depends on the defined area: A species which occurs as a casual in one region could be established in an adjacent area. Many (at least partial) adventive plant species display different degrees of naturalisation within one region. For instance, a species is indigenous, a casual and an established adventive at three different places within one investigation area (for a more detailed outline of this problem and examples see KEIL & LOOS 2001). Furthermore, in floristic field work it is often not possible to recognize the degree of naturalisation properly. It could be very problematic to make a differentiation between casual occurrences and locally established populations, if the populations were not studied over a longer period of time. In floristic field work such cases are called "synanthropic". But the original definition of sy-

nanthropy includes cultivated occurrences as well, therefore the term should be replaced by "spontaneosynanthropic" to exclude cultivated occurrences.

If the problems mentioned above are taken into consideration, it is possible to establish a checklist of the adventive plants of a region and evaluate their occurrences. The present study aims to point out the non-established adventive plants found in the western to central part of the Ruhrgebiet (the area between the cities of Bochum and Duisburg) since 1980 and mention their modes of introduction. In addition, differences between the means of introduction of formerly occurring casuals and the non-established adventives found within the period since 1980 are described. Vouchers and/or photographs of most taxa are included within the herbaria and the photo collections of the Biological Stations of Western Ruhrgebiet and the Unna district.

Non-established adventive plants – terms and definitions

Following SCHROEDER (1969) and all central European terminology contributions of recent times (e.g. KOWARIK 1999, 2002), the flora of a defined region can be divided into indigenous plant species (indigenophytes, idiochorophytes), archaeophytes (plant species which were introduced or immigrated anthropogenically before the discovery of America) and neophytes (plant species which were introduced or immigrated anthropogenically after the discovery of America). In contradiction, the term "adventive plant" is not covered by a standard definition; in our concept it contains neophytes and archaeophytes as well. Both neophytes and archaeophytes include established species and occurrences as well as non-established species and occurrences. The term "non-established" contains real casuals (ephemerophytes) and spontaneosynanthropic occurrences or species as defined above. As seen before, it is somewhat difficult to recognize the degree of naturalisation and, in some cases, also whether the occurrences were studied over longer periods of time. Many phanerophytes do not produce seed for years and do not spread vegetatively. Partly, decades of investigation time are necessary, before the real degree of naturalisation can be fixed. Consequently, in the present study ephemerophytes and spontaneosynanthropics are considered, because at least some of the spontaneosynanthropic species and occurrences will be proved to be ephemerophytic (not adapted to the climatic conditions within the investigation area).

It is important to differentiate between non-established plant species and occurrences.Table 3 contains all species which show principally non-established occurrences in the central Ruhrgebiet. Species like *Acer platanoides*, *Ailanthus altissima* or *Rubus laciniatus*, which are established in the central Ruhrgebiet in general, also include some ephemerophytic or spontaneosynanthropic occurrences, but these species are not treated. On the other hand, species which are predominantly non-established but show some established occurrences are mentioned (e.g. *Acer negundo, Petrorhagia saxifraga*). Some species which were included as spontaneosynanthropics in previous (not published) drafts of this contribution are proved to become predominantly locally established in the meantime – and were excluded from this updated list (*Campanula poscharskyana, Pachysandra terminalis, Pimpinella peregrina, Rumex rugosus*).

In this contribution only occurrences resulting from generative reproduction are considered, not so-called "relicts", developed from vegetative spreading (cf. LOOS 1997; e.g. *Sedum* species and hybrids, *Saxifraga ×geum*, *Rheum ×hybridum*, *Rhus typhina* etc.). Some species spread generatively and vegetatively, too (e.g. *Populus alba*), these species are included in table 3 except for *Parthenocissus inserta* which is clearly established. Phanerophytes like *Sorbus aucuparia* and *Populus tremula* are widely cultivated in urban areas, even in regions where they are not indigenous. Nowadays it is problematic to recognize these escaped occurrences and to differentiate them from the spreading of indigenous occurrences in the vicinity of the region. We excluded such cases from the list of this contribution, but we have them in mind as also the “relicts” (for further studies).

Another problematic aspect is given by escapes from special plant collections like botanical gardens (cf. JAGEL 2003). In the present study these occurrences are left out (only *Sonchus palustris* is mentioned as it is not obvious that it escaped from the Botanical Garden of Bochum).

A number of species seem to be casuals, but there is not a lack in adaptation to the climatic conditions. The appearence of these species depend on special ecological conditions caused by, for instance, soil management or water-levels. Such species are called "intermittents" (LOOS 1999b) and are left out here, too (as they are not real casuals; e.g. *Datura stramonium*, *Sinapis (Hirschfeldia) incana*, *Hyoscyamus niger*).

In the case of *Descurainia sophia*, it seems not clear if the species is a casual or an intermittent in the central-western Ruhrgebiet, but seems more likely that there is a high affinity to human activities at occurrences´ places, so we have omitted it from the list. Finally, so-called "anecophytes" (term postulated mainly by SUKOPP & SCHOLZ 1997) are not considered. These species derived (mostly by hybridisation) from non-native taxa, but as they arose without being cultivated, immigrated or introduced they could not be classified as neophytes or adventive plants (e.g. hybridigenous *Populus* taxa growing on former industrial ground, originated from complex hybrids planted for forestry, see KEIL & LOOS 2004).

Results

In the last 20 years, 357 non-established adventive species, taxonomic groups and hybrids were found within the investigation area (appraised average of approx. 15-20 % of the total flora of the western and central Ruhrgebiet). The most important source of non-established adventives is gardening (ornamental plants, herbs, vegetables) with 199 species/groups/hybrids, followed by hedging and roadside plantings with 77 taxa, cemeteries and parks with 66 taxa, xenophytics with 63 taxa. The sources from bird-seed (with 11 taxa) and indoor cultivation with only 2 taxa (*Azolla filiculoides, Soleirolia soleirolii)* are insignificant.

Table 1: Number of non-established adventive species in the western and central Ruhrgebiet.
Tab. 1: Zahl der nicht eingebürgerten Adventivpflanzen-Sippen im westlichen und zentralen Ruhrgebiet.

Cities	Number of non-established taxa
Duisburg*	133
Mülheim an der Ruhr	209
Essen	189
Gelsenkirchen	135
Bochum	264
Herne*	119
Total number in the research-area	357
Northrhine-Westphalia**	331

* prevailing industrial areas were investigated; ** after RAABE et al. (1996).

As can be seen from table 2 and 3, most non-established adventive occurrences of today are ergasiophygophytic in the strict sense (76 %), the percentage of xeno-

phytes including sowing plants and seed-contaminants is 24 %, xenophytic occurrences in the strict sense only 13 %.

Table 2: Sources of non-established adventive taxa in the western and central Ruhrgebiet.
Tab. 2: Herkünfte der nicht eingebürgerten Adventivpflanzen-Sippen im westlichen und zentralen Ruhrgebiet.

Sources	Number of taxa
Forestry	15
Gardening (ornamental plants, herbs, vegetables)	199
Cemeteries and Parks	66
Flower beds (at public places)	18
Hedging and Roadside plantings	77
Seed and Seed-contaminants	44
Agriculture	27
Bird-seed	11
Indoor cultivation	2
Xenophytic	63

Table 3: List of non-established adventive taxa in central Ruhrgebiet (1980-2004; including data from DÜLL & KUTZELNIGG 1987, REIDL 1989, DETTMAR 1992, JAGEL & GOOS 2002, FUCHS 2003 and SEIPEL 2005); U = casuals; S = spontaneosynanthropics.
Tab. 3: Liste der nicht eingebürgerten Adventivpflanzen-Taxa im zentralen Ruhrgebiet (1980-2004; unter Berücksichtigung von Daten aus DÜLL & KUTZELNIGG 1987, REIDL 1989, DETTMAR 1992, JAGEL & Goos 2002, FUCHS 2003 und SEIPEL 2005); U = Unbeständige; S = Spontaneosynanthrope.

Taxon		research area (cities)									sources									
	Status	Oberhausen	Duisburg	Mülheim a.d. Ruhr	Essen	Gelsenkirchen	Bochum	Herne	Forestry	Gardening (ornamental plants, herbs, vegetables)	Cemeteries and Parks	Flower beds (at public places)	Hedging and Roadside plantings	Sowing plants and Seed-contaminants	Agriculture	Bird-seed	Indoor cultivation	Aquarium	Xenophytic
Abutilon theophrastii	U			x	x	x	x									x			
Acer ginnala	S			x			x				x		x						
Acer negundo	S	x	x	x	x	x	x	x			x		x						
Acer saccharinum	S	x	x		x		x			x	x		x						
Acer tataricum	S						x			x	x		x						
Aconitum carmichaelii	S			x			x			x									
Aesculus hippocastanum	S	x	x	x	x	x	x	x		x	x		x						
Ageratum houstonianum	U				x	x	x	x		x									
Agrostis castellana	S		x			x	x							x					
Aira elegantissima	U			x						x									
Allium cepa	U		x	x	x					x					x				
Alnus cordata	S				x		x						x						
Alnus incana	S	x	x	x	x	x	x	x	x	x			x						
Althaea rosea	S		x	x	x	x	x	x		x									

Taxon		research area (cities)								sources									
	Status	Oberhausen	Duisburg	Mülheim a.d. Ruhr	Essen	Gelsenkirchen	Bochum	Herne	Forestry	Gardening (ornamental plants, herbs, vegetables)	Cemeteries and Parks	Flower beds (at public places)	Hedging and Roadside plantings	Sowing plants and Seed-contaminants	Agriculture	Bird-seed	Indoor cultivation	Aquarium	Xenophytic
Alyssum saxatile	S		x	x			x			x									x
Amaranthus blitum	U	?						x											x
Amaranthus cruentus	U	x		x			x			x									
Ambrosia artemisiifolia	U			x	x	x	x	x								x			
Amelanchier lamarckii	S	x	x	x	x	x	x	x		x			x						
Ammi majus	U						x	x								x			x
Anagallis foemina	U			x															x
Anemone blanda	S			x															
Anethum graveolens	U	x	x	x	x	x	x	x		x									
Anthyllis vulneraria s.l. (incl. *A. macrocephala* & hybrids)	S			x	x	x	x							x					x
Antirrhinum majus	S	x		x	x	x	x	x		x									
Apium graveolens (Cultivar)	U				x			x		x									
Aquilegia vulgaris (cvv.) & Hybrids	S	x	x	x	x	x	x	x		x									
Arabis caucasica	S					x	x	x		x									
Armeria maritima	U						x			x									
Artemisia abrotanum	U			x	x					x									
Artemisia absinthium	S	x		x	x	x	x							x					x
Artemisia dracunculus	U				x					x									
Artemisia biennis	S				x	x										x			x
Arum italicum	S	x				x				x									
Aruncus dioicus	U				x		x			x									
Asparagus officinalis	U	x	x	x	x	x	x	x		x					x				
Asperugo procumbens	U			x															x
Asperula arvensis	U			x															x
Astrantia major	U						x			x									
Aster dumosus	U						x			x									
Aster concinnus	U			x						x									
Aster novae-angliae	S					x	x			x									
Atriplex hortensis	S			x		x	x	x		x				x					
Atriplex tatarica	U		x																x
Aucuba japonica	S				x					x									
Aubrieta x *hybrida*	S			x						x									
Aubrieta deltoidea	S						x			x									
Avena nuda	U				x														x
Avena sativa	U		x	x	x	x	x	x							x				x
Avena strigosa	U			x		x													x
Azolla filiculoides	U			x		x											x	x	
Bassia densiflora	S				x														x
Bellis perennis cvv.	S	x								x									
Berberis julianae	S	x	x	x	x	x	x	x		x	x		x						
Berberis thunbergii	S	x	x	x	x	x	x	x		x	x		x						
Berberis x *ottawensis*	S			x							x		x						
Beta vulgaris	U		x	x	x	x	x								x				x
Betula maximowicziana	S		x							x	x								
Betula papyrifera (incl. hybrids with *B. pendula*)	S		x				x	x		x			x						
Bidens ferulifolia	S						x			x									
Borago officinalis	U	x		x	x	x	x	x		x									
Brassica oleracea	U		x	x	x	x	x			x									

Taxon		research area (cities)								sources									
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Brassica rapa	U			x	x		x								x				x
Briza maxima	U				x		x			x									
Bromus arvensis	U			x										x					x
Bromus carinatus	S			x	x	x	x							x					
Bromus pseudothominei	U						x												
Brunnera macrophylla	S			x	x		x			x									
Calendula officinalis	S	x	x	x	x	x	x	x		x									
Calystegia pulchra	U			x						x									x
Camelina sativa	U						x								x				?
Campanula alliariifolia	S						x			x									
Campanula carpatica	U							x		x		x							
Campanula medium	U						x	x		x									
Campanula portenschlagiana	S	x	x	x			x	x		x									
Cannabis sativa	S	x	x	x	x	x	x	x								x			
Caragana arborescens	S			x	x	x					x		x						
Carum carvi	S			x			x	x						x					x
Castanea sativa	S	x	x	x		x	x	x	x				x						
Catalpa bignoniodes	S			x	x	x	x			x	x		x						
Catananche coerulea	S				x					x									
Centaurea melitensis	U			x															x
Centaurea montana	S				x	x	x	x		x									
Centaurea stoebe s.l.	S						x												x
Centranthus ruber	S		x	x			x			x									
Cercidiphyllum japonicum	S						x				x								
Chaenorhinum origanifolium	S	x		x						x									
Chaerophyllum aromaticum	S		x		x					x									
Chamaecyparis lawsoniana	S				x	x	x			x	x								
Chenopodium capitatum	U			x										x					
Chenopodium hybridum	U			x			x												x
Chenopodium urbicum	U			x															x
Cichorium calvum	U						x							x					
Citrullus lanatus	U					x	x			x									x
Colutea arborescens	S					x					x		x						
Conringia orientalis	U			x	x		x							x					x
Consolida ambigua	U			x			x	x		x				x					
Coreopsis grandiflora	U			x						x		x							
Coreopsis tinctoria	U			x			x							x					
Cornus mas	S			x	x		x			x	x		x						
Corylus maxima (incl. hybrids with *C. avellana*)	S	x	x	x	x	x	x	x		x	x		x						
Corylus colurna	S	x			x								x						
Cosmos bipinnatus	U			x	x	x				x									
Cotoneaster bullatus	S		x		x	x	x	x		x	x		x						
Cotoneaster dielsianus	S		x	x	x	x	x	x		x	x		x						
Cotoneaster divaricatus	S	x	x	x	x	x	x	x		x	x	x	x						
Cotoneaster franchetii	S				x		x	x		x	x		x						
Cotoneaster hjelmquistii	S						x			x	x		x						
Cotoneaster horizontalis	S	x	x	x	x	x	x	x		x	x	x	x						
Cotoneaster integrifolius	S		x		x	x	x			x	x		x						
Cotoneaster lucidus	S		x		x		x			x	x		x						

Taxon		research area (cities)								sources									
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Cotoneaster rehderi	S				x	x	x	x		x	x		x						
Cotoneaster rotundifolius	S	x	x		x		x			x	x	x	x						
Cotoneaster salicifolius	S	x	x		x	x	x	x		x	x		x						
Cotoneaster x *suecicus*	S		x		x	x	x	x		x	x		x						
Cotula squalida	S						x				x								
Crataegus pedicellata	S	x		x		x	x	x					x						
Crataegus persimilis	S	x		x	x		x						x						
Crepis setosa	U			x			x							x					x
Cucubalus baccifer	S						x												x
Cucurbita maxima	U				x					x									x
Cucurbita melo	U				x					x									x
Cucurbita pepo	U			x	x		x			x									x
Cucumis sativus	U						x			x									x
Dahlia x *variabilis*	U				x		x			x		x							
Daucus x *sativus*	U				x			x		x									
Deutzia scabra	S				x		x	x		x			x						
Dianthus carthusianorum	S			x		x	x							x					
Dianthus deltoides	S			x		x	x	x		x		x							
Dianthus barbatus	S	x				x				x									
Dicentra spectabilis	S				x					x									
Dimorphotheca sinuata	U						x							x					
Doronicum x *excelsum*	S						x			x									
Dracocephalum parviflorum	U			x															x
Echinochloa esculenta	U			x	x	x	x									x			x
Echium plantagineum	U						x							x					
Eriobotrya japonica	S				x														x
Eruca sativa s.str.	U			x			x	x						x					
Erysimum cheiri	S			x						x									
Eschscholtzia california	U			x	x	x	x	x				x		x					
Euonymus fortunei	S	x		x	x														
Euphorbia lathyris	S	x	x	x	x	x	x	x		x									
Euphorbia stricta	S						x												x
Falcaria vulgaris	S						x												x
Fagopyrum esculentum	U	x	x	x	x	x	x	x						x					
Ficus carica	S	x	x	x	x	x	x	x											x
Foeniculum vulgare	S	x	x	x	x		x	x		x				x					
Forsythia x *intermedia*	S	x	x	x	x	x	x	x		x			x						
Fragaria x *ananassa*	S	x	x	x	x	x	x	x		x					x				
Fraxinus angustifolia	S						x						x						
Fraxinus ornus	S						x				x		x						
Geranium macrorrhizum	S	x		x	x	x	x	x		x		x							
Geranium sanguineum	S		x				x			x		x							
Glaucium corniculatum	U				x	x	x							x	x				
Glebionis coronaria	U			x	x		x	x		x				x					
Glebionis segetum	U					x	x							x					
Guizotia abyssinica	S				x	x	x												x
Helleborus niger	S						x			x					x				
Helianthus annuus	U	x	x	x	x	x	x	x		x					x				
Helianthus hirsutus	U			x						x									

Taxon		research area (cities)								sources									
	Status	Oberhausen	Duisburg	Mülheim a.d. Ruhr	Essen	Gelsenkirchen	Bochum	Herne	Forestry	Gardening (ornamental plants, herbs, vegetables)	Cemeteries and Parks	Flower beds (at public places)	Hedging and Roadside plantings	Sowing plants and Seed-contaminants	Agriculture	Bird-seed	Indoor cultivation	Aquarium	Xenophytic
Helianthus rigidus	S				x		x			x									
Herniaria hirsuta	S				x	x	x												x
Hordeum vulgare s.l.	U	x	x	x	x	x	x	x							x				
Hyacinthus orientalis	U	x	x	x	x		x			x									
Hyssopus officinalis	S				x		x			x									
Hystrix patula	S			x						x									
Iberis sempervirens	U			x		x	x			x				x					
Inula helenium	S		x	x			x	x		x									
Iris germanica s.l. (incl. l. *sambucina* & hybrids)	S			x	x	x	x			x									
Juglans regia	S	x	x	x	x	x	x	x		x									
Koeleria pyramidata	S						x			x	x								x
Laburnum *cf. anagyroides*	S	x	x	x	x	x	x	x											
Lagurus ovatus	U	x			x		x			x									x
Lemna minuta	S	x	x	x	x													?	x
Lepidium densiflorum	S			x		x													x
Lepidium sativum	U				x	x	x			x									
Lepyrodiclis holosteoides	U						x							x					
Leucanthemum paludosum	S				x		x			x									
Leucanthemum x *superbum*	U		x				x			x									
Levisticum officinale	U				x					x									
Ligustrum ovalifolium	S	x	x	x	x	x	x	x		x	x		x						
Ligustrum vulgare	S	x	x	x	x	x	x	x		x	x		x						
Linaria maroccana	U						x			x									
Linaria purpurea	S		x	x			x			x									
Linum austriacum	S		x				x			x									
Linum usitasissimum	S			x			x									x			
Lobelia erinus	U	x	x	x	x	x	x	x		x		x							
Lobularia maritima	S	x	x	x	x	x	x	x		x		x							
Lolium remotum = Festuca remota	U						x							x					
Lonicera nitida	S	x	x	x	x	x	x	x		x		x	x						
Lonicera pileata	S			x			x			x		x	x						
Lonicera tatarica	S	x	x	x	x	x	x			x			x						
Lunaria annua	S	x	x	x	x	x	x	x		x									
Lupinus angustifolius	U						x	x							x				
Luzula nivea	S						x				x								
Lysichiton americanus	S		x	x						x									
Maccleya cf. *cordata*	S			x			x			x									
Malope hybrids	U						x			x									
Malus toringo	S			x			x				x								
Malus x *domestica*	S	x	x	x	x	x	x	x		x					x				
Malva mauritiana	S		x			x	x	x						x					
Malva nicaeensis	U			x															x
Malva parviflora	U			x															x
Meconopsis cambrica	S				x		x			x	x								
Melilotus indicus	U			x	x		x							x					x
Melissa officinalis	U			x	x		x	x		x									
Mentha x *gracilis*	S		x	x						x									
Mimulus guttatus	S			x			x			x									
Miscanthus sinensis	S	x	x	x	x					x									

Taxon		research area (cities)								sources									
	Status	Oberhausen	Duisburg	Mülheim a.d. Ruhr	Essen	Gelsenkirchen	Bochum	Herne	Forestry	Gardening (ornamental plants, herbs, vegetables)	Cemeteries and Parks	Flower beds (at public places)	Hedging and Roadside plantings	Sowing plants and Seed-contaminants	Agriculture	Bird-seed	Indoor cultivation	Aquarium	Xenophytic
Muscari botryoides	S		x	x			x			x									
Nepeta cataria	S			x															x
Nepeta x fassenii	S		x	x		x	x			x									
Nicandra physalodes	U	x	x	x	x	x	x			x				x					
Nicotiana rustica	S	x		x	x		x			x									
Nigella damascena	U			x	x		x			x									
Nymphoides peltata	S			x			x			x									
Onopordum acanthium s.l. (hybrids)	S			x	x	x	x	x		x									
Omphalodes verna	S				x														
Ornithopus sativus	U				x									x					
Panicum capillare	S				x		x									x			
Panicum miliaceum	U		x	x	x	x	x									x			x
Panicum virgatum	U		x	x			x												
Papaver somniferum	S	x	x	x	x	x	x	x		x									
Parentucellia viscosa	S						x	x						x					
Pastinaca sativa s.str.	S						x			x				x					
Paulownia tomentosa	S		x	x		x	x						x						
Penstemon barbatus	S						x					?							?
Petrorhagia saxifraga	S			x			x			x									
Petroselinum crispum	U			x	x					x									
Petunia x *hybrida*	S	x					x			x		x							
Phacelia tanacetifolia	U	x	x	x	x	x	x	x						x	x				
Phalaris canariensis	U	x	x	x	x	x	x	x								x			x
Phaseolus vulgaris	U				x		x						x						
Philadelphus spp.	S		x	x	x								x						
Physalis franchetii	S			x	x	x	x	x		x									
Physalis peruviana	S	x		x						x									
Physocarpus opulifolius	S		x	x	x		x			x			x						
Phyteuma betonicifolium	S						x			?									
Phytolacca americana	U			x						x									
Phytolacca esculenta	S				x	x	x			x									
Picea abies	S	x	x	x	x	x	x	x	x										
Picea pungens	S			x					x										
Picris echioides	U			x		x	x							x					x
Pimpinella anisum	U			x						x									
Pinus nigra	S		x	x					x										
Pinus sylvestris	S	x	x	x	x	x	x	x	x		x								
Pinus strobus	S		x	x					x										
Pistia stratiotes	U	x		x						x									
Pisum sativum	U		x	x	x		x			x				x	x				
Plantago arenaria	U				x		x												x
Plantago coronopus	S			x	x														x
Platanus (x) *hispanica*	S	x	x	x	x	x	x						x						
Polemonium caeruleum	S						x			x									
Polypogon monspeliensis	S						x												x
Populus alba	S	x	x	x	x	x	x	x					x						
Populus x *canadensis*	S	x	x	x	x	x	x	x	x				x						
Potentilla fruticosa	S				x		x			x	x		x						
Primula x pruhoniciana	S						x			x									
Primula vulgaris (& hybrids)	S			x	x		x	x		x	x								

Taxon		research area (cities)								sources									
	Status	Oberhausen	Duisburg	Mülheim a.d. Ruhr	Essen	Gelsenkirchen	Bochum	Herne	Forestry	Gardening (ornamental plants, herbs, vegetables)	Cemeteries and Parks	Flower beds (at public places)	Hedging and Roadside plantings	Sowing plants and Seed-contaminants	Agriculture	Bird-seed	Indoor cultivation	Aquarium	Xenophytic
Prunus cerasifera	S	x	x	x	x	x	x	x		x	x		x						
Prunus cerasus	S						x			x									
Prunus domestica	S				x		x	x		x									
Prunus mahaleb	S		x		x	x	x	x					x						
Prunus laurocerasus	S	x	x	x	x	x	x	x		x	x		x						
Prunus persica	S		x		x		x			x			x						x
Pseudotsuga menziesii	S		x						x										
Pulmonaria saccharata	S				x		x			x									
Pyracantha cf. *coccinea*	S		x	x	x		x			x	x		x						
Pyrus x communis s.l.	S	x	x	x	x	x	x	x		x					x				
Quercus cerris	S		x										x						
Quercus palustris	S			x					x		x								
Quercus rubra	S	x	x	x	x	x	x	x	x		x		x						
Raphanus sativus	U		x	x	x	x	x	x							x				
Rapistrum rugosum	S	x	x	x	x	x	x	x											x
Rapistrum perenne	U		x																x
Reseda odorata	U				x														x
Rhododendron spec.	S			x							x								
Ribes alpinum	S	x	x	x	x		x	x		x	x		x						
Ribes aureum	S		x		x		x			x			x						
Ribes sanguineum	S		x	x	x	x	x	x		x	x								
Ricinus communis	U		x																x
Rosa glauca	S	x	x	x	x		x				x		x						
Rosa micrantha	S				x						x								
Rosa multiflora	S		x		x		x				x		x						
Rosa pimpinellifolia s.l.	S						x						x						
Rosa rugosa	S		x	x	x	x	x			x	x		x						
Rosa virginiana s.l.	S		x				x			x	x		x						
Rudbeckia hirta	S				x			x		x									
Rudbeckia laciniata	U			x						x									
Rudbeckia sullivantii	S					x	x			x									
Sagina subulata	S						x			x									
Salvia glutinosa	S						x			x									
Salvia splendens	S						x					x							
Salvia verticillata	U			x										x					
Salvinia cf. *natans*	U	x								?								x	
Sanguisorba canadensis	S						x												x
Sanguisorba muricata	S	x	x	x	x	x	x	x		x				x					
Saururus cernuus	S			x						?								x	
Secale cereale	U		x	x	x	x	x	x							x				
Setaria italica	U		x		x	x	x									x			x
Setaria lutescens	U			x															x
Setaria verticillata	S	x	x	x															x
Setaria viridis	S		x	x		x	x	x											x
Silene armeria	U			x	x	x	x	x		x				x					
Silene chalcedonica	U						x			x									
Silene coeli-rosa	U						x							x					
Silene coronaria	S		x	x	x	x	x	x		x									
Silene conoidea	U						x							x					

Taxon		research area (cities)								sources									
	Status	Oberhausen	Duisburg	Mülheim a.d. Ruhr	Essen	Gelsenkirchen	Bochum	Herne	Forestry	Gardening (ornamental plants, herbs, vegetables)	Cemeteries and Parks	Flower beds (at public places)	Hedging and Roadside plantings	Sowing plants and Seed-contaminants	Agriculture	Bird-seed	Indoor cultivation	Aquarium	Xenophytic
Silene gallica	U			x	x					x									
Silene noctiflora	U			x		x	x	x						x					
Silene otites s.l.	U						x												
Silene pendula	U			x						x									
Silybum marianum	U		x	x	x	x		x		x									
Sinapis alba	U		x	x	x	x	x	x						x	x				
Solanum lycopersicum	S	x	x	x	x	x	x	x		x					x				
Solanum tuberosum	U		x	x	x	x	x	x		x					x				
Soleirolia soleirolii	S			x	x		x										x		
Sonchus palustris	U						x			x									
Sorbus intermedia	S		x	x	x	x	x	x					x						
Sorghum halepense	U		x		x	x	x												x
Spinacia oleracea	U				x		x			x									
Spiraea x *billardii* s.l.	S			x															
Spiraea douglasii	S						x			x	x		x						
Spiraea japonica s.l.	S			x	x	x	x	x		x	x		x						
Stachys byzantina	S		x	x			x	x		x									
Tanacetum parthenium	S	x	x	x	x	x	x	x		x									
Taxus baccata	S	x	x	x	x	x	x	x		x	x		x						
Telekia speciosa	S			x	x		x			x									
Tellima grandiflora	S						x			x	x								
Thuja occidentalis	S				x		x				x		x						
Tilia platyphyllos s.l.	S	x	x	x	x	x	x	x	x		x		x						
Tilia cordata	S	x	x	x	x		x	x	x		x		x						
Tilia tomentosa s.l	S	x	x	x			x				x		x						
Tilia x europaea s.l.	S	x	x	x	x	x	x	x	x		x		x						
Tradescantia x andersoniana	U				x					x									
Trifolium alexandrinum	U				x										x				
Trifolium resupinatum	U		x	x	x	x	x	x							x				
Triticum aestivum	U	x	x	x	x	x	x	x							x				
Triticum spelta	U			x											x				
Tropaeolum majus	U		x	x	x			x		x									
Turgenia latifolia	U			x															x
Thymus vulgaris	S	x					x	x		x									
Ulmus glabra	S	x	x	x	x	x	x	x	x		x		x						
Ulmus x *hollandica*	S			x	x		x	x			x		x						
Vaccaria hispanica	U			x	x	x	x	x						x					
Verbascum phoeniceum	S		x			x	x												
Verbascum pulverulentum	S		x																x
Verbena hastata	S						x					x							
Veronica maritima	S					x	x							x					
Veronica spicata	U						x			x									
Viburnum lantana	S	x	x	x	x	x	x	x		x	x		x						
Viburnum rhytidophyllum	S		x	x			x			x	x		x						
Vicia faba	U			x	x			x							x				
Viola tricolor convar. *hortensis*	U			x			x			x	x								
Viola x *wittrockiana*	S	x	x	x	x	x	x	x		x	x	x							
Vitis vinifera	S		x	x	x		x			x									x
Zea mays	U		x	x	x	x	x								x	x			

Discussion

More than 1000 adventive plant taxa were mentioned by BONTE, SCHEUERMANN, HÖPPNER and PREUß (and their cooperators) from the beginning of the 20th century to the end of World War II. Xenophytic casuals - introductions from all continents – dominated adventive flora of this period. Most casuals were introduced by railways and by shipping. Investigation was particularly focused on goods stations and the large harbour at Duisburg-Ruhrort. The largest groups of invaders were companions of merchandise, especially fruit (originating from Mediterranean or subtropical regions) and lambs wool (see BONTE & SCHEUERMANN 1937).

Nowadays most of the adventives are ergasiophygophytes (i.e. escapes from cultivation). Changes in land-use and transport systems (especially the use of herbicides and processing methods) caused the decline of xenophytes, while new ergasiophytes, especially ornamental plants, are introduced year by year; their escape is supported by the increasing hypertrophy of soils which is similar to their growing conditions in gardens and plantations (KEIL & LOOS 2001). Today about 350 (probable) ephemerophytic taxa can be found in the Ruhrgebiet (see Tab. 3). Consequently, a decline of casual plant taxa of 70 % within a period of 60 years ought to be pointed out.

In protection of nature, ephemerophytic plants do not play an important role. Casuals disappear after very short periods of time, so it is not possible to protect them. On the other hand, it is not convenient to eradicate them because of their casualty. Additionally, the appearance of ephemerophytes reflect historico-cultural epochs and typical transportation with respect to mobility media, so casuals imply a certain historico-cultural importance. Eradicating adventive plants to prevent naturalisation of these taxa and (possible) following invasions should be avoided. It is not possible to predict the dispersal of an adventive plant taxon appropriately. Most of the ergasiophygophytes which appeared at the Ruhrgebiet were extinct after short periods of time due to the lack of adaptation to climatic and hypertrophied soil conditions, so in competition with indigenous and former established nitrophytes the ergasiophygophytes are not able to naturalise in most cases.

Acknowledgements

We would like to thank LOIS CHILD (Loughborough), HENNING HAEUPLER (Bochum), KATHRYN S. NICOLAI (Oberhausen), ANDREAS SARAZIN (Bochum) and RÜDIGER WITTIG (Frankfurt/Main) for comments on the manuscript and linguistic improvement; THORALD VOM BERG (Mülheim an der Ruhr), DIETRICH BÜSCHER (Dortmund) and his collaborators, RENATE FUCHS (Essen), ULRIKE GOOS (Castrop-Rauxel), ARMIN JAGEL (Bochum), THOMAS KALVERAM (Essen), PETER KIRCHER (Bochum), JÜRGEN PIEPER (Mülheim an der Ruhr), ANDREAS SARAZIN, RALF SEIPEL (Essen) and NINA WEIHRAUCH (Bochum) for reporting some occurrences of adventive plants.

References

BONTE, L. (1916): Beiträge zur Adventivflora des Niederrheins (1909-1912). – Sitzungber. Naturhist. Ver. preuss. Rheinlande u. Westfalens 1916 (D): 22-41.

BONTE, L., (1930): Beiträge zur Adventivflora des rheinisch-westfälischen Industriegebietes (1913-1927). – Verh. Naturhist. Ver. preuss. Rheinlande u. Westfalens 86: 141-255.

BONTE, L. & SCHEUERMANN, R. (1937): Beiträge zur Adventivflora des rheinisch-westfälischen Industriegebietes (1930-1934). – Decheniana 94: 107-142.

BÜSCHER, D., LOOS, G. H. & WOLFF-STRAUB, R. (1997): Charakteristik der Flora des Ballungsraumes Ruhrgebiet. – Mitt. der Landesanstalt für Ökologie, Bodenordnung und Forsten, Recklinghausen 97 (3): 28-35.

DETTMAR, J. (1992): Industrietypische Flora und Vegetation im Ruhrgebiet. – Diss. Bot. 191, 397 pp.

DÜLL, R. & KUTZELNIGG, H. (1980): Punktkartenflora von Duisburg und Umgebung. – Forschungsber. d. Landes Nordrhein-Westfalen, Opladen.

DÜLL, R. & KUTZELNIGG, H. (1987): Punktkartenflora von Duisburg und Umgebung. 2. Aufl. – IDH-Verlag, Rheurdt.

FUCHS, R. (2003): Floristisch-vegetationskundliche Untersuchungen im Duisburg-Mülheimer Wald unter besonderer Berücksichtigung der Moor-, Bruch- und Auenwälder. – Diploma Thesis, University of Duisburg-Essen, Course of Ecology Studies.

HAEUPLER, H. (2000): Biodiversität in Zeit und Raum – Dynamik oder Konstanz? – Ber. d. Reinh.-Tüxen-Ges. 12: 113-129.

HÖPPNER, H. & PREUß, H. (1926): Flora des Westfälisch-Rheinischen Ruhrgebietes unter Einschluß der Rheinischen Bucht. – Ruhfus, Dortmund.

JAGEL, A. & GOOS, U. (2002): Die Flora des Geländes der Ruhr-Universität Bochum und des benachbarten Kalwes und deren Grenzstellung zwischen zwei Großlandschaften. – Natur u. Heimat (Münster) 62 (3/4): 65-79.

JAGEL, A. (2003): *Lithospermum arvense* und *Ranunculus arvensis* in Bochum ausgestorben – oder nicht? Beobachtungen im Botanischen Garten Bochum. – Natur u. Heimat (Münster) 63 (2): 33-36.

KEIL, P. (1999): Ökologie der gewässerbegleitenden Agriophyten *Angelica archangelica* ssp. *litoralis*, *Bidens frondosa* and *Rorippa austriaca* im Ruhrgebiet. – Diss. Bot. 321, 186 pp. + suppl.

KEIL, P. & LOOS, G. H. (2002): Dynamik der Ephemerophytenflora im Ruhrgebiet – unerwünschter Ausbreitungspool oder Florenbereicherung ? – NEOBIOTA 1: 37-49

KEIL, P. & LOOS, G. H. (2004): Ergasiophygophyten auf Industriebrachen des Ruhrgebietes. – Flor. Rundbr. 38 (1-2): 101-112.

KOWARIK, I. (1999): Neophyts in Germany: Quantitative Overview, Introduction and Dispersal Pathways, Ecological Consequences, and Open Questions. – Texte Umweltbundesamt, Berlin 18/99: 12-36

KOWARIK, I. (2002): Biologische Invasionen in Deutschland: zur Rolle nichteinheimischer Pflanzen. – NEOBIOTA 1: 5-24.

LOOS, G. H. (1997): Neophytische Kulturflüchtlinge im Stadtzentrum von Kamen/Westfalen. – Decheniana 150: 5-26.

LOOS, G. H. (1999a): Die Neophyten und ihre Begriffssysteme. – Naturreport (Unna) Suppl. 2. 23 pp.

LOOS, G. H. (1999b): Die Bedeutung von Ephemerophyten für die Pflanzengeographie und Landschaftsbewertung. – Diploma Thesis, University of Bochum, Institute of Geography.

RAABE, U., FOERSTER, E., SCHUMACHER, W. & WOLFF-STRAUB, R. (1996): Florenliste von Nordrhein-Westfalen – Schriftenreihe der Landesanstalt für Ökologie, Bodenordnung und Forsten, Recklinghausen 10 (ed. 3), 196 pp.

REIDL, K. (1989): Floristische und vegetationskundliche Untersuchungen als Grundlagen für den Arten- und Biotopschutz in der Stadt – Dargestellt am Beispiel der Stadt Essen. – Diss., University of Essen, 811 pp.

SCHEUERMANN, R. (1928): Die Pflanzenwelt der Kehrichtplätze des rhein.-westfl. Industriegebietes. – Sitzungber. Naturhist. Ver. d. preuss. Rheinlande u. Westfalens 1928: 10-28.

SCHEUERMANN, R. (1929): Mittelmeerpflanzen der Güterbahnhöfe des Rheinisch-westfälischen Industriegebietes. – Verh. d. Naturhist. Ver. d. preuss. Rheinlande u. Westfalens 86: 257-342.

SCHEUERMANN, R. (1934): Mittelmehrpflanzen der Güterbahnhöfe des Rhein.-West. Industriegebietes. Erster Nachtrag. Beiträge zur Sytematik und Pflanzengeographie XXI. – Repert. spec. nov. reg. veg. Beih. 76: 65-99.

SCHEUERMANN, R. (1941): Die Pflanzen des Vogelfutters. – Natur am Niederrhein 17 (1): 1-13.

SCHEUERMANN, R. (1942): Der Anteil Südamerikas an der Adventivflora des rheinisch-westfälischen Industriegebietes. – Revista Sudamericana de Botanicae VII (2/4): 25-65.

SCHMITZ, U. (2002): Untersuchungen zum Vorkommen und zur Ökologie neophytischer Amaranthaceae und Chenopodiaceae in der Ufervegetation des Niederrheins. – Diss. Bot. 364. 140 pp.

SCHROEDER, F.-G. (1969): Zur Klassifizierung von Anthropochoren. – Vegetatio 16: 225-238.

SEIPEL, R. (2005): Floristische und Vegetationskundliche Untersuchungen auf dem Gelände der ehemaligen Sinteranlage in Duisburg-Beeck. – Diploma Thesis, University of Bochum, Geobotanic Working Group.

SUKOPP, H. & SCHOLZ, H. (1997): Herkunft der Unkräuter. – Osnabrücker Naturwiss. Mitt. 23: 327-333.

TREPL, L. (1990): Research on the anthropogenic Migration of Plants and Naturalisation, pp. 75-97. In: Urban Ecology (SUKOPP, H., HEJNY, S., eds.). – SPB Academic Publishing bv, The Hague.