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THE ANTHROPOGENIC REFUGE AREAS FOR BEE FLORA IN AGRICULTURAL LANDSCAPE

[1]Bożena Denisow, [2]Małgorzata Wrzesień

[1] Department of Botany, Agricultural University, Akademicka 15 str., 20 950 Lublin, Poland e mail: bozena.denisow@ar.lublin.pl
[2] Department of Geobotany, Institute of Biology, Maria Curie Skłodowska University, Akademicka 19, 20 033 Lublin, Poland; e mail: mseptember@tlen.pl

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S u m m a r y

The investigations were carried out in 2002 2006 in two municipalities of Konopnica and Jastków close to the western part of Lublin, Poland. The aim of the study was to identify the con dition of bee flora and determine the floristic richness depending on the biotops in agricultural landscape. Flora of the anthropoge nic refuge areas consists of 214 species, among them 80% were flow taxons. Apophytes (162 species 78%) predominated on all types of biotops under consideration. Perennials predominated in flora of boundary strips and bush communities. Mainly annual (40%) and biennial (15%) species comprise the flora of fallows. A great number of bee taxons represent meadow, segetal or rude ral communities. Most of flow plants compose loose patches, but their successive blooming ensures a source of food for *Apoidea* from early spring till the end of summer. The flora of boundary strips, bush communities and fallows significantly increases the biodiversity in agricultural landscape. The treatments including sowing, mainly on fallows with nectariferous and polleniferous species, would enrich generally weak flows in highly agricultural landscape.

Key words: refuge areas, agricultural landscape, pollenferous and nectariferous taxons, environs of Lublin

INTRODUCTION

The opinion about pollution of agricultural landscape is generally accepted (van O p s t a l, 2000). Rapid changes of agricultural technologies encouraged farmers to abandon traditional husbandry methods and mixed farming systems in favour of intensive enterprises with pesticides, herbicides, fungicides and other chemicals. New technologies influenced both segetal and ruderal flora. The advantages of synantropic taxons in agroecosystems are widely discussed. The benefits include soil enrichment with nutrients, positive alleopathic effects. A great number of weeds are known as bee plants and can be important from two main points of view, as honey raw material and the development of wild bees colonies (P a r i s h and B a z z a z, 1979; J a b ł o ń s k i and K o ł t o w s k i, 1995; W a r a k o m s k a, 1997; W r ó b l e w s k a, 2002). Unfortunately, the expansion of specialisation and intensification caused unprecedented changes of forage base (C o r b e t et al. 1991; J a b ł o ń s k i, 2000).

An increasing emphasis is now being placed upon replacement of environmentally distracted policies with other ones which encourage natural resources (D o s t a t n y, 2006). The one involving the emergence of contemporary agri-environmental strategies should save and rebuild distracted fragments of unarable lands. The aim of the present study was to identify the condition of bee flora and determine the floristic richness depending on the biotops in agricultural landscape.

MATERIAL AND METHODS

The characteristic of the study area

Field studies were carried out in the years 2002-2006 in two municipalities of Konopnica and Jastków close to the western part of the Lublin agglomeration (Fig. 1). The region is situated in the central-northern part of the Lublin Upland and is a part of the Nałęczów Plateau and the Bełżyce Plain. The area under investigations forms a broad belt between 51°96' – 50°86' N and of 20°28' – 22°6'E and extends on a highly undulated area at 180-252 m above see level. Most soils are clay-dusty and sandy-dusty or loess-originated brown and grey-brown (T u r s k i et al. 1993).

The potential natural vegetation of the area is composed of the Ciemięga stream valley with a large area of *Phragmitetea* class. In the close neighbourhood, there are wet, rarely mown meadows with communities from the *Molinion* and *Calthion* alliances. Higher located meadows with standard mowing management

are characteristic to *Arrhenatherion elatioris*. The most valuable as a source of bee flora is *Cirsietum rivularis* with the predominance of *Cirsium rivulare* (70%) and *Polygonum bistorta* (30%). Small surface areas are occupied by phytocenoses from *Scheuchzerio-Caricetea fuscae*. The fragments of *Ribo nigri-Alnetum* are present mainly in the eastern part of the Jastków municipality. Some other natural woodland complexes of varied size occur as isolated areas in different parts of the studied area. Usually, the forests represent fragmented forms of *Querco-Fagetea* and are reduced in species. Rapid economic changes after the transformation in 1989 caused strong anthropogenic pressure and are partly responsible for an increase of fallows to approx. 18% of arable lands. The cultivated area includes 7500 ha, the farming is still intensive and the mosaic structure of landscape characteristic for the eastern part of Poland is maintained (Figs. 2, 3). Most of the cultivated area is under cereals (63-68%) and about 18-22% is occupied by root crops (potato fields and sugar beet). An abundant nectar and pollen flow was observed only in May, during the blooming of both orchards and meadows. Entomophilous crops such as rape plantations and perennial papilionaceous were very rare.

Methods

Observations of the entire flora were made up separately on field margins, bush communities and fallows, every two-three weeks during vegetation to take seasonal blooming aspects and to assign the time and length of blooming. The list of nectariferous and polleniferous taxons was established on the basis of data from literature (Warakomska, 1995,1997; Wróblewska, 2002) and according to own observations. The record provides taxonomic nomenclature by Mirek et al. (2002) and the description of each taxon including its life span, geographic – historical status (Zając 1979; Zając et. al. 1998), sinecological group (Matuszkiewicz, 2001), and average time of blooming. The intensity of *Apoidea* foraging was estimated as averages on the basis of 30 min observations concerning each species, during sunny weather in the most intense foraging hours (10.00--14.00 EET) in full blooming period. The following range for bee visits was applied: weak – 0-1 $\cdot$ m^{-2}; medium 2-4 $\cdot$ m^{-2}; good >5 $\cdot$ m^{-2}.

RESULTS

The data concerning the diversity and distribution of bee flora in different agricultural biotops are given in Tab. 1.

Presently, the flora of the anthropogenic refuge areas consists of 214 species belonging to 39 families of which the most abundant are Asteraceae, Fabaceae, Rosaceae, Caryophyllaceae, Brassicaceae and Lamiaceae (Fig. 5). The great majority of taxons occurred on fallows – 153 species, among them 73% were identified as good bee plants. Then, 124 different vascular plants were present on boundary strips, including 103 nectariferous and polleniferous. In the flora of margins, a high grass participation (2%) was observed which is probably connected with a high level of fertilisation on adjacent fields. The least abundant and most floristically stable were bush communities with only 34 species recorded and recognised as flow species.

Apophytes (162 species – 78%) predominated on all types of biotops under consideration (Fig. 5). Alien species occurred less frequently and were represented by archeophytes (36 species – 17%), epecophytes (7 species – 3,3%), and of short duration agriophytes (only 4 species – 2%). The complete absence of efemerophytes indicates a very low coefficient of synantropisation in the analyzed biotops. Interestingly, a considerable increase of development in the last 15 years and the transformation of arable lands into fallows did not cause the inflow of alien species.

Perennials predominated among species recorded on different refuge areas in the studied agricultural landscape (Fig. 6). Annuals were most frequently recorded among species registered on fallows (approx. 40%) and biennials compose 15% of its flora. The spontaneously growing bush communities include only 15% of annual species. The changes in abundance of species during the successive five years of study on most of the studied biotops were insignificant. Only on fallows, the number of segetal flora decreases. Coincidentally, an increase of ruderal species and the occurrence of a bigger number of perennials were recorded. Unfortunately, the changes in the structure of fallow flora were associated with a decline in the number of flow species.

The spontaneously growing bushes most frequently develop on the edges of arable fields, the sunny slopes of loess ravines and were frequently covered by patches, different in size, predominated by *Prunus fruticosa* which is very important in the early spring aspect. Other shrubs often present and intensely foraged were *Rosa canina, R. dumalis, Crataegus monogyna.* Accompanying species were mainly heliophytes of the edge communities and meadow taxons: *Clinopodium vulgare, Prunella vulgaris, Heracleum sphondylium, Knautia arvensis* or *Agrimonia eupatoria*. The two last mentioned are particularly attractive for bees.

The most frequently found on field margins were *Achillea millefolium, Agrimonia eupatoria, Anthriscus sylvestris, Berteroa incana, Cichorium intybus, Euphorbia cyparisias, Hypericum perforatum, Lamium album, Lotus corniculatus, Potentilla anserina, Sedum maximum, Verbascum densiflorum, Vicia cracca.* The above species are valuable for pollinators as they form dense patches or are characterised by a long period of blooming.

Table 1
Alphabetical list and characterization of species (averages from 2002 2006).

A	B	C	D	E		F		G		H	I
				a	b	a	b	a	b		
Achillea millefolium L.	p	Ap	M A	+	2	+	2	+	1	20.05 30.09	medium
Adonis aestivalis L.	a	Arch	SM	+	1	.	.	.	.	10.05 10.06	weak
Aegopodium podagraria L.	p	Ap	Q F	.	.	+	1	+	2	20.05 10.07	weak
Agrimonia eupatoria L.	p	Ap	F B	+	2	+	2	+	2	10.06 15.08	good
Agrostis capillaris L.	p	Ap	NC	+	2	+	2	.	.		
Amaranthus retroflexus L.	a	Ep		+	2	.	.	.	.	20.07 20.09	weak
Anchusa officinalis L.	b	Arch	AR	+	1	.	.	.	.	15.05 30.09	v good
Anthriscus sylvestris (L.) Hoffm.	p	Ap	AR	.	.	+	2	.	.	15.05 15.06	weak
Anthyllis vulneraria L.	p	Ap	M A	+	2	+	2	.	.	20.05 30.07	medium
Apera spica-venti (L.) P. Beauv.	a	Arch	SM	+	2	+	1	+	1		
Arenaria serpyllifolia L.	a,b	Ap		+	2	.	.	.	.	20.05 30.09	weak
Armoracia rusticana Gaertn.	p	Ap	AR	+	1	+	1	.	.	15.05 20.08	weak
Artemisia absinthium L.	p	Arch	AR	+	2	+	2	.	.	10.07 30.09	weak
Artemisia campestris L.	p	Ap	F B	+	2	.	.	.	.	15.07 20.10	weak
Artemisia vulgaris L.	p	Ap	AR	+	2	+	1	.	.	15.07 20.10	weak
Astragalus cicer L.	p	Ap	TG	+	2	.	.	.	.	15.05 20.07	medium
Ballota nigra L.	p	Arch	AR	.	.	.	.	+	2	01.07 10.09	v good
Bellis perennis L.	p	Ap	M A	+	2	+	2	.	.	20.04 15.07	weak
Berteroa incana (L.) DC.	a	Ap	AR	+	2	+	2	.	.	10.05 30.09	v good
Bromus hordeaceus L.	b	Ap	M A	.	.	+	1	.	.		
Bromus inermis Leyss.	p	Ap	AIR	.	.	+	1	.	.		
Bunias orientalis L.	b	Ep		.	.	.	.	.	.	05.05 10.06	v good
Campanula glomerata L.	p	Ap	F B	+	1	+	1	.	.	10.06 01.09	medium
Campanula patula L.	b,p	Ap	M A	+	1	+	1	.	.	20.05 10.07	v good
Campanula rapunculoides L.	p	Ap	TG	+	1	+	1	.	.	10.06 01.09	v good
Campanula rotundifolia L.	p	Ap		+	1	.	.	.	.	10.06 01.09	v good
Capsella bursa-pastoris (L.) Med.	a	Ap	SM	+	2	+	1	.	.	20.04 10.10	v good
Cardaminopsis arenosa (L.) Hayek	b,p	Ap		+	2	.	.	.	.	20.04 20.05	weak
Carex hirta L.	p	Ap	M A	+	2	+	2	.	.	10.05 20.06	medium
Carlina vulgaris L.	b	Ap	F B	+	1	.	.	.	.	20.07 15.08	good
Centaurea cyanus L.	a	Arch	SM	+	1	.	.	.	.	10.06 01.08	v good
Centaurea jacea L.	p	Ap	M A	+	1	+	1	.	.	20.06 20.08	v good
Centaurea pannonica (Heuff.) Hayek	p	Ap	F B	.	.	+	1	.	.	20.06 20.08	v good
Centaurea scabiosa L.	p	Ap	F B	+	2	+	1	.	.	20.06 10.09	v good
Centaurea stoebe L.	b	Ap	F B	+	1	.	.	.	.	25.06 20.08	v good
Centaurium erythraea Rafn	b	Ap	IN	+	2	.	.	.	.	30.06 30.08	v good
Cerastium arvense L.s.s.	p	Ap		+	2	+	1	.	.	10.05 30.06	medium
Cerastium holosteoides Fr. Emend.Hyl.	a	Ap	M A	+	2	.	.	.	.	10.05 30.07	weak
Chamaecytisus ratisbonensis (Schaeff.) Rothm.	s	Ap		+	2	+	2	+	2	10.05 15.06	weak
Chamaenerion angustifolium (L.) Scop.	p	Ap	EP	.	.	+	1	.	.	20.06 20.07	v good
Chamomilla suaveolens (Pursh) Rydb.	a	Ep	M A	+	2	.	.	.	.	10.06 20.07	v good
Chelidonium majus L.	p	Ap	AR	.	.	+	1	+	2	05.05 10.10	good
Chenopodium album L.	a	Ap	SM	+	1	+	1	.	.	20.06 20.09	good
Cichorium intybus L.	p	Arch	AR	+	2	+	2	.	.	10.06 01.09	v.good
Cirsium arvense (L.) Scop.	p	Ap	AR	+	2	+	1	.	.	30.06 20.08	v good
Clinopodium vulgare L.	p	Ap	TG	.	.	+	2	+	1	15.07 20.08	good
Consolida regalis Gray	a	Arch	SM	+	1	+	1	.	.	10.06 20.07	medium
Convolvulus arvensis L.	p	Ap	AIR	+	2	+	2	.	.	10.06 10.09	medium
Conyza canadensis (L.) Conquist	a	Ep	SM	+	2	+	2	.	.		
Coronilla varia L.	p	Ap	TG	+	1	+	2	.	.	10.06 10.08	good
Crataegus monogyna Jacq.	s/t	Ap	RP	+	1	+	1	+	2	15.05 30.05	v good
Crepis tectorum L.	a,b	Ap	SM	.	.	+	1	.	.	10.06 10.09	mebium
Dactylis glomerata L.	p	Ap	M A	+	2	+	2	.	.		
Daucus carota L.	b	Ap	M A	+	2	+	2	.	.	20.06 15.09	weak
Descurainia sophia (L.)Webb ex Prantl	a/b	Arch	SM	+	1	+	1	.	.	20.05 10.10	weak
Dianthus carthusianorum L.	p	Ap	F B	+	2	.	.	.	.	15.06 20.07	good
Dianthus delthoides L.	p	Ap	KG	+	2	+	2	.	.	20.06 20.07	weak

cd. Table 1

A	B	C	D	E		F		G		H	I
				a	b	a	b	a	b		
Echinocystis lobata (F.Michx.)Torr. & Agray	a	Ag		.	.	.	.	+	2	30.06 15.08	weak
Echium vulgare L.	b	Ap	AR	+	2	+	1	.	.	10.06 10.09	v good
Elymus repens (L.) Gould.	p	Ap	AIR	+	2	+	2	.	.		
Epilobium montanum L.	p	Ap	AR	.	.	+	1	+	1	20.06 30.08	v good
Equisetum arvense L.	p	Ap	AIR	+	3	+	2	.	.		
Erigeron annuus (L.)Pers.	b/p	Ag		+	2	+	2	.	.	20.06 20.09	weak
Erigeron acris L.	b/p	Ap		+	1	.	.	.	.	20.06 20.10	weak
Erodium cicutarium (L.) L Her.	a	Ap		+	1	.	.	.	.	20.05 20.07	weak
Euonymus europea L.	s	Ap	RP	.	.	.	.	+	2	15.05 10.06	good
Euphorbia cyparissias L.	p	Ap	F B	+	1	+	3	.	.	01.05 20.05	good
Euphorbia esula L.	p	Ap		+	2	.	.	.	.	20.05 20.07	good
Euphorbia helioscopia L.	a	Arch	SM	+	1	.	.	.	.	10.05 10.06	weak
Euphrasia rostkoviana Hayne	p	Ap	M A	+	1	.	.	.	.	15.07 15.09	weak
Falcaria vulgaris Bernh.	b/p	Ap	AIR	.	.	+	2	.	.	20.06 15.08	weak
Fallopia convolvulus (L.) A.Love	a	Arch	SM	+	2	.	.	.	.	20.05 20.06	medium
Filipendula vulgaris Moench	p	Ap	F B	+	2	.	.	.	.	20.06 10.08	v good
Fragaria vesca L.	p	Ap	EP	.	.	+	3	.	.	10.05 10.06	medium
Fumaria officinalis L.	a	Arch	SM	+	2	.	.	.	.	20.05 20.08	weak
Gagea pratensis (Pers.)Dum.	p	Ap	SM	.	.	+	2	.	.	15.04 20.05	good
Galeopsis pubescens Besser	a	Ap	AR	+	1	+	1	.	.	15.06 01.09	v good
Galeopsis tetrahit L.	a	Ap	SM	.	.	.	.	+	1	10.06 20.09	medium
Galinsoga ciliata (Raf.)S.F.Blake	a	Ep	SM	+	2	.	.	.	.	15.07 30.09	weak
Galinsoga parviflora Cav.	a	Ep	SM	+	2	.	.	.	.	15.07 30.10	medium
Galium aparine L.	a	Ap	AR	+	1	+	1	+	1	10.06 15.09	weak
Galium mollugo L.	p	Ap	M A	+	1	+	2	+	1	15.06 15.09	weak
Galium verum L.	p	Ap	TG	.	.	+	2	.	.	10.07 20.09	medium
Geranium pratense L.	p	Ap	M A	+	1	+	1	.	.	10.06 10.08	medium
Geranium pusillum Burm. F. ex L.	a	Arch	SM	+	1	.	.	.	.	15.06 20.08	weak
Geranium robertianum L.	a/b	Ap	AR	+	1	.	.	.	.	15.05 20.07	medium
Geum urbanum L.	p	Ap	AR	.	.	+	1	+	1	01.06 20.06	good
Glechoma hederacea L.	p	Ap	AR	.	.	+	1	+	2	20.04 10.07	good
Gypsophilla muralis L.	a	Ap	IN	+	2	.	.	.	.		
Helichrysum arenarium (L.) Moench	b	Ap	KG	+	2	+	2			15.07 20.08	weak
Heracleum sibiricum L.	b/p	Ap	M A	.	.	+	1	.	.	10.07 5.08	weak
Heracleum sphondylium L.	b/p	Ap	M A	+	1	+	1	.	.	15.06 1.09	weak
Herniaria glabra L.	a/b	Ap	KG	.	.	.	.	.	.		
Hieracium bauhinii Schult.	p	Ap	F B	+	2	.	.	.	.	25.06 20.07	weak
Hieracium pilosella L.	p	Ap	NC	+	2	+	2	.	.	20.05 30.07	good
Hieracium umbellatum L.	p	Ap	NC	+	2	.	.	.	.	30.07 10.10	good
Hypericum perforatum L.	p	Ap		+	2	+	2	.	.	05.06 30.07	v good
Jasione montana L.	b	Ap	KG	+	2	.	.	.	.	10.06 30.07	medium
Knautia arvensis (L.) J. M. Coult.	p	Ap	M A	+	1	+	2	.	.	10.06 30.07	v good
Lactuca seriola L.	b	Arch	SM	+	1	+	1	.	.	20.06 20.09	weak
Lamium album L.	p	Arch	AR	+	1	+	1	+	1	20.04 30.09	v good
Lamium amplexicaule L.	a	Arch	SM	+	1	.	.	.	.	01.04 30.06	good
Lamium purpureum L.	a	Arch	SM	+	1	.	.	.	.	15.04 01.09	v good
Lapsana communis L.s.s.	a	Ap	SM	+	1	+	1	.	.	20.06 20.09	medium
Lathyrus pratensis L.	p	Ap	M A	+	2	+	2	.	.	15.06 15.07	good
Lavathera turingiaca	b	Ap				+	1			15.07 15.08	medium
Leontodon autumnalis L.	p	Ap	M A	+	1	+	2	.	.	20.06 30.09	v good
Leontodon hispidus L.	p	Ap	M A	.	.	+	1	.	.	30.06 15.10	weak
Lepidium ruderale L.	a	Ap	SM	+	1	.	.	.	.	20.05 10.09	weak
Leucanthemum vulgare	p	Ap	M A	+	2	.	.	.	.	15.06 15.08	weak
Linaria vulgaris Mill.	p	Ap	AR	+	1	+	1	.	.	15.06 20.09	v good
Lithospermum arvense L.	a/b	Arch	SM	+	1	.	.	.	.	15.06 20.07	weak
Lolium perenne L.	p	Ap	M A	+	2	+	2	.	.		
Lotus corniculatus L.	p	Ap	M A	+	2	+	2	+	1	10.05 15.09	v good
Luzula campestris (L.) DC.	p	Ap	NC	+	1	.	.	.	.		
Lychnis flos-cuculi L.	p	Ap	M A	+	1	+	1	.	.	10.05 25.06	v good

cd. Table 1

A	B	C	D	E		F		G		H	I
				a	b	a	b	a	b		
Malva alcea L.	p	Arch	AR	+	1	+	1	.	.	10.07 20.08	medium
Malva sylvestris L.	p	Arch	AR	.	.	+	1	+	1	10.06 20.08	medium
Matricaria maritima L. ssp. *inodora*	a	Arch	SM	+	2	+	1	.	.	10.05 20.09	medium
Medicago falcata L.	p	Ap	TG	+	2	+	2	.	.	10.06 15.09	v good
Medicago lupulina L.	a/b	Ap		+	2	+	2	.	.	10.06 15.08	medium
Medicago sativa L.	p	Ag		+	2	+	2	.	.	10.06 15.08	v good
Melandrium album (Mill.) Garcke	a/b	Arch	AR	+	1	+	1	.	.	20.05 30.09	weak
Melilotus alba Medik.	b	Ap	AR	+	2	+	2	.	.	10.06 15.08	v good
Melilotus officinalis (L.) Pall.	b/a	Ap	AR	.	.	+	2	.	.	01.06 20.07	v good
Mentha arvensis L.	p	Ap		+	1	.	.	.	.	20.07 20.09	medium
Myosotis arvensis (L.) Hill.	a	Arch	SM	+	1	+	1	.	.	10.05 20.07	weak
Oenothera biennis L.s.s.	b	Ap	AR	+	1	.	.	.	.	15.06 20.08	v good
Oenothera rubricaulis Kleb.	b	Ap	AR	+	1	+	1	.	.	15.06 20.07	medium
Ononis arvensis L.	p	Ap		.	.	+	2	.	.	15.06 20.08	weak
Origanum vulgare L.	p	Ap	TG	+	2	+	2	.	.	01.07 15.08	v good
Padus avium Mill.	ba	Ap	Q F	.	.	.	.	+	1	20.04 20.05	v good
Papaver argemone L.	a	Arch	SM	+	1	.	.	.	.	20.05 30.06	medium
Papaver rhoeas L.	a	Arch	SM	+	1	.	.	.	.	20.05 10.07	v good
Pastinaca sativa L.	b	Ap	M A	+	2	+	2	.	.	01.07 10.08	v good
Peucedanum oreoselinum (L.) Moench	p	Ap	TG	+	2	.	.	.	.		weak
Picris hieracioides L.	p/b	Ap	AR	+	1	.	.	.	.	10.07 10.09	weak
Pimpinella saxifraga L.	p	Ap		+	1	+	2	.	.	15.06 30.09	medium
Plantago lanceolata L.	p	Ap	M A	+	2	+	1	.	.	15.05 10.09	weak
Plantago major L.	p	Ap	M A	+	1	+	1	.	.	20.05 15.08	weak
Poa pratensis L.s.s.	p	Ap	M A	+	1	+	2	.	.		
Polygala comosa Schkuhr	p	Ap		+	1	.	.	.	.	15.05 20.06	weak
Polygonum aviculare L.	a	Ap	M A	+	2	+	2	.	.	10.05 30.10	weak
Potentilla anserina L.	p	Ap	M A	+	2	+	2	.	.	10.05 20.07	v good
Potentilla alba L.	b	Ap	Q F	.	.	+	1	.	.	30.04 30.05	weak
Potentilla argentea L.s.s.	p	Ap	AR	+	1	+	1	.	.	10.06 15.07	medium
Potentilla collina Wibel s.s.	p	Ap	KG	.	.	+	1	.	.	10.06 15.07	medium
Potentilla reptans L.	p	Ap	M A	.	.	+	2	.	.	05.05 10.09	v good
Prunella vulgaris L.	p	Ap	M A	+	1	+	2	+	1	10.05 20.08	weak
Prunus spinosa L.	s	Ap	RP	.	.	+	1	+	3	20.04 05.05	v good
Pyrus communis L.	t	Ap		.	.	+	1	+	1	01.05 20.05	good
Ranunculus acris L.	p	Ap	M A	+	1	+	2	+	1	10.05 20.07	good
Ranunculus bulbosus L.	p	Ap	F B	+	1	.	.	.	.	15.05 10.06	good
Ranunculus repens L.	p	Ap	M A	.	.	+	1	+	1	10.06 10.08	good
Raphanus raphanistrum L.	a	Arch	SM	+	1	.	.	.	.	10.06 10.10	v good
Rosa canina L.	s	Ap	RP	.	.	+	1	+	2	15.05 15.06	v good
Rosa majalis Herrm.	s	Ap		.	.	+	1	+	2	15.05 15.06	good
Rubus caesius L.	s	Ap	AR	+	2	+	2	.	.	25.05 10.07	v good
Rubus idaeus L.	s	Ap	EP	.	.	+	2	+	3	20.05 10.07	v good
Rumex acetosa L.	p	Ap	M A	+	2	+	2	.	.	10.05 20.07	weak
Rumex acetosella L.	p	Ap	KG	+	2	+	2	.	.	01.05 10.07	weak
Sambucus nigra L.	s	Ap	EP	.	.	+	1	+	2	20.05 20.06	weak
Saponaria officinalis L.	p	Ap	AR	+	2	+	2	.	.	10.06 20.07	weak
Sarothamnus scoparius L.	s	Ap	RP	.	.	.	.	+	2	15.05 15.06	v good
Scabiosa ochroleuca L.	p	Ap	F B	+	1	+	1	.	.	01.06 17.07	v good
Scrophularia nodosa L.	p	Ap	Q F	.	.	.	.	+	1	20.06 20.08	v good
Sedum acre L.	p	Ap	KG	+	2	.	.	.	.	15.05 20.07	v good
Sedum maximum (L.) Hoffm.	p	Ap		.	.	+	1	.	.	10.07 20.09	v good
Senecio jacobaea L.	b	Ap		.	.	+	1	.	.	01.07 30.08	weak
Setaria pumila (L.) P.Beauv.	a	Arch	SM	+	2	.	.	.	.		
Silene vulgaris (Moench) Garcke	a	Ap	SM	+	1	.	.	.	.	15.06 20.08	weak
Sinapis arvensis L.	a	Ep	SM	+	1	.	.	.	.	15.05 15.10	v good
Sisymbrium loeselii L.	b	Arch	SM	+	2	.	.	.	.	01.06 20.07	v good
Sisymbrium officinale (L.) Scop.	a/b	Arch	SM	+	1	+	1	.	.	20.05 30.09	v good
Solidago gigantea Aiton	p	Ag	AR	+	3	.	.	.	.	20.07 15.10	v good

cd. Table 1

A	B	C	D	E		F		G		H	I
				a	b	a	b	a	b		
Sonchus arvensis L.	p	Ap	SM	+	1	+	1	.	.	28.07 10.10	weak
Sonchus oleraceus L.	a	Arch	SM	+	1	.	.	.	.	20.06 15.09	weak
Sorbus aucuparia L.	t	Ap		.	.	.	.	+	1	10.05 30.05	medium
Stachys palustris L.	p	Ap	M A	+	1	.	.	.	.	10.06 20.09	medium
Stellaria graminea L.	p	Ap		.	.	+	1	.	.	10.05 20.06	weak
Stellaria media (L.) Vill.	a	Ap	SM	+	2	.	.	.	.	20.03 30.10	weak
Symphytum officinale L.	p	Ap		.	.	.	.	+	1	15.05 20.08	v good
Tanacetum vulgare L.	p	Ap	AR	+	2	+	2	.	.	20.07 01.10	good
Taraxacum officinale F. H.Wigg.	p	Ap	M A	+	2	+	2	.	.	05.05 25.05	v good
Thlaspi arvense L.	a	Ap	SM	+	1	.	.	.	.	15.05 20.08	weak
Thymus pulegioides L.	p	Ap		+	2	.	.	.	.	10.06 10.07	v good
Thymus serpyllum L.	p	Ap	KG	+	2	.	.	.	.	10.06 10.07	v good
Tilia cordata L.	t	Ap	Q F	.	.	.	.	+	1	30.06 20.07	v.good
Tragopogon pratensis L.s.s.	b	Ap	M A	.	.	+	1	.	.	15.05 20.07	medium
Trifolium alpestre L.	b	Ap	TG	.	.	+	1	.	.	20.06 15.07	medium
Trifolium arvense L.	a/b	Ap	KG	+	2	+	2	.	.	01.06 30.07	v good
Trifolium campestre Schreb.	a/b	Ap	KG	+	1	.	.	.	.	01.06 30.07	medium
Trifolium dubium Sibth.	a/b	Ap	M A	+	1	.	.	.	.	01.06 30.07	v good
Trifolium hybridum L.	p	Ap	M A	.	.	+	2	.	.	01.06 30.07	v good
Trifolium medium L.	p	Ap	TG	.	.	+	2	.	.	01.06 30.07	v good
Trifolium pratense L.	p	Ap	M A	+	1	+	1	.	.	01.06 30.07	v good
Trifolium repens L.	p	Ap	M A	+	2	+	2	.	.	20.05 30.08	v good
Tussilago farfara L.	p	Ap	AIR	+	2	+	2	.	.	01.04 25.04	v good
Urtica dioica L.	p	Ap	AR	+	2	+	1	.	.		
Verbascum densiflorum Bertol.	b	Ap	AR	.	.	+	1	.	.	10.06 05.09	medium
Verbascum nigrum L.	b	Ap	EP	.	.	+	1	.	.	05.07 10.08	v good
Verbascum phlomoides L.	b	Ap	AR	+	1	+	1	.	.	10.06 5.09	v good
Veronica agrestis L.	a	Ap		+	2	.	.	.	.	10.04 20.09	weak
Veronica chamaedrys L.s.s.	p	Ap		+	1	+	1	.	.	15.05 20.08	weak
Viburnum opulus L.	s	Ap	RP	.	.	+	1	+	1	10.05 10.06	v good
Vicia angustifolia L.	a	Arch	SM	+	1	+	1	.	.	10.05 15.08	medium
Vicia cracca L.	p	Ap	M A	+	2	+	2	.	.	10.06 20.08	v good
Vicia hirsuta (L.) S.F.Gray	a	Arch	SM	+	1	.	.	.	.	10.05 15.07	v good
Vicia sepium L.	p	Ap	TG	+	1	.	.	.	.	10.05 30.07	v good
Vicia tetrasperma (L.) Schreb.	a	Arch	SM	+	1	.	.	.	.	10.05 15.08	v good
Vicia villosa Roth.	a/b	Arch	SM	+	2	+	2	.	.	10.06 15.07	v good
Viola arvensis Murray	a	Arch	SM	+	2	.	1	.	.	10.05 30.09	medium

Explanations: A species; B life span: a annual, b biennial, p perennial, s shrub, t tree; C historical and geographical groups: Ap apophytes, Arch archaeophytes, Ep epecophytes, Ag agriophytes; D phytosociological unit: AR Artemisietea vulgaris, AIR Agropyretea intermedio repentis, EP Epilobietea angustifolii, F B Festuco Brometea, IN Isoeto Nanojuncetea, KG Koelerio glaucae Corynephoretea canescentis, M A Molinio Arrhenatheretea, NC Nardo Callunetea, Q F Querco Fagetae, RP Rhamno Prunetea, SM Stelarietea mediae, TG Trifolio Geranietea sanguinei; E fallows, F boundary strips, G bush communities (a presence, b degree of density: 1 single, 2 loose patches, 3 dense patches); H average time of blooming; I Intensity of insect's visits

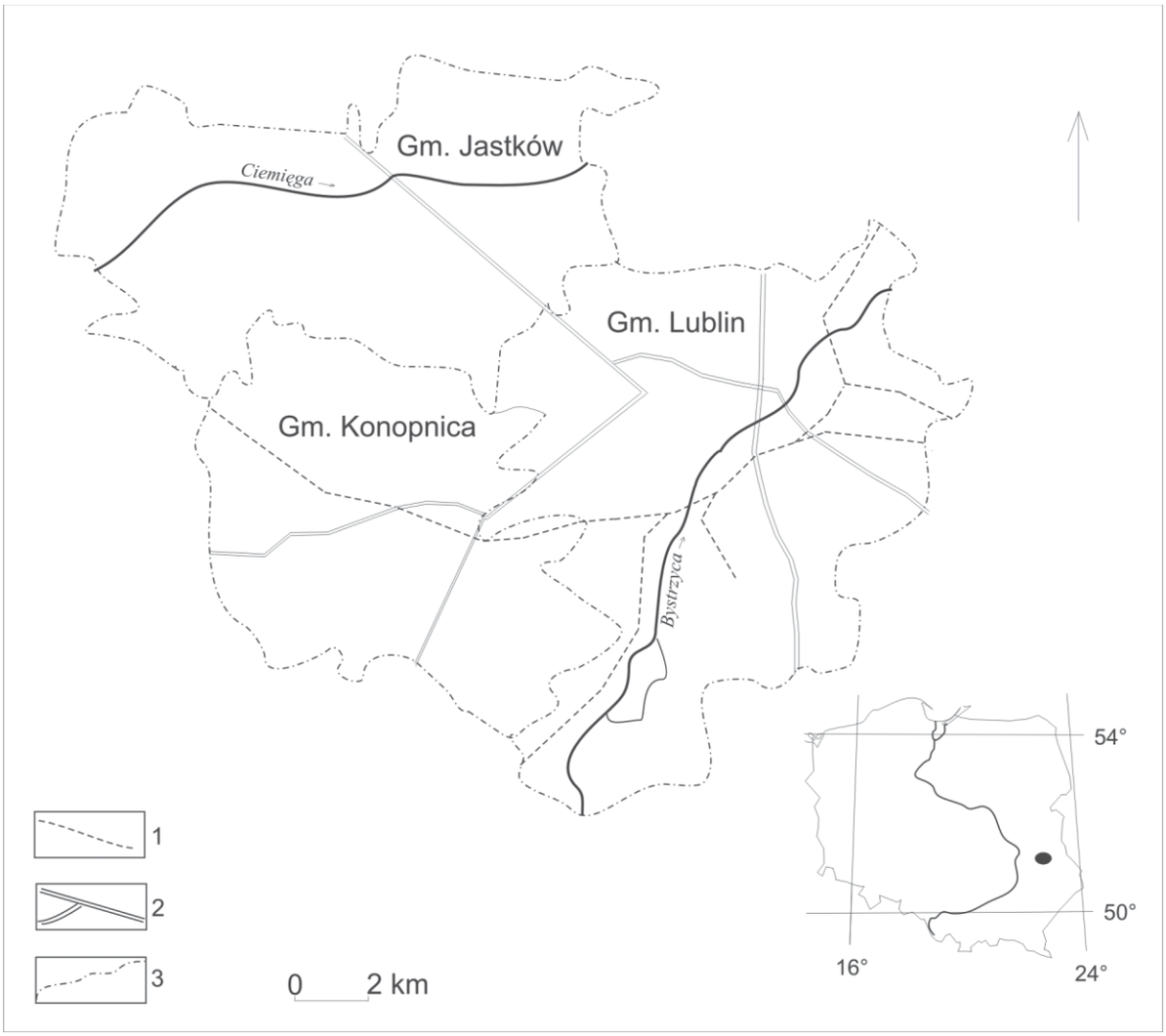


Fig. 1. The study area: 1 railway lines, 2 roads, 3 terrritorial borders.

Fig. 2. Bush communities in agricultural landscape in Konopnica.

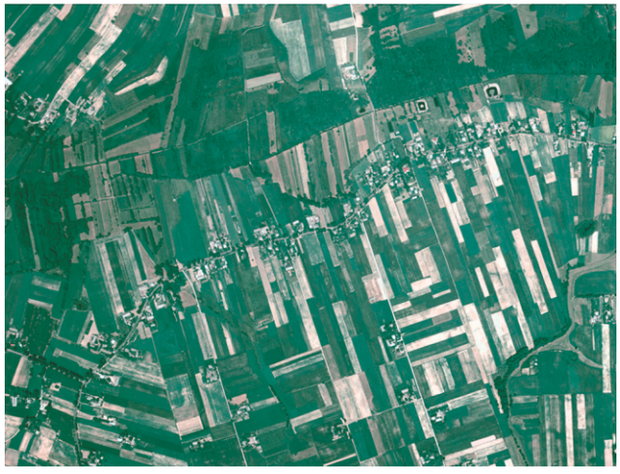


Fig. 3. Air photo showing mosaic structure of Jastków landscape.

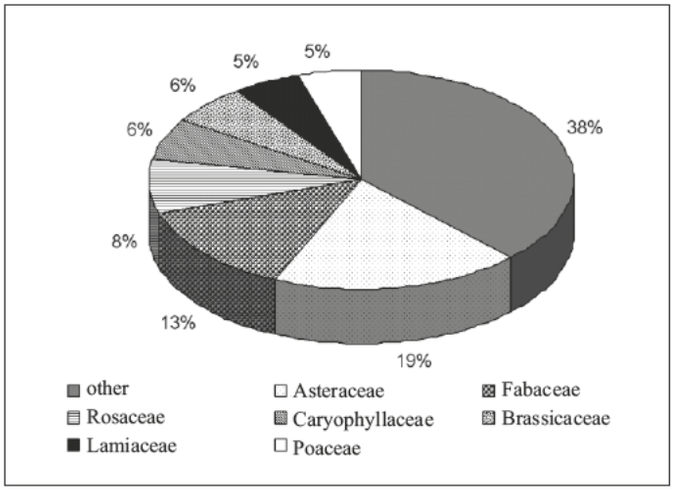


Fig. 4. The share of recorded species in botanical families.

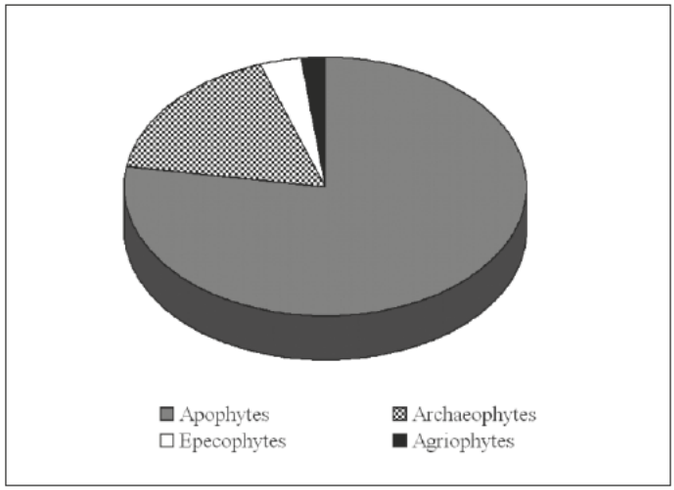


Fig. 5. The participation of geographical historical groups in recorded flora.

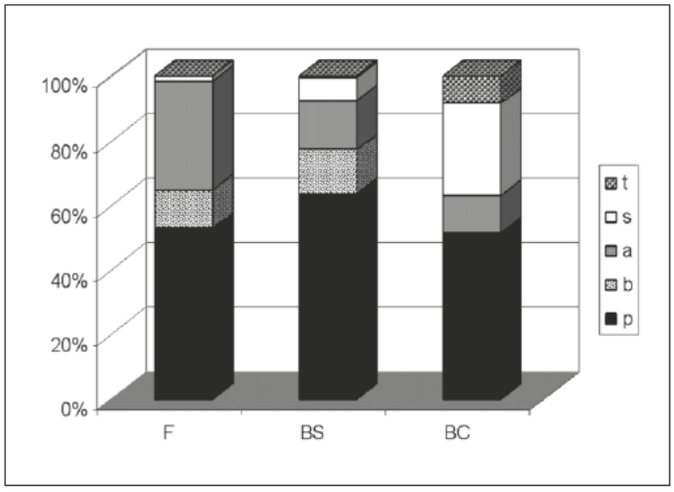
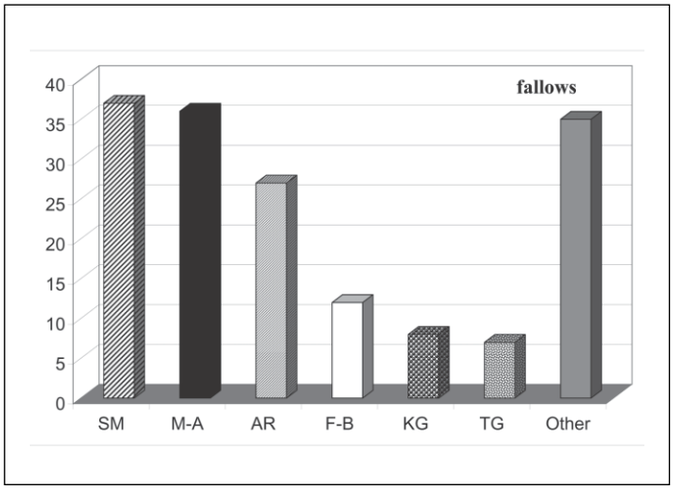
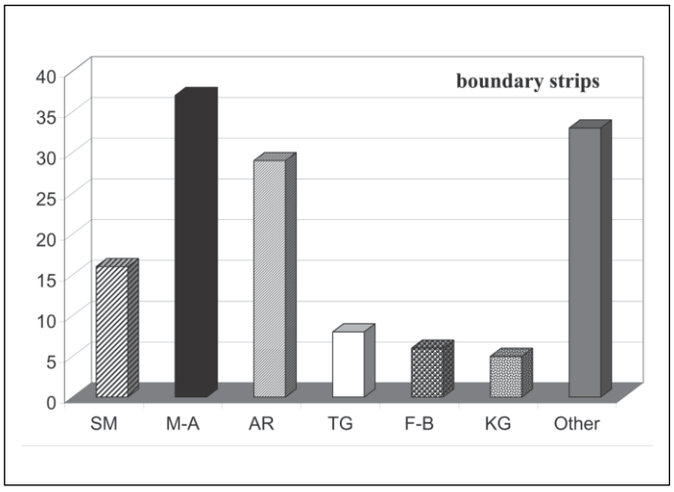


Fig. 6. Spectrum of life forms in different biotops: F: fallows, BS bus h communities, BC boundary strips, t tree, s shrubs, a annual, b biennial, p perennial.





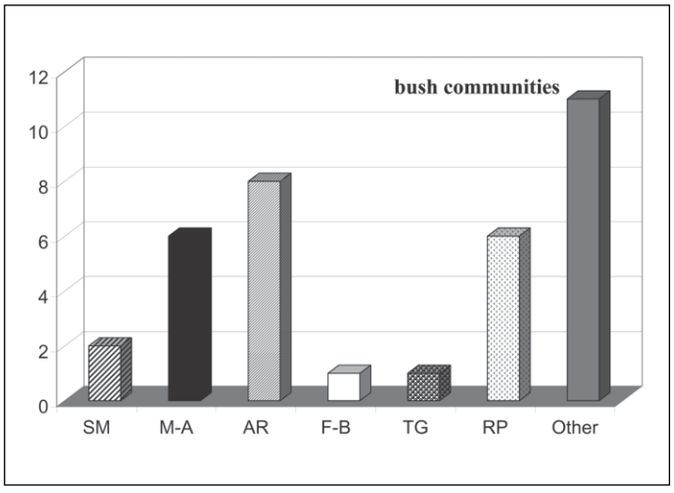


Fig. 7. Number of species in socio ecological groups AR Artemisietea vulgaris, AIR Agropyretea intermedio repentis, EP Epilobietea angustifolii, F B Festuco Brometea, IN Isoeto Nanojuncetea, KG Koelerio glaucae Corynephoretea canescentis, M A Molinio Arrhenatheretea, NC Nardo Callunetea, Q F Querco Fagetae, RP Rhamno Prunetea, SM Stelarietea mediae, TG Trifolio Geranietea sanguinei.

Taking into consideration the sinecological group, a considerable participation of species from *Stelarietea-medie* and *Molinio-Arrhenatheretea* classes on fallows was proved (Fig. 7). On boundary strips, a decrease of segetal species from *Stelarietea-medie* was recorded. The share of meadow and ruderal taxons on both fallows and boundary strips was comparable. Whereas in the flora of bushes ruderal (*Artemisietea vulgaris* class) and thermophilous species (*Rhamno-Prunetea* class) predominated.

Season-long succession of bloom was observed on boundary strips and fallows. The species in bush communities bloom mainly in early spring and provide the first and rather abundant nectar and pollen flow. Our observations have shown that the blooming plants on boundary strips and fallows create favourable conditions both for feeding and nesting for different *Apoidea*. Apart from *Apis mellifera*, bumblebees and solitary bees (mainly representatives of *Andrena*) were present. Generally, the density of *Apoidea* changed during the vegetation season and correlated with the blooming spectrum on the observed biotops. The largest density in bush communities occurred in April, whereas on field margins and fallows in summer.

The presently recorded flora of anthropogenic biotops is composed of some rare species: *Centaurium erythraea, Dianthus cartusianorum, Helichrysum arenarium, Lavanthera turingiaca, Ononis arvensis, Potentilla alba, Trifolium alpestre,* or *Viburnum opulus*. That is the confirmation of great importance of such habitats as essential areas retaining floristic biodiversity.

CONCLUSIONS

1. The flora of anthropogenic refuge areas in the studied landscape comprises 214 species of which 80% were classified as nectariferous or polleniferous. Fallows and boundary strips were the most abundant in species. The majority of taxons are apophytes which predominate over antropophytes. The complete absence of efemerophytes was associated with the character of the area.

2. The great majority of flow taxons are meadow, segetal or ruderal plants. Most of nectariferous or polleniferous taxons create loose patches, a small number forms dense areas, but the time and period of their blooming ensure a continuous, unbroken feeding band for *Apoidea* from early spring till late summer.

3. Boundary strips, fallows and bush communities form in agricultural landscape refuge areas for bee plants as well as for valuable, rare elements of flora, hence they positively influence the biodiversity.

4. The dynamic succession observed on fallows caused a decrease in bee flora in the successive years of study. The treatments including sowing fallows with nectariferous and polleniferous species would enrich generally weak flows in highly agricultural landscape.

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Miedze i zadrzewienia śródpolne jako refugia roślin pożytkowych w krajobrazie rolniczym

S t r e s z c z e n i e

Badania prowadzono w latach 2002-2006 na terenie gmin Jastków i Konopica położonych w bezpośrednim sąsiedztwie miasta Lublina. Dokonano inwentaryzacji roślinności w obrębie miedz, gruntów odłogowanych oraz zadrzewień śródpolnych ze szczególnym uwzględnieniem roślinności dostarczającej pożytku nektarowego i pyłkowego. Ogółem w obrębie obserwowanych biotopów zanotowano 214 gatunków roślin, w tym 80% stanowiły taksony pożytkowe. W analizowanej florze przeważały apofity – 78% nad gatunkami obcymi (kenofitami). We florze miedz i zadrzewień śródpolnych przewagę stanowiły gatunki wieloletnie. Taksony krótkotrwałe (40% – jednoroczne i 15% dwuletnie) dominowały na gruntach odłogowanych. Zdecydowana większość gatunków pożytkowych reprezentuje zbiorowiska łąkowe, segetalne i ruderalne. Większość z nich występuje w luźnych skupiskach, ale ich sukcesywne kwitnienie zapewnia, na badanym terenie, ciągłość taśmy pokarmowej od wczesnej wiosny do późnego lata. Miedze, zadrzewienia śródpolne oraz odłogi, stanowią ważne w krajobrazie rolniczym ostoje roślinności pożytkowej jednocześnie zwiększają walor bioróżnorodności florystycznej tych terenów. Wydaje się, że ten typ siedlisk można wykorzystywać do podsiewania gatunków nektarodajnych i pyłkodajnych w celu wzbogacania generalnie słabych pożytków na terenach rolniczych.