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INVESTIGATION OF GENETIC RESOURCES OF ORNAMENTAL WOODY PLANTS IN LITHUANIA IN 1998-2002

Audrius Skridaila, Jonas Naujalis, Darius Ryliškis, Valerija Baronienė, Valentinas Cirtautas, Tomas Kuisys

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The article deals with investigation of genetic resources of ornamental woody plants in Lithuania in 1998-2002. The goals of this studying - investigations of woody plants in the biggest collections managed by three scientific institutions of Lithuania, inventory of old trees in manor parks, and compiling a list of most valuable ornamental woody plants of Lithuania.

Key words: ornamental woody plant, genetic resources of Lithuania, old parks, botanical gardens

Audrius Skridaila, Vilnius University Botanical Garden, Kairėnų -43, LT - 2040 Vilnius; e-mail audrius.skridaila@gf.vu.lt

Introduction

In 1998-2002 the Lithuanian National Scientific Research Programme - Genetical Resources of Plants and Animals in Lithuania (Genefund) - has been carried out One theme of this Programme encompassed conservation and research of genetic resources of ornamental woody plants. Three Lithuanian scientific institutions deal with this theme: Botanical gardens of Vilnius and Kaunas universities and Dubrava Arboretum of the Lithuanian Forest Tree Breeding and Seed Farming Centre. The goals of the team studying ornamental woody plants were as follows: investigations of woody plant collections managed by the three institutions, inventory of old trees in manor parks, and compiling a list of most valuable ornamental woody plants of Lithuania.

Matherials and methods

The research was carried on in two subthemes: (1) investigations of ornamental woody plants in the botanical gardens of Vilnius University (VU) and Vytautas Magnus University (VMU) in Kaunas and Dubrava Arboretum of the Lithuanian Forest Tree Breeding and Seed Farming Centre; (2) observations in old parks and other Lithuania's green stands.

During the first stage, investigations on ornamental woody plants of 493 taxa, 14 genera and 7 families (557 specimens) have started in 1998:

- Vilnius University Botanical Garden: woody plants of 6 genera (85 taxa of Chamaecyparis L.; 28 taxa of Cotoneaster L.; 8 taxa of Hydrangea L.; 45 taxa of Rosa L.; 76 taxa of Syringa L.; and 12 taxa of Viburnum L. genera). All in all - 254 taxa;

- Botanical Garden of Vytautas Magnus University in Kaunas: also 6 genera (20 taxa of Abies L.; 17 taxa of Euonymus L.; 45 taxa of Juniperus L.; 27 taxa of Potentilla L.; 26 taxa of Spiraea L.; and 42 taxa of Thuja L. genera). All in all - 177 taxa.

- Dubrava Arboretum of Lithuanian Forest Tree Breeding and Seed Farming Centre: 2 genera (40 taxa of Picea L., and 29 taxa of Pinus L.). All in all - 69 taxa.

In order to make reliable assessment of plant adaptation and cultivation prospects in Lithuania, the same unified description scheme has been used in both subthemes: detailed certificate data were obtained for separate specimens (description of plant origin and taxonomy), as well as taxation data were collected and evaluation of generative maturity of plants was done.

The gene fund available at scientific research institutions was studied in a more detailed way about blossom, fruiting and resistance of plants to winter conditions; also damage done by frosts and cases of consorts manifestation were registered, etc. (Naujalis, Skridaila 2001). Studying old park plants, the research scheme was modified due to a broad dispersion of material. In the latter case, the data were collected from whole area of Lithuania; therefore, only single inventory of the plants was done. In exceptional cases, when unique or highly valuable plants were detected, their state was checked several times and more material was taken for propagation.

Certificate data of plant samples were collected according to a scheme recognised internationally (International Transfer... 1992). The taxation data about plants were collected according to schemes applied in international silviculture and botanical gardens, as well as those used for monument plants (Januškevičius, Budriūnas 1987).

Resistance of coniferous plants to winter conditions was evaluated according to a 7-point scale proposed by dendrologists of the Main Botanical Garden of Russian Science Academy. Winter resistance of deciduous plants was assessed according to an original 10-point scale proposed by E. Navys (2000).

Blossoming and fruiting of ornamental woody plants were assessed and manifestation of consorts was fixed according to schemes approved in Lithuania (Baronienė 2002).
All research data are stored in computerised databases of botanical gardens at Vilnius and Kaunas universities and Dubrava arboretum. The analysis of information collected in a five-year period enabled to compile a gene fund list of most valuable ornamental woody plants in Lithuania. The list comprises specimens, which are cultivated in Lithuania at least for 10 years.

Results

The investigations performed in the botanical gardens of Vilnius University and Vytautas Magnus University in Kaunas as well as Dubrava arboretum

In 1998-2002, 146 specimens of taxa introduced into the list of the most valuable ornamental woody plants were selected in VU Botanical garden, Kaunas VMU Botanical Garden and Dubrava arboretum. Additional group of 115 taxa was studied as potential candidates to supplement the above-mentioned list. These plants are resistant to Lithuania's climate and ornamental, but their cultivation in Lithuania lasted less than 10 years.

From VU Botanical Garden the most valuable plants of the following taxa were selected in 1998-2002: *Chamaecyparis* Spach. genus (10 specimens), *Cotoneaster* Medik. (4), *Hydrangea* L. (2), *Rosa* L. (10), *Syringa* L. (14), *Viburnum* L. (2), and 48 taxa (48 specimens) as potential candidates to the list. These plants are ornamental, resistant to Lithuanian climatic conditions and consorts, but their age does not reach 10 years, therefore they were included into a separate list of candidates.

From Kaunas VMU Botanical Garden the following most valuable specimens were selected: *Abies* Mill. (3), *Juniperus* L. (4), *Thuja* L. (5), *Euonymus* L. (2), *Potentilla* L. (5), and *Spiraea* L. (9) - all in all 28 samples representing 28 species, subspecies and cultivars. All these plants were of good or very good state, resistant to winter conditions, diseases and pests. Their age ranged from 10 to 71 years. Additionally 31 plant samples of 24 species and lower taxa ranks will be studied further. These plants are also of a very good state, resistant to unfavourable environment factors, but younger than 10 years (Table 1).

Table 1. Ornamental woody plants grown in the botanical gardens of Vilnius University and Kaunas Vytautas Magnus University and Dubrava Arboretum (1998-2002)

No	Name of genus	Number of taxa						Researches carried on in institutions
		research started in 1998	rejected (-) from or added (+) to the list after 1998-2000	researches carried on after 2000	rejected (-) from or added (+) to the list after 2001-2002	included into the list of most valuable plants after researches in 1998-2002	specimens candidates to the genefund list*	
				PINOPHYTA				
1.	*Abies* Mill.	20	-10	10	–	3	7	KVMU BG
2.	*Chamaecyparis* Spach.	82	-63	19	–	10	9	VU BG
3.	*Juniperus* L.	45	-23	22	-1	4	17	KVMU BG
4.	*Picea* L.	40	+2	42	+9	46	5	Dubrava Arboretum
5.	*Pinus* L.	29	+1	30	-2 /+12	31	11	Dubrava Arboretum
6.	*Thuja* L.	42	-28	14	-8	5	1	KVMU BG
	Total	**258**	**-121**	**137**	**-3 /+21**	**99**	**50**	
				MAGNOLIOPHYTA				
1.	*Cotoneaster* Medik.	28	-18	10	–	4	6	VU BG
2.	*Euonymus* L.	17	-9	8	-1 /+2	2	6	KVMU BG
3.	*Hydrangea* L.	8	-5	3	+1	2	2	VU BG
4.	*Potentilla* L.	27	-2	25	-5	5	15	KVMU BG
5.	*Rosa* L.	45	-22	23	–	10	13	VU BG
6.	*Syringa* L.	76	-28	48	-18	14	16	VU BG
7.	*Spiraea* L.	26	-14	12	+2	9	5	KVMU BG
8.	*Viburnum* L.	8	-5	3	–	1	2	VU BG
	Total	**235**	**-103**	**132**	**-24 /+5**	**47**	**65**	
	Total in both divisions	**493**	**-224**	**269**	**-27 /+16**	**146**	**115**	

Notes. * column 8 includes specimens candidates to the list of the most valuable plants, which grows in Lithuania up to 10 years.

Abbreviations: KVMU BG - Kaunas Vytautas Magnus University Botanical Garden, VU BG - Vilnius University Botanical Garden

Table – 2. Most valuable ornamental woody trees in old parks of manors, forests and other green plantations of Lithuania. Inventory results (1998-2002)

No.	Name of genus	Numbers of taxa (specimens) by different groups of value				
		trees unique or very rare in Lithuania	trees of especially dimensions	trees of other especially characteristics*	total in all groups by inventory	included into the list of genefund
				PINOPHYTA		
1.	*Abies* Mill.	2(5)	5(42)		7 (47)	7 (47)
2.	*Ginkgo* L.	1(1)			1 (1)	1 (1)
3.	*Juniperus* L.	1 (1)			1 (1)	1 (1)
4.	*Larix* Mill.	1 (3)	4(65)		5 (68)	5 (53)
5.	*Metasequoia* Hu et W. C. Cheng	1(1)			1 (1)	1 (1)
6.	*Picea* A. Dietr.	7(16)	4(19)		11 (35)	11 (35)
7.	*Pinus* L.	5(25)	5(110)	1(50)	10 (185)	10 (125)
8.	*Pseudotsuga* Carriere		2(15)		2 (15)	2 (15)
9.	*Taxodium* Rich.	1(2)			1 (2)	1 (2)
10.	*Taxus* L.	2(4)			2 (4)	2 (4)
11.	*Thuja* L.		2(10)		2 (10)	2 (10)
12	*Tsuga* (Endl.) Carriere		1(20)		1 (20)	1 (20)
	Total	21 (58)	23 (281)	(50)**	44 (389)	44 (314)
				MAGNOLIOPHYTA		
1.	*Acer* L.	3(6)	5(16)		8 (22)	8 (22)
2.	*Aesculus* L.	2(3)			2 (3)	2 (3)
3.	*Betula* L.	1(2)	1(1)		2 (3)	2 (3)
4.	*Carpinus* L.		2(3)		2 (3)	2 (3)
5.	*Catalpa* Scvop.	2 (2)			2 (2)	2 (2)
6.	*Coryllus* L.	1 (3)	1(1)		2 (4)	2 (4)
7.	*Fagus* L.	1(7)	1(16)		2 (23)	2 (23)
8.	*Fraxinus* L.		3(13)		3 (13)	3 (13)
9.	*Gleditsia* L.		1(1)		1 (1)	1 (1)
10.	*Juglans* L.	1 (1)	2(15)	1(1)	3 (17)	3 (17)
11.	*Liriodendron* L.	1(3)			1 (3)	1 (3)
12.	*Phellodendron* Rupr.		1(4)		1 (4)	1 (4)
13.	*Populus* L.		6(39)		6 (39)	6 (39)
14.	*Quercus* L.	2(5)	3(18)		5 (23)	5 (23)
15.	*Tilia* L.	2(4)	2(8)		4 (12)	4 (12)
16	*Ulmus* L.	2(2)	1(7)		3 (9)	3 (9)
	Total	18 (38)	29 (142)	1(1)	47 (181)	47 (181)
	Total in both divisions	39 (96)	52 (423)	1 (51)	91 (570)	91 (495)

From Dubrava Arboretum, in 1998-2002, 77 taxa specimens, including *Picea* L. (46) and *Pinus* L. (31) as most valuable woody plants, were selected. Additionally, 16 taxa specimens were included into the candidate list, since their age was less than 10 years. All they were resistant to winter (1 point) and spring frosts. These plants were mainly resistant to pests and fungal diseases. It was determined, however, that plants of two pine species - *Pinus sibirica* and *Pinus rigida* - are often affected by root cancer, therefore they were not included into the lists of most valuable plants or ornamental planting (Cirtautas 1998,2000, 2001).

In 1998-2002, the inventories of the most valuable ornamental woody plants growing in 213 old parks and other stands were compiled (Januškevičius 2002a, 2002b). These plants were attribute to 3 groups:

1. Plants rare and unique for Lithuania (e.g., *Ginkgo biloba* L., *Abies concolor* (Gordon et Glend.) Lindl. ex Hildebr., *Tsuga canadensis* (L.) Carr., *Liriodendron tulipifera* L., *Catalpa bignonioides* Walter, and *C. ovata* G. Don) - inventories of 96 specimens belonging to 39 taxa of 20 genera (including 58 specimens of 21 taxa and 9 genera of Pinophyta plants, and 38 specimens of 18 taxa of 11 genera of Magnoliophyta) were compiled.

2. Introduced and local trees and bushes grown often in the green stands (e.g., *Pinus strobus* L., *Larix decidua* Mill., *Aesculus hippocastanum* L., *Fagus sylvatica* L., *Fraxinus excelsior* L., and *Quercus robur* L.), which reached mature age and are notable for their impressive size (corresponding to a category of trees - nature monuments) and good state. This trop comprises 423 specimens of 52 taxa and 18 genera (including 281 specimens of 23 taxa of 7 genera of Pinophta, and 142 specimens of 29 taxa of 13 genera of Magnoliophyta).

3. Plants, which were found to be especially resistant to climate, diseases spread in Lithuania, etc. So, in Valkininkai forestry a whole stand of Weymouth pines (*Pinus strobus* L.) was detected with no pines damaged by Weymouth rust, although many pines in Lithuania are affected by this disease. All in al, in old parks of Lithuania and other stands, in 1998-2002, inventories of 570 plants belonging to 91 taxa and 28 genera were made. After the inventory data were analysed, a bit lower number of plants (495) were introduced into the gene fund of Lithuanian plants. By the way, checking plants in old parks (in 2001) a 100-year old maple *Acer campestre* 'Postelense' was detected (Geldren, De Jong et all 1994) it that had not been described in Lithuanian dendrologic literature before (Skridaila 2002). In 2002 it was propagated by grafting, now its clones are growing in 3 dendrologic collections of Lithuania. Performing inventory of old parks and other stands, interesting spruce and pine mutants were also detected; they are propagated and now being under investigation in VU Botanical Garden.

Only 8% (16) of the old parks studied in Lithuania were found to be well run - plants are healthy and vital, they blossom and give fruits. The state of plants in other parks, forlorn, left without care, is considerably worse. There is a risk of devastation and even extermination liquidation of tress and bushes.

Conclusions

1. In 1998-2002, in Vilnius and Kaunas Vytautas Magnus universities botanical gardens and Dubrava Arboretum specimens of most valuable ornamental woody plants belonging to 146 taxa of 14 genera have been investigated and selected, as well as introduced into the list of gene fund of Lithuanian plants. They will be studied further, and the most valuable specimens will be cloned and spread.

2. Additional 115 specimens, as candidates to the genefund, are expected to be introduced into the list after extra examination, when their cultivation in Lithuania exceeds 10-year period.

3. In old Lithuania's parks and stands, in 1998-2001, the inventory for 570 plants belonging to 91 taxa of 28 genera have been done, including 495 plants introduced into the gene fund list of most valuable plants in Lithuania. These plants make the most valuable part of ornamental woody plants in Lithuania. Their conservation will be guaranteed only in the case if they are propagated, their clones collected and protected in the bases of Lithuanian research institutions.

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HOW BIRDS ARE INFLUENCED BY GREEN TREE RETENTION IN CLEAR-CUTS?

Gediminas Brazaitis, Kęstutis Pėtelis

Brazaitis G., Pėtelis K. 2003. How birds are influenced by green tree retention in clear-cuts? *Acta Biol. Univ. Daugavp. 3 (2): 79 - 89.*

This study was made in southwestern Lithuania (54.4-55.1 o N; 23.2-24.2o E). We analyzed 164 clear-cut areas (0.5-20.0 ha) covering a total area of 546 ha. The number of bird species in clear-cut differed significant between density groups of large residual trees ($F=3.9$; $p<0.005$) as well as all residual trees ($F=2.92$; $p<0.05$). The highest number of species was observed in clear-cuts with 0.1-1.0 tree/ha as well as lowest in 5.1-10 trees/ha clear-cuts. The number of bird species in clear-cut areas didn't differ among density groups of small residual trees ($F=0.17$; $p<0.95$). The total density of birds in clear-cut area didn't differ among density groups of large ($F=2.19$; $p<0.1$) and small residual trees ($F=1.35$; $p<0.25$) as well as total density of residual trees ($F=1.61$; $p<0.17$). The Shannon-Weaver diversity index of bird community is stable while the density of large residual trees increase up to four per 1 ha. The lower values of index observed in the areas with higher density of residual trees. The influence of decrease of clear-cut size to bird community is similar as effect of large green tree density increase. The increase of residual tree density positive influenced later successional, but negative open areas species. The increase of edge species observed with the rise of the density of clear-cut residual trees up to 1-5 tree / ha.

Key words: residual tree, green tree retention, bird community, clear-cut

Gediminas Brazaitis, Kęstutis Pėtelis; Department of Silviculture, Lithuanian University of Agriculture, Studentu 11, Akademija-Kaunas, LT-4324, Lithuania; gebra@info.lzua.lt

Introduction

One of main factor influencing the abundance and regional distribution of forest birds is harvesting of mature forest stands (Virkkala 1987; Haila et al. 1994; Mönkkönen & Welsh 1994; Edenius & Elmberg 1996). Shorter rotation of stands and economic use of forest products reduce the number of hollow trees and large-branched trees suitable for hole nesters and big birds of prey (Shaw & Dowell 1990). Many researchers agree that to avoid such problems, forestry must imitate natural forest disturbance regimes (Niemi & Probst 1990; Hunter 1993, Angelstam & Mikusinski 1994; Hejl 1994). It is recommended that green and dead trees, groups of trees and small forest patches were retained in clear-cuts (Angelstam & Pettersson 1997; Fries et al. 1997; Schulte & Niemi 1998). Recently green tree retention has become an important management tool, but its ecological significance is still poorly known (Vanha-Majamaa & Jalonen 2001).

Green tree retention has three major objectives: (1) "life boating" species and processes over the regeneration phase, (2) increasing structural variation in the tree level of stand, and (3) enhancing connectivity on a landscape level (Franklin et al. 1997) by making the area between patches more favourable for movement (Bunnell 1999). The impact of green tree retention can be classified into two kinds of effects:, i.e. (1) a long-term effect that should be congruous with the life span of the new stand or longer, and (2) a short-term effect that mitigate the problem that the first succession stage after harvesting differs considerably compared to later stages.

The aim of this paper is to analyze the influence of green tree retention on bird communities in early successional clear-cut areas.

Methods

This study was made in southwestern Lithuania (54.4-55.1 o N; 23.2-24.2o E). Phytogeographically the study area was located in the transitional zone between the temperate lowland and hemiboreal forests (Ahti et al 1968; Natkevičaitė-Ivanauskienė 1983). The dominating tree species in study area as well as in investigated clear-cuts were Aspen Populus tremula, Birch Betula pendula, Black alder Alnus glutinosa, Hornbeam Carpinus betulus, Ash Fraxinus excelsior and Oak Quercus robur. Coniferous species were not common in the study area except for a few stands, which were omitted in this study. The presence of Scots pine Pinus sylvestris and more than 20% of Norway spruce Picea abies was avoided in the sampled mature forest stands.

Totally we analyzed 164 clear-cut areas (0.5-20.0 ha) covering an area of 546 ha. The borders of clear-cuts were coincident with the margins of the individual study sites. We have defined three groups of clear-cut sizes: small (0-2.0 ha), middle (2.1-5.0 ha) and large (5.1 ha and more). The clear-cuts ages were grouped into fresh (1-3 yr.), middle aged (4-6 yr.) and old (7-15 yr.).

Birds were counted by two-time mapping method (Brazaitis & Kurlavičius, in press), which is similar to the well-known standard mapping method (Tomialojc 1980; Pridnieks et al. 1986; Bibby et al. 1992). The main difference is that census plots were visited twice. Two time mapping had excellence on evaluating bird communities in relative small or medium sized irregular shape counting plots because of better possibility to detect birds location and avoid registrations that are outside plot as well as with the same efficiency evaluate whole area. The inventory started at 10th of April and lasted up to mid June. The first visit was performed before 15 May and the second visit later. Visits lasted up to 4.5 hours after sunrise. Inventories were made under clear, sunny and calm weather conditions without rain. The inventory speed was 8-10 ha/h. Simultaneous registration of same species birds was used to separate neighboring territories on one visit. The total number of breeding territories was estimated considering the distance between registered birds on separate visits. When distance was larger than the average width of breeding territory, two territories were noted, otherwise one breeding territory was identified. Scientific and English bird names, acronyms of studied bird species are presented in appendix 1.

Residual trees in the study area mostly were dispersed equally. Oak and ash were the dominating residual tree species. Residual tree density was estimated by counting the large and small trees on each investigated clear-cut area. Large trees were defined as trees with diameter of stem larger than 20cm. Small trees had a diameter of stem smaller 20 cm but height of tree larger 8m. Area and age of clear-cut areas were estimated from special forest maps used for forest management purposes.

One way and two-way ANOVA (F test) was used for hypothesis testing. Correlation between variables was estimated with Pearson correlation coefficients. Multivariate statistics direct gradient analysis method Canonal correspondence analysis (CCA) was used to estimate the influence of weather conditions to woodcock roding on the peak. As the result of CCA analysis biplot were performed. In the biplot factors are showed as vectors. Longer vectors are more important. The factors are not correlating if the angle between vectors is 90?. The decrease of the angle between vectors shows positive correlation as well as increase up to 180? - negative. The variables are plotted as swarm. The distance between variables shows dissimilarity: similar variables are plotted close to each other. The influence to each of variable could be described drawing a perpendicular from variable point to the vector. The influence of factor is higher if perpendicular falls in longer section.

Bird species distribution in relation to green tree retention was analyzed by coefficient of indicator value IndVal (Dufrene & Legendre 1997). IndVal analysis defines interval of characteristic factor values for each bird species. This method has advantages because of consideration relative abundance with it relative frequency of occurrence in the various groups of sites. IndVal was ranged within the pale from 0 to 100. Index was at the maximum when the individuals of species are observed in all sites of only one site group. The statistical significance of the species indicator values was evaluated using randomization procedure Monte Carlo test. PC-ORD software was used for IndVal calculation (McCune & Mefford 1997).

We ranged residual tree density values into 5 groups: 0; 0.1-1.0; 1.1-5.0; 5.1-10.0; 10.1-30.0 trees/ha. We analyzed the difference of bird species between all possible dichotomy grouped cases. If IndVal coefficients differed significantly or difference between designed groups, representing species, was 100% or more we assumed bird species preference to selected category.

All bird species in relation to their distribution status classified into four categories: (1) bird species that were typical to clear-cuts without or with relatively low residual tree density. Green tree retention had a negative influence; (2) bird species that were typical to clear-cuts with relative high residual tree density. Green tree retention had a positive influence; (3) bird species that were typical to clear-cuts with relative low or moderate residual tree density, with exception of clear-cuts without or with highest tree density; (4) bird species that were not influenced by green tree retention.

Results

Green tree retention and clear-cut size, canopy height

The density of large green trees didn't significantly differ in clear-cuts with various sizes

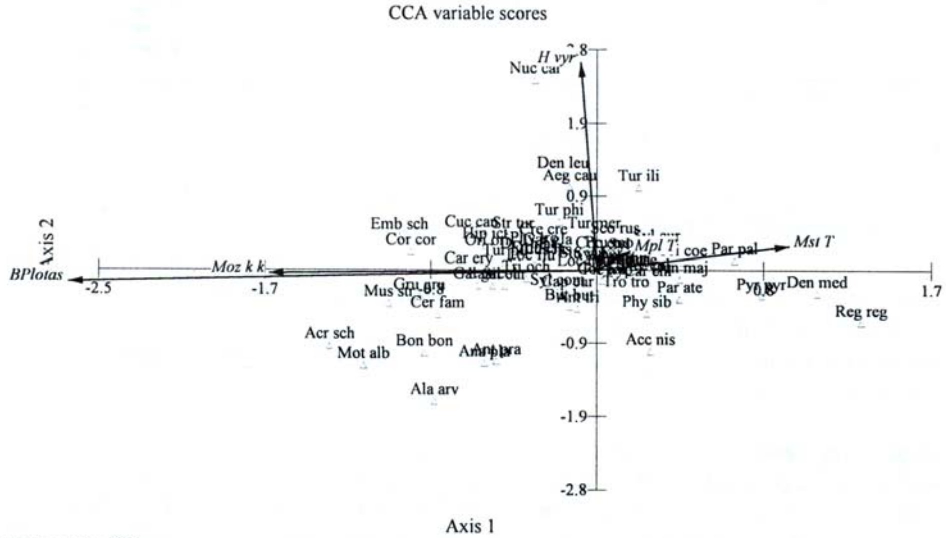
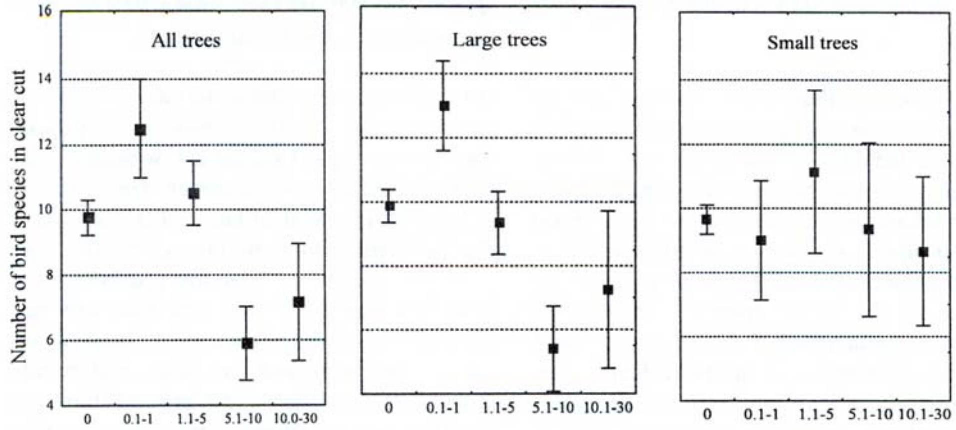


Fig. 1 The influence of large green trees (*Mst T*), clear-cut size (*BPlotas*), canopy height (*Hvyr*) and shape coefficient (*Moz K K*) to bird species in the clear-cut areas (CCA analysis biplot).



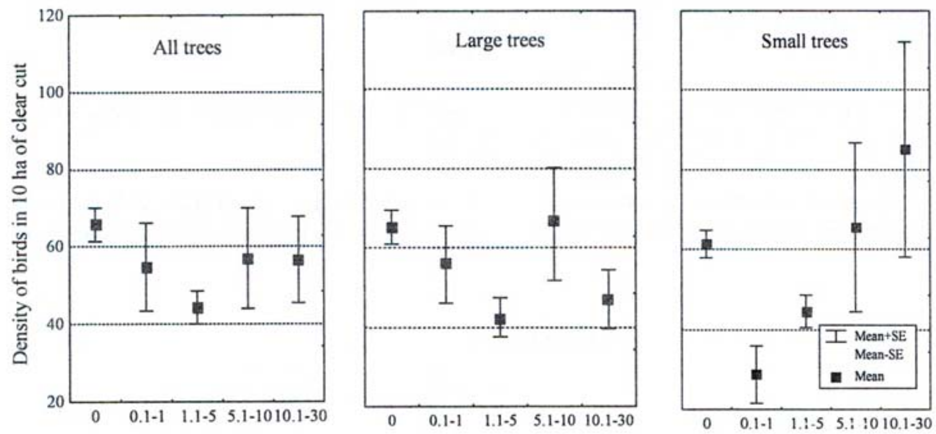


Fig. 2. Influence of large, small residual tree and their total density in clear-cuts to the number of bird species and the total density of birds.

(F=0,64, df=3; p<0.59) as well as the density of small green trees (F=0,70, df=3; p<0.55). Moreover, we found that the densities of large and small trees are independent (F=1.78, df=4; p<0.14).

Large residual tree density has opposite influence to bird species as clear-cut area (Fig. 1). The influence of decrease of clear-cut size to bird community is similar as effect of large green tree density increase (axis 2). The canopy height vector is perpendicular to discussed above factor vectors and influencing independently.

Green tree retention and the number of bird species

The number of bird species in clear-cut differed significant between density groups of large residual trees (F=3.9, df=4; p<0.005). The highest number of species was observed in clear-cuts with 0.1-1.0 tree/ha as well as lowest in 5.1-10 trees/ha clear-cuts (Fig. 2). The number of bird species in

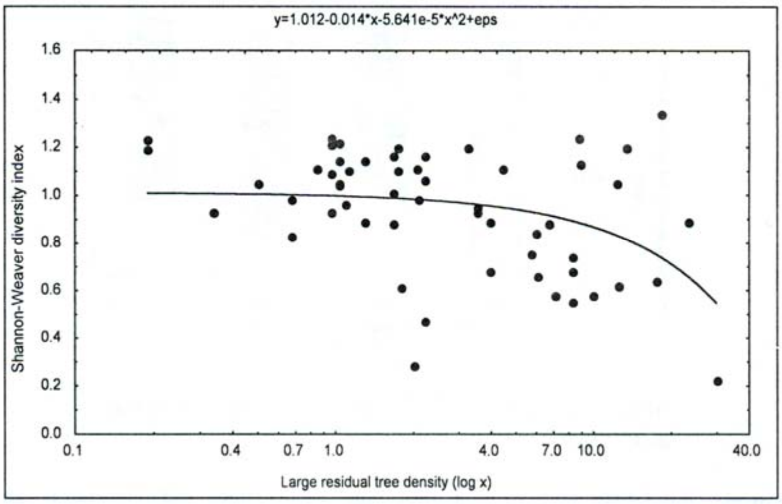


Fig. 3. Influence of large residual tree density to Shannon-Weaver diversity index of clear-cut bird community.

clear-cut area did not differ among density groups of small residual trees ($F=0.17$, $df=4$; $p<0.95$). The number of bird species in clear-cut areas significant differed in density groups of all residual trees ($F=2.92$ $p<0.05$). The variation character of this factor was similar to large residual trees (Fig. 2).

Green tree retention and the total density of breeding birds

The total density of birds in clear-cut area did not differ among density groups of large residual trees ($F=2.19$, $df=4$; $p<0.1$) as well as among density groups of small residual trees ($F=1.35$, $df=4$; $p<0.25$) and all residual tree density ($F=1.61$, $df=4$; $p<0.17$).

Shannon-Weaver diversity index

The Shannon-Weaver diversity index of bird communities is stable while the density of large residual trees increase up to four per 1 ha (Fig. 3). The Shannon-Weaver diversity index is lower in the areas with higher density of residual trees. The lowest value of this index observed in area with 30 tree / ha.

Green tree retention and bird species

The distribution of 33 species was related to the density of large residual trees. Most of species were typical for some contiguous residual tree density categories (Tab. 1).

Large green tree retention had a negative influence on such bird species (1): Snipe, Tree pipit, Robin, Song thrush, Wren, Sedge warbler, River warbler, Whitethroat, Garden warbler, Yellowhammer. Among the species that are negative influenced by green tree retention dominated bird species typical for open areas (Fig. 4). Bird species of later successional forest stages showed lowest rate.

Large green tree retention had a positive influence on such bird species (2): Turtle dove, Hazel grouse, Great spotted woodpecker, White-backed woodpecker, Thrush nightingale, Lesser whitethroat, Chiffchaff, Nuthatch, Nutcracker, Goldcrest, Great tit, Coal tit, Marsh tit, Chaffinch.

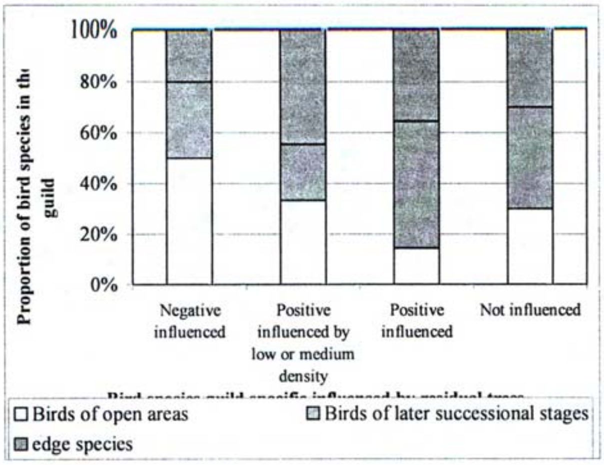


Fig. 4. The proportional differences of open areas, later successional and edge species among various bird species guilds

Among the species that are positively influenced by green tree retention dominated typical for later successional stages. Bird species typical for open areas showed lowest proportion.

Bird species that were typical to clear cuttings with relative low or moderate density of large residual trees (3): Common crane, Cuckoo, Blackbird, Fieldfare, Marsh warbler, Willow warbler, Raven, Jay, Starling. Among the species that are typical to the clear-cuts with low or moderate density of large residual trees dominated edge bird species, but the amount of open areas species are larger later successional stages species.

Bird species for which green tree retention had no influence (4): Mallard, Lesser spotted eagle, Buzzard, Woodpigeon, Green sandpiper, Black woodpecker, Red-backed shrike, Spotted flycatcher, Redwing, Grasshopper warbler, Icterine warbler, Blackcap, Dunnock, Long-tailed tit, Blue tit, Golden oriole, Goldfinch, Common rosefinch, Hawfinch and Reed bunting. Among the species that are not influenced by green tree retention all three guilds of birds are showed close to even proportions (birds of open areas, birds of later successional stages, edge species).

The increase of green residual tree density influencing later successional, open areas and edge species ratio (Fig. 5). Bird species of open areas are mostly typical for clear-cuts without residual trees. Half of all typical bird species are classified as open area bird species on this clear-cut category. Increase of the density of residual trees negatively influencing birds of open areas. Only 15% of all typical bird species are open area bird species in the clear-cuts with high amount of residual trees. Positive influence of residual trees to later successional stage bird species is observed. The amount of typical bird species increase from 15% in clear-cuts without residual trees up to more that 50% in clear-cuts with more than 5 residual trees / ha. The increase of edge species is observed with the rise of the density of clear-cut residual trees up to 1-5 tree / ha.

Discussion

The increase of green residual trees changes the composition of bird species in the clear-cut. The equal management of all cleared areas decreases the breadth of ecological niche and some species cannot find optimal environmental conditions. If we want improve environmental conditions for all (most) of bird species, avoiding future extinction, we need to plan multi-species management in the landscape. It means that diversity of environmental conditions (vegetation, size, residual trees density) must be diverse in clear-cut scale, but landscape unit should supply favourable habitat for all (most) bird species.

The long-lasting value of green tree retention to bird communities are also important. Intensive forestry dominated by a clear-cutting management system changes the stand structure of the forest landscape. Old-growth forest bird species are adapted to dominating uneven-aged stands with plenty of over-mature and dead trees. Such components are lacking in managed even-aged stands. Consequently, green tree retention is of high value for old-growth forest bird species during all stand rotation cycle. Diversity of environmental conditions is getting favourable for bird species with the high-specialized requirements.

Large trees with big branches are necessary for large raptor nests (Petty 1998). However, large raptors have requirements not only for the nesting tree, but also for the stand surrounded nesting place too, as well the landscape in which they hunt. Most of them inhabit middle-aged or older stands (Skuja & Budrys 1999). Relative tree mortality depends on size of the residual tree (Peltola et al. 1999). Smaller trees have higher probability survive up to period, when stand will satisfy environmental requirements for rare raptors. Hardwoods and pine are more important than softwood tree species.

Over-mature and dead trees is necessary habitat component for woodpeckers and others hollow nesters (Amcoff & Eriksson 1996; Fernandez & Azkona 1996; Pasinelli 2000). Green tree retention for cavity nesters should be appreciable up to regenerated stand will fill the gap without large softwood that fit for cavities. The length of period depends on a tree species composition and geographical position influencing growing rate of trees. It varies between 40-70 years. Large green tree retention without small trees in clear-cut areas would not fulfill long-term function for cavity nesters, because of susceptibility to windthrow (Arnott & Beese 1997). Softwood tree species has priority. Aspen is recommended because of importance to many declining beetle, lichen and bryophyte too (Siitonen & Martikainen 1994; Kuusinen, 1996).

Green tree retention in groups has advantages

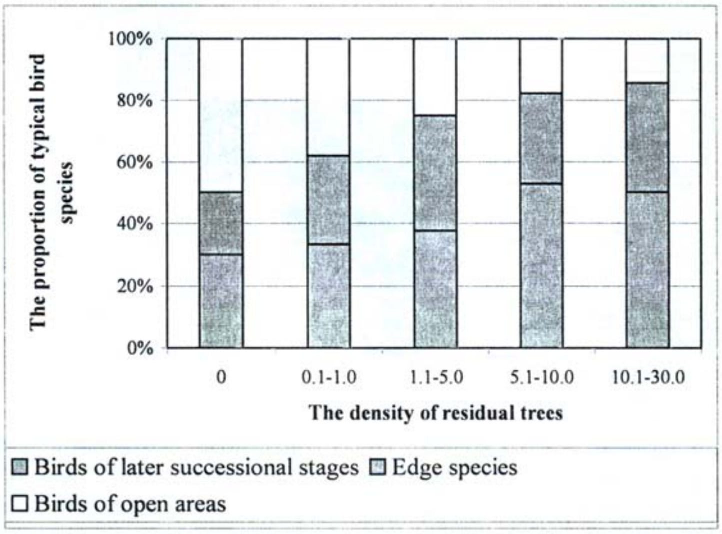


Fig. 5. The proportional differences of open areas, later successional and edge species among various residual tree densities

Tab. 1. Influence of large residual trees to bird species distribution. ** p<0,001; * p<0,05; Model represent all bird species that show IndVal>25 without reference to significance if exist double difference between groups. O – species of open landscape; E – edge species; M – species of later successional stages.

Species	Density of large residual trees (trees / 1 ha)					Ind Val and p	Guild
	0	0.1-1.0	1.1-5.0	5.1-10.0	10.1-30.0		
Acrocephalus schoenobaenus	■					7?	O
Gallinago gallinago	■	■				15?	O
Locustella fluviatilis	■	■				14*	O
Sylvia borin	■	■				43?	O
Troglodytes troglodytes	■	■				30?	M
Sylvia communis	■	■	■			56*	O
Erithacus rubecula	■	■	■	■		67*	M
Anthus trivialis	■	■	■	■		42	E
Emberiza citrinella	■	■	■	■		27	E
Turdus philomelos	■	■	■	■		26	M
Luscinia luscinia		■	■	■	■	21**	O
Parus ater		■	■	■	■	15?	M
Sitta europaea		■	■	■	■	21*	M
Nucifraga caryocatactes			■	■	■	8**	M
Streptopelia turtur			■	■	■	8?	E
Dendrocopos major				■	■	38*	M
Fringilla coelebs				■	■	60**	M
Regulus regulus				■	■	10?	M
Parus major				■	■	41	E
Phylloscopus collybita				■	■	51	E
Dendrocopos leucotos					■	12*	E
Bonasia bonasa					■	13*	M
Parus palustris					■	23*	E
Sylvia curruca					■	35**	O
Corvus corax		■	■	■		7*	M
Acrocephalus palustris		■	■	■		17?	O
Turdus pilaris		■	■	■		10*	O
Cuculus canorus		■	■			20**	E
Garrulus glandarius		■	■			25*	E
Sturnus vulgaris		■	■			25*	E
Grus grus		■				28*	O
Phylloscopus trochilus		■				47**	E
Turdus merula		■				26?	M
Total number of species	10	21	16	17	14		

over an equal dispersion of residual trees. (1) Typical forest bird species of first successional stages require larger open spaces that increase concentrating residual trees. Concentration mutually harmonizes requirements of specialized birds that require greater tree retention and species of first successional stages. (2) Groups of trees are more resistant to windthrow (Esseen 1994). The actual number of windthrows depends on many factors: climate, shape of the retention tree group, stand characteristic, ecology of tree species and other (Foster 1988; Peltola et al. 1999). (3) Grouping of trees in clear-cut areas make positive impact to old forest species guild, because of maintenance of environmental conditions near to old forest (Vanha-Majamaa & Jalonen 2001).

Residual trees are under high pressure of negative environmental factors. Trees are grown inside stand are not adopted to open landscape. Many of them are damaged by wind or dry and die. Arnott and Beese (1997) reported a residual trees loss of 25% after three years. By this reason the density of residual trees should be higher than the theoretical optimum.

Conclusions

When clear-cutting, forest management practices should be based on leaving two categories of both large (D>20cm) and small (D<20cm, H>8m) residual trees. It is recommended for forest birds in 1 ha of the clear-cut area leave one group (3-5 trees) of large (D>20 cm) and 5-10 small (D<20 cm; H>8m) residual trees. Small residual trees should be dispersed equally in the clear-cut area. In forests, where rare woodpecker or other hollow-nest species breed it is recommended to leave 10-30 large and 20-40 small residual trees, half of them disperse equally half - group in small patches. The retention of different tree species is important for different species. It is therefore recommended that retention is made both of softwood (mainly for woodpeckers) and hardwood (mainly for large nests).

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SOME DATA ON CADDISFLIES (TRICHOPTERA) DISTRIBUTION IN LITHUANIA

Giedrė Cibaitė

Cibaitė G. 2003. Some data on caddisflies (Trichoptera) distribution in Lithuania. *Acta Biol. Univ. Daugavp., 3 (2): 91 - 95.*

The data on short historical review of investigations of caddisflies in Lithuania are presented. The data on caddisflies distribution in Lithuania is based on adults and larvae investigations, from 1987 till 2002 and on literature data. Information on the distribution, abundance, flying activity periods of some caddisflies species is provided.

Keywords: Caddisflies, Lithuania, district, distribution

Giedrė Cibaitė, Vilnius University, Institute of Ecology, Akademijos 2, 2600 Vilnius, Lithuania. E-mail: giedre@ekoi.lt, entlab@centras.lt

Introduction

The first notes about Lithuanian Trichoptera (6 species) appeared in 1830 (Eichwald). Intensive investigations began in the 20th century. 45 species collected by W. Horn in Gavaitis Lake (Ignalina district) (Ulmer et al. 1917). M. Racięcka investigated Lithuanian Trichoptera, most in Vilnius and Trakai districts (Racięcka 1931, 1937), 127 species were recorded. 89 species of caddisflies were mentioned by R. Kazlauskas (1960), later he recorded 92 species (1963). The faunistical research carried out in Southern part of Lithuania, around Alytus district, 88 species were recorded (Spuris 1969). Investigations of caddisflies also carried out in common with researches of macrozoobenthos. The river of Nemunas was investigated since 1956 (Gasiūnas 1976), 25 species of caddisflies were mentioned. Zoobenthos was investigated in 26 rivers in 1994-1997, established 25 species of caddisflies (Pliūraitė 1999). In 1996-1999 the Šventoji river and its tributaries were investigated in Anykščiai district, 64 species were registered by larvae and imagos (Cibaitė 2000). In "Synopsis of the fauna of the Trichoptera of the USSR" the number of Trichoptera species registered in the Baltic states was 202 species, in Latvia - 188, Estonia - 152, Lithuania - 149 (Spuris 1989). The exact list of Lithuanian caddisflies species was not presented. In our days 169 species of caddisflies are known in Lithuania.

Material and methods

Material for the study was collected in 1987-2002, by the author and others (P. Ivinskis, J. Rimšaitė, V. Uselis, G. Švitra, D. Dapkus, M. Margienė, H. Ostrauskas, K. Arbačiauskas, S. Gumuliauskaitė). Larvae and imagos were investigated in 29 districts and Curonian Spit from 1987 till 2002 (fig. 1). Such abbreviations of districts are used: Ak - Akmenė, Al - Alytus, An - Anykščiai, CS - Curonian Spit, Ig - Ignalina, Jr - Jurbarkas, K - Kaunas, Kd - Kėdainiai, Kl - Klaipėda, Kr - Kretinga, L - Lazdijai, M - Marijampolė, Ml - Molėtai, Pk - Pakruojis, Pn - Panevėžys, Pl - Plungė, Pr - Prienai, Šlč - Šalčininkai, Š - Šiauliai, Šlt - Šilutė, Šr - Širvintos, Šv - Švenčionys, Trg - Tauragė, Tr - Trakai, Ukm - Ukmergė, Vr - Varėna,

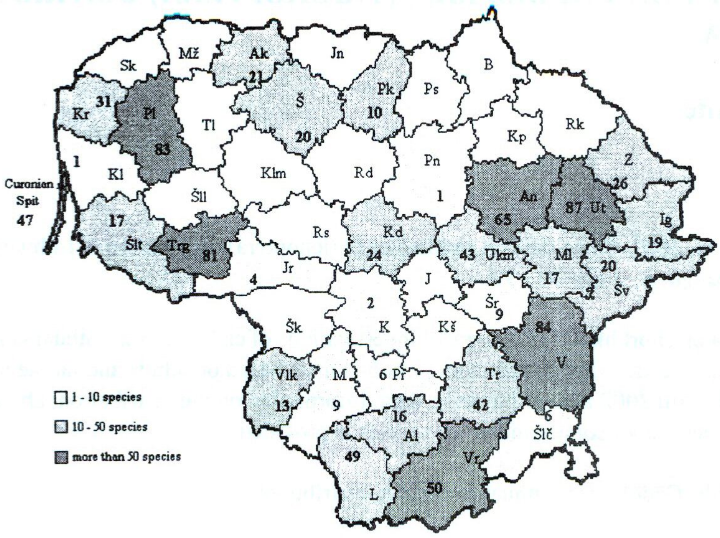

Fig. 1. Caddisflies investigated in districts of Lithuania in 1987-2002.

Table 1. Number of caddisflies species in the investigated districts of Lithuania in 1987-2002

Districts	Number of species	Districts	Number of species
Klaipėda (Kl)	1	Švenčionys (Šv)	20
Panevėžys (Pn)	1	Akmenė (Ak)	21
Kaunas (K)	2	Kėdainiai (Kd)	24
Jurbarkas (Jr)	4	Zarasai (Z)	26
Prienai (Pr)	6	Kretinga (Kr)	31
Šalčininkai (Šlč)	6	Trakai (Tr)	42
Marijampolė (M)	9	Ukmergė (Ukm)	43
Širvintos (Šr)	9	Curonian Spit (CS)	47
Pakruojis (Pk)	10	Lazdijai (L)	49
Vilkaviškis (Vlk)	13	Varėna (Vr)	50
Alytus (Al)	16	Anykščiai (An)	65
Molėtai (Ml)	17	Tauragė (Trg)	81
Šilutė (Šlt)	17	Plungė (Pl)	83
Ignalina (Ig)	19	Šiauliai (Š)	84
Šiauliai (Š)	20	Utena (Ut)	87

Vlk - Vilkaviškis, Z - Zarasai. Larvae were investigated in lakes, rivers and streams, from different conditions, using dip net. For imagos samplings were used sweeping net, light traps, and Jalas model automatic light traps. Also literature data on Lithuanian caddisflies were analyzed.

Results and Discussion

According literature data and investigations of caddisflies till 2002, 169 species (18 families) are known in Lithuania of the moment (fig. 2). Over 50 species were found in 6 districts, 10-50 species - in 15 districts and Curonian Spit, and 1-10 species - in 8 districts (table 1). Limnephilidae family is dominant among others families (56 species). According to investigations in 1987-2002, 2 new species of caddisflies were found only as larvae and 17 species as imagos using light traps in different districts. 20 species are known from literature but have not been found after 1987. The most widely distributed species were *Limnephilus flavicornis* Fabricius, 1787, it was found in 23 districts, *Glyphotaelius pellucidus* Retzius, 1783, *Limnephilus griseus* Linnaeus, 1758 - 21 districts. 34 species were registered in one district (table 2). Rare species in Lithuania established: *Erotesis baltica* Mac Lachlan, 1877, *Triaenodes unanimis* Mac Lachlan,

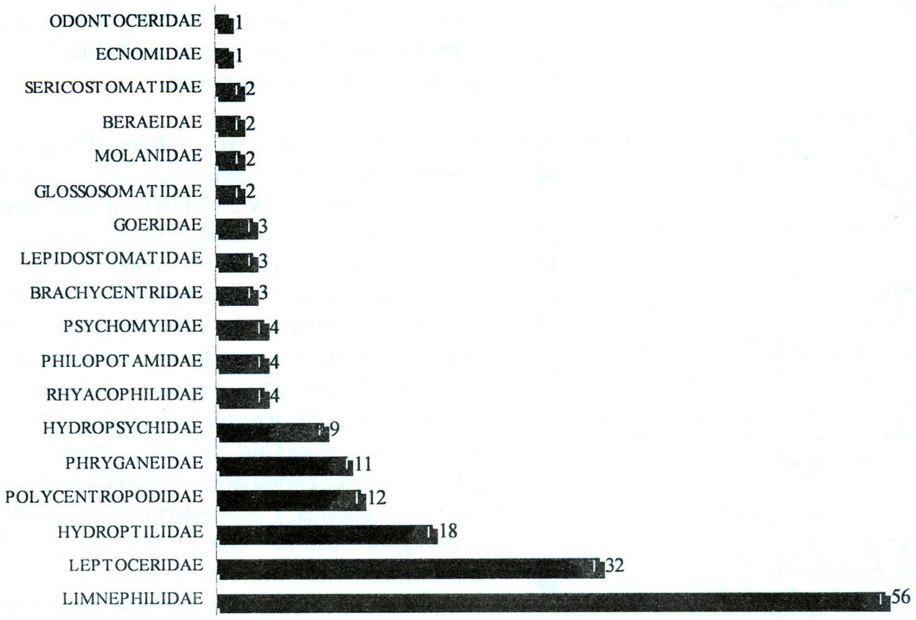

Fig. 2. Number of caddisflies families and species in Lithuania

1877, *Crunoecia irrorata* Curtis, 1834, *Asynarchus contumax* Mac Lachlan, 1880, *Apatania auricula* Forsslund, 1930, *Limnephilus luridus* Curtis, 1834. Three species, *Philopotamus montanus* Donovan, 1813, *Apatania zonella* Zetterstedt, 1840 and *Semblis phalaenodes* Linnaeus, 1758 were included in Red Data Book of Lithuania (1992).

Caddisflies investigations corroborate Jalas automatic light trap as effective method in different researches of insects. There were species, which were known only from the light trap material (some species from genera *Allotrichia, Hydroptila, Hydropsyche, Apatania, Limnephilus* and others) and did not registered in larval stadium. The most widely distributed species registered in larval and imago stadium and are known almost in all investigated districts of Lithuania. Rare species could be picked out for several reasons. Some species are registered once and only few individuals (*Hydropsyche contubernalis masovica* Malicky, 1977, *Athripsodes bilineatus* Linnaeus, 1758, *Erotesis baltica* Mac Lachlan, 1877, *Asynarchus contumax* Mac Lachlan, 1880, *Apatania auricula* Forsslund, 1930, *Limnephilus luridus* Curtis, 1834 and so on), others are known more abundance but from one or two localities (*Rhyacophila pascoei* Mac Lachlan, 1879, *Glossosoma boltoni* Curtis, 1834, *Allotrichia vilnensis* Racięcka, 1937, *Cyrnus trimaculatus* Curtis, 1834, *Limnephilus affinis* Curtis, 1834 and so on). Some species, which used to find long time ago, or were registered only in early larval stadium or as a female, could be checked and confirm because of some difficulties in identification (species from genera *Hydroptila, Philopotamus, Hydropsyche*). Others species have short flying period, that is why they are not very abundant (for example *Micrasema setiferum* Pictet, 1834, *Limnephilus nigriceps* Zetterstedt, 1840, *Hagenella clathrata* Kolenati, 1848). Species, included in Red Data Book of Lithuania also are known from very few localities and not abundant. *Philopotamus montanus* Donovan, 1813, is known from Kazlauskas, from Kaunas: Kulautuva stream, 02 June, 1955, 3, *Apatania zonella* Zetterstedt, 1840 is known from Kazlauskas, from Kaunas: Karklė stream, 05 May, 1954, 4, 01 Sep-

Table 2. The distribution of caddisflies species in districts of Lithuania

Species	Nr. of districts
L. flavicornis	23
G. pellucidus, L. griseus	21
L. rhombicus	20
Ph. grandis	18
L. sparsus	17
A. varia	16
M. angustata	15
O. ochracea, L. stigma	14
E. tenellus, A. pagetana, Ph. bipunctata, M. nigra, L. auricula, L. extricatus, L. lunatus, P. latipennis	13
N. punctatolineatus, L. ignavus, L. vittatus, L. marmoratus, C. dissimilis, M. longicornis	12
H. pellucidula, G. nigropunctatus, A. brevipennis, A. soror	11
C. flavidus, P. conspersa, P. flavomaculatus, L. subcentralis	10
H. angustipennis, G. pilosa, L. decipiens, L. politus, H. radiatus	9
O. flavicornis, T. minor, O. furva, L. bipunctatus, H. digitatus	8
C. crenaticornis, H. contubernalis, L. tineiformis, M. azurea, O. lacustris, L. hirtum, L. borealis, L. elegans, L. sericeus, P. rotundipennis, H. tesellatus, M. sequax	7
R. nubila, A. sexmaculata, I. lamellaris, P. pusilla, H. dubius, O. striata, L. incisus	6
T. waeneri, H. clathrata, N. ciliaris, S. personatum, A. aterrimus, A. cinereus, O. notata, I. dubia, G. nitidus, L. binotatus, L. germanus, Ch. villosa	5
R. fasciata, A. ochripes, A. multipunctata, H. simulans, L. phaeopa, N. bimaculata, A. obsoleta, C. fulva, L. interruptus, T. simulans, R. alpestris, P. nigricornis, M. lateralis	4
S. phalaenodes, O. costalis, H. picicornis, Ch. lepida, H. bulgaromanorum, O. reticulata, O. albicorne, M. tincta, O. tripunctata, S. punctatus, B. subnubilus, M. setiferum, S. pallipes, G. signatipennis, L. coenosus, L. dispar, L. fuscinervis, L. nigriceps, A. concentrica	3

tember, 1954, 7, 01 October, 1954, 9, 20 May, 1955, 2, 01 June, 1955, 8, and *Semblis phalaenodes* Linnaeus, 1758 is known from several authors from Švenčionys: Mera river, Daumilai, 28 May, 1954, 1, Pažeimenė, July, 1989, 1; Varėna: Merkinė, 15 June, 2001, 1; Ukmergė: 23 May, 2002, 1. The simultaneous investigations of caddisflies larvae and imagos must be continued.

Caddisflies of Lithuania were distributed in spring-summer, summer and summer-autumn flying periods. Spring-summer (IV 22-VI 04) activity characteristic for species *Goera pilosa* Fabr., *Micrasema setiferum* Pict., *Agapetus ochripes* Curt., *Glossosoma boltoni* Curt., *Oligotricha striata* L., and others. Summer (VI 04-VIII 14) flying periods stated for generas *Cyrnus, Agrypnia, Mystacides,* big part of *Limnephilus* genera *Molannodes tincta* Zett., *Micropterna sequax* McL., *Crunoecia irrorata* Curt.. Summer-autumn (VIII 14-XI 21) flying period determinated for *Halesus, Anabolia* generas, *Chaetopteryx villosa* Fabr., *Ironoquia dubia* Steph., *Limnephilus bipunctatus* Curt. and others. Autumn activity not picked out as separate, because there were not caddisflies species with maximum activity in October. Species attached to summer-autumn period appeared in August. Two flying periods, spring and autumn established for species *Limnephilus auricula* Curt. and *L. vittatus* Fabr. Some species of caddisflies had not exceptional flying period, they were founded through the whole year (*Rhyacophila, Hydropsyche* generas, *Glyphotaelius pellucidus* Retz., *Limnephilus sparsus* Curt., *Potamophylax nigricornis* Pict. and so on).

Conclusions

1. The most species of caddisflies were found most of all in districts where Jalas automatic light traps were used.

2. The most widely distributed species in Lithuania were *Limnephilus flavicornis* Fabricius, 1787, *Limnephilus griseus* Linnaeus, 1758 and *Glyphotaelius pellucidus* Retzius, 1783.

3. 34 species were registered in one district only. The rarest species in Lithuania were *Erotesis baltica* Mac Lachlan, 1877, *Triaenodes unanimis*

Mac Lachlan, 1877, *Crunoecia irrorata* Curtis, 1834, *Asynarchus contumax* Mac Lachlan, 1880, *Apatania auricula* Forsslund, 1930, *Limnephilus luridus* Curtis, 1834.
4. The biggest part of caddisflies had summer activity flying period in Lithuania.

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THE MONITORING OF THE FLIGHT ACTIVITY OF THE RED MASON BEE (*OSMIA RUFA* L.)

Beata Bąk, Jerzy Wilde, Janusz Bratkowski

Bąk B., Wilde J., Bratkowski J. 2003. The monitoring of the flight activity of the red mason bee (*Osmia rufa* L.). *Acta Biol. Univ. Daugavpil., 3 (2): 97 - 100.*

In the experiment conducted in 2000 (from 10th to 16th of May) and 2002 (from 14th to 25th of May) we observed the flight activity of the red mason bee. The flight activity of females was measured 3 times a day (in the morning at 8.00, in the afternoon at 13.00 and in the evening at 18.00). The temperatures were divided: I - temp. <13°C, II - 13 - 19,5°C, III - 20 - 25,5°C and IV - temp >25,5°C. The population of the solitary bees observed in 2000 had about 40 females, and the population in 2002 was estimated for 130 females. Bees showed the lowest activity in the morning hours returning only 1.2 times back to the nest. At that time all females made on average 20.9 flights per half an hour. The morning temperatures varied from 5 to 20oC. At noon the single bee made 2.6 returning flights. The average number of returning flights was estimated for 93.8 and the temperature varied from 13 to 29°C. By temperatures below 13°C bees were not active. The highest flight activity was at the temperatures over 25°C. In those conditions the single bee made 3.2 returning flights and 129.1. flights was recorded all in all. During windy and rainy weather there were no flights observed.

Key words: flight, red mason bee, Osmia rufa

Beata Bąk, Jerzy Wilde, Janusz Bratkowski; Apiculture Division, Warmia and Mazury University, Sloneczna 48, 10-719 Olsztyn, Poland, e-mail: beciabak@wp.pl

Introduction

Wild bees, that leads a solitary life, since a long time has been used in agriculture for pollination of agriculture crops. The red mason bee (*Osmia rufa* L) also belongs to these bees.

First specimens already appear at the beginning of April. That are drones. Females leave cocoons two weeks later and after copulation start settling the nest and laying eggs (Seidelmann 1995). During that time they are very active in order to get pollen to supply incubative cells with food for larvae hatching from eggs. They visit especially willingly richly blossoming fruit trees and bushes. The red mason bees do also not despise pollen from flowers of vetch, poppy, winter rape and other green plants. So we can say that this species is polyphagous (Ruszkowski, Bilinski 1986, Wilkaniec at al. 1997, 1998). Their flight activity lasts till the end of June.

In this way, they pollinate flowers of many plants. The red mason bee is a super pollinator. Its pollination efficiency is comparable with the efficiency of the honey bee (Wilkaniec, Wyrwa 1994). The red mason bee is recommend first of all for holders (Holm 1973), but it can be used successfully for pollinating of large plant areas (Wojtowski at al. 1992) and greenhouses (Giejdasz, Wilkaniec 1998). Because this bee does not need special conditions to be breed its keeping is very easy for everyone. It is enough to have reed canes to deliver a place for nesting (Wilkaniec, Giejdasz 2001). The goal of the observations was the monitoring of the flight activity of the red mason bee.

Material and Methods

The observation was curried out in the Apiculture Division in Olsztyn in the spring of 2000 (from 10th to 16th of May) and 2002 (from 14th to 25th of May). The trap-nest was made of common red stalks (length about 20cm), that were put into plastic bottles. In order to make observation easier the diagrams of nests were drew up, where the numbered circles answered each individual bottle, and points plotted answered an individual tube. The population of the solitary bees observed in 2000 had about 40 females, and the population in 2002 was estimated for 130 females. The flight activity of females was measured 3 times a day (in the morning at 8.00, in the afternoon at 13.00 and in the evening at 18.00). At those moments there were counted only bees flying into the nest and air temperatures were registered. The temperature were divided into following ranges: I - temp. <13°C, II - 13 - 19,5°C, III - 20 - 25,5°C and IV - temp >25,5°C. Statistical analyze was made with Statistica 6.0 program license number .

Results

During half an hour females of the red mason bee made 56 flights which resulted as 1.96 flights per one single bee. Bees showed the lowest activity in the morning hours returning only 1.2 times back to the nest (tab. 1). At that time all the females made on average 20.9 flights per half an hour. The morning temperatures varied from 5 to 20°C.

At noon the single bee made 2.6 returning flights. The average number of returning flights was estimated for 93.8 and the temperature varied from 13 to 29°C. In the evening by the temperatures of 12-26.5°C 53.4 flights were registered, on average 2.1 per one female.

The average number of returning flights measured at noon within half an hour was significantly higher at p=0.01 than in the morning and significantly higher at p=0.05 than in the evening. However, the average number of flights in the morning varied highly significant from stated in the midday hours and was significantly higher than in the evening (tab. 1).

The temperature increase was accompanied by the visibly increase in the number of flights (tab. 2).

By temperatures below 13°C bees were not active. In the range of 13-19.5°C bees returned 37.4 times and the single female bee flew on average 1.6 times. Within the 3rd temperature range (from 20 to 25.5°C) the single bee flew on average 2.6 times back to the nest, which was the result of 69.8 returning flights observed during half an hour. The highest flight activity was at the temperatures over 25°C. In those conditions the single bee made 3.2 returning flights and 129.1. flights was recorded all in all. During windy and rainy weather there were no flights observed.

Table 1. Temperature and fly activity of bees in different times day

	Min.-max. temp. (°C)	Average number flights/0.5h	Sd	Average number flights/one bee	Sd
Morning	5-20	20.9A	24.5	1.2Aa	1.3
Afternoon	13-29	93.8Ba	78.7	2.6B	1.3
Evening	12-26.5	53.5b	57.8	2.1b	1.2

Small letters indicate differences at p<0.05, capitals at p<0.01

The average number of returns observed within the highest temperature range was highly significant greater than averages calculated for the other temperatures.

The flight activity expressed as the average number of returning flights made by a single bee within the second temperature range was significantly lower than measured in the second temperature range and at the same

Table 2. The fly activity of bees in difference temperature rang

Rangers	Temperature (°C)	Average number flights/0.5h	Sd	Average number flights/one bee	Sd
I	<13	0	0	0	0
II	13-19.5	37.4A	48.3	1.6Aa	1.3
III	20-25.5	69.8A	56.4	2.6b	0.9
IV	>25.5	129.1B	85.5	3.2B	1.1

Small leters indificant differences at $p<0.05$, capitals at $p<0.01$

time highly significant lower in comparison with the highest temperatures.

Discussion

We have stated that the females of the red mason bee were most active at noon, whereas they showed the least activity in the morning hours. Seidelmann (1995) says that drones start flying at 8 in the morning and finish being active at 5 in the afternoon. According to her results drones had at 10 o'clock the greatest penchant for looking for female bees. However, Käpylä (1974, 1978) found during researches that the time of day did not have the effect on the flight activity. He drew a conclusion that the air temperature was the most important factor affecting significant the flights of bees, which has been confirmed by our investigations. In fact, the air temperature influenced significantly on the flight activity of *O. rufa*. The highest number of flights were noticed at the most warmest hours, while below 13°C there were no flights at all.

During investigations we observed that the strong wind prevented bees from flying, which disagrees the results of Domagala-Lipinska (1962) and Käpyla (1978), that found the strong wind might not restrict pollen and nectar collection by bees as well as their flight activity.

Conclusions

The time of day and the temperature influenced significantly on the flight activity of *Osmia rufa*.

The lowest flight activity was demonstrated by female bees in the morning and the highest at noon.

The higher was the air temperature, the females flew more actively.

Below 13°C the red mason bees did not fly.

Windy and rainy weather decreased the fly activity of bees.

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POLLEN COLLECTION BY 3 SUBSPECIES OF HONEYBEE *APIS MELLIFERA* L.

Jerzy Wilde, Maciej Siuda, Janusz Bratkowski

Wilde J., Siuda M., Bratkowski J. 2003. Pollen collection by 3 subspecies of honeybee *Apis mellifera* L. *Acta Biol. Univ. Daugavp., 3 (2): 101 - 106.*

In the experiment the pollen collection activity of three bee subspecies: *A. melifera mellifera, A. mellifera carnica* and *Apis mellifera caucasica* was evaluated, which was based on counting for 10 min. pollen foragers and the remaining bees. The foraging ratio was calculated from the formula: pollen foragers/100 total foragers. For the entire duration of the experiment the highest flight activity of pollen foragers was recorded in *A. m. mellifera* (106.7) vs. *A. m. caucasica* (65.4) (p=0.01). The relations changed if the foraging ratio was taken into consideration. The best bees were from the *A. m. carnica* breed (31.4) but only significantly better than the *A..m. caucasica* (27.8). The study also confirmed a tendency according to which a rise in flight rate starts in early morning hours to reach its peak at midday and to decline in the afternoon. At the temperatures below 22°C *A. m. mellifera* and *A. m. carnica* foraged for pollen most actively, but the means of the foraging ratio proofed that *A. m. carnica* bees flew the most efficient for pollen than *A. m. caucasica* bees. However, the highly significant number of pollen foragers of Central European bees (112.6) was found in temperatures over 23°C compared with *A. m. caucasica* (70.6) and *A. m. carnica* (67.6, p=0.01). Thus, the value of foraging ratio was adequate to foragers activity, it did not differed statistically.

Key words: honeybee, pollen, *Apis melliffera mellifrea, Apis melliffera carnica, Apis melliffera caucasica*

Jerzy Wilde, Janusz Bratkowski, Maciej Siuda; Apiculture Division, Warmia and Mazury University, Sùoneczna 48, 10-710 Olsztyn, Poland., e-mail: jurwild@uwm.edu.pl

Introduction

In Poland, the most commonly used subspecies of the honeybee (*Apis mellifera* Linnaeus 1758) are the Central European bee (*Apis mellifera mellifera* Linnaeus 1758), the *A.m. carnica* bee (*Apis mellifera carnica* Pollmann 1979) and the *A.m. caucasica* bee (*Apis mellifera caucasica* Gorbaczew 1916). Those subspecies differ from one another for the rate of colony development, number of bees in colony and for a number of morphological traits such as tongue length. Of the subspecies mentioned above the *A.m. carnica* bees show the fastest rate of development in the spring. The *A.m. caucasica* bees are later in reaching the full strength but their tongues are longer which makes them good red clover pollinators. The Central European bees are intermediate with respect to the above mentioned traits (Gromisz 1972).

The flight activity of bees is influenced by weather and flow conditions as well as by colony strength, the number of foraging bees. Weather conditions are chiefly dependent on air temperature, sunshine and wind intensity. Flow situation is governed by diurnal flowering pattern, nectar and pollen output as well as by the combination of those factors (Käpylä 1974). Flying activity of bees increases staring with early morning hours to reach its peak about midday and to decline in the afternoon (Domagala-Lipinska 1962, Grabowski at al. 2000). The number of bees foraging on nectar or pollen may vary depending on the needs of the bee colony (Hrassnigg, Crailsheim 1998). Essentially, nectar is collected by 60%, pollen by 25% and both substances by 15% of the foraging bees (Free 1960).

The aim of the study was to determine the collection activity of three bee subspecies as affected by time of day and temperature.

Material and method

The experiment was run at the apiary of the Chair of Apiculture, University in Olsztyn in April and May of 2002. The study comprised 9 colonies, each of the subspecies, *A. m. mellifera, A. m. carnica* and *A. m. caucasica* comprising three colonies. Flight activity was measured at 1-hour intervals from 8:00 to 18:00. Counting was done for 10 min. making a distinction between incoming bees with pollen loads treated as pollen foragers and the remaining bees. During the counts air temperature and air humidity were recorded by means of a thermo-hygrometer.

In order to make a more clear distinction between the times of day the data were assigned to three classes: class I - 8:00 to 11:00 - morning flight activity, class II - 12:00 to 14:00 - midday flight activity and class III - 15:00 to 18:00 - afternoon flight activity. Likewise, three temperature classes were distinguished; class I - 11° to 16°C, class H - 17 to 22°C, class HI - 23° to 29°C.

The foraging ratio was calculated from the formula: pollen foragers/100 total foragers.

The data were subjected to statistical analysis using STATISTICA software (Anova). The differences of means were tested for significance using the Duncan test.

Results and disscusion

The number of total foragers recorded in every subspecies was different, and the differences were confirmed statistically ($p=0.01$) in every case (tab. 1). The best was A. m. mellifera (375.7) then *A. m. carnica* (296.8) and the last was *A. m. caucasica* (205.1). For the entire duration of the experiment the highest flight activity of pollen foragers was recorded in *A. m. mellifera* (106.7) vs. *A. m. caucasica* (65.4), which was significant at $p=0.01$. The pollen foragers of *A. m. carnica* (94.4) showed the flight activity similar to that of the Central European bees which was only significantly ($p=0.01$) higher than the flight activity of the *A.m. caucasica* bees. The respective values of the for-

Table 1. The flight activity of all foragers and pollen foragers and the pollen foraging ratio

Subspecies	Total foragers Mean (SD)	Pollen foragers Mean (SD)	Pollen foraging ratio Mean (SD)
A. m. carnica	296.8 B(279.0)	94.4 b (111.2)	31,4b (22.6)
A. m. caucasica	205.1 A (184.9)	65.4 a (74.3)	27,8a (18.6)
A. m. mellifera	375.7 C (229.7)	106.7 B (89.3)	29,3 (18.1)

Explanation: capitals indicates differences at $p=0.01$, small letters at $p=0.05$
Foraging ratio - pollen foragers/ 100 total foragers

Table 2. The total number of incoming bees and pollen foragers and the polen foraging ratio at different day-time

Subspecies	8.00-11.00			12.00-14.00			15.00-18.00		
	Total foragers	Pollen foragers Mean (SD)	Pollen foraging ratio	Total foragers	Pollen foragers Mean (SD)	Foraging ratio	Total foragers	Pollen foragers Mean (SD)	Pollen foraging ratio
Carnica	257,5 B (245.6)	106.6 B (111.9)	33.9 (24.8)	391.7 B (344.7)	119.5 b (125.7)	28.8 (20.8)	266.5 bA (239.0)	65.5 (90.2)	24.2 (20.5)
Caucasica	167.1 A (170.5)	60.4 a (68.5)	28.7 (19.7)	248.9 A (195.7)	85.2 A (74.7)	29.3 (17.0)	212.4 aA (184.4)	55.5 (223.6)	20.4 (16.2)
Mellifera	347.4 C (201.6)	133.2 B (100.2)	31.9 (19.0)	462.3 C (252.8)	131.5 B (83.8)	27.4 (14.5)	340.2 B (224.0)	71.7 (70.6)	22.7 (18.5)

Explanation: capitals indicate differences at $p=0.01$, small letters at $p=0.05$
Foraging ratio - pollen foragers/100 total fora

aging ratio calculated for the *A.m. carnica, A.m. mellifera* and *A.m. caucasica* were 31.4, 29.3 and 27.8, respectively. The difference between the average flight activities, expressed as the ratio of flight activity of pollen foragers, for *A. m. mellifera* bees (29.3) and others was non-significant, whereas the statistical difference was found between *A.m. carnica* (31.4) and *A.m. caucasica* (27.8). As one see though *A.m. mellifera* were most active in number of total and pollen foragers, the relations changed if the ratio of foraging is taken into consideration. The best bees are from *A.m. carnica* breeds and only significantly better then the *A.m. caucasica.*

The data on the bee flight activity presented in this study are in the agreement with similar reports (Bratkowski, Wilde 1999, Free 1960). If the contribution of pollen foragers of the bee subspecies was calculated in this study (31.5% on average) it would be lower than the generally accepted estimates of 40% (Free 1960). The lower percentage of pollen foragers was probably due to good nectar secretion conditions during the study. A decline in pollen foraging under intensive nectar flow situation was also observed by others (Poliscuk 1984). The average flight activity of A.m. caucasica pollen foragers was similar to that determined by Bratkowski and Wilde (1999). They recorded only 9.3 incoming foragers within a 10 minute period in this subspecies, which was probably influenced by flow conditions. The average flight activity of A.m. carnica pollen foragers was lower than that found by Siuda et al. (1999). Within a period of 10 minutes they counted 255 bees with pollen loads. Bees from a line selected for high pollen foraging were used in that experiment. Tendency to hoard large stores of pollen to be genetically-based was also confirmed by other investigators (Hellmich at al. 1986, Wilde, Bratkowski 1997). These results imply that quite different results may be obtained when testing a line other than the one used in the present study. In the literature similar studies concerning *A.m. mellifera* bees are lacking.

Similar tendencies in the flight activity presented by the examined subspecies can be observed when analyzing the activity of foragers at different day-times (tab. 2).

In the morning hours (8:00 to 11:00) all subspecies of bees varied significantly ($p=0.01$) in the number of total foragers (tab. 2). But pollen foragers of *A. m. mellifera* (133.2) and *A m. carnica* (106.6) made significantly more foraging flights than those of *A. m. caucasica* (60.4). Thus, the average morning flight activity of *A. m. mellifera* was similar to that of *A. m. carnica.* Although, the differences were found and confirmed be-

Table 3. The flight activity of pollen foragers at different air temperatures and the pollen foraging ratio

Subspecies	11-16°C			17-22°C			23-29°C		
	Total foragers	Pollen foragers Mean (SD)	Foraging ratio	Total foragers	Pollen foragers Mean (SD)	Foraging ratio	Total foragers	Pollen foragers Mean (SD)	Foraging ratio
Carnica	198.3 (236.9	79.9B (120.2)	26.9 b (26.2)	368.2 B (293.7)	118.8B (113.1)	34.9 (18.9)	375.1bA B (271.5)	67.6A (58.0)	22.9 (18.1)
Caucasica	128.2 (156.9	41. 3A (59.5)	20.7 a (21.2)	248.7 A (187.6)	87.5A (78.5)	32.7 (14.7)	290.1 aA (173.7)	70.6A (69.3)	24.2 (12.0)
Mellifera	303.5 (230.6	98.5B (103.0)	24.7 (20.2)	413.9 B (232.8)	109.6B (84.2)	31.9 (17.8)	461.1 BC (168.6)	112.6B (110.3)	24.9 (10.5)

Explanation: capitals indicates differences at p=0.01, small letters at p=0.05
Foraging ratio - pollen foragers/ 100 total foragers

tween some subspecies, the means of the foraging ratio did not differ statistically. In the midday (12:00 to 14:00) a highly significant difference in the average flight activity of the total foragers was found between all the groups: *A.m. mellifera* (462.3), *A.m. carnica* (391.7) and *A.m. caucasica* (248.9) bees. However, the means calculated for pollen foragers of *A. m. caucasica* (85.2) were statistically lower then those for *A. m. mellifera* (131.5) and *A. m. carnica* (119.5). The difference in the flight activity between the two latter subspecies was no-significant. Such the relationship did not found statistical confirmation in the case of the pollen foraging ratio. In the afternoon (15:00 to 18:00) no statistical differences were found in the average flight activity of pollen foragers of the three bee subspecies and the foraging ratio. But it was in opposition to relation found in total foragers, that means were statistically (p=0.01) valid between *A.m. mellifera* (340.2) vs. A.m. caucasica (212.4) and *A.m. carnica* (266.5). But the differences at p=0.05 were found only between two latter groups of bees.

The study confirmed a tendency according to which a increase in the flight rate starts in the early morning to reach its peak at the midday and declines in the afternoon (Domagala-Lipinska 1962, Grabowski at al. 2000). This tendency was observed in the pollen foragers of all subspecies used in the experiment. The study done in Finland failed to show a clear-cut relationship between the day-time and increased flight activity of bees and bumblebees (Käpylä 1978).

The following ensues from the analysis of the flight activity of pollen foragers shown at different temperatures: at low temperatures (from 11 to 16°C) *A. m. mellifera* and *A. m. carnica* worked most actively averaging 98.5 and 79.9 individuals, respectively (tab. 3). Their flight activity was significantly higher than that of *A. m. caucasica* (41.3). The average flight activity of *A. m. mellifera* pollen foragers did not differe significantly from that of *A.m. carnica.* However, the means of the foraging ratio proved that *A.m. carnica* (26.9) flew most efficient on pollen then *A.m. caucasica* (20.7, p=0.05) and similary, but better than *A.m. mellifera* (24.7). Within the temperature range 17 to 22°C A. m. carnica bees were most active pollen foragers: bees on the averaging 118.8 followed by *A. m. mellifera* (109.6). They outnumbered *A. m. caucasica* (87.5) by a highly significant margin, whereas the confirmation from the statistical point of view was not found in means of foraging ratio calculated for all the subspecies. But its value was again the higher for A.m. carnica (34.9) than *A.m. mellifera* (31.9), despite the relations stated in the total number of foragers and pollen foragers, where *A.m. melliefera* were always the most active. In the highest temperature range (from 23°C to 29°C) the most number of *A. m. mellifera* (461.1) workers were noticed at the hive entrance. It was highly significant more than *A.m. caucasica* (290.1), whereas the difference between means of *A.m. carnica* and *A.m. caucasica* breeds were significant valid. The most active pollen foragers were *A.m. mellifera* averaging 112.6 individuals. They again outnumbered *A. m. caucasica* (70.6) and *A. m. carnica* (67.6) by a highly significant margin. But their activity was not confirmed by the foraging ratio, which assumed nearly the same values for three subspecies.

Grabowski et al. (2000) found a similar tendency in pollen foragers although the study did not involve temperatures higher than 25°C. In this study a decrease in the activity of pollen foragers was observed at temperatures higher than 23°C. Conceivably, the lack of interest in the pollen flow was caused by intensive nectar secretion by dandelion (*Taraxacum officinale* Web.) in this temperature. It must be underlined that these records were taken in an apiary with abundant food supply (pollen, nectar). These reliable and credible results could be obtained. Unlike in the investigations by other researchers who set up pollen traps or placed the colonies in low-pollen or low-nectar environment (Poliščuk 1984), in this study no effort was made to intensify the flight activity of worker bees in the search of defined products.

Conclusions

The tested bee subspecies differed in the flight activity. *A. m. mellifera* bees were the most active, whearase *A. m. caucasica* bees were the least active.

A.m. carnica have the higher efficiency in pollen foraging, that appears to be visible after introducing the foraging ratio that refers to the number of pollen foragers per 100 incoming bees.

A. m. mellifera and *A. m. carnica* bees showed higher flight activity than *A. m. caucasica* bees regardless of the day-time and the air temperature.

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THE GENETIC DIVERSITY OF BEAVERS (*CASTOR FIBER*) IN THE POPULATIONS REINTRODUCED IN LITHUANIA

Birute Norvaišaitė, Algimantas Paulauskas, Alius Ulevičius

Norvaišaitė B., Paulauskas A., Ulevičius A. 2003. The genetic diversity of beavers (*Castor fiber*) in the populations reintroduced in Lithuania. *Acta Biol.Univ. Daugavp., 3 (2): 107 - 112.*

During the first decades of the 20th century, European Beaver (*Castor fiber*) became extinct in Lithuania. In the 1940s, the beaver appeared again in the country as a result of natural immigration, as well as artificial reintroduction. The collecting of the material was carried out during 2001-2002 year from Merkys, Šventoji, Minija, Šešupė, Dubysa basin, and Nemunas delta in Lithuania. and biochemical staining were to analyze the of the European Beaver to estimate genetic variation of *C. fiber* in Lithuania. The genetic variability of 82 individuals from various basin were investigated using PAGE electrophoresis of 7 enzyme (esterase (EST), lactate dehydrogenase (LDH), malate dehydrogenase (MDH), malic enzyme (MDE), glucose-6-phosphate dehydrogenase (G6PD), a-glicerosephosphat dehydrogenase (a-GPD), superoksidismutase (SOD)) and 1 nonspecific-protein (NPR) systems. During our investigation were found 15 locus: *G6pd-1, G6pd-2, Mdh-1, Mdh-2, Mde-1, Ldh-1, Ldh-2, Est-1, Est-2, Est-3, Est-4, Npr-1, Npr-3, Npr-4,* and *Npr-5,* 12 of them were polymorphic but Mdh-2, Npr-1 and Npr-3 were monomorphic. The population genetic structure and genetic variation of beavers was evaluated. The frequency of alleles in all investigated basin was different at different loci.

Key words: Castor fiber, electrophoresis, isoenzymes, genetic diversity.

Birute Norvaišaitė, Algimantas Paulauskas. Department of Biology, Vytautas Magnus University, Vileikos 8, LT-3035 Kaunas, Lithuania, a.paulauskas@gmf.vdu.lt

Algimantas Paulauskas, Alius Ulevičius. Institute of Ecology of Vilnius University, Akademijos 2, LT-2600 Vilnius, Lithuania

Introduction

During the first decades of the 20th century, European Beaver (*Castor fiber*) became extinct in Lithuania. In the 1940s, the beaver appeared again in the country as a result of natural immigration, as well as artificial reintroduction. Today high population density (32 000 in 1999) was established in various water bodies and areas (Ulevičius 2000). A few years ago the Lithuanian beaver population was investigated on phenetical diversity using the method of non-metric variability of the skull (Ulevicius 1997). The results of investigations show that reintroduced beaver groups and especially groups of mixed origin distinguish by higher level of phenetical diversity from the beavers of the aboriginal group.

The aim of the present study was to estimate genetic variation of *C. fiber* in Lithuania during 2001-2002 year.

Material and methods

The collecting material of 82 individuals of the European Beaver was carried out during 2001-2002 year from Merkys, Šventoji, Minija, Šešupė,

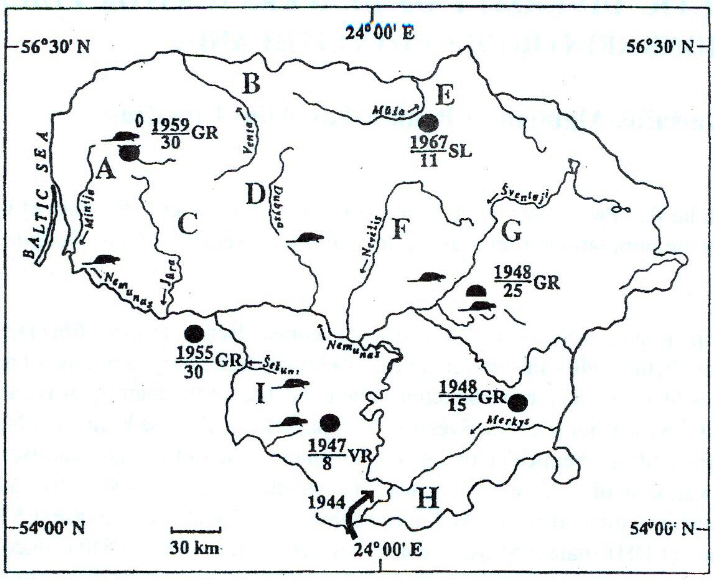

Fig. 1. Reintroduction places of C. fiber from Gromel (GR), Voronez (VR) and south Lithuania (SL).

 - places of our examples.

Dubysa basin, and Nemunas delta in Lithuania (Fig.1). Liver tissue homogenate of beaver were used for electrophoretic analysis. Approximately 5 g of individual frozen samples liver tissue was crushed in 5 ml of homogenate buffer (0.2 M Tris-HCl pH 8.1, 2% Triton X-100, 2.5 nM MgCl2 , 0.02 g NADP) by glasses homogenizator. The homogenate was centrifuged five minutes at 1500 rpm. The supernatant was collected in 200 ?l micro tubes and frozen at -20oC. Five ?l of homogenate were analyzed by electrophoresis in polyaclrylamide gel (PAAG), following Davis (1964), Brewer (1970) and Rothe (1994).

The genetic variability of 82 individuals from various basin were investigated using PAGE electrophoresis of 7 enzyme (esterase (EST), lactate dehydrogenase (LDH), malate dehydrogenase (MDH), malic enzyme (MDE), glucose-6-phosphate dehydrogenase (G6PD), a-glicerosephosphat dehydrogenase (a-GPD), superoksidismutase (SOD)) and 1 nonspecific-protein (NPR) systems.

The population genetic structure and genetic variation of beavers was evaluated using software BIOSYS-2 (Swofford et al. 1997) based on: allele and genotype frequencies; observed (H^o) and expected (H_{ex}) heterozygosity: mean (H_{mean}) heterozygosity: H_{mean}; polymorphism level $P_{0.95}$; number of alleles at locus and total number of alleles; heterozygote deficit estimated by D-statistics: $D = (H_o - H_{ex}) / H_{ex}$ (Table 2) . The BIOSYS2 program (Swofford and Selander 1997) was used for computation of genetic similarities and distances (Nei's and Roger's coefficient - Nei 1972, Roger 1972) and construction of phylogenetic tree by UPGMA method.

Results and discussion

During our investigation were found 15 locus: *G6pd-1, G6pd-2, Mdh-1, Mdh-2, Mde-1, Ldh-1, Ldh-2, Est-1, Est-2, Est-3, Est-4, Npr-1, Npr-3, Npr-4*, and *Npr-5*, 12 of them were polymorphic but Mdh-2, Npr-1 and Npr-3 were monomorphic

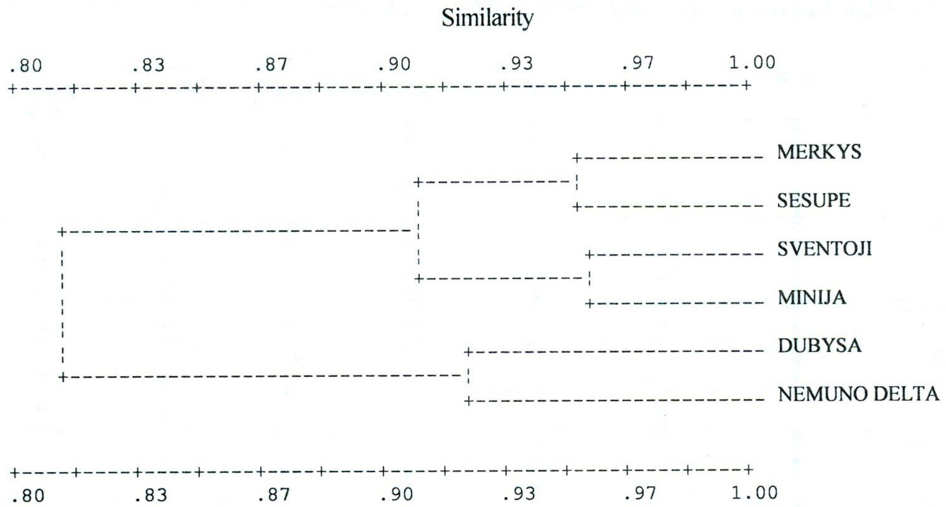

Fig. 2. Cluster analysis using unweighted pair group method
Coefficient used: Nei (1978) unbiased genetic identity

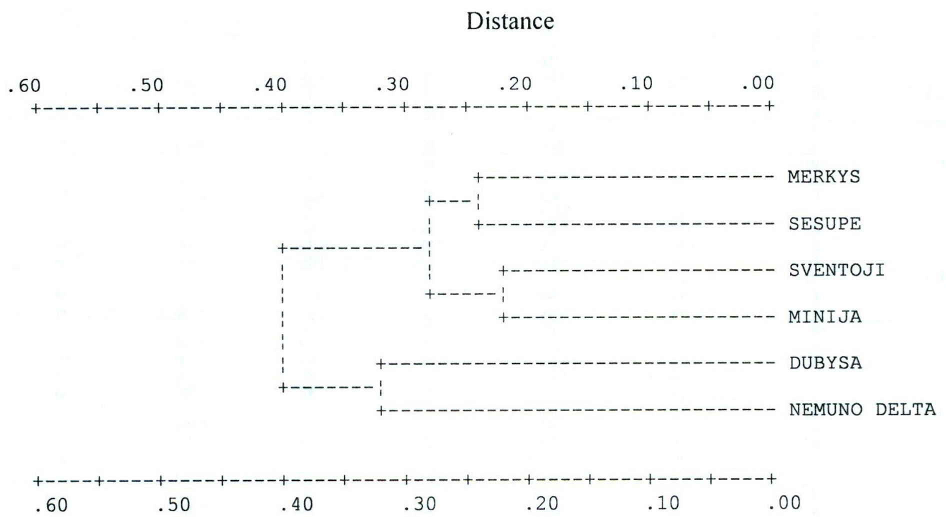

Fig. 3. Cluster analysis using unweighted pair group method
Coefficient used: Modified Rogers distance (Wright,1978)

(Table 1). The frequency of alleles in all investigated basin was different at different loci.

On investigating the genetic structure of beaver subpopulation from different basin (and reintroduction areas), a wide varity of genotypes and that at different loci was established (Table 2). In some beaver subpopulations in Lithuania we found absolute heterozygote deficit: of Mde-4 locus in Merkys subpopulation, of Gpd-2 in Minija subpopulation.

The mean, observed heterozygosity Ho was found between 0.307 in Merkys and 0.492 in Sesupe subpopulation (Table 3). The highest polimorphism was detected in Šventoji basin (88.2%) and the smallest was found in Dubysa basin (41.2%).

Table 1. Allele frequencies in populations of *C. Fiber* in Lithuania

Locus	Allele	Population					
		MERKYS	SVENTOJI	MINIJA	SESUPE	DUBYSA	NEMUNO DELTA
MDH-1	(N)	9	13	8	8	1	2
	A	0.278	0.577	0.063	0.250	0.000	1.000
	B	0.111	0.115	0.313	0.438	0.000	0.000
	C	0.333	0.077	0.250	0.250	1.000	0.000
	D	0.278	0.231	0.250	0.063	0.000	0.000
	E	0.000	0.000	0.125	0.000	0.000	0.000
MDH-2	(N)	9	24	13	11	1	1
	A	0.444	0.813	0.423	0.591	1.000	1.000
	B	0.333	0.125	0.231	0.182	0.000	0.000
	C	0.222	0.063	0.346	0.045	0.000	0.000
	D	0.000	0.000	0.000	0.182	0.000	0.000
MDH-3	(N)	2	4	5	11	1	1
	A	0.500	0.375	0.400	0.455	1.000	1.000
	B	0.500	0.625	0.600	0.545	0.000	0.000
MDE-1	(N)	8	16	7	11	1	2
	A	0.375	0.813	0.500	0.591	1.000	1.000
	B	0.438	0.125	0.357	0.091	0.000	0.000
	C	0.063	0.063	0.071	0.136	0.000	0.000
	D	0.125	0.000	0.071	0.182	0.000	0.000
MDE-2	(N)	4	13	12	11	1	1
	A	0.500	0.423	0.208	0.682	1.000	1.000
	B	0.375	0.500	0.500	0.318	0.000	0.000
	C	0.125	0.077	0.292	0.000	0.000	0.000
MDE-3	(N)	8	11	12	7	1	1
	A	0.188	0.273	0.375	0.357	1.000	1.000
	B	0.813	0.727	0.625	0.643	0.000	0.000
MDE-4	(N)	5	9	6	1	1	1
	A	0.400	0.111	0.583	1.000	1.000	1.000
	B	0.200	0.611	0.250	0.000	0.000	0.000
	C	0.400	0.278	0.167	0.000	0.000	0.000
GPD-1	(N)	7	31	8	13	2	3
	A	0.357	0.758	0.625	0.538	0.750	0.667
	B	0.643	0.242	0.375	0.462	0.250	0.333
GPD-2	(N)	8	9	3	2	2	1
	A	1.000	0.556	0.333	1.000	0.500	0.500
	B	0.000	0.444	0.667	0.000	0.500	0.500
NPR-1	(N)	9	16	3	3	1	3
	A	1.000	1.000	1.000	1.000	1.000	1.000
NPR-2	(N)	9	18	2	3	1	3
	A	1.000	1.000	1.000	1.000	1.000	1.000
NPR-3	(N)	9	31	12	13	2	3
	A	0.500	0.516	0.542	0.269	0.500	0.500
	B	0.389	0.435	0.333	0.231	0.500	0.500
	C	0.056	0.016	0.042	0.038	0.000	0.000
	D	0.056	0.000	0.083	0.423	0.000	0.000
	E	0.000	0.016	0.000	0.000	0.000	0.000
	F	0.000	0.016	0.000	0.038	0.000	0.000
NPR-4	(N)	9	21	3	3	2	3
	A	1.000	0.524	0.333	0.667	0.750	0.500
	B	0.000	0.476	0.667	0.333	0.250	0.500
EST-1	(N)	8	24	15	13	1	3
	A	0.375	0.229	0.167	0.154	0.500	0.500
	B	0.438	0.458	0.667	0.462	0.500	0.500
	C	0.188	0.063	0.033	0.077	0.000	0.000
	D	0.000	0.000	0.133	0.308	0.000	0.000
EST-2	(N)	9	29	12	13	1	3
	A	0.556	0.345	0.500	0.346	0.500	0.500
	B	0.333	0.414	0.375	0.346	0.000	0.333
	C	0.000	0.241	0.083	0.154	0.500	0.167
	D	0.111	0.000	0.042	0.154	0.000	0.000
EST-3	(N)	9	27	15	15	2	3
	A	0.278	0.296	0.300	0.233	0.000	0.167
	B	0.222 0.333	0.370	0.167	0.400	0.250	0.667
	C	0.167	0.296	0.400	0.367	0.750	0.167
	D		0.037	0.133	0.000	0.000	0.000
EST-4	(N)	9	26	15	13	2	3
	A	0.389	0.500	0.367	0.423	1.000	0.500
	B	0.500	0.442	0.467	0.308	0.000	0.500
	C	0.000	0.019	0.000	0.077	0.000	0.000
	D	0.111	0.038	0.167	0.192	0.000	0.000

Following Nei`s calculations the higest genetic distance was detected between beavers subpopulations from Nemuno delta and Merkys basin (0.733), and the lowest genetic distance was calculated between subpopulations from Šventoji and Minija (0.098) and this shows that these subpopulations are geneticaly the most resembled from all investigated subpopulations (I_{Nei} = 0.907)(Fig.2 and Fig.3).

Observed data in genetic variability of Lithuanian rivers populations of *C. fiber* consisted with morpfometric analysis of dr. A. Ulevicius. Also, genetic variability and distances data shows reli-

Table 2. Coefficients for heterozygote deficiency or excess

LOCUS	HETEROZYGOTES		FIXATION INDEX (F)	D	CHI-SQUARE	P
	OBSERVED	EXPECTED				
			POPULATION: MERKYS			
MDH-1	1	6.882	0.846	-0.855	19.98	0.0000
MDH-2	6	6.118	-0.038	-0.019	0.01	0.9325
MDH-3	0	1.333	1.000	-1.000	3.56	0.0593
MDE-1	5	5.533	0.036	-0.096	0.18	0.6716
MDE-2	1	2.714	0.579	-0.632	3.47	0.0626
MDE-3	3	2.600	-0.231	0.154	0.22	0.6425
MDE-4	0	3.556	1.000	- 1.000	11.62	0.0007
GPD-1	1	3.462	0.689	-0.711	4.11	0.0427
NPR-3	4	5.647	0.250	-0.292	1.47	0.2254
EST-1	4	5.400	0.210	-0.259	1.13	0.2867
EST-2	8	5.412	-0.565	0.478	3.74	0.0531
EST-3	8	7.000	-0.210	0.143	0.59	0.4417
EST-4	3	5.588	0.432	-0.463	3.47	0.0623
			POPULATION: SVENTOJI			
MDH-1	9	8.040	-0.164	0.119	0.45	0.5016
MDH-2	4	7.851	0.480	-0.491	9.58	0.0020
MDH-3	1	2.143	0.467	-0.533	1.49	0.2228
MDE-1	3	5.290	0.415	-0.433	5.08	0.0242
MDE-2	3	7.640	0.592	-0.607	7.47	0.0063
MDE-3	2	4.571	0.542	-0.563	3.82	0.0506
MDE-4	1	5.118	0.793	-0.805	10.75	0.0010
GPD-1	7	11.557	0.384	-0.394	4.98	0.0256
GPD-2	8	4.706	-0.800	0.700	4.94	0.0262
NPR-3	24	17.115	-0.425	0.402	6.79	0.0092
NPR-4	14	10.732	-0.336	0.305	2.04	0.1528
EST-1	7	7.255	0.015	-0.035	0.02	0.8806
EST-2	22	19.228	-0.164	0.144	1.22	0.2702
EST-3	22	18.868	-0.188	0.166	1.75	0.1853
EST-4	24	14.647	-0.671	0.639	14.98	0.0001
			POPULATION: MINIJA			
MDH-1	7	6.467	-0.155	0.082	0.21	0.6502
MDH-2	2	8.760	0.763	-0.772	16.20	0.0001
MDH-3	2	2.667	0.167	-0.250	0.39	0.5345
MDE-1	3	4.615	0.300	-0.350	1.91	0.1674
MDE-2	4	7.783	0.464	-0.486	5.84	0.0156
MDE-3	3	5.870	0.467	-0.489	3.12	0.0772
MDE-4	1	3.727	0.707	-0.732	6.95	0.0084
GPD-1	2	4.000	0.467	-0.500	2.28	0.1314
GPD-2	0	1.600	1.000	-1.000	4.32	0.0377
NPR-3	7	7.348	0.006	-0.047	0.05	0.8181
NPR-4	2	1.600	-0.500	0.250	0.27	0.6033
EST-1	10	7.897	-0.310	0.266	2.35	0.1255
EST-2	8	7.522	-0.110	0.064	0.09	0.7587
EST-3	15	10.931	-0.420	0.372	5.91	0.0151
EST-4	11	9.621	-0.183	0.143	0.59	0.4406
			POPULATION: SESUPE			
MDH-1	5	5.800	0.080	-0.138	0.42	0.5191
MDH-2	6	6.714	0.064	-0.106	0.30	0.5839
MDH-3	6	5.714	-0.100	0.050	0.03	0.8621
MDE-1	5	6.810	0.231	-0.266	2.05	0.1522
MDE-2	5	5.000	-0.048	0.000	0.00	1.0000
MDE-3	5	3.462	-0.556	0.444	1.60	0.2054
GPD-1	4	6.720	0.381	-0.405	2.30	0.1291
NPR-3	9	9.360	0.000	-0.038	0.05	0.8174
NPR-4	2	1.600	-0.500	0.250	0.27	0.6033
EST-1	10	8.960	-0.161	0.116	0.44	0.5058
EST-2	13	9.640	-0.402	0.349	4.60	0.0320
EST-3	10	10.103	-0.024	-0.010	0.00	0.9544
EST-4	12	9.240	-0.351	0.299	3.05	0.0806
			POPULATION: DUBYSA			
GPD-1	1	1.000	-0.333	0.000	0.00	1.0000
GPD-2	2	1.333	-1.000	0.500	0.89	0.3458
NPR-3	2	1.333	- 1.000	0.500	0.89	0.3458
NPR-4	1	1.000	-0.333	0.000	0.00	1.0000
EST-1	1	1.000	-1.000	0.000	0.00	1.0000
EST-2	1	1.000	-1.000	0.000	0.00	1.0000
EST-3	1	1.000	-0.333	0.000	0.00	1.0000
			POPULATION: NEMUNO DELTA			
GPD-1	2	1.600	-0.500	0.250	0.27	0.6033
GPD-2	1	1.000	-1.000	0.000	0.00	1.0000
NPR-3	3	1.800	-1.000	0.667	1.92	0.1659
NPR-4	1	1.800	0.333	-0.444	0.85	0.3556
EST-1	3	1.800	-1.000	0.667	1.92	0.1659
EST-2	3	2.200	-0.636	0.364	1.03	0.3098
EST-3	1	1.800	0.333	-0.444	1.54	0.2152
EST-4	3	1.800	-1.000	0.667	1.92	0.1659

Table 3: Genetic variability at 17 loci in all populations of *Castor fiber* (standard errors in parentheses)

	Population	Mean sample size per Locus	Mean no. of alleles per locus	Percentage of loci polymorphic*	Mean heterozygosity	
					Direct-count	HdyWbg expected**
1.	MERKYS	7.7±0.5	2.6±0.3	76.5	0.307±0.077	0.489±0.072
2.	ŠVENTOJI	18.9±2.0	2.8±0.3	88.2	0.436±0.080	0.472±0.052
3.	MINIJA	8.9±1.1	2.9±0.3	88.2	0.422±0.076	0.537±0.053
4.	ŠEŠUPĖ	8.9±1.1	2.7±0.3	76.5	0.492±0.079	0.471±0.069
5.	DUBYSA	1.4±0.1	1.4±0.1	41.2	0.324±0.105	0.284±0.091
6.	NEMUNO DELTA	2.2±0.2	1.6±0.2	47.1	0.373±0.110	0.310±0.086

* A locus is considered polymorphic if the frequency of the most common allele does not exceed 0,95
** Unbiased estimate (see Nei, 1978)

ability to beavers distribution considering to their intoduction places.

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THE GENETIC VARIATION OF MIGRATING WHITE-FRONTED GOOSE

Vykintas Baublys, Algimantas Paulauskas, Aniolas Sruoga

Baublys V., Paulauskas A., Sruoga A. 2003. The genetic variation of migrating white - fronted goose. *Acta Biol. Univ. Daugavp., 3 (2): 113 - 117.*

Multilocus isoenzymes and random amplified polymorphic DNA (RAPD) polymorphisms were examined of White-fronted goose (*Anser albifrons*). In allozyme analysis fifteen protein systems were investigated, and 20 loci were detected, from which 2 (Sod and Me-1) were monomorphic. For RAPD analysis ten primers each of 10 base pairs were used. The results from proteins polymorphism indicated that genetic diversity within geese was large (0.4308) and almost twice lower were obtained with RAPD (0.2464). After analyzing all concepts in our study we recommend to use RAPD analysis for further studies of White-fronted geese.

Key words: polymorphism, isoenzymes, RAPD, geese, migration

Vykintas Baublys; Vytautas Magnus University, Vileikos 8, LT-3035 Kaunas, Lithuania; e-mail: V.Baublys@gmf.vdu.lt;

Algimantas Paulauskas, Aniolas Sruoga; Vytautas Magnus University, Vileikos 8, LT-3035 Kaunas, Lithuania or Institute of Ecology of Vilnius University, Vilnius, Lithuania

Introduction

Molecular typing methods provide an opportunity for a powerful and reproducible approach of estimating genetic diversity within and among species. Proteins are markers of the specific genes and can be easily determined by applying electrophoresis. A polymorphism assay, based on the amplification of random DNA fragments, has been developed by Williams et al. (1990) and Welsh and McClelland (1990). It provides a very useful tool for genome analysis in population studies, where individual isolates can be compared rapidly (McPherson et al. 2000; Dowling et al., 1996, Palumbi et al. 1996). This randomly amplified polymorphic DNA (RAPD) assay has been widely used by researches because of its simplicity and applicability. The RAPDs have been used to detect species-specific markers, to estimate genetic relatedness among various bird species and within as well as between population genetic variability (Sruoga et al. 2000; Padilla et al. 2000; Sharma et al. 1998) as well as for genome mapping (Levin et al. 1993).

Lithuania is located on two White-fronted goose flyways: East Atlantic and Central Europe. Certain Lithuanian areas, located on the East Atlantic flyway, are very important for migratory populations of geese (Švažas et al., 1997). In recent years White-fronted goose is the dominant goose specie in Lithuania during migration period. The whole population wintering in NW Europe has increased (Scott et al., 1996). There is suggestion what such an increase is because of decrease of wintering populations in Central Europe. In this study by protein polymorphism and RAPD analysis we examined and evaluated the genetic variability of White-fronted geese. Second objective was a comparison of protein and

RAPD markers for the molecular characterization of Anser albifrons species.

Material and Methods

White-fronted geese liver homogenate was used as investigation material for protein electrophoresis. Samples were homogenized and stored at -20 (C until use. Disk-electrophoresis was carried out in a two layer vertical block of polyacrilamide slides following the methods suggested by Brewer (1970), Orstein (1964) and Murphy (1996) with some modifications to increase separation. Proteins were stained with Coomassie Blue G-250, enzymes were stained according to the commonly accepted methods, with some modifications (Корочкин 1977, Murphy 1996). All parameters and distances were calculated using Biosys-1, Biosys-2 and PopGene 1.32.

Using electrophoresis 15 protein systems were investigated: macroglobulin (Mc), posttransferin (Ptf), transferin (Tf), pretransferin (Prtf), postalbumin (Pa), albumin (Al), prealbumin (Pr), lactate dehydrogenase (Ldh), malate dehydrogenase (Mdh), esterase (Est), a-glicerophosphate dehydrogenase (a -Gpd), xanthine dehydrogenase (Xdh), glucose-6-phosphatdehydrogenase (G6pdg), malic enzyme (Me) and superoxide dismutase (Sod).

Samples were obtained during Vytautas Magnus University and Institute of Ecology research expeditions in Nemunas Delta region. Expeditions were carried out on March 23 in 1995 year, on April 12 in 1997 year, on April 7 in 1998 year (protein analysis); March 23 - 30 in 1999 year and on

Table 1. Composition of RAPD primers

Primer	Ol-2	Ol-3	Ol-4	Ol-5	Ol-6
Sequence (5^l to 3^l)	CTACGAGACT	CTCACCCGTC	CAATCGCCGT	CAAACGTCGG	GTCCACACGG
Primer	Ol-7	Ol-8	Ol-9	Ol-11	Ol-12
Sequence (5^l to 3^l)	ACGCCGTACG	ACGTCGAGCA	TCCGCTCTGG	GTGAGGCGTC	GATGACCGCC

Table 2. Genetic variability of White-fronted geese. A. Mean number of bands (A); Proportion of polymorphic loci at the 5% level; Mean Nei's gene diversity (H). B. Mean number of alleles per loci (A); Mean polymorphism (P); Observed heterozygosity (H).

A. RAPD analysis

Primer	Mean	Ol2	Ol3	Ol4	Ol5	Ol6	Ol7	Ol8	Ol9	Ol11	Ol12
A	11.49	9.4	12.2	13.8	11.6	11.9	9	13.6	9.4	12.8	11.1
P	76.89%	69.57%	80.27%	84.00%	75.77%	74.10%	78.77%	81.50%	75.27%	78.30%	71.27%
H	0.2464	0.2475	0.2876	0.2833	0.2189	0.2641	0.2511	0.2294	0.2095	0.2422	0.2301

B. Multilocus enzymes analysis

Proteins	Mean	Ldh	? - Gpd	Xdh	G6pdg-1	G6pdg-2	G6pdg-3	Mdh - 1	Mdh - 2	Me - 1	Me - 2
A	2.2	2	2	2	2	2	2	2	2	1	5
P	90.00%	poli	poli	Poli	poli	poli	poli	poli	poli	mono	poli
H	0.4308	0.4393	0.5000	0.2273	0.2947	0.4615	0.0000	0.3887	0.6117	0.0000	0.5873
Proteins	Est	Mc	Ptf	Tf	Prtf	Pa	Alb	Pr - 1	Pr - 2	Sod	-
A	3	2	2	4	2	2	2	2	2	1	-
P	poli	poli	poli	Poli	poli	poli	poli	poli	poli	mono	-
H	0.7527	0.2818	0.5606	0.8369	0.4626	0.4332	0.5669	0.2861	0.9252	0.0000	-

Table 3. Allele (protein analysis) and fraction (RAPD) frequencies of White-fronted geese

Loci	Alelle / Frequency	Fraction / Frequency	Fraction / Frequency	Fraction / Frequency	Fraction / Frequency	Fraction / Frequency	Fraction / Frequency
Ldh	100 / 0.3387	Ol2 primer	400 / 0.90909	1054 / 0.06818	1229 / 0.02273	Ol9 primer	826 / 1
	99 / 0.6613	2448 / 0.20455	367 / 0.09091	986 / 1	1114 / 0.27273	2581 / 0.02273	692 / 0.95455
α - Gpd	100 / 0.6000	2260 / 0.31818	350 / 0.27273	952 / 0.06818	994 / 0.84091	2343 / 0.02273	649 / 0.81818
	99 / 0.4000	2000 / 0.15909	300 / 0.43182	852 / 1	958 / 0.06818	2234 / 0.02273	586 / 0.97727
Xdh	100 / 0.6136	1860 / 0.09091	227 / 0.36364	784 / 0.31818	911 / 0.20455	1941 / 0.02273	531 / 0.50000
	99 / 0.3864	1730 / 0.34091	200 / 0.25000	745 / 0.43182	825 / 1	1679 / 0.65909	518 / 0.65909
G6pdg - 1	100 / 0.3750	1644 / 0.04545	150 / 0.20455	586 / 0.88636	774 / 0.29545	1588 / 0.34091	447 / 0.31818
	99 / 0.6250	1465 / 0.22727	Ol4 primer	554 / 0.65909	708 / 0.61364	1467 / 0.25000	411 / 0.81818
G6pdg - 2	100 / 0.5385	1286 / 0.81818	2723 / 0.02273	447 / 0.84091	607 / 0.93182	1418 / 0.04545	340 / 0.90909
	99 / 0.4615	1119 / 0.36364	2319 / 0.70455	362 / 1	572 / 0.97727	1282 / 0.02273	251 / 1
G6pdg - 3	100 / 0.3571	1056 / 0.70455	2101 / 0.20455	287 / 0.90909	512 / 0.18182	1253 / 0.31818	197 / 0.47727
	99 / 0.6429	957 / 0.56818	1780 / 1	Ol6 primer	455 / 0.79545	1163 / 0.88636	Ol12 primer
Mdh - 1	100 / 0.1579	900 / 0.31818	1648 / 0.22727	2637 / 0.02273	360 / 0.04545	1041 / 0.15909	2907 / 0.02273
	99 / 0.8421	861 / 1	1467 / 0.40909	2479 / 0.06818	333 / 0.09091	989 / 0.06818	2770 / 0.02273
Mdh - 2	100 / 0.4286	809 / 0.75000	1296 / 1	2222 / 0.02273	310 / 0.38636	969 / 0.11364	2502 / 0.09091
	99 / 0.5714	773 / 0.02273	1213 / 0.18182	2034 / 0.09091	290 / 0.88636	900 / 1	2213 / 0.06818
Sod	1	683 / 0.77273	1136 / 0.22727	1905 / 0.18182	221 / 0.29545	881 / 0.02273	2176 / 0.06818
Me - 1	1	651 / 0.68182	1077 / 0.04545	1763 / 0.56818	Ol8 primer	844 / 0.13636	2000 / 0.09091
Me - 2	100 / 0.0806	600 / 0.29545	1031 / 0.20455	1500 / 0.02273	3522 / 0.06818	800 / 0.13636	1878 / 0.22727
	99 / 0.1613	470 / 0.93182	958 / 0.79545	1429 / 0.79545	2347 / 0.09091	767 / 0.25000	1747 / 0.13636
	98 / 0.3871	436 / 0.09091	919 / 0.86364	1318 / 0.47727	2106 / 0.50000	687 / 0.97727	1482 / 0.97727
	97 / 0.2742	268 / 0.18182	817 / 0.84091	1260 / 0.06818	1896 / 0.86364	626 / 0.09091	1363 / 0.04545
	96 / 0.0968	219 / 0.13636	729 / 0.97727	1215 / 0.65909	1500 / 0.61364	581 / 0.54545	1256 / 0.65909
Est	100 / 0.1667	149 / 0.34091	672 / 0.65909	1127 / 1	1444 / 0.02273	517 / 0.97727	1148 / 0.90909
	99 / 0.4630	Ol3 primer	619 / 0.04545	984 / 1	1388 / 0.34091	455 / 0.04545	1042 / 0.93182
	98 / 0.3704	2962 / 0.34091	587 / 1	900 / 0.90909	1353 / 0.04545	441 / 0.06818	943 / 0.75000
Mc	100 / 0.2727	2350 / 0.59091	524 / 1	819 / 1	1186 / 0.04545	420 / 0.22727	800 / 0.63636
	99 / 0.7273	2303 / 0.02273	436 / 0.84091	728 / 0.63636	1125 / 0.31818	367 / 0.27273	764 / 0.02273
Ptf	100 / 0.7727	1868 / 0.36364	378 / 0.77273	679 / 0.77273	1031 / 100000	295 / 0.75000	700 / 0.90909
	99 / 0.2273	1848 / 0.15909	314 / 0.11364	570 / 0.54545	945 / 0.45455	252 / 0.02273	627 / 0.90909
Tf	100 / 0.0455	1596 / 0.77273	279 / 0.04545	526 / 0.61364	890 / 0.93182	243 / 0.65909	607 / 0.04545
	99 / 0.5000	1545 / 0.25000	233 / 0.72727	506 / 0.02273	809 / 0.65909	171 / 0.29545	548 / 0.79545
	98 / 0.3636	1440 / 0.90909	160 / 0.86364	446 / 0.22727	745 / 0.81818	Ol11 primer	489 / 0.75000
	97 / 0.0909	1381 / 0.56818	Ol5 primer	411 / 0.97727	676 / 0.25000	2588 / 0.02273	466 / 0.18182
Prtf	100 / 0.3182	1236 / 0.20455	2911 / 0.40909	382 / 0.02273	640 / 0.47727	2372 / 0.02273	433 / 0.22727
	99 / 0.6818	1100 / 0.93182	2649 / 0.36364	364 / 0.04545	593 / 0.02273	2137 / 0.04545	337 / 0.97727
Pa	100 / 0.3182	1031 / 0.70455	1805 / 0.11364	322 / 0.65909	538 / 1	2066 / 0.02273	320 / 0.11364
	99 / 0.6818	935 / 0.02273	1648 / 1	276 / 0.27273	461 / 0.63636	1881 / 0.04545	246 / 0.25000
Alb	100 / 0.3636	860 / 0.88636	1552 / 0.02273	224 / 0.22727	417 / 0.27273	1609 / 0.04545	208 / 0.06818
	99 / 0.6364	800 / 1	1433 / 0.97727	Ol7 primer	360 / 0.22727	1483 / 0.04545	175 / 0.22727
Pr - 1	100 / 0.5000	700 / 0.72727	1340 / 0.29545	1858 / 0.04545	330 / 0.13636	1320 / 0.81818	135 / 0.02273
	99 / 0.5000	610 / 0.65909	1294 / 0.06818	1574 / 0.04545	282 / 1	1239 / 0.97727	-
Pr - 2	100 / 0.4545	589 / 0.20455	1226 / 1	1500 / 0.20455	246 / 1	1090 / 0.93182	-
	99 / 0.5455	550 / 0.18182	1200 / 0.11364	1411 / 0.09091	214 / 1	985 / 0.88636	-
-	-	500 / 0.13636	1137 / 0.02273	1300 / 0.68182	167 / 0.79545	941 / 0.50000	-

April 18 in 2000 year (RAPD analysis). In multilocus enzymes analysis by protein electrophoresis method we analysed 50 individuals of White-fronted goose (Anser albifrons). For DNA analysis venous blood was collected from 44 birds. Blood samples (400-500 (l) were collected in heparin tubes and frozen at -20(C till use. DNA was extracted from blood by the method described by Miller et al. (1998) with an additional chloroform extraction step, dissolved in water and stored at -20°C.

Ten primers each of 10 nucleotides (Shanghai Sangon Ltd., China) were used for amplification (Table 1). The PCR and electrophoresis were performed as described by Sruoga et al. (1997). The gels were photographed and saved by the Gel Doc 1000 (Bio Rad, Germany) computer video system. Analysis was performed using TotalLab v.1.10 (Nonlinear Dynamics Limited, England) software. DNA fragment sizes were assessed by comparison with GeneRuler(tm) 100 bp DNA Lader Plus (MBI Fermentas, Lithuania). Parameters of biochemical polymorphism were calculated using AFLP-SURV 1.0 (Vekemans et al. 2002).

Results and Discussion

In multilocus isoenzyme analysis detected mean number of alleles per loci was 2,2 (Table 2). Fifteen enzymes systems were investigated, and 20 loci were detected, from which 2 (Sod and Me-1) were monomorphic (Table 3). In White-fronted goose gene frequencies analysis we detected what it varied from 0,0455 (Tf99 allele) to 0.8421 (Mdh-1 99 allele). In G6pdg-3 loci were not detected heterozygotes at all, it can be explained by selection against heterozygotes. Estimations of heterozygosity varied between loci a lot. The biggest observed heterozygosity detected in Pr-2 loci (0.9252) (Table 2). Also big heterozygosity detected in Tf loci (0.8369) and Est loci (0.7527). The lowest heterozygosity was detected in Xdh loci (0.2273). The mean heterozygosity was quite big (0.4308). It can be explained by very big genetic variability within population, investigation shows only 0.6984 genetic similarity between two White-fronted geese flocks. From 20 analysed loci we detected 90% polymorphic loci.

In Random amplified polymorphic DNA analysis we calculated amplification fragments frequencies (Table 3). Proportion of polymorphic loci varied between primers (Table 2); the lowest was for primer Ol2 (69.57%), the highest for Ol4 (84%). The mean proportion (76.89%) was lower then in protein analysis. Mean number of bands per individual varied between primers from 9 (Ol7) to 13.8 (Ol4). The mean number of bands per individual over all loci was 11,49.

Between the primers overall gene diversity varied slightly per primer. Significant differences were detected only between Ol3, Ol4 (0.2876, 0.2833 respectively) and other primers, also between Ol9, with lowest gene diversity (0.2095), and other primers. The mean gene diversity over all loci was 0.2464. It is almost twice lower then in multilocus enzymes analysis. The genetic similarity between three different migrating flock was from 0.8232 - 0.8348. It is significantly higher than in protein analysis. It can be what geese which breeding grounds are farer in North migrate through Lithuania earlier. That shows what populations from different breeding-grounds migrate throw Lithuania on different days of month. Samples for protein analysis taking date differs by a month so it is quite a lot time for completely different populations migration. Big heterozygosities suggest what White-fronted geese populations are mating with each other randomly and there is a low possibility of inbreeding. Using RAPD analysis polymorphism can be revealed by a few selected markers and wouldn't be significantly different. We recommend that RAPD be used in further studies.

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GENETIC DIVERSITY OF BANK VOLE (*CLETHRIONOMYS GLAREOLUS*) POPULATIONS IN ARTIFICIAL WATER RESERVOIR ISLANDS (ANTALIEPTĖ, LITHUANIA)

Daina Skiriutė, Algimantas Paulauskas, Rimvydas Šinkūnas, Linas Balčiauskas

Skiriute D., Paulauskas A., Šinkūnas R., Balčiauskas L. 2003. Genetic diversity of bank vole (*Clethrionomys glareolus*) populations in artificial water reservoir islands (Antalieptė, Lithuania). *Acta Biol. Univ. Daugavp., 3 (2): 119 - 124.*

Antalieptė 'sea' is an artificial water reservoir formed due to damming the river Šventoji in 1959. In 1999-2001 bank vole *(Clethrionomys glareolus)* was dominating (89.8 %) the species of small mammals in all study sites in Antalieptė reservoir, therefore bank voles of 5 islands, peninsula and the mainland populations were screened for genetic diversity. Seven loci of proteins of bank vole were used for evaluation of genetic diversity. Six of all the loci studied exhibited polymorphism in all populations in the study. The number of alleles per locus varied from 1.57 ± 0.53 to 2.0 ± 0.82 among the populations. Percent of loci heterozygous varied from 31% in the mainland, 21% in peninsula and from 10 to 18% in island populations of bank vole. Significant departures from Hardy-Weinberg equilibrium occurred at the 5 (level when tested on a per-locus or per-locality basis. Bank voles in artificial water reservoir island populations is found to be greatly differentiated genetically and clearly discriminated when expressed by FST=0.20. 80% of genetic diversity is displayed inside the populations. Genetic differentiation among populations of bank vole positively depends on an isolation-by-distance (r=0.870, p=0.06) between an island and the mainland. The Antalieptė reservoir shows 50 years period effect of fragmentation of landscape on species richness of voles and on genetic variability of bank voles.

Key words: fragmentation, *Clethrionomys glareolus*, proteins, genetic diversity.

Daina Skiriutė, Algimantas Paulauskas. Department of Biology, Vytautas Magnus University, Vileikos 8, LT-3035 Kaunas, Lithuania; e-mail: d.skiriute@gmf.vdu.lt

Algimantas Paulauskas, Linas Balčiauskas. Institute of Ecology of Vilnius University, Akademijos 2, LT-2600 Vilnius, Lithuania; e-mail: a.paulauskas@gmf.vdu.lt, linasbal@ekoi.lt

Rimvydas Šinkūnas. Centre of Environmental studies, Vilnius University, Čiurlionio 21, LT-2009, Vilnius, Lithuania; e-mail: dartagnan@centras.lt

Introduction

Because of the destruction and fragmentation of the landscape due to anthropogenic influence, natural habitats are becoming smaller, more fragmented and isolated. In an insular system, the water barrier separating the islands is suspected to severely affect migration rates and gene flow among populations. Restricted gene flow could speed up the genetic drift and heterozygote deficiency level because of inbreeding, which will reduce the within population variability and induce population differentiation (Slatkin 1987). It is known that insular rodent populations exhibit 'island syndrom' having higher densities and fewer dispersers (Adler and Levins 1994) course of the natural selection which acts against the dispersion of insular habitants increasing mortality of vole dispersers (Tamarin 1977). The proportion of rodent dispersers decreases when insularity and the length of the barrier to cross increases (Landry and Lapointe 1999).

To assess the potential negative impact of isolation on animal populations we compared levels of genetic diversity in island, peninsula and the mainland populations of bank vole *Clethrionomys glareolus* in artificial water reservoir in Antalieptė .

Material and methods

Antalieptė reservoir is located 15 km SW of Zarasai town (55°37' N, 26°02' E) of Lithuania (Fig. 1). The reservoir was formed in 1959 when the river Šventoji was dammed and thus flooding 26 lakes near the settlement of Antalieptė. The reservoir covers approximately 1911 ha. There are many long peninsulas and approximately 90 islands (tops of the former hills). The area of islands varies in size (from 0.05 to >6.6 ha) and the degree of isolation (15 to 500 m from the mainland). The largest islands: Arkliai (6.3ha), Didžioji (3.7ha). Bebrai (0.56ha) island is the oldest one. Most islands of the Antalieptė reservoir are covered with forest (Gražute...1994).

Sampling of small rodents from 20 islands of Antalieptė reservoir was carried out in the fall of 1999 - 2001. There were found several small rodent species inhabiting islands, i.e.: *Apodemus flavicolis, Clethrionomys glareolus, Microtus arvalis, M. agrestis*. The bank vole was dominating on the total of 89.8% of all the islands (on 16 out of 20 islands) in the study. Specimens were trapped following standard methods described by I.R. Flowerder (1976) with some modifications. A sample size varied through the years and was influenced by size of the island.

Samples of bank vole liver tissue were homogenised and analysed using polyacrilamide gel electrophoresis, following Davis (1964), Brewer (1970) and Rothe (1994) with some modifications (Skiriute et al. 2000). A total of seven protein loci screened for each specimen: glucose-6-phosphat dehydrogenase (Gpd1), malic enzyme (Me1,2), malate dehydrogenase (Mdh1), lactate dehydrogenase (LdhA, LdhB) and non-specific protein (Np4). Allelic variants were resolved by direct side-by-side comparison of migrating isozymes on the same gels. In some individuals, however, genotypes couldn't be determined for the entire set of loci due to insufficient quality of resolution.

Genetic diversity was estimated by the mean number of alleles per locus (A), the mean observed heterozygosity (H_0) and expected unbiased heterozygosity (H_E) for each locus and averaged over all loci using software BIOSYS-2 (Swofford et al. 1997). Deviations from Hardy-Weinberg equilibrium (HWE) were tested using a probability test and chi-square analysis (Weir & Cockerham 1984) with the significance value assigned by Monte Carlo permutation process with 1000 replicates in the POPGENE (3.1d) program (Raymond & Rousset 1995). Genetic differentiation was evaluated using FST (Weir & Cockerham 1984). The data examined for evidence of isolation-by-distance between island populations and the mainland performing leaner regression of estimates of $F_{ST}/(1-F_{ST})$ against the logarithms of interpopulation map distances (in metres), following F. Rousset (1997). In order to estimate the significance of regression there was performed Mantel test with 5000 randomisations for analysis.

Results and discussion

Seven loci of proteins of bank vole were used for evaluation of genetic variability of insular populations in an artificial water reservoir. LdhA locus was obtained to be monomorphic in all populations in the study. Six of all the loci studied exhibited polymorphism in all populations (Gpd1, Me1, Me2, Mdh1, Np4, LdhB) represent-

Table 1. Allele frequency in seven subpopulations of bank vole in an artificial water reservoir islands, peninsula and the mainland as a control in 1999-2001. n - number of individuals in a sample. N/A - no activity of a locus. * - significant deviation from HWE because of inbreeding, p<0.05

		Subpopulations														
		Arkliai			Bebrai		Berzai	Šeseliai		Didzioji		Peninsula			Mainland	
Locus		1999	2000	2001	1999	2001	1999	1999	2001	2000	2001	1999	2000	2001	2000	2001
n		(32)*	(7)	(22)*	(22)	(19)*	(8)	(5)	(9)	(10)*	(12)*	(6)	(5)*	(16)	(5)*	(18)
Gpd1	99	0.448	0.857	0.205	0.333	0.474	0.643		0.389	0.600	0.750	0.333	0.400		0.100	0.305
	100	0.431	0.143	0.750	0.667	0.526	0.357	0.750	0.389	0.400	0.167	0.667	0.600	1.000	0.700	0.556
	101	0.121		0.045				0.250	0.222		0.083				0.200	0.139
n		(22)*	(17)	(22)	(23)	(21)	(8)	(5)	(6)	(10)	(12)	(6)*	(5)	(16)	(5)	(18)
Me1	99	0.482	1.000	1.000	0.500	1.000	0.063	0.600	1.000	0.950	1.000	0.667	1.000	0.969	1.000	0.944
	100	0.466			0.409		0.875	0.200		0.050		0.333		0.031		0.056
	101	0.052			0.091		0.063	0.200								
n		(29)*	(16)*	(20)	(12)	(20)	(8)	(4)		(10)	(12)	(6)		(16)		(11)
Me2	99	0.733	0.594	0.700	0.625	0.875	0.667	0.500	N/A		0.250	0.250	N/A	0.531	N/A	0.772
	100	0.267	0.406	0.300	0.375	0.125	0.333	0.500		1.000	0.750	0.750		0.469		0.228
n			(18)	(20)		(21)			(9)	(10)	(12)		(5)	(13)	(4)	(17)
Mdh1	96	N/A	0.556	0.825	N/A	0.691	N/A	N/A	0.667	0.250	0.458	N/A	0.500	0.731	0.625	0.639
	100		0.444	0.175		0.309			0.333	0.750	0.542		0.500	0.269	0.375	0.361
n		(9)	(18)	(22)	(10)	(22)		(3)	(9)	(10)	(12)	(6)	(5)	(16)	(5)	(18)
Ldh B	100	1.000	0.944	1.000	1.000	1.000	N/A	0.833	0.944	1.000	1.000	0.900	1.000	0.969	1.000	0.972
	101		0.056					0.167	0.056			0.100		0.031		0.028
n		(36)	(18)	(22)	(25)	(22)	(8)	(5)	(9)	(10)	(12)	(6)	(5)	(16)	(5)	(17)
Np4	99	0.632	0.639	0.795	0.947	0.818	1.000	1.000	0.944	0.200	0.542	1.000	0.800	0.750	0.700	0.706
	100	0.368	0.361	0.205	0.053	0.182			0.056	0.800	0.458		0.200	0.250	0.300	0.294

ing from two to three alleles.

Significant departures from HWE occurred at the 5 (level when tested on a per-locus or per-locality basis. Only Beržai (1999) and Didžioji (2000) island populations (2 out of 10 samples of islands) of bank vole were in agreement with HWE after global multi-locus probability test (p<0.05). Probability test by locus showed disagreement for Gpd1 locus for almost all populations in the study (p<0.05) (Table 1). Significant departures from HWE occurred in island populations (p<0.05), while in peninsula and the mainland inconsistence with HWE was not significant (p>0.05) when tested globally. Šešėliai island bank vole population which is 40 meters from the bank and peninsula shows no significant departures from HWE when tested globally (p<0.05).

During 1999-2001 mean number of alleles per locus in the bank vole island populations ranged from 1.57 in islands, 1.65 in a peninsula and 1.84 in the mainland (Table 2).

Allele frequency fluctuations differed in sampling sites appearing to be more stable in the mainland and the older island of Bebrai (0.56 ha) (except Me1 locus). Genetic stability depends on island area and insularity showing less allele frequency fluctuations through the year of the study in the mainland, peninsula, Arkliai (6.3 ha) and Didžioji (3.17 ha) islands. Allele frequencies might change as a consequence of reproduction survival (genotype fertilities) and movements of individuals (Ishibashi et al. 1998). The distance from Šešeliai island to peninsula gives possibilities to move voles and mate within a larger area ("rescue effect") in order to avoid the accumulation of deleterious genes and renew gene pool (Ishibashi et al. 1998, Gaines & McClenagahn 1980). Mean number of alleles in Arkliai ranged from 1.71 to 2.0 through the years of the study showing high ge-

Table 2. The number of loci screened, mean number of alleles per loci, mean observed and expected heterozygosity in the bank voles from five island populations in Antaliepte reservoir in 1999-2001.

Population name	Year of sampling	Sample size, N	Loci screened	Mean number of alleles per locus	Observed Heterozygosity	Unbiased Heterozygosity
Arkliai	1999	34	6	2.00	0.179	0.340
	2000	18	7	1.71	0.159	0.265
	2001	22	7	1.71	0.211	0.209
Bebrai	1999	19	6	1.83	0.185	0.275
	2000	22	7	1.57	0.179	0.211
Berţai	1999	8	4	2.00	0.324	0.305
Šešėliai	1999	5	6	1.83	0.189	0.326
	2000	9	6	1.83	0.278	0.229
Didţioji	2000	10	7	1.57	0.143	0.191
	2001	12	7	1.71	0.167	0.264
Peninsula	1999	6	6	1.66	0.117	0.263
	2000	5	6	1.57	0.100	0.241
	2001	16	7	1.71	0.207	0.205
Mainland	2000	5	6	1.67	0.258	0.252
	2001	18	7	2.00	0.307	0.289

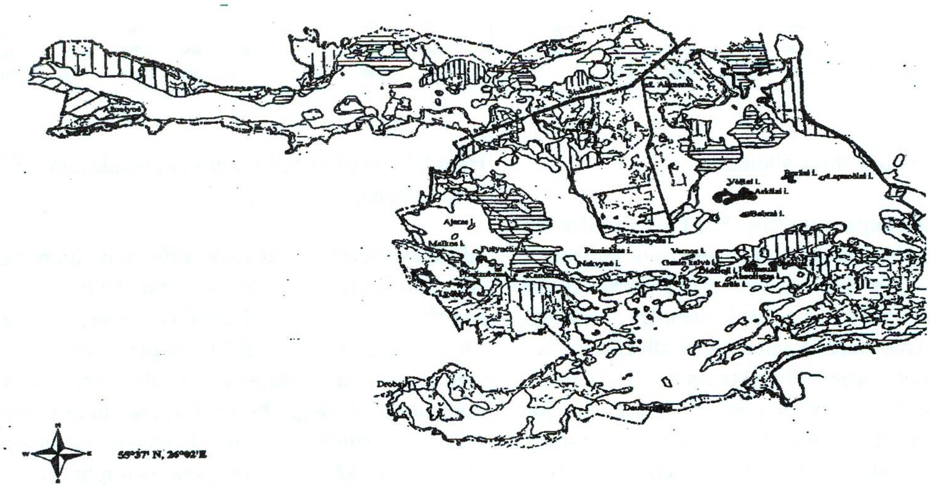

Fig. 1. Map of the Antalieptė reservoir (Lithuania) showing the islands, peninsula and the mainland selected for genetic diversity in this study.

netic variability but genotypes formed in most cases were homozygous. Arkliai population was not in HWE because of heterozygote deficit in Gpd1 (F_{IS}=+0.495, p=0.00) and Me2 (F_{IS}=+0.678, p=0.02) loci exhibiting significance. Loss of alleles in populations could appear because of genetic drift or "bottleneck effect" (Bujalska 1975) after trapping together with the worse survival of autumn generations of bank voles till the spring. Percent of loci heterozygous varied from 31% in the mainland, 21% in peninsula and from 10 to 18% in island populations of bank vole (Table 2).

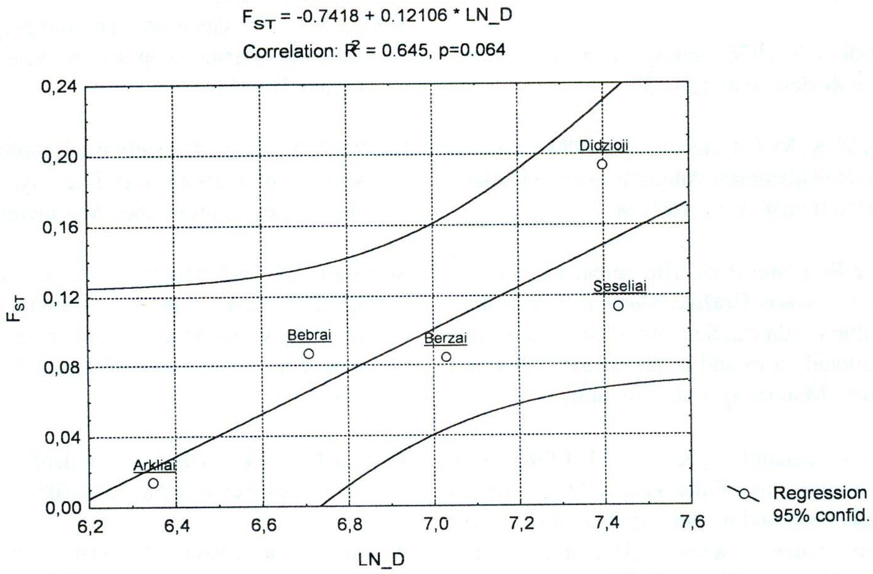

Fig. 2. Genetic differentiation among island populations of bank vole. Multilocus estimates of pairwise differentiation of island and the mainland are plotted against logarithm of map distances. The minimum distance between islands is 10m. FST was estimated according to Weir&Cockerham (1984).

There were no significant (p>0.05) correlations between island area, insularity and heterozygosity level (results not shown) in all years of the study. Genetic differentiation among island populations in an artificial water reservoir expressed as FST=0.20 is found to be great and indicates that "groups" could be clearly discriminated. The main reasons for genetic differentiation could be the genetic drift and the local adaptive selection (Slatkin 1987) acting on an allele frequency variance. The within-population variance accounts for the major part of molecular variation. The genetic diversity is highly variable between insular populations and is correlated with accessibility of control area from the islands (R2 =0.645, p=0.064) (fig. 2). The inbreeding coefficient FIS=0.31 shows heterozygote deficiency and assortative mating possibility in a populations. The genetic diversity level reflects not only the natural selection, genetic recombination and random genetic drift, but also the ecological stochastic processes such as demographic variation on island populations (Soule 1986, Lande 1988). Antalieptė reservoir shows 50 years period effect of fragmentation of landscape on genetic variability of bank voles.

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IS A NATURE RESERVE THE BEST FORM TO PROTECT INVERTEBRATES? - ON THE EXAMPLE OF DRAGONFLIES AND CADDISFLIES (INSECTA: ODONATA, TRICHOPTERA) OF THE „LAKE KOŚNO" RESERVE

Paweł Buczyński, Stanisław Czachorowski, Edyta Serafin, Witold Szczepański

Buczyński P., Czachorowski S., Serafin E., Szczepański W. 2003. Is a nature reserve the best form to protect invertebrates? - on the example of dragonflies and caddisflies (Insecta: Odonata, Trichoptera) of the „Lake Kośno" reserve. *Acta. Biol. Univ. Daugavp. 3 (2): 125 - 132.*

In the year 2001 dragonflies and caddisflies of the „Lake Kośno" landscape reserve and its surroundings were examined. On these rudiments the importance to the protection of aquatic insects was analysed. Clear differences in taxonomic diversity and the presence of special care species and indicator ones as well were stated to the reserve's disadvantage. The postulate of increasing the number of reserves and using other types (e.g. aquatic -, bog-, faunal- and landscape ones) for protection of water invertebrates was shown. The spreading out of the studied reserve was proposed in order to involve the most precious habitats of water invertebrates situated currently outside the reserve.

Key Words: Odonata, Trichoptera, Poland, evaluation, preservation, nature reserve

Paweł Buczyński. Department of Zoology, Maria Curie-Skłodowska University, Akademicka 19, 20-033 Lublin, Poland, e-mail: pbuczyns@biotop.umcs.lublin.pl;

Stanisław Czachorowski. Department of Ecology and Environmental Protection, University of Warmia and Mazury, Pl. Łódzki 3, 10-727 Olsztyn, Poland, e-mail: czachor@moskit.uwm.edu.pl;

Edyta Serafin. Department of Zoology, University of Agriculture, Akademicka 13, 20-033 Lublin, Poland, e-mail: eserafinek@wp.pl

Witold Szczepański. The Student Scientific Association of Entomologists „Kortoptera", University of Warmia and Mazury, Oczapowskiego 5, 10-718 Olsztyn, Poland, e-mail: w_szczep@poczta.fm

Introduction

Protected areas preserving biological resources through the protection of habitats are a very important form of nature protection. Their thickening network is the source of optimism with which official lobbies present the environmental state and protective actions. But the main question must be raised: does it reflect the real situation of our environment? Very often nature protection loses with economic businesses. The problem is the delimitation of reserves. Without funds for scientific researches the knowledge about environment is based on existent studies, many a time out-of-date or incomplete. Sometimes there are any like these. Moreover, the main data that can be used refer to vertebrates and higher plants only. In this case the newly set up reserves might not correspond with the needs for the protection of invertebrates.

The purpose of this paper was to analyse this problem on the basis of a reserve which encompassed main aquatic habitats. The researched object was the „Lake Kośno" reserve. The paper was based on dragonflies and caddisflies for these orders are often used in bioindication. The data about their threats in Poland are also available (Bernard et al. 2002; Czachorowski & Buczyński 2000).

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Study area

The „Lake Kośno" reserve covering the area of 1232,85 hectares is situated on the Olsztyn Lake District (the subregion of the Mazury Lake District) It encompasses an eutrophic lake Kośno and its surrounding forests (Kondracki 2000; Panfil 1985).

The investigated area has the typical glacial relief with forms of ground and terminal moraines. Except some human settlements the area is covered with coniferous - with dominant pine-tree - and mixed forests. In depressions there are lakes: Kośno (562,5 ha), Łajskie (40,0), Łowne Duże (40,0) Łowne Małe (12,5) and Czerwonka Mała (20,0) (Choiński 1991; Lewandowski 1992). These are eutrophic ones, only lake Łowne Małe is dystrophic and surrounded with a peatbog. The streams, which supply or link lakes, are numerous, usually natural and well preserved. Few small water bodies are present on inner-forest meadows. Among peatbogs the most common are transitional peatbogs originated from overgrowing lakes in different stage of succession. The only low peatbog, placed around the stream which supplied lake Kośno, was found in south-western part of the reserve. Three of the examined peatbogs, all within the reserve area, were meliorated and partially degraded.

Methods and material

Field works were conducted in July of the year 2001. They encompassed the southern part of the reserve and its surroundings. All types of surface waters were examined intensively, in general: one spring, 9 streams, 5 lakes, two small water bodies and 5 peatbogs were examined (Fig. 1). Adult dragonflies were observed away from waters, on roads and clearings.

Larval dragonflies and caddisflies were caught with a hydrobiological scoop. Exuviae of dragonflies and caddisfly imagines were directly handpicked, a light trap was also used in catching adult caddisflies. Adult dragonflies were not captured, they were only observed. Evidence material were: Odonata - 76 larvae, 18 exuviae; Trichoptera - 621 larvae, 302 imagines.

The listed dragonfly species were divided into three categories, with:
* confirmed development (criterion: the identification of larvae, sloughs and/or metamorphosis),
* probable development (mature imagines only, reproductive activities),
* not stated/confirmed development (mature imagines only, lack of reproductive activities).

Results

31 dragonfly species - 14 in the reserve, 30 outside - were stated. The most taxonomically diverse were the faunas of lakes, peatbogs and flowing waters, the less diverse - of water bodies. There were no dragonflies in a spring (Table 1).

The dominants were the species with broad ecological spectrum: eurytopes and poorly specialised stagnophiles. Synecological groups with narrow specialisation were represented by species associated with flowing waters (*Calopteryx spp., Platycnemis pennipes, Pyrrhosoma*

Table 1. Dragonflies collected. 1-6 – biotopes (1 – springs, 2 – running waters, 3 – lakes, 4 – peatbogs, 5 – small water bodies, 6 – imagines observed far from water bodies); A – nature reserve, B – outside the reserve; N – number of larvae and exuviae collected. Status of the species: ● – development was stated, ⊙ – probable development, O – no development was stated.

Species	1	2	3	4	5	6	A	B	N
1. *Calopteryx splendens* (Harris, 1782)		⊙	O				O	⊙	-
2. *C. virgo* (Linnaeus, 1758)		⊙						⊙	-
3. *Lestes dryas* Kirby, 1890				O				O	-
4. *L. sponsa* (Hansemann, 1823)			O	O	O		O	O	-
5. *L. viridis* (Vander Linden, 1825)			●		●			●	11
6. *Platycnemis pennipes* (Pallas, 1771)		●	●				●	⊙	1
7. *Ischnura elegans* (Vander Linden, 1840)		●	●				●	●	5
8. *Enallagma cyathigerum* (Charpentier, 1840)			⊙	O				⊙	-
9. *Pyrrhosoma nymphula* (Sulzer, 1776)		⊙			●			●	1
10. *Coenagrion hastulatum* (Charpentier, 1825)					●			●	1
11. *C. puella* (Linnaeus, 1758)		⊙	●		●		●	●	9
12. *C. pulchellum* (Vander Linden, 1825)			⊙		●			●	1
13. *Erythromma najas* (Hansemann, 1823)			●				●	⊙	1
14. *Brachytron pratense* (O.F. Müller, 1764)			●					●	3
15. *Aeshna cyanea* (O.F. Müller, 1764)		?			●			●	2
16. *Aeshna grandis* (Linnaeus, 1758)		O	●		●	O	●	●	22
17. *A. isosceles* (O.F. Müller, 1767)			⊙					⊙	-
18. *A. juncea* (Linnaeus, 1758)		O			⊙		⊙	⊙	-
19. *A. mixta* Latreille, 1805			●			O		●	1
20. *A. viridis* Eversmann, 1836		O	●		●			●	4
21. *Cordulia aenea* (Linnaeus, 1758)			●		⊙	O		●	4
22. *Somatochlora flavomaculata* (Vander Linden, 1825)		⊙	⊙		?	O	O	●	8
23. *S. metallica* (Vander Linden, 1825)		●	●		●		●	●	5
24. *Libellula depressa* Linnaeus, 1758		O						O	-
25. *L. fulva* (O.F. Müller, 1764)			●				●		1
26. *L. quadrimaculata* Linnaeus, 1758		O	⊙		●			●	4
27. *Orthetrum cancellatum* (Linnaeus, 1758)		O	●		O	O	●	⊙	1
28. *Sympetrum danae* (Sulzer, 1776)					O			O	-
29. *S. flaveolum* (Linnaeus, 1758)		O		O	O		O	O	-
30. *S. sanguineum* (O.F. Müller, 1764)			⊙		●		O	●	2
31. *S. vulgatum* (Linnaeus, 1758)			●	O	●			●	7

nymphula), peatbogs (*Lestes sponsa, Coenagrion hastulatum, Aeshna juncea, Sympetrum danae*) and astatic small water bodies (*Lestes dryas, Sympetrum flaveolum*).

The dragonfly assemblages of examined area were characteristic of the mixture of synecological elements. Not only were particular species noted in typical environments but also in different ones - usually adjacent. But that referred mainly to imagines. Larval assemblages were more typical, that means that they were dominated with specific and eurytopic species. The exceptions were the sites where the hydrological connection with different environments was stated. Especially in the upper stretches of streams flowed out of lakes the larvae of stagnophiles were noted numerously.

49 caddisfly species - 14 in the reserve and 42 outside it - were stated (Table 2). Taking into account the cases found in the area a next few species might have been expected. The most numerous were lacustrine species - 26. Four of them were typical of dystrophic and peatbog waters. The next four species were typical of small water bodies, 10 species were potamophiles and 9 were connected with small streams, two of which were typical of inner-forest, dystrophic streams and

Table 2. *Trichoptera* collected (l – larvae, i – imagines). 1-5 – biotopes (like in the Tab. 1), ✪ – imagines collected with a light trap; A – reserve, B – outside the reserve; L – number of larvae collected, I – of imagines, ?– of all specimens.

	Species	1	2	3	4	5	✪	A	B	L	I	?
1.	*Rhyacophila fasciata* Hagen, 1859		l						l	7	0	7
2.	*Orthotrichia costalis* (Curtis, 1834)			i			i		i	0	68	68
-.	*Orthotrichia* sp.						i		i	0	1	1
3.	*Agraylea sexmaculata* Curtis, 1834 (?)						i		i	0	1	1
4.	*Ecnomus tenellus* (Rambur, 1842)			i			i		i	0	4	4
5.	*Holocentropus picicornis* (Stephens, 1836)						i		i	0	1	1
6.	*Cyrnus crenaticornis* (Kolenati, 1859)		i	i				i	i	0	2	2
7.	*C. flavidus* McLachlan, 1864			l					l	3	0	3
-.	*Cyrnus* sp.						i		i	0	1	1
8.	*Polycentropus irroratus* (Curtis, 1835)						i		i	0	1	1
9.	*Psychomyia pusilla* (Fabricius, 1781)						i		i	0	10	10
10.	*Tinodes waeneri* (Linnaeus, 1758)			i					i	0	10	1
11.	*Hydropsyche angustipennis* (Curtis, 1834)		li	li			i	l	li	172	57	238
12.	*H. pellucidula* (Curtis, 1834)		l						l	3	0	3
-.	*Hydropsyche* sp.			i			i			0	28	28
13.	*Agrypnia obsoleta* (Hagen, 1858)			l		l		l	l	2	0	2
14.	*A. varia* (Fabricius, 1793)			i						0	1	1
15.	*Oligostomis reticulata* (Linnaeus, 1767)		l						l	1	0	1
16.	*Oligotrichia striata* (Linnaeus, 1758)					l			l	1	0	1
17.	*Trichostegia minor* (Curtis, 1834) (?)		l						l	1	0	1
18.	*Phryganea bipunctata* Retzius, 1783		l	l		l			l	5	0	5
19.	*P. grandis* Linnaeus, 1761			li				l	i	2	1	3
20.	*Goera pilosa* (Fabricius, 1775)			l					l	3	0	3
21.	*Silo pallipes* (Fabricius, 1781)		l							7	0	7
22.	*Lepidostoma hirtum* (Fabricius, 1781)			i						0	1	1
23.	*Ironoquia dubia* (Stephens, 1837)		l						l	1	0	1
24.	*Anabolia laevis* (Zetterstedt, 1840) (?)		l	l				l	l	88	0	88
25.	*Glyphotaelius pellucidus* (Retzius, 1783)			l				l		2	0	2
26.	*Limnephilus auricula* Curtis, 1834		l						l	1	0	1
27.	*L. flavicornis* (Fabricius, 1787)			i		l	i		li	8	2	10
28.	*L. lunatus* Curtis, 1834	l	l	l				l	l	47	0	47
29.	*L. marmoratus* Curtis, 1834			l			i		li	1	1	2
30.	*L. nigriceps* (Zetterstedt, 1840)			l				l	l	5	0	5
31.	*L. politus* McLachlan, 1865		l	l				l	l	40	0	40
32.	*L. rhombicus* (Linnaeus, 1758)		l				i		li	4	1	5
33.	*L. stigma* Curtis, 1834					l			d	10	0	10
-.	*Limnephilus* sp.		l	l					l	5	0	5
34.	*Chaetopteryx villosa* (Fabricius, 1798) (?)	l	l						l	129	0	129
35.	*Potamophylax rotundipennis* (Brauer, 1857)		l							2	0	2
36.	*Halesus digitatus* (Schrank, 1781)	l	l	l				l	l	10	0	10
37.	*H. radiatus* (Curtis, 1834)		l						l	11	0	11
-.	*Halesus* sp.		l							1	0	1
38.	*Sericostoma personatum* (Spence, 1826)		i				i		i	0	2	2
39.	*Notidobia ciliaris* (Linnaeus, 1761)		l						l	1	0	1
40.	*Molanna angustata* Curtis, 1834		l	li				i	li	9	5	14
41.	*Triaenodes bicolor* (Curtis, 1834)			l		l			l	19	0	19
42.	*Mystacides azurea* (Linnaeus, 1761)			i				i		0	2	2
43.	*M. longicornis* (Linnaeus, 1758)		l	li			i	i	li	6	5	11
-.	*Mystacides* sp.			l					l	9	0	9
44.	*Athripsodes aterrimus* (Stephens, 1836)			i				i		0	1	1
45.	*A. cinereus* (Curtis, 1834)						i		i	0	1	1
-.	*Athripsodes* sp.			l					l	5	0	5
46.	*Leptocerus tineiformis* Curtis, 1834			i			i		i	0	59	59
47.	*Oecetis furva* (Rambur, 1842)			i			i		i	0	6	6
48.	*O. lacustris* (Pictet, 1834)			i			i		i	0	25	25
49.	*O. ochracea* (Curtis, 1825)						i		i	0	5	5

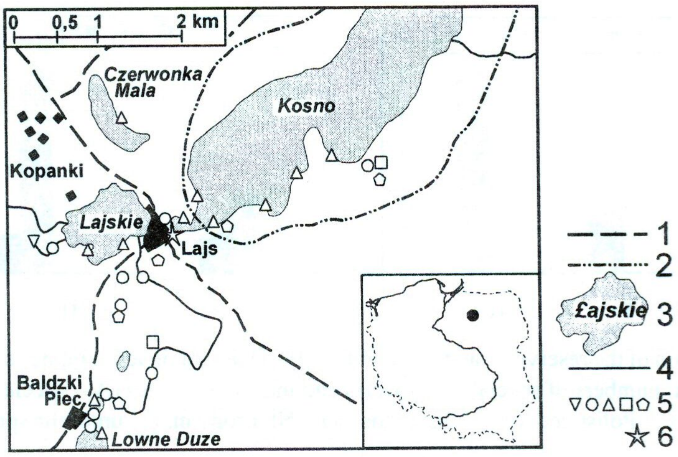

Fig. 1. Study area: 1 – main roads, 2 – borders of the reserve, 3 – lakes, 4 – streams, 5 – sites of hydrobiological studies (from left to right: springs, streams, lakes, small water bodies and peat bogs), 6 – place of catching with a light trap

one was typical of streams that dry up in summer.

Definitely more species were caught outside the reserve. But to a large extent it was caused by collecting caddisflies to a light trap. A huge part of species caught in this way represented lacustrine species descended from the protected part of lake Kośno. However, the proportion between the numbers of species (caught only in larval stages) - 9:27 - was the same when taking into account all development stages.

The most numerous caddisfly was Hydropsyche angustipennis - a potamophile, preferring river stretches flowing out of a lake. The second place took *Chaetopteryx villosa*, species typical of inner-forest streams. Lacustrine species like: *Orthotrichia costalis* (typical of eutrophic lakes), *Anabolia laevis* (typical of the shallowest littoral with a tree-covered shore) and *Leptocerus tineiformis* (typical of the zone of elodeids) were also numerous. Species associated with small water bodies were not numerous. Noteworthy was the fact of the occurrence of *Oligostomis reticulata* regarded as rare and endangered in Poland (Serafin & Czachorowski 2002). This species is connected with small watercourses in woodland areas, marshy grounds and peatbogs. Nevertheless this species has not been included in the Polish red list (Szczęsny 1992, 2002).

Similarly to the number of species in examined orders, the disproportion between fauna of the reserve and the fauna of its surroundings was very clear in terms of the occurrence of special care species and indicator species (Bernard et al. 2002, unpbl.; Czachorowski et al. 2000; Hilton-Taylor 2000; Instytut... 1997a; Rozporządzenie... 2001) (Fig. 2).

Discussion

Taking into consideration the short period of studies the collected material was rich: it represented 43% of the Polish dragonfly fauna and 18% of caddisfly fauna (Czachorowski 2002; Mielewczyk 1990, 1997). It presented the mixture characteristic of glacial areas, comprised of lacustrine, peatbog, stream and small water body species. About 10 next dragonfly species and 10-20 caddisfly species can be expected in area, especially spring ones associated with small water bodies and bog pools with *Sphagnum*. Nevertheless, the obtained results are sufficient for the aim of this paper.

A reserve should protect particularly valuable

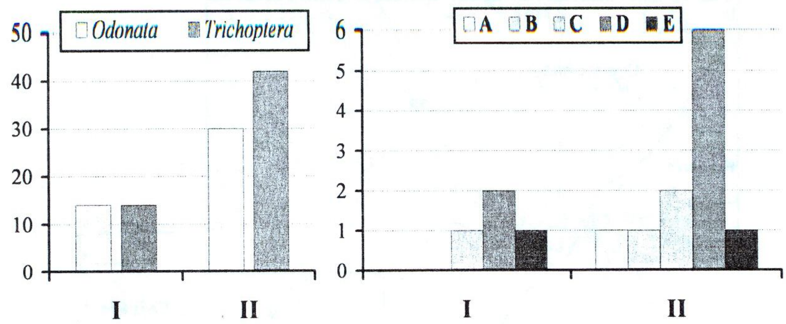

Fig. 2. Comparison of the reserve (I) and its vicinities (II). Diagram on left: number of species. Diagram on right: numbers of special care species and indicator species (A – species protection, B – IUCN Red list, C – Polish red list, D – list of the CORINE program, E – umbrella species)

natural areas. Interesting was the result of comparison between the reserve and its unprotected surroundings - to the reserve's disadvantage. Despite the similar habitats in two examined areas, in the surroundings the number of dragonfly species was double and caddisfly species - treble than in the reserve. The contrast in occurring special care species and species used in marking out areas of special natural value was also clear. Besides, the obtained numbers showed that the faunistic values of the whole investigated area were high.

The "Lake Kośno" reserve was set up to protect the specific features of the Olsztyn Lake District landscape (Instytut... 1999). In that case a question may be asked: are these critical comments justified in case of the reserve that protects a landscape not a fauna?

In 1999 there were 1251 reserves with the area of 140 000 hectares in Poland, of which about 120 were faunal ones. But only 6 of them with the area of 723,66 hectares protected invertebrates, always terrestrial insects - xerotermophilous ones those associated with forests (Baza... 1999; Instytut... 1997b). In that case where there are no reserves for protecting aquatic invertebrates, one can hope that insects are properly protected in floristic, aquatic and peatbog reserves. It is obvious that suitably chosen object like these should be inhabited by valuable assemblages of invertebrates which show in favour of their nature values.

According to the results presented in this paper practice does not reflect theory. The dragonfly and caddisfly assemblages of the „Lake Kośno" reserve were less taxonomically diverse, less specific and had fewer indicator or special care species than the surroundings of the reserve. From this point of view the less valuable area is under protection. This situation probably refers also to other groups of invertebrates.

On the basis on one case it is hard to judge all system of protected areas - this subject needs to be investigated further. But it seems to be that chosen example is representative and can picture the current state of at least in other than aquatic and peatbog reserves. If it is so, the following postulates can be proposed:

* for the efficient protection of aquatic invertebrates there is a necessity to set up reserves with taking into account their needs. In other cases, even the productive protective influence will be a side effect of the protection of other environmental elements, coincidental and hard to plan and control;

* the planned use of non-faunal reserves for the protection of aquatic invertebrates is possible. For this purpose the evaluation of these object must be done. The first step is to establish particularly valuable habitats and their fauna as well but not only in the area of the reserve but also in its surroundings. Then, if necessary, some

changes in the plan of protection can be made (if there is no conflict with the main aim of setting up a reserve) and/or the spreading out the protected area.

In case of the „Lake Kośno" reserve the attachment of a few forest section towards the south-west direction would be a solution. Then the area would encompass a dozen or so valuable streams and peatbogs, more interesting than these in the reserve what would elevate its natural features.

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BIODIVERSITY OF INSECTS IN STRICT NATURE RESERVES IN LITHUANIA

Vytautas Jonaitis, Povilas Ivinskis

Jonaitis V., Ivinskis P. 2003. Biodiversity of insects in strict nature reserves in Lithuania. *Acta Biol. Univ. Daugavp., 3 (2): 133 - 142.*

There has been generalized the original data of over 40 years of investigation and the published data about four strict nature reserves. Over 3000 species belonging to 9 orders of insects were recorded in Lithuanian strict nature reserves. The greatest number of species was found in Čepkeliai (2375) and Viešvilė (2365), the lowest number - in Žuvintas (2081) and Kamanos (2011). The Lepidoptera order contained over 1540 species, Coleoptera-1450, Hymenoptera-1124. The greatest species diversity was recorded for the Ichneumonidae family, over 554 species belonging to 230 genera were recorded. The distribution and relation between species number of some groups of ichneumonid fauna were analysed.

Key words: insect fauna, Coleoptera, Lepidoptera, Hymenoptera; Ichneumonidae, rare species.

Vilnius University, Institute of Ecology, Akademijos 2, 2600 Vilnius, Lithuania. E-mail: entlab@centras.lt

Introduction

The vegetation and landscape of all territories has been formed by the interactions between farming and nature for thousands of year. The situation in the structure of natural systems is quite different and defined by the functioning features of various groups of animal kingdom. Investigations into the insect fauna of protected territories have acquired considerable importance being considered as the most common animals in nature. Reserves of Lithuania are important to the protection of insects of swamps and wet forests. Because natural processes of succession occurring in the reserves result in changes in the fauna, major elements of the fauna should be established as soon as possible so that in the future changes in entomofauna could be recorded and the mechanism of those changes better understood. The succession in the reserves is a trouble. Different extreme measures, such as fire, are suggested in order to stop it. We think that in the reserves of Lithuania this would be ruinous, because habitats and invertebrates therein would be exterminated for a long time.

There are various publications on the investigation into the phytophagous and entomophagous insects of Lithuania up to 1986 (Jakimavičius 1988). Considerable share has been the supervisions overof the insect fauna of strict nature reserves, though special works devoted to the insect fauna of Lithuanian reserves were scarce (Заповедник Жувинтас 1968; Balevičius 1984).

A rather extensive investigation into insect fauna of Lithuanian reserves has been carried out later. The investigation into the structure and distribution of fauna of separate strict nature reserves has been carried out on individual groups of insects: Odonata (Станёните 1988a; Stanionyte 1993), Aphidoidea (Rakauskas et al. 1992), Lepidoptera (Ивинскис 1988a, 1988б, Ivinskis 1993, 1998; Ивинскис и др. 1988a, 1988б, 1990; Ivinskis Svitra 1992, Ivinskis, Mozūraitis 1995; Dapkus 1995; Švitra 1995; Dapkus et al. 1999), Coleoptera (Karalius, Monsevičius 1992, Pileckis, Monsevičius 1995, 1997), Diptera (Пакальнишкис 1989, Pakalniškis 1992; Pakalniškis, Podėnas 1992, Podėnas 1992; Spungis 1993; Podėnas, Pakalniškis 2000; Pakalniškis et al. 2000), Hymenoptera (Валента, Арбачаускас 1988; Йонайтис, Якимавичюс 1988; Якимавичюс 1988 Jakimavicius 1988; Монсявичюс 1988; Станёните 1988б; Budrys 1992; Jonaitis 1992, 1993, 2000; Monsevicius 1993,1995; Jonaitis Rimšaitė 2000) and some other small groups of insects. The data of Chalcidoidea and Proctotrupoidea fauna (Станёните 1988a) available until now provide quite little information. The summarized data on insect fauna of Lithuanian strict nature reserves were published not long ago (Жувинтас, 1993, Lietuvos..., 1997).

The purpose of this work is to present generalized data on the structure and distribution of insect fauna of Lithuanian strict nature reserves. The main research trend includes detailed features of the Lepidoptera and Ichneumonidae fauna, because of their close connection in various trophic relations.

Čepkeliai, Kamanos, Viešvilė and Žuvintas are strict nature reserves of Lithuania. The level of examination was different for separate groups of insects in the reserves. The best results were achieved when a complex investigation was conducted or an entomologist was working permanently. Research showed the lowest number of insect species to be in Žuvintas and Kamanos reserves compared to the others. In Žuvintas, there has been no entomological research for the last ten years, whereas in Kamanos it has been just lately that the situation has changed. Biodiversity of habitats does not differ essentially in the reserves, so we hope that the entomofauna there would be similar after an essential research is conducted.

Material and methods

Research on insect fauna of Lithuanian strict nature reserves was carried out in Čepkeliai, Kamanos, Viešvilė and Žuvintas. A long-term investigation into insect fauna has been carried out in Žuvintas reserve since 1960. Adult insects were caught with an entomological net, a light trap and hatchet out in a laboratory from various samples of preimaginal stages of insects. The material was collected and investigations were conducted by a great number of investigators from the Institute of Ecology of Vilnius University, Vilnius University, Vilnius Pedagogical University, Lithuanian Agricultural University, Kaunas T. Ivanauskas Zoological Museum, Lithuanian Institute of Forestry, various environmental protection institutions and some foreign scientific institutions. Analysis of the data from personal investigation of Lepidoptera and some groups of Hymenoptera, as well as the published data made it possible to reveal the structure and distribution of insect fauna in Lithuanian reserves.

Results

Over 3.000 species belonging to 9 orders of insects were recorded there during investigations in 1960-2002.The abundance of species in individual reserves studied was very diverse. The greatest number of species was found in Čepkeliai (2375). Then came Viešvilė (2365 species). The lowest number was recorded in Žuvintas (2081) and Kamanos (2011) reserves. The Lepidoptera order contained over 1500 species, Coleoptera - 1450, Hymenoptera - 1124.

The biodiversity of two orders, Lepidoptera and Hymenoptera, is presented here for discussion. The above mentioned reserves are meant to protect the biodiversity of swamps and surrounding forests. The complexes of moths are the same in

Table 1. The structure of ichneumonids fauna in the Lithuanian strict protectednature reserves

Subfamily	Number of species				
	Čepkeliai	Kamanos	Viešvilė	Ţuvintas	In total
Pimplinae	10	17	14	17	32
Tryphoninae	7	22	32	12	54
Adelognathinae	-	1	1	1	2
Xoridinae	-	1	1	-	1
Cryptinae	22	63	87	63	158
Banchinae	8	20	16	11	39
Ctenopelmatinae	7	27	44	23	73
Campopleginae	-	28	6	13	35
Tersilochinae	1	1	9	7	13
Ophioninae	-	4	4	2	5
Mesochorinae	-	7	10	3	13
Metopiinae	-	6	4	4	12
Anomaloninae	-	5	6	2	11
Acaenitinae	-	-	1	-	1
Collyrinae	1	1	1	-	2
Orthocentrrinae	-	14	14	9	30
Diplazontinae	2	10	6	12	17
Ichneumoninae	1	28	25	17	56

all the swamp reserves. The greatest differences are observed in the faunas of forests of peripheral zones of the reserves and forest meadows therein. The majority (56%) of species are common to all the reserves.

1020 moth species belonging to 49 families were recorded in Čepkeliai reserve. The greatest species diversity was established for Noctuidae (263). Other families ranged as follows: Geometridae (249), Tortricidae (84), Pyralidae (64), and group Rhopalocera (64 from 6 families). 982 moth species belonging to 50 families were recorded in Viešvilė reserve. The greatest number of species was discovered for Noctuidae (232). Other families ranged as follows: Geometridae (214), Tortricidae (146), Pyralidae (83), and group Rhopalocera (64 from 6 families).

817 moth species from 45 families were found in Žuvintas reserve: Noctuidae (205 species), Geometridae (154), Tortricidae (114), Pyralidae (67), Rhopalocera (73 from 6 families). 558 moth species belonging to 35 families were recorded in Kamanos reserve: Noctuidae (137), Geometridae (113), Tortricidae (69), Pyralidae (36), and Rhopalocera (67 from 6 families).

The survey index of the main moth families was almost twice lower in Kamanos than in the other reserves. Rhopalocera species from six families made half of the known in Lithuania, and the group

Table 2. The relation between species number of the some groups and total ichneumonid fauna of individual Lithuanian strict nature reserves.

Index	Strict nature reserves			
	Čepkeliai	Kamanos	Viešvilė	Ţuvintas
Percentage of secondary parasitic species	10	9	13	15
Percentage of rare species	19	58	52	19
Percentage of rare species registered solely in one reserve	7	48	36	12

was studied extensively. In each reserve, we observed some specific species not found elsewhere in Lithuania. In Čepkeliai, such species were *Helcystogramma albinervis* Gerasimov, 1929 (Gelechiidae), *Aterpia chalybeia* Falkovitsh, 1966 (Tortricidae), *Boloria frigga* Thunberg,1791. (Nymphalidae), in Viešvilė - *Cyclophora linearia* Hubner,1799 (Geometridae), *Brenthis daphne* Denis & Schiffermuler, 1775 (Nymphalidae), in Žuvintas - *Hellinsia inulae* Zeller, 1852 (Pterophoridae), and in Kamanos - *Tabenna bjerkandrella* Thunberg, 1784 (Choreutidae), *Erebia ligea* Linnaeus, 1758 (Nymphalidae). Such moth species as *Micropterix mansuetella* Zeller,1844, *Coleophora lewandowskii* Toll, 1953, *Aristotelia subdecurtella* Stainton,1859, *Pseudophilotes vicrama* Moore,1865, *Cabera leptographa* Wehrli, 1936, *Charaspilates formosaria* Eversmann,1837, *Aspitates gilvaria* Denis & Schiffermuler,1775, *Diachrysia zosimi* Hubner,1822, and *Pelosia obtusa* Herrich-Schaffer, 1847 could be observed just in the reserves.

Among Hymenoptera, the greatest species diversity was recorded for ichneumonids (Ichneumonidae). During 40 years of the investigation into ichneumonids over 554 species belonging to 230 genera were recorded in various ecosystems of the four Lithuanian reserves. The genera *Gelis* (33 species), *Phygadeuon* (18), *Glypta* (15), and *Lisanota* (12) were prevailing in the ichneumonid fauna therein. The following (o kur jos išvardintos, jei "following"?) 33 genera were represented by 4-9 and the other 517 genera - by 1-3 species.

Most ichneumonid species (about 43%) are restricted to all the reserves. 281 species belonging to 145 genera was found in Viešvilė reserve. It was one of the richest among the investigated reserves. The genera *Gelis* (21 species) were pre-

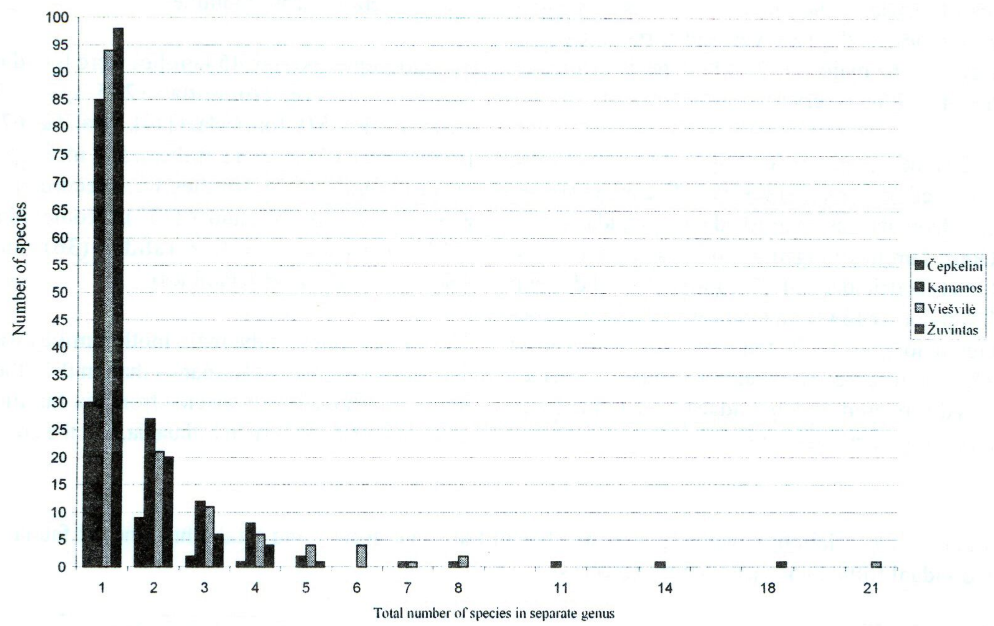

Fig.1. The distribution of ichneumonids fauna in the Lithuanian strict nature reserves

Table 3. Protected insect species in strict nature reserves in Lithuania

Order, species	Čepkeliai	Viešvilė	Žuvintas	Kamanos
Odonata				
Aeshna viridis Eversmann, 1836			Habitats Directive IV	
Leucorrhinia pectoralis Charpentier, 1825			Habitats Directive II	
Ophiogomphus cecilia Fourcroy, 1785		Habitats Directive II		
Coleoptera				
Carabus nitens Linnaeus, 1758		3(R) RB 2000	3(R) RB 2000	3(R) RB 2000
Agonum ericeti Panzer, 1809	3(R) RB 2000	3(R) RB 2000	3(R) RB 2000	3(R) RB 2000
Dytiscus latissimus Linnaeus, 1758			Habitats Directive II	
Liocola marmorata Fabricius, 1792			3(R) RB 2000	3(R) RB 2000
Peltis grossa Linnaeus, 1758	3(R) RB 2000	3(R) RB 2000		3(R) RB 2000
Gnorimus variabilis Linnaeus, 1758	3(R) RB 2000	3(R) RB 2000		
Polyphylla fullo Linnaeus, 1758	3(R) RB 2000			
Ceruchus chrysomelinus Hochenwart, 1785	3(R) RB 2000	3(R) RB 2000		
Boros schneideri Panzer, 1795	3(R) RB 2000; Habitats Directive II	3(R) RB 2000; Habitats Directive II		
Ergates faber Linnaeus, 1761	3(R) RB 2000			
Prionus corarius Linnaeus, 1758	3(R) RB 2000			
Cerambyx cerdo Linnaeus, 1758	Habitats Directive II			
Cucujus cinnaberinus Scopoli, 1763	Habitats Directive II			
Lepidoptera				
Synanthedon mesiaeformis Herrich-Schaffer, 1846		3(R) RB 2000		
Erynnis tages Linnaeus, 1758	3(R) RB 2000			
Parnasius mnemosyne Linnaeus, 1758				4(I) RB 2000, Bern Con. II
Papilio machaon Linnaeus, 1758	4(I) RB 2000	4(I) RB 2000	4(I) RB 2000	4(I) RB 2000
Lycaena dispar Haworth, 1803		4(I) RB 2000, Habitats Directive II	4(I) RB 2000, Habitats Directive II	4(I) RB 2000, Habitats Directive II
Pseudophilotes vicrama Moore	3(R) RB 2000			
Maculinea arion Linnaeus, 1758	3(R) RB 2000, Bern Con. II			
Maculinea teleius Bergsrasser, 1779		3(R) RB 2000, Habitats Directive II		
Euphydryas maturna Linnaeus, 1758			3(R) RB 2000, Habitats Directive II	3(R) RB 2000, Habitats Directive II
Euphydryas aurinia Rottenburg, 1775				3(R) RB 2000 Habitats Directive II
Brenthis daphne Denis & Schiffermuler, 1775		3(R) RB 2000		
Boloria frigga Thunberg, 1791	3(R) RB 2000			
Coenonympha hero Linnaeus, 1761			4(I) RB 2000, Bern Con. II	4(I) RB 2000, Bern Con. II
Oeneis jutta Hubner, 1806	3(R) RB 2000		3(R) RB 2000	
Lopinga achine Scopoli, 1763			Bern Con. II	Bern Con. II
Macaria carbonaria Clerck, 1759			3(R) RB 2000	3(R) RB 2000
Chariaspilates formosaria Eversmann, 1837	4(I) RB 2000		4(I) RB 2000	
Aspitates gilvaria Denis & Schiffermuler, 1775	3(R) RB 2000		3(R) RB 2000	3(R) RB 2000
Diachrysia zosimi Hubner, 1822	4(I) RB 2000		4(I) RB 2000	
Tyria jacobaeae Linnaeus, 1758	4(I) RB 2000			
Hymenoptera				
Lasioglossum prasinum Smith, 1848	3(R) RB 2000			
Bombus semenoviellus Skorikov, 1909	3(R) RB 2000	3(R) RB 2000		

vailing in the ichneumonid fauna of Viešvilė reserve. The following 17 genera were represented by 4-8 species and the other 126 genera - by 1-3 species.

The ichneumonid fauna of Kamanos reserve was made of 257 species belonging to 138 genera. The genera *Phygadeuon* (14 species) and *Glypta* (11) prevailed in Kamanos reserve. The following 12 genera were represented by 4-8 species and the other 124 genera - by 1-3 species.

The ichneumonid fauna of Žuvintas reserve was made of 196 species belonging to 130 genera. The largest 5 genera comprised only 4-5 species. The following 124 were represented by 1-3 species. Only 58 species belonging to 42 genera of ichneumonids were found in Čepkeliai reserve. All the genera were represented by 1-4 species. The structure of ichneumonids fauna in the Lithuanian strict nature reserves was diverse (Table 1); species belonging to 18 subfamilies were recorded in all the reserves. Cryptinae was one of the largest subfamilies, with recorded158 species. The numerous subfamilies were made by Ctenopelmatinae (73 species), Ichneumoninae

(56) and Tryphoninae (54). The following 15 subfamilies were represented by 1-39 species. Like in all the reserves, in individual reserves Cryptinae was also a predominant subfamily of ichneumonids: in Viešvilė - 87 species, in Kamanos and Žuvintas -63 species in each, and in Čepkeliai - 22 species. 17 subfamilies were represented by 1-44 species in Viešvilė, 16 subfamilies - by 1-28 species in Kamanos, 14 subfamilies - by 1-10 species in Čepkeliai. Thus the greatest biodiversity of Ichneumonidae were was observed in Viešvilė and Kamanos reserves.

Like in all territories and regions, in the reserves Cryptinae was a predominant subfamily of ichneumonids. Cryptinae species made a considerable part of the whole complex of ichneumonids in individual reserves: in Čepkeliai - about 38%, in Žuvintas - about 29%, in Viešvilė - about 24%, and in Kamanos - about 20%. Approximately one third of Cryptinae species are secondary parasitoids and form heterogeneous trophic relations. The heterogeneity of Cryptinae trophic relations is an indicator of a complexity of natural systems of various plant associations. Thus, the structure of the ichneumonid fauna in the Lithuanian reserves testified to a high biodiversity of the investigated territories.

Therefore, it is important to review one more aspect in the relations between species number of some groups and the total ichneumonid fauna of individual Lithuanian reserves. These relations can be expressed by the percentage of secondary parasitic species and percentage of rare species (Table 2).

The secondary parasitism is characteristic of Mesochorinae, approximately one third of Cryptinae and sometimes some species of Pimplinae ichneumonids. According to the abundance of secondary parasitic species individual reserves can be divided as follows: Žuvintas (15%), Viešvilė (13%), Čepkeliai (10%) and Kamanos (9%).

Rare species of the ichneumonid fauna of the Lithuanian reserves made about half of all the recorded species. Higher percentage of rare species clearly prevailed in Kamanos (58%) and Viešvilė (52%) reserves. The least percentage (about 19%) was in Čepkeliai and Žuvintas reserves. Similar relation has been determined for the percentage of rare species registered solely in one reserve (Table 2).

The ichneumonids Clistopyga canadensis Provancher, 1880., Delomerista japonica Cushman, 1937., Neliopisthus elegans Ruthe, 1855, Ceratophygadeuon longiceps Thomson, 1884, Olethrodotis modesta Gravenhorst, 1929, Priopoda xanthopsana Gravenhorst, 1855, Charops cantator De Geer, 1778, Nemeritis divida Dbar 1990, Tranosema nishiguchii Momoi, 1973, Aclima orbitalis Gravenhorst, 1829, Trichionotus clandestinus Gravenhorst, 1829, Triclistus areolatus Thomson, 1887, Mesochorus fulgurans Curtis, 1833, Proeliator propius Van Rossem, 1982, Zanthojoppa lutea Gravenhorst, 1829, and Amblyjoppa proteus Christ, 1791 are rare and interesting species for the Lithuanian fauna.

The summarized data on the distribution of ichneumonid fauna based on the total number of species in individual genus in the Lithuanian strict nature reserves (Fig. 1) have revealed distinct differences in the total number of species per genera and uncertain differences between separate reserves. The largest genus has been attributed to Viešvilė reserve; it comprised 21 species. The other dominant genera were observed in Žuvintas reserve, with 18 species, and in Kamanos reserve, with 11 and 14 species. The other genera were as follows: from two to eight species in a genus contained 51 genera in Kamanos reserve and 49 genera in Viešvilė reserve, from two to five species in a genus contained 31 genera in Žuvintas reserve and 12 genera in Čepkeliai reserve. One species in genera contained as follows: in Žuvintas - 98 genera, in Viešvilė - 94, in Kamanos - 85 and in Čepkeliai - 30 genera.

Some insect species found in the strict nature reserves are included in international conventions Convention..1979 (Bern convention), Council Directive 1992 (Habitat Directive) and the Red Data

Book of Lithuania (1992) (Table 3).

The weight of reserves for strictly protected species is not equal. 22 species were recorded in Čepkeliai (see the table3), 16 - in Žuvintas, and 13 in each, Viešvilė and Kamanos.

Conclusions

1. The complexity of the species composition of the four strict nature reserves in Lithuania is very diverse; over 3000 species belonging to 9 orders of insects were recorded. The greatest number of species was found in Čepkeliai (2375) and Viešvilė (2365). The lowest number was recorded in Žuvintas (2081) and Kamanos (2011). The Lepidoptera order contained over 1500 species, Coleoptera - 1450, Hymenoptera - 1124.

2. 1020 moth species belonging to 49 families were recorded in Čepkeliai reserve: Noctuidae (263), Geometridae (249), Tortricidae (84), Pyralidae (64), and group Rhopalocera (64). 982 moth species belonging to 50 families were recorded in Viešvilė reserve: Noctuidae (232), Geometridae (214), Tortricidae (146), Pyralidae (83), and group Rhopalocera (64). 817 moth species from 45 families were found in Žuvintas reserve: Noctuidae (205 species), Geometridae (154), Tortricidae (114), Pyralidae (67), Rhopalocera (73). 558 moth species belonging to 35 families were recorded in Kamanos reserve: Noctuidae (137), Geometridae (113), Tortricidae (69), Pyralidae (36), and Rhopalocera (67).

3. Among various families, the greatest species diversity was recorded for ichneumonids (Ichneumonidae), over 554 species belonging to 230 genera were recorded in the four Lithuanian reserves. The genera *Gelis* (33 species), *Phygadeuon* (18), *Glypta* (15), and *Lissonnota* (12) were prevailing in the ichneumonids fauna. The abundance of species in individual reserves was as follows: Viešvilė - 281 species, Kamanos - 257, Žuvintas - 196, and Čepkeliai - 58. The largest genera were observed in Viešvilė, with 21 species, in Žuvintas - 18 species, and in Kamanos reserve - they comprised 11 and 14 species. Rare species of the ichneumonid fauna made about half of all recorded species. Higher percentage of rare species clearly prevailed in Kamanos (58%) and Viešvilė (52%) reserves.

4. 38 insect species included in the Red Data Books of Lithuania and Bern, Habitat Convention are registered : 22 species in Čepkeliai, 16 - in Žuvintas, and 13 in each, Viešvilė and Kamanos.

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BIODIVERSITY AND CONSERVATION OF FLORA AND VEGETATION IN LITHUANIA

Zenonas Venckus

Venckus Z. 2003. Biodiversity and conservation of flora and vegetation in Lithuania. *Acta Biol. Univ. Daugavp., 3 (2): 143 - 146.*

The aim of this study was to survey the state of biodiversity of vegetation (flora, plant communities, ecosystems) in Lithuania, indication of the already performed work (legal system, laws directly related with biota protection and conservation of biodiversity, the Red Data Book of species and communities, protected areas) and the present efforts to protect biodiversity (Natural habitats of wild fauna and flora directive and Wild birds directive are being implemented).

Key words: biodiversity, habitats, Red Data Book.

Zenonas Venckus. University of Šiauliai, Šiauliai, Vilniaus 88, Lithuania; e-mail: OIKOS@fm.su.lt

Present situation of biodiversity

Lithuania belongs to the natural zone of mixed forests. Ecosystems of Lithuania include: natural/semi-natural – forests, wetlands, meadows, coasts, sandy areas, marine (the Baltic Sea and Curonian Lagoon), aquatic (lakes and rivers systems), and anthropogenic (agrarian and urban) ecosystems. Natural and semi-natural vegetation covers approximately 1/3 of Lithuania. Forests occupy 30,9% (2001), lakes - about 4%, meadows - about 6,5% (1980), wetlands – 6,4% (1995) of the Lithuanian territory.

The Lithuanian flora is comprised of 1694 species (Lietuvos ... 1980) (plants – 1249, mosses – 335, liverworts – 110). There are approximately 20 tree species, 57 bush, 23 shrub and 1149 herb. The number of plant species in different ecosystems are unequal. The most important are forests (713 species), meadows (550 species), wetlands (264 species), freshwater habitats (130 species) and sandy areas (167 species). Many Lithuanian plants are at the boundary of their distribution range.

From the point of view of plant biogeography Lithuania's communities are unique and important for regional and/or global biodiversity. Lithuania straddles the junction between boreal coniferous and broad-leaved forest. The conservation of rare Lithuanian species and communities, including those distributed mainly in the Baltics and those for which Lithuania represents the edge of their range, is important for both Lithuania and Europe. According to the classification of vegetation types commonly used in Europe, Lithuania's vegetation comprises 32 classes and 220 associations (Балявичене Ю., 1991), including many rare and endangered communities. For a small area (65,2 thousands sq. km) such diversity is significant.

About 85% of forests are semi-natural and only

1% is regarded as natural, while all other forests are plantational. Forests are characterized by higher biodiversity than other ecosystems. Forest communities fall into 30 associations (Lietuvos ... 2000). Although broad leaved deciduous forests are not abundant they are, with mature forests (15,3%) of various species composition, of great importance for conservation of forest biodiversity.

Natural meadows, particularly in forests and river valleys, typically boast the richest diversity of plants. Majority of natural flooded and continental meadows have been destroyed. The diversity of meadow communities is high (34 associations) (Lietuvos ... 1998). Biodiversity in sand communities is poorer (12 associations) (Lietuvos ... 2000).

Wetlands are among Lithuanian's most important ecosystems. The status of wetlands is highly dependent on their size. The diversity of wetland communities is not large (28 associations) (Lietuvos ... 2000).

Aquatic ecosystems include lakes, reservoirs, rivers, the northern part of the Curonian Lagoon, and the Baltic Sea along the coast of Lithuania. Vegetation of water bodies is characterized by high diversity (37 associations) of both fresh and saline water vegetation (Lietuvos ... 2000).

Ruderal communities occur on domestic non-hazardous waste dumps and fallow land. The ruderal flora comprises about 200 species. They grow in ever changing communities. The communities are open; they species composition is not constant (Biodiversity ... 1998).

Agrarian ecosystems occupy the largest land area in Lithuania (about 50%), and are marked by the most impoverished biodiversity. Urban ecosystems occupy nearly 5% of the territory of Lithuania (buildings – 2.7%, roads – 2.0%) (Biodiversity ... 1998).

Biodiversity degenerates in the course of man's economic development due to which several species of plants, fungi and animals have became endangered or extinct in Lithuania. During the Soviet period, biodiversity was most adversely affected by land drainage (drainage of natural meadows and wetlands), channelisation of small rivers, damage to river valleys and cutting of small forests. Small wetlands, particularly those on cultivated land, were destroyed by land reclamation and forest drainage.

Legal and institutional background

The Lithuanian legal system is comprised of laws, regulations, rules, Government resolutions, norms, methodologies, and recommendations. Legal acts that regulate the establishment of Red Data Books of plant and communities are important means for conservation of natural features and biodiversity. Previously adopted laws and new legal acts are being revised as the social-economic situation changes. Aiming to implement the regulations of international conventions and legal acts of the European Community, the amendments to many laws and other legal acts of Lithuania are adopted.

Laws directly related with biota conservation and biodiversity are: Law on Environmental Protection (1992), Law on Protected Plant, Animal and Fungi Species and Communities (1997), Law on Wildlife (1999), Law on Wild Vegetation (1999), Law on Protected Areas (2001), Regulations of the Ministry of Environment (1998). Many laws – Law on Land (1994), Law on Territorial Planning (1995), Law on Environmental Impact Assessment (1996) and Law on Forests (2001) include articles concerning biota protection and biodiversity.

Other legal acts that regulate the regime of biota protection and biodiversity are: Regulations of Reserves (1983), Individual Regulations of National Parks (1992), Individual Regulations of Regional Parks (1996). Decisions and implementations of some issues are regulated by the orders of the Minister of Environment.

Lithuania has ratified all international conventions aimed at the protection and conservation of nature and biodiversity. Convention on

Biodiversity Conservation (1992) was ratified in 1995 and thus Lithuania was obliged to prepare a national biodiversity study, strategy and action plan. Biodiversity conservation strategy and action plan (Biodiversity ... 1998) were prepared and adopted in 1998. The main goals of this document are to conserve the country's biological diversity – major ecosystems and species – for future generations.

The protection of biodiversity is the primary responsibility of the Ministry of Environment.

Lithuanian Red Data Book of species and communities

To protect species and communities Lithuanian Red Data Book has been compiled and protected areas have been established. Book (2000) includes 357 rare and endangered species of plants, which naturally grow and reproduce in Lithuania. The Red Date Book Commission divided the species into 6 categories according to their rarity, necessity of protection, and method of protection. The categories are consistent with those recommended by the Commission for rare and endangered species of the International union for the conservation of nature and natural resources protection: 0 – Ex (Extinct), 1 – E (Endangered), 2 – V (Vulnerable), 3 – R (Rare), 4 – I (Indeterminate), 5 – Rs (Restored).

Species distribution includes data on species range, distribution or known sightings (including secondary references or stressed habitats) in Lithuania. Biological description of species' habitat emphasizes the more characteristic types of habitat required for reproduction, incubation, and growth in Lithuania. Biological and ecological requirements, determining the preservation or extinction of the species, are singled out. The Book provides data on the size of species populations in various sighting locations as well as some statistical data on some species. Here, factors limiting the abundance of the species and reasons for their decline are noted.

Among 220 plant communities (according to the European classification of vegetation), 54 communities are included into the Red Data Book (Lietuvos...2000). There are 5 categories of plant communities in the Book. The community *Trapetum natantis* is extinct. Most plant communities which need protection grow in water bodies, meadows and wetlands.

Protected areas

Many plant species and communities are in the protected areas. Protected areas occupy 11,9% of the Lithuanian surface area. The system of protected areas consists of the biosphere reserve, the strict nature reserves (total 3), national parks (total 5), regional parks (total 30), and reserves (total 263). A large number of botanical, botanical-zoological and telmological reserves, which are important for the conservation of biodiversity, have been established within national and regional parks. However, some areas especially valuable from the biodiversity point of view (wetlands, peat bogs, meadows, sands) are still unprotected.

All natural protected areas and other ecologically important or relatively natural areas united by a system known as Nature Frame.

In natural and semi-natural territories of Lithuania some plant and animal species, which are extinct in some countries of West Europe, still grow and reproduce, habitats of European importance have survived. Therefore, some areas are included into international lists of protected territories. In 1993, when Lithuanian acceded to the Ramsar Convention, 5 wetlands (4 strict nature reserves and 1 regional park) were listed as Ramsar sites.

Measures for biota protection and conservation of biodiversity

Žuvintas Biosphere Reserve (18 493 ha) has been established (2002). Natural habitats of wild fauna and flora directive (92/43 EEC) and Wild birds directive (79/409 EEC) are being implemented. Habitats directive prescribes conservation of approximately 200 types of rare and endangered European habitats and their inclusion into the EE network of protected territories NATURA 2000. It has been determined that 52 types of habitats are present in Lithuania (Europinės ... 2001).

Conservation of forest areas characterized by high biodiversity is possible only isolating woodland key habitats and insuring they protection. Classification system (29 types determined) of these habitats and methods for inventory are created.

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DIVING WATER BEETLE *CYBISTER LATERALIMARGINALIS* DE GEER, 1774 (COLEOPTERA, DYTISCIDAE) AND WHIRLIGIG BEETLE *ORECTOCHILUS VILLOSUS* (MÜLLER, 1776) (COLEOPTERA, GYRINIDAE) IN LATVIA

Mārtiņš Kalniņš

Kalniņš M. 2003. Diving water beetle *Cybister lateralimarginalis* De Geer, 1774 (Coleoptera, Dytiscidae) and whirligig beetle *Orectochilus villosus* (Müller, 1776) (Coleoptera, Gyrinidae) in Latvia. *Acta Biol. Univ. Daugavp., 3 (2): 147 - 150.*

Two water beetle species are described in this paper - diving water beetle Cybister lateralimarginalis and whirligig beetle Orectochilus villosus. Both of the species were considered to be quite rare and with narrow ecological valence. Till 1997 C. lateralimarginalis was often found in East Latvia. In the latest years the species was found in places throughout the whole territory of Latvia. Possible that in Latvia the species has spread fast and it can outrival other large water beetle species. Till 1997 O. villosus in Latvia was known from few localities in Vidzeme and Latgale, it was chiefly found in small, fast flowing rivers. In the latest years the species was found in the rest of Latvia. Whirligig beetle was quite often ascertained in large, slowly flowing rivers and in two cases also in lakes. The fact, mentioned in literature, about the heliophoby has not been proved, the species was also observed during the day. On the whole, both mentioned species are widespread in Latvia. Due to lack of knowledge about the biology and ecology of species, as well as lack of data - species were considered to be rare and locally spread in Latvia.

Key words: Coleoptera, Gyrinidae, Dytiscidae, Orectochilus, Cybister, fauna, Latvia.

Mārtiņš Kalniņš. Latvian Entomological Society, Faculty of Biology, Kronvalda bulvāris 4, Rīga, LV-1842, Latvija; e-mail: vendene@delfi.lv

Introduction

The level of exploration about the distribution of many species in Latvia determines our state of knowledge. Till now few special investigations have been done about water beetles in Latvia and only some have been published (Иванова 1958). In Latvia the investigations of water beetle fauna is of accidental character. Both species mentioned in the paper were considered to be quite rare and with narrow ecological valence in Latvia (Зайцев 1953, Barševskis 1993). Most of observations have been carried out by the author of the paper, some of them by other scientists.

Material and methods

In former investigations the usage of entomological net was rather small or only the beforehand seen beetles have been caught. The usage of ground-seizure or drags for catching large species is not effective because beetles are able to escape. The usage of the net is also not always effective. The most effective method, as later turned out, was underwater "reaping" with a net and lasting visual observations.

Most beetles have been caught with entomological net, not catching visual seen beetles or following objects in the water (such as stomps, stones etc.). Part of beetles have been caught and set free after being determined. The collected material is being kept in the author's and other finders' collections.

Results and discussion

Diving water beetle *Cybister lateralimarginalis* De Geer, 1774, is one of the 8 largest (3-4 cm) diving water beetle species in Latvia. It is possible to add two polyphaga species - *Hydrophilus atterimus* Eschscholtz, 1882 and *H. piceus* (Linnaeus, 1758).

Till 1997 *C. lateralimarginalis* was quite often found in East Latvia (Latgale) (Barševskis 1993, Spuris 1991), but it has not been found in any other place in Latvia. In 1997 and 1999 *C. lateralimarginalis* was found in West Latvia, in North and central part of Latvia - lake Engure (West Latvia), surrounding of Valmiera, in a pound (North Latvia) and in lake Beberbeķu (the central part of Latvia) (Kalniņš 1999).

From 1999 till 2001 the species was found in many other places in Latvia: 1st December, 1999 - in Viesatu fish pound (Tukums district), after draining the pound 1 specimen was caught and several other were observed (leg. I.Pūce); 26th May, 2000 - 1 specimen was caught in Pērļupīte near Ieriķi (Cēsis district); 28th April, 2001 - 2 specimens were observed in lake Lobes (Ogre district); 5th May, 2001 - 2 specimens were caught in Doles sala (Rīga district) (leg. K.Vilks); 8th June, 2001 - 1 specimen was caught in the heath of Seda, in the old river of Seda (Valka district). While verifying the materials of collections one more specimen, before incorrectly determined as *Dytiscus*, from Melnezers (Rīga district) Ķemeri National Park in Raganu bog (12th June, 1995, leg. D.Teļnovs). In some places beetles were observed in a great number. 6 beetles have been caught in Lake Bedušu (Daugavpils district) near Ilgas in 7th-9th June, 1999 (leg. M.Balalaikin) (Barševskis 2001), but in June-July, 2001 even 25 beetles (leg. A.Barševskis). 5 specimens were caught in Daugavpils, Esplanādes reservoir (pound) in 21st May, 2001 (leg. A.Barševskis). Distribution of this species showed in Fig.1.

Data given in literature shows that the typical habitat of diving water beetle *C. lateralimarginalis* is stagnant waters, pounds (Klausnitzer 1996). In the Latvia the species has been found in stagnant waters - lakes, fishponds, ponds. Only one find has been found in running water - in a small forest river. Still, this could be of accidental character. This has been maintained by several *Dytiscus* genus diving water beetle species finds in rivers and springs, places which were absolutely inadequate not only for the development of species, but also for iong existence (not published materials of M.Kalniņš and D.Teļnovs).

Whirligig beetle *Orectochilus villosus* (Müller, 1776) is one of 11 whirligig beetle species found in Latvia. The species is the only one in its genus and it, when compared to *Gyrinus* genus species, is active in dusk or in the night. Some species of *Gyrinus* genus also are active in dusk.

Till 1997 *O. villosus* in Latvia was known from some localities in Vidzeme and Latgale (Barševskis 1993; Spuris 1991). In July 1997 and 1998 the species has been found in several Salaca basin rivers: Glāžupe (Limbaži district), Briede, Ķirele, Rūja, Salaca near Vecate and Skaņaiskalns (Valmiera district); in July 1998 in Gauja near Velēna (Gulbene district), Palsa mouth, Gaujiena (Alūksne district), Zīle, Seda (Valka district), Valmiera (Valmiera district), Liepa, Cēsis (Cēsis district), Baltezers channel, Carnikava (Rīga district) and river Uriekste (Gulbene district), but in June 2000 in rivers Rukūze and Svēte near Mūrmuiža (Jelgava district).

While carrying other entomologists inquiry out, many new localities of the species have been

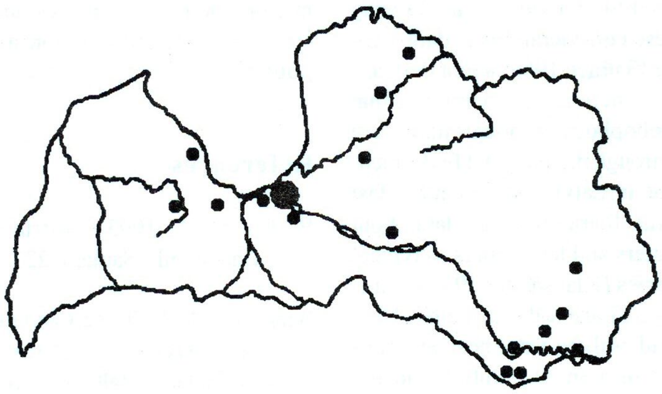

Fig. 1. Distribution of diving water beetle *Cybister lateralimarginalis* De Geer, 1774 in Latvia

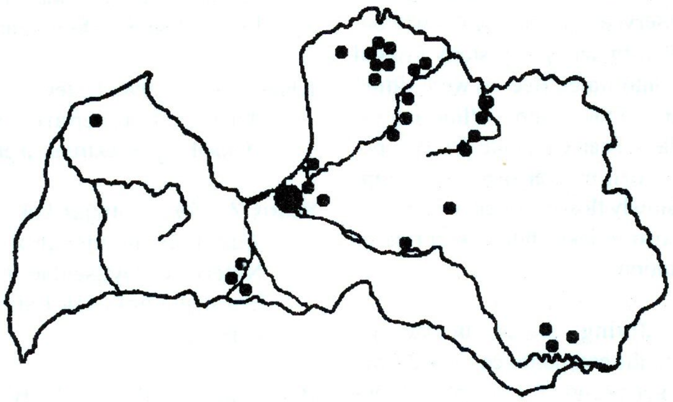

Fig. 2. Distribution of whirligig beetle *Orectochilus villosus* (Mü1ler, 1776) in Latvia

found: 4th August, 1991 - 1 specimen was caught in river Mazā Jugla near Cekule (Rīga district) (leg. F.Kovalevskis). In further years the species has been regularly observed in this place (oral report of D.Teļnovs). 1st July, 1995 - 1 specimen was caught and several others observed in river Stende, near mouth (Ventspils district) (D.Teļnovs); 24th June 1996 - 1 specimen has been caught in Salaca, but in June 25 near Silgaļi (Valmiera district) 2 specimens have been caught (leg. D.Teļnovs).

Very important are two finds of the species found in lakes. 12-13 July, 1994 - one just broken the cocoon beetle was found in lake Dridzis (Krāslava district) near Liepu sala (leg. D.Teļnovs) and several other beetles have been observed. 23rd August, 2001 - 3 beetles have been caught and several other observed in Lake Kāla (Madona district) near Tolkas sala. Distribution of this species showed in Fig.2.

Knowledge about the biology and ecology of the species is one of the most important factors in searching for species. This is very important while searching for whirligig beetle O.villosus. Among beetle researchers and hydrobiologists this species was considered to be living in fast flowing waters. Under these considerations is data mentioned in literature (Зайцев 1953) about the ecology of the species. There is also mentioned that beetles possess heliophoby, although they were seen to be active through daytime. All finds, mentioned in literature, in Latvia were found in fast flowing rivers. Still, literature gives data about slowly flowing waters and lake shores as typical habitats of the species (Klausnitzer 1996). Finds in the lake Dridzis and Lake Kāla maintain it. Near the isle in Lake Dridzis there are almost no water-plants or they are of a small number, and the lakebed is sandy. Most of observed beetles were sitting on above-water parts of alder stumps, under target barks, but part of them were freely swimming on the water surface through bulrush. But the place in Lake Kāla, where the whirligig beetles have been observed, was practically without any water-plants, with sandy and stony ground and stumps, sunk into water. Beetles were sitting on the sunken parts of the stumps. While analysing finds in Latvia one can conclude that the species can be come across in river spans full of rapids, as well as in slowly flowing rivers with not so rich vegetation, also in lake shores with rich or not so rich vegetation.

According to diving water beetle *C. lateralimarginalis*, the competitiveness with species of *Dytiscus* genus should be explored, because the species has been found in large quantities in lake Balticas near Varnavīči (Krāslava district) and it practically had concure other species of *Dytiscus* genus in Latvia (Barševskis, 1993). Probably that this is one of the reasons for many finds of the species lately.

In total, both mentioned species are widespread in Latvia. Due to lack of knowledge about the biology and ecology of species, as well as lack of data - species were considered to be rare and locally spread in Latvia.

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AVIFAUNA OF THE TĒRVETE NATURE PARK

Aigars Kalvāns

Kalvāns A. 2003. Avifauna of the Tērvete Nature Park. *Acta Biol. Univ. Daugavp., 3 (2): 151 - 152*

The article content information about avifauna of Tērvete Nature Park. 108 bird species were recorded in the park during the study period.

Aigars Kalvāns, Forest faculty, Latvia University of Agriculture, Akadēmijas 11, LV-3001 Jelgava, Latvia. E-mail: kaigars@one.lv

Breeding bird atlas data of the Tērvete Nature Park are presented in this study. The park is situated in the middle part of Latvia. Forests cover the most part of the territory, among them there is a noble pine forest- it is an outstanding and several pines are up to 300 years old. On the north part of the park situated 74 ha big pound with islands. An inventory of the forest bird fauna of the park was carried out in the year 2000. Standard methods for atlas-type mapping inventories were used. The territory (3600 ha) was investigated according to 1x1 km squares (54 in total, 52 of them were surveyed) (Fig. 1.). 108 bird species were recorded in the park during the study period. Breeding was confirmed for 33, probable - for 52 and possible - for 23 species. 14 more species were observed before the study period or in 2001, but were not found in 2000. Time spent in the square, number of visits in the square and habitat diversity in the square was used for subjective evaluation if the survey in the square was complete. According to this evaluation procedure 32 squares were considered completely surveyed, but in 20 survey was insufficient for recording all species. Simplified Finnish line-transect counts in six routes were used to estimate numbers of the most common breeding songbird species in the park (Fig. 2.). The most common species in the park were Chaffinch (*Fringilla coelebs*): >1000 pairs, Tree Pipit (*Anthus trivialis*): >800 pairs and Pied Flycatcher (*Ficedula hypoleuca*): >500. High numbers of common bird species were recorded in old dry pine forest with thick undersotry: (Pied Flycatcher (*Ficedula hypoleuca*): >500 pairs, Treecreeper (Certhia familiaris): >300, Crested Tit (*Parus cristatus*): >300, Nutchach (*Sitta europaea*): >250. Tērvete Nature Park is breeding place for 14 species of Latvian Red Data Book and 24 species of 1. Appendix of Birds Directive of European Union (Table 1).

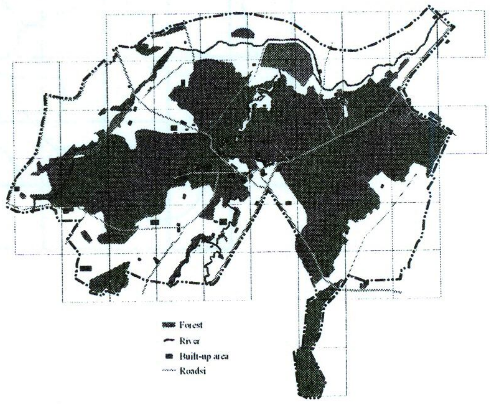

Fig. 1. Tērvete Nature Park.

Table 1. Species of Latvian Red Data Book (RDB) and species of 1. Appendix of Birds Directive of European Union (EU) breeding in Tērvete Nature Park

Species		Status		Population estimate
		RDB	EU	(pairs)
Little Grebe	*Tachybaptus ruficollis*	*		1
Common Bittern	*Botaurus stellaris*	*	*	1
Black Stork	*Ciconia nigra*	*	*	0-1
White Stork	*Ciconia ciconia*		*	1-2
Honey Buzzard	*Pernis apivorus*		*	1-2
Marsh Harrier	*Circus aeruginosus*		*	1
Lesser Spotted Eagle	*Aquila pomarina*	*	*	0-1
Osprey	*Pandion haliaetus*	*	*	0-1
Common Kester	*Falco tinnunculus*	*	*	1
Quail	*Coturnix coturnix*	*		>1
Spotted Crake	*Porzana porzana*	*	*	0-1
Corncrake	*Crex crex*	*	*	4
Common Tern	*Sterna hirundo*		*	0-1
Nightjar	*Caprimulgus europaeus*	*	*	>1
Common Kingfisher	*Alcedo atthis*	*	*	3-4
Roller	*Coracias garrulus*	*	*	0-1
Grey-headed Woodpecker	*Picus canus*		*	1
Black Woodpecker	*Dryocopus martius*		*	2
Middle Spotted Woodpecker	*Dendrocopus medius*	*	*	8-10
White-backed Woodpecker	*Dendrocopus leucotos*	*	*	>3
Woodlark	*Lullula arborea*		*	>5
Barred Warbler	*Sylvia nisoria*		*	5-7
Red-breasted Flycatcher	*Ficedula parva*		*	>20
Red-backed Shrike	*Lanius collurio*		*	15-20
Ortolan Bunting	*Emberiza hortulana*		*	1-3

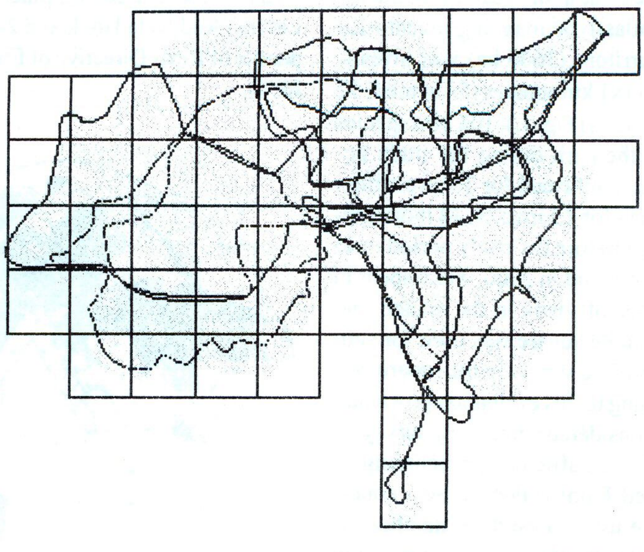

Fig. 2. Routes of counts