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PRELIMINARY INVESTIGATIONS ON BIOCENOSES OF FOREST ISLANDS IN AN AGRICULTURAL LANDSCAPE

WSTĘPNE BADANIA NAD BIOCENOZAMI WYSP LEŚNYCH W KRAJOBRAZIE ROLNICZYM

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ABSTRACT. Forest islands studies were carried out in the agricultural landscape of Western Poland, 15 km northeast of Poznań. Ten forest islands of varying size (from 0,05 ha to 1,5 ha) were investigated. Flora and plant communities of small forests were examined; 58 plant communities were found. Small areas of forest islands became the refuges of forest plant species in an agricultural landscapes. Differentiation, number and domination structure of invertebrate fauna (*Acari, Araneae, Apoidea, Curculionidae*) and small mammals were studied. The studied forest islands provide suitable conditions for survival and reproduction of many animals species, and for others they are at least a place for feeding or momentary shelter.

KEY WORDS. Forest islands, agricultural landscape, plant communities *Acari, Araneae, Apoidea, Curculionidae, Micromammalia.*

1. Introduction

Landscape studies carried out from ecological point of view and concerning its restitution and conservation were initiated by the professor of Poznań Adam Mickiewicz University, Adam Wodziczko, already before the Second World War (Wodziczko 1932, 1945, 1946). The term „physiocenosis" introducet by him to define an ecological unit of multi or over-ecosystemic character still deserves our attention and popularistation. Wodziczko precisely differentiates ecological and architectural aspects of a landscape. Therefore Wodziczko's physiocenosis and present understanding of a landscape can be considered identical. Landscape ecology is today intensely developed in many world centres and by many researchers (e. g. Risser et al. 1984; Forman and Godron 1986; Turner 1987; Urban et al. 1987; Baker 1989; Turner and Gardner 1991; Ryszkowski and Bałazy 1992; Banaszak 1993, Vos and Opdam 1993). The agricultural landscape predominating in the Western and Central Europe occupies a significant place in these studies. In Poland it constitutes about 60 % of the country's territory deciding, to a large extent, about the quality of the whole natural environment. In the agricultural landscape of many European cuntries forests were reduced to small fragments surrounded by arable fields under intensive farming. Hence, human activity lead to breaking of habitats of many plant and animal species into small, isolated islands. These islands together with tree shelter belts and swards constitute refuges for fauna and flora and their importance is the greater the more intensive farming (e. g. Czarnecki 1956; Banaszak 1983; Opdam et al. 1985; Dąbrowska-Prot 1987, 1992; Kozakiewicz and Szacki 1987; Dzwonko and Loster 1988; Loster 1989).

This work presents some results of research on flora and plant communities of forest islands and on relation between differentiation and density of selected soil and above ground fauna and the size of these habitats.

2. General characteristics of the area

The investigated area is located about 15 km northeast of Poznań, on the edge of the Landscape Park „Zielonka Forest". It is enclosed by a complex of „Dziewicza Góra" (Virgin Mountain) forests the „Kobylnica Forests" and the river Główna. There are areas under intensive farming (about 1200 ha) between the villages Wierzenica, Wierzonka, Milno and Kicin (Fig. 1).

The morphological differentiation is also expressed in the vegetation cover. The discussed area is dominated by habitats of poor series of oak-hornbeam forests – *Galio sylvatici-Carpinetum* (Wojterski et al. 1982). Rather small areas are occupied by the potential habitats of mixed forest *Querco robotis-Pinetum*. Only in the valley of the river, along its tributaries and in local small depressions there are riverside forest habitats (*Circaeo-Alnetum* and *Ficario-Ulmetum campestris*) and habitats of fertile alder forests (*Ribo nigri-Alnetum*).

The investigated area, although covering but a small surface, is characterized by a rich network of different forest islands. They have been developed primarily in the form of woodlots with a circumference of 100-200 meters. The widest afforestations with a natural character exted in a small tunnel valley running down to the valley of the Główna river. The fields of the Plant Breeding Station of Wierzenica-Wierzonka are separated by balks where single trees and shrubs grow. One can also encounter 20-30 meter wide and several hundred meter long compact hedges (*Pruno-Crataegetum*). The field roads and highways are accompanied by one-row or two-row tree belts, whereby the tree plantation on both sides between the villages Wierzonka and Milno is particular noteworthy. The plantation consists of norway maple (*Acer platanoides*), sycamore (*Acer psudoplaatanus*) and oak (*Queercus robur*).

Furthermore, several trees are recorded as nature monuments within the discussed area. They are magnificent white poplars (*Pupulus alba*), oaks (*Quercus robur*) and wild pear (*Pyrus communis*) (Banaszak and Ratyńska 1992).

3. Material and Methods

The field studies were carried out in the vegetation seansons 1991-1993. For the purpose of this paper 10 field forest communities were selected (A-J) localised mainly within oak-hornbeam and carr forest habitats: A – „Duży wąwóz", B – „Mały wąwóz", C – „Duże zadrzewienie", D – „Osikowe", E – „Jesionowe", F – „Długi pas czyżni", G – „Stary cmentarz (dębowe) H – „Głogowe", I – „Wiązowe", J – „Sosnowe (Żalik)").

The focus of interest was concentrated on the lever of the vegetation cover organisation and on the complexes of plant communities. The latter are understood in similar way as Matuszkiewicz (1990), as spatially distinguished, repeated functional systems of related facia, preserving a relative structural and genetic homogeneity. All the above mentioned afforestations were treated as one complex of plant communities. Phytosociological relieves were made of them according to

the generally accepted Braun-Blanquet method with the modification by Barkman et al. (1964) and the role of species was played by the plant communities.

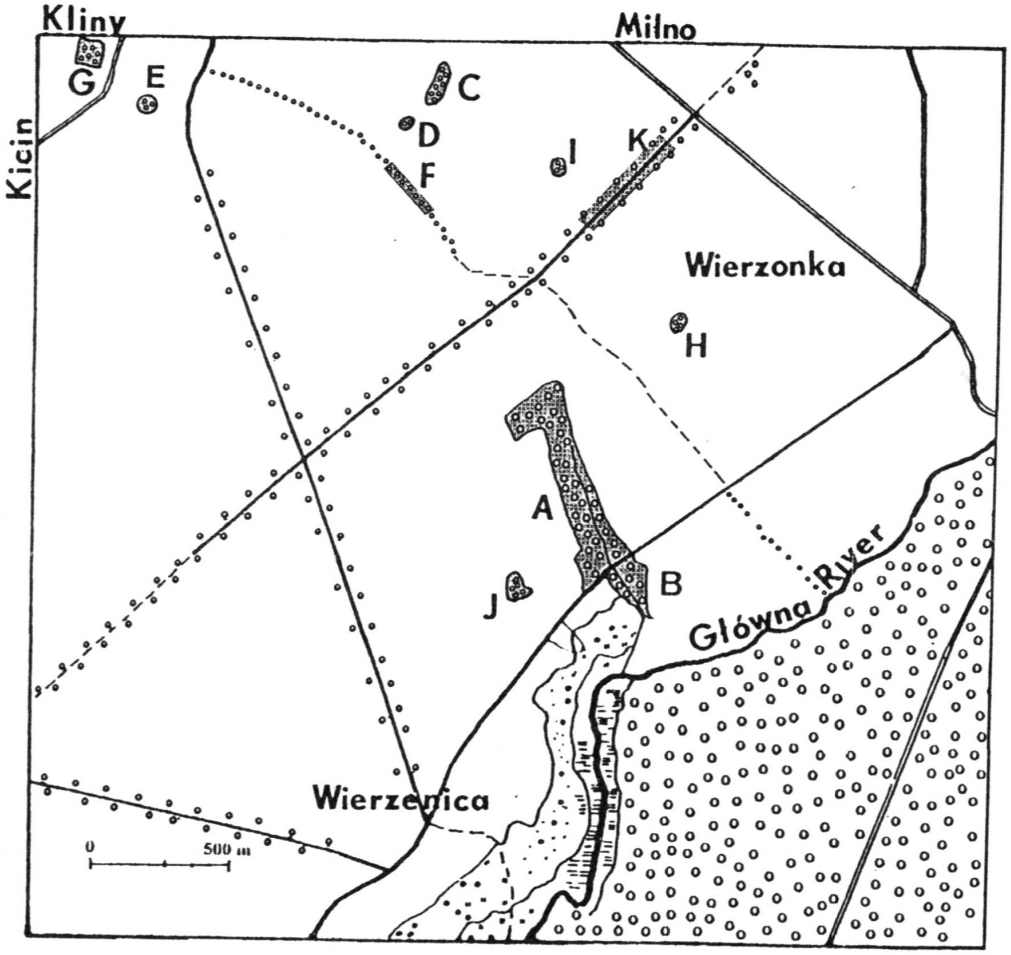

Fig. 1. The map of the investigated area. A, B, C... –studied forest islands, explantion see p. 47.

The accepted systematic of the distinguished phytocenons agrees in general outline with the description by W. Matuszkiewicz (1981) and Brzeg (1981).

The acarological studies were carried out in 4 forest islands (C, D, H, J). The samples were taken in spring and atutumn of 1992 from two soil horizons: 1-5 cm and 6-10 cm, smples were taken representing twop soil levels: 0-5 cm and 6-10 cm, in 10 repetitions. *Acari* were driven away in Tullgren apparatus and preserved in 70 % ethyl alcohol. In all, 80 samples of forest litter and soil were taken which yielded 12420 mites.

The spiders – *Araneae* – were collected with the following methods: a) entomological scoop, b) soil traps, c) shaking branches, trees and shrubs, d) search in the shrub, herbs, grass and litter layers, e) collecting from under stones, fallen tree trunks and branches, and from under tree bark, f) catching spiders with nets and those running in the surface litter, stones, fallen trees. The samples were collected from May to October, twice a month (in 1991) and once a month (in 1992). Each time the tree, under growth, vegetal cover and litter layers were searched as well as ther ground undedr stones.

Coleoptera (*Curculionidae*): The material was gathered in Jyly 1993 from the forest islans (B, C, F, H, I). Quantitative samples were taken using soil traps (Barber traps).

The studies on Apoidea were carried out in 6 communities (J and H – from 1990, C, I i O – from 1992). Quantitative samples were taken from April to September in 2 or 3 weeks periods. The belt method was applied (Banaszak 1980). In two communities (I and C) the samples were divided into the internal ones, collected within a community (at least a few meters from its edge), and the external ones, collected in the contact zone between a community and surrounding fields.

The studies on mammals were started in autum 1992 in three field forest communities considered the most interesting and convenient for investigation of small mammals: D, D, E. Two eight days long catching series were carried out in autumn, 16 – 25 September 1992 and 23 September to 7 October 1993, and one four days long in spring – 20-24 April 1993. Non-killing traps and oat flakes as a bait were used. This kind of bait attracts mainly rodents (on which the study was to focus). Accidentally caught insectivores generally do not survive the period between subsequent trap checks carried out once a day. For observations of the number and movement of animals the CMR method (Catching, Marking, Repeated catching) was applied.

4. Results

4.1. Analysis of aerial photographs of the investigated area

For analysis of some elements of natural environment, diapositive spectrozone aerial photographs and panchromatic photos taken in several time intervals were used. The most valuable source of information proved to be spectro-zone photographs taken in 1:10 000 scale.

Analysis of field and roadside forest communities revealed that at generally preserved network of these structures, local changes of their state and size can be observed. The longest (over 1 km long) belt of field forest enclave stretching form Kliny willage in the south-west direction has clearly developed two levels. Its present state, as compared to the forties, is more regular with smaller of breaks.

Analysis of roadside tree belts in the northern part reveals missing tree stretch about 360 m long, while in the southern part and increase in the tree stretch on the 500 m long segment as well as afforestation of the second row on the length of about 700 m.

Relatively slight changes were made in land utilisation but in two placdes afforestation took place while in one forest was felled. The spectro-zone photographs facilitated also describing changes in the reange of each cultivated area. In the north-west part near Milno and Kicin fields were enlarged while in the south-east near Wierzonka their parcellation and non-farming utilization took place.

In the south-eastern part, more variable hipsometrically, photographs reveal characteristic structure of small effluvial cones at slope bottoms and thin lines intruding highland, being traces of small erosion cuts.

4.2. Vegetation

During the field studies carried out far, 10 different forest islands were subject to particular studies (patch and belt refuges). The composition and quantitative relations of the plant communities creating the above afforestations units are presented in Table 1. The floristic composition of the stands has a seminatural character. However, due to the small area, influence of the surrounding cultivations is frequently a strong one. Ther uncontrolled felling of trees and the absence of cultivation treatments create various forms of degeneration. They are: pinetization, i. e. the introduction of coniferous trees into deciduous habitats, geranietization revealed in a mass outbreak in the undergrowth of one-two-year developmental cycle from the *Lapsano-Geranion* alliance, and to a lesser degree, cespitization (excessive sodding) and fruticetization being the result of a strong development of the shrub layer. The above mentioned forms of forest community degeneration were distinguished by Olaczek (1972), Brzeg & Krotoska (1984).

Tabela 1. The composition and quantitative relations of the plant communities creating the forest islands

Forest islan mark nr w terenie	A	B	C	D	E	F	G	H	I	J
	8	9	4	5	7	10	6	2	3	1
Potential habitat	C–A F–U G–C	F–U	C–A F–U G–C	F–U G–C	F–U	G–C	G–C	G–C	G–C	G–C P–Q
Number of communities	43	17	19	9	8	18	12	11	9	13
Forest communities										
Circaeo–Alnetum	1	.	.	.	.	.	.	.	.	.
Ficario –Ulmetum	4	5	.	.	.	.	.	.	.	.
F–U. geranietyzation	.	.	2m	3	1	.	.	.	.	.
Galio–Carpinetum geranietyz.	2a	.	3	.	.	.	.	.	5	.
G–C. pinetyzation	2m	.	.	.	.	.	.	.	.	.
Querco roboris–Pinetum	+	.	.	.	.	.	.	.	.	.
Chelidonio–Robinetum	.	.	+	.	.	.	.	.	.	.
Populus tremula com., juv.	.	.	.	.	.	+	.	.	.	.
Pinus sylvestris com.	.	.	.	.	.	.	.	.	.	%
Σ	5	1	3	1	1	1	–	–	1	1
Shrub communities										
Salicetum pentardo-cinereae	+	.	.	.	.	.	.	.	.	.
Rhamnus cathartica com.	+	.	.	.	.	.	.	.	.	.
Cuscuto–Humuletum lupuli	+									
Convolvulo–Rubetum caesii	+	+	.	.	.	.	.	.	.	.
Sambucetum nigri	3	+	2m	3	3	2b	2b	.	.	.
Pruno–Crataegetum	2a	1	4	2a	2b	%	+	4	.	1
Rubus caesious com.	+	.	r	.	.	.	.	1	.	+
Rosa sp. com.	.	.	.	.	.	r	.	.	.	.
Syringa vulgaris com.	.	.	.	.	.	.	3	.	.	.
Licietum halimifolii	.	.	.	.	.	.	r	.	.	.
Σ	7	3	3	2	2	3	4	2	–	2
Wetland communities										
Phragmitetum communis	r	.	.	.	.	.	.	.	.	.
Caricetum gracilis	+	.	.	.	.	.	.	.	.	.
Cardamino–Beruletum erecti	+	.	.	.	.	.	.	.	.	.
Caricetum vulpinae	+	.	+	.	.	.	.	.	.	.
Phalaridetum arundinaceae	.	.	1	.	.	.	.	.	.	
Σ	4	–	2	–	–	–	–	–	–	–
Meadow & sward communities										
Scirpetum silvatici	r	.	.	.	.	.	.	.	.	.
Potentilla reptans com.	r	.	.	.	.	.	.	.	.	.
Bromus intermis com.	+	.	.	.	.	.	.	.	.	.

Poetum trivialis	1	.	1	.	+	.	.	.	.	.
Festuca ovina sl. com.	1	.	.	.	.	.	.	.	.	2m
Arrhentheretum medioeuropaeum	2m	.	.	.	.	r	.	1	2a	1
aff. Rumici –Alopecuretum	.	.	r	.	.	.	.	.	.	.
Σ	6	–	2	–	1	1	–	1	1	2
Tall herb communities										
Eupatorietum cannabini	r	.	.	.	.	.	.	.	.	.
Chaerophylletum aromatici	r	.	.	.	.	.	.	.	.	.
Chelidonium majus com.	r	+	.	.	.	.	.	.	.	.
Helianthetum tuberosi	r	+	.	.	.	.	.	.	.	.
Impatiens parviflora com.	+	+	.	.	.	.	.	.	.	.
Urtico–Aegopodietum	3	3	.	.	.	.	.	.	.	.
Anthriscetum silvestris	r	+	.	.	.	2m	.	+	.	.
Alliario–Chaerophylletum	+	+	r	1	.	+	.	.	.	1
Alliarietum officinalis	1	.	2m	2m	.	2m	.	+	+	.
Urtica dioica com.	2m	2b	3	3	2b	3	2b	3	1	2m
Galio–Veronicetum	+	+	1	.	2m	2m	2b	+	2m	+
Trifolio–Geranietea cl. com.	+	.	.	.	.	+	.	.	.	+
Conium maculatum com.	r	.	.	.	.	r	.	.	.	.
Galeopsis tetrahit com.	.	.	r	.	.	.	.	.	.	.
Σ	13	8	5	3	2	7	2	4	3	4
Clearcut communities										
Epilobietum angustiofolii	+	.	.	.	.	.	.	.	.	.
Calamagrostetum epigei	+	.	.	.	.	r	.	.	.	r
Rubetum idaei	+	.	.	.	.	+	.	+	.	r
Σ	3	–	–	–	–	2	–	1	–	2
Ruderal communities										
Rumex obtusifolius com.	+	.	.	.	.	.	.	.	+	.
Tanaceto–Artemisietum	+	+	+	.	.	.	.	.	.	.
Leonario–Arctietum	1	+	.	.	3	r	r	.	.	.
Leonuro–Arctietum	1	+	.	.	3	r	r	.	.	.
Leonuro–Ballotetum	1	2a	+	+	.	+	+	2b	2a	.
Convolvulo–Agropyre	.	.	.	.	.	+	.	.	.	.
Saponaria officinalis com.	.	.	.	.	.	.	1	.	.	.
Lamium album com.							+	.	.	.
Σ	4	3	2	1	1	3	4	1	1	–
Field-accompanying communities										
Bromus tectorum com.	2m	2a	.	.	.	.	.	.	.	2m
Agropyron repens com.	3	2b	2b	3	.	4	2a	3	4	3
Stellaria media com.	+	.	+	+	+	.	+	2m	+	.
Σ	3	2	2	2	1	1	2	2	2	2

Particularly noteworthy within the tall herb communities (due to the occupied area) are patches with dominating blackthorn (*Pruno-Crataegetum*) and elder (*Sambucetum nigri*). A somewhat different character is shown by the already historic materials referring to the cemetery in Kliny (G). In the summer of 1992 that area was ordered, some trees and all shrubs were cut out and herbaceous plants were destroyed. The shrub layer was built here of lilac (*Syringa vulgaris*) and elder (*Sambucus nigra*).

The communities of herbaceous species of the investigated afforestations are grouped in three main groups: phytocenoses of skirt community, ruderal and field character whose genesis is connected with the direct neighbourhood of cultivated fields. The first of them i mainly represented by patches with *Urtica dioica*, patches of the *Alliarietum officinalis* and *Alliario-Chaerophylletum* and *Galio-Veronicetum*. The ruderal associations whose presence, similarly to that of segetal communities, is the result of strong anthropopressures, do not occupy any major area. Most widespread among them are the phytocenoses with *Balloto-Leonuretum* and *Leonuro-Arctietum*. It must be stressed that the distinction between nitrophilous skirt communities, the *Galio-Calystegietalia* order, ruderal phytocenons and the *Onopordietalia* order sometimes has a somewhat artitrary character. Among the communities whose presence is closely connected to the neighbouring cultivated fields, and reference to the size of area patches, *Agropyron repens* dominates. In the majority of the discussed afforestations, phytocenoses with *Stellaria media* were also observed.

The total number of plant communities observed in the investigated afforestations is 58. With reference to the phytocenons included, the most differentiated is the forest overgrowing the largest ravine running to the Główna river (complex 1, Table 1). Taking into consideration the degenaration forms, 46 plant communities were found here. The poorest in this respect are the small-area field refuges (only 8-9 phytocenons).

The greatest participation of the communities with a character similar to the natural and semi-natural one were found in the ravines running to the Główna river (complexes 1, 2, Table 1). Among the studied afforestations, they are distinguished by the presence of well preserved *Ficario-Ulmetum campestris* and *such phytocenons as Urtico-Aegopodietum*, *Convolvulo-Rubetum caesi*, *Helianthetum tuberosi* and communities with *Cheliodonium majus* (i. e. nitrophilous skirt communities).

Field observations have shown that the composition and the quantitative relations of herbaceous plant communities accompanying field afforestations are influenced by the exposure. On the borders (edges) with southern and westerm

exposure, phytocenons occur with a mezocerothermophilous character and with the participation of such species as: *Euphorbia cyparissias*, *Poa pratensis ssp. augustifolia*, *Galium molugo*, one can also encounter here patches of grass and ruderal vegetation. On the edges of afforestations with northern and eastern exposures nitrophilous edges communities definitely dominate.

Small-areas of forest islands become also the refuges of forest species in the agricultural landscape. During the investigations (and excluding trees and shrubs) tree species of fern been found: *Dryopteris spinulosa*, *D. filix-mas* and *Pteridium aquilinum*, *numerous* grasses: *Poa nemoralis*, *Festuca gigantea*, *Brachypodium sylvaticum*, *Dactylis acschersoniana*, *Melica nutans* and also *Scrophularia nodosa*.

The so called ecological lands also present enclaves which supply refuges for species and communities of perennial vegetation with a seminatural character. Intensive utilization of arable land consists of maintaining cultivated phytocenons in the aerly stage of succession. The cultivations usually change every year or every second year.

Perennial herbaceous vegetation and grasses can develop only on the field edges, on balks, in field afforestations and in inaccessible places like slopes, ravines, local depressions etc.

4.3. Soil acarofauna-*Acari*

Four investigated field forest communities (C, D, H. J) were dominated by 25 species from the *Gamasida* order (Table 2). The greatest number of the *Gamasida* species was observed in the community of the largest area – 19, while in the remaining ones it was from 9 to 11. *Alliphis siculus*, *Amblyseius sp.*, *Hypoaspis aculeifer* and *Leioseius bicolor* appeared on all investigated surfaces.

The general number of mites on the studied units was high-from 23.4 to 204.4 thousand of indiv./m^3 (Table 3).

Tabela 2. Species composition of *Gamasida* in studied forest islands

Species of *Acari*	Forest island			
	D u Z e	O s i k o w e	W i ą z o w e	G ł o g o w e
Alliphis siculus (Oudemans)	+	+	+	+
Amblyseius obtusus (C. L. Koch)	–	–	+	+
Amblyseius sp.	+	+	+	+
Arctoseius cetratus (Sellnick)	+	+	+	–
Dendrolaelaps foveolatus (Leitner)	+	+	–	–
Hypoaspis aculeifer (Canestrini)	+	+	+	+
Hypoaspis austriaca (Sellnick)	+	–	–	–
Hypoaspis praesternalis (Willmann)	+	+	+	–
Hypoaspis vacua (Michael)	+	–	+	–
Leioseiurs bicolor (Berlese)	+	+	–	+
Macrocheles sp.	+	–	–	–
Nenteria breviunguiculata (Willmann)	–	–	+	–
Pachylaelaps furcifer Oudemans	+	–	–	–
Pachyseius humeralis (Berlese)	+	–	–	+
Parasitus kraepelini (Berlese)	+	–	–	–
Pergamasus lapponicus Trägardh	+	–	–	–
Pergamasus misellus Berlese	+	–	–	–
Pergamasus runciger Berlese	+	+	–	–
Proctolaelaps pygmaeus (Müller)	–	–	–	+
Rhodacarellus subterraneus Willmann	–	–	–	+
Trachytes aegrota (C. L. Koch)	+	–	–	–
Uropoda minima Kramer	+	+	+	–
Veigaia nemorensis (C. L. Koch)	+	+	+	–
Zercon sp.	–	–	+	+
Sum of species	19	11	12	9

+ present – absent

Tabela 3. Density (in thousand of ind./1 m^2) of *Acari* in studied forest islands

Acari–group	Forest islands			
	Duże	Osikowe	Wiązowe	Głogowe
Gamasida	7.5	1.5	1.5	4.3
Others	196.9	65.0	21.9	100.5
Sum	204.4	66.5	23.4	104.8

In each forest island the number of mites was different and on the surfaces C and H it was much greater than 100 thousand indiv./m^2 and it was comparable to the one observed in patches of Scots pine forest with moss in the vicinity of Włocławek (Seniczak et al. 1994). Whereas in the D and J objects the total number of acarofauna did not vary from that found in multispecies afforestations (over 0.5 ha) on dry habitat near Turew (Seniczak et al. 1987, 1991 a, b; Kaczmarek 1990).

The observed large differentiation of the acarofauna number in the studied forest communities can be related to their size. On greater objects (C and J) larger number of plant communities and more flora species (Ratyńska and Szwed 1992), and their greater biocenotic stability appeases the effects of agrotechnical treatment and creates better conditions for acarofauna life. In the C field forest also the highest level of actual water content of soil which, undobtfully, favours development of the majority of mite groups. High number of acarofauna in the J forest at relatively low water content level resulted mainly from high proportioin of *Acaridi*da better adjusting to periodical deficit of soil water.

The small area field forest communities do not develop in their internal parts stable micro-environmental conditions, and stratified structure of their plant communities is often considerable disturbed. There practically the whole refuge functions as an edge community (Ranney et al. 1981).

The results of acarological investigation reveal relatively great differentation concerning both the number and species composition of *Gamasida* living in the discussed forest islands. Analysis of the domination structure of these mites indicates also greater stability of acarocenosis in the greatest forest (C) as compared to the remaining ones. Occurrence of *Alliphis siculus, Nenteria breviunguiculata, Arctoseius cetratus* and *Rhodacarellus subterraneus* populations in the investigated forest makes their acarofauna similar to that found in soils under permanent cultivation.

4.4. Spiders – *Araneae*

Araneofauna of the studied sites seems to be relatively rich consaidering small area of the field forest communities. So far 56 species included in 13 families have been descriebed. Among the families the richest in species are: *Argiopidae* – 12 species, *Theririidae* – 11 species, *Linyphidae* – 8, and Thomisidae – 6. Among all families five are represented by 1 species: *Dictionidae, Dysderidae, Pisuaridae* and *Anyphenidae*. In samples three genera were the most frequently encountered: *Araneus, Theridion, and Paradosa.*

In the forest islands two plant layers are clearly separated. Therefore the collected specimens were qualified according to their association to the layer of trees and high bushes or to the vegetal cover and litter one. On the basis of this distinction the differences between both forest floors were established (Tables 4 and 5). The lower layer is richer in families, poorer in species but more numerous (according to estimations). The araneofauna of the upper floor is more differentiated with respect to species but less numerous.

The number of spiders in sampling pediords varied considerably. On basis of the general estimate the following changes in the number were observed: great number of spiders in the period May – mid June, fall in the number of collected specimens in July and August and gradual increase till October.

Tabela 4. Familly of spiders and numbers of species in vegetal cover of forest islands

Familly	Number of species		
	Żalik	Głogowe	Wiązowe
Dictinidae	1	–	–
Dysderidae	1	1	1
Pisuaridae	1	1	–
Theriididae	5	7	7
Licosidae	5	3	3
Clubionidae	–	1	1
Argiopidae	3	3	2
Tetragnathidae	1	1	1
Linyhidae	4	5	6
Thomisidae	1	1	–
Salticidae	–	1	1
Agelenidae	1	–	–
12	23	24	22

Tabela 5. Familly of spiders and number of species in layer of trees and hihg bushes of forest islands

Familly	Number of species		
	Żalik	Głogowe	Wiązowe
Dictynidae	1	1	1
Argiopidae	8	8	9
Tetragnathidae	2	2	2
Lynyphidae	1	1	1
Theridiidae	7	7	7
Clubionidae	1	1	1
Anyphenidae	1	1	1
Thomisidae	4	3	3
Salticidae	2	2	1
9	27	26	26

4.5. Pollinating insects – *Apoidea*

Up to now the results indicate that the investigated field forest communities are settled by a large number of bees *Apoidea*, though there are clear differences both between the forests and various study years. No relationship was found between the *Apoidea* number and the area of forest island (Table 6). Mean seasonal density of *Apoidea* was from 300 indiv./ha to 2450 indiv./ha. At the time of the highest number, spring months (April, beginning of May), the maximal numbers reached 7000 indiv,/ha (H) (Fig. 3). At the present state of research it is possible to state that the number of bees in a given forest island depends on food base, i. e. on the presence of pollen and nectar producing plants, and on occurrence of convenient nesting sites. The differences in the number in various seasons also indicate the considerable effect of weather conditions on bee populations. Different densities were found inside the forests and on their edges. The contact zones between a forest and a field have much greater densities than internal parts what is related to the distribution of fodder plants.

Tabela 6. Mean density for season (ind./ha) of *Apoidea* of forest island

Forest island	Year	Wild bees	Apis mellifera	Apoidea (wild bees + Apis)
Żalik	1991	400,0	106,2	506,2
	1992	350,0	10,0	360,0
Głogowe	1991	472,7	540,9	1013,6
	1992	290,9	186,4	477,3
	1993	2175,0	275,0	2450,0
Duże	1992	347,9	75,0	422,9
	1993	678,5	121,4	792,9
Wiązowe	1992	200,0	100,0	300,0
	1993	964,3	42,9	1007,1
Osikowe	1992	293,7	18,7	312,5
	1993	1125,0	100,0	1225,0
Droga	1993	600,0	85,7	685,7

On the edges, communities rich in nectar plants are developed resulting in *Apoidea* accumulation in this zone. The mean density in the contact zone varied from 590 indiv./ha to 1835.7 indiv./ha, while that inside the forest island was from 10 indiv./ha to 328.5 indiv./ha. Despite significant differentiation in *Apoidea* number in forest islands, it is possible to notice similarities appearing in all investigated sites. Among them is the course of the number dynamics. In each investigated forest two clear-cut peaks were observed: spring – with predomination of *Andrena* (the most numerous is *Andrena nigroaena*), and summer – with predomination of *Bombus* (*Terrestriombus, B. pascuorum*) (Fig. 2, 3).

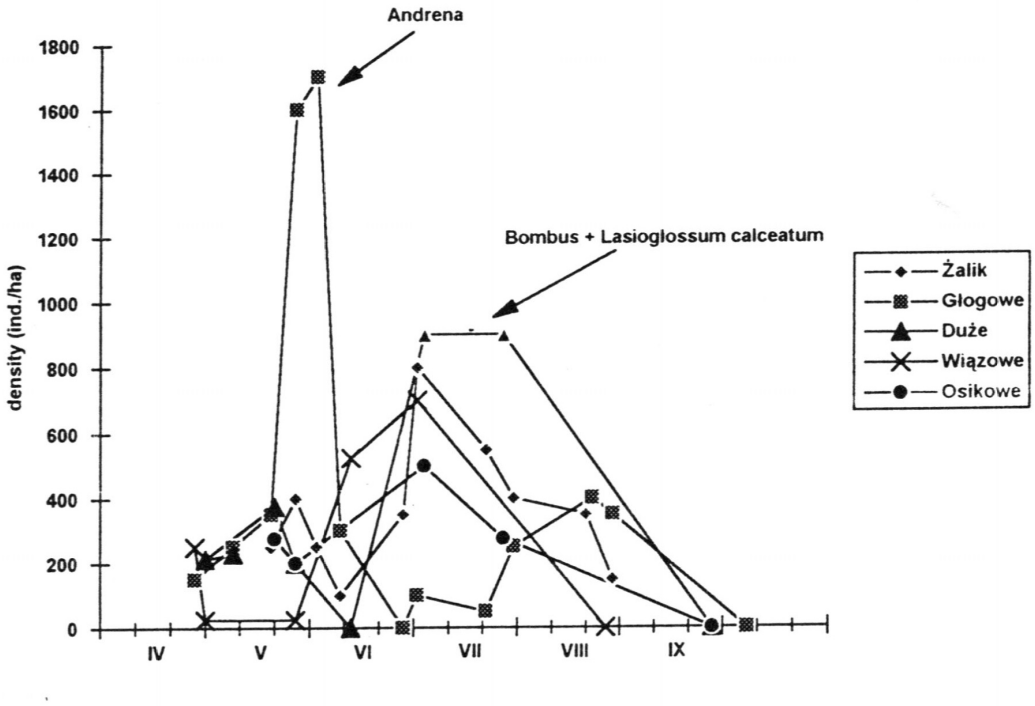

Fig. 2. Numbers dynamic of *Apoidea* in studied forest

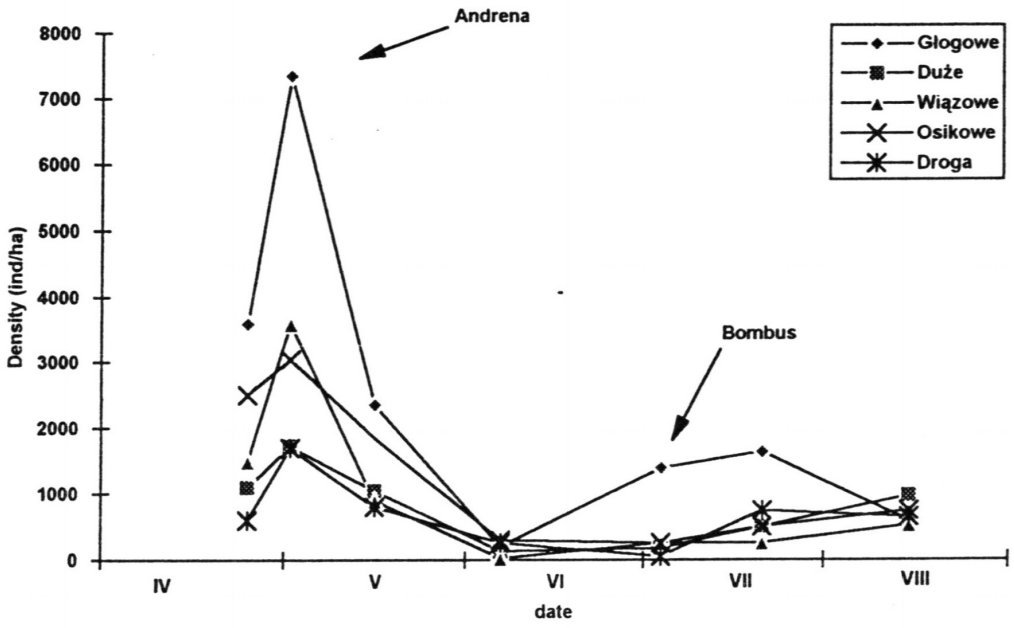

Fig. 3. Numbers dynamic of *Apoidea* in studied forest islands

4.5. The weevils fauna – *Curculionidae*

In the investigations carried out on agricultural landscape near Poznań were found 36 species of *Curculionidae* from 6 subfamilies: *Otiorrhynchinae, Brachyderinae, Curculioninae, Calandrinae, Apioninae and Rhynchitinae* (see tab. 7).

Tabela 7. Spectrum of weevils fauna (Coleptera, Curculionidae) in the forest island near Poznań

Species	Wąwóz		Wiązowe		Duże I		Duże II		Żalik		Głogowe		Pasowe	
	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha
Subfam. Otiorrhynchinae														
Otiorrhynchus (s. str) raucus F	–	–	2	100	–	–	1	50	–	–	–	–	1	50
Otiorrhynchus (Dorymerus) intrususu Reich.	–	–	–	–	–	–	–	–	–	–	–	–	1	50
Phyllobius (Dieletus) argentatus L.	–	–	–	–	–	–	–	–	–	–	1	50	1	50
Phyllobius (s. str) arborator Herbst.	–	–	–	–	–	–	–	–	–	–	–	–	2	100
Subfam. Brachyderinae														
Sitona griseus F.	1	50	–	–	–	–	–	–	–	–	–	–	–	–
Sitona flavescens Marsh.	–	–	–	–	1	50	1	50	–	–	2	100	–	–
Sitona lineatus L.	–	–	–	–	4	200	25	1250	1	050	7	350	44	2200
Sitona puncticollis Steph..	–	–	–	–	–	–	2	100	–	–	1	50	–	–
Sitona crinitus Herbst.	–	–	–	–	–	–	28	1400	–	–	9	450	23	1150
Sitona suturalis Steph.	–	–	–	–	–	–	–	–	–	–	–	–	4	200
Sitona cylindricollis Fahrs.	–	–	–	–	–	–	–	–	–	–	–	–	9	450
Strophosmus melangrammus Forst.	–	–	–	–	–	–	–	–	–	–	–	–	3	150
Subfam. Curculioninae														
Curculio glandium Marsh.	1	50	–	–	–	–	–	–	–	–	–	–	–	–

Species	Wąwóz		Wiązowe		Duże I		Duże II		Żalik		Głogowe		Pasowe	
	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha
Curculio crux F.	1	50	–	–	–	–	–	–	–	–	–	–	–	–
Subfam. Calandrinae														
Ceuthorrhynchus (s. str.) guadridens Panz.	1	50	–	–	–	–	1	50	–	–	1	50	–	–
Ceuthorrhynchus (Ethlecus) pollinarius Forst	5	250	–	–	–	–	1	50	–	–	–	–	–	–
Ceuthorrhynchus (Calosirus) posthumus Germ.	1	50	–	–	–	–	–	–	–	–	–	–	–	–
Ceuthorrhynchus (s. str.) assimilis Payk v.														
litturatus Sch.	1	50	–	–	–	–	–	–	–	–	–	–	–	–
Ceuthorrhynchus (s. str.) assimils Payk.	–	–	–	–	–	–	1	50	1	50	–	–	1	50
Ceuthorrhynchus (s. str.) Roberti Gyll.	–	–	–	–	–	–	–	–	–	–	1	50	–	–
C. (s. str.) Roberti Gyll. subsp. alliariae Bris	–	–	–	–	–	–	2	100	–	–	1	50	–	–
C. (Hadroplontus) asperifoliarium Gyll.	–	–	–	–	–	–	1	50	–	–	5	250	3	150
Ceuthorrhynchus (Calosirus) floralis Payk.	–	–	–	–	–	–	–	–	–	–	2	100	–	–
Sibina peellucens Scop.	–	–	–	–	–	–	1	50	–	–	–	–	–	–
Stereonychus fraxini Deg.	11	550	–	–	–	–	–	–	–	–	–	–	–	–

Species	Wąwóz		Wiązowe		Duże I		Duże II		Żalik		Głogowe		Pasowe	
	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha	nr. of ind	ind/ ha
s. fraxini v. flavoguttatus Stierl	8	400	–	–	–	–	–	–	–	–	–	–	–	–
Rhynchaenus (Euthoron) fagi L.	3	150	–	–	–	–	–	–	–	–	–	–	–	–
Rhamphus pulicarius Herbst.	13	650	–	–	–	–	–	–	–	–	–	–	–	
Rhamphus oxyacanthae Marsch.	–	–	–	–	–	–	1	50	–	–	–	–	–	–
Smicronx coecus reich.	–	–	–	–	–	–	–	–	–	–	4	200	–	–
Subfam. Apioninae														
Apion (Taeniapion) urticarium Herbst.						2	100		1	50	8	400	2	100
Apion (Catapion) burdigalense Wenck.	–	–	–	–	–	–	–	–	–	–	1	50	–	–
Apion (s. str.) aestimatum Fst.	–	–	–	–	–	–	–	–	–	–	–	–	1	50
Subfam. Rhynchitinae														
Rhynchites (Coenorrhinus) aeguatus L.	–	–	–	–	–	–	–	–	–	–	1	50	–	–
Attelabus nitens Scop.	–	–	–	–	–	–	–	–	–	–	–	–	1	50

The number of the species of *Curculionidae* has been strictly connected with the afforestation and the number of plant species. Significantly higher density has been observed in the large forests islands where the big number of species of the plant communities is growing (see Fig. 4). Most part of these species of plant communities are the host – plants and the source of food for insects. From this point of view we considered 3 ecological categories of weevil species:

- swpecies characteristics, strictly connected with the hostplant,
- species of passage for which the forest islands are only a temporary source of food,
- species non-characteristics who accidentaly appear in this habitat (see tab. 8).

Also, the investigated habitats differed considerably in their species composition as is show in the fig. 5.

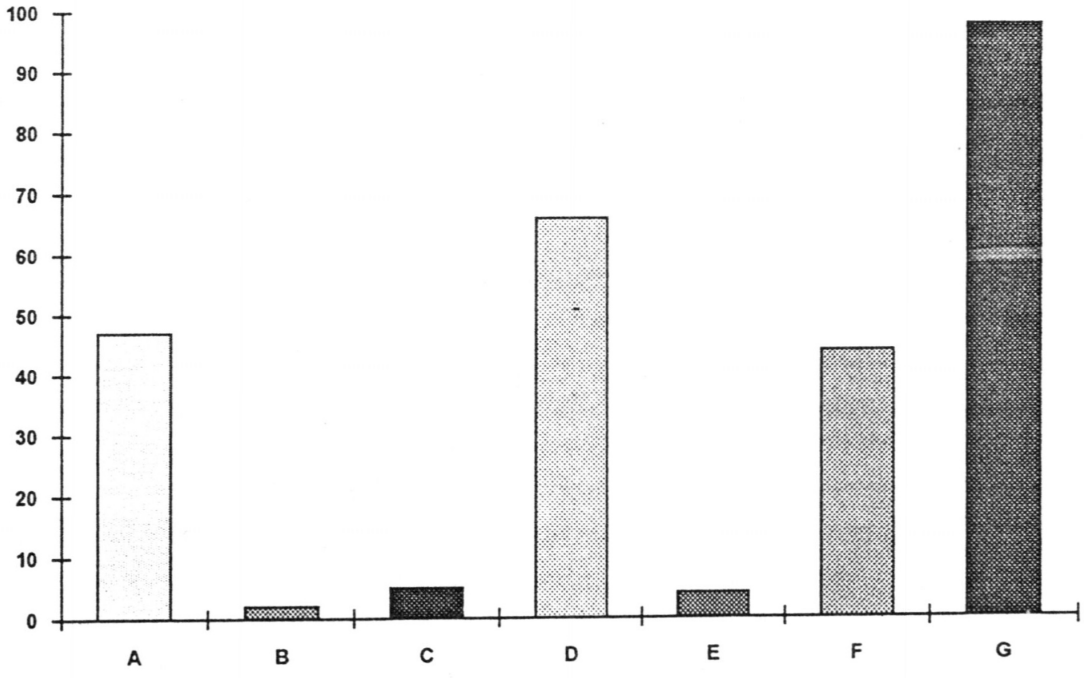

Fig. 4. Density of weevils in the forest islands of the agriculture landscape area near Poznań.
A – Wąwóz, B – Wiązowe, C – Duże-crop, E – Żalik, F – Głogowe, G – Pasowe.

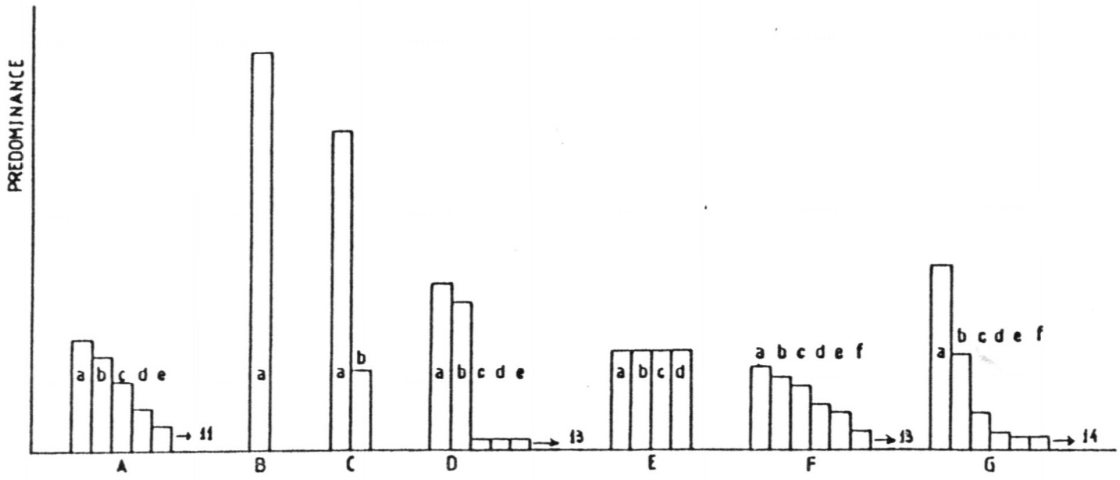

Fig. 5. Dominance structure of *Curculionidae* in the forest islands. A: Wąwóz: a–*Rhamphus pulicarius*, b–*Stereonychus fraxini* Deg., c-*S. phraxini v. flavoguttatus* Strl., d-*Ceuthorrhynchus pollinarius* Forst., e-*Rhynchaenus fagi* L.B. : Wiązowe: a-*Otiorrynchus raucus* F. C: Duże-crop: a-*Sitona lineatus* L., *Sitona flavescens* Marsh. D: Duże-forest island: a-*Sitona crinitus Herbst.*, b-*Sitona lineatus* L., c-*Sitona puncticollis* Steph., d-*Ceuthorrhynchus roberti* Gyll. *subsp. alliariae* Briss., e-*Apion urticarium* Herbst. E: Żalik: a-*Sitona lineatus* L., b-*Strophosomus melanogrammus* Forst., c-*Ceuthorrhynchus assimilis* Payk., d-*Apion urticarium* Herbst. F: Głogowe: s-*Sitona crinitus* Herbst., b-*Apion urticarium* Herbst., c-*Sitona lineatus* L., d-*Ceuthorrhynchus asperifoliarum* Gyll., e-*Smicronyx coecus* Reich., f-*Sitona flavescens* Marsh., g-*Ceuthorrhynchus floralis* Payk. G: Pasowe: a-*Sitona lineatus* L., b-*Sitona crinitus* Hbst., c-*Sitona inops* Schonh., d-*Sitona suturalis* Steph., e-*Sitona cylindricollis* Fahrs., f-*Ceuthorrhychus asperifoliarum* Gyll.

Tabela 8. List of host-plant of *Curculionidae* species in the agricultural landscape near Poznań. a = species characteristics, a1 – 0. raucus F., a2-Ph. argentatus L., a3-S. suturalis Steph., a4-Stroph. melanogrammus Forst., a5-C. glandium Marsch., a6-Ceuth. quadridens Panz., a7-Ceuth. assimilis Payk., a8-Ceuth. pollinarius Forst., a9-A. urtucarium Herbst., a10-Ceuth. posthumus Germ., a11-Ceuth. roberti Gyll., a12-Ceyth. asperifoliarum Gyll., a13-Ceuth. floralis Payk. a14-S. fracini Deg., a15-R. oxyacanthae Marsh., a16-S. coecus Reich., a17-Rh. aequatus L., a18-A. nitens Scop.; b = species of passage, b1-Ph. arborator Herbst., b2-S. flavescens Marcg., b3-S. lineatus L., b4-A. aestimatum Fst., b5-S. puncticollis Steph., b6-S. crinitus Herbst., b7-C. crux F., b8-R. pulicarius Herbst., b9-A. burdigalelense Wenck.; c = species noncharakteristics, c1-S. inops Schonh., c2-S. griseus F., c3-S. cyllindricollis Fahrs., c4-S. pellucens Scop., c5-rh. fagi L., c6-0. intrusus Reich.

Species of host plants	Species of Curculionidae
	a1Sorbus aucuparia L.
Malus silvestris	2
Sorbus aucuparia	3
Vicia cracca	4
Acer platanoides	5
Quercus sessiliflora	6
Brassica napus	7
Brassica napus	8
Urtica dioica	9
Urtica dioica	10
Capsella bursa-pastoris	11
Alliaria petiolata	12
Cynoglossum officinale	13
Sisymbrium officinale	14
Fraxinus excelsior	15
Pyrus communis	16
Cuscuta europa	17
Crataegus monogyna	18
Quercus robur	b1
Alnus glutinosa	2
Pisum arvense	3
Medicago sativa	4
Medicago sativa	5
Trifolium pratense	8
Salix viminalis	9
Medicago minima	c1
Ononis repens	2
Ononis campestris	3
Melilotus officinalis	4
Lychnis coronaria	5
Fagus silvatica	6
Unknown host	

4.7. Small mammals – *Micromammalia*

In the study period an important role in communities of small mammals ihabiting the investigated forests (C, D, E) was played by three species: *Clethrionomus glareolus*, *Apodemus flavicollis* and *A. agrarious*, which were „using" the forest islands in various ways (Tab. 9).

Tabela 9. Comparision of participation of *Micromammalia* in chosen forest island (1992-1993)

Species	Forest island											
	C (duże)			D (osikowe)			I (wiązowe)			Σ		
	Aut.	Spr.	Aut.	Aut.	Spr.	Aut.	Aut.	Spr.	Aut.	Aut.	Spr.	Aut.
	1992	1993	1993	1992	1993	1993	1992	1993	1993	1992	1993	1993
Apodemus flavicollis	16	2	41	9	2	2	4	–	2	29	4	45
Apodemus sylvaticus	2	2	1	–	1	–	–	–	–	2	3	1
Apodemus agrarius	14	–	17	4	–	11	–	–	–	18	–	28
Clethrionomys glareolus	52	9	32	2	–	5	–	–	5	54	9	42

Bank vole, most strongly associated with forest, found its optimal habitat in the object C. In the autumn 1992 its population was numerous. Despite strong pressure of predators, a part of individuals survived winter and started procreation in spring. The local population was joined by indivydual migrants from outside. Winter death toll resembled that in normal forest conditions (Gliwicz 1990). In the autumn of 1993 the vole population was smaller. It lacked the individuals which survived winter. Probably this was due to predators activity. Favourable environmental conditions of this forest island cause that, despite its small area, the population settled there has a chance to survive a whole year there. Different results were obtained in similar with respect to size but poorer forest islands in the Suwałki Landscape Park (Gliwicz 1990). Two smaller forest islands were colonized periodically by few specimens.

Forest mouse is more mobile so it is possible that a part of population marked in autumn survived till the spring of 1993, but, before starting procreation season, it had emigrated. The only female which was in the forest already in the spring

survived till autumn bearing young ones, probably numerous, since both in the spring and the autumn 1993 signs of feeding were visible on her. In the autumn of 1993 the *Apodemus flavicollis* population was numerous and obviously consisted of the indivivuals born here and of those which emigrated from the fields.

The most labile inhabitants of the forest islands are field mice. In autumn they arrived in the C and D objects from the fields in great numbert but in spring this species was totally absent there. There are probably two explanations of this fact. Before breeding season the mice, after wintering in the conditions more fabourable than in fields, return to fields or they fail to do so, because forest islands rich in food and shelters, are also inhabited by numerous predators and can be a specific trap.

The third species of *Apodemus* genus – *A. sylvaticus* appeared in a vey small number but it is worthwhile noticing that both specimens observed in autumn on the C object survived till spring. However, they had probably emigrated at the beginning of procreation seanson.

It is important to indicate total lack of the most common rodent of the Wielkopolska agrocenoses – *Microtus arvalis*. Forest communities similar to the analysed one do not constitute a danger for surrounding crops because they are not refuges of this harmful species.

For the species as *Apodemus agrarius* arriving in forest islands from fields for winter, or for these specimens of *Microtus arvalis* which seek protection there during various agrotechnical treatments, these habitats can constitute a trap where they are quite easily caught by predatory mammals.

In the studied forest island were found carnivorous mammals which undoubtfully exert considerable pressure on discussed rodent species.

Two inhabited fox (*Vulpes vulpes*) dens were found as well as numerous droppings of fox, marten (*Martes foina*) ora paolecat (*Mustela putorius*) and weasel (*Mustela nivalis*). Two weasels were accidentally caught in rodent traps. In autumn 1992 rodents were frequently stolen from the traps by carnivora. In winter 1992/1993 a survey carried out after snowfall indicated prosence of many fox traces within forest islands.

5. Recapitulations and conculusions

A relationship was found between the size of forest islands and the degree of „naturalness" expressed by the percentage of forest species and the number of natural and seminatural communities (particularly of the edge communities).

The investigated forest islands are settled by rich in species invertebrate fauna (*Acari, Araneae, Apoidea, Curculionidae*), though these habitats differ with respect to fauna composition corresponding to floristic differentiation. The greatest number of species was found in the forest enclave with the largest area. The studied forest islands also have relatively high number of invertebrate fauna as compared to, e. g. greater forest patches. In case of *Apoidea* and *Acari* record densities were found, comparable to the richest habitats of natural character. For flying insects forest islands are a permanent habitat (particularly for smaller species of wild bees and some *Curculionidae*) or a place where they appear for short time to get nectar.

Forest islands are also numerously inhabited by rodents (*Rodentia*), though species composition and number of this group of mammals is there a subject of considerable seasonal variation. The discussed field forest communities turn out to be particularly intensively colonized and penetrated by predatory mammals (*Carnivora*) while *Insectiovora* appear in small numbers. The function of forest islands in life of various mammal species is different. For example, for *Clethrionomys glareolus* they are a permanent habitat and for other species – a temporary refuge (e. g. for *Apodemus agrarius*) while in case of *A. flavicollis* and *A. sylvaticus* some individuals live permanently in small forest islands and others use them only temporarily. The most common rodent of agrocenoses – *Microtus arvalis* was not observed in the forest islands. Hence it can be concluded that field forest enclaves similar to the analysed ones do not constitute a threat for adjacent fields as a refuges of this harmful species. In turn, *Apodemus agrarius* arriving in forest islands for winter or *Apodemus agrarius* seeking shelter on their edges during agrotechnical treatments, are an easy prey for carniverous mammals.

Both the intensity and coincidence of these phenomena indicates a very strong penetration by and numerous presence of *Carnivora* in the forest islands.

The formation of the landscape according to the reguirements of the present ecological knowledge should strive to preserve (or reconstruct) its mosaic character. In areas, where agricultural land dominates, the elements of arborescent plants, should be absolutely protected and fragments of balks should be laft unutilized.

Streszczenie

Badaniami objęto dziesięć wysp leśnych w krajobrazie rolniczym położonym w otulinie parku Krajobrazowego Puszcza Zielonka (15 km połudn. wsch. od Poznania). Omawiany obszar, aczkolwiek niewielki powierzchniowo (ok. 1200 ha), cechuje się zróżnicowaną rzeźbą terenu i bogatą siecią zadrzewień śródpolnych. Wykształcone są one przede wszystkim w postaci remiz o niewielkich powierzchniach, najczęściej o obwodzie 100-200 m. Te niewielkie kępy drzew porastających dziś zagłębienia terenowe lub niewielkie wzniesienia nie były użytkowane rolniczo. Przeważają siedliska ubogich serii grądów *Galio Sylvatici-Carpinetum* (Wojterski i inni 1982). Niewielkie powierzchnie zajmują potencjalne siedliska boru mieszanego *Pino-Quercetum*. Jedynie wzdłuż dopływów rzeczki Głównej i w niewielkich obniżeniach terenowych stwierdzono siedliska łęgowe: *Circaeo-Alnetum* i *Ficario-Ulmetum* campestris oraz niewielkie powierzchnie żyznego lasu – *Ribo Nigri-Alnetum*. Stwierdzono związek pomiędzy wielkością wysp leśnych i stopniem naturalności, wyrażonej udziałem gatunków leśnych i liczbą zbiorowisk o charakterze naturalnym i seminaturalnym, szczególnie zespołów okrajkowych.

Badane wyspy leśne zasiedla bogata gatunkowo fauna bezkręgowców (*Acari, Araneae, Apoidea, Curculionidae*), chociaż środowiska te różnią się między sobą składem fauny, odpowiednio do bogactwa zróżnicowania florystycznego. Największą liczbę gatunków stwierdzono w zadrzewieniu powierzchniowo największym. Badane wyspy leśne odznaczały się także stosunkowo wysoką liczebnością fauny bezkręgowców, w porównaniu np. do większych powierzchni leśnych. W przypadku *Apoidea* i *Acari* uzyskano rzadko spotykane gdzie indziej zagęszczenia. Wyspy leśne są stałym miejscem życia, zwłaszcza dla mniejszych form (dzikich pszczół i niektórych *Curculionidae*) lub też miejscem, gdzie przebywają krótko dla zdobycia pokarmu.

Wyspy leśne są licznie zamieszkiwane przez gryzonie i intensywnie penetrowane przez ssaki drapieżne. Rola tych wysp dla poszczególnych gatunków ssaków jest zróżnicowana. Dla nornicy rudej są miejscem, w którym większość osobników lokalnej populacji spędza całe życie. Dla myszy polnych są raczej okresowym schronieniem przyciągającym liczne osobniki jesienią a opuszczanym późną wiosną. Myszy leśne licznie emigrują (lub giną w inny sposób) z zadrzewień na początku sezonu rozrodczego, lecz część populacji zostaje w nich przez całe lato, tu się rozmnaża i stąd podejmuje dalekie wypady na pola w celu zdobycia pożywienia. Jesienią do miejscowej populacji dołączają osobniki napływowe. Dla ssaków drapieżnych zadrzewienia są miejscem zakładania gniazd i wychowywania młodych, a drobne ssaki tutaj przebywające stanowią dla nich pewną rezerwę pokarmową.

Godne uwagi jest to, że w badanych wyspach leśnych nie odłowiono wcale nornika zwyczajnego. Nie stanowią one zatem refugium dla tego szkodliwego dla rolnictwa gatunku. Mogą one być natomiast dla niego swoistą pułapką, z której pojedyncze okazy chroniące się tu w czasie zabiegów agrotechnicznych są szybko wyławiane przez drapieżniki.

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