Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

HABITAT DETERMINATION OF TAWNY OWL (*STRIX ALUCO*) PREY COMPOSITION DURING BREEDING PERIOD

Laima Balčiauskienė, Deivis Dementavičius

Balčiauskienė L., Dementavičius D. 2006. Habitat determination of Tawny Owl (*Strix aluco*) prey composition during breeding period. *Acta Biol. Univ. Daugavpil., 6 (1-2): 1-12.*

The material was collected from 13 nest-boxes of the Tawny Owl (*Strix aluco*) near the Kauno Marios reservoir in Rumšiškės forests, Central Lithuania, after the breeding period in 2000–2005. Out of 1125 recovered prey items, mammals comprised 82.1% (56.9–98.7%); birds, 3.0% (0–40.0%); amphibians, 14.5% (0–39.2%). 17 mammal (including 4 insectivore, 2 bat and 11 rodent), at least 11 bird and 3 amphibian species represented in the diet. We found that the presence of clear-cuts and re-growing forest glades within 0.5 km around the nest-box had the greatest influence on the differences in prey diversity, especially, on the preying of uncommon mammal species, such as bats, water shrew (*Neomys fodiens*), birch mouse (*Sicista betulina*), harvest mouse (*Micromys minutus*), water vole (*Arvicola terrestris*) and common dormouse (*Muscardinus avellanarius*). The share of the main mammalian prey items was mostly influenced, first, by drier owl hunting areas (less *Apodemus flavicollis* and *Clethrionomys glareolus* and more *Microtus* voles compared with areas near water), second, by the nest-box proximity to the forest edge (more *A. flavicollis* and less shrews compared to the areas inside the forest) and, third, by the presence of clear-cuts and glades (less *Microtus* voles). Differences in numbers of birds preyed by the Tawny Owl in the compared habitats were not expressed. The most frequently captured birds were chaffinch (*Fringilla coelebs*) and thrushes (*Turdus* spp.). More amphibians were preyed by owls in the forest and further from water bodies. The amphibian share in the Tawny Owl prey was less where clear-cuts were present around nest-boxes.

Key words: Tawny Owl, prey composition, breeding period, habitat

Laima Balčiauskienė. Institute of Ecology of Vilnius University, Akademijos 2, LT-08412 Vilnius-21, Lithuania. E-mail: laiba@ekoi.lt

Deivis Dementavičius. T. Ivanauskas Zoology Museum, Laisvės al. 106, LT-44253 Kaunas, Lithuania. E-mail: ornit@zoomuziejus.lt

Introduction

Tawny Owls (*Strix aluco*) are sedentary and their home range varies with habitat, being generally smaller in dense woodland. If only wooded areas be considered, Tawny Owl density in Central Europe is 0.5–1.0 (up to 1.5) pairs per km^2 (Glutz & Bauer 1980, Galeotti 2001). Tawny Owls take only the prey species that are available in their immediate vicinity. These owls are strongly territorial, and it is suggested that only by having a territory and knowing it Tawny Owls can survive (Southern 1970).

Though most of the hunting of Tawny Owls is done from the perch, they can use a variety of other catches – birds are taken mostly from roosting sites, bats in flight, may hunt in nests, open holes and on the ground (Cramp 1989). This also means that a variety of open and forested habitats are used (reviews in Mikkola 1983, Cramp 1989, Galeotti 2001). Generally, in rural areas mammals are dominating, while in towns – birds do. Bird share is less in open habitats (Cramp 1989).

For the Tawny Owl in Poland, environmental variations have been discussed by various authors, but their studies concerned mainly farmland communities and urban areas or data collected close to forest boundaries and in the vicinity of buildings (Goszczyński 1977, 1981, Ruprecht & Szwagrak 1987, Gramsz 1991, Goszczyński *et al.* 1993, Zalewski 1994, Ruprecht *et al.* 1998). Consequently, the understanding of the foraging ecology of the Tawny Owl and its predation pressure on prey populations in forest ecosystems remains rather poor (Żmihorski & Osojca 2006).

The aims of the study in Central Lithuania were to investigate: (1) if mammal, bird and amphibian shares in the food of breeding Tawny Owls differ in various habitats surrounding the nest-box, and (2) if proportions of various small mammal species in the prey have any habitat dependences.

Material and methods

Prey remains were collected from 13 Tawny Owl nest-boxes in Rumšiškės forests near the Kauno Marios reservoir, Kaišiadorys district, Central Lithuania, after the breeding period in 2000–2005. Nest-boxes were placed in the territory of about 100 sq. km: ten in the Rumšiškės-Pravieniškės forest or on its edge (where forest covers ca. 80% of the territory), and three in a 130 ha

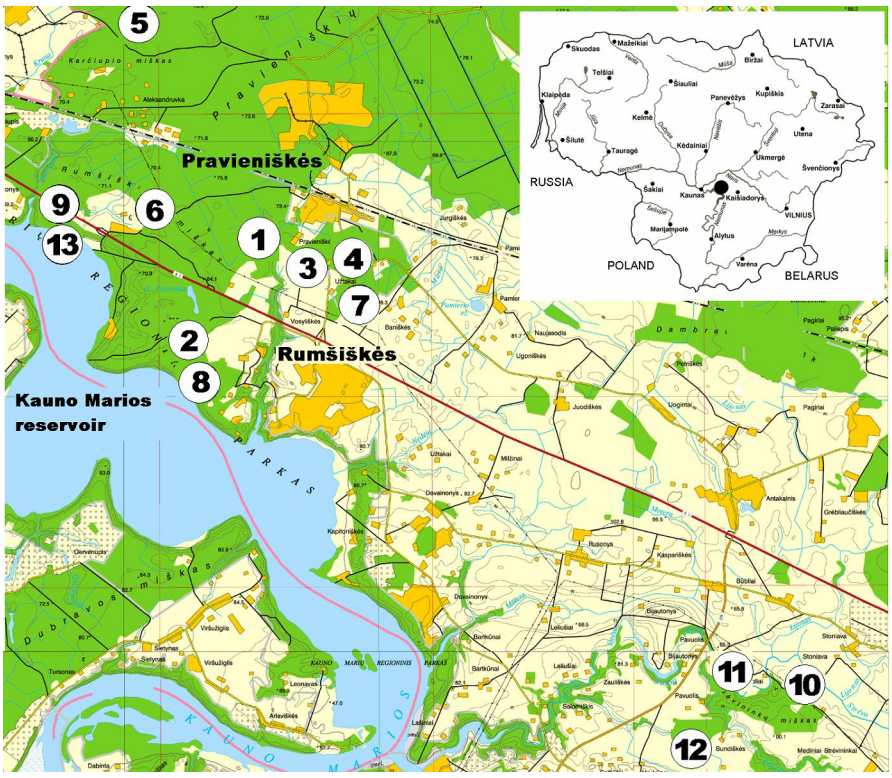


Fig. 1. Study area

Strėvininkai forest groove amid fields (Fig. 1). The main habitat type near nest-boxes was mixed deciduous/coniferous forest (Table 1).

Totally, 16 samples were collected: 2 in the years 2000 and 2002, one in 2003 (all three in the Rumšiškės forest district), 5 in 2004 (Rumšiškės and Pravieniškės forest districts), and 6 in 2005 (Rumšiškės and Kruonis forest districts).

The generally known rules for collecting prey remains from the nest-boxes, identifying prey items and the number of prey were applied (Balčiauskienė *et al*. 2005a, b).

Habitat influence upon the diet of the Tawny Owl in the breeding period was assessed: (1) by grouping the sites according to diet composition (based on the recovered prey remains) and

Table 1. Description of the habitat in the surroundings of Tawny Owl nest-boxes

Nest-box No.	Co-ordinates	Habitat	Surroundings
1.	54^{0}53'36.12"N 24^{0}11'56.46"E	Mixed deciduous and spruce forest of various age, dominating tree species – poplar, birch, spruce and oak, rich undestorey of hazel; abundant re-growing clear-cuts, uncultivated meadows bordering the forest edge.	Praviena rivulet flows next to the nest-box.
2.	54^{0}52'31.62"N 24^{0}10'33.54"E	Mature mixed deciduous and spruce stands dominated by spruce, oak, birch and hornbeam trees.	Forest edge bordered by raised meadows.
3.	54^{0}53'23.82"N 24^{0}12'54.48"E	Mixed deciduous and spruce forest of various age, dominating tree species – poplar, birch, spruce and oak, rich understorey of hazel; abundant re-growing clear-cuts.	Forest edge bordered by uncultivated meadows.
4.	54^{0}53'29.64"N 24^{0}13'36.66"E	Mixed deciduous and spruce forest dominated by poplar, spruce, oak, black alder and birch, with rich understorey. A few re-growing woodlots are present.	Several farmsteads with gardens and meadows are situated close to the forest.
5.	54^{0}56'21.48"N 24^{0}9'32.58"E	Mixed deciduous/coniferous forest dominated by black alder, poplar, birch, spruce and oak, with rich understorey. Many re-growing woodlots are present.	Locality is surrounded by boggy areas.
6.	54^{0}54'3.24"N 24^{0}9'42.24"E	Mixed deciduous and spruce forest dominated by spruce, birch, poplar, oak. Rich understorey, re-growing woodlots and undergrowth are characteristic.	Forest is bordered by raised meadows.
7.	54^{0}52'53.4"N 24^{0}13'27.9"E	Mixed spruce/deciduous stands dominated by spruce, oak, black alder and birch, with scarce understorey and fresh woodlots.	Forest is bordered by uncultivated meadows and agricultural fields.
8.	54^{0}52'5.46"N 24^{0}10'50.46"E	On the shore of the Kauno Marios reservoir – mixed coniferous/deciduous stands dominated by spruce, pine, oak, hornbeam, with various understorey and re-growing woodlots.	Forest is bordered by meadows.
9.	54^{0}54'15.96"N 24^{0}8'9.12"E	Mixed spruce/deciduous stands dominated by spruce, oak, pine, birch, with lush understorey, fresh woodlots and young stands.	
10.	54^{0}48'43.62"N 24^{0}21'51.42"E	On the edge of the Strėvininkai forest – mature stands of poplar, spruce, birch and oak dominating, with rich understorey of hazel.	Bordered by raised or/and unmanaged meadows.
11.	54^{0}48'49.5"N 24^{0}20'54.42"E	On the edge of the Strėvininkai forest – mature stands of poplar, spruce, birch and oak dominating, with rich understorey of hazel.	Bordered by raised or/and unmanaged meadows. Near the Strėva river.
12.	54^{0}48'38.2"N 24^{0}20'10.0"E	On the edge of the Strėvininkai forest, a groove in the former kolkhoz forest: mature stands of poplar, spruce, birch and oak dominating, with rich understorey of hazel.	Bordered by raised or/and unmanaged meadows.
13.	54^{0}53'52.5"N 24^{0}7'55.32"E	Mature, mixed coniferous/deciduous stands dominated by spruce, pine, poplar, birch and hornbeam, with rich understorey and re-growing woodlots.	Near the Kauno Marios reservoir.

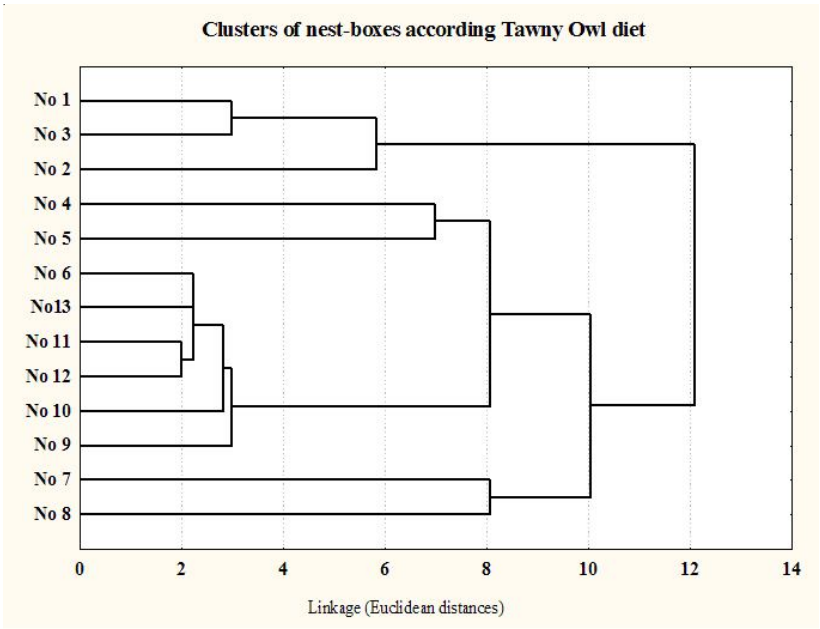


Fig. 2. Similarity of the Tawny Owl diet composition in the breeding period according to prey remains found in the nest-boxes

then comparing habitat structure around nest-boxes, and (2) by grouping the sites according to surrounding habitat features and testing diet differences among them.

Three habitat sets were singled out in the radius of 0.5 km around the nest box with the presence or absence of features chosen:

1. nest-boxes near water bodies or rivulets (No. 1, 5, 8, 11, 13) *vs.* nest-boxes in drier places;
2. nest-boxes hanged out at the forest edge (No. 1, 2, 3, 6, 7, 10, 11, 12, 13) *vs.* those in the forest;
3. nest-boxes close to clear-cuts and forest glades *vs.* places without clear-cuts (No. 10, 11).

Table 2. Diet composition of Tawny Owl in Rumšiškės forests in the breeding period.

Nest-box No.	Mammals		Birds		Amphibia		N of species	Shannon's *H*	Simpson's *c*
	N	%	N	%	N	%			
1.	76	98.7	–	–	1	1.3	9	2.01	0.35
2.	162	93.6	2	1.2	9	5.2	14	2.28	0.29
3.	108	87.8	6	4.9	9	7.3	14	2.78	0.21
4.	67	62.0	7	6.5	34	31.5	24	3.64	0.12
5.	103	88.8	2	1.7	11	9.5	15	3.05	0.15
6.	6	60.0	4	40.0	–	–	7	2.65	0.18
7.	117	78.0	1	0.7	32	21.3	15	3.13	0.14
8.	91	81.3	–	–	21	18.8	10	2.57	0.21
9.	29	56.9	2	3.9	20	39.2	11	2.92	0.16
10.	44	69.8	4	6.3	15	23.8	13	3.18	0.14
11.	34	82.9	1	2.4	6	14.6	10	2.84	0.18
12.	56	91.8	1	1.6	4	6.6	11	2.25	0.32
13.	32	91.4	2	5.7	1	2.9	6	1.78	0.42

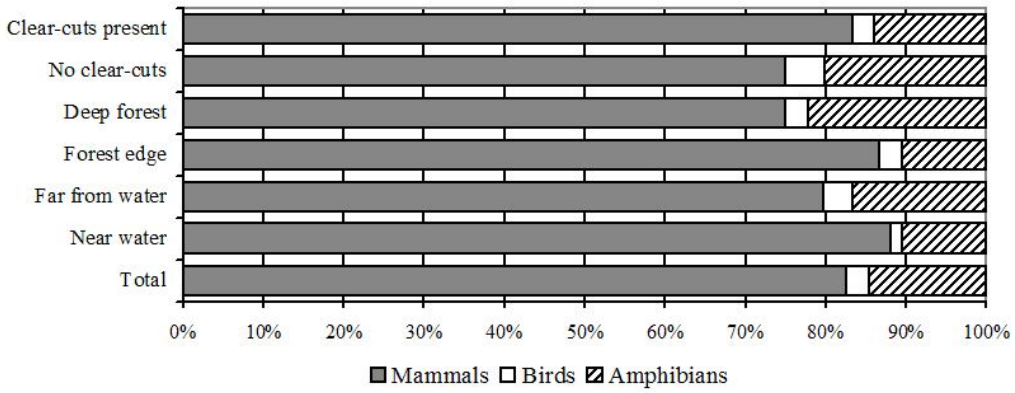


Fig. 3. Comparison of the main diet components of the Tawny Owl in the breeding period, depending on the nest-box surrounding habitat.

Diet composition by numbers in said groups was compared by χ^2 statistics. Cluster analysis (StatSoft 2004) was done by joining (tree clustering), based on the diet composition.

Results

In general, the diversity of the Tawny Owl diet in Rumšiškės forests was quite high (values of Shannon˙s index close to or exceeding 3) and, according Simpson˙s index, not dominated by one or few food sources (*c* in most cases less than 0.20; Table. 2). From 1125 recovered prey items, mammals comprised 82.1%. Seventeen mammal species, including 4 insectivorous, 2 bat and 11 rodent species, were represented. The yellow-necked mouse (*Apodemus flavicollis*) and bank vole (*Clethrionomys glareolus*), traditionally regarded as forest dwellers, comprised 59.8%; *Microtus* voles, 18.8%; shrews, 14.1% of all preyed mammals.

Birds in the prey were represented by at least 11 species: robin (*Erithacus rubecula*), blackbird (*Turdus merula*), song thrush (*Turdus philomelos*), mistle thrush (*Turdus viscivorus*), tits (*Parus* sp.), nuthatch (*Sitta europaea*), treecreepers *(Certhia* sp.), sparrows (*Passer* sp.), chaffinch (*Fringilla coelebs*), bullfinch (*Pyrrhula pyrrhula*), hawfinch (*Coccothraustes coccothraustes*) and undetermined passerine birds (Passerines undet). Most frequently captured birds were *Fringilla coelebs* and thrushes (*Turdus* spp.). Generally, the bird share in the diet was not significant, exception for the nest-box No. 6 (40%).

From 163 recovered individuals of amphibians, the common frog (*Rana temporaria*) prevailed (137 individuals). The grass frog (*Rana arvalis*) was much less numerous in the prey remains (25 individuals) and just one common spadefoot (*Pelobates fuscus*) individual was found. The impact of amphibians in the diet was much bigger than that of birds, especially in the nest-boxes No. 9 (39.2%), No. 4 (31.5%), No. 7 (21.3%) and No. 6 (18.8%; Table 2).

When grouped according to the diet composition (numbers of recovered prey items of mammals, birds and amphibians), nest-boxes No 11, 12, 13 and 6 fell into the cluster of highest similarity (Fig. 2). All enlisted nest-boxes were situated on the forest edge or close to it, bordered by raised meadows.

Comparing the shares of mammals, birds and amphibians in the diet of Tawny Owls breeding in nest-boxes surrounded by different habitats

Table 3. Mammal composition (N of preyed individuals) in the diet of the Tawny Owl from food remains in the nest-boxes with different habitat characteristics

Species	Total	Water		Forest		Clear-cuts	
		close to	far from	edge	deep	present	none
Talpa europaea	3	–	3	2	1	2	1
Sorex araneus	116	23	93	70	46	111	5
S. minutus	6	3	3	2	4	6	–
Sorex spp.	1	1	–	–	1	1	–
Neomys fodiens	7	–	7	5	2	5	2
Eptesicus serotinus	1	–	1	–	1	1	–
Plecotus auritus	1	–	1	1	–	–	1
Chiroptera undet.	3	2	1	1	2	3	–
Sicista betulina	16	–	16	3	13	16	–
Muscardinus avellanarius	16	4	12	6	10	16	–
Clethrionomys glareolus	244	79	165	174	70	228	16
Arvicola terrestris	7	–	7	2	5	7	–
Microtus oeconomus	41	6	35	33	8	31	10
M. agrestis	73	11	62	34	39	66	7
M. arvalis	49	5	44	42	7	42	7
Microtus spp.	11	–	11	2	8	11	–
Micromys minutus	4	2	2	2	2	4	–
Apodemus flavicollis	309	90	219	239	70	282	27
Mus musculus	6	4	2	6	–	4	2
Rattus norvegicus	3	2	1	2	1	3	–
Rodentia undet.	7	–	–	–	–	7	–
No of species, *S*	17	12	17	16	15	16	10
Shannon's *H*	2.667	2.318	2.745	2.484	2.866	2.633	2.689
Simpson's *c*	0.220	0.283	0.202	0.248	0.178	0.223	0.200

(Fig. 3), we found several statistically significant differences. Mammals were better represented in the presence of clear-cuts near the nest-box (83.4% *vs*. 75.0% when clear-cuts were absent near the nest-boxes, χ^2 =4.59, p=0.03), on the forest edge (86.6% *vs*. 74.9% in the deep forest, χ^2 =24.09, p<0.001) and near water (88.2% *vs*. 79.7% in drier places, χ^2 =155.05, p<0.001). Differences in bird numbers preyed by the Tawny Owl in the compared habitats were less expressed. The bird share in the prey remains from nest-boxes near water bodies was thrice less that in the prey remains from nest-boxes hanged in drier places (1.3% *vs*. 3.7%, χ^2 =4.96, p=0.03). We found that more amphibians were preyed by owls in the forest (22.5% *vs*. 10.5% on the forest edge, χ^2 =27.96 p<0.001) and in drier places (16.6% *vs*. 10.5% near water bodies, χ^2 =7.63 p<0.01). The presence of clear-cuts lessened amphibian part in the Tawny Owl prey (14.0% *vs*. 22.2% in the habitat with no clear-cuts, χ^2 =2.93 p<0.1).

The composition of preyed mammals – the main food of the Tawny Owl – was also compared among the three sets of habitat described above (Table 3, Fig. 4). The presence of clear-cuts and re-growing forest glades within 0.5 km around the nest-box had the greatest influence on the differences in prey composition. Higher prey diversity was found in prey remains from nest-boxes situated close to clear-cuts and forest glades – the number of species preyed was *S*=16, Shannon˙s *H*=2.63, compared to *S*=10, *H*=2.69 in the surroundings without clear-cuts. The presence of open spaces in the forest was especially important for a greater possibility for owls to catch individuals of uncommon mammal species, such as bats, water shrew (*Neomys fodiens*), birch mouse (*Sicista betulina*), harvest mouse (*Micromys minutus*), water vole (*Arvicola*

terrestris) and common dormouse (*Muscardinus avellanarius*). The neighborhood of water bodies had a negative influence on prey diversity (*S*=12, *H*=2.32 *vs.* *S*=17, *H*=2.75 in drier surroundings). A nest-box position with respect to the forest edge (9 nest-boxes near the edge neighboring raised or unused meadows, *S*=16, *H*=2.48 *vs.* 4 boxes in the forest, *S*=15, *H*=2.87) had less influence (Table 3).

Statistically, the diet composition of the Tawny Owl was different in all pairs of habitats compared (Fig. 3): near water *vs.* drier habitat (χ^2 =151.8), forest edge *vs.* deep in the forest (χ^2 =71.1), and clear-cut presence *vs.* clear-cut absence (÷^{2}=102.1); in all three cases df=4, p<0.0001. In the drier owl hunting area, compared with hunting areas near water, the diet contained more *Microtus* voles (χ^2 =41.4, p<0.0001), less *A. flavicollis* (χ^2 =16.4, p<0.0001) and less *C. glareolus* (χ^2 =7.1, p<0.01); in all cases df=1. The diet of Tawny Owls breeding in the nest-boxes close to the forest edge contained more *A. flavicollis* (χ^2 =13.3, p<0.001) and less shrews (χ^2 =3.8, p<0.05) than the diet of owls breeding deeper in the forest. When nest-box surroundings were characterised by the presence of clear-cuts and glades, the diet of Tawny Owls included less *Microtus* voles (χ^2 =38.95, p<0.0001) and more shrews (χ^2 =12.6, p<0.001); in all cases df=1.

Discussion

Tawny Owls are sedentary and their home range varies with habitat. Various authors report the hunting radius of the Tawny Owl varying from 200 to 700 m from the nest site, and at most reaching 1000 m (Wendland 1963, Lundberg 1980, Cramp 1989). On the northern edge of distribution, the home range was estimated as large as 91–1780 ha (Sunde *et al.* 2001); thus, the radius of activity reached 500–2400 m. In Central and Western Europe, individual territories of this bird in optimum habitats are 25–30 ha; in deciduous woods, 18.2 ± 2.06 ha; in mixed farmlands, 37.4 ± 14.04 ha; in mature spruce forests, 46.1 ± 7.12 ha (Cramp 1989). This means that Tawny Owls hunt mainly in the 240–380 m radius from the nesting place, limiting the choice of prey as well as the variety of covered habitats. In publications concerning NE Poland (Żmihorski & Osojca 2006) and UK (Redpath 1995), the habitat was de-

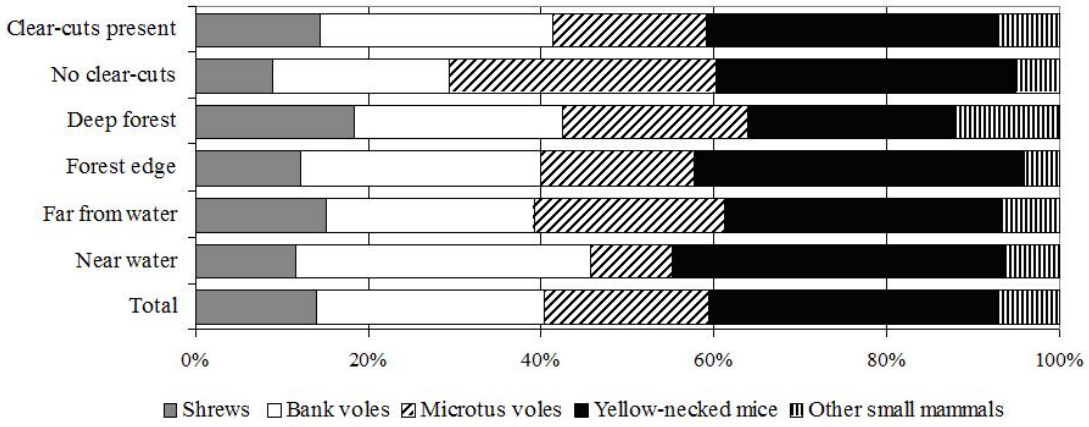


Fig. 4. Comparison of mammal share in the diet of the Tawny Owl in the breeding period, depending on the nest-box surrounding habitat

scribed in the radius of 500 m from the pellet collecting site. South of the distribution range, individual territories become even smaller: in Italy, Tawny Owl males fly less than 250 m for hunting on average (Galeotti 1998). These results are contrary to the data of Juškaitis (2001, 2004) who in south-western Lithuania found Tawny Owls to be hunting up to 1,600 m away from the nest-box, thus stating that their feeding area might cover a sufficiently bigger set of habitats. As we have not carried out special investigations on the territory size of owls, the distance of 500 m was chosen for the habitat description in our study, as most often used in published sources.

In general, the Tawny Owl is a very adaptable species known to breed in forests of different types, on arable land and also in urban environments (Southern 1970, Mikkola 1983, Hirons 1985, Ranazzi *et al*. 2000). In the Tawny Owl, behavioural differences, such as perching time and interperch distances, are influenced by the presence of trees in the home range and overall habitat fragmentation (Redpath 1995), but there are owl species, which do not exhibit diet differences according to habitat (Marti 1974).

Usually, more prey species are identified from nest contents than from adult owl pellets. Birds form a much larger proportion of prey brought to nests, particularly in May-June (Petty 1999). In our study, only one case of high bird percentage in the diet of Tawny Owls was registered (the nest-box was situated on the forest edge neighbouring an open area of raised meadows). Food remains in other nest-boxes contained merely 1.2–6.5% of birds according to prey numbers. Other data from Central Lithuania showed that birds were also a minor food item group in Tawny Owl pellets (Balčiauskienė *et al.* 2006); the same was found for NE Poland, Romincka Forest (Żmihorski & Osojca 2006).

Though rodents form an important part of the Tawny Owl diet, passerines also are important as a food item (Overskaug *et al.* 1995, Jedrzejewski *et al.* 1996, Overskaug & Bolstad 1999). Compared to the other available habitats, passerines are common in mixed deciduous-coniferous forests (Nilsson 1979). This was true also in our case – the highest share of passerine birds in the diet was registered in the nest-box No. 6 situated in the mixed deciduous and spruce forest.

A share of amphibians was high in about half of the cases under our investigation (ca. 10–40% of all prey items identified), except for the nest-boxes situated close to water bodies. On average, amphibians comprised 14.5% of all prey items. We may presume that the investigated forest habitats and meadows were damp enough for amphibians to survive and that hunting possibilities for owls were scarcer directly on the shore of water bodies covered by high and lush vegetation. Such presumption corresponds to the statement of Wendland (1972) that the presence of a suitable habitat is crucial to the occurrence of frogs and toads in the Tawny Owl diet. In his case, spring and summer food of one owl individual comprised 45% (presumably by numbers of items) of common spadefoots (*Pelobates fuscus*); the common toad (*Bufo bufo*) was much commoner in the area, but only 5 occurred in 31 986 prey items. And on the contrary, no amphibians were recorded in the diet at Wytham, UK, where there were very few habitats suitable for frogs (Galeotti 2001).

A relatively high proportion of amphibians (33.8% of prey items) in the pellets from the Romincka Forest was considerably higher than in the pellets from other forest complexes in Poland. This was presumably due to a low density of rodents and abundance of small water bodies, giving perfect conditions to amphibian breeding and survival (Żmihorski & Osojca 2006). Usually, higher proportion of birds and amphibians in the Tawny Owl prey was observed when the main prey became scarce (Cramp 1989). For example, as alternative prey, shrews, birds and amphibians were the most important for the Tawny Owl in the Białowieża National Park (Jędrzejewski *et al.* 1994).

It is generally true that a richer habitat supports greater density of rodents. In our investigations we found that a share of the main food items – *A. flavicollis*, *C. glareolus* and *Microtus* voles –

was related to habitat peculiarities of the territory surrounding the nest-box. The main habitat features were the presence of clear-cuts and re-growing forest glades, forest edges and dryness of the territory. These findings correspond to the data of other authors or may be explained by the features of ecology and habitat distribution of preyed small mammal species (Balčiauskas *et al.* 1999).

While snap-trapping small mammals on croplands in Lithuania *C. glareolus* were caught mainly on the forest edge (Mažeikytė 1990a). Abundance of another main prey of the Tawny Owl, *A. flavicollis*, was also higher in the forest ecotone zones (Mažeikytė 1990b). These findings may explain a positive influence of both the forest edge and the clear-cut (as in the latter case the forest ecotone is also formed) on the share of these two prey items in the owl diet.

The owl diet is largely determined by the ratio of open to wooded areas within the hunting area. The proportion of *C. glareolus* is usually higher in the diet of Tawny Owls having their hunting grounds within forests than in small woods or parks surrounded with cropland. Even in the diet of the Barn Owl (*Tyto alba*), a species preferring open areas, the proportion of *C. glareolus* markedly varies depending on whether the hunting grounds of this bird are located within cropland or bordered by forests (Goszczyński 1983).

Negative relationship between small mammals and wood size was also found by Redpath (1995) and in some other studies (Telleria *et al.* 1991). Mammals may have moved into the woods from the surrounding fields after harvest, thus increasing population levels in the forest edge zone (Tew & MacDonald 1993). It can be concluded that the intermediate woods, where food is abundant and energetic costs are not great, present an optimum habitat for Tawny Owls in the area (Redpath 1995, Galeotti 2001).

In nest-box No. 5 in the Pravieniškės forest, we found an exceptionally high number of *S. betulina* in the prey remains – 11 out of 197 preyed individuals, which constituted 9.5% of the diet. The habitat around the nest-box was typical: black alder, poplar, birch, spruce and oak forest with rich understorey and many re-growing woodlots. Earlier we had made two new records of *S. betulina* from avian predator pellets in a similar habitat in Lithuania (mature or over-mature deciduous stands with mature spruce trees) (Balčiauskienė *et al.* 2005b).

The presence of clear-cuts near nest-boxes also had a positive effect on the presence of two other small mammal species, namely *M. avellanarius* and *A. terrestris*, in the owl diet. The remains of individuals of both species were found in the nest-boxes situated in the forest near re-growing clear-cuts.

Our results do confirm that it is quite reasonable to raise nest-boxes for Tawny Owls at the forest edges or near clear-cuts within the forest. Here, with a combination of open spaces and forest ecotone, owls have the best possibility to find diverse prey with minimum energetic costs and time, both of which are limited in the breeding season.

Conclusions

1. In Central Lithuania, the diet of Tawny Owls in the breeding period was influenced by habitat features of the territory around the nest-box.

2. The share of the main mammalian prey items was mostly influenced, first, by drier owl hunting areas (less *Apodemus flavicollis* and *Clethrionomys glareolus* and more *Microtus* voles compared with areas near water), second, by the nest-box proximity to the forest edge (more *A. flavicollis* and less shrews compared to areas inside the forest), and, third, by the presence of clear-cuts and glades (less *Microtus* voles).

3. The presence of clear-cuts and re-growing forest glades within 0.5 km around the nest-

box had the greatest influence on the differences in prey composition, especially on the preying of uncommon mammal species.

4. If an owl prey analysis is targeted to faunistic investigations of small mammals, pellets and prey remains from nest-boxes should preferably be collected near clear-cuts and re-growing forest glades or in forest edge zones.

References

Balčiauskas L., Trakimas G., Juškaitis R., Ulevičius A., Balčiauskienė L. 1999. Lietuvos žinduolių, varliagyvių ir roplių atlasas. Antras papildytas leidimas. (Atlas of Lithuanian Mammals, Amphibians & Reptiles). Vilnius: 120. (In Lithuanian and English).

Balčiauskienė L., Juškaitis R., Atkočaitis O. 2005a. The diet of the Tawny Owl (*Strix aluco*) in south-western Lithuania during the breeding period. *Acta Zoologica Lituanica*, 15 (1): 13–20.

Balčiauskienė L., Skuja S., Zub K. 2005b. Avian predator pellet analysis in biodiversity and distribution investigations. *Acta Biologica Universitatis Daugavpiliensis*, 5 (1): 67–74.

Balčiauskienė L., Jovaišas A., Naruševičius V., Petraðka A., Skuja S. 2006. Diet of Tawny Owl (*Strix aluco*) and Long-eared Owl (*Asio otus*) in Lithuania as found from pellets. *Acta Zoologica Lituanica*, 16 (1): 37–45.

Cramp S. (ed.) 1989. *Handbook of the Birds of Europe, the Middle East and North Africa*. Vol. IV. *Terns to woodpeckers*. Oxford, New York: Oxford University Press.

Galeotti P. 1998. Correlates of hoot rate and structure in male Tawny Owls *Strix aluco*: implications for male rivalry and female mate choice. *Journal of Avian Biology*, 29: 25–32.

Galeotti P. 2001. BWP Update. 3 (1): 43–77. Oxford University Press.

Glutz von Blotzheim U.N, Bauer K.M. 1980. *Handbuch der Vogel Mitteleuropas*. Bd. 9. Wiesbaden, West Germany: Akad. Verlagsgesellschaft.

Goszczyński J. 1977. Connection between Predatory Birds and Mammals and Their Prey. *Acta Theriologica*, 30: 399–430.

Goszczyński J. 1981. Comparative analysis of food of owls in agrocenoses. *Ekologia Polska*, 23 (3): 431–439.

Goszczyński J. 1983. Predators. [In: Ecology of the bank vole, ed. K. Petrusewicz]. *Acta Theriologica*, 28 (1): 49–54.

Goszczyński J., Jabłoński P., Lesiński G., Romanowski J. 1993. Variation in diet of Tawny Owl *Strix aluco* L. along urbanization gradient. *Acta Ornithologica*, 27 (2): 113–123.

Gramsz B. 1991. Pokarm puszczyka *Strix aluco* w lesie grądowym koło Oławy (Tawny Owl *Strix aluco* diet in oak hornbeam forest near Oława (South-Western Poland). *Acta Ornithologica*, 26 (1): 3–13. (In Polish).

Hirons G.J.M. 1982. The effect of fluctuations in rodent numbers on breeding success in the Tawny owl *Strix aluco*. *Mammal Review*, 12 (4): 155–157.

Jędrzejewski W., Jędrzejewska B., Zub K., Ruprecht A.L., Bystrowski C. 1994. Resource use by Tawny Owls *Strix aluco* in relation to rodent fluctuations in Białowieża National Park, Poland. *Journal of Avian Biology*, 25: 308–318.

Jędrzejewski W., Jędrzejewska B., Szymura A., Zub K. 1996. Tawny owl (*Strix aluco*) predation in a pristine deciduous forest

(Białowieża National Park, Poland). *Journal of Animal Ecology*, 65 (1): 105–120.

Juðkaitis R. 2001. Kaip toli skrenda medþioti naminės pelėdos? (How far do Tawny Owl (*Strix aluco*) fly to hunt?) *Ciconia*, 9: 30–31. (In Lithuanian).

Juðkaitis R. 2004. Local impact of the Tawny owls (*Strix aluco*) on the common dormice (*Muscardinus avellanarius*) in Lithuania. *Ekologia* (Bratislava), 23 (3): 305–309.

Lundberg A. 1980. Why are the Ural Owl *Strix uralensis* and the Tawny Owl *S. aluco* parapatric in Scandinavia? *Ornis Scandinavica*, 11: 116–120.

Marti C.D. 1974. Feeding ecology of four sympatric owls. *Condor*, 76: 45–61.

Mažeikytė R. 1990a. General characteristics of the small mammal communities in the landscapes of hilly morainic uplands and clayey plains (Характеристика сообществ мелких млекопитающих в холмисто-моренной возвышенности и глинистой равнины.). In: П. Блузма (отв. ред.) *Млекопитающие в культурном ландшафте Литвы*: 90–105. Вилънюс: Мокслас. (In Russian).

Mažeikytė R. 1990b. Dynamics of *Microtus arvalis* Pall. numbers on non-irrigated cultivated pastures in the lowland of the Middle Lithuania (Динамика численности *Microtus arvalis* Pall. на недождеваемых культурных пастбищах Среднелитовской низменности). *Ekologija* (Vilnius), 1: 34–43. (In Russian).

Mikkola H. 1983. *Owls of Europe*. London: T & AD Poyser.

Nilsson S.G. 1979. Density and species richness of some forest bird communities in south Sweden. *Oikos*, 33: 392–401.

Overskaug K., Kristiansen F., Sunde P.1995. Sex-specific diet analysis of the Tawny Owl *Strix aluco* in Norway. *Journal of Raptor Research*, 29: 137–140.

Overskaug K., Bolstad J.P. 1999. Fledgling behavior and survival in northern Tawny Owls. *The Condor*, 101: 169–174.

Petty S.J. 1999. Diet of Tawny Owls (*Strix aluco*) in relation to Field Vole (*Microtus agrestis*) abundance in a conifer forest in northern *England Journal of Zoology* (London), 248: 451–465.

Ranazzi L., Manganaro A., Ranazzi R., Salvati L. 2000. Density, territori size, breeding success and diet of Tawny Owl *Strix aluco* population in a Mediterranean urban area (Rome, Italy). *Alauda*, 68(2): 133–143.

Redpath S.M. 1995. Habitat fragmentation and the individual: tawny owls *Strix aluco* in woodland patches. *Journal of Animal Ecology*, 64: 652–661.

Ruprecht A. L., Szwagrzak A. 1987. Zur Ernährung der Eulen im Westteil des Bialowieza-Urwaldes. *Ökologie der Vögel*, 9 (2): 89–96.

Ruprecht A. L., Szwagrzak A., Kościów R. 1998. Analysis of owl pellets from the Puszcza Notecka forest complex (W Poland). (Skład pokarmu sów Puszczy Nadnoteckiej). *Badania Fizjograficzne nad Polską Zachodnią Seria C*, 45: 81–103. (In Polish).

Southern H.N. 1969. Prey taken by Tawny Owls during the breeding season. *The Ibis*, 111 (3): 293–299.

Southern H.N. 1970. The natural control of a population of Tawny Owls (*Strix aluco*). *Journal of Zoology*, London, 162: 197–285.

StatSoft, Inc. 2004. STATISTICA (data analysis software system), version 6. www.statsoft.com.

Sunde P., Overskaug K., Bolstad J.P., ¨ ien I.J. 2001. Living at the limit: Ecology and behaviour of Tawny Owls *strix aluco* in a northern edge population in Central Norway. *Ardea*, 89(3): 495–508.

Telleria J.L., Santos T., Alcįntara M. 1991. Abundance and food searching intensity of wood mice (*Apodemus sylvaticus*) in fragmented forests. *Journal of Mammalogy*, 72: 183–187.

Tew T.E., MacDonald D.W. 1993. The effects of harvest on arable wood mice *Apodemus sylvaticus*. *Biological Conservation*, 65: 279–283.

Wendland V. 1963. Fünfjährige Beobachtungen an einer Population des Waldkauzes (*Strix aluco*) im Berliner Grunewald. *Journal of Ornithology*, 194: 23–57.

Wendland V. 1972. Zur Biologie des Waldkauzes. *Vogelvelt*, 93: 81–91.

Zalewski A. 1994. diet of urban and suburban Tawny Owls (*Strix aluco*) in the breeding season. *Journal of Raptor Research*, 28: 246–252.

Żmihorski M., Osojca G. 2006. Diet of the Tawny Owl (*Strix aluco*) in the Romincka forest (North East Poland). *Acta Zoologica Lituanica*, 16 (1): 54–60.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

AIRBORNE ARTEMISIA POLLEN IN ÐIAULIAI (LITHUANIA) ATMOSPHERE WITH REFERENCE TO METEOROLOGICAL FACTORS DURING 2003-2005

Martynas Kazlauskas, Ingrida Šaulienė, Alfredas Lankauskas

Kazlauskas M., Šaulienė I., Lankauskas A. 2006. Airborne *Artemisia* pollen in Ðiauliai (Lithuania) atmosphere with reference to meteorological factors during 2003-2005. *Acta Biol. Univ. Daugavp., 6 (1-2): 13 - 24.*

This article analyses the results of Artemisia pollen monitoring. These pollen makes 9,2 ±1,3 % of all annual registered pollen. There were plenty of studies on impact of meteorological factors on pollen amounts in the air, there is a lot of information, but it is the first study in Lithuanian climate conditions. Here the main unit chosen for analysis is two-hour pollen monitoring data, which are more precise than average daily results in evaluating impact of meteorological factors on pollen and plant behaviour. It is estimated that Artemisia pollen season in Lithuania starts in the second part of July and ends in the first part of September. Productiveness and duration of pollen season period with large Artemisia microspores concentrations are very dependent on rainfalls, and this period in Lithuania is the most pluvious. Threshold accumulation temperature for Artemisia in our country is 6,5°C, and required accumulated heat is 1429 ± 3°C. From the last day of frost it is accumulated in 123 ± 9 days. Artemisia pollen have a day cycle. The most amount of pollen is found from 9 am to 1 pm, even 61-66% of daily total. Pollen are most intensively ripped off from anthers at 9 am, and the peak forms a bit later, at about 11 am. Referring to Artemisia sources study, large local sources were identified, basing on this the possibility of large amounts of pollen brought from distant territories was denied.

Key words: airborne pollen, allergy, Artemisia, Lithuania, meteorology.

Martynas Kazlauskas, Ingrida Šaulienė, Alfredas Lankauskas. Department of Environmental research, Faculty of Natural Sciences, Ðiauliai University, Višinskio 19, 77156 Ðiauliai, Lithuania. E-mail: oikos@fm.su.lt.

Introduction

Big part of human population is sensitive to pollen of some plants. Composition and seasoning of airborne pollen, as well as strength of polynosis, time and provocatives differs over different locations in the world. Aeropolinologic monitoring in Lithuania has started only in 2003, a lot later than in bigger European countries, so data range is smaller. With increase of environmental pollution and climate changes airborne pollen monitoring is becoming of greater importance medically and socio-economically.

Plants which are very alergonenic and blossom in late summer and autumn such as *Parietaria* L. do not grow in Lithuania, whereas *Ambrosia* L.

is not naturalized and it is not common in our country, although its airborne pollen sometimes are found. It is believed, that extra small amounts of them registered in atmosphere are determined by sources, that are outside of Lithuania (Saar et al. 2000). The most significant vegetative nature aeroalergens in our region are *Plantago* L., *Rumex* L., *Chenopodium* L., *Solidago* L., but the amounts of their airborne pollen is relatively small (Šaulienė & Motiekaitytė 2005, Šaulienė et al. 2003). The greatest part of non-arboreal pollen in this period is created by *Urtica* L. (17%). Nettles are allergic just mildly, so they are not significant. Main provokers of allergies in our country are pollen of Poaceae (R.Br.) Bernhart and *Artemisia* L.

Exceptional amounts of Artemisia pollen in Ðiauliai aerobiological station, in 8th International Congress on Aerobiology, surveying the EAN database content, are acknowledged as the largest in whole Europe (Jeager 2006). This indicates the roughness of environmental management means, and the unenviable condition of pollen sufferers in Ðiauliai. Due to such superfluity of pollen the situation gives the best conditions for studying reasons and regularities of airborne Artemisia microspores. The aim of the study is to find out an impact of meteorological factors on dispersion of Artemisia pollen, and to determine seasoning, amounts and sources of these pollen in Ðiauliai.

Material and methods

Place, climate and vegetation

Ðiauliai is located 100 km east of eastern shore of the Baltic Sea, in Northern part of Lithuania. The population of Ðiauliai is approximately 112 thousand citizens. Pollen collecting device was set in 18 m height (135 m above sea-level), on water tower in Ðiauliai University Botanic Garden, in western part of the town (55°55'96" N and 23°16'95" E). All buildings in radius of one kilometre are not higher than two storeys. Local vegetation mostly consists of relatively small garden trees and grasslands; however there are some high, mostly not allergic tree groups nearby.

Climate in Lithuania is mainly influenced by Atlantic air masses, and the Baltic Sea. According to Lithuanian Hydrometeorological Service, average yearly temperature is 6,2°C. Winters are mild (-4,0°C), springs are chilly (5,5°C), summers – moderately warm (16,0°C), autumns are long and warm (7,0°C). The warmest month is July (17,0°C), and the warmest period – the first ten days of August (17,5°C). Southwest air masses coming from the Atlantic determines conditions with large amount of rainfall whole year. Average yearly rainfall in Lithuania is 670 mm. The rainiest months are July (79 mm) and August (77 mm). The maximum rainfall falls in afternoon. There is no exceptionally dominant wind direction; however the most frequent is Southwest (225°) wind.

In geographical view Lithuanian territory is in critical location: it is stretched on joint of boreal conifer and broadleaved forest belts. Type of zonal vegetation – mixed coniferous and broadleaved forests, however at the time they cover only small areas. Succession of their associations is degradative, due to intense economical activities (Balevičienė et al. 2000). Natural ecosystems are very afflicted, and most of artificial ones are poorly maintained, therefore they are dominated by ruderal plants associations, and *Artemisia vulgaris* L. rate here is even 63% (Motiekaitytė 2002). Such phyto-associations are mostly found along roads, construction sites, derelict fields, unmaintained homesteads, and town green areas.

Seasoning of vegetation in Lithuania is determined not by a mode of humidity, but by temperature fluctuations. *Artemisia vulgaris* – perennial, warmth-loving plant. After the frost is gone, and with increase of average day temperature above the threshold, they start to develop and grow in various speed, depending on amount of heat accumulated.

Pollen measurements

Aerobiological studies performed in 2003-2005 from February to October, using Hirst type pollen trap (Hirst 1952). Its effectiveness is about 80% for pollen sized particles in normal wind conditions (Gregory & Hirst 1957). Seven-Day Volumetric Spore Trap was used (Burkard LTD, UK). Drum had been changed once a week. Samples for analysis under microscope were being prepared under standard methodology and chemical compounds, given in user manual of the aerobiological device. Slides were analysed for pollen grains in twelve transverses, using light „NIKON eclipse 50i" microscope, with magnification of 400 times (Käpylä & Penttinen 1981). In this way were taken the main unit of monitoring results – bi-hourly pollen data.

Meteorological data

Meteorological data was recorded in Šiauliai meteorological station, 2,8 km North-East from the trap, in town territory with very similar level of urbanization. Temperature, humidity, wind direction and speed recorded in 3 hour intervals, and amount of rainfall – in 6 hour ones. There were distinguished 16 wind directions. Speed is expressed in m/s. This and other Lithuanian meteorological stations do not store any more detailed data.

Data elaboration

The period treated as the main pollination season (MPS) was the period from the day, when cumulative pollen sum reaches 2,5% (Alba et al. 2000), and 5% (Nillson & Persson 1981, Latalowa et al. 2002, Pérez 2001) of all yearly pollen to the day, when it makes 97,5% and 95% correspondingly. The first method of data width counting was used to give a pollen calendar, and the second – to perform all remaining calculations.

Threshold accumulation temperature (TAT) was considered the lowest, average day temperature when Artemisia can develop or grow. Accumulated heat (AH) for Artemisia was expressed in °C, which was got after summing all average dayly temperatures that are higher than the threshold. AH and TAT required for Artemisia to blossom was calculated taking meteorological data since the day, when frost is totally gone of the ground until beginning of pollen season. For calculating TAT hypothetical TAT were taken from 0 to 10°C, in step of 0,5°C. By each TAT_H, respective AHs had been got for each year. Standard deviation of three year AHs belonging to each TAT_H was calculated. Artemisia TAT was considered as TAT_H group having the lowest standard deviation.

With an intention to evaluate a possibility of plant communities to have a impact on aerobiological situation, „productivity" of each direction, respectively to trap, was counted. This expression was obtained by dividing the total amount of pollen, brought in some specific direction, from the occurrence rate of that wind direction.

Results and discussion

Pollen season

Referring to our performed 3 year studies, Artemisia pollen seasons in Lithuania starts in second half of July and in a beginning of September they are over (Fig. 1).

Pollen season duration and amount of microspores vary quite much. MPS in Šiauliai lasts on average for 28 days. In total Artemisia makes 9,2 ±1,3 % of all pollen caught during one year.

Native habitat of A. vulgaris is in submeriodinal and meriodinal zone – in Europe, North Africa, Western and Central Asia, where weather is substantially warmer. So, due to natural biological properties, to burst into blossom these plants need many days of high temperature. Therefore in Lithuania Artemisia overspreads pollen just

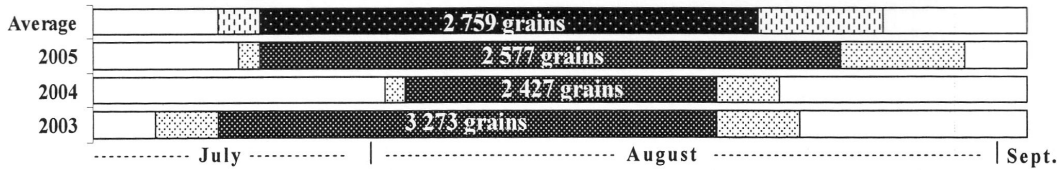


Fig. 1. Characteristics of Artemisia pollen seasons in Ðiauliai in accordance with data of three year monitoring. Seasons calculated by 2,5% and 5% methods, represented by different textures.

once a year and blossoms for a relatively short time.

Season can be prolonged by long distance transport (Gioulekas et al. 2004, Saar et al. 2000, Johansen 1991). First pollen in small amount could be brought by wind from souther populations (Kasprzyk 2003), however we didn't get such result in our studies. Most probably such mismatch was conditioned by characteristic of higher air turning, i.e. arch shape trajectory, which are discussed in previous works (Šaulienė & Veriankaitė 2006, Peter et al. 2001). To avoid possible mistake, 5% MPS method was used for calculation.

Study of accumulated heat revealed, that TAT for Artemisia vegetation in Lithuania is 6,5°C. In calculation AH group (TAT_H=6,5°C in 2003-2005) standard deviation was several times smaller than of all others. Big AH similarity in all three years showed that A. vulgaris growing in Ðiauliai are very conditioned by a rule of accumulated heat (Table 1). This gives conditions to forecast beginning of Artemisia MPS easily and correctly. It is possible that freeze in AH period can destroy the effect of heat accumulated up to now (Iglesias et al. 2003). Although, there were not such cold spells on years of our study, still it has to be taken into account when forecasting MPS start. It has to be noted, that amount of sunlight got in accumulation period partially compensates the lack of required AH (Table 1). However, the results can be judged just as an assumption, because of relatively short observation period.

Influence to pollination season of precipitation and relative humidity (by daily means)

Lithuania is in a middle latitude western coast climate by air masses type and their circulation (Алисов & Полтараус 1974). Differently from tropical climate territories characteristic regular climate factors, it is not possible to forecast them in Lithuania, they are determined by interface between cyclones ant anticyclones. One of the

Table 1. Data related to AH and TAT in study years.

Season	*AH then TAT_H=0*	*AH then TAT_H=6,5*	*Day then frost is totally gone*	*Start of MPS*	*Duration of AH period*	*Sulight hours during AH period, then average day temperature is >TAT*
2003	1458	1429	Mar 30	Jul 24	117	843
2004	1515	1432	Mar 24	Aug 02	132	799
2005	1477	1426	Apr 04	Jul 26	114	893

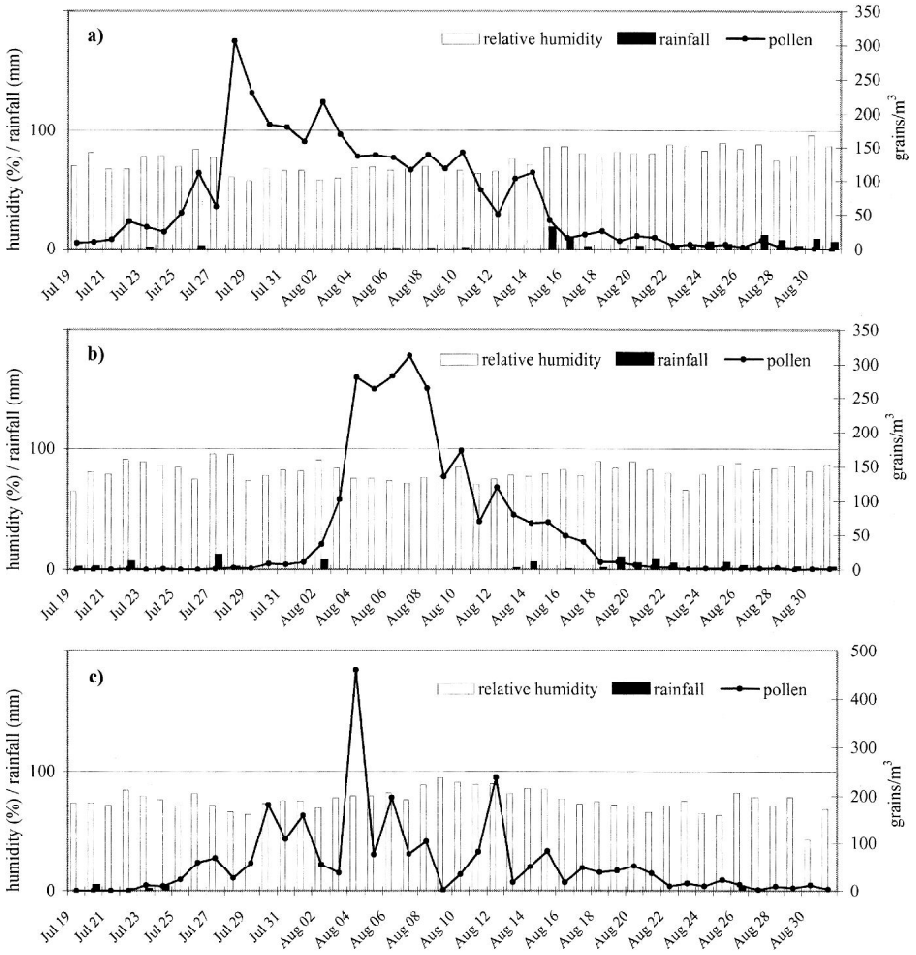


Fig. 2. Dependence of pollen concentration in air on rainfall and relative humidity according ? iauliai pollen monitoring and meteorological stations data of year 2003 (a), 2004 (b) and 2005 (c). Maximal value of Y axis is lowered for easier comparison

most important factors for change of Artemisia pollen concentration in the air are rainfalls (Fig. 1) and a high relative humidity related to it (Barnes et al., 2001).

Duration of MPS with high pollen concentration is limited by these factors, and from that partially depends the total sum of yearly airborne pollen. In MPS period high relative humidity has a negative effect on high pollen concentrations (Fig. 2c). Therefore amount of pollen in 2005 was a lot smaller than in 2003, although duration of MPS almost equal. Rainy days condition lag of MPS (Fig. 2b), and fast end (Fig. 2a, b). Deficit in sunlight during rainy days condition lower average day temperature. The result – delay in accumulation of AH required for Artemisia to blossom. Although the rain impacts pollen concentration heavily, however with enough of AH, pollen are being spread in small amount right after rain. The day of AH required by Artemisia to blossom conditions beginning of MPS, but does not influence large amounts of pollen in the air and their time. Tendency is being forecast, when an average and/or high Artemisia pollen concentration in the air accumulate each year after a couple

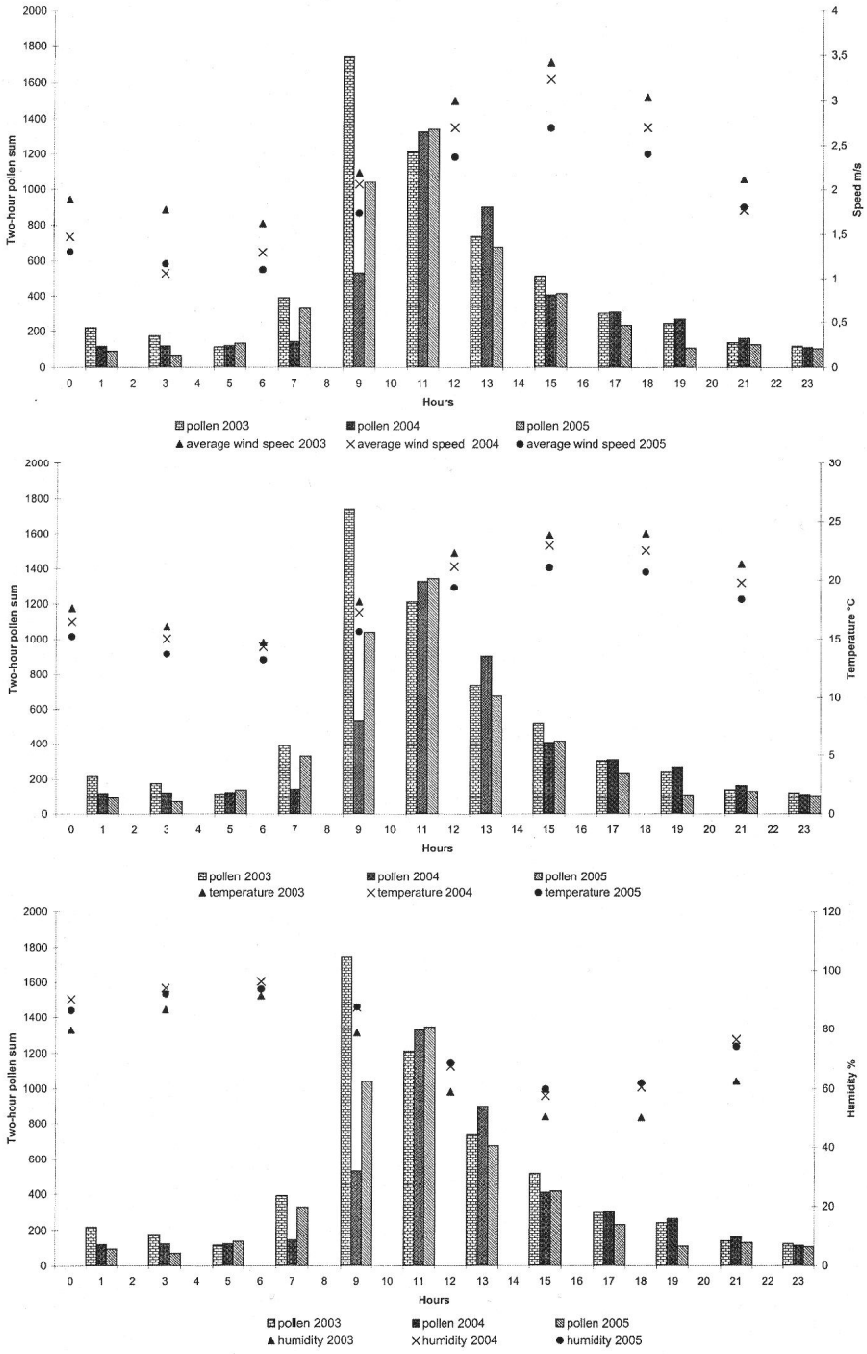


Fig. 3. Pollen concentrations and three meteorological factors (average wind speed, temperature and humidity) variation during day, basing on three year monitoring data.

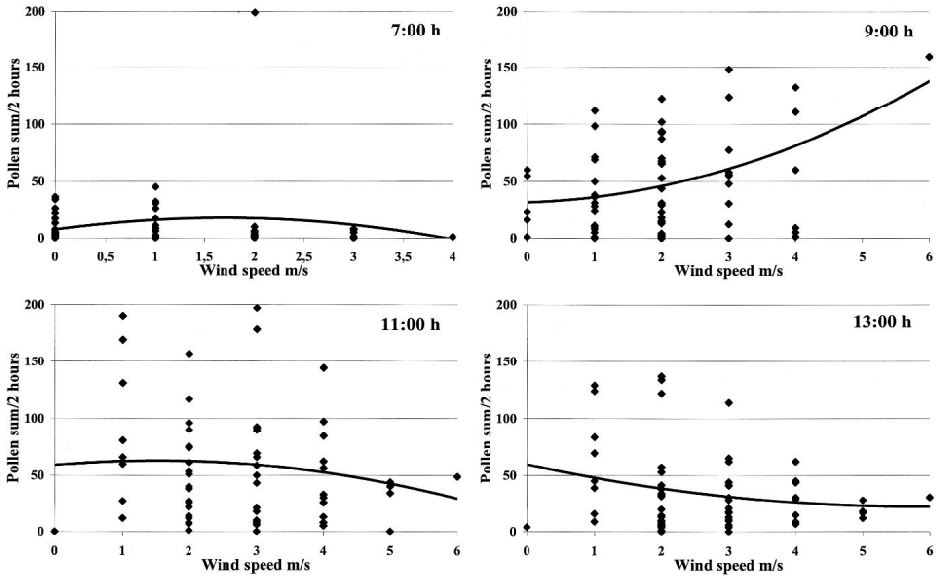


Fig. 4. Dependence of pollen concentration in the air from wind speed in certain period of a day.

rainy days in the beginning of August.

Daily patterns

To understand Artemisia pollen biology better it is essential to explore concentration fluctuation during day time. It can be said that fluctuations of pollen concentration registered in pollen trap are simultaneously to Artemisia reaction, because these plants grow only in a range of 14 km. Such small range conditions a fast pollen carry from a source to the trap. Passing in time due to distant urbanized areas is hardly probable, because: 1) travelling pollen clouds because of air capacity mixing and gravitation force abate, so they cannot condition large concentrations; 2) distant sources, judging about the type of Artemisia growth areas, do not form large arrays, such as communities edificators *Betula* L., *Quercus* L., *Alnus* Mill. or woods from other trees, consequently the amount of pollen created is out and way smaller (high Artemisia pollen concentrations are registered due to close distance between sources of these plants and a trap).

Independently from climate change, in Lithuania on different year the average value of any meteorological parameter at some specific hour is very similar (Fig. 3). Day have the characteristic of periodicity of meteorological factors, except days with rainfall. Such behaviour in other countries is observed not only for these factors, but also for pollen (Pérez et al. 2001, Nitiu 2004). Depending on time of a day, fluctuation of pollen concentrations registered in Šiauliai monitoring station was very high. Total amount of pollen in an interval of quarter of a day long of pollen minimum (hours 11pm–6am), depending on MPS year, makes 8-10% of all pollen caught during one day, and in an interval of one sixth part of a day long of pollen maximum (hours 9am–1pm) – 61-66%. In a time of a day, differently than in submeriodinal-meriodinal climate regions (Giner et al. 1999), just one peak is registered – 11 am.

Judging by the change of factors most important to aeropalinology, critical hours are 6 am. and 3 pm. In a morning temperature and wind speed are lowest, but the highest relative air humidity.

In an afternoon – everything proportionally vice versa.

Until now many studies were performed where increase of airborne pollen concentration was noticed with increase of temperature and decrease of relative air humidity (Nitiu 2004, Pérez 2003, Käpylä 1981). Artemisia anther should crack and spread pollen when temperature is highest and humidity is lowest, but it is not so. The largest amount of pollen is found, when changes happen towards the mentioned, most suitable situation. This can be explained as adaptation of Artemisia as of segetal, R-strategy plant to create conditions to pollen to stay in the air as long as possible, when lowest humidity and highest wind speed, that they would be brought as far as possible. Meanwhile woody plants with opposite strategy, e.g. *Acer* L., *Fraxinus* L., *Platanus* L., *Celtis* L. do not hurry to spread their pollen so early (Nitiu 2003). Such wide and effective spread gives better conditions for recombination and changeability with natural selection conditioning better adaptability in general. Fast adaptation is the main condition for reactive and relatively uncompetitive plants of this strategy to exist.

After identification of Artemisia characteristic to react to the time of day, start of blossoming of local Artemisia plants, can be identified no only by methods of phenologic observations, but also by biologically determined change of airborne plant pollen during one day. The first MPS day can be considered the day, when form of a pollen amount chart in a limit of one day is that of Artemisia characteristics (Fig. 3). Dissimilar charts should be considered as conditioned by pollen brought by distal transport, emergence of which is not dependent on the time of a day.

Amount of pollen caught during 2003-2005 (when analysing by a time of a day) depended from wind speed differently. For the most part of a day (hours 3 pm to 7 am) the average pollen concentration by various wind groups was smaller than 50 pcs./m^3 and the dependence was very similar to the results of the 7 am. (Fig. 4). The average daily pollen concentration larger than 50 pcs./m^3 were only in three time groups. At one moment there is clear positive relation between pollen concentration in the air and wind speed, at another period that has high pollen concentration the relation was negative.

Comparing 7 am and 9 am moments, when wind speed was 3 m/s, we can observe a different Artemisia reaction: 9 am – wind is suitable for spreading pollen, but on 7 am it is not. It is likely, that ripe microspores are not ready for spreading in the air on 7 am due to endogenic factors or due to too high air humidity. On 11 am the same wind speed (in very suitable meteorological conditions) is not suitable factor for growth of pollen concentration in the air, because anthers are already empty at that time. So, Artemisia pollen are being spread only in the morning between 7 am and 11 am, i.e. about 9 o'clock. Our observations show, that a peak in the air forms a bit later, about 11 am. Time difference arises from a couple of reasons: 1) it takes time for pollen to get trapped into the trap from plants and environmental surfaces in their growth areas, where they were settled from the early morning; 2) newly spread pollen mix with ones already floating in the air.

This consistent pattern clearly shows an exceptional moment in Artemisia biology, when pollen are the most ready to be spread from anthers. Judging by a negative relation, amount of pollen is not increasing at 7 am and 11 am. Previously formed air volumes (with big pollen concentrations), with increasing wind speed are being dashed with a clean (in aeropalinological regard) air more, therefore with increasing wind speed concentration of Artemisia pollen is getting lower.

It is important to find out whether pollen spreading is delayed to a later period of a day, if meteorological conditions at 9 am are not suitable for pollination? Because Artemisia season is one of the shortest comparing to that of other plants, there were few such days, when it was raining at 9 am. It will be done later, because it is necessary

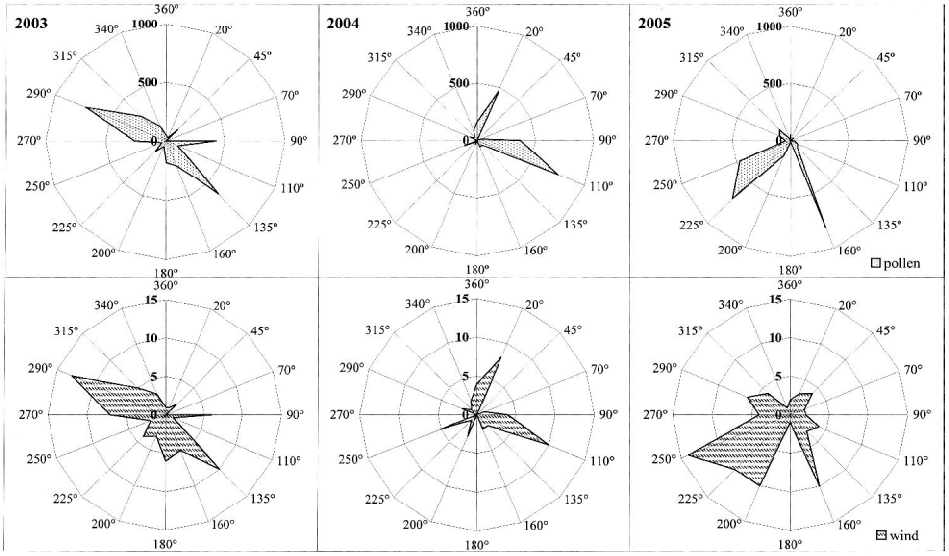


Fig. 5. Total amount of pollen caught and wind recurrence in various directions in pollen spread season in 2003-2005. Similar charts were used by C.F. Pérez (2001).

to have pollen monitoring data of a longer period to form a data set for such research.

Pollen sources

Amounts of airborne pollen in every territory are mostly conditioned by nearby growing arrays of their ripening plants (Adams-Groom et al. 2002). In a case of allergenic pollen, these populations are undesirable and should be diminished to improve life quality. Such sources can be tentatively discovered by linking meteorological measurements with pollen monitoring data. Amount of pollen found on "Melinex" tape on area matching some period can be treated as brought by some wind direction from a population existing in that direction with regard to the pollen trap. Wind direction is changing quite often, therefore its impact on amount of pollen should not be evaluated in too large time intervals, e.g. when finding an average direction of a day. An interval should be as short as possible. The minimal interval, conditioned by a device, is two hours.

In this way, attributing amounts of microspores to winds of some direction, it is possible to count how much pollen a wind of some direction brought in one season, or in a longer period. However this is not enough, because winds of different directions occur not equally often. So it also needs to count wind direction registration rate in a same season, that later would be possible to calculate an average amount of pollen brought in every direction during two hour period.

Wind speed and direction has an impact on microspores concentration in air in the sunlight period of a day, when conventional and other air movements prevail (Pérez et al. 2001). At night and second part of a day an amount of airborne pollen is smallest, because at such period they are spread and new ones are not released. Therefore it is more expedient to search for pollen sources in such period of a day, when there are highest amount of them in air around ripening

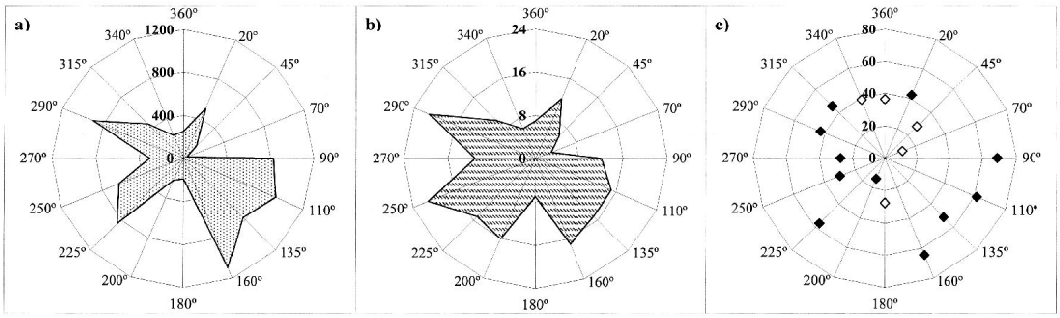


Fig. 6. During all monitoring period, in Artemisia pollen spread season, in most productive period for pollen (9 am–3 pm) a – total registered pollen, b – wind directions recurrences, and c – average amount of pollen brought in one direction (hollow points mark <10 times recurrence in that direction during whole 3 year).

plant arrays (in our calculations between 9 am. and 3 pm). This is the first important reason.

Artemisia pollen amounts vary during a day not only because of wind direction. In calculating data of a whole season, in a period of a day when there are no pollen – wind recurrence would be counted in. This would result in a big bias, because fluctuation is cyclical, there is a possibility to count just these day intervals, when amount of pollen is biggest by the time of a day, i.e. 9 am – 3 pm. This is the second reason.

Dominating wind directions during the monitoring period were different each year, as well as pollen sources (Fig. 5). It can be observed that amount of pollen is very dependent on dominating wind directions.

Although in 1998 were no registered urbophitocenoses in Šiauliai, it should not be trusted just because of the document, because Artemisia is not a tree, but a ruderal plant, populations of which can decrease as well as increase in one place in a relatively short time, or

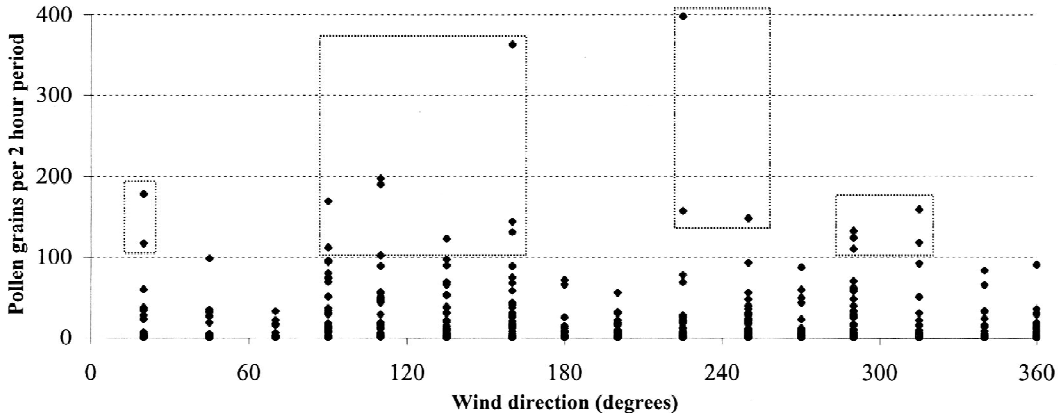


Fig. 7. Chart of pollen spread by wind directions, basing on 3 year monitoring data. Marked pollen are these that give a possibility to decide from which directions the largest amounts of pollen were brought in 2 hour interval.

even establish in new niche. Directions with an averagely largest pollen amount show, where are the largest Artemisia arrays. Therefore, populations to be reviewed should be expected in directions given in Fig. 6, i.e. 90°, 110°, 135°, 160° and 225°.

Maximums of pollen concentration, that can also be related to wind direction, is an important indicator in dealing with the sources. According to analysis (Fig. 7) such directions are: 20°, 90°–160°, 225°–250°, 290°–315°.

After subjectively generalizing the results of direction study, the largest Artemisia sources are in 90°–110°, 160°, and 225° directions in respect of the trap.

According to Artemisia inventory data, there were many registered Artemisia sources in 90°–110°, 160° directions, because these directions cover the greatest part of the town. Areas in 225° direction are town outskirts with a road next to Artemisia populations, and high voltage electricity transfer line, under which there are no economical activities and areas are not maintained. Therefore, the study of sources deny the possibility of pollen brought from far away.

Conclusions

Seasons of Artemisia pollen in Lithuania begin in the second part of July and end in the first part of September. Time and duration of a pollen season as well as amount of microspores is very dependent on rainfall, which are at the utmost in this time of a year. Artemisia TAT in our country is 6,5°C, and the required AH counting from the day of last frost – approximately 1429°C, which is accumulated approximately in 123 days. More than a half airborne Artemisia pollen found during one day are airborne between 9 am and 1 pm. Pollen are ripped off from anthers most intensively on 9 am, and the peak forms a bit later – on 11 am. Basing on the study of Artemisia sources, large local sources were identified, in regard with which town and district authorities should take action to clean it.

References

Adams-Groom B., Emberlin J., Corden J., Millington W., Mullins J. 2002. Predicting the start of the birch pollen season at London, Derby and Cardiff, United Kingdom, using a multiple regression model, based on data from 1987 to 1997. Aerobiologia, 18: 117–123.

Alba F., Guardia C.D., Comtois P. 2000. The effect of meteorological parameters on diurnal patterns of airborne olive pollen concentration. Grana 39, 200–208.

Balevičienė J., Balevičius A., Grigaitė O., Patalauskaitė D., Rašomavičius V., Sinkevičienė Z., Stankevičiūtė J. 2000. Lietuvos raudonoji knyga: augalų bendrijos. Vilnius. (In Lithuanian)

Barnes C., Pacheco F., Landuyt J., Hu F., Portnoy J. 2001. The effect of temperature, relative humidity and rainfall on airborne ragweed pollen concentrations. Aerobiologia 17: 61–68.

Giner M.M., Garcij J.S.C., Sellés J.G. 1999. Aerobiology of Artemisia airborne pollen in Muricia (SE Spain) and its relationship with weather variables: annua and intradiurnal variations for three different species. Wind vectors as a tool in determining pollen origin. Int J Biometeorol 43: 51–63.

Gioulekas D., Balafoutis C., Damialis A., Papakosta D., Gioulekas G., Patakas D. 2004. Fifteen-year records of airborne allergenic pollen and meteorological parameters in Thessaloniki, Greece. Int J Biometeorol 48: 128–136.

Gregory P.H., Hirst J.M. 1957. The summer airspora at Rothamsted in 1952. J. Gen. Microbiol. 17: 135–152.

Hirst, J. 1952. An automatic volumetric spore trap. Ann. Appl. Biol. 39: 257–265.

Iglesias I., Méndez J., Comtois P. 2003. Aerobiologicalsurvey of Alnus pollen in Ourense (N.W. Iberian Peninsula), 1993–2000. Grana 42: 112–120.

Johansen, S. 1991. Airborne pollen and spores on the Arctic island of Jan Mayen. Grana 30, 373–379.

Kasprzyk I. 2003. Flowering phenology and airborne pollen grains of chosen tree taxa in Rzeszów (SE Poland). Aerobiologia 19: 113–120.

Käpylä M. 1981. Diurnal variation of non-arboreal pollen in the air in Finland. Grana 20, 55–59.

Käpylä M., Penttinen A. 1981. An evaluation of the microscopical counting methods of the tape in Hirst-Burcard pollen and spore traps. Grana 20, 131–141.

Motiekaitytė V. 2002. Urbophytocenosis: syntaxonomy, toxicotolerance, succesions, functions. Vilnius. (In Lithuanian).

Nillson S., Persson S. 1981. Tree pollen spectra in the Stockholm region (Sweden), 1973-1980. Grana 20, 179–182.

Nitiu D.S. 2003. Annual, daily and intradiurnal variation of Celtis pollen in the city of La Plata, Argentina. Aerobiologia 19: 71–78.

Nitiu D.S. 2004. Intradiurnal fluctuation of pollen in La Plata, Argentina. Part I, herbaceous pollen types. Aerobiologia 00: 1–6.

Pérez C.F., Gardiol M., Paez M.M. 2001. Comparison of intradiurnal variation of airborne pollen in Mar del Plata (Argentina). Part I. Non-arboreal pollen. Aerobiologia 17: 151–163.

Pérez C.F., Gardiol J.M., Paez M.M. 2003. Comparison of diurnal variation of airborne pollen in Mar del Plata (Argentina). Part II. Arboreal pollen. Grana 42, 151–163.Peter K., Water V., Levetin E.: 2001, Contribution of upwind pollen sources to the characterization of Juniperus ashei phenology. Grana 40: 133–141.

Saar M., Gudþinskas Z., Ploompuu T., Linno E., Minkienė Z., Motiekaitytė V. 2000. Ragweed plants and airborne pollen in Baltic states. Aerobiologia, 16: 101–106.

Šaulienė I., Motiekaitytė V., Kazlauskas M. 2003. Oro užterštumo žiedadulkėmis Šiaulių mieste ypatumai. Vadyba 3: 171–173 . (In Lithuanian).

Šaulienė I., Motiekaitytė V. 2005. Pecularities of aeropalinological monitoring in northern Lithuania. Environmental engineering 1: 252–257.

Šaulienė I., Veriankaitė L. 2006. Application of Backward air mass trajectory analysis in evaluating airborne pollen dispersion. Environmental engineering 14: 113–119.

Алисов Б.П., Полтараус Б.В.: 1974, Климатология. Москва. (In Russian).

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

SURFACE FIRES EFFECT ON GROUND VEGETATION IN SCOTS PINE FORESTS IN LITHUANIA

Vitas Marozas, Jonas Racinskas, Edmundas Bartkevicius

Marozas V., Racinskas J., Bartkevicius E. 2006. Surface fires effect on ground vegetation in Scots pine forests in Lithuania. *Acta Biol. Univ. Daugavp., 6 (1-2): 25 - 30.*

The aim of this work was to investigate the changes of ground vegetation (mosses, lichens and herbs) in pine forests after surface fires. The study area was located in Southern part of Lithuania. The ground vegetation was recorded in forest stands burned in different time (11 years interval) and compared with the nearby control fire untouched area. It was determined that species richness increased after fire. Early successional species invaded in burned areas immediately after fire. Abundance of dominant species (*Vaccinium myrtillus* L. and *Vaccinium vitis-idaea* L.) recovered after 5 years. Pioneer moss species (*Polytrichum piliferum* Hedw. and *Polytrichum juniperinum* Hedw.) replaced late successional mosses (*Dicranum polysetum* Sw., *Dicranum scoparium* Hedw., *Hylocomium splendens* (Hedw.) Schimp. and *Pleurozium schreberi* (Brit.) Mitt.). Changes of ground vegetation induced by surface fire remained 3-4 years after fire. Herbaceous and dwarf shrubs recovered 5-6 years after fire, moss cover - 9 years after fire. Differences in moss species composition still remained 11 years after fire.

Keywords: herbs, mosses, succession.

Marozas V., Bartkevicius E. Department of Ecology, Lithuanian University of Agriculture, Studentu 11, Akademija, Kaunas distr., Lithuania. Tel./fax +370 37 752224; e-mail vitas.marozas@lzuu.lt

Racinskas J., Bartkevicius E. Department of Silviculture, Lithuanian University of Agriculture, Studentu 11, Akademija, Kaunas distr., Lithuania.

Introduction

Fire is an important ecological factor regulating forest succession in boreal forests (Johnson, 1992; Engelmark, 1993; Parviainen, 1996; Ryan, 2002; Gromtsev, 1996). Overall effect of fire on ecosystems is complex. Fires can change belowground physical, chemical and microbial processes eliminate aboveground biomass. Severe crown fires can change successional rates, alter vegetation species composition, C:N ratios, decrease mineralisation rates, result nutrient losses. Therefore, surface fires can promote an herbaceous flora, increase plant available nutrients (Gromtsev, 2002, 1996; Parviainen, 1996). Fires affect the species composition, stand characteristics, regeneration conditions. Fires favour shade-intolerant tree species (*Pinus sylvestris* L., *Betula* spp.) and eliminate such species as *Picea abies* (L.) Karst. (Zackrisson, 1977; Päätalo, 1998; Kauhanen, 2002).

In many areas foresters have removed fire from forest ecosystems (Gromtsev, 2002, 1996; Parviainen, 1996; Päätalo, 1998; Tinner et al., 1999). In Lithuania the annual number of fires is about 700 (from 200 to 1600 per year); and total burned area range from 100 to 700 ha per year. Average burned area per one fire is 0.45 ha (Lithuanian statistical yearbook of forestry, 2005). Number of fires per year depends on the meteorological conditions of the year. In the future, with elevated temperature, the risk of fire may increase, because summers may become longer and drier.

In Lithuania 84% of fires emerge in pine forests. In coniferous forests the highest number of fires emerges in middle age stands (50-80 years) – 58%; in young stands (10-40 years) – 36%; in mature and overmature (over 80 years) - 16%. In Lithuania surface fires prevail (97.3%), crown fires consist - 1% and underground fires – 1.7% (Lithuanian statistical yearbook of forestry, 2005).

Occurrence of fires in Lithuania has decreased considerably during the last century, due to efficient fire prevention and control system. Nowadays, natural disturbances are recognized as important ecological factor affecting forest biodiversity (Angelstam, 1998; Bergeron et al., 2002; Kuuluvainen, 2002). Introduction of the use of controlled fire in forestry is now recognized (Granström, 1996; Parviainen, 1996).

Importance of fire as a natural disturbance factor in Lithuania has not been well documented. Only sporadic observations were presented on fire impact to pine forest ecosystems (Karazija, 1988). There is a need for more thorough investigations on vegetation reestablishment after fire in pine forests ecosystems.

The aim of this work was to investigate the changes of ground vegetation (mosses, lichens and shrubs) in pine forests after surface fires.

Materials and Methods

The study area is located in Southern part of Lithuania and falls in the transitional deciduous coniferous mixed forest boreonemoral zone of Europe (Ahti et al. 1968).

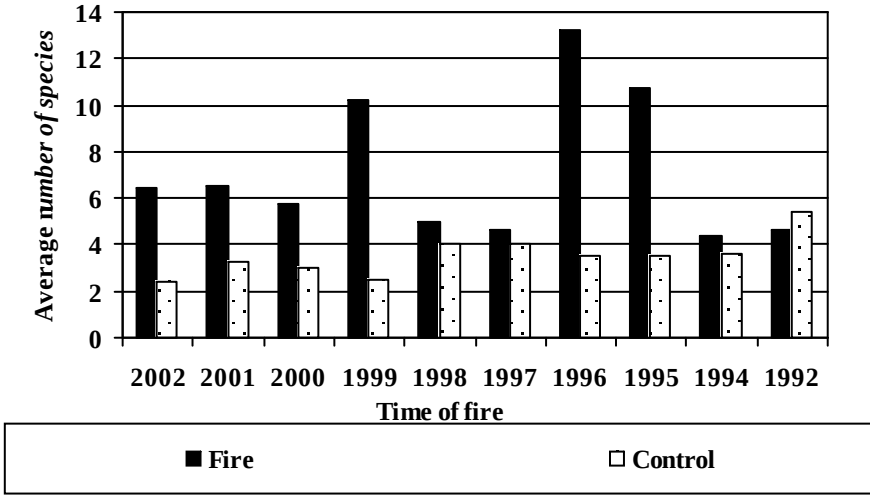
We used the chronosequence approach to describe the early ground vegetation dynamics after fire by taking pine stands in similar sites according soil, topographic conditions and stand characteristics, but in different time periods after fire (Pickett, 1989). To consider the changes in ground vegetation we selected pure, middle-age, *Vaccinium* type pine stands, which were burned in 1992 and 1994-2002 years. Observations were made in 2003. Burned area was identified according fire traces on tree stems. The fire was low intensity, only ground vegetation was burned. We selected 5 burned areas for each year (total 50 burned stands). We also selected control fire untouched stands near each burned area. We assumed that vegetation in control areas left unchanged and reflected initial vegetation composition before fire occurred. Vegetation sampling was conducted during July and August of 2003. In twenty 1x1 m plots we recorded species composition and projection cover (in per cent) of dwarf shrubs, herbs and mosses. We also counted the amount of shrubs, saplings and seedlings in the plots. Overall shrubs, herbs and mosses cover was also estimated. Nomenclature followed Jankeviciene (1998).

From twenty plots data we calculated mean values for each burned and control fire untouched area. Then we averaged data for each burned and control area in different time separately.

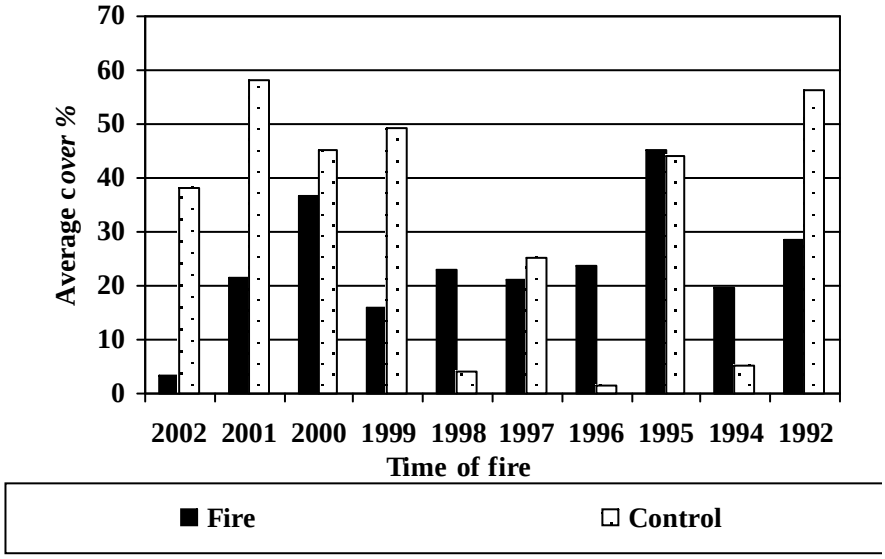
Mann-Whitney nonparametric test was used to identify significant differences in vegetation projection cover, and amount of shrubs, saplings and seedlings between burned and untouched areas using the software STATISTICA.

Results

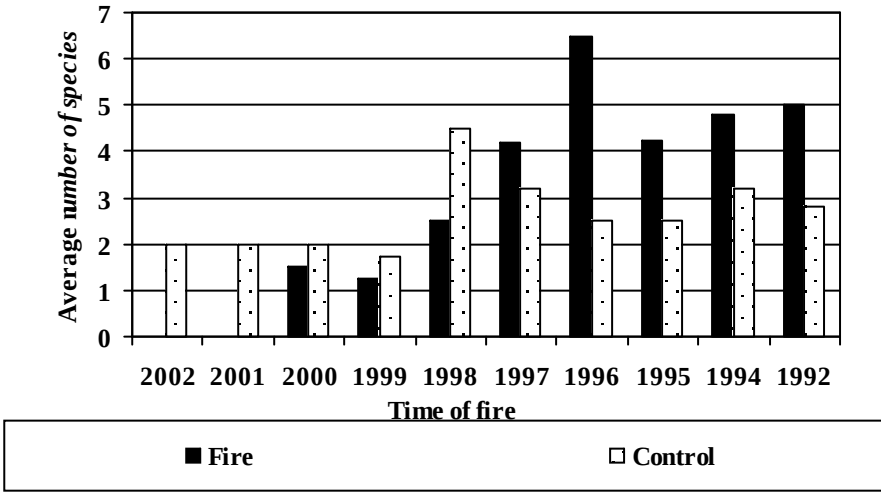
In burned and control areas we recorded 31 herbaceous and dwarf shrub species. 28 species occurred in burned and 17 in control areas. 14 herbaceous and dwarf shrub species occurred only in burned areas: *Achillea millefolium* L., *Conyza canadensis* (L.) Cronquist, *Filago*



(* - Mann Whitney test $p<0.05$)
Fig. 1. Average species number (in 1 m^2 plots) of herb and dwarf shrub layer in burned and control areas. Data collected in 2003



(* - Mann Whitney test $p<0.05$)
Fig. 2. Average projection cover of herb and dwarf shrub layer in burned and control areas. Data collected in 2003.



(* - Mann Whitney test $p<0.05$)
Fig. 3. Average species number of moss and lichen layer in burned and control areas. Data collected in 2003.

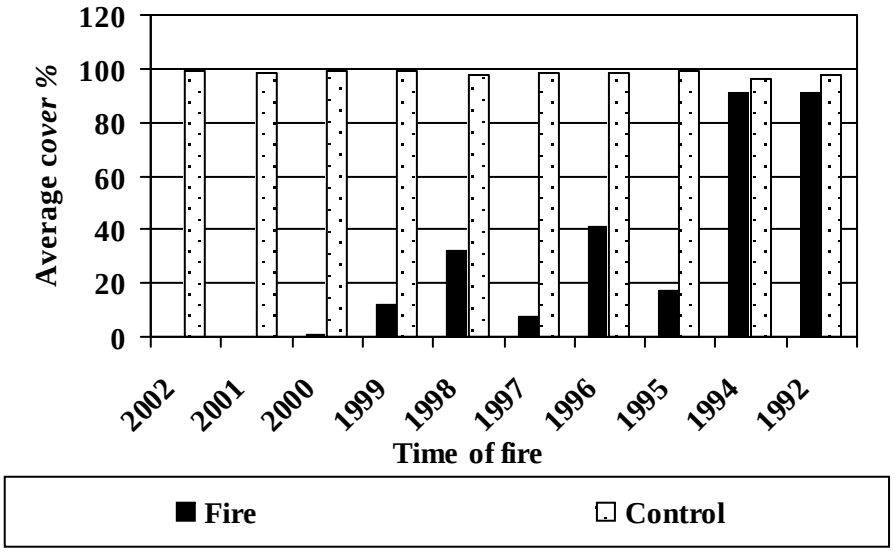
arvensis L., *Helianthemum nummularium* (L.) Mill., *Hypericum perforatum* L., *Knautia arvensis* (L.) Coult., *Linaria vulgaris* Mill., *Luzula pilosa* (L.) Willd., *Pilosella officinarum* F.W.Schultz et Sch. Bip., *Rubus idaeus* L., *Rumex acetosa* L., *Veronica officinalis* L., *Vicia sylvatica* L. and *Viola rupestris* F.W.Schmidt. 3 herbaceous and dwarf shrub species occurred only in control areas: *Chimaphila umbellata* (L.).W.P.C. Barton, *Deschampsia cespitosa* (L.) P.Beauv. and *Maianthemum bifolium* (L.) F.W.Schmidt.

Average herbaceous and dwarf shrub species number per 1 m^2 in burned areas was always higher than in fire untouched control areas (Fig. 1). In burned areas in average we recorded 4.4.-13.2 herbaceous and dwarf shrub species while in control areas - 2.4-5.4 species. In many cases the differences between burned and fire untouched control areas were significant ($p<0.05$). Average projection cover of herbaceous and dwarf shrub species ranged from 3.3% to 45.2% in burned areas, and from 1.6% to 58.1% in control areas (Fig. 2). In areas burned in 1998, 1996, 1995 and 1994 the average projection cover was higher than in control areas. In areas burned more recently the average projection cover was lower than in control areas.

Vaccinium myrtillus L. and *Vaccinium vitis-idaea* L. comprised the largest proportion of the projection cover. Projection cover of the species was significantly lower in the first year after fire. *Calluna vulgaris* L. disappeared in burned areas of first four years, but it recovered and its abundance became higher than in control areas of older ones.

Species of *Agrostis capillaris* L., *Calamagrostis epigejos* (L.) Roth, *Chamerion angustifolium* (L.) Holub, *Festuca ovina* L., *Melampyrum pratense* L. and *Solidago virgaurea* L. were more abundant in burned areas.

In burned and control areas we recorded 11 mosses and lichen species. 9 species occurred in burned and 7 in fire untouched control areas. 4 mosses species occurred only in burned areas: *Ceratodon purpurus* (Hedw.) Brid., *Funaria hygrometrica* Hedw., *Polytricum juniperinum* Hedw. and *Polytricum piliferum* Hedw. Lichens



(* - Mann Whitney test $p<0.05$)
Fig. 4. Average projection cover of moss and lichen layer in burned and control areas. Data collected in 2003.

(*Cladonia arbuscula* (Wallr.) Flot. and *C. rangiferina* (L.) F.H.Wigg.) occurred only in control areas.

Average moss and lichen species number per 1 m^2 in burned areas ranged from 0 to 6.5 while in control areas – from 1.8 to 4.5 species (Fig. 3). In areas burned in 2002 and 2001 mosses were absent. In areas burned in 1997 and earlier the number of moss species was higher than in control areas.

Average projection cover of mosses and lichens ranged from 0% to 97.2% in burned areas and from 96.0% to 96.8% in control areas (Fig. 4). Abundance of mosses started to recover in areas burned in 2000 and reached the level of control in areas burned in 1994 and 1992. However, the species composition has changed. *Polytrichum juniperinum* Hedw. and *Polytrichum piliferum* hedw. have spread and predominated in areas burned in 1994 and 1992. Abundance of *Dicranum polysetum* Sw., *Dicranum scoparium* Hedw., *Hylocomium splendens* (Hedw.) Schimp. and *Pleurozium schreberi* (Brit.) Mitt. started to recover in areas burned in 1998.

Conclusion

Species richness increased after surface fire. Early successional species appeared in burned areas immediately after fire. Abundance of dominant species (*Vaccinium myrtillus* L. and *Vaccinium vitis-idaea* L.) recovered after 5 years.

Pioneer moss species (*Polytrichum piliferum* Hedw. and *Polytrichum juniperinum* Hedw.) replaced late successional mosses (*Dicranum polysetum* Sw., *Dicranum scoparium* Hedw., *Hylocomium splendens* (Hedw.) Schimp. and *Pleurozium schreberi* (Brit.) Mitt.) after fire.
Changes of ground vegetation induced by surface fire remained 3-4 years after fire. Herbaceous and dwarf shrubs recovered 5-6 years after fire, moss cover - 9 years after fire. Differences in moss species composition still remained 11 years after fire.

References

Ahti, T., Hämet-Ahti, L., Jalas, J., 1968. Vegetation zones and their sections in northwestern Europe. Ann. Bot. Fenn. 5, 169-211.

Angelstam, P.K., 1998. Maintaining and restoring biodiversity by developing natural disturbance regimes in European boreal forest. J. Veg. Sci. 9 (4), 593-602.

Bergeron, Y., Leduc, A., Harvey, B.D., Gauthier, S., 2002. Natural fire regime: a guide for sustainable management of the Canadian boreal forest. Silva Fenn. 36(1), 81–95.

Bukantis, A., 1994. Lietuvos klimatas [Climate of Lithuania]. Vilnius Univ. Pres., Vilnius (In Lithuanian).

Egelmark, O., 1993. Early post-fire tree regeneration in a Picea-Vaccinium forest in northern Sweden. J. Veg. Sci. 4 (6), 791-794.

Granström, A., 1996. Fire ecology in Sweden and future use of fire for maintaining biodiversity. In: Goldammer, J.G., Furyaev, V.V. (eds.), Fire in ecosystems of Boreal Eurasia. Kluwer Academic Publisher, The Netherlands, 445-452.

Gromtsev, A.N., 2002. Natural disturbance dynamics in the boreal forests of European Russia: a review. Silva Fenn. 36 (1), 41-55.

Jankeviciene, R. (eds.), 1998. Dictionary of Plant Names. Institute of Botany Publishers, Vilnius.

Johnson, E.A., 1992. Fire and vegetation dynamics: studies from the North American boreal forest. Cambridge University press, New York.

Karazija, S., 1988. Lietuvo miškų tipai [Forest types of Lithuania]. Mokslas, Vilnius (In Lithuanian).

Kauhanen, H., 2002. Occurrence of fires in the Eastern Saariselkä area, North-West Russia. Silva Fenn. 36 (1), 383-392.

Kuuluvainen, T., 2002. Natural variability of forests as a reference for restoring and managing biological diversity in boreal Fennoscandia. Silva Fenn. 36(1), 97–125.

Lithuanian statistical yearbook of forestry 2005. 2005. State forest survey service, Vilnius.

Päätalo, M-L., 1998. Factor influencing occurrence and impacts of fires in northern European forest. Silva Fenn. 32 (2), 185-202.

Parviainen, J., 1996. Impact of fire on Finnish forest in the past and today. Silva Fenn. 30 (2-3), 353-359.

Pickett, S.T.A., 1989. Space-for-time substitution as an alternative to long-term studies. In: Likens, G.E. (eds.), Long-term studies in ecology,. Springer-Verlag, New York, NY, pp. 110-135

Tinner, W., Hubschmid, P., Wehrli, M., Ammann, B., Conedera, M., 1999. Long-term forest fire ecology and dynamics in Switzerland. J. Ecol. 87 (2), 273-289.

Zackrisson, O., 1977. Influence of forest fires on the north Swedish boreal forest. Oikos 29 (1), 13

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

THE EVALUATION OF PHENOTYPIC DIVERSITY OF *THYMUS X OBLONGIFOLIUS* OPIZ ACCORDING TO SOME MORPHOLOGICAL CHARACTERS AND COMPARISON WITH PARENT SPECIES

Kristina Ložienė, Violeta Kamašina

Ložienė K., Kamašina V. 2006. The evaluation of phenotypic diversity of *Thymus x oblongifolius* Opiz according to some morphological characters and comparison with parent species. *Acta Biol. Univ. daugavp., 6 (1-2): 31 - 38.*

The phenotypic diversity of interspecific hybrid *Thymus x oblongifolius* Opiz was investigated according to the lengths and widths of leaves, the length/width ratios of leaves and the lengths of inflorescences. The material of Herbariums of Institute of Botany (Vilnius, BILAS) and Vilnius University (Vilnius, WI) was used. Was established that *T. x oblongifolius* Opiz plants varied strongly according to widths of leaves and lengths of inflorescences particularly. The variation of investigated morphological parameters of *T. x oblongifolius* Opiz was mediate between the variation of parent species *Thymus pulegioides* L. and *Thymus serpyllum* L.

Key words: *Thymus x oblongifolius* Opiz, *T. pulegioides* L., *T. serpyllum* L., phenotypic diversity.

Kristina Ložienė. Institute of Botany, Žaliųjų Ežerų 49, LT-08406, Vilnius, Lithuania; e-mail: kristina.l@botanika.lt

Violeta Kamašina. Vilnius University, Čiurlionio 21, LT-2600, Vilnius, Lithuania; e-mail: viokas@omni.lt

Introduction

Cross-pollination is known to be a frequent phenomenon for species in the genus *Thymus* (*Gogina 1990*, *Thompson et al. 1998*), therefore many interspecific hybrids of natural origin are described (*Mateo & Crespo 1997*, *Salgueiro et al. 1993*, *Schmidt 1977*, *Soó 1970*). The high infraspecific variability of morphological features is characteristic for the species of this genus (*Jalas 1972*, *Lyka 1927*).

Two *Thymus* species, namely *T. pulegioides* L. and *T. serpyllum* L. and their hybrid *T. x oblongifolius* Opiz, grow wild in Lithuania and other Baltic States (Latvia and Estonia) (*Kuusk et al.1996*, *Gudžinskas 1990, Lekavičius & Jaskonis 1969*). Usually, *T. x oblongifolius* Opiz is found in habitats where both parent species grow together or in the close vicinity (*Ložienė & Vaičiūnienė 1999, Lekavičius & Jaskonis 1968*). *T. x oblongifolius* Opiz have the hairy same as *T. serpyllum* L. and 4-angled same as *T. pulegioides*

L. stem (*Jalas 1947*). The chemical composition of essential oil and the chromosome number of this interspecific hybrid showed an intermediate condition compared with those of the parent species – *T. pulegioides* L. and *T. serpyllum* L. (*Ložienė & Mįrtonfiovį 2004, Lo˛ienė & Venskutonis 2002, Jalas & Kaleva 1967*).

The goal of this study was to evaluate the phenotypic diversity of interspecific hybrid *T. oblongifolius* Opiz according to some morphological characters and to compare it with parent species – *T. pulegioides* L. and *T. serpyllum* L.

Material and Methods

The phenotypic diversity of 20 *T. x oblongifolius* Opiz, 57 *T. pulegioides* L. and 39 *T. serpyllum* L. individual plants was evaluated in conformity with the samples kept in Herbariums of Institute of Botany (Vilnius, BILAS) and Vilnius University (Vilnius, WI). The following quantitative morphological characters were investigated: the lengths and widths of leaves (mm), the length/width ratios of leaves and the lengths of inflorescences (mm). The lengths of leaves (including petioles) and their maximum widths were measured in the middle of flowering stems. 10–20 leaves and 5-20 flowering stems with inflorescences were used for measurements in each plant. The statistical software package STATISTICA 7 was employed in the work.

Results and Discussion

The statistical analysis of morphological characters showed that the lengths of inflorescences of *T. x oblongifolius* Opiz varied within the widest pale (the variation coefficient numbers 68,7 %) (Table 1). The variation of leaves was less. The widths of leaves varied more than the lengths of leaves (the variation coefficient 28,5 and 23,6 %, respectively) (Table 1).

The values of lengths and length/width ratios of leaves were akin to a typical normal distribution (Fig. 1, 2). The curtosis and skewness (the descriptive parameters of character distribution) of following characters were approximate to zero (Table 1). The distribution of values of leaves lengths and inflorescences lengths was not normal. That reflected in the right-skewed asymmetry of their distribution plots and in the high curtosis and skewness values (Fig. 3, 4; Table 1).

Table 1. The main statistical characters of investigated morphological properties of *Thymus x oblongifolius* Opiz, *Thymus pulegioides* L. and *Thymus serpyllum* L.

Note: LL – the lengths of leaves, WL – the widths of leaves, L/W – the length/width ratios of leaves, LI – the lengths of inflorescences.

Species	Morphological character	Mean	Min	Max	St. error	Variation coefficient (%)	Curtosis	Skewness
T. x oblongifolius	LL (mm)	7.7	1.0	13.0	0.07	23.6	0.51	0.42
	WL (mm)	2.6	1.5	5.5	0.03	28.5	1.14	1.15
	L/W	3.0	0.7	5.5	0.02	21.7	0.93	0.62
	LI (mm)	9.8	2.0	67.0	0.27	68.70	15.68	3.10
T. pulegioides	LL (mm)	10.2	2.0	21.0	0.08	21.98	3.22	1.05
	WL (mm)	4.7	2.0	9.0	0.04	23.77	-0.32	0.17
	L/W	2.2	1.3	4.0	0.01	19.28	1.65	0.94
	LI (mm)	15.8	3.0	108.0	0.56	96.60	7.45	2.48
T. serpyllum	LL (mm)	5.6	2.0	12.0	0.07	30.47	0.09	0.49
	WL (mm)	1.8	1.0	5.0	0.03	36.67	4.53	1.51
	L/W	3.3	1.5	8.0	0.04	31.53	3.29	1.45
	LI (mm)	7.2	2.0	27.0	0.13	42.40	6.68	1.90

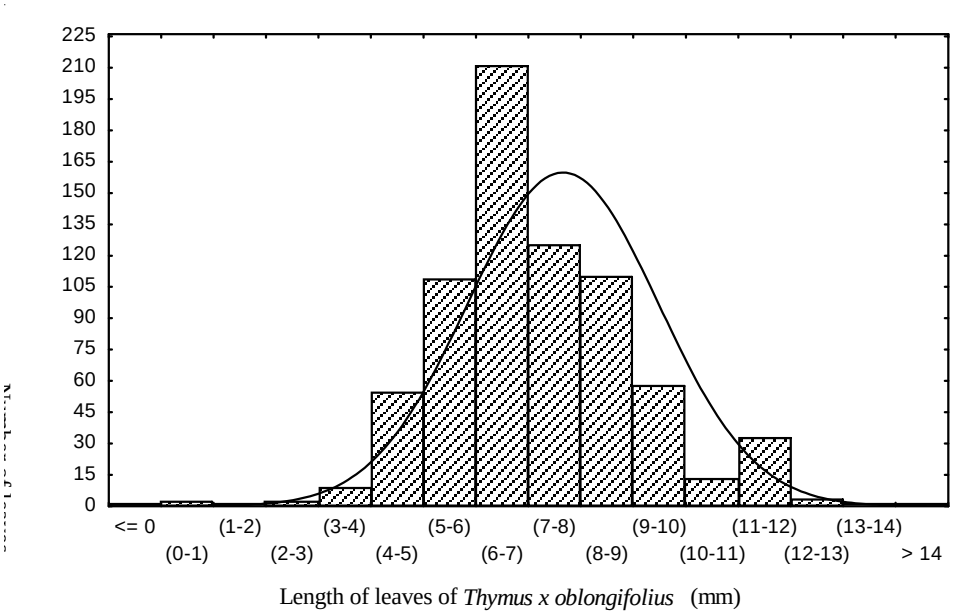


Fig. 1. The histogram of distribution of leaves lengths of *Thymus x oblongifolius* Opiz.

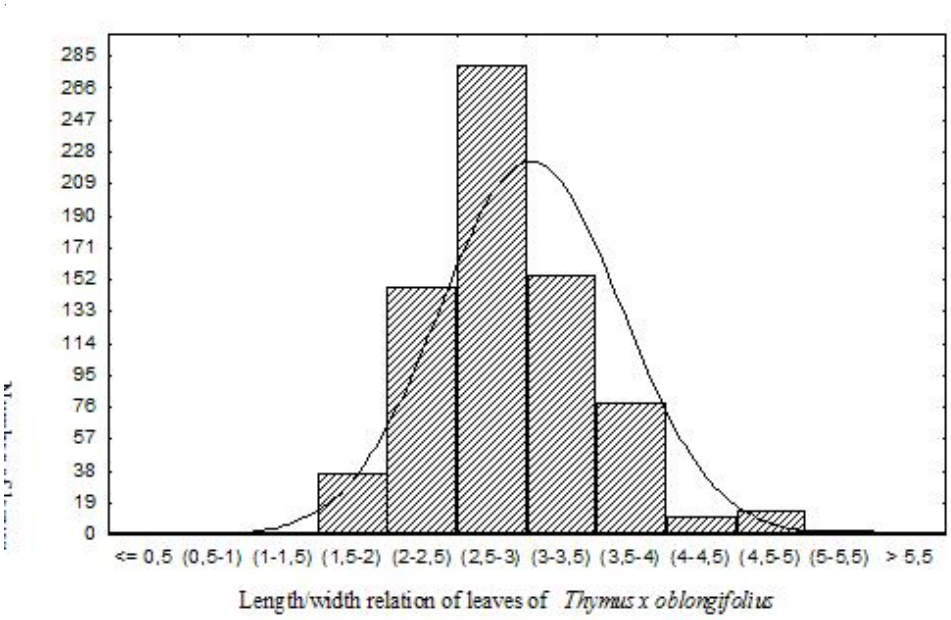


Fig. 2. The histogram of distribution of length/width ratios of leaves of *Thymus x oblongifolius* Opiz.

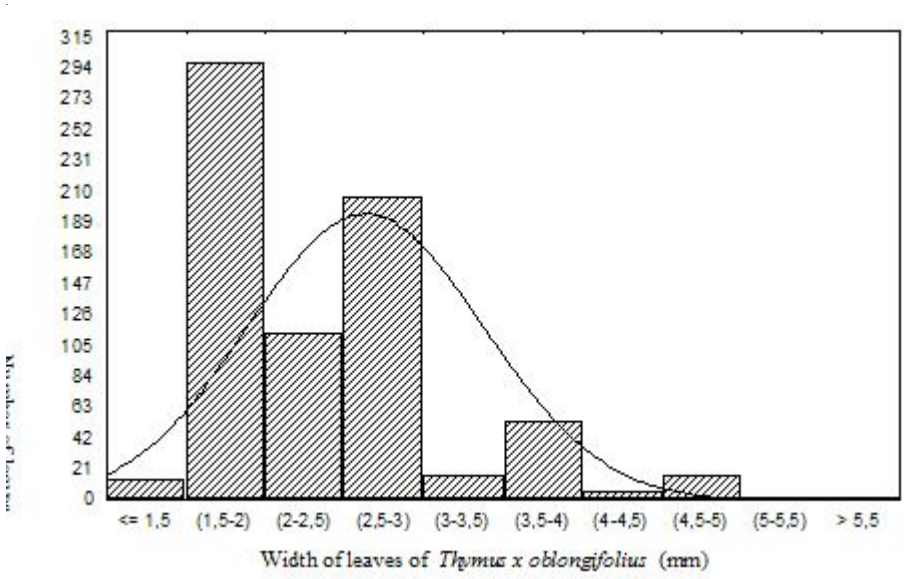


Fig.3. The histogram of distribution of leaves widths of *Thymus x oblongifolius* Opiz.

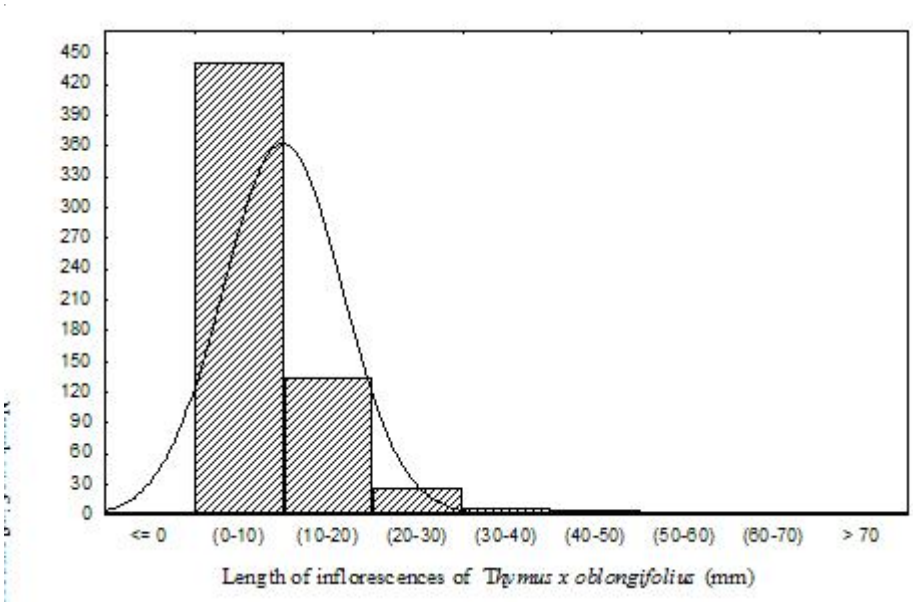


Fig. 4. The histogram of distribution of inflorescences lengths of *Thymus x oblongifolius* Opiz.

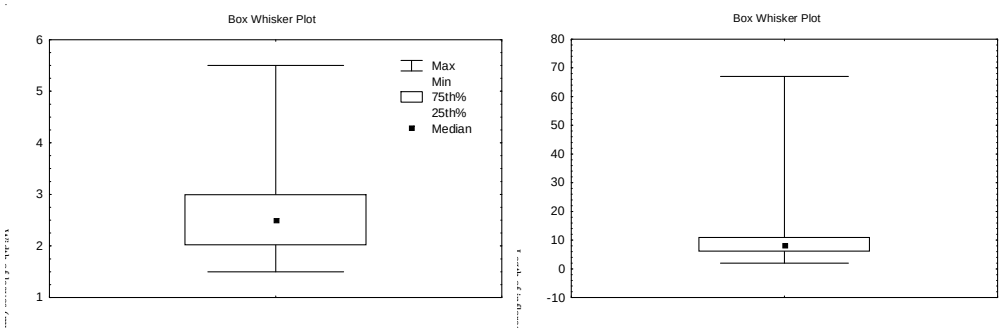


Fig. 5. The column dispersion diagrams of leaves widths and inflorescences lengths of *Thymus x oblongifolius* Opiz.

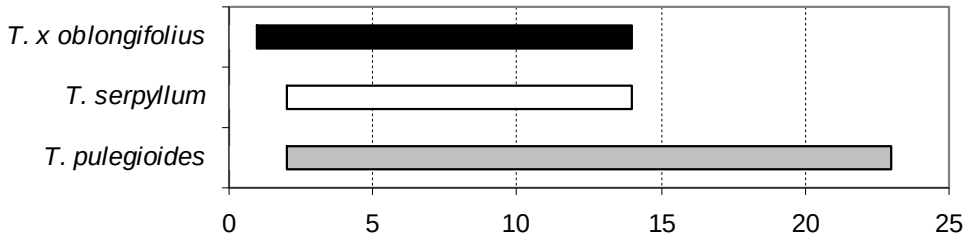


Fig. 6. The variation ranges of leaves lengths (mm) of *T. x oblongifolius* Opiz, *T. serpyllum* L. and *T. pulegioides* L

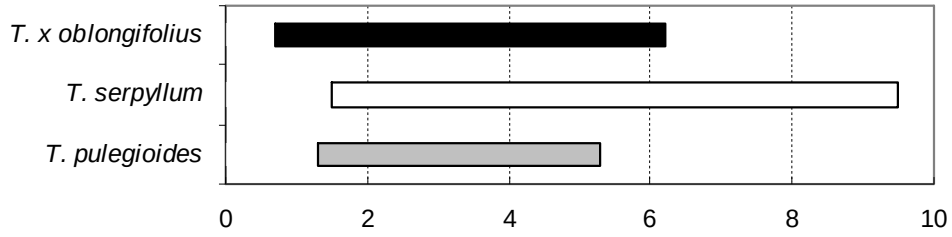


Fig. 7. The variation ranges of length/width ratios of leaves of *T. x oblongifolius* Opiz, *T. serpyllum* L. and *T. pulegioides* L.

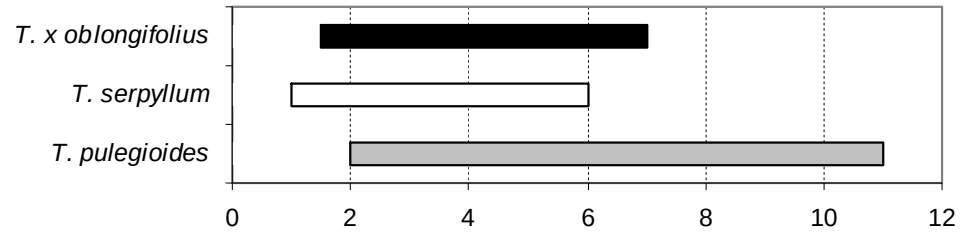


Fig. 8. The variation ranges of leaves widths (mm) of *T. x oblongifolius* Opiz, *T. serpyllum* L. and *T. pulegioides* L.

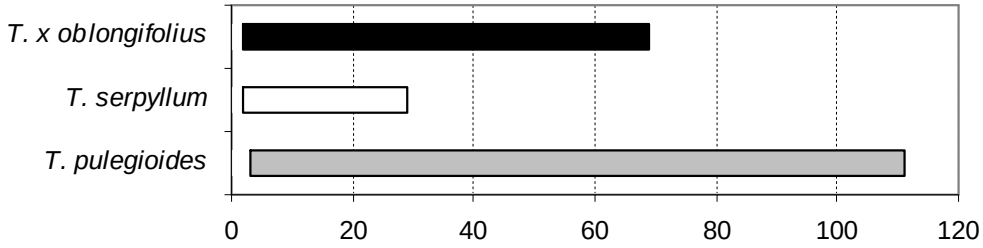


Fig. 9. The variation ranges of inflorescences lengths (mm) of *T. x oblongifolius* Opiz, *T. serpyllum* L. and *T. pulegioides* L.

The column dispersion diagrams of leaves widths and inflorescences lengths of *T. x oblongifolius* Opiz also showed that the exclusive big values are between their values of measurements, i. e. wider leaves and particularly long inflorescences in comparison with leaves and inflorescences, which get in the quartile boxes (Fig. 5).

Following all results showed the big phenotypic diversity of *T. x oblongifolius* Opiz according to leaves form and inflorescences lengths. Such big variation indicates the possible infraspecific differentiation according to following morphological characters. Therefore may separate three and two groups of plants according to leaves widths and inflorescences lengths, respectively: the plants with narrowly lancet-shaped (to 2 mm width), lancet-shaped (2–3 mm width) and egg-shaped (3–5,5 mm width) lforms of eaves and the plants with short ball-shaped (to 20 mm length) and long ear-shaped (20–67 mm length) forms of inflorescences. Both intrinsic (genetic) and external (ecological) factors may determine the phenotypic diversity of *T. x oblongifolius* Opiz. Because *T. x oblongifolius* Opiz is interspecific hybrid is likely that big part of influence fall to genetical factors.

The comparison of morphological characters of *T. x oblongifolius* L. with *T. pulegioides* L. and *T. serpyllum* L. showed that the variation of investigated morphological parameters of *T. x oblongifolius* Opiz is mediate between the parent species. The variation of leaves lengths (Fig. 6) and inflorescences lengths (Fig. 9) of hybrid was less than *T. pulegioides* L., but bigger than *T. serpyllum* L. The variation of leaves widths of hybrid was as *T. serpyllum* L. however varied within the pale of bigger values (Fig. 8). The variation of length/width ratios of *T. x oblongifolius* Opiz leaves was less than *T. serpyllum* L., but bigger than *T. pulegioides* L. (Fig. 7). The impli-

cation is that the variation of leaves forms of *T. x oblongifolius* Opiz is more similar to *T. serpyllum* L. than to *T. pulegioides* L.

References

Kuusk V., Tabaka L., Jankevičienė R. (eds.). 1993. Flora of the Baltic Countries, Vol.2. Eesti Loodusfoto AS, Tartu, 372 Pp.

Gudþinskas Z. 1990. Vascular plants of Lithuania. Institute of Botany, Vilnius.

Gogina E. E. 1990. Mutability and form development in the genus Thymus L. Moscow, 207 Pp. (In Russian).

Jalas J. 1947. Thymus pulegioides L. x Th. serpyllum ssp. angustifolius (Pers.) Vollm. (Th. oblongifolius Opiz, non H. Braun), ein für Ostfennoskandien neuer Bastard. Mem. Soc. F. Fl. Fenn., 23: 151–154. (In German; summary in Finnish).

Jalas J. 1972. Thymus L. In: Tutin T. G. (ed.): Flora Europaea, No 3. Cambridge University Press, Pp. 172–182.

Jalas J., Kaleva K.1967. Chromosome studies in Thymus L. (Labiatae). V. Ann. Bot. Fenn., 4: 74–80.

Lekavičius A. A., Jaskonis J. A. 1969. O rode tim˙jana (Thymus L.) v Litve (3. Posobie dlja opredelenija taksonov tim˙jana i nekotorye biometričeskie dannye o ego predstaviteljakh) (The genus of thyme (Thymus L.) in Lithuania. (3. Key for the thyme taxon determination and some biometrical data concerning the representatives of the genus)). Lietuvos MA Darbai, Ser. C, 1(48): 31–37. (In Russian; abstracts in Lithuanian, English).

Lekavičius A. A., Jaskonis J. A. 1968. O rode tim˙jana (Thymus L.) v Litve (2. Vnutrividovyeformy i nekotorye biokhimičeskie svojstva tim˙jana bloðinnogo) (The genus of thyme (Thymus L.) in Lithuania. (2. Intraspecific forms and some biochemical properties of larger wild thyme)). Lietuvos MA Darbai, Ser. C, 2(46): 19–23. (In Russian; abstracts in Lithuanian, English).

Ložienė K., Vaičiūnienė J. 1999. Intraspecific diversity of Thymus pulegioides L. and characteridtic of habitats. Botanica Lithuanica, 5 (1): 27–40. (In Lithuanian; abstract in English).

Ložienė K., Vaičiūnienė J., Venskutonis P. R. 2002. Chemical composition of the essential oil of an interspecific hybrid of thyme (Thymus x oblongifolius Opiz) growing wild in Lithuania. Journal of Essential Oil Research, 14: 308–311.

Ložienė K., Mįrtonfiova L. 2004. Thymus chromosome numbers from Lithuania. Thaiszia–Journal of Botany (Koðice), 14: 63–73.

Lyka K. 1927. Thymus L. Thymian, Quendel. - In: Hegi G. (ed.): Illustrierte Flora von Mitteleuropa, No 5. Munchen. Pp. 2306–2327.

Mateo G., Crespo M. B. 1997. A new hybrid of the genus Thymus L. (Labiatae). Anales del Jardin Botanico de Madrid, 55: 167–168.

Salgueiro L. R., Proenēa da Cunha A., Paiva J. 1993. Chemotaxonomic characterization of a Thymus hybrid from Portugal. Flavour and Fragrance Journal, 8: 325–330.

Schmidt P. 1977. Die Arten der Gattung Thymus L. in Sachsen. Ber. Arbeitsgem. sächs. Bot., 11: 5–12. (In German).

Soó R. 1970. Thymi Hungariae–Macierzanki (Thymi) Węgier. Fragmenta Floristica et Geobotanica, 16: 25–37. (In German; summary in Hungarian).

Thompson J. D., Manicacci D. & Tarayre M. 1998. Thirty-Five Years of Thyme: A Tale of Two Polymorphisms. Why so many females? Why so many chemotypes? BioScience, 48: 805–815

Accepted: 12.12.2006.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

SECONDARY METABOLITES VARIATION IN *HYPERICUM MACULATUM*

Edita Bagdonaitė , Saulius Kazlauskas

Bagdonaitė E. , Kazlauskas S. 2006. Secondary metebolites variation *Hypericum maculatum. Acta Biol. Univ. Daugavp., 6 (1-2): 39 - 44.*

The investigations described the variation in chemical characters of *Hypericum maculatum* Crantz wild populations and field accessions. The results of quantitative analysis (HPLC) of secondary metabolites in leaves and flowers are presented. The flavonoids (hyperoside, isoquercitrin, quercetin) were identified under the UV waves of 254 nm, and hypericin – under the waves of 590 nm. Larger quantities of quercetin and hypericin accumulate during the flowering stage while the hyperoside and isoquercitrin – during vegetative and budding phases. Most suitable time for gathering raw material is budding and flowering phases (middle of June to the first half of July). The quantitative variation of active substances in different habitats and field accessions allows the selection of the best plant samples for their cultivation and conservation in field collections.

Key words: *Hypericum maculatum*, chemical variability, hypericin, flavonoids, wild populations, field accessions

Edita Bagdonaitė. Laboratory of Economic Botany, Institute of Botany, Žaliųjų Ežerų 49, 08406, Vilnius, Lithuania

Saulius Kazlauskas. Kaunas University of Medicine, A. Mickevičiaus 9, 44307, Kaunas, Lithuania

Introduction

Hypericum maculatum Crantz is a perennial medicinal plant belonging to the family *Hypericaceae* L. In raw material of *Hypericum* many groups of secondary metabolites, possibly with pharmacological action, are determined. Rapidly increasing demand for raw material of *Hypericum* in the world market motivates detailed studies of these plants. In Lithuania, only *H. perforatum* is regarded as medicinal plant. Investigations of *H. maculatum* are required aiming to determine which species accumulates larger amounts of valuable secondary metabolites.

The flavonoids (hyperoside, isoquercitrin, quercetin) and hypericin are the main active substances of *H. maculatum.* They support regeneration of human body cells, provide disinfection, and act as antidepressant, antibacterial, antiviral, and anti-inflammation tools (Kitanov et al. 1991). Such large spectrum of the applicable functions depends on the quantity of each substance.

The objective of this paper is to determine the regularities of the quantitative variation of hyperoside, isoquercitrin, quercetin and hypericin in flowers and leaves of *H. maculatum* in different habitats, field accessions and different plant development phases.

Material and Methods

The material of *H. maculatum* (from 9 sites) was collected during field trips in 1999 in the phase of full flowering. The seeds (from 8 sites) have been gathered in fall period and sown in the field collection of the Institute of Botany (Lithuania). The plants were grown under the same cultivated field conditions on the soil with P_2O_5 contents 202.9 mg/kg, K_2O – 213.9 mg/kg, pH – 5.42 and organic matter – 2.21 %. The evaluation of field accessions has been carried out in 2001. The flowering tops of 30 cm in length were collected in the 2nd year of cultivation. The harvested plant material was dried in room for ten days at an ambient air temperature, then packed in paper bags and kept in dry and dark environment at room temperature.

Samples of 1.0 g each of dried flowering tops of *H. maculatum* with moisture content of 10.0 % were mechanically ground to obtain a homogenous drug powder and extracted with 50 % EtOH (100 ml) for 90 min., at 70 ^{O}C temperature. The prepared samples were kept in dark in a refrigerator until used. Quantitative analysis of flavonoids and hypericin in the ethanolic extracts of flowers and leaves was carried out by modified HPLC gradient elution method (Hölzl et al. 1987). Compounds were identified by means of pure standards.

In order to determine statistically significant difference between the obtained values, the one–way analyses of variance (ANOVA) was used with the STATISTICA software package. The cluster analysis was applied to compare and group accessions according to their content of secondary metabolites.

Results and Discussion

The content of flavonoids and hypericin varies highly in different populations, accessions, and parts of plant. In a typical flavonoid spectrum of *H. maculatum*, hyperoside, isoquercitrin, quercetin are the major components. Our previous investigations indicated that flavonoid rutin (usually present in the flowers of *H. perforatum*) is absent from the flavonoid pattern of *H. maculatum*, or present only in trace amounts (Bagdonaitė et al. 2002; Radušienė et al. 2002, 2004).

Significant differences were detected in the mean concentrations of quercetin, hyperoside, isoqercitrin and hypericin in flowers and leaves. Lager amounts of quercetin and hypericin were found in flowers, while content of hyperoside+isoquercitrin was higher in leaves. Wild populations of *H. maculatum* are characterised by high variability in the amount of secondary metabolites (Fig. 1). In this study isoquercitrin and quercetin levels in the flowers varied between populations from 8.98–13.64 mg/g and from 2.12–5.49 mg/g, respectively. The maximum contents of isoquercitrin (5.00 mg/g) and quercetin (1.80 mg/g) given by A. Umek et al. (1999) are lower than our data.

The results of chemical evaluation show the variability of hypericin in raw material among populations. The content of hypericin in the flowers of *H. maculatum* ranges within 0.24–0.51 mg/g, while in the leaves we observed small amounts of hypericin (0.01–0.09 mg/g). The content of hypericin referred by other authors (Kartnig et al. 1989; Brantner et al. 1994; Umek 1999) are higher (0.44–2.50 mg/g) than ours. P. Martonfi et al. (2006) have reported lower content of hypericin in the flowers of *H. maculatum* (0.03–0.34 mg/g) than obtained by this study. Quantitative data from different authors vary significantly. This can by caused by different methods of sampling and analyzing.

The results obtained by this study testify to the strong interaccession variability of flavonoids

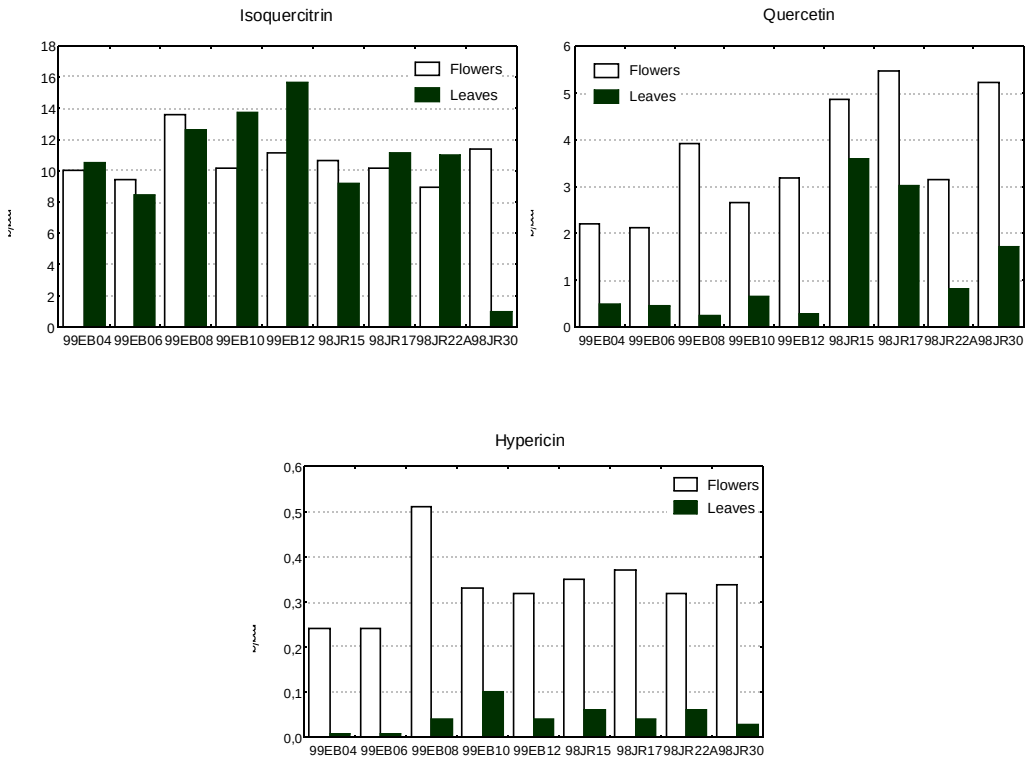


Fig. 1. Contents of secondary metabolites in flowers and leaves of *H. maculatum* wild populations

and hypericin content in *H. maculatum*. Therefore, the accessions were analyzed by means of a cluster analysis. For the representation of the dendrogram the Euclidean Furthest Neighbour Method was chosen, as this gives the best reflection of the clusters. Each line representing an accession, totally 5 well-separated clusters were recognized (Fig. 2). The first cluster, which includes the accession No. 407, is the most distant in the dendrogram. The distinction of this accession is predetermined by the highest level of hypericin. The second cluster (No. 384) contains higher than average quantity of quercetin and hyperoside+ isoquercitrin. The three accessions, No. 378, No. 422, No. 382, of the third cluster are characterized by high contents of quercetin. In the fourth cluster two accessions (No. 376, No. 409) are included. Here much hyperoside+isoquercitrin was determined. The fifth cluster (No. 405) are characterized by relatively low contents of secondary metabolites.

Finding accessions with equally high flavonoid and hypericin content in the case of *H. maculatum* seems to be quite difficult, as the investigated accessions exhibited rich either in flavonoids or in hypericin. The obtained results indicated that *H. maculatum* is the most important source for obtaining hyperoside.

Variability of chemical characteristics of *H. maculatum* accessions is lower than among plants from the same wild populations, still the differences among accessions remain. A. Smelcerovic et al. (2006) have shown that there were significant differences in the active compound contents of samples collected from the same location, which suggests that genetic factors may play a role in determining the active

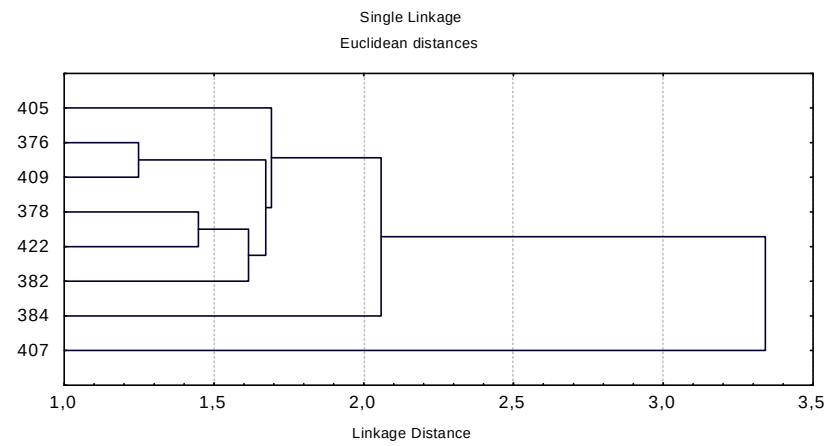


Fig. 2. Results of cluster analysis of flavonoids and hypericin in the accessions of *H. maculatum*

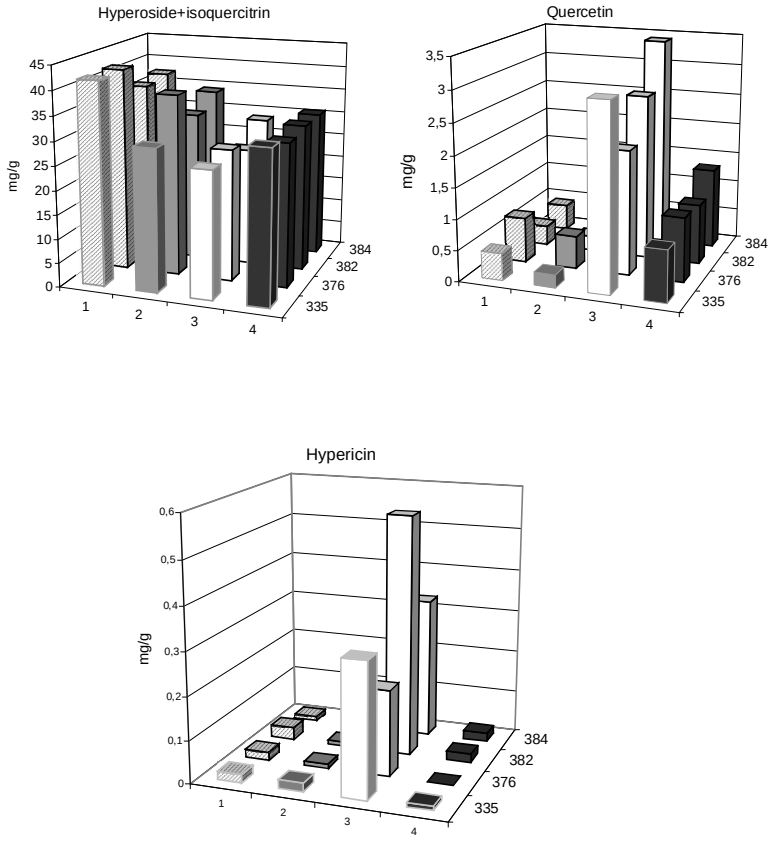


Fig. 3. Dynamics of flavonoids and hypericin accumulation in the accessions of *H. maculatum* (1 – vegetative stage, 2 – budding, 3 – flowering stage – in flowers, and 4 – flowering stage – in leaves)

compound contents. Basically, these data correspond with our data. Taking into consideration that flavonoid contents is the major criterion for the evaluation of a crude drug of *H. maculatum*, the accessions which accumulated high levels of flavonoids seem to be promising for further breeding.

The results of our investigation reveal that changes in the amounts of secondary metabolites in plants of *H. maculatum* during the growth period depend upon the phases of plant growth and development. Flavonoids and hypericin accumulation dynamics in *H. maculatum* at different stages of development is indicated in Fig. 3. Before budding period, the level of hypericin was very low, but increased rapidly and reached its maximum at the stage of flowering. The results for the hypericin accumulation dynamics correspond to the data reported by A. Brantner et al. (1994) and G. Kitanov (2000). The highest amounts of hyperoside and isoquercitrin accumulate during vegetative and budding phases while the highest amounts of quercetin – during the flowering stage. According to literature references (Kitanov 1995), the highest amount of flavonoids were found at flowering time and this period is recommended for gathering of the drug material.

In Lithuania, most suitable time for gathering the medicinal raw material is from the middle of June till the first half of July.

Conclusions

1. Wild populations of *H. maculatum* are characterised by high variability in the amount of secondary metabolites; therefore, in order to obtain homogenous and high-quality raw material of *H. maculatum* it should be cultivated in plantations.

2. Due to valuable chemical composition some *H. maculatum* populations (99EB08 – high amount of hypericin; 98JR15, 98JR17 – plenty of quercetin) and field accessions (384 – much quercetin and hyperoside+isoquercitrin; 407 – hypericin; 376, 409 – much hyperoside+isoquercitrin) are worth for conservation *in situ* and *ex situ*.

3. Changes in the amounts of secondary metabolites in plants of *H. maculatum* during the growth period depend upon the phases of plant growth and development. The highest amounts of hyperoside and isoquercitrin accumulate during vegetative and budding phases while the amounts of quercetin and hypericin – during the flowering stage. Most suitable time for gathering raw material is budding and flowering phases (middle of June to the first half of July).

References

Bagdonaitė E., Radušienė J. 2002. Analysis of variation of phenotypical characters in *Hypericum maculatum* Crantz. wild populations. Biologija, 1: 46–49.

Brantner A., Kartnig T., Quehenberger F. 1994. Vergleichende phytochemische Untersuchungen an *Hypericum perforatum* L. und *Hypericum maculatum* Crantz. Scientia Pharmaceutica, 62: 261–276.

Hölzl J., Ostrowski E. 1987. Johanniskraut (*Hypericum perforatum* L.). – HPLC – Analyse der wichtigsten Inhaltsstoffe und deren Variabilität in einer Population. Dtsch. Apoth. Ztg., 127 (23): 1227–1230.

Kartnig T., Gruber A., Sauer H. 1989. Comparative phytochemical investigations of *Hypericum* species. Planta Medica, 55: 215.

Kitanov G. 1995. Dynamics and contents of tannins and flavonoids in *Hypericum perforatum* L. and *Hypericum maculatum* Crantz. Farmacia, 5-6: 13–17.

Kitanov G. 2000. The dynamics and content of hypericins in *Hypericum perforatum* L. and *Hypericum maculatum* Crantz growing in Bulgaria. Acta Pharmaceutica, 50: 65–68.

Kitanov G. M., Nikolov N Tz. 1991. Phenolic constituents of *Hypericum maculatum*. Fitoterapia, 62: 92.

Martonfi P., Repčak M., Zanvit P. 2006. Secondary metabolites variation in *Hypericum maculatum* and its relatives. Biochemical Systematics and Ecology, 34: 56–59.

Radušienė J., Bagdonaitė E. 2002. Phenotypic variation in *Hypericum perforatum* L. and *H. maculatum* Crantz wild populations in Lithuania. Journal of Herbs, Spices & Medicinal Plants, 9 (4): 345–351.

Radušienė J., Bagdonaitė E., Kazlauskas S. 2004. Morphological and chemical evaluation on *Hypericum perforatum* and *H. maculatum* in Lithuania. Acta Horticulturae (ISHS), 629: 55-62.

Smelcerovic A., Verma V., Spiteller M., Ahmad S. M., Puri S. C., Qazi G. H. 2006. Phytochemical analysis and genetic characterization of six *Hypericum* species from Serbia. Phytochemistry, 67: 171–177.

Umek A., Krefts S., Kartnig T., Heydel B. 1999. Quantitative phytochemical analyses of six *Hypericum* species growing in Slovenia. Planta Medica, 65: 388–390.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

THE EFFECT OF THE SEASON ON THE OLFACTORY LEARNING OF WORKER HONEYBEES (*APIS MELLIFERA CARNICA* POLLM.) TO QUEEN BEE PHEROMONE

Laima Blažytė-Čereškienė, Algirdas Skirkevičius

Blažytė-Čereškienė L., Skirkevičius A. 2006. The effect of the season on the olfactory learning of worker honeybees (*Apis mellifera carnica* Pollm.) to queen bee feromone. *Acta Biol. Univ. daugavp., 6 (1-2): 45 - 50.*

Conditioning the proboscis extension reflex of harnessed honeybees (*Apis mellifera carnica*) is used to study the effect time of the year (in temperate climates) has on the olfactory learning. Results of the present research show that a season is very important factor influencing ***both learning ability*** and speed of learning of worker bees to the queen bee extract odour (dose of 0.001 queen equivalent). The optimum olfactory learning of bees was achieved in early autumn (more than 80% of bees responded to conditioned stimulus in August and September), whereas the poor conditioning level was obtained in June (63% of bees). The highest speed of conditioning occurs in autumn (in September – November). Whereas the lowest speed of conditioning was in spring (from March to July).

Key words: *Apis mellifera carnica*, olfactory stimulus, conditioning, queen pheromone, season.

Laima Blažytė-Čereškienė. Institute of Ecology, Vilnius University, Vilnius, Lithuania, e-mail: blazyte@ekoi.lt

Algirdas Skirkevičius Vilnius Pedagogical University, Vilnius, Lithuania, e-mail: algskirk@ktl.mii.lt

Introduction

In temperate climates, the honey bee colony follows a seasonal cycle related to its needs throughout the year (Seeley and Visscher 1985). It is known that foraging experiences, communication (Naumann et al. 1991), sensitivity of chemoreceptors (Skirkevičius and Skirkevičienė 1999), olfactory response of bees with proboscis extension before a food reward (Erber 1980, Skirkevičius and Blažytė-Čereškienė 2005) vary depending upon seasonal changes in colony. Very little research has been conducted on seasonal variations in honey bee learning performance. Menzel et al. (1974) states that learning curves are unaffected by season, however later researchers have alluded to seasonal variations in olfactory learning (Menzel 1990, Frisch 1965, Menzel et al. 2001), but do not expand this question. Ray and Ferneyhough (1997) offer a more information about the effect of season on olfactory learning. These authors note that best olfactory learning was in winter and poor in spring. However they refer the conditioned response to

geraniol after three learning trials and do not analyse the conditioning speed which may be very important for successful acquisition.

Thus in this study we examine the effect of the season on the olfactory conditioning of honeybees to the queen extract odour (pheromone). We turned attention to two attributes that describe learning of bee workers: 1. Number of workers that showed conditioned response after ten learning trials 2. Number of learning trials, required for acquisition (speed of conditioning).

Material and Methods

Bees. The study was carried out in the Lithuania during two years (in January – November 2001 and 2002). In the first half of each month, 40-60 individuals were investigated. In total, 968 workers were studied. The honeybee colony *Apis mellifera carnica* Pollm. housed at Institute of Ecology, Vilnius University. It was hived in a 16-frame (435x300 mm) standard hive. The colony contained brood at all stages, a sufficient number of workers to cover the brood nest adequately, the mated egg-laying queen, honey and pollen. Worker bees could freely fly out through the windows˙ openings and forage.

On test days a simple of worker bees was collected from the hive and placed in groups of ten bees in plastic cages (160 mm in length and 30 mm in diameter). Bees were then quickly anaesthetized by chilling in a refrigerator for a few minutes. While anaesthetized, bees were removed from the cages and individually restrained in the test-stand with wing-clips (Skirkevičius et al. 2000). The animals were used for experiments approximately 30 minutes after fixing.

Conditioning. Before the conditioning, the bees were checked for the unconditioned response, the reflexive extension of the proboscis after applying sucrose solution to the antennae. A conditioning trial consisted of forward-pairing the conditioned stimulus (odorous substance presented to the worker˙s head 5 mm from the antennae for 5 sec) with the unconditioned stimulus (sucrose solution was delivered by touching the antennae with sucrose solution). Reward delivery started 5 sec after odorant offset and lasted for about 1 sec. The whole training procedure lasted for approximately 6 seconds. All bees received 10 training trials with an inter-trial interval of 60 sec. Bees responding to the conditioned stimulus prior to conditioning were discarded.

Stimuli. The odor used as conditioned stimulus was queen extract. It was made by soaking mated egg-laying queens in ethanol. The extract was calibrated according to the amount of *E*-9-oxo-2-decenoic acid (9-ODA). The queen extract containing 100-150 μg of 9-ODA (Apšegaitė and Skirkevičius 1995) was equated to one queen equivalent (Qeq). For stimulation of workers, we used 0.01ml of the extract that contained 0.1 mg 9-ODA. Consequently, the dose of the stimulus was 0.001 of the queen equivalent.

Statistical analysis. The significance of the year or the month on the percentages of bees displaying the conditioned response after ten conditioning trial or the differences in speed of conditioning was examined using Kruskal-Wallis tests. For comparing different groups with each other, the Mann Whitney U-test was applied. All means are presented as ± one standard error. All statistical tests were performed with the software SPSS.

Results

The percentage of worker bees displaying the conditioned response to queen extract odour after ten training trials in 2001 year did not change from those in 2002 year and seasonal variation in learning ability remained consistent over all years investigated (Kruskal-Wallis test: χ^2=0.76; df=1; p=0.38). The data over the two year period were added and presented together (Fig. 1).

While the conditioned response level showed a marked seasonal variation (Kruskal-Wallis test: χ^2=27.51; df=11; p<0.01). The honey bees had

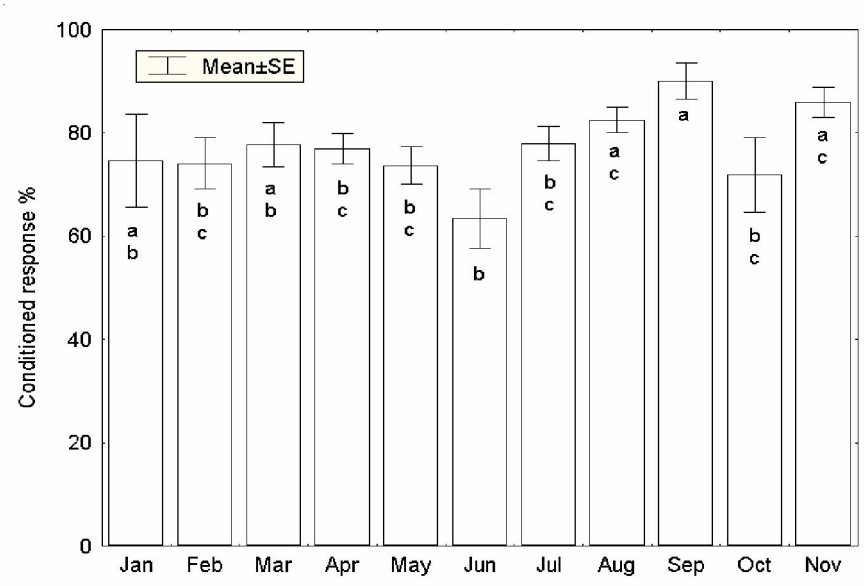


Fig. 1. Seasonal variation in the proboscis extension response conditioning of worker bees (*Apis mellifera carnica* Pollm.) to the queen bee extract odour (0.001Qeq). Columns represent the average percentage of bees showing the conditioned response. Columns with different letters indicate significant differences (Mann-Whitney test).

a consistently high level of olfactory conditioning in winter and spring months. Kruskal-Wallis test did not show statically significant differences in response level from January to May (χ^2 =1.02; df=4, p=0.91). There were about 75% of worker bees responding to conditioned stimulus. In Jun the number of these workers was 63.4%, however decrease is not significant statistically (Mann-Whitney test: U=43; N_1=10; N_2=12; p=0.26). From July the conditioning level began to increase and achieved optimum in early autumn. The bees responding to conditioned stimulus in September were more than in April (Mann-Whitney test: U=7.0; N_1=6; N_2=8; p=0.03), May (Mann-Whitney test: U=8.5; N_1=6; N_2=10; p=0.02), Jun (Mann-Whitney test: U=7.5; N_1=6; N_2=12; p<0.01) and July (Mann-Whitney test: U=14.5; N_1=6; N_2=12; p=0.04). In October the level of olfactory conditioning decreased to 71.8% of worker bees, i.e. there was their less than in September and difference is significant statistically (Mann-Whitney test: U=7.5; N_1=6; N_2=9; P=0.02). Kruskal-Wallis test showed that seasonal changes also may have influenced on the speed of the conditioning to the queen extract odour (Kruskal-Wallis test: χ^2 =65.55; df=11; p<0.01) (Fig.2). Optimum speed of olfactory learning was achieved in autumn. It did not differ statistically from September to November (Kruskal-Wallis test: χ^2 =4.73; df=2; p=0.09). The bees needed for acquisition on average two learning trials. In winter trial number required for acquisition increased. It was about three learning trials in January and February. In early spring the speed of conditioning steady increased. That is the average number of learning trials decreased to 2.5 in March and it was significantly less comparing with February (Mann-Whitney test: U=1110; N_1=55; N_2=64; p<0.01). From March to July the speed of conditioning required for acquisition

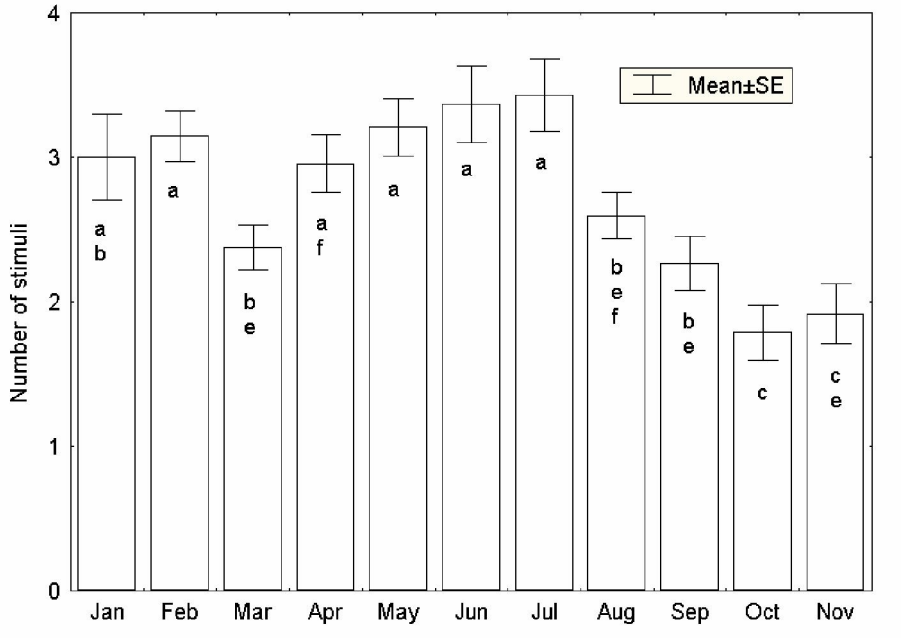


Fig. 2. Seasonal variation in the speed of conditioning needed for acquisition of worker bees (*Apis mellifera carnica* Pollm.). Columns represent the average number of presented olfactory stimuli with reward which was needed for acquisition. Columns with different letters indicate significant differences (Mann-Whitney test).

decreased. That is in April – July the olfactory conditioning of honey bees was slowest. The most bees needed for acquisition more than three learning trials.

Discussion

The data of our research demonstrate that a season is very important factor influencing the proboscis extension response conditioning and speed of learning of worker bees to the queen bee extract odour.

The optimum olfactory learning of randomly chosen bees was achieved in early autumn (more than 80% of bees responded to conditioned stimulus in August and September), whereas the poor conditioning level was obtained in June (63%). The speed of conditioning also depends on the season. The highest speed of conditioning occurs in autumn (in September – November). Whereas the lowest speed of conditioning was in spring (from March to July).

If we compare the results are obtained while investigating seasonal dynamics of the conditioning of worker bees to geraniol (Ray, Ferneyhough, 1997), with the seasonal variation of the conditioned response level to the queen bee extract odour in worker bees investigated by us, we shall notices some differences. The results of Ray and Ferneyhough (1997) investigations showed that optimum olfactory learning was achieved in winter months, with poor conditioning levels in spring from March to June. Whereas, the data of our research demonstrate the lowest level of conditioned response to queen bee odour was only in June. The authors mentioned above used three training trials, where our honey bees received ten training trials. It will be observed,

that honey bees in our experiments received more training trials and in April – July the bees needed for acquisition more than three learning trials. However, when bees are kept under artificial conditions (indoor colony), when the queen bee lays eggs all year round, the season have no effect on the conditioning (Ray, Ferneyhough, 1997). These results are of particular interest for researchers which can work with honey bees from outdoor colonies only during the summer months. They may find poor levels of olfactory learning. Wherefore it is essential to take notice of the time of the year when compare the learning abilities of honey bees.

Conclusions

Results of the present research show that a season is very important factor influencing ***both learning ability*** and speed of learning of worker bees to the queen bee odour. The optimum olfactory learning of bees was achieved in early autumn (more than 80% of bees responded to conditioned stimulus in August and September), whereas the poor conditioning level was obtained in June (63% of bees). The highest speed of conditioning occurs in autumn (in September – November). Whereas the lowest speed of conditioning was in spring (from March to July). It is essential to take notice of season when compare the learning abilities of honey bees.

References

Apšegaitė V., Skirkevičius A. 1995. Quantitative and qualitative composition of extract from virgin and mated honeybee queens (*Apis mellifera* L.). Pheromones, 5: 23-36.

Erber J. 1980. Neural correlates of non-associative and associative learning in the honeybee. Verh. Dtsch. Zool. Ges., 73: 250–261.

Frisch K. von. 1965 Tanzsprache und Orientierung der Bienen. Berlin, Heidelberg, New York.

Menzel R. 1990. Learning, memory, and "cognition" in honeybees. In Neurobiology of Comparative Cognition, (Ed. R.P. Kesner, D.S. Olten) p. 237 – 292. N.J. Hillsdale: Erlbaum.

Menzel R., Erber J., Masuhr Th. 1974. Learning and memory in the honeybee. In Experimental Analysis of Insect Behaviour (Ed. L.B. Browne) p. 195 – 217, Berlin, Heidelberg, New York: Springer-Verlag.

Menzel R., Manz G., Menzel R., Greggers U. 2001. Massed and spaced learning in honeybees: the role of CS, US, the intertrial interval, and the test interval. Learning and Memory, 8:198–208.

Naumann K., Winston M.L., Slessor K.N., Prestwich G.D., Webster F.X. 1991. The production and transmission of honey bee queen (*Apis mellifera* L.) mandibular gland pheromone. Behavioral Ecology and Sociobiology, 29: 321 – 332.

Ray S., Ferneyhough B. 1997. Seasonal variation of proboscis extension reflex conditioning in the honey bee (*Apis mellifera*). Journal of Apicultural Research, 36 (2): 108 – 110.

Seeley T.D., Visscher P.K. 1985. Survival of honeybees in cold climates: the critical timing of colony growth and reproduction. Ecological Entomology, 10: 81–88.

Skirkevičius A., Blažytė L., Skirkevičienė Z. 2000. Influence of keeping bees (*Apis mellifera carnica* Pollm.) in colonies or caged on the formation of conditioned reflex on the queen bee pheromones. Pszczelnicze zeszyty naukowe, 44 (2): 43 - 53.

Skirkevičius A., Blažytė-Čereškienė L. 2005. Response of workers (*Apis mellifera carnica* Pollm.) by proboscis extension to queen extract odour before conditioning procedure. Biologija, 4: 82-87.

Skirkevičius A., Skirkevičienė Z. 1999. New data on annual sensitivity dynamics of pheromonal receptors in worker honeybees (*Apis mellifera* L.). Pheromones, 6: 21 – 26.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

OXYTHYREA FUNESTA (PODA, 1761) (COLEOPTERA: SCARABAEIDAE: CETONIINAE) IN THE FAUNA OF LATVIA

Andris Bukejs, Arvīds Barševskis, Edgars Rudāns

Bukejs A., Barševskis A., Rudāns E. 2006. *Oxythyrea funesta* (Poda, 1761) (Coleoptera: Scarabaeidae: Cetoninae) in the fauna of Latvia. *Acta Biol. Univ. Daugavp., 6 (1-2): 51 - 56.*

The dung beetle *Oxythyrea funesta* (Poda, 1761) is a rare and insufficiently known species both for Latvia and for the region of the Baltic Sea basin on the whole. The locality of *Oxythyrea funesta* (Poda, 1761) discovered in Daugavpils district Bebrene is the largest in number of specimens (>130) caught in Latvia. General dilating of the species areal to the north is evident.

Key words: *Oxythyrea funesta*, Scarabaeidae, Latvia, fauna, rare species, areal dilating.

Bukejs A., Barševskis A., Rudāns E. ; Institute of Systematic Biology, Daugavpils University, Vienības 13 -2 29, LV-5401, Daugavpils, Latvia; andris.bukejs@biology.lv, arvids.barsevskis@biology.lv, edgars.rudans@biology.lv

Introduction

In the fauna of Latvia *Oxythyrea funesta* (Poda, 1761) (Fig. 1) is one of the five species of Cetoniinae Leach, 1815 (Telnov et al. 1997; Telnov 2004; Smetana 2006. This is a stenotop, thermophil, floricol, herbicol and phytophag species (Koch, 1989). It was considered that *Oxythyrea funesta* (Poda, 1761) is typical for the forest-steppe and steppe European parts. Till June 1992 this species was not established in the middle of Baltic countries. Only several localities of this species with small number of specimen were described in Latvia till that time. At present in the region of the Baltic Sea basin *Oxythyrea funesta* (Poda, 1761) is a rare species about which you can not find any generalized information.

Results and Discussion

The *Oxythyrea funesta* (Poda, 1761) was caught on the territory of Latvia for the first time on June 15, 1992 in Riga (Mežaparks, on flowers of *Centaurea sp*. in the waste land, 4 specimens, leg. D. Telnovs and A. Pushko) (Telnov 1996). Distribution of this species in Latvia showed in Fig. 2.

One more specimen was found on flowers on June 26, 2001 in Valmiera district, Vidusburtnieks (leg. V. Spuņģis) (Telnov 2001).

In the summer of 2005 Andris Bukejs collected a big number of *Oxythyrea funesta* (Poda, 1761) in Daugavpils. All the material was hand-picked on *Centaurea rhenana* Borean flowers not far from the railway. The total number of the specimens collected is 11: 21.VII.2005. (1 specimen), 22.VII.2005. (1 specimen), 24.VII.2005. (4 specimens), 26.VII.2005. (2 specimens) and 22.VIII.2005. (3 specimens). At in the begginning and in the middle of Augus, 2005 the author saw a great number of *Oxythyrea funesta* (Poda, 1761) specimens at the same place (on sunny days more that 15 specimens, including coupling

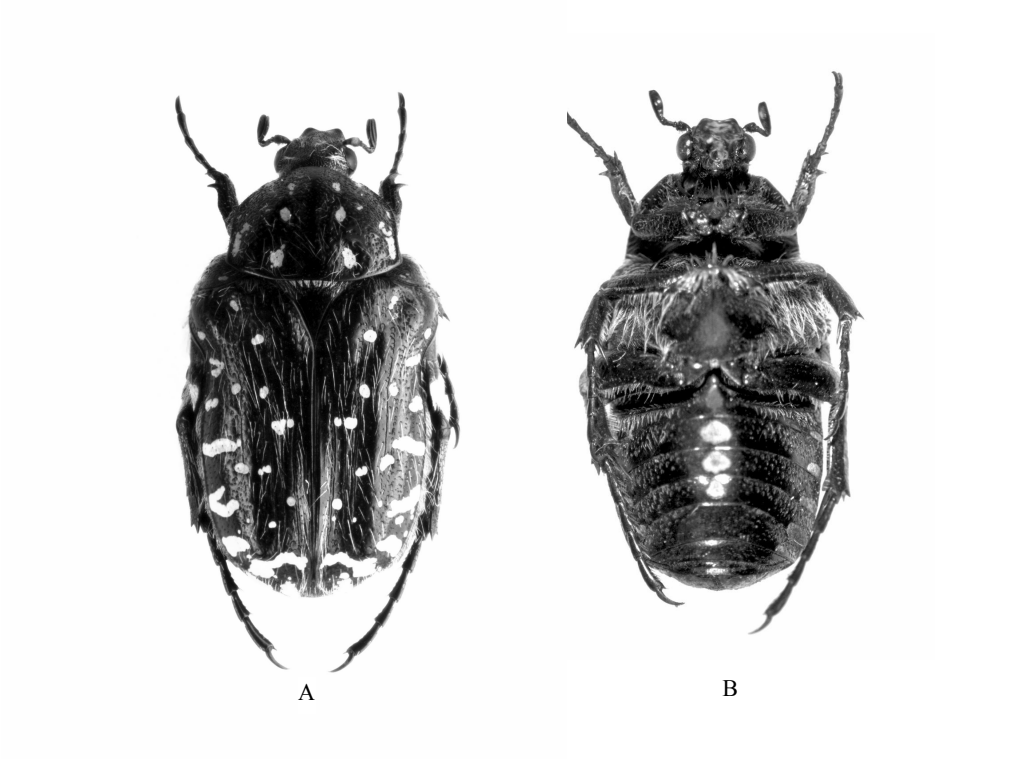


Fig. 1. Habitus of *Oxythyrea funesta* (Poda, 1761): A – dorsal view, B – ventral view

ones; on dull days there were much fewer of them).

Till 2005 this species was know in Latvia from some localities (Telnov et al. 2006): Valmiera district Vecate parish Vidusburtnieks protected nature territory (1 specimen, egde of boreal mixed forest, on flower, leg. J. Gailis); Ludza district 9 km SE Kārsava (2 specimens, old cutting area in coniferous forest, on flowers of Umbelliferae, leg. A. Napolov & I. Roma) and Ludza district Malnava village (1 freshly dead specimen, hollow Norway maple (*Acer platanoides*), leg. A. Napolov & I. Roma).

Studying a fauna of the beetles of Latvia in 2006 the new localities of *Oxythyrea funesta* (Poda, 1761) were found: Daugavpils district, Bebrene, on flowers of *Centaurea sp*., 01.VII.2006. (4, leg. E. Rudāns), 11.VII.2006. (122, leg. E. Rudāns), 15.VII.2006. (1, leg. E. Rudāns), 13.VII.2006. (3, leg. E. Rudāns), 02.IX.2006. (2, leg. E. Rudāns); Daugavpils city, on flower of *Centaurea sp*. 18.VII.2006. (1, leg. A. Bukejs); Valka district, Seda village, Seda bog, 03.VII.2006. (2, leg. A. Barševskis, U. Valainis & A. Pankjāns); Jēkabpils district, Dunava, 56º12’93"N 26º12’17"E, 01-08.VIII.2006. (11, leg. A. Barševskis & K. Barševska), 11-13.VIII.2006. (9, leg. A. Barševskis), 14-18.VIII.2006. (7, leg. A. Barševskis & K. Barševska), 29-31.VIII.2006. (5, leg. A. Barševskis); Preiļi district, Aglona, 14.VIII.2006. (1, leg. A. Barševskis); Madona district, Aiviekste, 56º40’73" N 25º59’04"E, 22.VIII.2006. (1, leg. A. Barševskis); Krāslava district, Skaista, 10.VIII.2006. (1, leg. S. Ungurs). The locality of

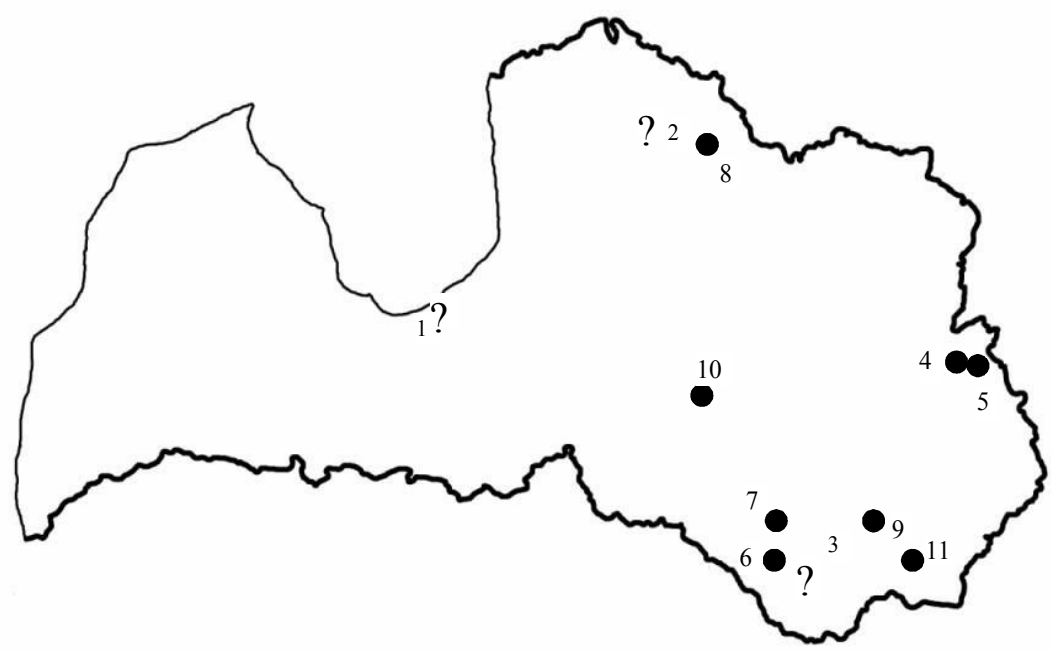


Fig. 2. Distribution of *Oxythyrea funesta* (Poda, 1761) in Latvia:

1 - Rīga, Mežaparks (corner of Kokneses Str. and Ķīšezera Str.); 2 - Vidusburtnieks and Vidusburtnieks protected nature territory, Vecate parish, Valmiera district; 3 – Daugavpils; 4 – 9 km SE Kārsava, Ludza district; 5 - Malnava village, Ludza district; 6 – Bebrene, Daugavpils district; 7 - Dunava, Jēkabpils district; 8 - Seda village, Seda bog, Valka district; 9 - Aglona, Preiļi district; 10 – Aiviekste, Madona district; 11 Skaista, Krāslava district

Oxythyrea funesta (Poda, 1761) discovered in Daugavpils district Bebrene is the largest in number of specimens caught in Latvia. All the materials are kept in the collection of the Institute of Systematic Biology (Daugavpils, Latvia).

In the north-east of Lithuania (Jgna, Mikalavas, Daugėliškis environs), not far from the Latvian border a big number of *Oxythyrea funesta* (Poda, 1761) (7 speciemens) was collected on June 6, 2004 (Šablevičius 2004). That find and the author‘s next finds in Latvia affirm the fact of gradual distribution of localities of this species with a great number of specimens in the Baltic Sea basin region.

In his monograph S. Medvedev (1964) shows the northern border of the *Oxythyrea funesta* (Poda, 1761) areal coming through Kaliningrad district, Lithuania (Kaunas), Belarus (Vitebsk), northern Ukraine, Tambov, Saratov, Bugulma, Belebey and Turgay.

During the last ten years the areal of the given species has essentially spread to the north. In the Enumeratio Coleopterorum Fennoscandiae, Daniae et Baltiae (Silfverberg 1992) *Oxythyrea funesta* (Poda, 1761) only Lithuania is mentioned and Denmark as an introduced species. In the next catalogue (Silfverberg 2004) Lithuania, Latvia, Estonia and Finland are mentioned as well.

Only one *Oxythyrea funesta* (Poda, 1761) specimen was found in the south of Estonia (Kanaküla, 58°16‘00“N, 25°10‘00“E) on June 9, 2002 (Roosileht, 2003).

In Russia *Oxythyrea funesta* (Poda, 1761) was discovered in the north of Yaroslavl district (Власов 2003) and south of Vologda district. On June 21, 2003 a specimen was caught in Leningrad district (near the village of Sapyorniy, some 10-15 km NE of St. Peterburg) on Umbelliferae Juss. plant flowers (oral information from P. Baturin). In the summer of 2005 Pavel Baturin caught one more specimen on the flower of Umbelliferae Juss. plant in Kolpinsk (St.Peterburg suburbus).

All the summarized facts about dung betle *Oxythyrea funesta* (Poda, 1761) point to the fact of gradual dilating of this species areal to the north.

The pictures are made by Zeiss stereomicroscope *Zeiss SteREO Lumar V12* and *Axiocam* digital camera.

Acknowledgement

The authors are thankful to Pavel Baturin (St. Peterburg, Russia), Katrīna Barševska, Uldis Valainis, Ainārs Pankjāns and Sandis Ungurs for the cooperation during material collection.

In the processing of material and the preparation of the article the facilities of European Social Fond (project VPD1/ESF/PIAA/04/NP/3.2.3.1./0003/065) were used.

References

Koch K. 1989. Die Käfer Mitteleuropas. Ökologie, 2. Goecke & Evers Verlag, Germany: 1-382.

Roosileht U. 2003. New dung beetle Oxythyrea funesta (Coleoptera: Scarabaeidae) in Estonian fauna. Baltic J. Coleopterol., 3 (1): 53-54.

Šablevičius B. 2004. New and rare for Lithuania beetles (Coleoptera) species collected in 1988-2004. New and rare for Lithuania insect species: Records and description, 16. Vilnius: 27-31.

Silfverberg H. 1992. Enumeratio Coleopterorum Fennoscandiae, Daniae et Baltiae. Helsingin Hyönteisvaihtoyhdstys – Helsingfors Entomologiska Bytesförening: 1-94.

Silfverberg H. 2004. Enumeratio nova Coleopterorum Fennoscandiae, Daniae et Baltiae. Sahlbergia, 9: 1-111.

Smetana A. 2006. Cetoniinae, pp. 283 – 313. In: Löbl I., Smetana I. (ed.) Catalogue of Palaeartic Coleoptera. Vol. 3. Scarabaeoidea, Scirtoidea, Dascilloidea, Buprestoidea, Byrrhoidea. Stenstrup: Apollo Books, 690 pp.

Telnov D. 1996. Sixty three new and rare species of Coleoptera in the fauna of Latvia. Latv. Entomol., 35: 36-43.

Telnov D. 2001. To the knowledge of Latvian Coleoptera. 1. Latv. Entomol., 38: 1-69.

Telnov D. 2004. Check-List of Latvian Beetles (Insecta: Coleoptera). In Telnov D. (ed.) Compedium of Latvian Coleoptera, vol 1. Rīga, Pertovskis & Co: 1-114.

Telnov D., Barševskis A., Savich F., Kovalevsky F., Berdnikov S., Doronin M., Cibuļskis R., Ratniece D. 1997. Check-list of Latvian Beetles (Insecta: Coleoptera). Mitt. Internal. Entomol. Ver., Frankfurt a.M., Suppl. V: 1 - 40.

Telnov D., Fägerström Ch., Gailis J., Kalniņš M., Piterāns U., Vilks K. 2006. Contributions to the Knowledge of Latvian Coleoptera. 5. Latv. Entomol., 43: 78-125.

Власов Д. В. 2003. Потепление и миграция в природе. Экология и жизнь, 6 (2003): 60.

Медведев С. И. 1964. Пластинчатоусые (Scarabaeidae). Подсем. Cetoniinae, Valginae. Фауна СССР. Жесткокрылые. Том 10, вып. 5. М.-Л., Наука: 1-376.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

MATERIALS ABOUT THE TRIBE XANTHOLININI ERICHSON, 1839 (COLEOPTERA: STAPHYLINIDAE) IN THE FAUNA OF LATVIA

Raimonds Cibuļskis

Cibuļskis R. 2006. Materials about the tribe Xantholinini Erichson, 1839 (Coleoptera: Staphylinidae) in the fauna of Latvia. *Acta Biol. Univ. Daugavp., 6 (1-2): 57 - 64.*

New data about rove beetles' species of *Xantholinini* Erichson, 1839 tribe are summarized in the article. *Xantholinus audrasi* Coiffait is mentioned for the first time for Latvian fauna.

Key words: Staphylinidae, Xantholinini, Latvia, fauna.

Raimonds Cibuļskis, Institute of Systematic Biology, Daugavpils University, Vienibas str. 13 – 229, LV-5401, Daugavpils, Latvia; e-mail: raimcib@tvnet.lv

Introduction

First data about the rove beetles' species of *Xantholinini* Erichson, 1839 tribe in Latvian fauna appeared in 1875 in Zeidlic's monograph about fauna of beetles in Baltic (Seidlitz 1875). More than 20 works were published later, fragmentary and incomplete information about rove beetles of this tribe can be found in them. This is the first resumptive work and specific research about rove beetles of *Xantholinini* Er. tribe in Latvian fauna.

197 specimens of rove beetles were processed in the investigations, they represent 13 species and 5 genera. There were processed rove beetles from various collections: collection of beetles of Daugavpils University Institute of Systematic Biology (DUBC), private collection of article's author (RCC), collection of Latvian Association of Entomology (LEB).

„Catalogue of Palaearctic Coleoptera, Volume 2" (Lobl & Smetana 2004) and H.Coiffait's work about Palearctic rove beetles (Coiffait 1972) were used for the specification of species' systematics. The catalogues of Palearctic and world rove beetles (Lobl & Smetana 2004, Herman 2001) were used for the nomenclature of scientific titles of the species. The information about the species, which can be found in Latvia was based on North European and Latvian catalogues of beetles (Silfverberg 2004, Telnov 2004). The following information is given in the list of species: the title of species, published bibliographical sources in Latvia and unpublished material about the processed collections.

Results and discussion

Species of *Xantholinini* Er. tribe can be distributed worldwide. At the moment 77 genera and

1180 species are known in this tribe (Herman 2001). 8 genera and 21 species are included in Latvian fauna (Silfverberg 2004, Telnov 2004). Majority of them – 7 are distributed in Europe (*Leptophius flavocinctus* (Hochhuth), *Xantholinus longiventris* Heer, *Xantholinus audrasi* Coiffait, *Xantholinus gallicus* Coiffait, *Xantholinus tricolor* (Fabricius), *Xantholinus laevigatus* Jacobson). Other species have wider areas of distribution: Palearctic – 5 species (*Leptacinus sulcifrons* (Stephens), *Gyrohypnus fracticornis* (Müller), *Gyrohypnus angustatus* Stephens, *Hypnogyra angularis* (Ganglbauer), *Xantholinus linearis* (Olivier)), cosmopolitic – 5 species (*Leptacinus pusillus* (Stephens), *Leptacinus batychrus* (Gyllenhal), *Phacophallus parumpunctatus* (Gyllenhal), *Gauropterus fulgidus* (Fabricius), *Gyrohypnus punctulatus* (Paykull)), Euro-Siberian – 4 species (*Leptacinus formicetorum* Märkel, *Gyrohypnus atratus* (Heer), *Nudobius lentus* (Gravenhorst), *Xantholinus distans* Mulsant & Rey), Holarctic – 1 species (*Leptacinus intermedius* Donisthorpe) (Lobl & Smetana 2004, Herman 2001).

After processing of the mentioned collections 13 species of rove beetles of *Xantholinini* Er. tribe were denoted, they are included in 5 genera. One of them - *Xantholinus audrasi* Coiffait is mentioned for the first time for Latvian fauna. Hitherto this species was familiar in Estonia, Sweden and Norway.

During the monitoring of the material of rove beetles obscure species for Latvian fauna were denoted, these are: *Phacophallus parumpunctatus* (Gyllenhal), *Leptacinus formicetorum* Märkel and *Xantholinus distans* Mulsant & Rey, there is almost no data about them in literature. All three species were denoted by G.Zeidlic (Seidlitz 1891) in the end of the 19th century in Kurzeme and Livland, but concrete deposits were not given. This is the first case during the last century, when the species were distributed in Latvia. *Phacophallus parumpunctatus* (Gyllenhal) till now was known from Kurzeme (Seidlitz 1891). This is sinanthropus species with covert way of life, it can be distributed in old rural houses, cattlesheds and cellars. Hitherto concrete deposits for other two species were not found in Latvia. *Leptacinus formicetorum* Märkel is mirmecophil species, which mainly can be distributed in antheaps of *Formica* genus. Supposedly the species is distributed more widely, because antheaps are investigated rather little.

The majority of species of *Xantholinini* Er. tribe are more or less frequent for Latvian fauna. However even so simple species as *Gyrohypnus angustatus* Stephens, *Nudobius lentus* (Gravenhorst), *Xantholinus linearis* (Olivier) and *Xantholinus tricolor* (Fabricius) are known from not more than 30 deposits in Latvia. Besides the detection of at least one more species can be foreseen. Therefore detailed fauna investigations of rove beetles of this tribe are planned to be continued.

List of species

***Xantholinini* Erichson, 1839**

***1. Leptacinus formicetorum* Märkel, 1841**

Seitlitz 1891 [1887-1891]; Telnov 2004

Examined material: 3 exs. – Daugavpils distr., Skrudaliena p., Ilgas, Silene Nature Park, in *Formica rufa* antheap, 12.-13.IX.2000, 3 exs., A.Barševskis leg. (DUBC).

***2. Phacophallus parumpunctatus* (Gyllenhal, 1827)**

Seitlitz 1887-1891; Jakobson 1905; Rathlef 1905; Silfverberg 1992; Telnov et al. 1997; Silfverberg 2004; Telnov 2004

Examined material: 1 ex. – Daugavpils distr., Līksna p., Augšpole, 56°00'65N 26°26'18E, flying near farmstead, 14.VIII.1996, 1 ex., R.Cibuļskis leg. (DUBC).

***3. Gyrohypnus (s. str.) punctulatus* (Paykull, 1789)**

Ulanowski 1883; Seitlitz 1887-1891; Rathlef 1905; Brammanis 1930; Silfverberg 1992; Telnov et al. 1997; Silfverberg 2004; Telnov 2004

Examined material: 10 exs. – Daugavpils distr., Līknsa p., Augšpole, 56°00 65N 26°26 18E, near farmstead, 21.IX.1996, 1 ex., R.Cibuļskis leg. (DUBC), in open area flying near farmstead, 11.V.1997, 2 exs., R.Cibuļskis leg. (RCC), in soil on field, 09.V.1998, 2 exs., R.Cibuļskis leg. (DUBC); Daugavpils distr., 1,8 km SW Vabole, wet meadow with bush, 21.II.1997, 1 ex., R.Cibuļskis leg. (DUBC), on the dung of elk in clearing of mixed forest, 27.IV.1997, 1 ex., R.Cibuļskis leg. (RCC); Daugavpils distr., Skrudaliena p., Ilgas, Silene Nature Park, 08.IX.1997, 1 ex., A.Barševskis leg. (DUBC); Jēkabpils distr., Rubeņi, 28.IV.1999, 1 ex., I.Leiskina leg. (DUBC), 03.VIII.1999, 1 ex., I.Leiskina leg. (DUBC).

***4. Gyrohypnus (s. str.) fracticornis* (Müller, 1776)**

Stiprais 1979; Stiprais, Varzinska 1985; Barševskis 1993; Barrševskis et al. 2002; Silfverberg 1992; Telnov et al. 1997; Silfverberg 2004; Telnov 2004

Examined material: 5 exs. – Daugavpils distr., Daugavpils, 14.X.1993, 1 ex., A.Barševskis leg. (DUBC); Daugavpils distr., Līksna, 14.VII.1994, 1 ex., R.Cibuļskis leg. (DUBC), 14.X.1994, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Līksna p., Augšpole, 56°00 65N 26°26 18E, in open area flying near farmstead, 11.V.1997, 2 exs., R.Cibuļskis leg. (RCC).

***5. Gyrohypnus (s. str.) angustatus* Stephens, 1833**

Ulanowski 1883; Seitlitz 1887-1891; Rathlef 1905; Brammanis 1930; Stiprais 1979; Stiprais, Varzinska 1985; Barševskis 1993; Barševskis et al. 2002; Jansson 2002; Silfverberg 1992; Telnov et al. 1997; Silfverberg 2004; Telnov 2004

Examined material: 57 exs. – Daugavpils distr.: Vasargelišķi, 04.VI.2005, 1 ex., A.Barševskis leg. (DUBC); Daugavpils distr., Līksnas p., Augšpole, 56°00 65N 26°26 18E, near farmstead under stone, 05.V.1995, 1 ex., R.Cibuļskis leg. (DUBC), in soil on field, 06.V.1995, 1 ex., R.Cibuļskis leg. (DUBC), near farmstead under firewood log, 03.VII.1996, 1 ex., R.Cibuļskis leg. (DUBC), the same place, 23.VIII.1996, 1 ex., R.Cibuļskis leg. (DUBC), near farmstead under stone, 07.III.1997, 1 ex., R.Cibuļskis leg. (DUBC), near farmstead and meadow under stones, 18.IV.1997, 2 exs., R.Cibuļskis leg. (RCC), near farmstead under stone, 09.V.1997, 1 ex., R.Cibuļskis leg. (DUBC), flying near farmstead, 11.V.1997, 2 exs., R.Cibuļskis leg. (DUBC); Daugavpils distr., Līksna, 18.IV.1995, 1 ex., R.Cibuļskis leg. (DUBC), 19.X.1996, 1 ex., R.Cibuļskis leg. (DUBC), 17.V.1997, 2 exs., R.Cibuļskis leg. (RCC), 15.VI.1997, 1 ex., R.Cibuļskis leg. (DUBC), 09.VII.1997, 2 exs., R.Cibuļskis leg. (RCC), 06.IX.1997, 1 ex., R.Cibuļskis leg. (DUBC), 12.IV.1998, 1 ex., R.Cibuļskis leg. (DUBC), 09.V.1998, 2 exs., R.Cibuļskis leg. (DUBC), 11.IX.1999, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Vabole, 19.X.1996, 1 ex., R.Cibuļskis leg. (DUBC), 12.IV.1998, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Skrudalienas p., Ilgas, Silene Nature Park, 11.IX.1997, 1 ex., A.Barševskis leg. (DUBC), 27.IV.1999, 1 ex., R.Cibuļskis leg. (DUBC), 06.V.1999, 1 ex., A.Bar□evskis leg. (DUBC); Daugavpils distr., Svente, 29.VII.2003, 1 ex., N.Strode leg. (DUBC); Daugavpils distr., Dunava, agrocenosis 06.IX.1998, 1 ex., A.Bar□evskis leg. (DUBC); Daugavpils distr., Tabores p., Elerne, 01.V.2001, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Naujenes p., Lociki 15.IV.2000, 1 ex., R.Cibuļskis leg. (DUBC); Preiļi distr., Jersika, Kurpnieki, 04.V.2005, 1 ex., A.Barševskis leg. (DUBC); Jēkabpils distr., Rubeņi, 28.IV.1999, 1 ex., I.Leiskina leg. (DUBC), 21.V.1999, 2 exs., I.Leiskina leg. (DUBC), 04.VII.1999, 1 ex., I.Leiskina leg. (DUBC), 21.IV.2000, 1 ex., I.Leiskina leg. (DUBC), 22.IV.2000, 2 exs., I.Leiskina leg. (DUBC); Valkas distr., Sedas bog 18.V-14.VI.2003, 1 ex., V.Spuņģis leg. (LEB); Tukums distr., Pūre 09.-23.IV.2001, 1

ex., V.Petrova leg. (DUBC), 25.VII.-08.VIII.2001, 2 exs., V.Petrova leg. (DUBC); Ventspils distr., Usma p., Moricsala, 01.-31.V.2003, 3 exs., U.Valainis leg. (DUBC), 15.-30.V.2003, 4 exs., U.Valainis leg. (DUBC), 01.-30.VI.2003, 5 exs., U.Valainis leg. (DUBC), 01.V.-31.X.2003, 1 ex., U.Valainis leg. (DUBC).

6. *Nudobius lentus* (Gravenhorst, 1806)

Seitlitz 1872-1875; Seitlitz 1887-1891; Rathlef 1905; Barševskis 1997b; Cibuļskis 1998; Barševskis 2001; Barševskis et al. 2002; Jansson 2002; Silfverberg 2004; Telnov 2004

Examined material: 42 exs. – Daugavpils distr., Daugavpils, in pine forest under bark of pine stumps and dead pine, 28.III.1999, 4 exs., R.Cibuļskis leg. (DUBC); Daugavpils distr., Naujene p., Stropi, 26.-27.V.2006, 5 exs., A.Bukejs leg. (DUBC), 06.V.2006, 5 exs., A.Bukejs leg. (DUBC), 09.VI.2006, 3 exs., A.Bukejs leg. (DUBC); Daugavpils distr., Kalupes p., in mixed forest near clearing under bark of fir stump, 10.VI.2000, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Vabole, in coniferous forest on pine stumps, 18.IV.1997, 2 exs., R.Cibuļskis leg. (RCC), in mixed forest under bark of fir stump, 18.V.1997, 1 ex., R.Cibuļskis leg. (DUBC), in mixed forest under bark of dead pine, 28.III.1998, 1 ex., R.Cibuļskis leg.); Daugavpils distr., Maļinova, in pine forest under bark of dead pine, 15.IV.2000, 1 ex., R.Cibuļskis leg. (DUBC), in coniferous forest under bark of dead pine, 10.V.2001, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Nīcgale, in clearing of mixed forest under bark of fir and birch stumps, 13.V.1995, 5 exs., R.Cibuļskis leg. (DUBC), in clearing of deciduous forest under bark of falling down asp trumk, 06.VIII.1998, 1 ex., R.Cibuļskis leg. (DUBC), in mixed forest under bark of fallen tree trunk, 04.V.2001, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Bebrene, 01.IV.1999, 1 ex., I.Grīne leg. (DUBC), 04.IV.1999, 3 exs., I.Grīne leg. (DUBC); Daugavpils distr., Dviete, 06.VIII.2000, 1 ex., I.Leiskina leg. (DUBC); Daugavpils distr., Skrudaliena p., Ilgas, Silene Nature Park, 06.III.1992, 1 ex., A.Barševskis leg. (DUBC), 06.V.1999, 1 ex., A.Barševskis leg. (DUBC), 01.-31.VII.2002, 1 ex., A.Barševskis leg. (DUBC); Daugavpils distr., Vecsalienas p., Orehovka, in valley of Lazdukalni river in deciduous forest under bark of decaying stump, 09.IV.1999, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., 2,5 km NE Saliena, in valley of Poguļanka river in fir forest under bark of falling down tree, 09.VII.1999, 1 ex., R.Cibuļskis leg. (DUBC); Madonas distr., Lejasciems, 02.V.2005, 1 ex., A.Barševskis leg. (DUBC).

7. *Xantholinus (s. str.) linearis* (Olivier, 1795)

Seitlitz 1872-1875; Ulanowski 1883; Seitlitz 1887-1891; Rathlef 1905; Brammanis 1930; Danks 1943; Stiprais 1979; Barševskis 1993; Spuņģis 2001; Barševskis et al. 2002; Silfverberg 1992; Telnov et al. 1997; Silfverberg 2004; Telnov 2004

Examined material: 29 exs. – Daugavpils distr., Daugavpils, pine forest, 28.III.1999, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Līksna, 11.III.1994, 7 exs., R.Cibuļskis leg. (RCC), 26.V.1995, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Līksna p., Augšpole, 56°00 65N 26°26 18E, in soil on field, 06.V.1995, 2 exs., R.Cibuļskis leg. (DUBC),near farmstead under firewood log, 22.VIII.1996, 1 ex., R.Cibuļskis leg. (DUBC), in mixed forest on stump of birch, 04.V.1997, 1 ex., R.Cibuļskis leg. (RCC), under stone near rye field, 12.IV.1998, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Vabole, 11.III.1994, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Kalupe, in fir forest under fir trunk, 04.VI.2001, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Kalkūne, in meadow under moss in moist soil, 02.IV.2000, 3 exs., R.Cibuļskis leg. (DUBC); Daugavpils distr., Svente, 10.VII.2003, 1 ex., N.Strode leg. (DUBC); Daugavpils distr., Skrudaliena p., Ilgas, Silene Nature Park, 02.IX.1995 1 ex., A.Barševskis leg. (DUBC), 09.-12.IX.1996, 1 ex., A.Barševskis leg. (DUBC), 04.VII.2005, 1 ex., A.Barševskis leg. (DUBC); Jēkabpils distr., Zasa, 14.VIII.2001, 1 ex., I.Leiskisna leg. (DUBC); Jēkabpils distr., Teiči bog, 25.V.-24.VI.2003, 1 ex., V.Spuņģis leg. (LEB); Tukuma distr., Pūre, 09.-23.IV.2001, 1 ex., V.Petrova

leg. (DUBC), 07.V.-04.VI.2001, 1 ex., V.Petrova leg. (DUBC), 25.VII.-08.VIII.2001, 1 ex., V.Petrova leg. (DUBC); Ventspils distr., Usma p., Moricsala, 01.-31.V.2003, 1 ex., U.Valainis leg. (DUBC).

8. Xantholinus (s. str.) longiventris Heer, 1839

Ulanowski 1883; Barševskis 1993; Bar□evskis 2001; Silfverberg 1996; Telnov et al. 1997, Silfverberg 2004; Telnov 2004

Examined material: 4 exs. – Daugavpils distr., Līksna p., Augšpole, 56°00'65N 26°26'18E, in open area flying near farmstead, 11.V.1997, 1 ex., R.Cibuļskis leg. (DUBC), 11.III.1994, 1 ex., R.Cibuļskis leg. (RCC), 18.IV1996, 1 ex., R.Cibuļskis leg. (RCC); Daugavpils distr., Vabole, in mixed forest, 11.IV.1998, 1 ex., R.Cibuļskis leg. (DUBC).

9. Xantholinus (s. str.) audrasi Coiffait, 1956

Examined material: 7 exs. – Daugavpils distr., Līksna, 11.III.1994, 1 ex., R.Cibuļskis leg. (RCC), 01.IV.1994, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Vabole, meadow, 22.II.1997, 1 ex., R.Cibuļskis leg. (DUBC), in meadow under stone, 28.II.1997, 1 ex., R.Cibuļskis leg. (RCC); Daugavpils distr., Kalkūne, in meadow under moss and dead grass on moist soil, 02.IV.2000, 2 exs., R.Cibuļskis leg. (DUBC, RCC); Jēkabpils distr., Rubeņi 04.IV.1999, 1 ex., I.Lieskina leg. (DUBC).

Note: New species for fauna of Latvia.

10. Xantholinus (s. str.) gallicus Coiffait, 1956

Silfverberg 2004

Examined material: 5 eks. Tukums distr., Ķemeri bog, National Park of Ķemeri, 01.-15.X.2000, 1 ex., V.Spuņģis leg. (RCC), 16.V.-13.VI.2003, 1 ex., V.Spuņģis leg. (LEB); Cēsis distr., Sudas bog, 18.V.-14.VI.2003, 1 ex., V.Spuņģis leg. (DUBC); Jēkabpils distr., Teiči bog, 25.V.-24.VI.2003, 2 exs., G.Akmentiņš leg. (LEB).

11. Xantholinus (Purrolinus) tricolor (Fabricius, 1787)

Ulanowski 1883; Seitlitz 1887-1891; Müthel 1889; Rathlef 1905; Danks 1939; Danks 1943; Danka, Stiprais 1971; Stiprais 1979; Barševskis 1993; Baršvskis et al. 2002; Jansson 2002; Silfverberg 1992; Telnov et al. 1997; Silfverberg 2004; Telnov 2004

Examined material: 27 exs. – Daugavpils distr., Daugavpils, in pine forest under moss, 17.IX.1998, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Naujene p., Stropi, clearing, 09.VII.2006, 1 ex., A.Bukejs leg. (DUBC); Daugavpils distr., Līksna, in coniferous forest on pine stump, 18.IV.1997, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Vabole, VIII.1993, 1 ex., R.Cibuļskis leg. (DUBC), in coniferous forest in decaying wood, 17.VIII.1994, 1 ex., R.Cibuļskis leg. (RCC), in coniferous forest in soil, 11.IX.1994, 1 ex., R.Cibuļskis leg. (DUBC), in coniferous forest under bark of pine, 15.IV.1995, 1 ex., R.Cibuļskis leg. (RCC), in coniferous forest under fallen tree, 19.X.1996, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Maļinova, coniferous forest, 10.V.2001, 1 ex., R.Cibuļskis leg. (RCC); Daugavpils distr., Dunava, 22.-23.VI.1998, 1 ex., A.Barševskis leg. (DUBC); Daugavpils distr., Svente, 21.VII.2003, 1 ex., N.Strode leg. (DUBC), 29.VII.2003, 1 ex., N.Strode leg. (DUBC), 07.VIII.2003, 2 exs., N.Strode leg. (DUBC), 26.VIII.2003, 1 ex., N.Strode leg. (DUBC), 11.IX.2003, 4 exs., N.Strode leg. (DUBC), 21.IX.2003, 1 ex., N.Strode leg. (DUBC); Daugavpils distr., Šedere p., 4 km SE Rauda, in pine forest under stone, 05.VI.2001, 1 ex., R.Cibuļskis leg. (DUBC), in deciduous forest under falling down tree, 06.VI.2001, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Medumi, in mixed forset near lake Medumi under fallen leafs of trees on soil, 30.V.2001, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Demene, in deciduous forest under fallen leafs of trees on soil, 01.VI.2000, 1 ex., R.Cibuļskis leg.

(DUBC); Ventspils distr., Usma p., Moricsala, 01.-30.VI.2003, 2 exs., U.Valainis leg. (DUBC), 01-31.VIII.2003, 1 ex., U.Valainis leg. (DUBC).

12. Xantholinus (Typhlolinus) laevigatus **Jacobson, 1847**

Silfverberg 2004; Telnov 2004

Examined material: 6 exs. – Daugavpils distr., Līksna p., 2 km W Kri¸i, in pine forest under bark of stump and under moss in soil, 24.VII.1999, 2 exs., R.Cibuļskis leg. (RCC); Daugavpils distr., Kalupe, in mixed forest bark of falling down tree, 10.VI.2000, 1 ex., R.Cibuļskis leg. (DUBC); Daugavpils distr., Saliena p., Faltopi, in valley of Poguļanka river in deciduous forest, 08.VI.2001, 1 ex., R.Cibuļskis leg. (DUBC); Ventspils distr., Usma p., Moricsala, 06.IX.2002, 1 ex., U.Valainis leg. (DUBC), 01.-30.IX.2003, 1 ex., U.Valainis leg. (DUBC).

13. Xantholinus (Helicophallus) distans **Mulsant & Rey, 1853**

Seitlitz 1887-1891; Rathlef 1905; Silfverberg 1992; Telnov et al. 1997; Silfverberg 2004; Telnov 2004

Examined material: 1 ex. Krāslava distr., Šķeltiņi, 16.IX.1995, 1 ex., A.Barševskis leg. (DUBC).

Acknowledgement

I would like to thank my colleagues from Institute of Systematic Biology of Daugavpils University for the cooperation during material collecting and Voldemārs Spuņgis for material from Entomological Society of Latvia.

This study has been supported by VPDI/ESF/PIAA/04/NP/3.2.3.1./0003/065 project.

References

Barševskis A. 1993. Austrumlatvijas vaboles. Daugavpils, Saule: 1 –221.

Barševskis A. 1997. Augšdaugavas vaboļu (Insecta: Coleoptera) faunistiskās īpatnības. Daba un muzejs - Rīga, Adverts, 7: 8 - 9 (+ tabula).

Barševskis A. 2001. New and rare species of beetles (Insecta: Coleoptera) in the Baltic states and Belarus. Baltic J. Coleopterol., 1 (1-2): 3 - 18.

Barševskis A., Savenkovs N., Evarts-Bunders P., Daniele I., Pētersons G., Pilāts V., Zviedre E., Pilāte D., Kalniņš M., Vilks K., Poppels A. 2002. Silenes dabas parka fauna, flora un veģetācija. Baltijas Koleopteroloģijas institūts, Daugavpils, 1 - 107.

Brammanis L. 1930. Zur Kenntnis der Koleopterfauna des Saatkampesschutzgrabens in der Oberforstrei Intschukalns (Hinzenberg). Folia Zool. hydrobiol. Riga. 2 (1): 128 – 135.

Cibuļskis R. 1998. Latvijas faunai jaunas īsspārņu (Coleoptera, Staphylinidae) sugas. Latv. Entomol., 36: 66 - 68.

Coiffait H. 1972. Coléoptčres Staphylinidae de la région Paléarctique occidentale. I. Generalites. Sous-familles: Xantholininae et Leptotyphlinae. Nouvelle Revue d'Entomologie. Supplément. 2 (2): i – ix + 1 – 651.

Danks L. 1939. Verzeichnis der inder Umgebung von Rūjiena (Lettland) 1936 gesammelten Staphyliniden. Korrespondenzblatt des Naturforscher-Vereins zu Riga. 63: 77 - 82.

Danks L. 1943. Verzeichnis der von mir hauptsächlich in der Umgebung von Kokenhusen (Lettland) gesammelten Staphyliniden. Folia Zoologica et hydrobiologica. Riga. 12, 1: 128 – 202.

Danka L., Stiprais M. 1972. Dažas ziņas par Pierīgas dārzu kolonijas "Dārziņi" kukaiņu

faunu. Zooloģijas muzeja raksti. LVU, Rīga. 8.

Freude H., Harde K.W., Lohse G. A. 1964. Die Käfer Mitteleuropas. Staphylinidae I. Goecke & Evers Verlag, Krefeld. 156 – 166.

Herman L.H. 2001. Catalog of the Staphylinidae (Insecta: Coleoptera). 1758 to the end of the second Millennium. VI. Staphylinine group (Part 3), Staphylininae: Staphylinini (Quediina, Staphylinina, Tanygnathinina, Xanthopygina, Incerta Sedis), Xantholinini, Staphylinidae incerta sedis. Bulletin of the American Museum of Natural History, 265: 3615 – 3835.

Jakobson G. 1905. Žuki Rosiji, Zapadnoij Evropi i sopredeļnih stran. 1. Sankt-Peterburg. 1 - 1024.

Jansson N. 2002. Oaks, lichens and beetles on Moricsala island in Latvia - an ecological approach. Repport 2002: 2. 43 p. + 17 Appendixes.

Lohse G.A., Lucht W.H. 1989. Die Käfer Mitteleuropas. Supplementband 1 mit Katalogteil. Goecke & Evers Verlag, Krefeld. 156 – 159.

Müthel K. 1889. Neue Käfer. Korrespondenzblatt des Naturforscher-Vereins zu Riga. 32: 6 - 8.

Rathlef H. 1905. Coleoptera Baltica. Käfer Verzeichnis der Ostseeprovinzen nach den Arbeiten von Ganglbauer und Reitter. Archiv fr die Naturkunde Liv-, Est- und Kurlands Serie 2. Biologische Naturkunde. Dorpat. 12. 3.: 1 – 199.

Seidlitz G. 1875. [1872-1875] Fauna Baltica. Die Käfer (Coleoptera) der Ostseeprovinzen Russlands. Arch. Naturk. Liv-, Est- und Kurlands. Ser. 2, 5: 4 + XLII + 142 + 560.

Seitlitz G. 1891. [1887-1891] Fauna Baltica. Die Käfer (Coleoptera) der deutschen Ostseeprovinzen Russlands. 2. Aufl. Königsberg: 12 + LVI + 192 + 818.

Silfverberg H. 1992. Enumeratio Coleopterorum Fennoscandiae, Danniae et Baltiae. Helsingin Hyönteisvaihtoyhdistys – Helsingfors Entomologiska Bytesförening: 1 – 94.

Silfverberg H. 1996. Adittions and corrections to Enumeratio Coleopterorum Fennoscandiae, Daniae et Baltiae. Sahlbergia, 3 (2): 33 – 62.

Silfverberg H. 2004. Enumeratio nova Coleopterorum Fennoscandiae, Daniae et Baltiae. Sahlbergia, 9: 1 – 111.

Smetana A. 1958. Fauna ÈSR. Sv.12. Drapèikoviti □ —□□!—□□ Staphylinidae I. Staphylininae. Èeskoslovenská Akademie Ved, Praha: 1 – 438.

Smetana A., 2004: Staphylininae, pp. 687–698. *In* I.Löbl & A.Smetana (ed.): Catalogue of Palaearctic Coleoptera, Vol. 2. Stenstrup: Apollo Books, 942 pp.

Spuņģis V. 2001. Changes in arthropod species composition and density in the burned area of Sudas bog in Latvia. Acta Biol. Univ. Daugavp., 1. (1): 11 - 15.

Stiprais M. 1979. Dažas faunistiskas ziņas par Latvijas īsspārņiem. Latv. Entomol. 22: 35 □ —□□!—□ □40.

Stiprais M., Varzinska R. 1985. Vaboles cūkkopības kompleksā Jumpravā. Latv. Entomol. 28: 18 - 31.

Szujecki A. 1976. Klucze do oznaczania owadów Polski. Czźš XIX. Chrz'szcze (Coleoptera). Zeszyt 24 d. Kusakowate (Staphylinidae: Wyd³uæaki - Xantholininae. Panstwowe Wydawnictowo Naukowe, Warszawa. 1 -45.

Telnov D. 2004. Check – List of Latvian Beetles (Insecta: Coleoptera). Compedium of Latvian Coleoptera. Vol. 1. Rīga, 112 pp.

Telnov D., Barsevskis A., Savich F., Kovalevsky F., Berdnikov S., Doronin M., Cibulskis R., Ratniece D. 1997. Check – List of Latvian Beetles (Insecta: Coleoptera). Mitt. Internat. Entomol. Ver. Frankfurt a. M., Suppl. V: 1 – 140.

Ulanowski A. 1883. Z fauni coleopterologicznej Inflant polskich. Krakov, Spravozd. Kom. Fizijogr. – T. XVIII: 1 – 60.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

MATERIALS ABOUT THE FAUNA OF BEETLES (INSECTA: COLEOPTERA) OF NAUJENE RURAL MUNICIPALITY (DAUGAVPILS DISTRICT, LATVIA). PART 1.

Andris Bukejs

Bukejs A. 2006. Materials about the fauna of beetles (Insecta: Coleoptera) of Naujene rural municipality (Daugavpils district, Latvia). Part 1. *Acta Biol. Univ. Daugavp., 6 (1-2): 65 - 76.*

During the research periods (2000-2006) in Naujene rural municipality Daugavpils district 165 beetles species were found that belon to 28 families, from which 5 species are protected in Latvia. Among recorded species 75 are new for fauna of Naujene rural municipality and eight species for eastern Latvia (Latgale). This publication is the first part of results of our research of a fauna of the beetles of Naujene rural municipality.

Key words: Coleoptera, fauna, Naujene rural municipality, Daugavpils district, Latvia.

Andris Bukejs. Institute of Systematic Biology, Daugavpils University, Vienibas Str. 13 – 229, Daugavpils, LV-5401, Latvia; carabidae@inbox.lv

Introduction

This article contains the information on a fauna of the beetles (Coleoptera) of Naujene rural municipality (Daugavpils district, Latvia). By the purpose of research was more complete to study a fauna of Coleoptera of the given area. There was no till this moment concrete and complete information in the Latvian literature about fauna of Coleoptera in Naujene rural municipality. There are publications, devoted to more extensive areas of Latvia (Barševskis 1988, 1988a, 1993), in which can find some information about a fauna of the beetles of Naujene rural municipality; and also articles devoted concrete taxa of Coleoptera (Barševskis 1989a, 1997, 1999; Bukejs 2005); and series of publications (Barševskis 1987, 1989, 1991, 1997a, 2001; Barševskis et al. 2004; Telnov 2001; Telnov et al. 2006) in which contain the information about localities of separate species of the beetles.

This publication is the first part of results of our research of a fauna of the beetles of Naujene rural municipality. There is the information about species of Coleoptera from 28 families (Leiodidae, Silphidae, Scaphidiidae, Lucanidae, Geotrupidae, Scarabaeidae, Buprestidae, Byrrhidae, Elateridae, Throscidae, Lycidae, Cantharidae, Dermestidae, Anobiidae, Cleridae, Dasytidae, Malachiidae, Silvanidae, Erotylidae, Endomychidae, Coccinellidae, Melandryidae, Meloidae, Oedemeridae, Pyrochroidae, Anthicidae, Tenebrionidae, Cerambycidae, Bruchidae, Attelabidae) is given.

MATERIALS AND METHODS

The material was collected since 2000 till 2006 in different places of Naujene rural municipality (Daugavpils district, Latvia) (fig.1). In the given

area various habitats were investigated: mixed forest, a skirt, valley and bank of Daugava river (Daugavas Loki Nature Park), bank of Lielais Stropu lake, dry meadows, agrocenozis, park, bog and forest clearing.

For the collecting of a stuff the various methods were used: entomological net, pitfall trap and visual obsevartion of habitats (under different objects, on soil, on plants etc.). While studying the fauna of Coleoptera of Naujene rural municipality >720 specimens were collected.

The systematics, which is applied in H. Silfverberg (2004), is used as the basis in this list of species.

The material is stored in the collection of Institute of Systematic Biology Daugavpils University (DUBC) and in the private collection of author.

RESULTS

According to the results of the investigation hold on the area of Naujene rural municipality 165 species of Coleoptera belonging to 28 families were ascertained, from which 5 species are protected in Latvia.

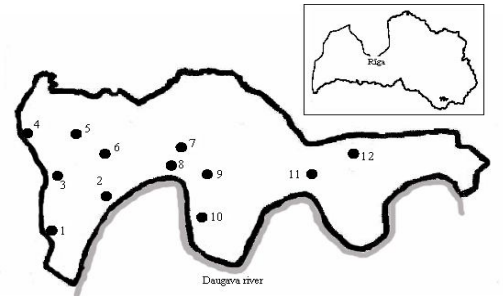


Fig. 1. Location of research area.
Naujene rural municipality: 1 – Vecstropi, 2 – Krauja, 3 – Stropi, 4 – 0,5 km E from Križi (Daugavpis City), 5 – Kašatniki, 6 – Lociki, 7 – Naujene, 8 – Juzefova park, 9 – Vecpils, 10 – Butiški, 11 – Vasargeliški, 12 – Bukšti.

In the species list after the species name the place where it was found and the collecting date are indicated, in the brackets are indicated the number of collected specimens, information about habitat and collector's name abbreviation: A.Ba. – Arvīds Barševskis, A.Bu. – Andris Bukejs, G.L. – Guntis Lociks, M.B. – Maksims Balalaikins, M.S. – M. Skutele.

LIST OF SPECIES.

Leiodidae Fleming, 1821

1. *Sciodrepoides fumatus* (Spence, 1815) – Stropi, 16-17.06.2006. (2, in a cellar, A.Bu.).

Silphidae Latreille, 1807

2. *Thanatophilus rugosus* (Linnaeus, 1758) - Lociki, 16.VII.2001. (1, G.L.).

3. *Thanatophilus sinuatus* (Fabricius, 1775) - Lociki, 16.VII.2001. (1, G.L.).

4. *Thanatophilus dispar* (Herbst, 1793) – Lociki, 16.VII.2001. (1, G.L.).

5. *Oiceoptoma thoracica* (Linnaeus, 1758) – Stropi, IX.2003. (3, in pitfall trap, A.Bu.).

6. *Phosphuga atrata* (Linnaeus, 1758) – Lociki, 13.X.2000. (2, G.L.); Stropi, IX.2003. (2, in pitfall trap, A.Bu.), 13.VII.2005. (1, M.S.); Naujene, 15.X.2004. (9, Juzefova park, A.Ba.).

7. *Nicrophorus investigator* Zetterstedt,1824 – Naujene, 21.VI.2002. (3, in Juzefova park, A.Ba.).

8. *Nicrophorus* fossor Erichson, 1837 (=*interruptus* Stephens,1830) – Naujene, 21.VI.2002. (1, in Juzefova park, A.Ba.).

9. *Nicrophorus vespilloides* Herbst, 1783 – Stropi, VII.2003. (3, in pitfall trap, A.Bu.), IX.2003. (3, in pitfall trap, A.Bu.).

10. *Nicrophorus vespillo* (Linnaeus, 1758) – Stropi, 05.VIII.2006. (1, on cow excrements, A.Bu.).

Lucanidae Latreille, 1806

11. *Sinodendron cylindricum* (Linnaeus, 1758) – Naujene, 21.V.2002. (6, in Juzefova park, A.Ba.), 25.V.2002. (3, Juzefova park, A.Ba.), 15.X.2004. (3, Juzefova park, A.Ba.).

12. *Platycerus caprea* (DeGeer, 1774) – Stropi, 27.V.2006. (1, A.Bu.), 16.VI.2006. (1, A.Bu.).

13. *Platycerus caraboides caraboides* (Linnaeus, 1758) – Naujene, 24.V.2002. (1, Juzefova park, A.Ba.), 15.X.2004. (6, Juzefova park, A.Ba.); Stropi, 16.VI.2006. (2, mixed forest, under dry rotten birch bole, A.Bu.; and four specimens were observed).

14. *Dorcus parallelopipedus* (Linnaeus, 1758) – Naujene, 25.V.2002. (2, Juzefova park, A.Ba.); Stropi, 12.VI.2005. (2, on old birch, A.Bu.), 11.VIII.2006. (1 dry specimen, forest near Lielais Stropu lake, in dry rotten birch bole, A.Bu.). Protected species in Latvia.

Geotrupidae Latreille, 1806

15. *Anoplotrupes stercorosus* (L.G.Scriba, 1791) – Stropi, VI-IX.2000-2004. (>40, mixed forest, in pitfall, A.Bu.), 29.VII.2006. (1, A.Bu.), 10.VIII.2006. (1, A.Bu.), 11.VIII.2006. (1, A.Bu.); Krauja, 28.VII.2006. (1, A.Bu.).

16. *Geotrupes spiniger* (Marsham, 1802) – Lociki, 06.VIII.2001. (1, G.L.), 18.IX.2001. (1, G.L.), 14.VIII.2006 (1, dry meadows, A.Ba.).

17. *Geotrupes stercorarius* (Linnaeus, 1758) – Stropi, IX.2003. (2, A.Bu.), 04.VIII.2006. (2, on cow excrements, A.Bu.), 10.VIII.2006. (2, A.Bu.).

18. *Trypocopris vernalis vernalis* (Linnaeus, 1758) – Butiški, 12.VIII.2006. (1 dry specimen, A.Bu. & M.B.).

Scarabaeidae Latreille, 1802

19. *Aphodius erraticus* (Linnaeus, 1758) – Lociki, 18.VII.2001. (1, G.L.), 14.VIII.2006. (3. A.Bu.).

20. *Aphodius subterraneus* (Linnaeus, 1758) – Lociki, 18.VII.2001. (2, G.L.), 27.VIII.2001. (2, G.L.).

21. *Aphodius fossor* (Linnaeus, 1758) – Lociki, 18.VII.2001. (1, G.L.), 27.VIII.2001. (1, G.L.); Stropi, 20.VII.2006. (7, in cow excrements, A.Bu.).

22. *Aphodius rufipes* (Linnaeus, 1758) – Stropi, 05.VIII.2006. (13, in cow excrements, A.Bu.); Lociki, 18.VII.2001. (2, G.L.).

23. *Aphodius depressus* (Kugelann, 1792) – Lociki, 06.V.2001. (2, G.L.).

24. *Aphodius distinctus* (O.F.Müller, 1776) – Stropi, 16.IV.2006. (1, in flight), 23.IX.2006. (1, in flight, A.Bu.).

25. *Aphodius prodromus* (Brahm, 1790) – Stropi, 07.V.2006. (6, on horse excrements, A.Bu.).

26. *Aphodius foetidus* (Herbst, 1783) – Lociki, 18.VII.2001. (2, G.L.); Stropi, 05.VIII.2006. (3, in cow excrements, A.Bu.).

27. *Aphodius fimetarius* (Linnaeus, 1758) – Lociki, 13.X.2000.(1, G.L.), 18.VII.2001. (5, G.L.), 27.VIII.2001. (4, G.L.); Stropi, 05.V.2006. (1, A.Bu.), 07.V.2006. (1, A.Bu.), 17.VII.2006. (3, A.Bu.), 29.VII.2006. (9, A.Bu.), 04.VIII.2006. (4, in cow excrements, A.Bu.), 05.VIII.2006. (3, in cow excrements, A.Bu.), 10.VIII.2006. (2, A.Bu.).

28. *Aphodius foetens* (Fabricius, 1787) – Stropi, 29.VII.2006. (1, A.Bu.), 04.VIII.2006. (2, in cow excrements, A.Bu.).

29. *Aphodius ater* (DeGeer, 1774) – Lociki, 18.VII.2001. (1, G.L.).

30. *Aphodius rufus* (Moll, 1782) (=*scybalarius* (Fabricius, 1781) – Lociki, 18.VII.2001. (1, G.L.).

31. *Aphodius plagiatus* (Linnaeus, 1767) – Naujene, 21.V.2002. (2, in Daugava river walley, A.Ba.).

32. *Aphodius granarius* (Linnaeus, 1767) – Stropi, 29.VII.2006. (1, A.Bu.).

33. *Oxylomus sylvestris* (Scopoli, 1763) – Lociki, 07.VIII.2006. (1, G.L.).

34. *Copris lunaris* (Linnaeus, 1758) – Stropi, 05.VIII.2006. (1, on fresh cow excrements, A.Bu.). Protected species in Latvia.

35. *Omaloplia ruricola* (Fabricius, 1775) – Križi, 0,5 km E, 12.VII.2006 (2, A.Ba.).

36. *Amphimallon solstitiale solstitiale* (Linnaeus, 1758) – Stropi, 08.VII.2006. (1, in flight, A.Bu.).

37. *Melolontha melolontha* (Linnaeus, 1758) – Vasargeliški, 26.VI.2001. (1, G.L.).

38. *Hoplia graminicola* (Fabricius, 1792) – Vasargeliški, 26.VI.2001. (1, G.L.).

39. *Oryctes nasicornis nasicornis* (Linnaeus, 1758) – Kašatniki, 09.VIII.2001. (3, G.L.). Protected species in Latvia.

40. *Anomala dubia* (Scopoli, 1763) – Vasargeliški, 26.VI.2001. (1, G.L.); Stropi, 27.VI.2006. (1, A.Bu.), 08.VII.2006. (1, A.Bu.).

41. *Phyllopertha horticola* (Linnaeus, 1758) – Stropi, 09.VI.2006. (2, agrocenozis, A.Bu.), 27.VI.2006. (1, A.Bu.).

42. *Cetonia aurata aurata* (Linnaeus, 1758) – Lociki, 20.V.2001. (1, G.L.), 21.VII.2001. (1, G.L.); Butiški, 12.VIII.2006. (1, A.Bu. & M.B.); Stropi, IX.2003. (1, A.Bu.), 16-17.VI.2006. (1, A.Bu.), 27.VI.2006. (>20, on flowers of Umbelliferae, A.Bu.), 09.VII.2006. (1, old forest clearing, A.Bu.).

43. *Potosia cuprea metallica* (Herbst, 1782) – Lociki, 22.VI.2001. (1, G.L.); Stropi, 16.VI.2006. (1, old forest clearing, A.Bu.), 09.VII.2006. (2, old forest clearing, A.Bu.).

44. *Trichius fasciatus* (Linnaeus, 1758) – Stropi, 28.VI.2006. (1, old forest clearing, A.Bu.); Krauja, 28.VII.2006. (1, A.Bu.); Lociki, 21.VII.2001. (1, G.L.), 06.VIII.2001. (1, G.L.).

Buprestidae Leach, 1815

45. *Chalcophora mariana mariana* (Linnaeus, 1758) – Vasargeliški, 26.VI.2001. (2, G.L.); Stropi, 28.VI.2006. (1, old forest clearing, on dry pine bole, A.Bu.). Protected species in Latvia.

46. *Poecilonota variolosa variolosa* (Paykull, 1799) – Naujene, 25.V.2002. (2, Juzefova park, A.Ba.).

47. *Anthaxia quadripunctata* (Linnaeus, 1758) – Stropi, 28.VI.2006. (1, old forest clearing, A.Bu.), 02.VII.2006. (1, A.Bu.), 09.VII.2006. (1, old forest clearing, A.Bu.); Lociki, 14.VIII.2006. (1, A.Ba.).

48. *Anthaxia godeti* Gory, Laporte de Castelnau, 1839 – Križi, 0,5 km E, 12.VII.2006 (1, A.Ba.).

49. *Trachys minutus* (Linnaeus, 1758) – Stropi, 26-27.V.2006. (2, A.Bu.), 03.VI.2006. (3, A.Bu.), 11.VIII.2006. (3, A.Bu.); Butiški, 12.VIII.2006. (2, valley of Daugava river, A.Bu. & M.B.), 21.VIII.2006. (1, near Daugava river, A.Bu. & M.B.); Lociki, 26.V.2001. (1, G.L.), 24.VIII.2001. (1, G.L.), 14.VIII.2006. (5, A.Ba.).

50. *Trachys troglodytes* Gyllenhal, 1817 – Lociki, 05.VIII.2001. (1, G.L.); Stropi, 11.VIII.2006. (1, A.Bu.).

Byrrhidae Latreille, 1804

51. *Morychus aeneus* (Fabricius, 1775) – Lociki, 29.V.2001. (1, G.L.).

52. *Cytilus sericeus* (Forster, 1771) – Stropi, 29-30.IV.2006. (2, agrocenozis, A.Bu.), 01.V.2006. (1, A.Bu.).

53. *Byrrus pilula pilula* (Linnaeus, 1758) – Lociki, 22.VI.2001. (1, G.L.).

Throscidae Laporte de Castelnau, 1840

54. *Trixagus dermestoides* (Linnaeus, 1767) – Vasargeliški, 02.VIII.2001. (1, G.L.); Lociki, 26.VI.2001. (1, G.L.).

Elateridae Leach, 1815

Distribution of click-beetles species of Latvia's fauna see in A.Barševskis (2005).

55. *Agrypnus murinus* (Linnaeus, 1758) – Stropi, 13.V.2006. (1, A.Bu.), 03.VI.2006. (2, A.Bu), 09.VI.2006. (1, agrocenozis, A.Bu.), 16.VI.2006. (2, A.Bu.), 27.VI.2006. (1, A.Bu.), 02.VII.2006. (1, A.Bu.).

56. *Athous subfuscus* (Müller, 1767) – Stropi, 09.VI.2006. (7, A.Bu.), 09.VII.2006. (1, forest clearing, A.Bu.).

57. *Cidnopus aeruginosus* (Olivier, 1790) – Stropi, 05.V.2006. (2, A.Bu.), 13.V.2006. (2, A.Bu.), 03.VI.2006. (3, A.Bu.), 09.VI.2006. (2, A.Bu.).

58. *Ctenicera pectinicornis* (Linnaeus, 1758) – Stropi, 03.VI.2006. (2, A.Bu.).

59. *Actenicerus sjaelandicus* (O.F.Müller, 1764) – Stropi, 03.V.2006. (3, A.Bu.).

60. *Prosternon tessellatum* (Linnaeus, 1758) – Butiški, 12.VIII.2006. (2, valley of Daugava river, A.Bu. & M.B.).

61. *Selatosomus cruciatus* (Linnaeus, 1758) – Stropi, 29.IV.2006. (1, mixed forest, in dry rotten birch bole, A.Bu.).

62. *Selatosomus aeneus* (Linnaeus, 1758) – Stropi, 29-30.IV.2006. (4, A.Bu.), 05.V.2006. (2, agrocenozis, A.Bu.), 06.V.2006. (1, A.Bu.), 13.V.2006. (9, A.Bu.), 26-27.V.2006. (3, A.Bu.), 09.VI.2006. (3, agrocenozis, A.Bu.), 17.VII.2006. (1, A.Bu.).

63. *Ampedus sanguinolentus* (Schrank, 1776) – Naujene, 25.V.2002. (1, Juzefova Park, A.Ba.).

64. *Agriotes obscurus* (Linnaeus, 1758) – Naujene, 25.V.2002. (1, Juzefova Park, A.Ba.); Stropi, 03.VI.2006. (1, A.Bu.), 09.VI.2006. (1, agrocenozis, A.Bu.).

65. *Ectinus aterrimus* (Linnaeus, 1761) – Stropi, 03.VI.2006. (5, A.Bu.), 09.VI.2006. (1, agrocenozis, A.Bu.).

66. *Dalopius marginatus* (Linnaeus, 1758) – Stropi, 14.V.2006. (1, bank of Lielais Stropu lake, A.Bu.), 26-27.V.2006. (1, A.Bu.), 03.VI.2006. (1, A.Bu.), 09.VI.2006. (3, agrocenozis, A.Bu.).

67. *Cardiophorus ruficollis* (Linnaeus, 1758) – Stropi, 29-30.IV.2006. (5, A.Bu.), 06.V.2006. (1, A.Bu.).

Lycidae Laporte de Castelnau, 1840

68. *Platycis minutus* (Fabricius, 1787) – Lociki, 08.VIII.2001. (1, G.L.)

69. *Lygistopterus sanguineus* (Linnaeus, 1758) – Naujene, 25.V.2002. (2, Juzepova park, A.Ba.).

Cantharidae Imhoff, 1856

70. *Cantharis fusca* Linnaeus, 1758 – Lociki, 26.V.2001. (2, G.L.).

71. *Cantharis rustica* Fallén, 1807 – Naujene, 25.V.2002. (1, Juzevofa park, A.Ba.); Stropi, 27.VI.2006. (1, A.Bu.).

72. *Cantharis nigricans* (O.F.Müller, 1776) – Lociki, 26.V.2001. (1, G.L.); Stropi, 03.VI.2006. (1, A.Bu.), 09.VI.2006. (2, A.Bu.).

73. *Cantharis pellucida* Fabricius, 1792 – Lociki, 26.V.2001. (1, G.L.); Naujene, 25.V.2002. (3, Juzefova park, A.Ba.); Stropi, 03.VI.2006. (1, A.Bu.), 09.VI.2006. (1, A.Bu.).

74. *Cantharis livida* Linnaeus, 1758 – Stropi, 26-27.V.2006. (1, A.Bu.), 09.VI.2006. (1, agrocenozis, A.Bu.), 16.VI.2006. (1, A.Bu.).

75. *Cantharis fulvicollis* Fabricius, 1792 – Stropi, 02.VII.2006. (1, A.Bu.), 09.VII.2006. (1, old forest clearing, A.Bu.).

76. *Rhagonicha fulva* (Scopoli, 1763) – Butiški, 12.VIII.2006. (>15, valley of Daugava river, A.Bu. & M.B.); Krauja, 28.VII.2006. (2, A.Bu.); Lociki, 21.VII.2001. (1, G.L.); Vecstropi, 14.VII.2005. (1, M.S.).

77. *Rhagonycha limbata* Thomson, 1864 – Lociki, 15.V.2001. (1, G.L.); Stropi, 09.VII.2006. (2, old forest clearing, A.Bu.).

Dermestidae Latreille, 1807

78. *Dermestes lardarius* Linnaeus, 1758 – Lociki, 10.VIII.2001. (3, G.L.); Stropi, 24.III.2006. (1, in room, A.Bu.).

79. *Attagenus smirnovi* Zhantiev, 1973 – Stropi, V.2004. (1, A.Bu.).

80. *Anthrenus scrophulariae scrophulariae* (Linnaeus, 1758) – Stropi, 13.V.2006. (33, on flowers of *Prumus sp*., A.Bu.).

81. *Anthrenus museorum* (Linnaeus, 1761) – Lociki, 22.VI.2001. (2, G.L.); Stropi, 17.VII.2006. (2, A.Bu.).

Anobiidae Kirby, 1837

82. *Ptinus fur* (Linnaeus, 1758) – Lociki, 07.VIII.2001. (1, G.L.).

83. *Ptinus raptor* Sturm, 1837 – Lociki, 07.VIII.2001. (1, G.L.).

84. *Cacotemnus rufipes* (Fabricius, 1792) – Stropi, 22.VII.2006. (1, A.Bu.).

85. *Hadrobregmus pertinax* (Linnaeus, 1758) – Lociki, 07.VIII.2001. (1, G.L.); Stropi, 13.V.2006. (3, A.Bu.).

86. *Priobium carpini* (Herbst, 1793) – Vecstropi, 14.VII.2005. (1, M.S.).

Cleridae Latreille, 1802

87. *Tillus elongatus* (Linnaeus, 1758) – Stropi, 09.VII.2006. (1, A.Bu.).

88. *Korynetes caeruleus* (DeGeer, 1775) – Lociki, 16.VII.2001. (1, G.L.), 02.VIII.2001. (1, G.L.).

Melyridae Leach, 1815

89. *Dasytes niger* (Linnaeus, 1761) – Stropi, 13.V.2006. (2, A.Bu.); Butiški, 12.VIII.2006. (1, valley of Daugava river, A.Bu. & M.B.).

Dasytes plumbeus (O.F.Müller, 1776) – Lociki, 21.VII.2001. (1, G.L.), 27.VIII.2001. (2, G.L.); Krauja, 28.VII.2006. (1, A.Bu.); Stropi, 09.VII.2006. (4, forest clearing, A.Bu.).

90. *Dasytes fusculus* (Illiger, 1801) – Stropi, 09.VI.2006. (1, A.Bu.), 28.VI.2006. (1, forest clearing, A.Bu.).

91. *Dolichosoma lineare* (Rossi, 1792) – Stropi, 08.VII.2006. (1, A.Bu.), 09.VII.2006. (1, old forest clearing, A.Bu.).

92. *Malachius bipustulatus* (Linnaeus, 1758) – Naujene, 25.V.2002. (3, Juzefova park, A.Ba.); Stropi, 13.V.2006. (1, A.Bu.).

93. *Anthocomus rufus* (Herbst, 1784) – Lociki, 14.VIII.2001. (1, G.L.); Stropi, 11.VIII.2006. (1, A.Bu.).

94. *Anthocomus equestris* (Fabricius, 1781) (= bipunctatus Harer) – Stropi, 09.VI.2006. (1, A.Bu.), 17.VII.2006. (1, A.Bu.).

Silvanidae Kirby, 1837

95. *Uleiota planata* (Linnaeus, 1761) – Krauja, 28.VI.2006. (1,mixed forest, under a bark of dead fir, A.Bu.); Bukšti, 03.VIII.2001. (2, G.L.).

Erotylidae Latreille, 1802

96. *Tritoma subbasalis* (Reitter, 1896) – 29-30.IV.2006. (4, on fresh birch stump, A.Bu.).

97. *Triplax rufipes* (Fabricius, 1775) – Stropi, 11.VIII.2006. (4, in fungi, A.Bu.).

Endomychidae Leach, 1815

98. *Endomychus coccineus* (Linnaeus, 1758) – Stropi, 14.V.2006. (3, swampy bank of Lielais Stropi lake, A.Bu.).

Coccinellidae Latreille, 1807

99. *Chilochorus renipustulatus* (L.G.Scriba, 1790) – Stropi, 29-30.IV.2006. (1, A.Bu.); Lociki, 26.VIII.2001. (1, G.L.).

100. *Exochomus quadripustulatus* (Linnaeus, 1758) – Stropi, 27.IV.2006. (1, in flight, A.Bu.).

101. *Coccinula quatuordecimpustulata* (Linnaeus, 1758) – Butiški, 12.VIII.2006. (4, valley of Daugava river, A.Bu. & M.B.); Stropi, 05.V.2006. (1, A.Bu.), 08.VII.2006. (1, A.Bu.), 04.VIII.2006. (1, A.Bu.), 10.VIII.2006. (1, A.Bu.); Lociki, 27.VIII.2001. (1, G.L.).

102. *Anisosticta novemdecimpunctata* (Linnaeus, 1758) – Butiški, 12.VIII.2006. (2, valley of Daugva river, A.Bu. & M.B.); Stropi, 08.VII.2006. (1, A.Bu.), 11.VIII.2006. (3, A.Bu.).

103. *Propylea quatuordecimpunctata* (Linnaeus, 1758) – Bukšti, 03.VIII.2001. (1, G.L.), Lociki, 06.VIII.2001. (1, G.L.); Stropi, 06.V.2006. (1, A.Bu.), 09.VI.2006. (1, A.Bu.), 09.VII.2006. (2, old forest clearing, A.Bu.), 17.VII.2006. (1, A.Bu.), 10.VIII.2006. (1, A.Bu.), 11.VIII.2006. (1, A.Bu.); Krauja, 28.VII.2006. (1, A.Bu.); Butiški, 12.VIII.2006. (3, valley of Daugav river, A.Bu. & M.B.).

104. *Calvia decemguttata* (Linnaeus, 1767) – Stropi, 13.VII.2005. (1, M.S.).

105. *Calvia quatuordecimguttata* (Linnaeus, 1758) – Lociki, 14.VIII.2001. (1, G.L.); Stropi, 09.VII.2006. (1, old forest clearing, A.Bu.).

106. *Anatis ocellata* (Linnaeus, 1758) – Stropi, 09.VII.2006. (1, old forest clearing, A.Bu.).

107. *Tytthapsis sedecimpunctata* (Linnaeus, 1761) – Lociki, 02.VIII.2001. (1, G.L.), 27.VIII.2001. (1, G.L.); Stropi, 23.IX.2006. (1, A.Bu.).

108. *Halyzia sedecimguttata* (Linnaeus, 1758) – Lociki, 02.VIII.2001. (1, G.L.); Stropi, 29-30.IV.2006. (1, A.Bu.).

109. *Psyllobora vigintiduopunctata* (Linnaeus, 1758) – Lociki, 21.VII.2001. (1, G.L.); Stropi, 13.VII.2005. (1, M.S.), 05.V.2006. (1, A.Bu.), 27.VI.2006. (1, A.Bu.), 17.VII.2006. (2, A.Bu.); Butiški, 21.VIII.2006. (1, valley of Daugava river, A.Bu. & M.B.).

110. *Aphidecta obliterata* (Linnaeus, 1758) – Lociki, 13.X.2000. (3, G.L.).

111. *Hippodamia notata* (Laicharting, 1781) – Butiški, 12.VIII.2006. (2, valley of Daugava river, A.Bu. & M.B.), 21.VIII.2006. (1, valley of Daugava river, A.Bu. & M.B.); Krauja, 28.VII.2006. (2, A.Bu.); Stropi, 29.VII.2006. (3, A.Bu.), 11.VIII.2006. (1, A.Bu.); Lociki, 21.VII.2001. (1, G.L.), 24.VII.2001. (1, G.L.).

112. *Hippodamia tredecimpunctata* (Linnaeus, 1758) – Lociki, 21.VII.2001. (1, G.L.); Stropi, 09.VI.2006. (1, A.Bu.), 10.VIII.2006. (1, A.Bu.); Butiški, 12.VIII.2006. (1, valley of Daugava river, A.Bu. & M.B.).

113. *Hippodamia variegata* (Goeze, 1777) – Butiški, 12.VIII.2006. (2, valley of Daugava river, A.Bu. & M.B.).

114. *Coccinella septempunctata* Linnaeus, 1758 – Butiški, 12.VIII.2006. (1, valley of Daugava river, A.Bu. & M.B.), 21.VIII.2006. (1, valley of Daugava river, A.Bu. & M.B.); Lociki, 06.VIII.2001. (1, G.L.); Stropi, 26-27.V.2006. (2, A.Bu.), 29.VII.2006. (1, A.Bu.).

115. *Coccinella magnifica* Redtenbacher, 1843 (= *distincta* Faldermann, 1837) – Stropi, 09.VI.2006. (1, A.Bu.); Butiški, 21.VIII.2006. (1, valley of Daugava river, A.Bu. & M.B.).

116. *Coccinella quinquepunctata* Linnaeus, 1758 – Lociki, 08.VIII.2001. (1, G.L.); Butiški, 12.VIII.2006. (2, valley of Daugava river, A.Bu. & M.B.), 21.VIII.2006. (2, valley of Daugava river, A.Bu. & M.B.).

117. *Adalia bipunctata* (Linnaeus, 1758) – Lociki, 13.X.2000. (3, G.L.); Butiški, 12.VIII.2006. (1, valley of Daugava river, A.Bu. & M.B.).

118. *Subcoccinella vigintiquatuorpunctata* (Linnaeus, 1758) – Lociki, 20.VIII.2001. (5, G.L.); Stropi, 27.VI.2006. (1, A.Bu.); Butiški, 12.VIII.2006. (5, valley of Daugava river, A.Bu. & M.B.), 21.VIII.2006. (2, near Daugava river, A.Bu. & M.B.).

Melandryidae Leach, 1815

119. *Melandrya dubia* (Schaller, 1783) – Naujene, 24.V.2002. (1, Juzefova park, A.Ba.), 25.V.2002. (2, Juzefova park, A.Ba.). It is a single locality in eastern Latvia (in valley of river Daugava).

Tenebrionidae Latreille, 1802

120. *Lagria hirta* (Linnaeus, 1758) – Krauja, 28.VII.2006. (1, A.Bu.).

121. *Opatrum riparium* Scriba, 1865 – Bukšti, 21.X.2000. (1, G.L.).

122. *Melanimon tibiale* (Fabricius, 1781) – Stropi, 29-30.IV.2006. (1, A.Bu.).

123. *Uloma culinaris* (Linnaeus, 1758) – Kašatniki, 09.VIII.2006. (2, G.L.); Stropi, VII.2003. (1, A.Bu.).

124. *Uloma rufa* (Piller, Mitterpacher, 1783) – Stropi, IX.2003. (1, A.Bu.).

125. *Tribolium castaneum* (Herbst, 1797) – Stropi, 09.VI.2006. (1, A.Bu.). Synantropic species.

126. *Tenebrio molitor* (Linnaeus, 1758) – Lociki, 16.VII.2001. (1, G.L.). Synantropic species.

127. *Mycetochara flavipes* (Fabricius, 1792) – Naujene, 25.V.2002. (3, Juzefova park, A.Ba.).

128. *Bolitophagus reticulatus* (Linnaeus, 1767) – Stropi, 29-30.IV.2006. (4, A.Bu.), 29.VII.2006. (2, A.Bu.); Butiški, 12.VIII.2006. (4, A.Bu. & M.B.), 21.VIII.2006. (1, A.Bu. & M.B.); Krauja, 28.VII.2006. (4, A.Bu.); Vasargeliški, 26.VI.2001. (1, G.L.).

129. *Crypticus quisquilius* (Linnaeus, 1761) – Stropi, VII.2002. (3, A.Bu.), VIII.2002. (8, A.Bu.), 27.VI.2006. (1, A.Bu.); Vasargeliški, 26.VI.2006. (1, G.L.).

130. *Diaperis boleti* (Linnaeus, 1758) – Stropi, 14.V.2006. (4, bank of Lielais Stropu lake, in fungi, A.Bu.), 16.VI.2006. (2, old forest clearing, A.Bu.).

Oedemeridae Latreille, 1810

131. *Chrysanthia viridissima* (Linnaeus, 1758) – Stropi, 08.VII.2006. (1, A.Bu.).

132. *Chrysanthia geniculata* (W.Schmidt, 1846) (= *nigricornis* Westhoff, 1881) – Krauja, 28.VII.2006. (1, A.Bu.); Stropi, 17.VII.2006. (1, A.Bu.), 08.VII.2006. (8, A.Bu.), 09.VII.2006. (2, old fores clearing, A.Bu.), 29.VII.2006. (2, A.Bu.), 11.VIII.2006. (1, A.Bu.).

133. *Oedemera lurida* (Marsham, 1802) – Krauja, 28.VII.2006. (1, A.Bu.); Stropi, 27.V.2006. (1, A.Bu.), 08.VII.2006. (1, A.Bu.).

134. *Oedemera virescens* (Linnaeus, 1767) – Stropi, 26-27.V.2006. (1, A.Bu.), 09.VII.2006. (1, old forest clearing, A.Bu.).

Meloidae Gyllenhal, 1810

135. *Meloe violaceus* Marsham, 1802 – Stropi, 02.V.2006. (1, mixed forest, in dry rotten birch bole, A.Bu.). Protected species in Latvia.

Pyrochroidae Latreille, 1807

136. *Pyrochroa coccinea* (Linnaeus, 1761) – Stropi, 09.VII.2006. (1, old forest clearing, A.Bu.).

137. *Schizotus pectinicornis* (Linnaeus, 1758) – Lociki, 26.V.2001. (1, G.L.).

Anthicidae Latreille, 1819

138. *Notoxus monoceros monoceros* (Linnaeus, 1760) – Butiški, 12.VIII.2006. (5, near Daugava river, A.Bu. & M.B.); Stropi, VIII.2000. (2, sandy agrocenozis, A.Bu.), 20.IX.2005. (1, A.Bu.), 26-27.V.2006. (1, A.Bu.), 08.VII.2006. (1, A.Bu.), 13.VIII.2006. (1, A.Bu.).

139. *Omonadus floralis* (Linnaeus, 1758) – Lociki, 07.VIII.2001. (1, G.L.), 20.VIII.2001. (1, G.L.); Stropi, 02.VII.2006. (1, A.Bu.).

Cerambycidae Latreille, 1802

140. *Spondylis buprestoides* (Linnaeus, 1758) – Stropi, VII.2002. (1, A.Bu.), 09.VI.2006. (fragments of a body, mixed forest, A.Bu.), 29.VII.2006. (2, A.Bu.); Vecstropi, 14.VII.2005. (2, M.S.).

141. *Tetropium castaneum* (Linnaeus, 1758) – Stropi, 09.VII.2006. (9, old forest clearing, under a bark of dead arbor, A.Bu.).

142. *Rhagium mordax* (DeGeer, 1775) – Stropi, 13.V.2006. (1, A.Bu.), 14.V.2006. (2, bank of Lielais Stropu lake, A.Bu.), 03.VI.2006. (2, A.Bu.),

143. *Oxymirus cursor* (Linnaeus, 1758) – Stropi, 09.VI.2006. (fragments of a body, mixed fors, A.Bu.).

144. *Pachyta quadrimaculata* (Linnaeus, 1758) – Krauja, (1, on a flower of Umbelliferae, A.Bu.).

145. *Dinoptera collaris* (Linnaeus, 1758) – Stropi, 28.VI.2006. (1, old forest clearing, on a flower of *Rubus idaeus*, A.Bu.), 09.VII.2006. (1, old forest clearing, A.Bu.), 04.VIII.2006. (1, A.Bu.).

146. *Pseudovadonia livida* (Fabricius, 1776) – Stropi, 27.VI.2006. (1, A.Bu.), 02.VII.2006. (1, A.Bu.), 17.VII.2006. (1, A.Bu.).

147. *Paracorymbia maculicornis maculicornis* (DeGeer, 1775) – Stropi, 10.VI.2006. (2, on a flower, A.Bu.), 08.VII.2006. (1, A.Bu.), 09.VII.2006. (2, old forest clearing, A.Bu.).

148. *Stictoleptura rubra rubra* (Linnaeus, 1758) – Krauja, 28.VII.2006. (2, A.Bu.); Stropi, 29.VII.2006. (1, A.Bu.); Butiški, 12.VIII.2006. (1, valley of Daugava river, A.Bu. & M.B.).

149. *Anastrangalia reyi* (Heyden, 1889) – Stropi, 28.VI.2006. (2, old forest clearing, A.Bu.), 09.VII.2006. (1, old forest clearing, A.Bu.).

150. *Leptura quadrifasciata quadrifasciata* Linnaeus, 1758 – Butiški, 12.VIII.2006. (1, valley of Daugava river, A.Bu. & M.B.); Naujene, 25.V.2002. (1, Juzefova park, A.Ba.); Stropi, 27.VI.2006. (1, on a flower of Umbelliferae, A.Bu.), 28.VI.2006. (1, old fores clearing, A.Bu.), 09.VII.2006. (1, old forest clearing, A.Bu.), 29.VII.2006. (6, A.Bu.).

151. *Stenurella melanura* (Linnaeus, 1758) – Stropi, 08.VIII.2006. (3, A.Bu.), 09.VII.2006. (4, old forest clearing, A.Bu.).

152. *Stenurella bifasciata bifasciata* (O.F.Müller, 1776) – Butiški, 12.VIII.2006. (1, valley of Daugava river, A.Bu. & M.B.).

153. *Obrium cantharinum cantharinum* (Linnaeus, 1767) – Stropi, 02.VII.2006. (1, A.Bu.).

154. *Callidium violaceum* (Linnaeus, 1758) – Stropi, 13.VII.2005. (1, M.S.), 27.V.2006. (1, A.Bu.), 10.VI.2006. (1, A.Bu.).

155. *Xylotrechus rusticus* (Linnaeus, 1758) – Naujene, 25.V.2002. (2, Juzefova park, A.Ba.).

156. *Lamia textor* (Linnaeus, 1758) – Stropi, 13.VII.2005. (1, M.S.).

157. *Pogonocherus decoratus* Fairmaire, 1855 – Stropi, 26.VII.2006. (1, a forest near Lielais Stropu lake, A.Bu.).

158. *Tetrops praeustus* (Linnaeus, 1758) – Stropi, 16-17.VI.2006. (1, A.Bu.).

Bruchidae Latreille, 1802

159. *Bruchus loti* Paykull, 1800 – Naujene, 25.V.2002. (1, Juzefova park, A.Ba.).

160. *Bruchus atomarius* (Linnaeus, 1761) – Stropi, 29.VII.2006. (1, A.Bu.).

Attelabidae Billberg, 1820

161. *Neocoenorrhinus aequatus* (Linnaeus, 1767) – Stropi, 10.VI.2006. (4, on flowers of *Aronia melanocarpa*, A.Bu.), 17.VII.2006. (1, A.Bu.).

162. *Byctiscus betulae* (Linnaeus, 1758) – Lociki, 26.V.2001. (1, G.L.); Stropi, 09.VI.2006. (1, A.Bu.).

163. *Byctiscus populi* (Linnaeus, 1758) – Stropi, 09.VI.2006. (1, A.Bu.).

164. *Deporaus betulae* (Linnaeus, 1758) – Lociki, 19.V.2001. (1, G.L.), 26.V.2001. (1, G.L.); Naujene, 25.V.2002. (1, Juzefova park, A.Ba.).

165. *Apoderus coryli* (Linnaeus, 1758) – Vecpils, 21.VIII.2006. (1, A.Bu.); Stropi, 09.VI.2006. (1, A.Bu.); Butiški, 03.VIII.2001. (1,G.L.).

Among recorded species 75 are new for fauna of Naujene rural municipality: Leiodidae (1), Silphidae (3), Geotrupidae (2), Scarabaeidae (7), Buprestidae (5), Byrrhidae (1), Elateridae (5), Throscidae (1), Lycidae (2), Dermestidae (3), Anobidae (4), Cleridae (2), Melyridae (3), Silvanidae (1), Erotydae (1), Coccinellidae (5), Oedemeridae (2), Pyrochroidae (1), Anthicidae (1), Tenebrionidae (9), Cerambycidae (11), Bruchidae (1) and Attelabidae (4).

Recorded several species which are included in the list of indicators of natural forest habitats: *Dorcus parallelipipedus* (Linnaeus, 1758), *Platycerus caprea* (DeGeer, 1774), *Platycerus caraboides caraboides* (Linnaeus, 1758), *Chalcophora mariana mariana* (Linnaeus, 1758), *Poecilonota variolosa variolosa* (Paykull, 1799), *Melandrya dubia* (Schaller, 1783).

The records published in the article will complete the information about Coleoptera species distribution in Latvia.

ACKNOWLEDGMENTS

The author is grateful to Prof. Arvīds Barševskis for help in determination of species, to my friend Maksims Balalaikins and to studentds Guntis Lociks and M. Skutele for the cooperation during material collection.

This study has been supported by VPD1/ESS/PIAA/04/NP/3.2.3.1/0003/0065 project.

REFERENCES

Barševskis A. 1987. Some date on the fauna of ground beetles from the south-east part of Latvia. Latv. Entomol., 30: 8 – 14. (in Latvian, English summary).

Barševskis A. (Баршевскис А.) 1988. Фаунистические исследования жуков юго-восточной части Латвии в различных биотопах. Экологическое воспитание в средней и высшей школе. Даугавпилс: 63 - 75. (in Russian).

Barševskis A. 1988a. Materials about the beetle fauna in the old valley of the river Daugava between the town Krāslava and Daugavpils. Latv. Entomol., 31: 35 – 38. (in Latvian, English summary).

Barševskis A. 1989. On new and little-known species of beetles in the fauna of Latvia. Latv. Entomol., 32: 52 – 53. (in Russian, English summary).

Barševskis A. 1989a. Materials about ladybirds (Coccinellidae) in the valley of the river Daugava between the towns Krāslava and Daugavpils. Latv. Entomol., 32: 48 – 51. (in Latvian, English summary).

Barševskis A. 1991. Some new beetles species in fauna of Latvia. Latv. Entomol., 34: 28 – 32. (in Latvian, English summary).

Barševskis A.1993. The beetles of Eastern Latvia. Daugavpils, Saule: 1 – 221. (in Latvian, English summary).

Barševskis A. 1997. Austrumlatvijas skrejvaboļu (Coleoptera: Carabidae) fauna un aizsardzība. Daugavpils, DPU DIVIC: 1 – 113. (in Latvian).

Barševskis A. 1997a. Materials about Latvian beetles (Coleoptera). Acta col. latv., 1 (2): 63 – 71. (in Latvian).

Barševskis A. 1999. Latgales vaboļu (Insecta: Coleoptera) fauna. Adefāgo vaboļu apakškārta (Adephaga). Acta Latgalica, 10. Daugavpils, DPU, Saule: 325 – 365. (in Latvian).

Barševskis A. 2001. New and rare species of beetles (Insecta: Coleoptera) in the Baltic countries and Byelourus. Baltic J. Coleopterol., 1 (1-2): 3 – 18.

Barševskis A. 2005. Catalogue of click-beetles (Coleoptera: Elateridae) of Latvia. *Proceedings on Taxonomy and Faunistics of Beetles (Coleoptera) dedicated to the 100th birthdayof the Latvian entomologist Mihails Stiprais (1905 – 1990)*: 7 - 28.

Barševskis A., Valainis U., Bičevskis M., Savienkovs N., Cibuļskis R., Kalniņš M., Strode N. 2004. Faunistic records of the beetles (Hexapoda: Coleoptera) in Latvia. 1. *Acta Biol. Univ. Daugavp*., 4 (2): 93 – 106.

Bukejs A. 2005. Fauna of ground-beetles (Coleoptera: Carabidae) in the sandy agrocenozis of Stropi (Daugavpils district, Latvia). *Acta Biol. Univ. Daugavp*., 5 (1): 23 - 26.

Telnov D. 2001. To the knowledge of Latvian Coleoptera, 1. Latv.Entomol, 38: 61 – 69.

Telnov D., Fägerström Ch., Gailis J., Kalniņš M., Piterāns U., Vilks K. 2006. Contributions to the Knowledge of Latvian Coleoptera. 5. Latv. Entomol., 43: 78-125.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

PECULIARITIES OF VASCULAR PLANT FLORA OF THE BEREZOVYE ISLANDS ARCHIPELAGO (GULF OF FINLAND, RUSSIA)

Elena A. Glazkova

Glazkova E.A. 2006. Peculiarities of vascular plantflora of the Berezovye Islands Archipelago (Gulf of Finland, Russia). *Acta Biol. Univ. Daugauvp., 6 (1-2): 77 - 82.*

On the basis of the author's detailed investigations in 2004-2005 and critical summarizing of all available data on vascular plants of the Berezovye Islands archipelago, an overview of the flora of this one of the largest regional complex sanctuaries in the Leningrad Region is represented. In total, 610 vascular plant species were recorded on the archipelago. The main peculiarities of the islands' flora (relatively high species richness and diversity, presence of species on boundaries of their basic distribution areas, considerable proportion of maritime species) are discussed. The paper contains also a brief history of floristic research on the islands as well as the information about rare and protected plant species on the archipelago.

Key words: vascular plants, flora, islands, Gulf of Finland, Berezovye Islands archipelago

Elena A. Glazkova, Ko*marov Botanical Institute, Russian Academy of Sciences, Prof. Popov str. 2, 197376 Saint-Petersburg, Russia; e-mail: eglazkova@hotmail.com; eglazkova@pochta.ru*

The archipelago of Berezovye Islands (83919 hectares), one of the largest regional complex sanctuaries in the Leningrad Region, is situated in the north-eastern part of the Gulf of Finland, in 2-4 km to the west of the town of Primorsk. It comprises 3 big islands: Bolshoy Berjozovy, Zapadny Berezovy and Severny Berezovy with total area 81.8 sq. km, and about 30 small islands.

Initially, the archipelago was included in the Vyborgsky sanctuary, established in 1976. The status of an individual protected area was granted to the archipelago of Berezovye Islands in 1996 to preserve the habitats of rare plant and animal species, large colonies of nesting birds and the stop-over sites of waterfowl during their spring and autumn migrations, to protect the breeding sites of the Baltic ringed seal and grey seal as well as spawning grounds and fattening places of marketable fishes.

As an interesting and well-defined study object, the flora of the islands has permanently attracted the interest of botanists. Before 1939 floristic investigations on the Berezovye Islands were carried out by Finnish botanists (mainly by E. Nylander in 1851 and V. Erkamo in 1934), but the old data on the flora (literature and herbarium specimens) are very scanty. The revision of plant specimens, kept at the Botanical Museum of Helsinki University (H), revealed only 42 specimens, collected on the archipelago. Since 1939 the islands have remained a closed military zone for more than 50 years and were not accessible

for botanists. In 1989 N.N. Tzvelev (Komarov Botanical Institute) visited the biggest islands of archipelago and published the information of the most interesting findings on these islands as well as the vegetation description (Цвелев, 1991, 1992). In 2004-2005 the detailed floristic research on the archipelago was carried out by the author of this paper (Глазкова, 2005). For the first time the flora of all islands of the archipelago, including the smallest ones, was studied, many localities of rare and threatened in North-West Russia plant species were recorded and mapped with GPS employment. Besides a traditional route method of investigation, a cartographical method (plant recording with the use of 1x1 km squares) has been applied to get more precise data on the distribution and frequency of each species on the islands.

As the result of the author's own investigations and critical summarizing of all available data on the archipelago's flora, collected from literature sources, archives and herbarium specimens, 610 vascular plant species (including established aliens) from 302 genera and 95 families were registered on the Berezovye Islands archipelago.

Taking into consideration comparatively small area of the archipelago (84 sq. km), the number of species on the islands is rather high. The main factors, causing a considerable plant species richness of the island flora, are as follows: significant diversity of habitat types, climatic conditions, high degree of safety of the islands' ecosystems and at the same time a long history of settlements and land use on the largest islands.

Of particular interest in botanical respect is the flora of coastal meadows and seashores, which are habitats of many rare and protected in the Leningrad region plant species: *Carex mackenziei* V.Krecz., *C. scandinavica* E.W.Davies, *C. glareosa* Wahl., *Blysmus rufus* (Huds.) Link, *Centaurium pulchellum* (Sw.) Druce, *C. littorale* (D.Turner) Gilmour, *Myrica gale* L., *Scutellaria hastifolia* L., *Tripolium vulgare* Nees, *Tripleurospermum maritimum* (L.) Koch, *Atriplex praecox* Hulph., *A. calotheca* (Rafn) Fries, *Allium schoenoprasum* L., etc. A group of aquatic halophilous plants is well represented in the flora of the islands. *Batrachium marinum* Fries, *Potamogeton pusillus* L., *Stuckenia marina* (L.) Tzvel., *S. filiformis* (Pers.) Borner, *Zannichellia repens* Boenn. are widespread on the archipelago. In numerous small shallow lagoons and coastal lakes, where salinity increases considerably due to high insulation and water evaporation, such rare halophytes as *Najas marina* L. and *Ruppia brachypus* J. Gay occur. Another aquatic plant species, which deserves special mention, is *Alisma wahlenbergii* (Holmb.) Juz., a Baltic Sea endemic plant. Its populations on the islands of the archipelago are the biggest ones in the Baltic Region. The sandy and sand-stony littoral is developed on many islands. Besides common plant communities with *Leymus arenarius* (L.) Hochst., *Honckenya peploides* (L.) Ehrh., *Isatis tinctoria* L., *Cakile baltica* Jord. ex Pobed., *Calamagrostis meinshausenii* (Tzvel.) Viljasoo, *Senecio viscosus* L., *Lathyrus maritimus* Bigel., etc., on sandy ridges and dunes a very interesting community with *Carex arenaria* L., *Festuca arenaria* Osbeck, *F. sabulosa* (Anderss.) Lindb. f. and *Empetrum subholarcticum* V. Vasil. occurs. Other very peculiar plant communities on the islands are coastal black alder forests with *Molinia caerulea* (L.) Moench , *Chamaepericlymenum suecicum* (L.) Aschers. et Graebn., *Succisa pratensis* Moench, *Calluna vulgaris* (L.) Hull, *Juncus balticus* Willd., *Myrica gale* L., widespread along the stony seashores.

It is interesting, that many above-mentioned species, being very rare plants in the Leningrad Region, are very common and abundant on the Berezovye Islands and typical components of plant communities. At the same time, some common for the mainland plant species are absent or rare on the islands. For instance, typical freshwater species (aquatic and coastal-aquatic) play insignificant role in the archipelago's flora.

Species of bogs (mainly raised and transitory mires), boggy meadows and swampy black alder thickets are represented very well on the islands.

Of a great interest are pine-peat moss mires on Bolshoy and Zapadny Berezovye Islands, where some rare in the Leningrad Region species occur: *Lycopodiella inundata* (L.) Holub, *Rhynchospora fusca* (L.) Ait., *Drosera intermedia* Hayne, *Kreczetowiczia caespitosa* (L.) Tzvel.

Among the numerous small islands of the archipelago an uninhabited island Maly Berezovy (with area about 0.44 sq. km) turned out to be the most original and interesting in connection of its flora and vegetation. In contradiction to other islands, where mainly coniferous and small-leaved forests predominate, this island is covered by a typical broad-leaved forest with *Tilia cordata* L., *Acer platanoides* L., *Quercus robur* L. and *Fraxinus excelsior* L. Besides many common boreal species, the herbaceous-dwarf shrub layer includes of some nemoral and boreonemoral species: *Poa nemoralis* L., *Polygonatum multiflorum* (L.) All., *Paris quadrifolia* L., *Ficaria verna* Huds., *Milium effusum* L., *Stellaria holostea* L., *S. nemorum* L., *Anemonoides nemorosa* (L.) Holub, *Scrophularia nodosa* L., *Dryopteris filix-mas* (L.) Schott, *D. expansa* (C. Presl) Fras.-Jenk. et Jermy, *Melandrium dioicum* (L.) Coss. et Germ., *Ribes alpinum* L., *Melica picta* C. Koch., *Mercurialis perennis* L., *Corydalis solida* (L.) Clairv. The latter three species are absent on the other islands of the archipelago. *Melica picta* C. Koch., a very rare in North-West Russia thermophilous species, is very abundant in the zone between the forest margin and seashore meadows on the Island of Maly Berezovy.

Many small islands of the archipelago are nesting and resting places for many birds. The populations of colonial seabirds (mainly gulls and terns) exert a considerable influence on the vegetation cover of the islands, through such factors as manuring with nitrates, the transport of seeds, soil and plant disturbance, trampling. The flora of these islets, where the impact of seabirds' activity is very significant can be characterized as poor-in-species (usually less than 100 species) and very specific, ornithocoprophilous with the luxuriant growth of many nitrophilous species (*Elytrigia repens* (L.) Nevski, *Persicaria lapathifolia* (L.) S.F.Gray, *Atriplex littoralis* L., *A. prostrata* Bouch. ex DC., *Galeopsis bifida* Boenn., etc.) and some weeds (*Stellaria media* (L.) Vill., *Senecio vulgaris* L., *Lepidotheca suaveolens* (Pursh) Nutt., *Polygonum aviculare* L. s.str., *Chenopodium album* L., *Capsella bursa-pastoris* (L.) Medic., *Spergularia rubra* (L.) J. et C.Presl).

One of chorological peculiarities of the archipelago's flora is presence of species on the boundaries of their basic distribution areas, including some Fennoscandian and Baltic Sea endemic plant species. The number of "boundary" species on the islands is 19. The species on their northern (*Centaurium pulchellum* (Sw.) Druce, *Festuca sabulosa* (Anderss.) Lindb. f., *Rumex hydrolapathum* Huds., *Scutellaria hastifolia* L., *Selinum carvifolia* (L.) L., *Sieglingia decumbens* (L.) Bernh., *Carex hartmanii* Cajand.) and eastern (*Atriplex calotheca* (Rafn) Fries, *A. littoralis* L., *Carex pilulifera* L., *Drosera intermedia* Hayne, *Centaurium littorale* (D.Turner) Gilmour, *Isatis tinctoria* L., *Rhynchospora fusca* (L.) Ait.) boundaries prevail in the flora, a smaller number being on the southern (*Carex glareosa* Wahl., *Chamaepericlymenum suecicum* (L.) Aschers. et Graebn., *Arabidopsis suecica* (Fries) Norrl.) and north-eastern (*Carex arenaria* L.) limits of their basic distribution areas.

In spite of relatively high number of vascular plants on the archipelago of Berezovye Islands, less originality and richness of the archipelago's flora compared with the flora of the outer islands of the eastern Gulf of Finland (Gogland, Bolshoy Tuters, Maly Tuters etc.) should be underlined. In contradiction to the outer islands with a number of species, which do not occur in the other territories of North-West Russia (Глазкова, 2001), on the Berezovye Islands such "differential" species are absent, and in general the flora of the archipelago is rather typical for the flora of Karelian Isthmus. The cause of that is not only the difference in geomorphology and climate of these island groups, but also different history of their flora. According to a paleogeographical re-

construction by Estonian scientists (Veski, Heinsalu, Vassiljev, 1995), the development of the flora of Gogland could begin already in the late Alleruđ (10800 y BP) and Bolsoy Tuters in Boreal period of Holocene (9500 y BP) (Глазкова, 2001), when the islands emerged from under the water surface. As for Berezovye Islands, the largest islands of the archipelago emerged from the sea only in the Subboreal climatic period of Holocene. A great number of small islands of the archipelago have emerged from the sea during the Limnea Stage in Subatlantic period and this process is in progress also nowadays.

Due to specific nature features of the territory and high degree of safety of the ecosystems of the archipelago, its flora contains 91 species, listed as threatened in Red Data Books of Eastern Fennoscandia (Kotiranta et al., 1998), the Baltic Region (1993) and the Red Data Book of the Leningrad Region (2000). Of the 27 vascular plant species, protected in the Leningrad region, 3 (*Melica picta* C. Koch*., Centaurium pulchellum* (Sw.) Druce*, Alisma wahlenbergii* (Holmb.) Juz.) belong to the I protection category (endangered species), 7 (*Centaurium littorale* (D.Turner) Gilmour, *Tillaea aquatica* L.*, Scutellaria hastifolia* L.*, Drosera intermedia* Hayne*, Tripleurospermum maritimum* (L.) Koch*, Ajuga pyramidalis* L.*, Centunculus minimus* L.) to the II category (vulnerable species) and 17 (*Myrica gale* L.*, Lycopodiella inundata* (L.) Holub*, Tripolium vulgare* Nees*, Blysmus rufus* (Huds.) Link*, Carex glareosa* Wahl., *C. hartmanii* Cajand.*, C. arenaria* L.*, Carex mackenziei* V.Krecz.*, Cardamine parviflora* L.*, Isatis tinctoria* L.*, Rhynchospora fusca* (L.) Ait.*, Kreczetowiczia caespitosa* (L.) Tzvel., *Chamaepericlymenum suecicum* (L.) Aschers. et Graebn., *Allium schoenoprasum* L.*, Najas marina* L., *Ruppia brachypus* J. Gay, *Isoėtes echinospora* Durieu) to the III protection category (rare species).

The study has been supported by Russian Foundation for Basic Research (projects ¹ 05-0449658 and 05-04-63009), Russian Science Support Foundation and St. Petersburg Scientific Center of Russian Academy of Sciences.

References

Глазкова Е.А. 2001. Флора островов восточной части Финского залива: состав и анализ (Vascular flora of the islands of the eastern Gulf of Finland: structure and analysis). Под ред. Р.В.Камелина. СПб, Изд-во С.-Петерб. ун-та, 348 с. (In Russian; abstract in English).

Глазкова Е. А. 2005. Флора островов Финского залива (в пределах России): итоги и перспективы изучения (Flora of the islands of the Gulf of Finland (within Russia): results and prospects of studies). Изучение флоры Восточной Европы: достижения и перспективы. Тезисы докладов Международной конференции, 23-28 мая 2005 , г. Санкт-Петербург, 2005. С. 21. (In Russian).

Красная книга природы Ленинградской области (Red Data Book of Nature of the Leningrad Region). 2000. Том 2. Растения и грибы. Отв.ред. Н.Н.Цвелев. СПб., 672 с. (In Russian and English).

Цвелев Н.Н. 1991. О некоторых редких и критических видах Березовых островов (Ленинградская область) (On some rare and critical species of the Berezovye Islands). Новости сист. высш. раст. Т. 28. С. 158□ ™□0+K□166. (In Russian).

Цвелев Н.Н. 1992. Заказник «Выборгский» (Sanctuary “Vyborgsky”). Очерки растительности особо охраняемых природных территорий Ленинградской области. Под ред. М.С. Боч, В.И. Василевича. С. 22–31. (In Russian).

Red Data Book of Baltic Region. 1993. Part I. List of threatened vascular plants and vertebrates. Uppsala; Riga. 195 p.

Kotiranta H., Uotila P., Sulkava S., Peltonen S.-L. (eds.). 1998. Red Data Book of East Fennoscandia. Helsinki. 351 p.

Veski S., Heinsalu A., Vassiljev J. 1995. Paleogeographical and vegetational history of the island of Suursaari (Hogland), Gulf of Finland: Preliminary results. Eesti Looduseuurijate Seltsi

Aastaraamat. K. 76. Lk. 194–207.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

THE ECOLOGICAL AND PHYTOSOCIOLOGICAL CHARACTERISTIC OF COMMUNITIES WITH *ACHILLEA MILLEFOLIUM* IN LITHUANIA

Odeta Gudaitytė

Gudaitytė O. 2006. The ecological and phytosociological characteristic of communities with Achillea Millefolium in Lithuania. *Acta Biol. Univ. Daugavp., 6 (1-2): 83 - 90.*

Phytosociological dependence was examined in the communities with *Achillea millefolium*. At 152 habitats of *A. millefolium* vegetation records were made. This species was found in 15 syntaxonomic classes representing different growing habitats. The resources of milfoils prevailed in dry grasslands of *Cynosurion cristati* communities and ruderal habitats of *Dauco-Meliliotion*.

Keywords: communities, *Achillea millefolium*, phytosociological dependence, habitat.

Odeta Gudaitytė, Institute of Botany, Laboratory of Economic botany, Žaliųjų ežerų 49, LT - 08406 Vilnius; Lithuania; e-mail odeta.g@botanika.lt

Introduction

Achillea millefolium L. s.l. (Asteraceae), commonly known as yarrow or milfoil, is a group of closely related species and subspecies widely distributed throughout the temperate and boreal zones of the Northern Hemisphere in Eurasia (Kucik & Zuzuk 2002, Chandler et. al. 1982). It is abundantly found in central and northern Europe, sparsely in southern Europe, and has been widely introduced in North America (Mulligan & Bassett 1959). Yarrows were discovered in meadows, edges of forests, abandoned fields, slopes, roadsides, outskirts and wastes. For the first time in Lithuania the phytosociological dependence of *Achillea millefolium* was investigated. The main aim of this investigation was to examine the habitats and communities with *Achillea millefolium*.

Material and methods

Field investigations were performed in summer, 2001–2003. Phytosociological investigations were carried out in 42 districts of Lithuania. Description localities of communities were chosen randomly. The vegetation records were made at 152 habitats of *A. millefolium* (Fig. 1.). Abundance and coverage of each species were evaluated according to the Braun-Blanquet scale. The relevé (phytosociological record) were assigned to phytosociological dependence according to the Lithuanian vegetation class system (Balevičienė et al. 1998, Motiekaitytė 2002). Size of a representative plot in herb phytocoenoses was 16 m^2, in shrub communities 100 m^2.

pH was measured potentiometrically, the amounts of mobile phosphorus (P_2O_5) and humus in the soils of the habitats were defined photoelotrocolimetrically, mobile potassium

(K_2O) – by flame photometry at Chemical Analysis Sector of the Institute of Botany. Samples of soil were evaluated using scale of Lithuanian soils (*Adomaitis et al. 1998*). The hierarchical cluster analysis was employed to determine the relationships among communities' soils from different habitats. As a unit for measuring the distance between the means of the characteristics, Euclidean distance was used. Before applying clusters analysis, all variables were standardized.

Results and discussion

The vegetation covering localities of *A. millefolium* was assigned to 15 syntaxonomic classes (Table 1) and 14 communities had not yet formed.

Dominant habitats of milfoils (*A. millefolium*) were founded abandoned fields, roadsides and meadows. Slope meadows were oriented toward the southwest, south or southeast, sometimes – northwest and west. Edges of a wood, embankments, wood-cutting areas, banks of ditches and rivers composed of minority habitats.

The described abandoned fields belong to *Artemisietea vulgaris* (33 %) and *Molinio-Arrhenatheretea elatioris* (30 %), roadsides – to *Molinio-Arrhenatheretea elatioris* (47 %) and *Artemisietea vulgaris* (16 %), meadows – to *Molinio-Arrhenatheretea elatioris* (56 %) and *Trifolio-Geranietea sanguinei* (15 %) communities.

The communities with *A. millefolium* in the edges of forests were attributed to six, whereas on the river banks – to four communities' classes. *A. millefolium* was registered in the embankments (*Festuco-Brometea, Nardetea strictae)*, in the forest sites (*Trifolio-Geranietea sanguineii* and *Nardetea strictae*) as well in the cutting areas (*Trifolio-Geranietea sanguinei* and *Epilobietea angustifolii)*.

The number of species varied from 5 to 36 per relevé. Herb layer was covering 30–100 % of the habitat area. Most communities are damaged by economical activity. Lowlands and slopes are pastureland and hayfields. Most former agricultural lands are not cultivated, sand and gravel quarries closed. It is unformed, succession communities.

The species constancy and coverage were low in the abandoned fields and roadsides (herb layer coverage reaches ranges from 60 to 80 %, mosses – from 0 to 20 %). The diversity of species in *Agropyretea repentis* and *Chenopodietea* communities was rather low (12–14). *Elytrigia repens, Chenopodium rubrum* acquire the highest constancy and abundance here. Milfoil grows in bigger groups in *Agropyretea repentis* communities, meanwhile in *Chenopodietea* communities – separatly.

Amount of potassium varied from 0.13 mg/kg to 0.19 mg/kg on the average in *Agropyretea repentis* communities (in Molėtai, Klaipėda and Kupiðkis districts). Soil ranged from low acid (pH 5.09) to neutral and alkaline (pH 7.46) and were sufficiently humuous. Klaipėda district, Dituva soil had a big amount of phosphorus (636.80 mg/kg) in the community. In Kupiðkis district soil reaction was neutral (pH 7.16), amount of phosphorus and potassium average (174.60 mg/kg and 140.70 mg/kg, respectively), high humidity (5.67 %) in *Sisymbrietalia* J. Tx. Matuszkiewicz 1962 em. Görs 1966 (*Radušienė & Gudaitytė 2005*).

Termoxerophylic hemicryptophyte *Artemisietea vulgaris* communities were situated in Akmenė, Anykščiai, Druskininkai, Kaunas, Kėdainiai, Mažeikiai, Pakruojas, Panevėžys, Pasvalys, Plungė, Prienai, Raseiniai, Rokiškis, Skuodas, Šakiai, Šilalė, Tauragė, Varėna, Vilnius districts, occuring in thirsty, different mechanic composition soil. The species number per relevé were very diverse due to habitats diversity. In many localities covering of herb 40–100 % of the area were found. *Artemisia campestris, A. vulgaris, Daucus carota* were recorded constantly. Frequently, occurred species with wide ecological amplitude (*Dactylis glomerata, Elytrigia repens, Tripleurospermum perforatum*). Growing types

Table 1. Communities with *Achillea millefolium*

Class	Soil type	Number of investigated communities
Molinio-Arrhenatheretea elatioris R. Tx. 1937	L, SL, G, S	68
Artemisietea vulgaris Lohm., Prsg. et Tx. in Tüxen 1950 em. Kopeck? 1979	All	24
Trifolio-Geranietea sanguinei Th. Müller 1961	L, SL, C, S	12
Koelerio-Corynephoretea Klinka et Novak 1941	S, SL	9
Nardetea strictae Rivas Goday et Borja Carbonell 1961	S, G, SL	7
Galio-Urticetea dioicae Passarge ex Kopeck? 1969	S, G, SL, L	5
Vaccinio-Piceetea abieitis Br.-Bl. et al. 1939	SL, G	5
Epilobietea angustifolii Tx. et Prsg. in Tx. 1950	S, G, SL	4
Festuco-Brometea erecti Br.-Bl. et R. Tx.1943	L, C, G, S	4
Plantaginetea majoris Tx. et Prsg. in Tx. 1950	SL, G	4
Agropyretea repentis Oberd., Th. Müller et Görs in Oberd. et al. 1967	S, SL	3
Stellarietea mediae R. Tx., Lohm. et Prsg. 1950	S, SL	3
Salicetea purpurea Moor 1958	S, G, L	2
Querco-Fagetea sylvaticae Br.-Bl. et Vlyger in Vlyger 1937	L	1
Chenopodietea Br.-Bl. in Br.-Bl. et Negre 1952 em. Lohm. et J. Tx., R. Tx. ex Matuszkiewicz 1962	L	1

L – loam, SL – sandy loam, S – sand, C – clay and G – gravel

of milfoil were 1-3 type. *Artemisietea vulgaris* soils content varied from low to high phosphorus (4.31–1181.00 mg/kg), potassium (46.50–648.00 mg/kg), humus (0.87–5.67 %). Soil reaction ranged from acid (pH 4.22) to neutral and alkaline (pH 7.98). Number of species per relevé varied significantly– from 11 to 27 in natural meadows *Arrhenatheretalia elatioris* Pawłowski 1928 communities (Kėdainiai, Marijampolė, Panevėžys, Plungė, Radviliškis, Raseiniai, Rokiškis, Šakiai, Šalčininikai, Švenčionys, Telšiai, Ukmergė, Varėna, Vilkaviškis, Vilnius, Zarasai districts). Meanwhile, number of species per relevé, in damp to wet and humid soils with poor aeration (*Balevičienė et al. 1998*) *Molinietalia caeruleae* W. Koch 1926 communities (Rokiðkis, Švenčionys, Ukmergė, Varėna districts), varied from 14 to 22. *Dactylis glomerata, Agrostis capillaris, Centaurea jacea, Deschampsia cespitosa, Phleum pratense, Plantago lanceolata, Trifolium pratenie, Vicia cracca* nearly consistently grow in habitats of *Molinio-Arrhenatheretea elatioris* communities. Growing type of milfoil was 2 or 4 in natural and semi-natural communities. There were inventoried 30 *Cynosurion cristati* R. Tx. 1947 communities with yarrow. Herb layer was thick (coverage 70–100 %). Little grasses, legume (*Lotus corniculatus, Vicia cracca*) and other herbs dominated in this anthropogenized pastures and natural meadows. The soil composition differed in different orders. The amounts of soil macro elements (nitrogenous, phosphorus, potassium) varied a lot: potassium – from 17.29 to 392.70 mg/kg, phosphorus – from 1.70 to 514.90 mg/kg, humus – from 1.52 to 9.00 %, soil reaction from pH 4.39 to pH 8.00 in *Arrhenatherion elatioris* and *Cynosurion cristati*. There were measured similar amounts of potassium in soil (72.60–236.80 mg/kg) and soil reaction (5.01–7.90)) in *Calthion palustris* R. Tx. 1937 em. Leburn et al. 1949, *Alopecurion pratensis* Passage 1964 and *Molinion caeruleae* W. Koch 1926, though humus (2.16–11.12 %) and phosphorus (41.80–596.70 mg/kg) higher than in *Arrhenatheretalia elatioris* communities.

In the psychrophilic meadow *Nardetea strictae*, Bandžų, Kretinga, Pakruojas, Skuodas, Šilalė, Šilutė, Švenčionys communities were inventoried of 17–29 vascular plant species. The cover

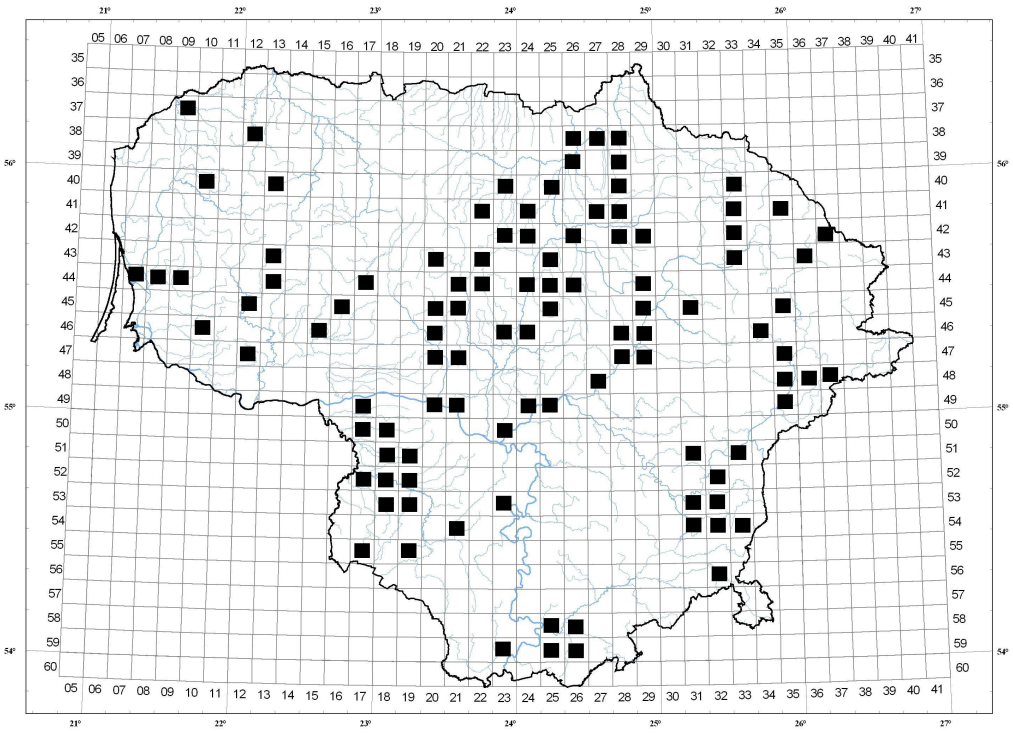


Fig. 1. Locates of *Achillea millefolium* coenopopulations examined in 2001–2003.

of herbs was sparse (sometimes only 50 %). Most constant were species characteristic to the this class: *Thymus pulegioides, Hypericum maculatumi* or to fertile meadows: *Agrostis capillaris, Dactylis glomerata, Deschampsia cespitosa, Plantago lanceolata*. Only single plants of milfoil were found in those communities. Despite the fact that *Violion caninae* Schwickerath 1944 communities settle in normally-irrigated, acidic soils (*Balevičienė et al. 1998*) in this case soil reaction on sites ranged from acid (pH 3.84) to neutral (pH 7.02), amounts of potassium, phosphorus and humus wide ranged (27.10–955.30 mg/kg; 5.00–957.00 mg/kg; 3.41–6.23 %).

Trifolio-Geranietea sanguinei communities were recorded in Akmenė, Anykščiai, Bandžų, Kelmė, Kretinga, Molėtai, Panevėžys, Utena, Zarasai districts, on the edges of wood and slope meadows. Number of species varied from 5 to 30 per relevé. *Trifolium medium, Senecio jacobea, Knautia arvensis, Silene pratensis* were registred constantly. Frequently *A. millefolium* grew by nests or patches in those communities. There were growing a lot of species of *Molinio-Arrhenatheretea* In this xerotermic habitat, but the constancy of them was low. Shrubs and trees (*Alnus incana, Malus sylvestris, Crataegus monogyna, Juniperus communis* and etc.) were found singularly. In spite of the fact that diversity of species in these communities was big, the constancy of them was low, generally about 1–10 %. It evidence to ecotonic character of habitat. The soil of slope meadows had a big amount of phosphor (till 423.50 mg/kg), potassium (till 925.60 mg/kg) and humus (till 13.42 %) and was neutral (to pH 7.54).

Xerothermic steppe meadows *Festuco-Brometea erecti* communities occured in Ukmergės,

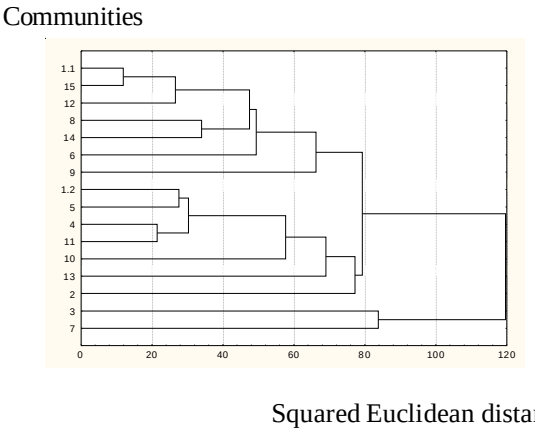


Fig. 2. The cluster analysis dendrogram of *Achillea millefolium* communities separated according composition of soil. 1.1. – *Arrhenatheretalia elatioris*, 1.2. – *Molinietalia caeruleae*, 2 – *Trifolio-Geranietea sanguinei*, 3 – *Galio-Urticetea dioicae*, 4 – *Artemisietea vulgaris*, 5 – *Koelerio-Corynephoretea*, 6 – *Festuco-Brometea erecti*, 7 – *Nardetea strictae*, 8 – *Vaccinio-Piceetea abieitis*, 9 – *Salicetea purpurea*, 10 – *Plantaginetea majoris*, 11 – *Stellarietea mediae*, 12 – *Chenopodietea*, 13 – *Agropyretea repentis*, 14 – *Querco-Fagetea sylvaticae*, 15 – *Epilobietea angustifolii*.

Varėnos, Vilniaus, Zarasų districts. There were registred 1830 vascular plants species. Among them dominated legume plants *Medicago falcata, M. lupulina, Melilotus albus, Trifolium montanum, T. repens.* In these communities consistently and in abundance grew characteristic species of fertile meadows, abandoned fields. The growings of milfoil was of 1-2 type. Habitats soil reaction was neutral (pH 6.85–7.98). Amount of humus (1.29–3.12 %), phosphorus (24.70–106.40 mg/kg) and potassium (27,60–119,00 mg/kg) varied.

There were recorded 21–33 species in antropogenic annual and perrenial species *Plantaginetea majoris* communities, in Švenčionys, Varėna and Vilnius districts. The coverage of herbs – 70–90 %, dominated by resistant to tread underfoot *Polyganum avicularis, Poa annua,* a lot of shotts forming *Trifolium repens*. *Artemisia campestris, Equisetum arvense, Plantago major, Taraxacum officinale* constantcy were recorded, milfoil grew singly or in tussocks. Soil varies from acid (pH 4.10) to neutral (pH 7.52), from low (99.10 mg/kg) to very high phosphorus (451.70 mg/kg), low-potassium (88.90–101.90 mg/kg), from average (2.61 %) to high humusity (4.91 %).

There were inventoried 14–29 species in the continental sand *Koelerio-Corynephoretea* communities. In communities of Jonava, Švenčionys, Utena, Varėna and Vilnius districts diagnostic spiecies of class (*Trifolium arvense, Knautia arvensis, Rumex acetosella*) were accompanied by *Agrostis capillaris, Dactylis glomerata, Plantago lanceolata* and single *A. millefolium*. A lot of speicies of bryochytes (till 80 %) and lichens (*Cladonia* spp.) (till 30 %), there were found in habitats a big and large amount of phosphor (230.80–356.40 mg/kg). Soil reaction shifted from nearly neutral (pH 6.14) to neutral and alkaline

(pH 8.01), amount of potassium and humus from low to high (74.50–264.00 mg/kg and 1.20–4.84 %, respectively).

Only 1–3 descriptions were made in the communities with milfoil of other classes. Plants grew singularly or by small groups. Nitrophylo–ecotonic wild and anthropogenic communities *Galio-Urticetea* were described in Varėna, Panevėžys, Vilkaviškis and Pasvalys districts, on abandoned fields and roaosides, there were registred 11-20 species of vascular plants – composition of soil varied from low-acid (pH 5.84) to neutral (pH 7.25), from low (68.40 mg/kg) to high amount of phosphorus (403.90 mg/kg), from low (1.26 mg/kg) to high humusity (5.48 mg/kg). There was a high amount of potassium – 879.40 mg/kg. Rarely yarrow were found in segetal *Stellarietea mediae, Chenopodietea*, deciduous woodland *Querco-Fagetea sylvatica* as well in wood-cutting areas *Epilobietea angustifolii* communities.

Segetal *Stellarietea mediae* communities composed of 16–30 plants species in Panevėžio, Ukmergės and Vilniaus districts. Soil composition varied from acid (pH 4,19) to neutral and alkaline (pH 7.46), from big (200.40 mg/kg) to larger amount of phosphorus 388.00 mg/kg, from low (1.84 %) to average humus (3.03 %), from low (85.00 mg/kg) to high amount of potassium (340.50 mg/kg).

Wood-cutting areas *Epilobietea angustifolii* communities in Šiauliai, Panevėžys and Šilutės districts, recorded 24–29 species, in deciduous woodland *Querco-Fagetea sylvaticae* (Pakruojas district), same as in steppe communities – 18–30 species. There was small diversity of species, somewhat consistently growing *Urtica dioica,* grasses. Trees and shrubs covered 60–80 %, herbs – 70–80 % of area. In soil of deciduous woodland was average phosphorus (121.50 mg/kg) and low potassium (54.50 mg/kg), in wood-cutting areas – more phosphorus (185.98±38.59 mg/kg) and average alkaline (115.98±41.45 mg/kg). This soil had more humus (3.22–7.75 %) and was nearly neutral reaction (pH 6.27–6.96).

On ditches and rivers banks located *Salicetea purpurea* communities (their were descibed in Radviliškis and Prienai districts) whereas together with characteristic species of this class (*Salix* spp.) constantly were *Elytrigia repens, Persicaria maculosa, Rumex acetosella.* The species number per relevé was 16–32. Communities were formed by dense (cover 80 %) herbs and shrubs (60–70 %) layer. Soil was neutral and alkaline (pH 7.63), with very small amount of phosphorus (13.00 mg/kg) and potassium (93.50 mg/kg), average humus (2.77 %).

12–22 species were registred in the coniferous wood *Vaccinio-Piceetea abieitis* communities, in Druskininkų, Pavenėžio and Telšių districts. There constantly grew: *Calamagrostis epigeios, Lotus corniculatus, Rubus idaeus.* Communities were rich in bryophytes species: *Barbula unguiculata, Bryum argenteum, B. caespiticium, Pleurozium schreberi, Thuidium abietinum.* Mosses covarage varied (10–70 %) due to ecological conditions of a habitat. Soil reaction variesd from average acid (pH 4.82) to neutral (pH 7.31), amount of macro elements varied: phosphorus from low (54.50 mg/kg) to high (220,50 mg/kg), potassium and humus from low to average (53.80–114.50 mg/kg, 1.36–5.42 %, respectively).

Hierarchical cluster analysis was employed to determine relationship among communities with *A. millefolium* according to composition of soil (Fig. 2.). Communities of fertile meadows were separated to orders, because of different composition of soil. All communities of fifteen classes formed two big groups. The first contained thirteen, second one – communities from two syntaxonomic classes. The exceptions of soil from *Galio-Urticetea dioicae* and *Nardetea strictae* communities was determined by big amounts of potassium (370.37–435.20 mg/kg). *Chenopodietea, Epilobietea angustifolii, Festuco-Brometea erecti, Querco-Fagetea sylvaticae, Salicetea purpurea, Vaccinio-Piceetea abieitis* and *Arrhenatheretalia elatioris* communities formed first subgroup, *Agropyretea repentis, Artemisietea vulgaris, Koelerio-Corynephoretea, Plantaginetea majoris, Stellarietea mediae, Trifolio-Geranietea*

sanguinei and *Molinietalia caeruleae* – the second one. There was very low phosphorus in the soil of first subgroup communities, while much in the second. The highest amount of phosphorus (374.67 ±136.07 mg/kg) was found in *Agropyretea repentis* communities, of abandoned fields. The lowest amount of phosphorus was discovered in the soil of *Salicetea purpurea* communities – 13.00 mg/kg, humus (2.02 %) – in the steppe meadows. All analysed soils were poor in nitrogen (0.09–0.26%). The soil pH ranged from slightly acid to alkaline (5.77–7.63).

A. millefolium habitats had a wide range of soil types and concentrations of soil nutrients. Analysed soils were poor in nitrogen and contained various amounts of phosphorus and potassium. Mean quantities of humus varied from 2.0 to 7.8%. Numerous populations of *A. millefolium* were found in dry grasslands of *Cynosurion cristatii* order and ruderal communities of *Dauco-Melilotion* alliance.

References

Adomaitis T. R., Antanaitis A., Eitminavičius L., Lubytė J., Matusevičius K., Mažvila J., Vaiðvila Z. J. 1998. Lietuvos dirvožemių agrochminės savybės ir jų kaita. Kaunas (in Lithuanian).

Balevičienė J., Kizienė B., Lazdauskaitė Ž., Patalauskaitė D., Rašomavičius V., Sinkevičienė Z., Tučienė A., Venckus Z. 1998. Lietuvos augalija. Pievos. **1**: 3–270. – Kaunas-Vilnius (in Lithuanian).

Chandler R., Hooper S., Harvey M. 1982. Ethnobotany and Phytochemistry of Yarrow Achillea millefolium, Compositae. – Economic botany, **36 (2)**: 203–223.

Kucik R. V., Zuzuk B. M. 2002. Yarrow – Achillea millefolium L. – Provizor **15**: 34–38 (in Russian).

Mulligan G. A., Bassett I. J. 1959. Achillea millefolium compex in Canada and portions of the United States. – Canadian Journal of Botany **37**: 73–79.

Radušienė J., Gudaitytė O., 2005. Distribution of proazulenes in Achillea millefolium s.l. wild populations in relation to phytosociological dependence and morphological characters. – Plant Genetic Resources: characterization and utilization, **3 (2)**: 136–143.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

THE DISTRIBUTION AND ECOLOGY OF MEDICINAL LEECH *HIRUDO MEDICINALIS* LINNAEUS, 1758 (HIRUDINEA: ARHYNCHOBDELLAE) IN LATVIA

Mārtiņš Kalniņš

Kalniņš M. 2006. The distribution and ecology of medicinal leech *Hirudo medicinalis* Linnaeus, 1758 (Hirudinea: Arhynchobdellae) in Latvia. *Acta Biol. Univ. Daugavp., 6 (1-2): 91 - 94.*

The article contains information about distribution and ecology of medicinal leech *Hirudo medicinalis* in Latvia. *H. medicinalis* is recorded into all Latvia. Most known localities are concentrated in the central part of Latvia. The medicinal leech in Latvia is apparent that the majority of the Latvian population has been recorded in general water-types - lakes, bog lakes and ox-bows. Only few specimens have been found in minority habitats – rivers, ponds and pools. Most of all ox-bows have a dense vegetation with high diversity of aquatic plants species.

Key words: Hirudinea, *Hirudo medicinalis*, distribution, ecology, Latvia, protected species

Mārtiņš Kalniņš. Nature Protection Board, Eksporta iela 5, Rīga, LV-1010, Latvija; e-mail: martins.kalnins@dap.gov.lv

Introduction

The medicinal leech *Hirudo medicinalis* Linnaeus, 1758 is one of the officially protected invertebrate species in Latvia (Regulations of Cabinet of Ministry 2000. Nr. 396. List of specially protected species and limited available specially protected species. 14 November 2000.). *H. medicinalis* can be found in the most of European countries and in some Asian and African countries. This species is also included into the IUCN Red List of threatened animals (http://www.redlist.org/search/details.php?species=9494). The species is now protected in the majority of European countries following its addition to Appendix III of the Bern-Convention 1979. The species has also been included in Appendix V of the Habitat and Species Directive (Council… 1992) and in Appendix II of the Washington-Convention (CITES).

In Latvia, the species has been known since 1937, when it was first mentioned by Trauberga (Latvijas zeme... 1937) but without concrete localities. Later Sloka describes the species as „not common" (Слока 1956) in the Latvia. Later the species was found in some other watercourses, but these records published as some remarks about confirmed localities and overall distribution have been made in different articles (Kalniņš 2001).

Material and Methods

Published data, the collections/records of the Department of Zoology and Animal Ecology of Faculty of Biology in University of Latvia, collections/records of the Institute of Biology, the data collected within the project "EMERALD-NATURA 2000" and material collected by the author and some other Latvian invertebratologists have all been used in the analysis of the distribution of this species. In the period from 2001 to 2002, protected nature areas were studied within the project "EMERALD-NATURA 2000". The material of *H. medicinalis* obtained personally by the author and by "EMERALD-NATURA 2000" was collected by using a water net or by visual searching and capturing by hand. This material covers the period from 1997 to 2005.

Results and Discussion

Distribution of the *H. medicinalis* in Latvia is given on Figure 1. The current map is based on 5x5 km squares. The data is divided in two parts: older records – before 1990 (grey squares) and recent records – after 1991 (black squares). In total, *H. medicinalis* is recorded into 30 squares in Latvia (fig. 1). Most known localities are concentrated in the central Latvia. Partially this is a result of differences in intensity of recording in different regions. 17 of all squares have been discovered within the last decade. This is result of focused studies of protected nature territories during the "EMERALD-NATURA 2000" project and author activities. So far assessment of populations of *H. medicinalis* suggests that there are 8-14 areas where this species occurs in Latvia, based mainly on literature and records of the species (Latvijas PSR Sarkanā... 1985, Latvijas Sarkanā.... 1998). As the kind of habitat where the species has been found is widespread in Latvia and the environmental situation of the historically known areas has not changed significantly, the total number of areas where it occurs is likely much higher. Based on the information above, the minimum number of areas where it occurs could be estimated as at least 50-70, whereas the maximum number cannot be as-

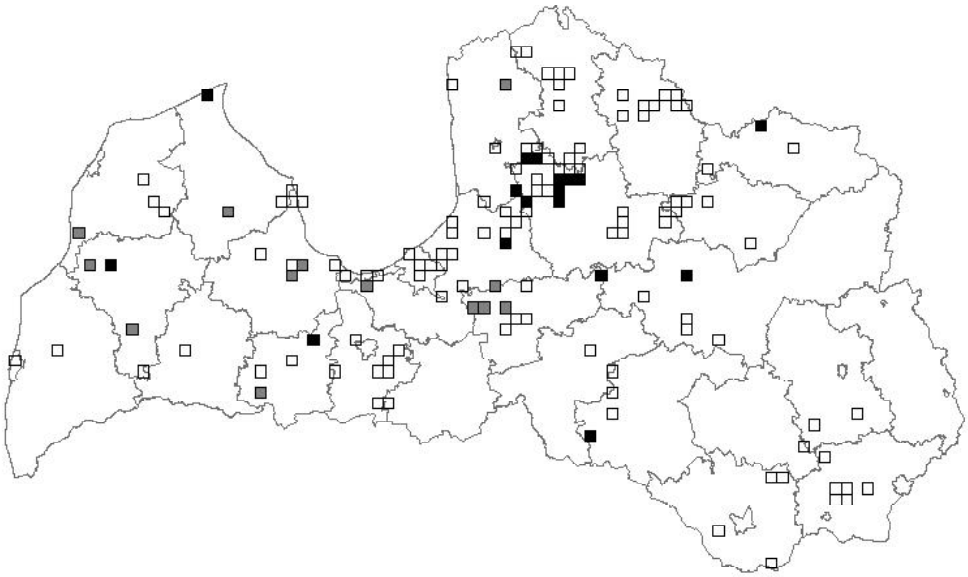


Figure 1. The distribution of the medicinal leech *Hirudo medicinalis* Linnaeus, 1758 in Latvia (hollow square – all leech species records, grey square - former findings of *H. medicinalis* (before 1990), black square - recent findings of *H. medicinalis* (after 1991))

sessed due to the lack of data. So far *H. medicinalis* was found in 7 ox-bows along the river Gauja inside the Gauja National park. Approximately 350-400 ox-bows are estimated to occur along River Gauja from Gaujiena to the estuary (~250 km) (Kalniņš, personal observations). Based on data on the species density and habitat requirements, it is considered *H. medicinalis* populations are possibly to be found in ~1/3 of all ox-bows inside the Gauja National park (e.g. 30-40 ox-bows). Probably, the valley of the River Gauja is also a migration corridor, because there is stable habitat continuity.

Assessing all records of the species in Latvia it is apparent that the majority of the Latvian population has been recorded in general water-types - lakes (15 records), bog (brownwater) lakes (4 records), ox-bows (9 records). Only few specimens have been found in minority habitats – rivers, ponds and pools. Most of all ox-bows have a dense vegetation with high diversity of aquatic plants species.

Acknowledgement

This research is presented thanks to the project "Cross boundary river habitats as corridors for protected species migration - monitoring and management strategy" awarded by the Latvian Environmental Protection Fund (Latvijas vides aizsardzības fonds) in 2005. Special thanks to Zane Pīpkalēja for the English corrections.

References

Council Directive 92/43EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora.

Kalniņš M. 2001. Gaujas Nacionālā parka aizsargājamie un retie ūdens bezmugurkaulnieki. Book of abstracts. International Conference "Research and conservation of biological diversity in Baltic region", Daugavpils: 44-45.

Latvijas zeme, daba, tauta. II. 1937. Rīga.

Latvijas PSR Sarkanā grāmata.1985. Rīga, Zinātne: 254-255.

Latvijas Sarkanā grāmata. Retās un apdraudētās augu un dzīvnieku sugas. Bezmugurkaulnieki 4. 1998. Rīga: 326-327.

Слока Я.Я. 1956. Материалы о фауне пиявок (*Hirudinea*) ЛатвССР. АН ЛатвССР №3, Рига: 89-93.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

BIODIVERSITY OF INSECTS IN VARNIAI REGIONAL PARK IN LITHUANIA

Povilas Ivinskis, Vytautas Jonaitis, Jolanta Rimšaitė

Ivinskis P., Jonaitis V., Rimšaitė J. 2006. Biodiversity of insects in Varnai Regional Park in Lithuania. *Acta Biol. Univ. Daugavp., 6 (1-2): 95 - 102.*

Original data on investigations in various territories of Varniai Regional Park, Lithuania, were summarized. Over 400 insect species belonging to 5 orders were recorded. Lepidoptera included over 159 species, Coleoptera - 60, Hymenoptera – 176, Diptera – 14 and Odonata - 10. Among parasitic insects, the greatest species diversity was recorded for the Ichneumonidae family, 140 species belonging to 88 genera were recorded. The distribution and relation between the number of species of various genera of the ichneumonid fauna in forest and meadow ecosystems were analysed. Besides, characteristics of insects listed in the Red Data Book of Lithuania were presented.

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

Povilas Ivinskis, Vytautas Jonaitis, Jolanta Rimšaitė. Institute of Ecology of Vilnius University, Akademijos 2, LT-08412, Vilnius-21, Lithuania. E-mail: entlab@centras.lt

Introduction

The territory of Varniai Regional Park is very interesting from the geomorphological point of view as it is rich in slopes, valleys, rivers, bogs and lakes. A great variety of the park˙s landscape conditioned the formation of biogeocenologically valuable natural systems with very different structures. Lately, only more or less small fragments of these systems have survived, whereas the remaining part of the territory has been strongly transformed due to agricultural conversion. As a result, it is very interesting to explore biogenic resources of the remaining natural systems and insects appear to be one of them.
The aim of this work was to make a careful analysis of species composition and distribution of the main insect groups (Lepidoptera, Hymenoptera) in separate ecosystems and to assess the status of protected species.

Material and methods

Detailed studies of the insect fauna were carried out from May through October, 2005. The main insect orders, Hymenoptera and Lepidoptera, and some fragmental material of the following three orders, Odonata, Coleoptera and Diptera, were involved in investigation. Insects were collected by means of traditional entomological methods: light and pitfall traps and entomological nets. The collected larvae and caterpillars of some insects were reared until the imago stage under laboratory conditions. Samples of adult moths and

ichneumonids were collected from the grass, tree trunks, from under stumps and the bark of logs. Investigations were carried out on the hills of Medvėgalis and Sprūdė, the lakesides of Lūkstas, Stervas and Birþulis, and in various ecosystems of the Debesnų bog.

Results and discussion

Over 400 insect species belonging to 5 orders were recorded in Varniai Regional Park.

The number of species in separate insect groups was found to be different. The most numerous among parasitic families were ichneumonids, with the recorded 140 species from 88 genera (see Table 1). The ichneumonids of the *Phygadeuon* Gravenhorst 1829 (8 species) and *Diadegma* Förster 1869 (6 species) genera dominated. The largest number of ichneumonids (105 species) was recorded on the Medvėgalis hill. Analysis of distribution of ichneumonids in separate ecosystems revealed that their diversity and abundance was significantly higher in the forest ecosystems, where 104 species were recorded, with 39-71 individuals in the forest area of 300 m^2. The meadows supported 59 species with abundance of 18-28 individuals. A total of 23 species were found in the forest and meadow ecosystems. The most abundant were *Charops cantator* Degeer, 1778 (never before found so abundantly in Lithuania) and *Lissonota coracinus* Gmelin, 1970 and made up 9 and 6% of all the recorded ichneumonid individuals, respectively. Ichneumonids of 21 species were the most frequent and made up from 1 to 3% of all the detected individuals. Particularly rare ichneumonid species recorded in the regional park were *Ectopius rubellus* Gmelin in Linnaeus, 1790, *Platylabus vibratorius* Thunberg, 1822, and *Crypteffigies albilarvatus* Gravenhorst, 1820.
Varniai Regional Park was dominated by ichneumonids that are lepidopterous (about 40% of all ichneumonid species) and hymenopterous (about 32%) parasites. Ichneumonids, the secondary phytophagous parasites, were identified only in the forest ecosystems and constituted about 12% of all the ichneumonid species. Consequently, higher trophic links function only in some of the forest ecosystems. On the basis of diversity and the structure of separate ichneumonid subfamilies, we can judge about the structure of natural systems and the richness of ecosystems in the given territry (Jonaitis, 1990). The predominance of Cryptinae ichneumonids is the indicator of natural ecosystems characterised by a higher level of species diversity, whereas the prevalence of Campopleginae representatives shows a higher level of natural ecosystem transformation. Ichneumonidae of the subfamilies Cryptinae (23% of all the recorded individuals, 37 identified species) and Campopleginae (21% of individuals, 17 species) dominated in Varniai Regional Park. Therefore, we can maintain that the regional park supports not only complex biocenological structures, but also highly urbanised ecosystems.

A total of 33 sawfly species belonging to 16 genera of 3 families (see Table 2) were observed in Varniai Regional Park. Seven species of the *Nematus* Panzer, 1801 genus were dominant. The largest number of species (27) was recorded in the forest ecosystems. The meadows contained 10 species of sawflies, whereas 4 species were found in the forest and meadow ecosystems.

In the forest fragments, the fauna of fungus gnats was poor and sparse, only 6 species belonging to Mycetophilidae and Keroplatidae families were found. The detected species are associated with rotting plant material and dead wood. A new for the Lithuanian fauna the dipteran species *Rhamphomyia (Holoclera) culicina* (Fallén, 1816) (Empididae) was recorded.

Lepidoptera families accounting for 159 species from 127 genera belonging to 22 families were the most numerous among phytophagous families, with Noctuidae (43 species) and Geometridae (27 species) being dominant among them. The highest species diversity was observed in the already formed ecotones of the Medvėgalis hill. *Zygaena lonicerae* (Scheven, 1777) was a massive species in the meadows surrounding the hill. Despite the radically converted habitats in the

Table 1. Number of ichneumonid (Hymenoptera, Ichneumonidae) species and distribution in regional park of Varniai

Genus	Total number of species	In ecosystems of	
		forests	meadows
Scambus Hartig, 1838	3	2	1
Tromatobia Förster, 1798	1	1	
Itoplectis Förster, 1868	1	1	
Apechtis Förster, 1868	1	1	
Pimpla Fabricius, 1804	2	2	
Phytodietus Gravenhorst, 1829	1	1	
Netelia Gray, 1860	1	1	
Tryphon Fallen, 1813	3	3	2
Ctenochira Förster, 1855	1	1	
Eridolius Förster, 1868	1		1
Ischnoceros Gravenhorst, 1829	1		1
Encrateola Strand, 1916	1	1	
Acrolyta Förster, 1868	1		1
Aclastus Förster, 1868	1		1
Xenolytus Förster, 1868	1		1
Gelis Thunberg, 1827	2	2	
Odontoneura Förster, 1868	1	1	
Mastrus Förster, 1868	1	1	
Ethelurgus Förster, 1868	1	1	
Glyphicnemis Förster, 1868	1		1
Bathythrix Förster, 1868	1	1	1
Phygadeuon Gravenhorst, 1829	8	6	5
Stilpnus Gravenhorst, 1829	1		1
Mesoleptus Gravenhorst, 1829	4	3	4
Atractodes Gravenhorst, 1829	2	1	1
Cubocephalus Ratzeburg, 1848	1	1	
Schenkia Förster, 1868	2	2	1
Pleolophus Townes in Townes and Gupta, 1962	2	2	1
Aptesis Förster, 1850	3	2	2
Gambrus Förster, 1868	1	1	
Aritranis Förster, 1868	1	1	
Caenocrypus Thomson, 1873	1	1	
Glypta Gravenhorst, 1829	6	4	3
Apophua Morley, 1913	2	2	
Lissonota Gravenhorst, 1829	4	4	2
Genus	Total number of species	In ecosystems of	
		forests	meadows

Lethades Davis, 1897	1		1
Rhorus Förster, 1868	2	2	
Pion Schi¸dte, 1838	1	1	
Sympherta Förster, 1868	1	1	
Perilissus Holmgren, 1855	4	2	3
Absyrtus Holmgren, 1859	1	1	
Alexeter Förster, 1868	3	2	1
Rhinotorus Förster, 1868	1	1	
Mesoleius Holmgren, 1855	1	1	
Synodites Förster, 1868	1	1	
Mesoleptidea Viereck, 1912	1		1
Hadrodactylus Förster, 1868	1		1
Phobetes Förster, 1868	1	1	
Euryproctus Holmgren, 1855	2	1	2
Barycnemis Förster, 1868	1		1
Diaparsis Förster, 1868	1		1
Sinophorus Förster, 1868	1	1	
Campoplex Gravenhorst, 1829	1		1
Casinaria Holmgren, 1859	1	1	
Charops Holmgren, 1859	1	1	
Dusona Cameron, 1900	1	1	
Nemeritis Holmgren, 1860	1	1	
Bathyplectes Förster, 1868	1	1	
Campoletis Förster, 1868	1	1	1
Dolophron Förster, 1868	1	1	
Diadegma Förster, 1868	6	3	4
Olesicampe Förster, 1868	1	1	1
Alcima Förster, 1868	1	1	
Ophion Fabricius, 1798	3	3	
Enicospilus Stephens, 1835	2	2	
Agrypon Förster, 1860	1	1	1
Exochus Gravenhorst, 1829	1	1	
Astiphromma Förster, 1868	4	4	
Mesochorus Gravenhorst, 1829	1	1	
Helictes Haliday in Curtis, 1837	1		1
Oxytorus Förster, 1868	1	1	
Collyria Schi¸dte, 1839	1		1

Genus	Total number of species	In ecosystems of	
		forests	meadows

Orthocentrus Gravenhorst, 1829	1	1	
Tymmophorus Schmiedeknect, 1913	1		1
Diplazon Nees, 1818	1	1	1
Promethes Förster, 1868	1	1	1
Sussaba Cameron, 1909	1		1
Colpognathus Wesmael, 1844	2	1	1
Centeterus Wesmael, 1844	1	1	
Herpestomus Wesmael, 1844	1	1	
Aethecerus Wesmael, 1844	1		1
Ectopius Wesmael, 1859	1	1	
Cyclolabus Heinrich, 1935	1	1	
Platylabus Wesmael, 1844	1	1	
Cratichneumon Thomson, 1893	4	3	1
Crypteffigies Heinrich, 1961	1	1	
Barichneumon Thomson, 1893	1		1
Ctenichneumon Thomson, 1894	1	1	
Total	140	104	59

nearby areas, quite a large number of protected species was recorded during the investigation, which implies that the Medvėgalis and its environs are key habitats of the protected insect species, where 3 Lepidoptera and 3 Coleoptera species included in the Red Data Book of Lithuania were found.

Parnassius mnemosyne (Linnaeus, 1758), a common species in western Lithuania, was abundantly found, though it does not usually occur in other parts of the country (Ivinskis, 2004; Ivinskis, Augustauskas, 2004). The population of *Parnassius mnemosyne* (Linnaeus, 1758) so far known as the most abundant, was recorded on the Spr?d? hill. About 300 individuals were observed at one time. This species is trophically linked to *Corydalis* Vent. and found in hilly landscapes and near river slopes. In the Medv?galis complex, these moths were first observed 30 years ago. This is the only place in Lithuania where one population has been observed for so long a period.

Papilio machaon Linnaeus, 1758 is a common though not abundant species in Lithuania and is associated with farming activities. It occurs by road- or field sides and in other anthropogenically affected habitats. During our investigation, it was observed in the open meadows of the southwestern slopes.

A variable *Aricia eumedon* (Esper, 1780) population was found in the meadows of the southeastern Medv?galis foot. It is the only population in western Lithuania. This species likes wet, rich and shrubby meadows overgrown with caterpillar food plants – Geraniums. *Coenonympha hero* Linnaeus, 1761 and *Hyporaia aulica* Linnaeus, 1758 were not detected, though recorded during the previous year?s investigation.

Studies of Coleoptera revealed that the forest patches covering the hills are inhabited by a number of rare species. *Calosoma inquisitor* Linnaeus, 1758, so far known from the Vilnius environs and the Curonian Spit (Juodkrant?), was found on the southeastern slope of the Medv?galis. This species moves rapidly on the trees and feeds on insect larvae. It quickly responds to massive pest outbreaks in forests and can be abundant in pest foci.

Table 2. Number of sawfly (Hymenoptera, Symphyta) species and distribution in regional park of Varniai

Genus	Total number of species	In ecosystems of	
		forests	meadows
Pamphilius Latreile, 1802	1	1	
Arge Schrank, 1802	1	1	
Cladius Illiger, 1807	1		1
Nematus Panzer, 1801	7	5	3
Aneugmenus Hartig, 1837	1		1
Dolerus Panzer, 1801	2	2	1
Athalia Leach, 1817	1	1	
Hoplocampoides Enslin, 1918	1	1	1
Eurhadinoceraea Enslin, 1918	1	1	
Monosoma MacGillioray, 1908	1		1
Allantus Panzer, 1801	1		1
Aglaostigma Kirby, 1882	1	1	
Tenthredopsis Costa, A. in Costa, D., 1859	3	3	
Pachyprotasis Hartig, 1837	2	2	
Macrophya Dahlbom, 1836	4	4	
Tenthredo Linnaeus, 1758	5	5	1

The most abundant in Lithuania population of *Carabus coriaceus* Linnaeus, 1758, the largest species of ground beetles in the country, was recorded on the Medv?galis hill. Only a few locations of this species in the country have been known so far. The species likes heavy soils and deciduous forests. *Dendroxena quadrimaculata* (Scopoli, 1772) beetles were found on the Medv?galis southeastern and southern slopes. This beetles are carniferous and his abundance are under the influence of fitofagous abundance.

Uleiota planata Linnaeus, 1758 was found on the Medv?galis southeastern slopes. They are included in the list of specialised species of forest key habitats (Ehnström et al., 2003).
Summarising, we may conclude that Varniai Regional Park contains the fragments of natural forest ecosystems that are rich in the ichneumonid fauna, rare beetle communities, as well as in the protected complexes of indicator Lepidoptera in mesophytic meadows. These forest fragments of a rich structure are the sanctuary zone for the enrichment of trophic links in the neighbouring meadows and other ecosystems.

Conclusions

1. The complexity of species composition in Varniai Regional Park in Lithuania is diverse; over 400 species belonging to 5 orders of insects were recorded. The highest number of species was recorded for Lepidoptera (159 species) and Hymenoptera (176) orders.

2. Among various families of Hymenoptera, the greatest species diversity in the regional park was recorded for ichneumonids (Ichneumonidae), 140 species belonging to 88 genera. In total, 104 species were recorded in the forest and 59 – in meadow ecosystems. Some fragments of forests ecosystems have accumu-

lated very rich communities of various ichneumonid species.

3. The moth species *Parnasius mnemosyne* Linnaeus, 1758, *Papilio machaon* Linnaeus, 1758 and *Aricia eumedon* (Esper, 1780) and the beetle species *Calosoma inquisitor* Linnaeus, 1758, *Carabus coriaceus* Linnaeus, 1758, and *Dendroxena quadrimaculata* (Scopoli, 1772) have been identified in investigation areas, which were included in the Red Data Book of Lithuania, whereas *Uleiota planata* Linnaeus, 1758 has been entered on the list of key habitat species.

4. A new for the Lithuanian fauna dipteran species *Rhamphomyia (Holoclera) culicina* (Fallén, 1816) (Empididae) was found.

References

Jonaitis V. 1990. Resources, formation and functioning of host-parasite entomocomplexes in ecosystems. Vilnius, Mokslas: 232.

Ehnström B., Ivinskis P., Ferenca R. 2003. Insects of forest key habitats. Vilnius –Linköping: 80.

Ivinskis P. 2004. Lepidoptera of Lithuania. Annotated catalogue. Vilnius: 380.

Ivinskis P., Augustauskas J. 2004. Butterflies of Lithuania. Kaunas, Lututė: 247.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

AN INVESTIGATION OF DRAGONFLY (ODONATA) ECOLOGY AT THE TĪTMAŅU OXBOW, GAUJA NATIONAL PARK, LATVIA

Mārtiņš Kalniņš

Kalniņš M. 2006. An investigation of dragonfly (Odonata) ecology at the Tītmaņu oxbow, Gauja National Park, Latvija. *Acta Biol. Univ. Daugavp., 6 (1-2): 103 - 108.*

The article contains information about dragonfly investigations made in the central part of Latvia, during the vegetation season of 2005. Information about number of species and individuals and phenology of adult dragonfly are obtained. Information was based on adult dragonflies regular countings during the all vegetation season. During the present study 29 species of dragonfly were recorded from Tītmaņu ox-bow. Coexistence and segregation analyses of related species (family Libellulidae, genus *Coenagrion*) were made and differences in flight periods and period duration were established.

Key words: Odonata, ecology, Latvia, phenology, seasonal dynamics, coexistence

Mārtiņš Kalniņš. Nature Protection Board, Eksporta iela 5, Rīga, LV-1010, Latvija; e-mail: martins.kalnins@dap.gov.lv

Introduction

The dragonfly fauna of Latvia is well-known in a national sense, but less well-known regionally. Although dragonflies are a relatively small rather easily explored insect group, up to now there are little ecological data for the group in Latvia. This is despite the fact that the first data about dragonflies in Latvia was published in the second part of 18th century (Fischer 1778). The first ecological data on dragonflies are to be found in the records of B. Bērziņš (Bērziņš 1934, 1942), who gives information about distribution, habitats and flight times. The second significant published record of Latvian dragonflies is that of Z. Spuris (Спурис 1956), where, for the first time, summarised information about Latvian dragonflies is given, as well as the habitats of larvae and adults, flight times, a zoogeographical description of the dragonfly fauna and so on. Subsequently more publications on dragonfly larvae appeared, although ecological data remained fragmentary. More specialised investigations of dragonfly fauna and ecology were made in 1999 on the Lake Engure Nature Park (Inberga-Petrovska 2003). These included quantitative and faunistic studies, as well as seasonal dynamics and dependence on meteorological conditions. Ecological data and observations on protected species were also discussed by Kalniņš, Inberga-Petrovska (2005) and Kalniņš (2006).

At a time when many invertebrate species are declining, it is useful to know more about these species, as well as their biotopes and frequency of occurrence. This knowledge may help to provide reasons for population change and perhaps help to avert them where necessary.

Material and Methods

The investigations were made in the district of Cēsis, in Līgatne, Tītmaņu oxbow, in Gauja National Park. They were made during 2005, from May 6 (before the flight period of dragonflies) until October 20 (after the flight period of dragonflies).

Tītmaņu oxbow is a typical oxbow in the old valley of Gauja. It is surrounded with mixed broadleaved forest with some small clearings and

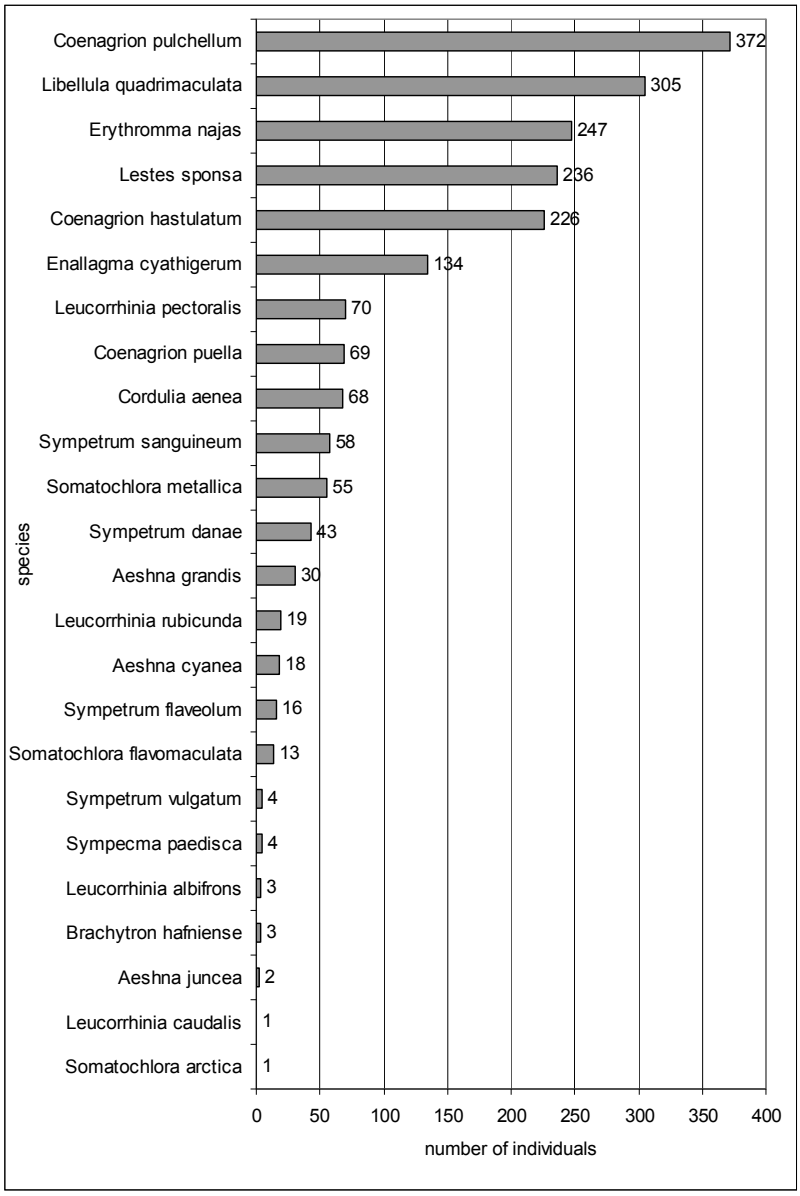


Figure 1. Numbers of individual dragonfly species in Tītmaņu oxbow in summer 2005 (numbers of individuals counted during the season)

meadows. It is a separate watercourse with an area ~22 ha. Less than half of the oxbow is open water, the rest is overgrown with reedswamp, mainly composed of sedges *Carex* and reeds *Phragmites*. There are also numerous hydrophytes including *Stratiotes*, *Potamogeton*, and *Myriophyllum*. *Equisetum* and clumps of *Dryopteris* occur.

Ten sampling sites were established in the oxbow (each ~20-50 m^2), disposed in different habitats. The vegetation at each sampling site was determined using the Braun-Blank scale, whether above or below the water level. Tree-covered and shaded areas were included. During the season 20 counts were made from each site. All adult dragonflies were counted with different intervals, from 7 to 14 days. Counts were made in the first part of the day from 09:00 hrs until 13:00 hrs. The time spent at each site was from 5 to 15 minutes.

The following meteorological conditions were registered during each count:

Wind (force using Beaufort scale)
- Air temperature
- Cloud cover (using four ball scale)
- Rainfall

Results and discussion

Number of species and individuals

Up to now knowledge of the number of species of dragonfly living in the Tītmaņu oxbow was derived from limited research conducted during 2002 and 2004 (Kalniņš, unpublished). This work found 10 species of dragonfly, three of which, *Calopteryx splendens*, *Calopteryx virgo*, and

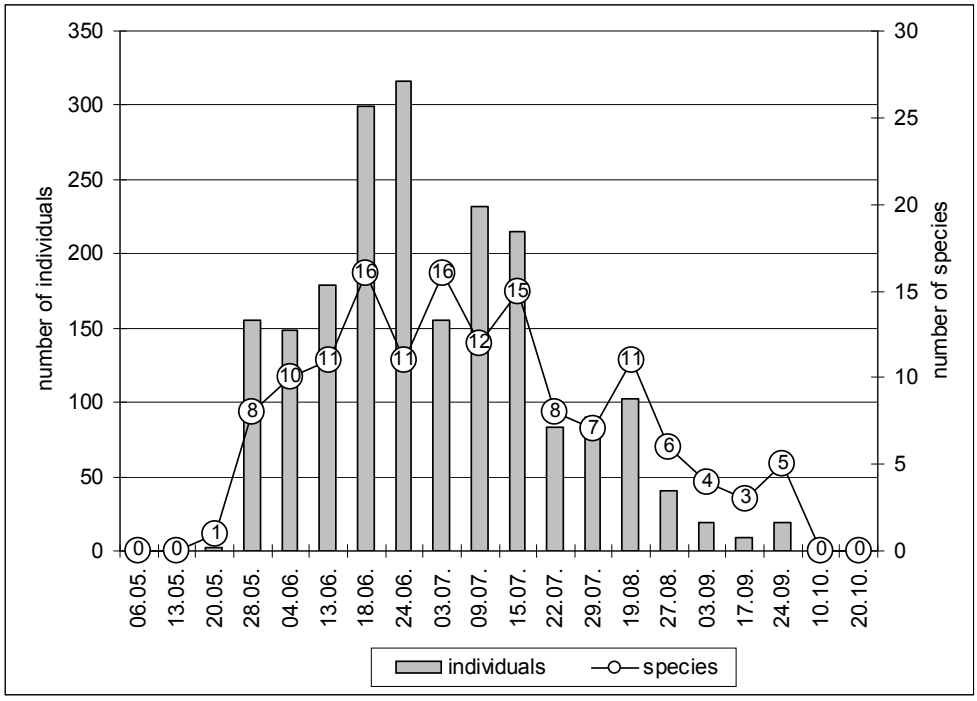


Figure 2. Seasonal dynamics of dragonfly species and numbers of individuals in Tîtmaòu oxbow during the summer of 2005 (number of individuals and species counted in all sampling sites)

Gomphus vulgatissimus, probably do not breed in the oxbow. The other species, *Aeshna viridis*, *Cordulia aenea*, *Leucorrhinia albifrons*, *L. pectoralis*, *Libellula quadrimaculata*, *Erythromma najas* and *Sympetrum vulgatum*, were observed relatively often and in larger numbers.

During the present study 29 species of dragonfly were recorded from Tītmaņu oxbow namely: *Aeshna cyanea, A. grandis, A. juncea, Brachytron hafniense, Calopteryx splendens, C. virgo, Coenagrion hastulatum, C. puella, C. pulchellum Enallagma cyathigerum, Erythromma najas, Cordulia aenea, Somatochlora arctica, S. flavomaculata, S. metallica, Gomphus vulgatissimus, Ophiogomphus cecilia, Lestes sponsa, Sympecma paedisca, Leucorrhinia albifrons, L. caudalis, L. pectoralis, L. rubicunda, Libellula quadrimaculata, Sympetrum danae, S. flaveolum, S. sanguineum, S. vulgatum,* and *Platycnemis pennipes. Aeshna viridis* recorded previously was not confirmed.

Based on the number of individuals observed during the season species which occur or may occur in Tītmaņu oxbow, could be conventionally divided into three groups (Figure 1), i.e. those with:

- >100 individuals (six species),
- 10-100 individuals (11 species),
- <10 individuals (seven species).

The number of observations demonstrates that:

- 8 species were observed on from one to three counting days,
- 10 species were observed on from four to seven counting days,
- 6 species were observed on from eight to eleven counting days.

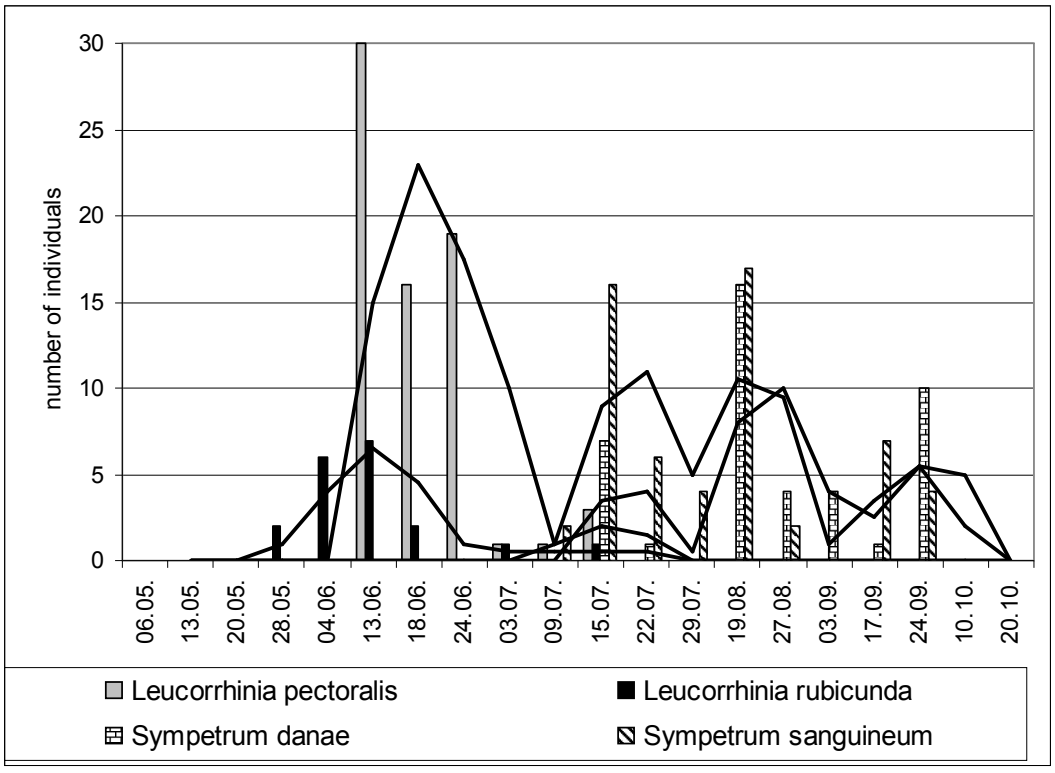


Figure 3. Seasonal dynamics and trends in number of species of *Leucorrhinia* and *Sympetrum* (Odonata: Libellulidae) in Tîtmaòu oxbow during the summer of 2005 (numbers of individuals and species counted at all sampling sites)

From these data it could be concluded that regular counting during the entire season is required to obtain a realistic impression of the total number of species of dragonfly, and of those which may or may not be declining.

Phenology

During 2005 it was established that in the initial flight period of dragonflies (at the end of May) the number of species initially increased very sharply, but this then slowed, with the maximum being achieved at the end of June (Figure 2). From the end of June until the middle of July a large number of species were recorded at the sampling sites. From the second part of July until the end of September the number of species decreased progressively.

Although the number of species from June until the beginning of August altered relatively little, changes in the numbers of individuals are relevant (Figure 2). Analysing segregation of related species, it is established that, for example in the family Libellulidae, dragonflies of the genera *Leucorrhinia* and *Sympetrum* are seasonally segregated. Figure 3 demonstrates that adult *Leucorrhinia rubicunda* appear before *Leucorrhinia pectoralis* but build up slowly and steadily, in contrast to the latter species. *L. rubicunda* achieves its maximum during this time after which it decelines in numbers steadily (Figure 3). Although the flight period and its maximum extent are somewhat different for both species, both occur until the middle of July. The analyses of flight dynamics for both species of *Sympetrum* (Figure 3) did not establish clear differences of periodicity between them. Apparently temporal segregation is determined by other factors, such as availability of preferred prey.

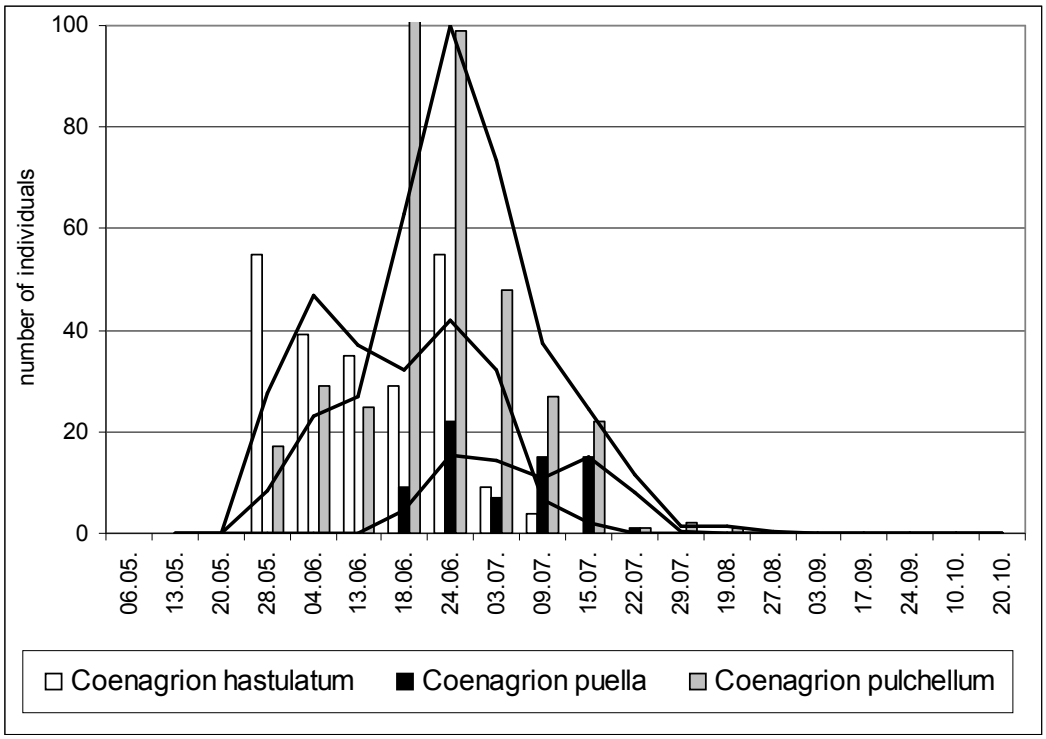


Figure 4. Seasonal dynamics and trends in numbers of species of *Coenagrion* (Odonata: Coenagrionidae) in Tītmaņu oxbow during the summer of 2005 (number of individuals and species counted in all sampling sites)

Differences in genera were also analysed in three species of *Coenagrion*; *C. hastulatum*, *C. puella* and *C. pulchellum*. These are closely similar species which as larvae live in the same habitats and vegetation structures, but their flight times are distinct. Adult *C. hastulatum* and *C. puella* appear at the same time, but *C. hastulatum* reaches a maximum number of individuals first. After this *C. pulchellum* begins to appear, but in smaller numbers and with a shorter overall flight duration (Figure 4).

Coexistence and segregation of species are determined not only by division in time but also in space. Dragonflies of the genera *Leucorrhinia* are observed feeding mainly in the watercourse or along the banks, while dragonflies of the genera *Sympetrum* feed mainly in meadows close to their sites of origin.

Conclusions

This research demonstrates that for the comparatively simple objective of clarification of diversity of dragonfly species a somewhat extensive study is required. Without this extended work programme, some imaginary results might be produced, and knowledge of the true status of particular species, including their potential population fluctuations, would not be established properly.

The most relevant result of this research is the provision of information on the phenology of dragonflies, i.e. the seasonal dynamics of the species and their frequency. It was established that prior conjecture about the phenology of dragonflies was reasonably exact, but they did not explain the current findings of coexistence and segregation at species level. Countings at Tītmaņu oxbow reveal seasonal dynamics and trends for dominant species, providing a more objective rationale for factors determining coexistence and segregation.

To provide objective judgement about factors determining the coexistence and segregation of recedent species, it will be necessary to undertake more complete data analyses of other variables such as ethology of the species, significance of vegetation, and so on.

Acknowledgements

Special thanks to Zane Pīpkalēja (Rīga) for assistance with the treatment of the data and to Paul F. Whitehead (United Kingdom) and Dmitry Telnov (Latvia Entomological Society, Rīga) for the English corrections.

References

Bērziņš B. 1934. Insektu masu parādības. – "Daba un Zinātne", I, 5. Rīga: 157.

Bērziņš B. 1942. Beitrag zur Kenntnis der Odonatenfauna Lettlands. - Folia zool. et Hydrobiol., vol.11, N 2: 329 – 350.

Fischer J.B. 1778. Versuch einer Naturgeschichte von Livland. Erste Aufl. Leipzig, S. 155 – 156.

Inberga-Petrovska S. 2003. Spāru faunas un ekoloģijas pētījumi Engures ezera dabas parkā. - Daba un Muzejs, 8: 59-67.

Kalniņš M., Inberga-Petrovska S. 2005. Distribution and ecology of dragonflies *Aeshna viridis* (Eversmann, 1835) and *Ophiogomphus cecilia* (Fourcroy, 1785) in Latvia. 3rd International Conference "Research and Conservation of biological diversity in Baltic region". Book of abstracts. Daugavpils University. Daugavpils, Latvia; 20-22 April: 68-69.

Kalniņš M. 2006. Upjuspāru (Odonata: Gomphidae) izplatība un sastopamības biežums Gaujā. Ģeogrāfija. Ģeoloģija. Vides zinātne: Referātu tēzes. Rīga: Latvijas Universitāte: 1-303 (298-301).

Спурис З.Д. 1956. Стрекозы Латвийской ССР. Изд-во АН ЛатвССР, Рига: 1-96.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

AQUATIC AND SEMIAQUATIC BUGS (*HETEROPTERA*: *NEPOMORPHA ET GERROMORPHA*) OF WATER BODIES IN THE MIDDLE REACH OF THE RIVER BUG AND ITS VALLEY

Lech Lechowski, Paweł Buczyński

Lechowski L., Buczyński P. 2006. Aquatic and semiaquatic bugs (*Heteroptera*: *Nepomorpha et Gerromorpha*) of water bodies in the middle reach of the River Bug and its valley. *Acta Biol. Univ. Daugavp., 6 (1-2): 109 - 116.*

In the years 2002-2003 aquatic and semiaquatic bugs of the middle reach of the River Bug valley were studied, the last large non-regulated river of Middle Europe. 28 bug species were recorded from 36 study sites. *Paracorixa concinna, Aphelocheirus aestivalis* and *Microvelia buenoi* are rare in Polish fauna. The following bug assemblages inhabiting the River Bug, streams, ditches and canals, oxbows, natural and anthropogenic small water bodies were characterized. In the River Bug oxyphilous *Aphelocheirus aestivalis* and *Micronecta griseola* were found, however, heteropterofauna of the river was regarded as transformed due to strong pollution. The assemblages inhabiting standing waters turned out to be valuable, especially those in oxbows – the most important habitat of aquatic bugs.

Key words: Water bugs, *Heteroptera*, river valley, assemblage, Bug, Poland

Lech Lechowski, Paweł Buczyński, Maria Curie-Skłodowska University, Department of Zoology, Akademicka 19 St., PO-20-033 Lublin, Poland*pbuczyn@biotop.umcs.lublin.pl*

Introduction

Aquatic true bugs of water environments of middle-eastern Poland have been fragmentary known until recently (Tenenbaum 1921; Wróblewski 1980a). In recent years a few papers have been published, presenting the state of discussed insects in the selected environments of the Łęczyńsko-Włodawska Plain (Buczyński, Staniec 1998; Płaska 2002a, 2002b, 2002c, 2003) and „Lasy Janowskie" Landscape Park (Lechowski et al. 2000). Little precise is also data from the Roztocze region (Krajewski 1990). Nevertheless, the state of knowledge on the fauna of the biggest regional rivers as well as waters from their valleys has never been the focus of attention of hemipterologists, similar to the situation in other regions of Poland (Mielewczyk 2003).

The second largest river of his area, after Wisła, is the River Bug. Particularly valuable feature of this rivers is the naturalness of its valley (the lack of regulations). Thus, in the river valley the rarely found composition of environments has been preserved as well as hydrological relationships depending on the river influences. The studies on macrophytes, aquatic insects (dragonflies, beetles, caddisflies), diurnal butterflies, fish, birds and some mammals have shown high values of the nature of the river valley (Buczyński 1995, 1996, 2003, 2006; Kucharczyk 1999; Pałka et al. 2002; Przewoźny et al. 2005; Serafin 2004). So

the undertaking the studies on aquatic bugs seemed to be justifiable.

Study area

The River Bug, with its total length of 755 km, is the largest right-side tributary of the River Wisła. The research covered the left-side of the river valley, on its central course, between two villages: Gołębie (50°38'N, 24°05'E) and Wola Uhruska (51°19'N, 23°38'E). The River Bug is a trans-boundary watercourse between Poland and the Ukraine.

The examined reach of the River Bug valley is situated in the contact zone between Eastern and Western Europe. According to geomorphology it is included to two macroregions: the Wołyń Upland and Polesie Wołyńskie (Kondracki 2001). This connection with Eastern Europe is exposed in the consideration of recently proposed synchorological divisions and zoogeographic regionalization. In case of the first criterion the area belong in the whole to Western Wołyń, however, taking faunal element into account, it is included to Subpontiac District of Middle-European region (Kostrowicki 1999; Matuszkiewicz 1999). In older papers the discussed area was regarded as the part of the Lublin Upland although nowadays the conventionary character of the border between this units is emphasized.

The River Bug on the study site is meandering lowland river with slow current and annual overflows. It flows through a vast valley carved in loess sediments lying on limestone rocks (Kondracki 2001). The width of the valley ranges from several to ca. 10 km, and the floodplain reaches up to 5 km (Szwajgier et al. 2002). In the River Bug valley there are numerous oxbows in different succession stages and small water bodies, temporary mainly. After-excavation water bodies are also found, the most interesting are situated in a gravel pit in Gródek, by Metallurgical-Sulphuric Line (Linia Hutniczo-Siarkowa, LHS). There are a few astatic water bodies with rich helophyte vegetation and the bottom covered by *Chara foetida* A.Br.

In the light of the binding from 2004 five-stage scale the whole studied reach of the River Bug in general classification belongs to 4th class (unsatisfying quality). The values of physical, oxygen and microbiological indices was estimated as bad or very bad. The best was valued salinity (1st class along the whole length). As for biological indices, particular reaches of the river were included to 2nd-4th classes, however, water quality improved with a river course, reaching 2nd class in the area of Dorohusk (Miazga, Skwarek 2005).

Methods and material

The studies were conducted in the years 2002 and 2003. The material was collected during two periods: 4-6 and 7-10. The samples were taken for 36 study sites, situated in the vicinity of the following places: l. Gołębie (UTM grid KS01); 2. Kryłów (KS01); 3. Ślipcze (KS02); 4. Gródek (GB03); 5. Husynne (GB13); 6. Strzyżów (KS03); 7. Dubienka (GB05); 8. Dorohusk (FB97); 9. Świerże (FB97); 10. Hniszów (FB88); 11. Wola Uhruska (FB88).

The main method was taking a semi-quantitative samples by a hydrobiological scoop. In the case of the Bug River the dredge was also used. The studies covered: 10 sites on the River Bug, 5 streams, 3 ditches and canals, 8 oxbows, 9 natural small water bodies, one complex of small anthropogenic water bodies (a gravel pit in Gródek) . The collected material covers 1002 imagines and 148 larvae and it is a part of the collection of the Department of Zoology of UMCS; in the analysis imaginal material was used only.

Species diversity was calculated according to Shannon – Weaver diversity index – $H^{'}$ – its values are influenced by the most numerous species mostly (Trojan 1992).

Results and discussion

During the conducted studies 28 aquatic and semi-aquatic bug species were found (Table 1), which constitutes over 41% of national fauna (Cmoluchowa, Mielewczyk 1990). The increase in species number is not expected for the examined river valley stretch has no wooded habitats and peat bog waters. Thus in the examined material there are no or occurred very sporadically shade-seeking (skiophilous) and peat bog (tyrphophilous) species. Nevertheless, according to studies on other aquatic insects, those ecological elements should be present near the study area, north to Wola Uhruska, on so called "poleski stretch of the River Bug valley" (Buczyński et al. 2005; Przewoźny et al. 2005; Serafin).

Three species found from among others: *Paracorixa concinna, Aphelocheirus aestivalis* and *Microvelia buenoi* are regarded as rare in Polish fauna (Mielewczyk, Tończyk 2004).

In standing waters the presence of 23 species of *Heteroptera* was recorded. The highest species number was found in oxbows – 606 individuals belonging to 18 species. The most numerous was *Plea minutissima* which constituted ca. 50% of the collected specimens. So high dominance testified the good ecological condition of the oxbows: admittedly this species prefers eutrophic waters but also avoids shallow, muddy and hipertrofic water bodies (Mielewczyk 2003). More numerous populations were formed by: *Ilyocoris cimicoides*, *Cymatia coleoptrata* and *Microvelia reticulata*. Such qualitative composition can be regarded as a typical of the character of the habitat. *Plea minutissima* and *Cymatia coleoptrata* are as a rule more numerous in deeper and temporary water bodies, unshaded and with well developed vegetation (Mielewczyk 2002) on the contrary to *Microvelia reticulata* which inhabits sheltered and insolated sites (Wróblewski 1980b). The assemblages of *Heteroptera* of natural small water bodies (16 species) and the complex of anthropogenic water bodies (10 species) referred to the fauna of the oxbows in terms of the composition and dominance structure, however, qualitative and quantitative diversities were lower.

In running waters 19 species were found in general. The faunas of streams as well as ditches and canals were qualitative poor (accordingly: 9 and 8 species), with the lack of the species quantitatively distinctive. However, the assemblages of *Heteroptera* of the River Bug were very diversified in terms of numbers of species (16 taxa) and the value of H˙Index =3,11.

The highest numbers in the River Bug reached: *Micronecta griseola*, *Aphelocheirus aestivalis* and *Gerris paludum*. Two first species were caught in the river only. A characteristic element of a clean lowland river is *Aphelocheirus aestivalis* – typical rheophilous and oxyphilous species, preferring gravel-bottomed sites (Kurzątkowska 2004; Pliūraitė, Kesminas 2004). Thus this species avoids polluted waters and in many countries and regions it is regarded as a endangered one (Bubiunas, Jagminiene 2001; Günther et al. 1998; Płaska 2003; Schöll et al. 2003). On the study area it was found in Gródek only. The indicator species of clean waters is also *Micronecta griseola* but it inhabits standing and running waters, especially larger lakes (Mielewczyk 2003). If ecological conditions get worse (pollution, the increase in trophy) this species disappears (Günther et al. 1998; Płaska 2003). It was found numerously in the River Bug in Świerże (48 individuals) and Gródek (8 individuals). The rarity of the both species in the River Bug confirms the results of monitoring conducted by WIOŚ in Lublin, especially in the range of oxygen indices (Miazga, Skwarek 2005). Worth mentioning is the fact that after strong regress in the second half of the 20th century *A. aestivalis* has been recently commonly found in many large Polish and European rivers, e.g. Narew (Buczyński et al. in press), Odra (Oder) (Schöll et al. 2003), Neman (Nemunas) (Bubiunas, Jagminiene 2001), Rhein (Rhōne) (Schöll 2002). On this background the situation of this species in the River Bug is not very favourable despite lots of microhabitats suitable for this water bug.

The third of the dominating species in the River

Table 1. Aquatic and semiaquatic bugs recorded in the valley of the middle reach of the River Bug. Localities: 1 – Go?¿bie, 2 – Kry?ów, 3 – ?lipcze, 4 – Gródek, 5 – Husynne, 6 – Strzy?ów, 7 – Dubienka, 8 – Dorohusk, 9 – ?wier?e, 10 – Hniszów, 11 – Wola Uhruska. Habitats: a – the River Bug, b – streams, c – ditches and canals, d – oxbow lakes, e – small water bodies, f – gravel pit.

Species	Localities											Material collected						
	1	2	3	4	5	6	7	8	9	10	11	a	b	c	d	e	f	Σ
1. *Micronecta griseola* Horv.				a					a			56						56
2. *Cymatia coleoptrata* (Fabr.)	a			acd			d	d		d	d	1		1	44			46
3. *Callicorixa preusta* (Fieb.)	ad		a	f	c					d				3	3	7	2	15
4. *Hesperocorixa linnaei* (Fieb.)			a									1						1
5. *Hesperocorixa sahlbergi* (Fieb.)				ef			e			d	d				7	1		8
6. *Paracorixa concinna* (Fieb.)	a															2		2
7. *Sigara falleni* (Fieb.)	d		e	d	f	a	d	a			b	7	9		21	1		38
8. *Sigara lateralis* (Leach)	a				f								1			8		9
9. *Sigara limitata* (Fieb.)				f													4	4
10. *Sigara semistriata* (Fieb.)			a	fd						d	a	1					1	2
11. *Sigara striata* (L.)	da	ab		f	f				d	a	db	4	16		8	1	1	30
12. *Notonecta glauca* L.			ae	def	c df		d	d	ad	ad	db	2	5	2	22	4	9	44
13. *Ilyocoris cimicoides* (L.)	da	ab	ae	abde	ef		d	d	da	dk	db	8	7	6	82	9		112
14. *Nepa cinerea* L.	a	ab	a	eb	fc	a	d	d	da	da	dab	11	2	3	6	2		24
15. *Ranatra linearis* L.			ae		d		d		d	da	d	1			5	2		8
16. *Aphelocheirus aestivalis* (F.)				a								39						39
17. *Plea minutissima* Leach	ade			afde	ef		db	da	da	d	d	4	4	3	299	25	2	337
18. *Mesovelia furcata* Muls. et Rey												8			41			49
19. *Microvelia reticulata* (Burm.)				efdc			d		d					2	35	1	18	56
20. *Microvelia buenoi* Drake															1			1
21. *Gerris argentatus* Schum.							edc		d						8	1		9
22. *Gerris lacustris* (L.)		b	a					a				21	5		5	3	2	36
23. *Gerris odontogaster* (Zett.)	a		ae	efd	fc			d	d	d			5	4	11	6	4	30
24. *Gerris paludum* (Fabr.)	a			a	a	a	d		da			35			7			42
25. *Gerris rufoscutellatus* Latr.			ae													1		1
26. *Gerris thoracicus* Schum.			a									1						1
27. *Hydrometra gracilenta* Horv.				d											1			1
28. *Hydrometra stagnorum* (L.)	a											1						1
Total number of species / specimens:	12	4	12	17	11	4	11	8	11	11	10	201	54	24	606	74	43	1002

Bug, *Gerris paludum*, was numerously found in the river but it was not numerous in the oxbows (Dubienka, Gródek, Świerże). This species is not strictly associates with water quality it needs large water bodies. On the study area it was recorded in Gródek only.

Species diversity of water bugs expressed in the values of the index H˙ was the highest in small water bodies (H˙=3,20) and in the River Bug (H˙=3,11). The lowest value was recorded in the fauna of streams (H˙=1,90). It reflected the diversity of habitats. Small water bodies in the River Bug valley are strongly diversified as for their locality, bottom type and composition and richness of vegetation. The same refers to the large rivers, rich in microhabitats associated with current, bottom type and the character of a river bank. However, streams, ditches and canals are not so complex thus their fauna is poorer and less varied.

The collected material confirm the fact that the crucial role in forming and maintenance of faunistic richness of the area play the River Bug and its oxbows. It was also confirmed by the studies on beetles of the River Bug and Narew, though in this case of importance were small water bodies (Biesiadka, Pakulnicka 2004; Przewoźny et al. 2005). As for oxbows the most crucial is the prevention of the increase in trophy and the maintenance of habitat diversity representing a few stages of succession. So, water quality of the River Bug causes that the conditions for aquatic bugs are not optimal but standing waters in its valley – especially oxbows – can be regarded as suitable habitats with well preserved fauna.

References

Biesiadka E., Pakulnicka J. 2004. Chrząszcze wodne (*Coleoptera*) Łomżyńskiego Parku Krajobrazowego Doliny Narwi. Parki

Narodowe i Rezerwaty Przyrody, 23 (3): 427-447.

Bubinas A., Jagminiene I. 2001. Bioindication of ecotoxicity according to community structure of macrozoobenthic fauna. Acta Zoologica Lituanica, 11 (l): 90-96.

Buczyński P. 1995. Materiały do poznania ważek (*Odonata*) Lubelszczyzny. Część I. Wiadomości Entomologiczne, 14 (2): 75-83.

Buczyński P. 1996. Nowe stanowiska ważek (*Odonata*) ze wschodniej części Wyżyny Lubelskiej. Wiadomości Entomologiczne, 15 (l): 5-11.

Buczyński P. 2003. *Aeshna affinis* Vander L. (*Odonata: Aeshnidae*) w dolinie Bugu w roku 2000. Wiadomości Entomologiczne, 22 (l): 48-49.

Buczyński P. 2006. General notes about the dragonfly (*Odonata*) fauna of the River Bug valley in the Lublin Region (SE Poland). In: R. Buchwald (ed.). Habitat selection, reproductive behaviour and conservation of central-European dragonflies (*Odonata*). Proceedings of the 23rd Annual Meeting of the „Association of German-Speaking Odonatologists (GdO) at Oldenburg (Lower Saxony, Germany), 19.-21.3.2004. Aschenbeck & Isensee Universitätsverlag, Oldenburg, 73-80.

Buczyński P., Buczyńska E., Kasjaniuk A. 2005. Ważki (*Odonata*) i chruściki (*Trichoptera*) rezerwatu „Magazyn" (Polesie Zachodnie). Parki Narodowe i Rezerwaty Przyrody, 24 (1): 117-130.

Buczyński P., Serafin E., Lechowski L. in press. Niektóre owady wodne (*Odonata*, *Heteroptera*, *Coleoptera*, *Trichoptera*) Narwiańskiego Parku Narodowego – wyniki wstępnych badań. Parki Narodowe i Rezerwaty Przyrody,

Buczyński P., Staniec B. 1998. Waloryzacja godnego ochrony torfowiska Krugłe Bagno (Pojezierze Łęczyńsko-Włodawskie) w oparciu o wybrane elementy jego fauny. Rocznik Naukowy Polskiego Towarzystwa Ochrony Przyrody „Salamandra", 2: 95-107.

Cmoluchowa A., Mielewczyk S. 1990. Heteroptera – Pluskwiaki różnoskrzydłe. In: J. Razowski (ed.). Checklist of Animals of Poland. Vol. I, Part XXXII/1-20. Ossolineum, Wrocław – Warszawa – Kraków, 71-90.

Günther H., Hoffmann H.-J., Melber A., Remane R., Simon H., Winkelmann H. 1998: Rote Liste der Wanzen (*Heteroptera*) (Bearbeitungsstand: 1997). In: M. Binot, R. Bless, P. Boye, H. Gruttke, P. Pretscher (eds). Rote Liste gefährdeter Tiere Deutschlands. Bundesamt für Naturschutz, Bonn-Bad Godesberg, 235-242.

Kondracki J. 2001. Geografia regionalna Polski. Wydawnictwo Naukowe PWN, Warszawa, 401 pp.

Kostrowicki A. S. 1999. Świat zwierzęcy. In: L. Starkel (ed.). Geografia Polski – środowisko przyrodnicze. Wydawnictwo Naukowe PWN, Warszawa: 475-493.

Krajewski S. 1990. Pluskwiaki wodne (*Heteroptera*) Roztocza. In: Fauna Roztocza – Materiały na Sympozjum, Zwierzyniec 25-27 września 1990. Instytut Zoologii PAN, Warszawa, 32.

Kucharczyk M. (ed.) 1999: Problemy ochrony i renaturalizacji dolin dużych rzek Europy. Wydawnictwo Uniwersytetu Marii Curie-Skłodowskiej, Lublin.

Kurzątkowska A. 2004. 3.1.5. Pluskwiaki wodne (*Heteroptera aquatica*). In: M. Kistowski, L. Mosdorf (eds). Zasoby i zagrożenia

środowiska przyrodniczego w powiecie ełckim i mieście Niemenczyn. Wyższa Szkoła Finansów i Zarządzania w Białymstoku, Białystok, 78-81.

Lechowski L., Buczyński P., Stryjecki R. 2000. Wodne pluskwiaki (*Heteroptera*) Lasów Janowskich. Wiadomości Entomologiczne, 19 (2): 69-78.

Matuszkiewicz W. 1999. Szata roślinna. In: L. Starkel (ed.). Geografia Polski – środowisko przyrodnicze. Wydawnictwo Naukowe PWN, Warszawa, 427-475.

Miazga J. Skwarek M. 2005. Wody powierzchniowe płynące. In: M. Burdzicki, E. Piebiak (eds). Raport o stanie środowiska województwa lubelskiego w 2004 roku. Biblioteka Monitoringu Środowiska, Lublin: 73-90.

Mielewczyk S. 2002. Ocena jakościowego i ilościowego występowania pluskwiaków (*Heteroptera*) w stawach parku pałacowego w Turwi (Park Krajobrazowy im. Gen D. Chłapowskiego). Rocz. nauk. Pol. Tow. Ochr. Przyr. „Salamandra", Poznań, 7: 87-99.

Mielewczyk S. 2003. Wiosenny stan entomofauny (*Odonata, Heteroptera, Coleoptera*) w rzece Warcie i zbiornikach przyrzecznych w Nadwarciańskim Parku Krajobrazowym. Rocznik Naukowy Polskiego Towarzystwa Ochrony Przyrody „Salamandra", 7: 87-99.

Mielewczyk S., Tończyk G. 2004. *Heteroptera*; *Nepomorpha*. In: W. Bogdanowicz, E. Chudzicka, I. Pilipiuk, E. Skibińska (eds). Fauna Polski. Charakterystyka i wykaz gatunków. Muzeum i Instytut Zoologii PAN, Warszawa, 228-230.

Pałka K., Dębała A., Hołowiński M., Łupiński D., Wasiluk D. 2002. Motyle dzienne *Rhopalocera* doliny Bugu. In: A. Dombrowski, Z. Głowacki, W. Jakubowski, I. Kovalchuk, M. Nikiforov, Z. Michalczyk, W. Szwajgier, K.H. Wojciechowski (eds). Korytarz ekologiczny doliny Bugu. Stan – Zagrożenia – Ochrona. Fundacja IUCN Poland, Warszawa: 155-168.

Pliūraitė V., Kesminas V. 2004. Species composition of macroinvertebrates in medium-sized Lithuanian rivers. Acta Zoologica Lituanica, 14 (3): 10-25.

Płaska W. 2002a. Seasonal changes of zoopleuston in the shallow littoral zone in the Uściwierz Lake (the Lublin Polesie Region). Acta Agrophysica, 67: 245-248.

Płaska W. 2002b. Zonality in the occurrence of zoopleuston in the shallow littoral of the Piaseczno Lake (the Lublin Polesie Region). Acta Agroph., 67: 249-254.

Płaska W. 2002c. Preliminary researches on species composition of water bugs (*Heteroptera aquatica*) in nine lakes of Łęczyńsko-Włodawskie Lakeland. Annales Universitatis Mariae Curie-Skłodowska, sec. C, 57: 119-126.

Płaska W. 2003. Pluskwiaki wodne (*Heteroptera aquatica*) jako wskaźniki stanu ekologicznego wód płynących (badania wstępne). Acta Agrophysica, 68: 493-499.

Przewoźny M., Buczyński P., Mielewczyk S. 2005. Chrząszcze wodne (*Coleoptera: Adephaga, Hydrophiloidea, Byrrhoidea*) doliny Bugu w województwie lubelskim (południowo-wschodnia Polska). Nowy Pamiętnik Fizjograficzny, 4 (1-2): 19-47.

Serafin E. 2004. Species diversity of the caddisflies (*Trichoptera*) in the left-bank River Bug valley. Teka Komitetu Ochrony i Kształtowania Środowiska Przyrodniczego, l: 195-201.

Schöll F., Błachuta J. Sonnenburg F., Soldan P. 2003. Makrozoobentos Odry 1998-2001.

Międzynarodowa Komisja Ochrony Odry przed Zanieczyszczeniem, Wrocław, 49 pp.

Schöll F. (Ed.) 2002. Das Makrozoobenthos des Rheins 2000. Internationale Kommission zu Schutz des Rheins, Koblenz, 38 + 8 pp.

Szwajgier W., Kovalchuk I., Michalczyk Z., Turczyński M. 2002. Fizjograficzna charakterystyka doliny Bugu i jego dorzecza. In: A. Dombrowski, Z. Głowacki, W. Jakubowski, I. Kovalchuk, M. Nikiforov, Z. Michalczyk, W. Szwajgier, K.H. Wojciechowski (eds). Korytarz ekologiczny doliny Bugu. Stan – Zagrożenia – Ochrona. Fundacja IUCN Poland, Warszawa, 17-28.

Tenenbaum S. 1921. Pluskwiaki (*Rhynchota*) z Ordynacji Zamojskiej. Pamiętnik Fizjograficzny, 26, zool.: 1-15.

Trojan P. 1992. Analiza struktury fauny. Memorabilia Zoologica, 47: 1-121.

Wróblewski A. 1980a. Stan zbadania entomofauny wodnej w Polsce. Wiadomości Entomologiczne, 1 (4): 235-240.

Wróblewski A. 1980b. Pluskwiaki (*Heteroptera*). Fauna słodkowodna Polski, Warszawa – Poznań, 8: 1-157.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

DISTRIBUTION OF *ALLIUM URSINUM* L. IN LITHUANIA

Birutė Karpavičienė

Karpavičienė B. 2006. Distribution of *Allium ursinum* L. in Lithuania. *Acta Biol. Univ. daugavp., 6 (1-2): 117 - 121.*

Allium ursinum subsp. *ursinum* occurs naturally in Lithuania. The habitats of the species are concentrated in the central and western lowlands of Lithuania. It occurs frequently on loamy soils with a low phosphorus and high humus content. The pH of the soils on which *A. ursinum* grows varies between 4.2 and 7.5. It occupies flat areas and slopes with northern aspect. Communities with *A. ursinum* in Lithuania can be assigned to the *Alnion incanae* and *Carpinion betuli* alliances of the *Querco-Fagetea* class.

Keywords: *Allium ursinum*, distribution, infraspecific variation, Lithuania

Birutė Karpavičienė. Institute of Botany, Laboratory of Economic Botany, Žaliųjų Ežerų 49, LT-08406 Vilnius, Lithuania; e-mail biruta.k@botanika.lt

Introduction

Allium ursinum, or bear˙s garlic, is naturally widespread in temperate Europe to the Caucasus. It is the species of category 5 (Rs) of the Red Data Book of Lithuania (Kundrotas, 2005) as well as included in the Red Data Books of the neighbouring countries, Latvia (Ingelög et al., 1992) and Belarus. However, only sparse data concerning the prevalence of *A. ursinum* and its infraspecific taxa in Lithuania and neighbouring countries have been published.
The aim of this work is to clarify the distribution of *A. ursinum* and its infraspecific taxa in Lithuania as well as ascertain the differentiation of its habitats.

Material and methods

The registration of habitats of *Allium ursinum* was based on herbarium material, personal observations and questionnaires of foresters. The species distribution in Lithuania was mapped applying the national grid system (Gudþinskas, 1993).

The surface of pedicels in *A. ursinum* was studied on 32 specimens of herbaria of Vilnius University (WI), Institute of Botany (BILAS) and Kaliningrad State University as well as on living material from 38 populations.

Chemical analysis of soil was done at the Sector of Chemical Analysis of the Institute of Botany: pH was determined by means of a potentiometer,

total contents of nitrogen, P_2O_5 and humus were done by photoelectric colorimeter, K_2O – by flame photometer.

Field studies were performed in 2000–2004. Phytosociological assessments were carried out according to J. Braun-Blanquet (1964) approach of vegetation investigation and classification. The total plant coverage was estimated visually for each vegetation layer in percentage.

Results und Discussion

The species *A. ursinum* is subdivided into two subspecies according to the smoothness of pedicel surface (Fig. 1). *A. ursinum* subsp. *ucrainicum* Kleop. et Oxner, with smooth pedicels, occurs in the eastern part of the species distribution area, and *A. ursinum* subsp. *ursinum*, with scabrid pedicels and numerous papillae, occurs in the western part of the distribution area (Stearn, 1980). According to J. Sojįk (1968) the border between the distribution areas of these subspecies runs through the Baltic states and Kaliningrad region with *A. ursinum* subsp. *ucrainicum* as well as some cline occurring in Lithuania.

The review of *A. ursinum* specimens in the herbarium of Kaliningrad State University revealed that *A. ursinum* subsp. *ursinum* occurred in neighbouring Kaliningrad region because all studied specimens indicated typical characters of the subspecies – scabrid pedicels with numerous papillae.

Among Lithuanian populations only the southernmost one contained individuals with smooth or slightly scabrous pedicels. The other populations dominated by individuals with clearly papillated pedicels, although single individuals were found in two populations with smooth pedicels as well. Based on these data it could be assumed that *A. ursinum* subsp. *ucrainicum* is not distributed in Lithuania, as reported by J. Sojįk (1968), instead it is *A. ursinum* subsp. *ursinum* and some intermediate forms.

Information was collected on more than 100 habitats of *Allium ursinum* in Lithuania. Populations of *A. ursinum* varies as for area occupied and density of plants: from spots with single individuals to large pure stands covering several hectares. The most of habitats are concentrated in the central and western lowlands of Lithuania (Fig. 2). There are the largest stands of *A. ursinum* in this area as well. Meanwhile, the species is rare in the southern and eastern parts of the country.

One of the possible reasons of uneven distribution of *A. ursinum* is historical. M. Hermy (1992) assumes that the species belongs to the category of ancient forest species, which are unable or almost unable to establish in secondary forests. This assumption is partly confirmed by the inventory of forests potentially most valuable from the biological point of view (Kurlavičius, Mozgeris, 2003). According to this inventory the most of such forests are concentrated in the central Lithuania. There is also known that southern and eastern parts of the country are mostly occupied by secondary forests (Basalykas et al., 1958), where *A. ursinum* rarely occurs.

The most of the habitats occur on flat areas (50 %) and slopes with northern aspect (26 %). The rest were identified on the slopes with eastern (11 %) and western (8 %) aspects. No one habitat was found on slopes with southern aspect. 89 % of studied habitats were located next to the rivers, rivulets and springs. Although it is reported that *A. ursinum* avoided waterlogged soils (Tutin, 1957), in the current study it was found thriving on swampy and springy slopes sinked with fresh water and high humus content (8.8–17.9 %). Humus content in the soil of the others habitats varied from 3.7 to 8.1 % (6.0±0.3 % on average). The pH of the soils on which *A. ursinum* occurs in Lithuania lies between 4.2 and 8.1. The soil phosphate content in all habitats was low (96.3±13.0 mg/kg on average). According to O. Honnay et al. (1998) the high soil phosphate content inhibits the colonization of ancient-forest species. Moreover, soil phosphate may be used in archaeology as an indicator of former agricultural land use (Gebhardt, 1982).

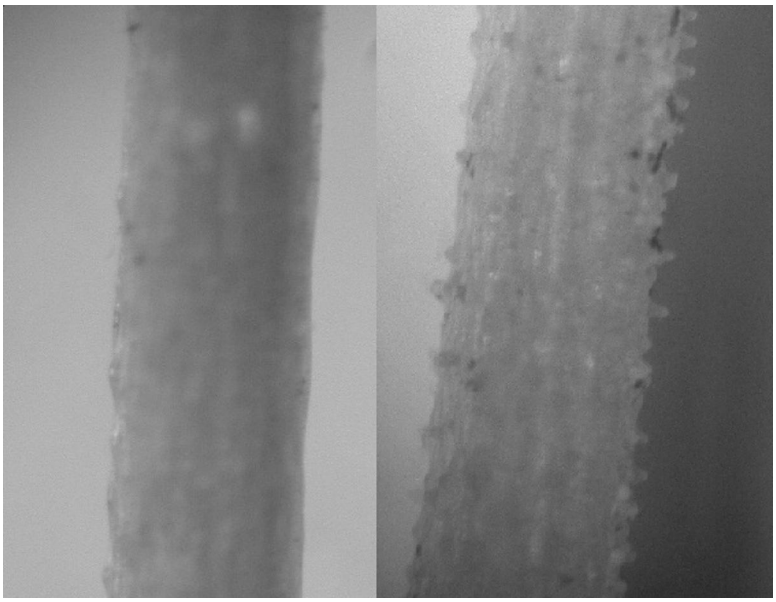


Fig. 1. The surface of pedicels of *Allium ursinum*: smooth (on the left) and scabrid with papillae (on the right)

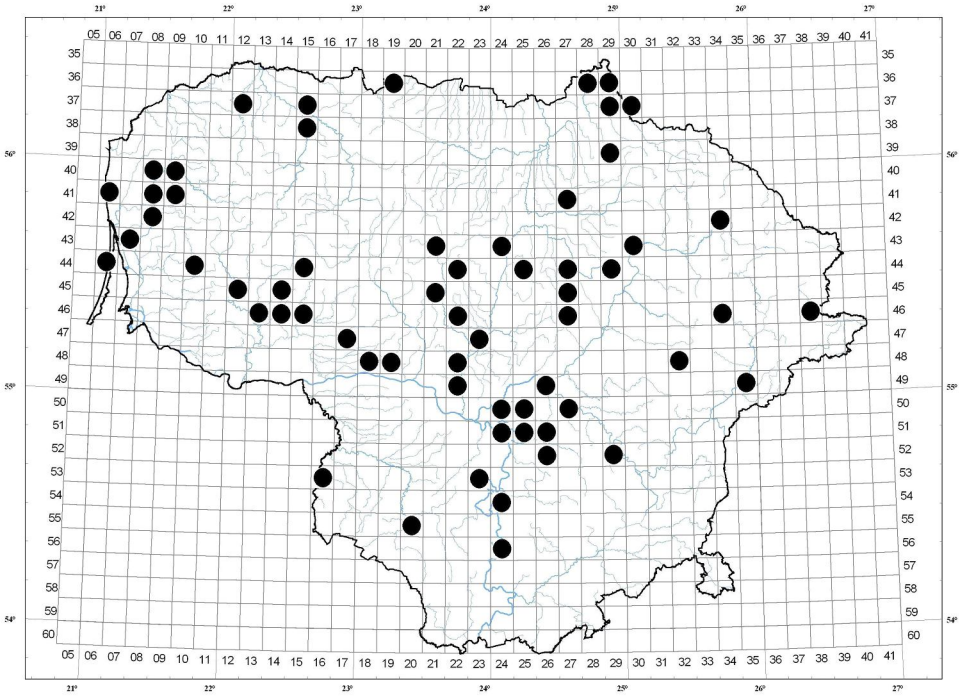


Fig. 2. Distribution of *Allium ursinum* in Lithuania

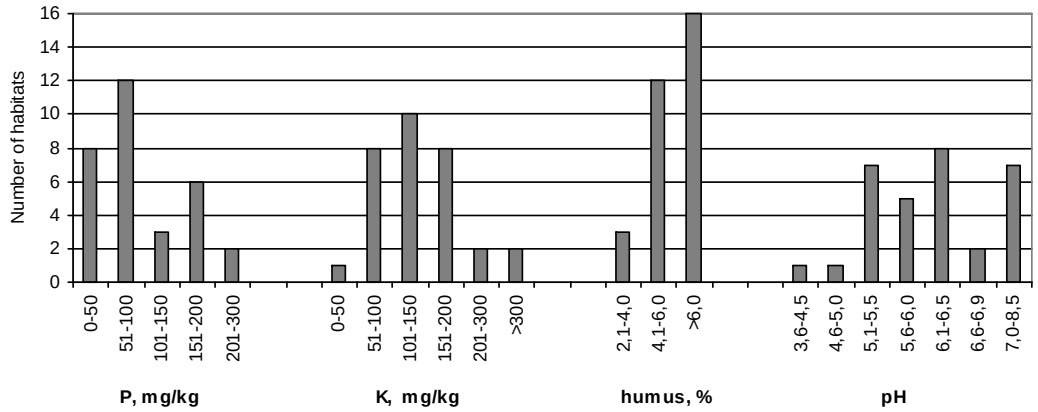


Fig. 3. Variation of soil chemical characteristics in the habitats of *Allium ursinum*. P – P_2O_5; K – K_2O

The communities with *A. ursinum* in Lithuania can be assigned to the *Alnion incanae* Pawłowski 1928 and *Carpinion betuli* Issler 1932 alliances of the *Querco-Fagetea* class. The coverage of tree layer ranges from 10 to 100 %. More abundant and frequent was *Fraxinus exelsior* often accompanied by *Acer platanoides, Alnus glutinosa, A. incana* and *Tilia cordata*. *Ulmus glabra, Corylus avellana, Lonicera xylosteum* and *Padus avium* form lower tree and shrub layers. The overgrown shrub layer of *Corylus avellana* as well as predominance of *Betula pendula* and *Populus tremula* in the tree layer of some communities indicates anthropogenic changes in their structure.

The cover of herbs was usually dense and dominated by *A. ursinum*. The coverage of fully developed *A. ursinum* plants in studied populations ranged from 5 to 100 % (63 % on average). In summer, after the decaying of *A. ursinum* aboveground parts, the freed ground is occupied by another herbaceous species. In herb layer, most constant and abundant species were *Aegopodium podagraria, Lamiastrum galeobdolon* and *Mercurialis perennis*. The cover of the moss layer reached from 5 – 80 % (33 % on average). The dominant and most constant moss species were *Plagiomnium undulatum* and *Eurhynchium angustirete*.

Many habitats of *A. ursinum* in Lithuania are located in protected areas: forest reserves and regional parks. However, human activities take place even there. More than 10 % of studied populations were registered to occur in clear cutting areas. It was observed that *A. ursinum* is more affected by unfavourable factors, such as fungi and frosts, namely, in clear cuttings as well as in forests with thin cover. In certain years the sexual reproduction of the species does not take place there at all.

References

Basalykas A., Bieliukas K., Chomskis V., Červinskas E., Garmus P., Gudelis V., Kaušyla K., Mačionis A., Natkevičaitė M., Seibutis A., Styra B., Tarvydas S. 1958. Lietuvos TSR fizinė geografija. 1. Vilnius.

Braun-Blanquet J., 1964: Pflanzensoziologie. Grundzuge der Vegetationskunde. – Wien, New York.

Gebhardt H., 1982: Phosphatkartierung und bodenkundliche Geländeuntersuchungen zur Eingrenzung historischer Siedlungs- und Wirtschaftsflächen der Geestinsel Flögeln, Kreis Cuxhaven. – Probl. der Kustenforschung im sudlichen Nordseegebiet, **14**: 1–19.

Gudþinskas Z. 1993. Genus *Ambrosia* L. (*Asteraceae*) in Lithuania. Thaiszia (Koðice) 3: 89–6.

Hermy M. 1992. Compositional development of deciduous forests from non-forest precursors in northern Belgium: evidence from historical ecology. In: A. Teller, P. Matthy, J.N.R. Jeffers (eds.), Responses of forest ecosystems to environmental changes. London, 437–444 p.

Honnay O., Degroote B., Hermy M., 1998: Ancient-forest plant species in western Belgium: a species list and possible ecological mechanisms. – Belgian journal of botany, **130(2)**: 139–154.

Ingelög T, Andersson R., Tjernberg M. (eds.), 1993: Red Data Book of the Baltic Region. – Uppsala – Riga.

Kundrotas A. 2005. Dėl aplinkos ministro 2003 m. spalio 13 d. įsakymo Nr. 504 "Dėl į Lietuvos raudonąją knygą įrašytų saugomų gyvūnų, augalų ir grybų rūšių sąrašo patvirtinimo" pakeitimo. Valstybės žinios 76-2784

Kurlavičius P., Mozgeris G. 2003. Biologinės įvairovės apsauga Lietuvos miškuose – naujos galimybės. In: Lietuvos biologinė įvairovė. Vilnius, 41–44 p.

Soj?k J. 1968. Rozð?¸ en?plemen *Allium ursinum* L. v ? eskoslovensku. Preslia, 40(3): 294–300.

Stearn W.T. 1980. *Allium* L. In: T.G. Tutin, V.H. Heywood, N.A. Burges, D.M. Moore, D.H. Valentine, S.M. Walters, D.A. Webb (eds.), Flora Europaea 5. Cambridge, 49–69 p.

Tutin T. G., 1957: Biological flora of the British isles. *Allium ursinum* L. – Journal of Ecology, **45**: 1003–1010.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

ISOENZYME POLYMORPHISM OF VENDACE (*COREGONUS ALBULA*) OF THE LAKES LEJAS AND NIRZAS IN LATVIA

Jeļena Oreha, Natālija Škute, Artūrs Škute

Oreha J., Škute N., Škute A. 2006. Isoenzyme polymorphism of vendace (*Coregonus albula*) of the lakes Lejas and Nirzas in Latvia. *Acta Biol. Univ. Daugavp., 6 (1-2): 123 - 133.*

Isoenzyme systems of vendace *Coregonus albula* from 2 lakes of Latvia were studied. Muscle tissue homogenate was used for electrophoretic investigations in polyacrilamide gel. Four izoenzyme systems malic enzyme, malate dehydrogenase, peroxide dismutase, esterases and non – specific protein system were analysed. Sixteen polymorphic loci were selected for the genotype analysis of two vendace populations. Across whole systems analysis of genotypes show that numbers of heterozygotes are different from number of homozygotes in Lake Lejas a little. The analysis of genotypes of vendace population from Nirzas lake are showed that homozygote strongly predominate over heterozygotes. Follow that analyses there is some shortage of heterozygotes in both population. That genetic instability is a characteristic of vendace population as a little as a large in both studied lakes. We regard necessary to carry out additional researches on the given question, to give more affirmative answer about the reasons of genetic instability of populations

Key words: *Coregonus albula*, izoenzyme system, homozygote, heterozygote, genotypes.

Jeļena Oreha, Natālija Škute, Artūrs Škute. Department of Biology, University of Daugavpils, Vienības Str. 13, Daugavpils, LV – 5401, Latvia; e – mail: jelena@dau.lv , natash@dau.lv, artur@dau.lv.

Introduction

Coregonine fishes, which belong to the *Salmonid* family, consist of three genera: *Prosopium, Sstenodus and Coregonus*. Based on morphology, contradictory hypotheses have been presented on the phylogenetic relationships within the *Coregininae*.

Vendace (*Coregonus albula*) is a widwespread fish in waters of the Holarctic. North salmonid fishes are known to occur as sympatric forms, differing in their morphology and life history characters. At least a part of this diversity has evolved after the last glaciations (Hansen et al. 1999). Due to their short evolutionary history, these sympatric forms represent a potential to study speciation in its early stages (Bernatchez 2004). Usually sympatric forms occur as “species pairs” but in some cases four to six sympatric forms can be distinguished (Sendek 2004).

Some authors classify all Eurasian vendace as one species (Покровский 1967, Дрягин и др. 1969, Шапошникова 1976). There is a possibility that European and Siberian vendace represent two rases of one and the same widespread species.

Three evolutionary non – exclusive have been proposed to explain this diversity. Firstly, the forms may simply represent phenotypic plasticity within single spawning population. Phenotypic differentiation may arise in response to variable feeding environments during ontogeny (Hindar & Jonsson 1993; Skulason & Smith 1995). Secondly, the forms may also have diverged in allopatry, subsequently invading the same lake. After double or multiple invasions the forms have been able to maintain their differences. The third scenario is that the forms have developed in sympatric, as has been documented in other species. It has been argued that competition could be the diversifying force through which character release can lead to differentiation in the absence of other closely related species (Bernatchez et al. 1999).

Some lakes of Europe are inhabited by sympatric forms of vendace, which spawn at different time of the year (spring, autumn, winter) (Schulz & Freyhof 2003). Hence separate species of vendace in Europe should be distinguished. It is supposed that spring – and winter – spawning vendace are of poliphiletic origin.

Genetic differetiation among sympatric populations has been documented in many salmonid species, for example lake whitefish *Coregonus clupeaformis* (Mitchill) (Bernatchez et al. 1999). In whitefish (*Coregonus lavaretus* L.) several sympatric forms are often recognized, and management and exploitation is often based on the characterization of forms based on the number of gillrakers (Sandlund et al. 2002).

In Europe, isoenzyme analysis has been used in the investigation of vendace populations for 20 years already. There is no information on isoenzyme systems in vendace from Latvian lakes. The purpose of this study was to determine enzyme systems and compare genotypes in vendace from Nirzas and Lejas lakes of Latvia.

Study area

Lake Nirzas is in Nirzas rural municipality of Ludzas region of Latvia. The lake's area is 552 ha with maximum depth 21 metres (a middle depth is 8,2 meters). This is flowing lake. There are one stream and some ditches flowing in and one stream is flowing out. In addition to whitefish, there are perch (*Perca fluviatilis*), pike (*Esox lucius*), roach (*Rutilus rutilus*), bream (*Abramis brama*), tench (*Tinca tinca*), eel (*Anguilla anguilla*), pike – perch (*Stizostedion lucioperca*) and less often ruffe (*Gymnocephalus cernua*), white bream (*Blicca bjoerkna*), burbot (*Lota lota*), crucian carp (*Carassius carassius*), bleak (*Alburnus alburnus*), ide (*Leuciscus idus*), rudd (*Scardinius erythrophthalmus*).

Lake Lejas is in Kombuu rural municipality of Kraslavas region of Latvia. The lake's area is 177 ha with maximum depth 34 meters (a middle depth is 8,2 meters). This is flowing lake with three small islands. There are five ditches are flowing in and river Dubna is flowing out. In addition to whitefish, there are perch (*Perca fluviatilis*), pike (*Esox lucius*), roach (*Rutilus rutilus*), tench (*Tinca tinca*), crucian carp (*Carassius carassius*) (www.ezeri.lv).

Material and methods

There were 69individuals from Lejas and Nirzas lakes of Latvia investigated for isoenzyme system analysis. The samples were collected from Nirzas and Lejas lakes.

Liver tissue homogenate of vendace was used for electrophoretic investigations of isoenzyme systems. The defrosted liver tissue was homogenised in a glass homogeniser, using the buffer 0,2M Tris – HCl, pH 8,0; 0,01ml/ml Triton X – 100; 4mg/ml $MgCl_2$; 0,2mg/ml NADP. The homogenization ratio was 1:2 (tissue: buffer), and 10 □ F20ģl of the homogenate was used for the electrophoretic analysis.

To prevent enzyme degradation, the prepared homogenates were kept at a temperature of –20 ^{0}C. (Глазко & Созинов 1993).

Polyacrilamide gel (PAAG) was used as a supporting medium. The vertical gel electrophoresis apparatus was utilised for isoenzyme electrophoresis in a vertical PAAG block. Gel plates (115x15x3mm), were prepared according to modified Davis and Raymond's protocols (Paulauskas & Tubelyte – Kirdiene 2002). To separate malic enzyme (ME), malate dehydrogenase (MDH), and peroxide dismutase (SOD) the one – layer 5% PAA gel was used. The two – layer PAA gel (5%/ 7,5%) was used for the separation of esterases (EST) and non – specific protein (NSP) systems. A plate placed into gel before its hardening formed cavities in the medium. These were filled with the invetigated homogenate before electrophoresis. The polymerisation of gel lasted 15 – 20 minutes. Electrode vessels were filled with the operating electrode buffer. A 40% sacharoze solution was added to the homogenate to make samples more, viscous and to prevent their movement in gel the bromphenol blue was added to the homogenate. For isoenzyme systems was used Tris – EDTA H_3BO_3 buffer, pH~ 8,4 (Paulauskas & Tubelyte – Kirdiene 2002).

Before electrophoresis, operating buffers were prepared from these solutions by adding distilled water 1:10 (buffer: water). Electrophoresis was performed by three stages: pre – electrophoresis (voltage 160V, duration 30 min); withdrawal of samples from cavities (80V, 40mA, 20min); and operating mode (250V, 110 – 140mA, 1 – 3hrs). A cooling system was used to maintain the temperature of 3 – 5 ^{0}C, in the course of electrophoresis, which lasted for 2 – 3 hours.

After electrophoresis, gels were incubated in stain at 37 ^{0}C. Dyeing mixtures for the separation of enzyme activity zones were prepared according to standard protocols (Harris & Hopkinson 1976) with some modifications (Paulauskas & Tubelyte – Kirdiene 2002).

Electrophoresis of five systems was performed: malic enzyme (ME), esterases (EST), non – specific protein (NSP), malate dehydrogenase (MDH), and peroxide dismutase (SOD).

The enzyme nomenclature follows the IUBNC (International Union of Biochemistry Nomenclature Committee 1984) regulation (http://www.chem.qmul.ac.uk/iubmb/enzyme/index.html#recommend).

When analysing gels, the distribution of protein fractions in phoregrams was assessed on the basis of relative electrophoretic mobility. Enzyme activity zones were numbered with respect to their position between the cathode and anode. The zone nearest the anode was marked as number 1, others being numbered respectively in ascending order. Protein fractions in zones were identified as follows: E (fast), D (less fast), C (intermediate), B (slow moving), A (more slow moving). The genetic control of the corresponding isoenzymes (separate loci and corresponding alleles was interpreted in accordance with literature data (Vuorinen 1984) and standard protocols (Harris & Hopkinson 1976, Paulauskas & Tubelyte – Kirdiene 2002).

The computer program "BIOSYS – 2" (Swofford & Selander 1997) was applied for the analysis of isoenzyme systems and frequencies of genes and genotypes.

Results

Analysis of enzyme systems:

1. Malate dehydrogenase (MDH, Mdh, E. C. 1.1.1.37).

NAD – dependent MDH is a dimer. The electrophoresis showed a two polymorphic zones, which are genetically controlled by the locus Mdh – 2 and Mdh – 3. It was founded only one polymorphic zone in this isoenzyme system of vendace from lakes of Lithuania (Kaupinis et al. 2004). (Fig. 1)

2. Peroxide dismutase (SOD, Sod, E. C. 1.15.1.1)

The SOD enzymes in vendace show two polimorphic zones on phoregrame. Sod – 1 and

Table 1. Numbers of observed (Go) and expected (Ge, Hardy – Weinberg equilibrum) genotypes in vendace population from two Latvian lakes

Locus	Genotype	Nirzas		Lejas	
		Go	Ge	Go	Ge
Mdh – 2	A – A	23	20.194	3	2.545
	A – B	19	24.612	2	2.909
	B - B	10	7.194	1	0.545
Mdh - 3	A – A	5	1.681	1	0.909
	A – B	8	14.637	3	3.182
	B - B	33	29.681	2	1.909
Me – 2	A – A	19	13.087	2	0.909
	A – B	5	16.826	1	3.182
	B - B	11	5.087	3	1.909
Me – 3	A – A	19	11.144	0	0.909
	A – B	9	24.711	5	3.182
	B - B	21	13.144	1	1.909
Sod – 1	A – A	9	12.478	0	0.091
	A – B	18	12.783	1	1.636
	A - C	6	4.261	1	0.182
	B – B	1	3.043	4	3.273
	B – C	1	2.130	0	0.818
	C - C	0	0.304	0	0.0
Sod – 2	A – A	33	31.456	1	0.545
	A – B	3	4.494	0	1.818
	A - C	2	3.595	2	1.091
	B – B	1	0.127	2	0.909
	B – C	0	0.253	1	1.364
	C - C	1	0.076	0	0.273
Nsp – 2	A – A	0	0.171	0	0.273
	A – B	1	1.829	0	0.818
	A - C	3	1.829	3	1.636
	B – B	2	3.429	1	0.273
	B – C	11	7.314	1	1.636
	C - C	1	3.429	1	1.364
Nsp – 3	A – A	12	7.886	0	0.545
	A – B	0	8.229	4	2.909
	B - B	6	1.886	2	2.545
Nsp – 4	A – A	6	4.371	0	0.909
	A – B	6	9.257	5	3.182
	B - B	6	4.371	1	1.909
Nsp – 5	A – A	5	4.371	1	0.091
	A – B	8	9.257	0	1.818
	B - B	5	4.371	5	4.091
Nsp – 6	A – A	0	0.789	0	0.091
	A – D	2	0.632	0	0.909
	A – E	3	1.895	2	0.909
	D – D	0	0.053	2	0.909
	D – E	0	0.632	1	2.273
	E – E	0	0.789	1	0.909
	A – B	0	1.579		
	A – C	1	0.316		
	B – B	1	0.526		
	B – C	0	0.263		
	B – D	0	0.526		
	B – E	3	1.579		
	C – C	0	0.0		
	C – D	0	0.105		
	C – E	0	0.316		

Nsp – 7	A – A	0	4.371	1	1.364
	A – C	17	8.743	4	3.273
	C – C	0	3.886	1	1.364
	A – B	1	0.514		
	B – B	0	0.0		
	B – C	0	0.486		
Nsp – 9	A – A	0	2.6	2	1.364
	A – B	14	8.8	2	3.273
	B - B	4	6.6	2	1.364
Est – 3	A – A	11	16.612	1	1.909
	A – B	8	6.874	2	1.273
	A - C	15	10.883	3	1.909
	B – B	0	0.641	0	0.091
	B – C	4	2.214	0	0.545
	C – C	0	1.660	0	0.273
	A – D	14	8.019		
	B – D	0	1.631		
	C – D	0	2.583		
	D - D	0	0.883		
Est – 4	A – A	6	5.714	3	3.111
	A – B	4	4.571	2	1.778
	B - B	1	0.714	0	0.111
Est – 5	A – A	7	8.041	2	0.909
	A – B	7	11.959	1	2.273
	A - C	19	11.959	0	0.909
	B – B	6	4.186	1	0.909
	B – C	10	8.670	2	0.909
	C - C	0	4.186	0	0.091

Table 2. Protein and enzyme systems in *Coregonus albula* population in Lejas and Nirzas lakes (M – monomorphic loci; P – polymorphic loci)

Isoenzyme systems	Nirzas Number of loci	Lejas Number of loci
Malate dehydrogenase	2(P)	2 (P)
Peroxide dismutase	2(P)	2(P)
Malic enzyme	2(P)	2(P)
Esterases	3 (P)	3 (P)
Non – specific protein	1 (M) + 7 (P)	1 (M) + 7 (P)
Total	17 (16P)	17 (16P)
Degree of polymorphisms	94,12 %	94,12%

Sod – 2 were detected analogically as in this isoenzyme system of vendace from lakes of Lithuania (Kaupinis et al. 2004). (Fig. 2)

3. Malic enzyme (ME, Me, E. C. 1.1.1.40) ME is a tetramer, NADP – dependent malat dehydrogenase; which catalysis the conversion of L – malate into piruvate. The analysis of vendace phoregrams from Latvian lakes, as well as from Lithuanian lakes (Kaupinis et al. 2004), revealed two polimorphic zones, of this enzyme which are genetically controlled by the locus Me – 2 and Me – 3. (Fig. 3)

Table 3. Quantity of observed homozygotic and heterozygotic genotypes in vendace population in two Latvian lakes

Lejas				Nirzas			
Heterozygotes		Homozygotes		Homozygotes		Heterozygotes	
Genotype	Number	Genotype	Number	Genotype	Number	Genotype	Number
A - B	28	A - A	17	A - A	150	A - B	111
A - C	13	B - B	25	B - B	108	A - C	63
B - C	4	C - C	2	C - C	2	B - C	26
A - E	2	D - D	2	D - D	0	A - E	3
D - E	1	E - E	1	E - E	0	D - E	0
Total	48		47		260	A - D	16
						B - E	3
							222

4. Esterases (EST, Est, E. C. 3.1.1.-)

Esterases are enzymes belonging to hydrolases. The analysis of vendace phoregram from Latvian lakes revealed three polimorphic zones of this enzyme Est – 3, Est – 4, Est – 5. (Fig. 4) In analogical investigation of esterases from Lithuania vandace the five polimorphic zones of Est was found.

5. Non – specific protein system (NSP, Nsp)

Nine zones were emerged in that system. Seven zones were analysed. Locus Nsp – 1 is monomorphic. (Fig. 5).

Discussion

Four isoenzyme systems and nonspecific protein system were used for genetical population

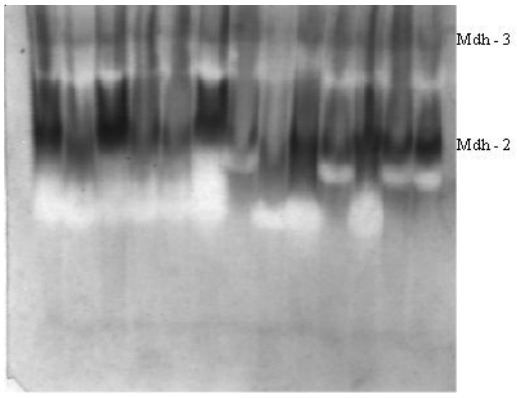


Fig. 1. Izoenzyme MDH spectrum in vendace (*Coregonus albula*) population from lake Nirzas

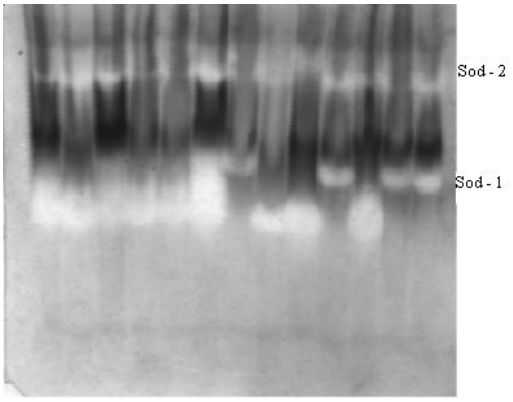


Fig. 2. Isoenzyme SOD spectrum in vendace (*Coregonus albula*) population from lake Nirzas

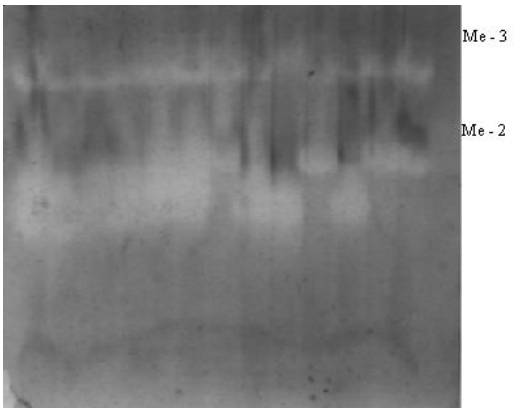


Fig. 3. Isoenzyme ME spectrum in vendace (*Coregonus albula*) population from lake Nirzas

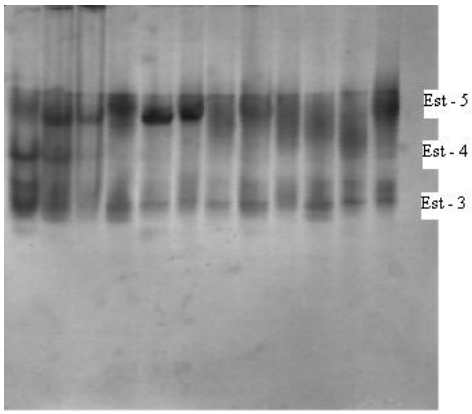


Fig. 4. Isoenzyme EST spectrum in vendace (*Coregonus albula*) population from lake Nirzas

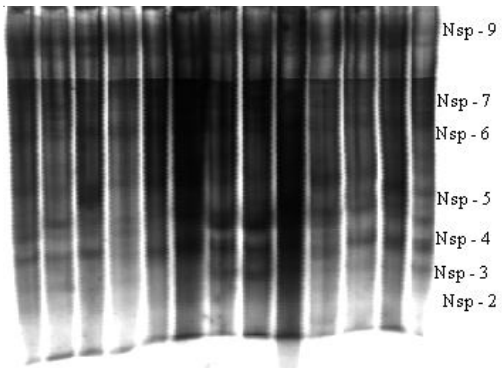


Fig. 5. Protein NSP spectrum in vendace (*Coregonus albula*) population from lake Nirzas

analysis. The greatest number of polimorphic loci was established in non – specific protein and esterases (Table 2).

The number of locus may be very different across populations. The number of locus in used isoenzyme system in vendace population from Nirzas and Lejas lakes are analogical. One and two loci in the Me isoenzyme system were recorded in vendace populations from lakes of Lithuania, Finland and Russia, correspondingly (Vuorinen 1984; Kaupinis et al. 2004; Ļaškeviča 1989).

In Latvian waters, two polimorphic zones were established in the system malate dehydrogenase.

Fig. 6. Quantity of observed and expected genotypes of isoenzyme systems in vendace populations in Nirzas and Lejas lakes

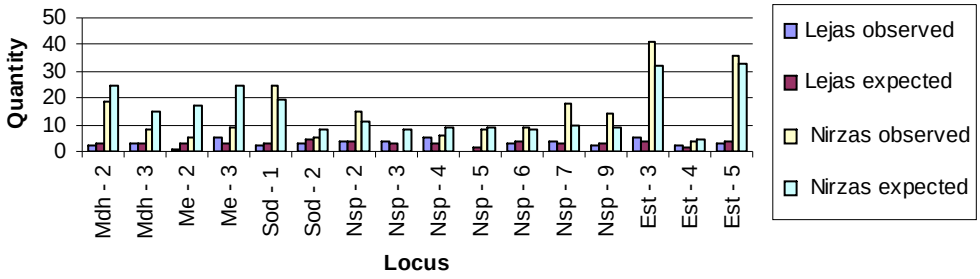
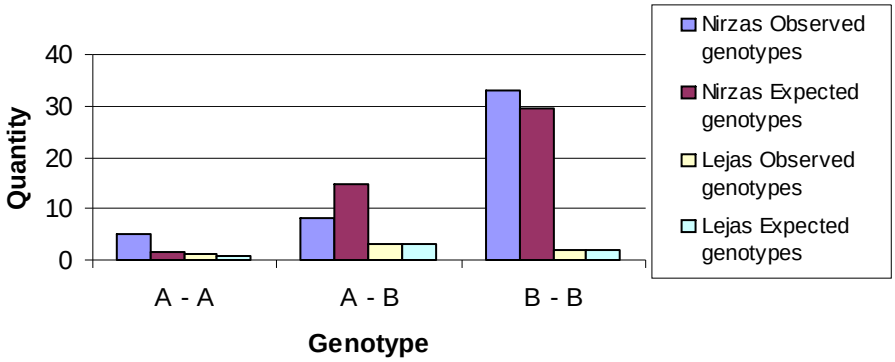


Fig. 7. Quantity of observed and expected genotypes of Mdh - 3 loci in vendace (*Coregonus albula*) populations in Nirzas and Lejas lakes



This result corresponds to that in vendace populations from Finland (Vuorinen 1984, Kaupinis et al. 2004). In contrast populations from England and Lithuania indicate one polimorphic zone in the same system (Beaumont et al. 1995)

In peroxide dismutase only one locus was detected in vendace populations from lakes of Russia, England and Finland. This genetic variability in those populations was lower than in Latvian and Lithuanian populations were two polimorphic loci were observed (Kaupinis et al. 2004).

To accept to attention the number of polimorphic locus in the considered earlier systems it is possible to assume, that closest for Latvian population is a Lithuanian population of *Coregonus albula*, but the most remote is an England population of *Coregonus albula*.

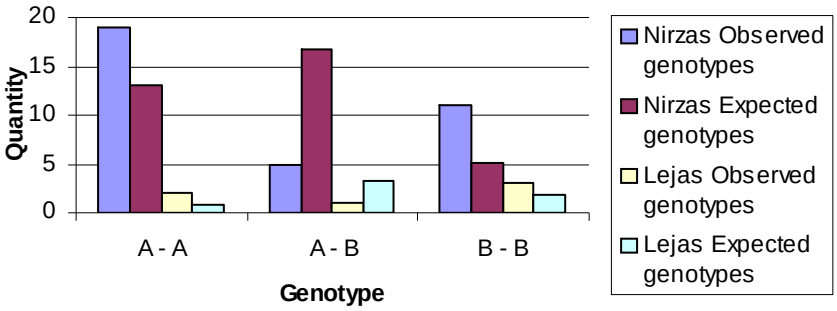
The loci of mention systems show the well readable genotypes on phoregrammes. The observed and expected number genotypes the both populations (by Hardy – Veinberg) can see in table 1. Across whole systems analysis of genotypes show that numbers of heterozygotes are different from numbers of homozygotes in Lake Lejas a little (Table 3). AA and BB genotypes are predominating among of homozygotes and AB and AC genotypes are predominating among of heterozygotes. AB genotype is dominant in the lake Lejas in the whole. EE homozygota and DE heterozygota are more seldom meet.

The analysis of genotypes of vendace population from Nirzas lake are showed that homozygote strongly predominate over heterozygotes (Table 3). The homozygotes AA and BB are meet frequently, AB heterozygota meet slightly seldom and heterozygotes AC and BC meet more rarely. CC homozygota and AE heterozygota meet very rarely. The genotypes DD, EE, DE don't meet at all in population of Lake Nirzas (Table 1). He mentioned genotypes don't meet at all in a result of Lithuanian researches (Kaupinis 2004).

A distribution of genotypes in these isoenzyme systems is different. A comparison of distribution of genotypes, which made on isoenzyme systems base, was assumed the following results. Total frequency of heterozygotes AB, AC and BC in Lake Nirzas of esterases are considerably prevails over homozygotes genotypes AA and BB (Fig. 6.).

Essential domination of observed homozygotes over observed heterozygotes in systems Mdh, Me, Sod of vendace population of Lake Nirzas. This date is a little different in Nsp system from Lake Nirzas (Fig. 6.). Frequencies of heterozygotes and homozygotes are close enough in Lake Lejas. Differences between the observed and expected

Fig. 8. Quantity of observed and expected genotypes of Me - 2 loci in vendace (Coregonus albula) populations in Nirzas and Lejas lakes



genotype numbers may vary at different loci (Fig. 6.). In Mdh – 3 system of vendace population from Lake Nirzas (Fig. 7) the prevalence is expressed of observed and expected according with Hardi – Veinberg low numbers of homozygotes and plain shortage of heterozygotes in this locus. Observed and expected genotypes quality as homozygotes as heterozygotes are approximately similar in this locus. Me - 2 loci show similar results, namely: homozygotes and heterozygotes are predominating over expected date and shortage of heterozygotes is very much expressed (by Hardi – Veinberg) (Fig. 8.). Follow that analyses there is some shortage of heterozygotes in both population. There is very difference in observed and expected quantity of heterozygotes of Mdh and Me loci which there are deficit of heterozygotes in (Fig. 6.). The analogical investigations in Lithuanian lakes show that there is more shortage of heterozygote genotypes in vendace population.

Many authors explain this that *Coregonus albula* population may be spatial deviated in groups inside lake. In this way, arising isolation may lead to inbreeding. The results of anthropogenic influence may be reason of genetical nonstabily in population (catch of fish).

In our case comparing the morphometric parameters of lakes Nirzas and Lejas it is necessary to note that lake Nirzas in 3 times it is more than Lake Lejas on the area. However, its depth in 1, 5 times is less than depth of Lake Lejas, but at the same time, both lakes have identical average depth - 8, 2 meters. As *Coregonus albula* is a pelagic species, we can to assume the conditions of existence in lake are more comfortable for the given species, and a consequence it is the high enough parameter heterozygotes in Lake Lejas. We regard necessary to carry out additional researches on the given question, to give more affirmative answer about the reasons of genetic instability of populations

Acknowledgement

Authors are grateful to Dr. biol., asoc. prof. Algimantas Paulauskas, Ph.D.student Judite Areškevičiūtė and others staff of Molecular ecology laboratory Vytautas Magnus University (Lithuania).

References

Beaumont A. R., Bray J., Murphy J. M. and Winfield I. J. 1995. Genetics of whitefish and vendace in England and Wales. Journal of Fish Biology, 46 (5): 880 – 890.

Bernatchez L. 2004. Ecological theory of adaptive radiation. An empirical assessment from

coregonine fishes (*Salmoniformes*). In: Hendry A. P. & Stearns S. C. (eds.): Evolution Illuminated. Salmon and their Relatives. Oxford University Press. Oxford. Pp. 175 – 207.

Bernatchez L., Chouinard A. and Lu G. 1999. Integrating molecular genetics and ecology in studies of adaptive radiation: whitefish, *Coregonus* sp.; as a case study. Biological Journal of the Linnean Society, 68: 173-194.

Enzyme Nomenclature. 1984. International Union of Biochemistry Nomenclature Committee. Published by Academic Press, Orlando, Florida

Hansen M. M., Mensberg K. – L. D. and Berg S. 1999. Postglacial recolonization patterns and genetic relationships among whitefish (*Coregonus sp.*) populations in Denmark, inferred from mitochondrial DNA and microsatellite markers. Molecular Ecology, 8: 239 – 252.

Harris H. and Hopkinson D. A. 1976. Handbook of enzyme electrophoresis in human genetics. Amsterdam. North Holland Publishing Company.

Hindar K. and Jonsson B. 1993. Ecological polymorphism in Arctic charr. Biological Journal of the Linnean Society, 48: 63-74.

Kaupinis A., Paulauskas A., Bukelskis E. 2004. Isoenzyme systems and genotypes in vendace (*Coregonus albula* (Linnaeus 1758)) from Lithuanian lakes. Acta Zoologica Lithuanica. Vol. 14 (4): 5 – 10.

Paulauskas A. and Tubelyte – Kirdiene V. 2002. Practicum in Genetics: Part III. Genetics of isoenzymes. Kaunas, Vytautas Magnus University publishers (In Lithuanian).

Sandlund O.T., N¿ sje T.F., Saksgård R. and ¨ stbye K. 2002. Gillraker development in juvenile polymorphic European whitefish (*Coregonus lavaretus* L.) in Lake Femund, Norway. Arch. Hydrobiol. Special Issues Advances in Limnology, 57: 553-562.

Schulz M. and Freyhof J. 2003. *Coregonus fontanae*, a new spring – spawning cisko from Lake Stechlin, northern Germany (Salmoniformes: Coregonidae). Ichthyological Exploration in Freshwaters, 14 (3): 209 – 216.

Sendek D.S. 2004. The origin of sympatric forms of European whitefish (*Coregonus lavaretus* (L.) in Lake Ladoga based on comparative genetic analysis of populations in North - West Russia. Annales Zoologici Fennici, 41: 25-39.

Skślason S. and Smith. T.B. 1995. Resource polymorphisms in vertebrates. Trends in Ecology & Evolution, 10: 366- 370.

Swofford D.L. and Selander R.B. 1997. BIOSYS-2: a computer program for the analysis of allelic variation in population genetics and biochemical systematic. Colorado, U. S. A.: Illinois Natural History Survey, Champaign.

Vuorinen J. 1984. Electrophoretic expression of genetic variation and duplicate gene activity in vendace, *Coregonus albula* (Salmonidae). Hereditas, 101: 85-96.

Дрягин П. А., Пирожников П. Л., Покровский В. В. 1969. Полиморфизм сиговых рыб (*Coregoninae*) и его рыбохозяйственное значение. Вопросы ихтиологии 9 (1): 14 - 25.

Глазко В. Н., Созинов И. А. 1993. Генетика изоферментов животных и растений. Киев. Урожай.

Перелыгин А. А. 1989. Генетическая дифференциация популяций европейской ряпушки *Coregonus albula* L. Из трех больших озер Северо - Запада СССР. В кн.: Кирпичников В. С. (ред.) Генетика в аквакультуре. Лнинград: наука. Сс. 113 - 125.

Покровский В. В. 1967. О морфологических особенностях, происхождении и географическом распространении беломорской ряпушки *Coregonus sardinella maris albi* Berg. Извещение Государственного научно - Исследовательского института озерного рыбного Хозяйства 62: 100 - 114.

Шапошникова Г. Х. 1976. История расселения сигов рода *Coregonus.* В кн.: Скарлато О. А. (ред.) Зоогеография и систематика рыб. Ленинград: ЗИН АН СССР. Сс. 54 - 67.

http://www.chem.qmul.ac.uk/iubmb/enzyme/index.html#recommend

www.ezeri.lv

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

RED OAK (*QUERCUS RUBRA* L.) CONDITION AND MORPHOLOGICAL TRAITS DIFFERENCES IN SOUTHERN LITHUANIAN FOREST

Lina Straigyte, Remigijus Zalkauskas

Straigyte L., Zalkauskas R. 2006. Red oak (*Quercus rubra* L.) condition and morphological traits differences in southern Lithuanian forest. *Acta Biol. Univ. Daugavp., 6 (1-2): 135 - 140.*

In Lithuanian forests the first red oaks were introduced about 1875. Today stands mostly are 40-60 years old. In Lithuania still dominates opinion, that *Q.rubra* L. has better volume growth than *Q. robur* and is economically more profitable to raise this alien oak. This index encouraged to plant more *Q. rubra* in the forest. But only a few scientists consider it as invasive tree. The paper analyses condition of the fruiting age red oaks in the forest stands, phenotype differences, morphological traits relations to site types, tree position at stand and relation to stand age. Some significant differences or tendencies were detected in several life history and morphological traits.

Lina Straigyte, Remigijus Zalkauskas; Department of Silvicultute, Lithuanian University of Agriculture, Studentu 11, Akademija-Kaunas, LT-53361; Straigyte@gmail.com

Introduction

Northern red oak was introduced in Europe during 17th century. It was first planted in botanical collections before being planted in forest at the end of 19th century. Plantations were established all over Europe. The first uses in forestry are dated of the end of 19th century and the beginning of the 20th century (Duceusso et al.1997).

These plantations were small (less than 1 or 2ha). In Lithuanian forests red oaks were introduced about 1875 (Ramanauskas, 1963). Mainly they are growing in Klaip?da, ? ilut?, Jurbarkas, Vilkavi?kis, Alytus, Vilnius regions (Kairi?k?tis et al. 1962). The second planting activity was after 50 – 60 years. According to Lithuanian stands inventory data, today there are growing 73 stands with north red oak in Lithuania forest, but only a few of them are mature. Mostly stands are 40-60 years old. In the young age red oak have better volume growth than native *Quercus robur* L (Gradeckas, Malinauskas, 1990). It possess good potential for natural coppice and seed regeneration and there is no marked difference in susceptibility to fungi and insect damages from other native tree species (Danusevi?ius et al. 2002). This index encouraged to plant more *Q. rubra* in the forest. Other dominant opinion – animals less browse red oaks than English oaks.

All alien species in the new ecosystem meet different floristic, climatic environment. Success of invasive species in the new place is often influenced by low enemy quantity (the *enemy release hypothesis*; (Keane & Crawley, 2002). Introduced plants have 84% less fungi species and 24% less virus species than those growing in they natural environment (Mitchell, Power, 2003). *Quercus rubra* in European part grow faster and have less

damage by enemies, than in they natural environment in North America (Daubrée, Kremer, 1993). Low number of the enemies allows to put all plant?s energy not for defense but for growth, which made exotic species a powerful competitor (Blossey, Nötzold. 1995).

The primary focus of this study was to assess red oaks condition in the forest stands, to find out appropriate morphological traits and different types of sites influence morphological traits, diameter growth. The second focus was to clear up if animals browse red oak seedlings.

Study area

This study was conducted on 10 red oak forest stands, which are located in southern Lithuania. There were measured 130 red oak fruiting trees. The following criteria were established for stand selection:
a) red oak must grow in the forest stand;
b) red oak age must be fruiting, not younger.
In majority stands red oaks are dominant, only in a few – second tree species.

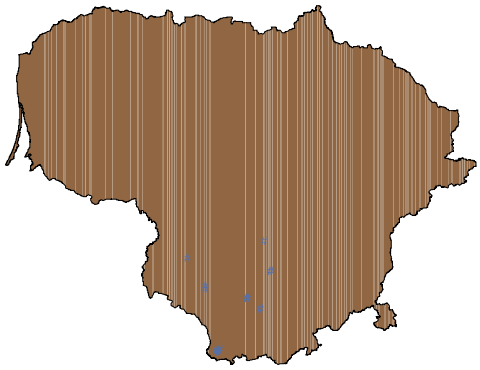


Fig.1. Red oak stands in S. Lithuanian forest

Methods

In every stand there was measured red oak trees age, height, diameter at breast height (DBH), tree position classification by Kraft, crown top condition, crown dieback, crown size, crown density, stem damages, stem straightness, straight stem height, stem form, corner between stem and crown branches accretion. With a Hahlof electronic clinometer was measured the total height of the tree from the ground to the top of the tree and from the ground to the first branches. Tree age record: drill the tree at breast height with an increment borer and count the rings from the outside edge of the core to the pith.

Crown dieback was defined as branch mortality which begins at the terminal portion of a branch and proceeds toward the trunk. Dead branches below the upper 50% of the crown are assumed to have died from competition and shading, and was not considered as part of crown dieback. Binocular was used for assisting in the data collection. Crown density was measured by standing about ½ to 1 length away from the tree. Foliage below the crown ball was not included in the crown (Alexander. 1994).

The tendencies of possible reaction *Quercus rubra* morphological traits on site type, forms dependence on tree position at stand, relations of some morphological traits and stand age were evaluated by PC-ORD indicator species analysis. Indicator values calculated with method of Dufrene, Legendre (1997). INDICATOR VALUES in our analysis show percentage of perfect indication – morphological traits relation to environment conditions - based on combining the values for relative abundance of trees of specific morphological trait at group and relative frequency of this form at group. Relative abundance and frequency of trees of specific morphological traits were calculated at *Quercus rubra* stands. MONTE CARLO test of significance of observed maximum indicator value with 1000 permutations were applied.

In every site there were calculated all red oak seedlings taller than 30 cm. There was made headcount of damaged seedlings after animals browse.

Table1 Tree condition averages

	n=26	n=17	n=32	n=7	n=35	n=13
Soil type	Medium fertility	High fertility	Medium fertility	High fertility	Medium fertility	High fertility
Age class	4	4	5	5	8	8
Height (m)	20	21	26	22	23	26
DBH (cm)	27	25	27	30	38	42
Kraft class	2	3	2	2	2	2
Top condition	whole	whole	whole	whole	whole	whole
Crown dieback	0	0	<30%	<30%	<30%	<30%
Crown size	wide	wide	wide	medium	medium	medium
Crown density	40-50%	40-50%	40-50%	40-50%	40-50%	40-50%
Leaves size	normal	normal	normal	normal	normal	normal
Stem damages	0	0	<25%	0	<25%	0
Straight stem height (m)	9	9	10	10	9	11
Stem form	angular	angular	angular	angular	angular	angular
Crown branch corner	$30\text{-}50^0$	$50\text{-}70^0$	$50\text{-}70^0$	$50\text{-}70^0$	$50\text{-}70^0$	$30\text{-}50^0$

Results and discussion

After the measuring of red oak trees, we grouped them by age and stroke the averages of tree condition. Tree condition data are in Table1.
Most trees have whole tops, normal size of leaves, angular stem form, with 40-50% crown density and belong to 2 Kraft class. Younger trees have wider crown. In the older age crown dieback emerge on numerous occasions, but doesn?t exceed 30%. Straight stem height ranges between 9-11 meters. At young age in both site types this height is the same, only 80 years old trees growing at high-fertility site are taller.

In high fertility site oak has greater diameter of growth in the same age class, than in medium fertility site. Only in younger age (40 years) we

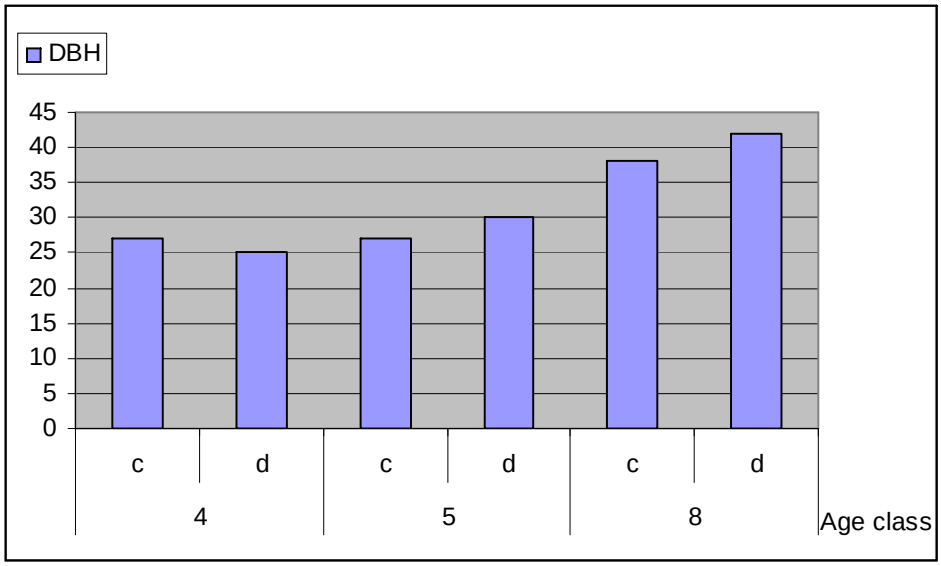


Fig.2. Diameter difference depending on site type
D – high-fertility site, c – medium fertility site.

Table 2 *Quercus rubra* morphological traits relation to site type

Phenotype difference	Max indicator value in group	Site type **d** (high fertility)	Site type **c** (medium fertility)	MONTE CARLO test, p*
		4 stands	6 stands	
Stem straightness SS0	54	35	**54**	0.647
SS1	58	**58**	42	0.503
SS2	64	36	**64**	0.168
SS3	60	7	**60**	0.232
Crown branch angle CC1	33	0	**33**	0.480
CC2	52	28	**52**	0.548
CC3	54	**54**	46	0.703
CC4	56	44	**56**	0.374
CC5	63	6	**63**	0.126
Crown size narrow	50	18	**50**	0.563
Crown size medium	51	49	**51**	0.923
Crown size wide	50	30	**50**	0.540
Crown density CD3	65	26	**65**	0.180
CD4	60	40	**60**	0.271
CD5	48	**48**	43	0.772
CD6	33	8	**33**	0.572

* proportion of randomized trials with indicator value equals to or exceeds the observed indicator value. p = (1 + number of runs >= observed)/(1 + number of randomized runs)

SS0 – straight stem, SS1 – crooked stem, SS2 – two-stemmed tree, SS3 – three or many-stemmed tree.
CC1 - crown branch angle>90^0, CC2 – 70-90^0, CC3 - 50-70^0, CC4 - 30-50^0, CC5 - <30^0.
CD3 - crown density 30-39%, CD4 - 40-49%, CD5 -50-59%, CD6 –density 60-69%.

Table 3. *Quercus rubra* morphological traits relation to tree position at stand

Phenotype difference	**Kraft class 1**	**Kraft class 2**	**Kraft class 3**	**Kraft class 4**	MONTE CARLO test, p
	9 stands	10 stands	8 stands	4 stands	
Stem straightness SS0	**30**	8	1	0	0.166
SS1	*13*	***54***	*14*	*0*	*0.005*
SS2	0	**38**	20	22	0.184
SS3	3	**39**	9	21	0.104
Crown branch angle CC1	*11*	***53***	*13*	*3*	*0.005*
CC2	*2*	***48***	*12*	*2*	*0.028*
CC3	3	2	**14**	0	0.368
CC4	*0*	***46***	*9*	*0*	*0.024*
CC5	3	14	**33**	17	0.227

SS0 - straight stem, SS1 – crooked stem, SS2 – two-stemmed tree, SS3 – three and many-stemmmed tree.
CC1 - crown branch angle >90^0, CC2 – 70-90^0, CC3 - 50-70^0, CC4 - 30-50^0, CC5 - <30^0.

Table 4. *Quercus rubra* morphological traits in relation to stand age

Morphological traits	**4 age class**	**5 age class**	**8 age class**	MONTE CARLO test, p*
	3 stands	4 stands	3 stands	
Stem straightness SS0	11	**60**	24	0.043
SS1	38	21	**41**	0.712
SS2	21	**47**	31	0.303
SS3	4	6	**77**	0.044
Crown branch angle CC1	0	20	7	1.000
CC2	7	**41**	39	0.613
CC3	**35**	30	**35**	1.000
CC4	30	30	**40**	0.447
CC5	0	37	**51**	0.298

found bigger diameter at medium fertility site. Like we see in the Table 1, it is because at this age at high-fertility site trees belong to 3 Kraft class.

There is no significant site type predetermination of morphological traits of *Quercus rubra* (perhaps because of few available stands in analysis), but still some tendencies can be distinguished (Table 2):

- two or many-stemmed tree is more typical for less fertile soil type;
- crown branch angle of 50-70 degree is more common for more fertile soil type while crown branch angle varies at less fertile soil type;
- sparse and wide crown is more common for less fertile soil type.

According to the results, straight stems are more common for trees of first Kraft class (although this test is not significant) (Table 3.).

Quercus rubra morphological forms are better expressed at older stands (Table 4):

- stem branching is more common for older stands;
- according to results, straight stems are common at 50 years old stands, although this might be caused by thinning means;
- sharper crown stem angle is more common to older stands.

Seedling damages after browse

There were measured all red oak seedlings in the 10 different sites.

In every stand, except one, there were found browsed seedlings of red oak. >90% of seedling tops were browsed. But they are still alive and are growing. We can?t agree with opinion, that animals don?t like red oak seedlings.
According to our study results, we state, that health condition of red oak trees is very good, there is small number of fungi, insect damages. They grow big biomass. At the other side, many red oak stems are curved or two-stemmed trees. Straight stem length is only ~10 m. This index is

Table 5. Seedling damages after animal browse

Stand	1	2	3	4	5	6	7	8	9	10
Damage (%)	95	90	90	95	99	99	0	95	95	80

not good for timber production. At last, it is not true, that animals don?t browse red oak seedlings.

References

Blossey B, Notzold R. 1995. Evolution of increased competitive ability in invasive nonindigenous plants: A hypothesis. J. Ecol. 83: 887-889.

Danusevi?ius J., Gabrilavi?ius R., Danusevi?ius D. 2002. Quality of Red Oak (*Quercus rubra* L.) Stands on Abandoned Land. Baltic Forestry, 8 (1): 51-56.

Daubree J B., Kremer A. 1993. Genetic and phenological differentiation between introduced and natural populations of *Quercus rubra* L. ANSFAS.50 (Suppl 1), ELSEVIER, INRA, 271-280p.

Duceusso, H. Bennehart, A. Kremer 1997. Geographic variations of *Quercus rubra* in European tests. Diversity and adaptation in Oak species. Proceedings. 58-67 p.

Dufrene, M. and P. Legendre, 1997. Species assemblages and indicator species: the need for a flexible asymmetrical approach. *Ecological Monographs*, 67: 345-366.

Gradeckas A., Malinauskas A. 1990. Maumed?io ir Raudonojo ??uolo introdukcijos rezultat¸ analiz? ir priemoni¸ ?eldiniams veisti paruo?imas (Introduction of larch species and Red oak and recommendations on establishment of forest of these species). Reports of Lithuanian Forest Research Institute 1990 series, Girionys, pp 152-209 (in Lithuanian).

Kairi?k?tis L. & Ko. 1962. Lietuvos TSR mi?kai (Lithuanian SSR forests). Vilnius, 368 p.

Mitchell, C.E. and A.G. Power, 2003. Release of invasive plants from fungal and viral pathogens. Nature 421:625-627.

Ramanauskas V. 1963. Dendrologija (Dendrology). Vilnius, pp 28-31.

S.A.Alexander. 1994. Forest health monitoring. Field methods guide.

Accepted: 25.09.2006.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

ANTINUTRITIONAL FEED FACTORS IN VARIETIES OF OILSEED RAPE (*BRASSICA NAPUS* L.) AND PEAS (*PISUM SATIVUM* L.) GROWN IN LITHUANIA

Asta Racevičiūtė-Stupelienė, Vilma Šašytė, Romas Gružauskas

Racevičiūtė-Stupelienė A., Šašytė V., Gružauskas R. 2006. Antinutritional feed factors in varieties of oilseed rape (*Brassica napus* L.) nad peas (*Pisum sativum* L.) grown in Lithuania. *Acta Biol. Univ. daugavp., 6 (1-2): 141 -149.*

The aim of the research was to determine the antinutritional factors present in local protein rich feedstuffs (oilseed rape and peas). The chemical analyses of four varieties of winter oilseed rape (*Brassica napus* L.) ('Pastell', 'Kronos', 'Valesca', 'Kasimir') and eight varieties of spring-sown oilseed rape (*Brassica napus* L.) ('Siesta', 'Mozart', 'Hunter', 'Haydn', 'Sponsor', 'SW Landmark', 'Dorothy', 'Trend') showed them to have high level of phytate phosphorus from 4.06 to 5.66 mg/g DM, being comprising from 69 to 80% DM of the total phosphorus. Glucosinolates analyses in the blend of oilseed rape showed, total glucosinolate to be only 7.96 ģmol/g. Four varieties of peas (*Pisum sativum* L.) ('Rainiai', 'Neosypajuscijsia', 'IP-5', 'Sobel') had a high level of galactosides (raffinose) which varied in wide ranged from 2.9% to 9.2% DM. Analyses of NDF and ADF indicated some variability (12.1–13.0% DM and 9.1–10.2% DM respectively) among varieties of peas.

Key words: oilseed rape, peas, antinutritional factors.

Asta Racevičiūtė-Stupelienė, Department of Animal Husbandry, Lithuanian Veterinary Academy, Tilžės str. 18, 47181 Kaunas, Phone: +370 37 363505, E-mail: rasta@lva.lt

Introduction

Oilseed rape is one of the most important oilseeds in the world and in addition to the use of the oil in nutrition or technical applications, the residues of the oil pressing process are used as an excellent vegetable source of energy for animal nutrition (rich in protein). Unfortunately, a variety of antinutritive compounds, such as glucosinolates, phytic acid and others limit the use of oilseed rape and their by-products for susceptible animals (Bjergegaard et al. 1998; Matthäus & Schumann 2003). Although during the last decade varieties of low glucosinolates and erucic acid contents ('double low oilseed rape') have been developed by plant breeding, proper processing or a combination of breeding and processing, they are only used in restricted amounts for monogastric animals (Jensen et al. 1995; Liu et al. 1995; Sørensen 1991; Zyla & Koreleski 1993). The presence of phytates in oilseed rape causes phosphorus, calcium, protein and other nutrient deficiency syndromes in poultry and other monogastric animals (Zyla & Koreleski 1993; Newkirk & Classen 2001). Monogastric animals lack the enzyme needed to di-

gest efficiently phytate in their feed. As a result, they excrete large amounts of P into the environment (Viveros et al. 2000; Pandey et al. 2001).

Peas provide another important source of proteins and amino acids. As it is well documented, peas are known to contain oligosaccharides (raffinose, stachyose, verbascose), which are almost non-digestible and could cause disorders of the digestive tract (Saini 1989). Also a high amount of fibre matters (cellulose, hemicellulose) reduces digestibility of protein and other nutrients of peas (Jeroch 1999). The objectives of the following studies were to determine the antinutritional factors present in local feedstuffs (oilseed rape and peas).

Materials and Methods

Materials

Clean and uncontaminated samples of four varieties of winter oilseed rape (Brassica napus L.) (‘Pastell˙, ‘Kronos˙, ‘Valesca˙, ‘Kasimir˙) and eight varieties of summer oilseed rape (Brassica napus L.) (Siesta, ‘Mozart˙, ‘Hunter˙, ‘Haydn˙, ‘Sponsor˙, ‘SW Landmark˙, ‘Dorothy˙, ‘Trend˙) were taken for analyses. All varieties were grown in Kaunas Research Station of Plant Sorts (Muniškių village) in 2002–2003. Samples of four varieties of peas (‘Rainiai˙, ‘Neosypajusčijsia˙, ‘IP-5˙, ‘Sobel˙) (Pisum sativum L.) were taken for analyses. Peas were grown in Dotnuva Plant Breeding Station (Kėdainių region).

Botanical description of winter oilseed rape (Lietuvos respublikos augalų veislių katalogas 1997; Lietuvos respublikos augalų veislių katalogas 1998; Lietuvos valstybinis augalų veislių tyrimo centras 2003):

‘SW Pastell˙ was developed in Sweden. Plants average high is 116 cm. This sort is very resistant for lodge and seeds don˙t crumble off siliques. These features of variety are evaluated of 9 point. Growing period – 196 days. Seeds are large, 1000 seeds weigh 4.91 grams. Average seeds yield is 4.74 t/ha.

‘Kronos˙ was developed in Germany. Average seeds yield is 3.56 t/ha. Plants are enough high, generally 135 cm height, but don˙t lodge. Seeds don˙t crumble off siliques. It is evaluate of 8.7 point. Plants of ‘Kronos˙ is middle- forwardness. Growing period – 196 days.

‘Valesca˙ was developed in Germany. Growing period – from 321 to 337 days. Average seeds yield is 3.04 t/ha. Plants average high is 143 cm, slightly lodge. In normal circumstances sort is good for winter. It is resistant for seeds crumble off and siliques few pop. Seeds are large, 1000 seeds weigh from 4.10 to 5.14 grams.

‘Kasimir˙ was developed in Germany. Average seeds yield is 2.26 t/ha. Seeds are large, 1000 seeds weigh from 4.10 to 5.20 grams. In normal circumstances sort is good for winter (4-5 point). Plants average high is 148 cm, is resistant for lodge (4.8 pount) and seeds don˙t crumble off siliques (4.2 point). Growing period – from 331 to 337 days.

Summer oilseed rape (Lietuvos respublikos augalų veislių katalogas 1997; Lietuvos respublikos augalų veislių katalogas 1998; Lietuvos valstybinis augalų veislių tyrimo centras 2003; Lietuvos valstybinis augalų veislių tyrimo centras 2005):

‘Siesta˙ was developed in Germany. Average seeds yield is 2.86 t/ha. Plants average high is 120 cm. Growing period – 101 days. It is resistant for lodge (8.7 point) and seeds don˙t crumble off siliques (8.7 point). 1000 seeds weigh 3.66 grams.

‘Mozart˙ was developed in Germany. Average seeds yield is 2.72 t/ha. Seeds are middle-sized, 1000 seeds weigh 3.54 grams. Plants average high is 115 cm. They are strong, slightly lodge (8.1 point), seeds don˙t crumble off siliques (8.6 point). Growing period – 97 days.

‘Hunter˙ was developed in Germany. Average seeds yield is 2.92 t/ha. Seeds are large, 1000 seeds weigh 4.05 grams. Plants average high is 107 cm. Growing period – 99 days. They are re-

sistant for diseases. Plants lodge is evaluated of 8.3 point, seeds crumble off siliques - 8.5 point.

'Haydn' was developed in Germany. Average seeds yield is 2.63 t/ha. Seeds are middle-sized, 1000 seeds weigh 3.57 grams. Plants average high is 113 cm. Growing period – 98 days. Plants lodge is evaluated of 8.2 point, seeds crumble off siliques - 8.5 point.

'Sponsor' was developed in Sweden. Average seeds yield is 2.27 t/ha. Seeds are large, 1000 seeds weigh from 3.20 to 5.10 grams. Growing period – from 91 to 112 days. It is resistant for lodge, seeds don't crumble off siliques.

'SW Landmark' was developed in Sweden. Average seeds yield is 2.91 t/ha. Seeds are large, 1000 seeds weigh 4.13 grams. Plants average high is 111 cm. Plants of 'Kronos' is middle - forwardness. Growing period – 97 days. They are resistant for diseases. Plants lodge is evaluated of 8.0 point, seeds crumble off siliques - 8.6 point.

'Dorothy' was developed in Denmark. Average seeds yield is 2.70 t/ha. Seeds are middle-sized, 1000 seeds weigh 3.99 grams. Plants average high is 108 cm. They are strong, slightly lodge (7.7 point), seeds don't crumble off siliques (8.5 point). Growing period – 96 days. They are resistant for diseases.

'Trend' was developed in Germany. Average seeds yield is 2.65 t/ha. Seeds are middle-sized, 1000 seeds weigh 3.80 grams. Average plants high is 114 cm. Growing period – 97 days. Plants lodge is evaluated of 8.0 point, seeds crumble off siliques - 8.0 point.

Botanical description of pea varieties (Bogužas 1995):

'Neosipajusčijsia' was developed in Ukraine. Blow white, 1 or 2 blossoms in truss, stems short (90-130 cm). Variety is early, growing period – from 70 to 80 days. Pods straight from 5 to 7 cm long. Seeds are globose, smooth, white with yellowy tinct. Mature seeds don't crumble off from pods. 1000 seeds weigh from 220 to 250 grams. This variety is especially plenteous if are growing on pure crop.

'Rainiai' was developed in Lithuania. Blossoms are small, dark red, stems 150-200 cm long. Late - growing period from 112 to 125 days. Seeds are small, oval, steel-purple with black spots, smooth. 1000 seeds weigh from 110 to 135 grams. If ripen condition is unfavourable some few seeds become darken. Variety is quite plenteous. Harvest of green mass is 25.0–28.0 t/ha.

'IP-5' was developed in Hungary. Blossoms are purple or red, big. Stems 140-160 cm long. Growing period – from 78 to 102 days. Mature about 23-34 days early than 'Rainiai'. Apace grow in start of growing period. For the green fodder grow from 35 to 51 days. Seeds are brownish with dark spots; on either side of seeds are grind. 1000 seeds weigh 200 grams.

'Sobel'. Demi-leafles variety of peas was developed in Denmark. Variety is forward, resistant for diseases and lodge. Growing period – from 90 to 96 days, lodge is evaluated of 6 point. Plants are enough short, generally 52–69 cm height, and white blossoms. Seeds are globose, yellow and very large. 1000 seeds weigh from 260 to 300 grams.

The samples were freeze-dried and stored at room temperature in airtight containers prior to chemical analysis. Samples were ground in a hammer mill and passed through a 0.5-mm sieve.

Total P, phytate-P analyses in the rape oilseeds

The amounts of total phosphorus, phytate-P in oilseed rape were investigated using facilities of the Institute of Animal Nutrition, Hohenheim University (Germany).

The phosphorus analyses in oilseed rape were made according to the methods of VDLUFA (Naumann & Bassler 1993) The total phosphorus was measured spectrophotometrically at a wavelength of 420 nm after mineralising the sample by breaking down and converting with vanadomolybdate. The phytate phosphorus

content was determined according to the AOAC-method (Barbara & Oberleas 1986) by exchange of anions. The phytate phosphorus was extracted out of doubled dried sample with diluted 2.5% hydrochloric acid, mixed with EDTA/NaOH solution and put into an anion-exchange-column. Phytate were eluted with 0.7 mol NaCl and broken down by a mixture of concentrated HNO_3/H_2SO_4 to determine the total phosphorus colorimetrically.

Glucosinolates (GSL) analyses in oilseed rape

For the glucosinolates analyses the average sample from blend of all oilseed rape varieties was taken. Glucosinolates were determined by the HPLC gradient method. The type of the column was nuklozyl C18. The length of the wave was 229 nm. All GSL values were converted to ġmol g^{-1} dry weight (EU-Methodenvorschrift: Bestimmung des Ölsaaten Glucosinolatgehaltes 1990; Thies 1988).

Oligosaccharide (raffinose) analyses in peas

Oligosaccharide contents in peas were analysed using facilities of the Institute of Animal Nutrition and Planned Crop Storage, Agricultural Faculty, Martin-Luther-University Halle-Wittenberg (Germany) by HPLC according to Carré (Carré et al. 1995).

Ground samples (1g) were placed into a screw-cap test tube, to which 30ml of 50:50 (vol/vol) methanol-water was added. Samples were well mixed and tubes were placed in a water bath to boil for 30 min. Extraction was filtered and dried using a rotary evaporator at 40 ^{0}C. The residues were extracted with 2 ml of water and centrifuged at 10000 min^{-1} for 5 min. The samples were filtered (size of pore 0.4 ġl). From the filtrate, 10 ġl was injected into the high-performance liquid chromatography (HPLC) analyser. Analysis conditions of HPLC: acetonitril-water was used as a mobile phase (70:30); effusion speed – 1ml/min; pressure – 130 bars; temperature – 30^{0}C; the type of column – nucleosyl 100 NH_2; diameter of column – 4 mm; length of column – 25 cm. The solution composed of 23.9% glucose, 24.8% sacharose, 2.05% raffinose, 1.90% stachyose and 1.07% verbascose was used as the standard of identification.

Neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) analyses in peas

The analyses were done according to the method of Van Soest (Goering & Van Soest 1970). The NDF was measured by boiling 1.00 g sample of peas in a special NDF – solution for about 60 min. (NDF-solution: 93g EDTA ethylenediamine tetra acetic acid – disodium salt and 34g di-sodium tetra borate-decahydrate were dissolved in a beaker in 2 l water. After cooling off, 150g dodecylsulfate-sodium salt and 50 ml 2-ethoxyethanol were added. Triethylene glycol can be used as a substitute due to the toxicity of 2-ethoxyethanol. In another beaker, 22.8g sodium dihydrogenphosphate is dissolved in 2 l water being gently heated up and after cooling off, were added to the first batch. The solution was filled up with distilled water; the pH value had to be between 6.9 and 7.1). Then the boiled samples were filtered through glassfilters (ROBU GLASSFILTER, Borosilicat 3.3, Por 2). The part of peas samples that did not dissolve remains on the glassfilters were rinsed out with hot water and then with acetone. After 60 min the samples were dried at 105^{0}C for at least 8 hours or overnight and after cooling were weighed and the content of NDF was calculated.

The ADF was determined in much a similar way, except a different detergent was used under acid (pH=2) conditions (ADF-solution: 20g N-cetyl-N,N,N-trimethyl-ammoniumbromid are diluted in 1 l sulphuric c = 0.5 mol/l).

The samples were boiled and filtered as in the NDF procedure. Because of a different detergent and acid conditions, hemicellulose and cell solubles dissolved and were filtered away. The residue left was ADF and consisted mainly of cellulose and lignin.

The ADL was measured by further treating ADF with 72% of sulphuric acid; the remains were rinsed out with hot water until pH = 7 and then were dried at 105^{0}C for at least 3 hours and cooled off in desiccator. Glassfilters were incinerated at 500^{0}C for at least 2 hours. After cooling, the glassfilters were weighed, and the content of ADL was calculated.

Hemicellulose was calculated by difference NDF-ADF, and cellulose was calculated from the difference ADF-ADL.

Statistical analysis

Data were subjected to ANOVA procedures using the software package Statistica for Windows, Version 5.0 (StatSoft Inc. 1995).

Results and discussion

The purpose of our investigation was to determine some antinutritional substances in local protein rich feedstuffs, e.g. oilseed rape and peas. The content of total phosphorus and phytate-P of oilseed rape grown in Lithuania are shown in Table 1. Rapeseeds and their by products had a very high level of phytate-P [4.06–5.66 mg/g dry matter (DM)], being about between 69% and 80% DM of the total phosphorus. Our results are similar to those obtained by other authors (Eeckhout & De Paepe 1994; Ravindran et al. 1999; Thompson 1986; Viveros 2000). The highest amount of phytate-P was determined in two varietes of spring-sown oilseed rape – Siesta (78%) and Mozart (78%). Phytate-P amount in summer oilseed rape is statistically higher than in winter oilseed rape ($P<0.0001$). However it doesn˙t depend on the analysed sort ($P=0.3855$). Analogical situation are observed between amount of total P in winter and summer oilseed rape - $P=0.010$ and $P=0.2440$ respectively.

Glucosinolates (GSL) analyses in the blend of oilseed rape showed the total glucosinolate to be only 7.96 ġmol/g. From the separate glucozinolates fractions the highest part consist of progoitrin (3.36 ġmol g^{-1}) and 4-hydroxyglucobrassicin (2.28 ġmol g^{-1}). Other fractions (gluconapoleiferin, gluconapin, glucobrassicanapin, glucobrassicin, gluconasturtiin, 4–methoxyglucobrassicin, neoglucobrassicin) compound from 0.02 to 1.08 ġmol/g. In 2002 other researchers (Šeškevičienė et al. 2002) analysed the total glucosinolates in several varieties of winter and spring-sown oilseed rape. The content of GSL in individual

Table 1. Phytate-P and total P amount in several varieties of rape oilseed

Feedstuffs	Dry matter, %	Phytate-P g/kg DM	CV*, %	Total P g/kg DM	CV*, %
Winter oilseed rape:					
SW Pastell	95.40	4.23^a	0.43	5.83^a	2.72
Kronos	94.59	4.06^a	1.33	5.92^a	0.16
Valesca	95.05	4.30^a	1.25	6.02^a	0.10
Kasimir	95.14	4.30^a	0.64	6.13^a	0.47
Summer oilseed rape:					
Siesta	92.58	5.47^b	1.23	7.00^b	0.43
Mozart	92.16	5.66^b	1.06	7.05^b	1.56
Hunter	90.65	5.52^b	0.59	7.73^b	0.39
Haydn	92.34	5.06^b	1.78	7.14^b	2.34
Sponsor	94.33	5.36^b	2.50	7.23^b	0.33
SW Landmark	91.29	5.29^b	1.56	7.12^b	0.58
Dorothy	93.57	5.31^b	0.98	7.43^b	1.48
Trend	91.76	5.42^b	1.09	7.34^b	0.14

* CV – coefficient of variation

$^{a, b}$ Values within a column not followed by a common letter are significantly different ($P<0.05$)

Table 2. Some antinutritional factors in several varieties of peas, grown in Lithuania (% DM)

Varieties of peas	Oligosaccharides				NDF[a]	CV*, %	ADF[b]	CV*, %	Hemi-cellulose	ADL[c]	Cellu-lose
	Total	CV*, %	Raf-finose	CV*, %							
Rainiai	23.6[d]	2.5	2.9[d]	0.6	12.5[d]	2.5	9.8[d]	1.0	2.7[d]	0.4	9.4[d]
Neosypajus-čijsia	27.2[ef]	1.7	6.6[e]	0.9	13.0[d]	2.3	10.2[d]	0.9	2.8[d]	0.8	9.5[d]
IP-5	21.6[f]	1.9	8.6[f]	0.3	12.9[d]	1.8	10.1[d]	1.4	2.8[d]	0.4	9.7[d]
Sobel	25.8[g]	2.3	9.2[g]	0.5	12.1[d]	1.1	9.1[d]	1.3	3.0[d]	0.5	8.6[d]

* CV – coefficient of variation
[a] NDF – neutral detergent fibre
[b] ADF – acid detergent fiber
[c] ADL – acid detergent lignin
[d - g] Values within a column not followed by a common letter are significantly different (P<0.05)

samples of both oilseed rape types differed significantly reaching in spring-sown oilseed rape 5-22 mmol/g (91% DM) and in winter oilseed rape - 6-17 mmol/g (91% DM). The total concentration of GSL, and the relative proportions of the individual GSL were affected by the genotype of the plant and the agronomic conditions under which they were grown. Supplying large amounts of both N and S to the crop not only increased the total glucosinolate concentration, but also increased the proportion of progoitrin in the glucosinolate fraction (Zhao et al. 1994). The goitrin that is produced from the hydrolysis of progoitrin reduces the incorporation of iodine into the precursors of thyroxine, and it also interferes with secretion of thyroxine (Chubb 1982). Therefore, it is still relevant to control the glucosinolates content, and look at the effect of processing on the nutritional value of oilseed rape and its by products.

Some antinutrition factors in peas are shown in Table 2. The analyses of total oligosccharides and one of the α– galactosides (raffinose) showed a high variation among the seed varieties, e.g. 21.6 to 27.2% DM and from 2.9 to 9.2% DM, respectively. Performed statistical analyses showed that amount of raffinose is statistically different between the sorts of pea (P<0.05). The amount of total oligosaccharides in 'Neosypajusčijsia' is statistically higher with comparison to 'IP-5' (P<0.05). According to the Saini and Frejnagel (Saini 1989; Frejnagel et al. 1997), the galactosides usually represent less than 5% (raffinose about 0.5% of DM) of the pea DM and do not produce flatulence, but our investigation showed a very high level of raffinose. The high concentrations of galactosides in the alimentary tract may result in fluid retention and an increased flow rate of digesta, which adversely affects utilization and absoption of nutrients. These compounds are not broken down in the small intestine but ferment in the hind hut, resulting in flatulence and disruption in digestion (Classen 1996).

The NDF and ADF analyses showed some variability (12.1–13.0% DM and 9.1–10.2% DM, respectively) among four varieties of peas ('Rainiai', 'Neosypajusčijsia', 'IP-5', 'Sobel'). These vari-

etal differences are responsible for much of variation in NDF (13.2–25% DM), ADF (5.3–10.2% DM) and hemicellulose (0.9–12.4% DM) content reported in various nutrient publications and databases (Cerning-Beroard & Filiatre-Verel 1979; Hickling 2003; Kozlowska 2001). However statistical analyses didn˙t show the differences among the varieties of pea (P>0.05).

The different values (found in the literature) of the content of phytate phosphorus, NDF, ADF and so on of these feedstuffs may be due to genetics, variety, soil climatic conditions and also the analytical method used.

Conclusions

Oilseed rape grown in Lithuania have high level of phytate phosphorus, which amount in summer oilseed rape is statistically higher than in winter oilseed rape. However it doesn˙t depend on the analysed sort.

The amount of total glucosinolates in oilseed rape grown in Lithuania was small. The total concentration of GSL, and the relative proportions of the individual GSL are affected by the genotype of the plant and the agronomic conditions under which they were grown. Therefore, it is still relevant to control the glucosinolates content, and look at the effect of processing on the nutritional value of oilseed rape and its by products.

The analyses of total oligosccharides and one of the galactosides (raffinose) showed a high variation among the peas varieties. The amount of raffinose is statistically different between the sorts of pea.

Acknowledgements

The authors wish to thank Dr. F. Schöne from Thüringer LUFA (Germany) for conducted chemical glucosinolates analyses.

References

Barbara F. H., Oberleas D. 1986. Anion-Exchange Method for Determination of Phytate in Foods: Collaborative Study. J. Assoc. Off. Analyt. Chem., 68: 667 – 670.

Bjergegaard C., Jensen S. K., Quinsac A., Sørensen H. 1998. Analyses of antinutritional compounds in rapeseed. In: Recent advances of research in antinutritional factors in legume seeds and rapeseed, 93. Wageningen. EAAP publication. Pp. 67 – 90.

Bogužas R. 1995. Žirniai. Dotnuva – Akademija. ISBN 9986-540-05-4. Pp. 12.

Carré B., Gomez J., Chagneau A.M. 1995. Contribution of oligosaccharide and polysaccaride digestion, and excreta losses of lactic acid and short chain fatty acids, to dietary metabolisable energy value in broiler chickens and adult cockerels. Br Poult Sci, 36: 611 – 629.

Cerning-Beroard J., Filiatre-Verel A. 1979. Etude comparée de la composition glucidique des graines de pois lisse et ridé. Lebensm-Wiss u-Technol., 12: 273 – 280.

Chubb L.G. 1983. Anti-nutritive factors in animal feedstuffs. In: Recent Advances in Animal Nutrition (W. Haresign ed.). Butterworths, London, UK. Pp. 21-37.

Classen H. L. 1996. Enzymes in action. Feed Mix, 4(2): 22 – 28.

EU-Methodenvorschrift: Bestimmung des Ölsaaten Glucosinolatgehaltes durch HPLC. Anhang VIII der Verordnung (EWG). Nr. 1864/90 vom 29.6.90. Amtsblatt Nr. 2170 vom 3.7.90. Pp. 28 – 34.

Frejnagel S, Zdunczyk Z, Krefft B. 1997. The chemical composition and nutritive value

of low- and high-tannin faba bean varieties. J. Anim. Feed Science, 6: 401 – 412.

Goering H. K., Van Soest P. J. 1970. Forage fiber analyses (apparatus, reagents, procedures and some applications). USDA Agricultural Handbook No. 379. ARS, Washington DC. Pp. 19.

Hickling D. 2003. Canadian Feed Peas Industry Guide. 3rd Ed. Pulse Canada Winnipeg, Manitoba. Pp. 7.

Jensen S. K., Liu Y.G., Eggum B.O. 1995. The influence of feed and hull content on the composition and digestibility of rapeseed in rats. Anim. Feed Sci. Technol., 54: 9 – 19.

Jeroch H. 1999. Futtermittelkunde/Ernährung Landwirtschaftlicher Nutztiere. Eugen Ulmer Verlag, Stuttgart. Pp. 211 – 214.

Kozlowska H. 2001. Carbohydrates in Grain and Legumes Seeds (Hedley C. L. ed.). CAB International. Pp. 74.

Lietuvos valstybinis augalų veislių tyrimo centras. Lietuvos sąlygoms tinkamiausių augalų veislių 2003 m. sąrašas. Vilnius. 2003. Pp. 65 – 68.

Lietuvos valstybinis augalų veislių tyrimo centras. Lietuvos sąlygoms tinkamiausių augalų veislių 2004 m. sąrašas. Vilnius. 2004. Pp. 64 – 66.

Lietuvos valstybinis augalų veislių tyrimo centras. Lietuvos sąlygoms tinkamiausių augalų veislių 2005 m. sąrašas. Vilnius. 2005. Pp. 85.

Liu Y. G., Jensen S. K., Eggum B. O. 1995. The influence of seed size on digestibility and growth performance of broiler chickens fed full-fat rapeseed. J. Sci. Food Agri., 67: 135 – 140.

Matthäus B., Schumann W. 2003. Variation of nutritive and antinutritive compounds of rapeseed in dependent on the year of cultivation and variety. In: Proceedings of the 11th International Rapeseed Congress, Copenhagen, Denmark. Vol. 4. Pp. 1260 – 1262.

Naumann C., Bassler R. (ed.) 1993. Methodenbuch, Band III. Die chemische Untersuchung von Futtermitteln. VDLUFA-Verlag, Darmstadt.

Newkirk R. W., Classen H. L. 2001. The non-mineral nutritional impact of phytate in canola meal fed broiler chicks. Anim. Feed Sci. Technol., 91: 115 – 128.

Pandey A., Szakacs G., Soccol C.R., Rodriguez-Leon J.A., Soccol V.T. 2001. Production, purification and properties of microbial phytases. B Tech, 77: 203 – 214.

Ravindran V., Bryden W. L., Kornegay E.T. 1995. Phytase: Occurrence, bioavailability and implications in poultry nutrition. Avian Poult. Biol. Rev., 6: 125 – 143.

Saini H. S. 1989. Legume seed oligosaccharides. In: Huisman J., van der Poel A. F. B., Liener I. E. (eds.): Recent Advances of Research in Antinutritional Factors in Legume Seeds. Pudoc, Wageningen. Pp. 329 – 341.

Sørensen H. 1991. Glucosinolates: structure-properties-function. In: Canola and Rapeseed, Production, Chemistry, Nutrition and Processing Technology (F Shahidi, ed.). Van Nostrand Reinhold, New York. Pp. 149 – 172.

StatSoft, Inc. 1995. STATISTICA for Windows. Version 5.0. StatSoft Inc, Tulsa OK.

Eeckhout W., De Peape M. 1994. Phytata- und Phytata – P in Futtermitteln. Anim. Feed Sci. Technol., 47: 19 – 29.

Šeškevičienė J., Mikulionienė S., Jonuškienė I., Jeroch H. 2002. Substances influencing the nutritive value of rape (*Brassica napus*) and rapeseed cake. Anim. Husbandry, 3: 39 – 41.

Tinkamiausių Lietuvoje auginti 1997 metais augalų veislių sąrašas. Lietuvos respublikos augalų veislių katalogas. Vilnius. 1997. Pp. 38.

Tinkamiausių Lietuvoje auginti 1998 metais augalų veislių sąrašas. Lietuvos respublikos augalų veislių katalogas. Vilnius. 1998. Pp. 28.

Tinkamiausių Lietuvoje auginti 1996 metais augalų veislių sąrašas. Lietuvos respublikos augalų veislių katalogas. Vilnius. 1996. Pp. 33.

Thies W. 1988. Isolation of sinigrin and glucotropaeolin from cruciferous seeds. Fat Sci. Technol., 90: 311 – 314.

Thompson L. U. 1986. Phytic acid: chemistry, nutritional effect and removal. In: 4th World Congress of Animal Feeding; Garsi. Ed.; Madrid. Spain.

Viveros A., Centeno C., Brenes A., Canales R., Lozano A. 2000. Phytase and acid phosphatase activities in plant feedstuffs. J. Agri. Food Chem., 48: 4009 – 4013.

Zhao F, Evans E. J, Bilsborrow P. E., Syers J. K. 1994. Influence of nitrogen and sulphur on the glucosinolate profile of rapeseed (*Brassica napus* L). J. Sci. Food Agric. 64: 295 – 304.

Zyla K., Koreleski J. 1993. In-vitro and In-vivo Dephosphorylation of Rapeseed meal by Means of Phytate-Degrading Enzymes Derived from *Aspergillus niger*. J. Sci. Food Agri., 61: 1 – 6.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

MORPHOMETRIC DATA OF WOLF (*CANIS LUPUS* L.) INTERNAL ORGANS

Renata Špinkytė-Bačkaitienė, Kęstutis Pėtelis

Špinkytė-Bačkaitienė R., Pėtelis K. 2006. Morphometric Data of Wolf (*Canis lupus* L.) Internal Organs. *Acta Biol. Univ. Daugavp., 6 (1-2): 151 - 154.*

The aim of this study is to perform the morphometric analysis of wolves' (*Canis lupus* L.) internal organs and to compare these data. We were compared data of the heart, the lungs, the liver, the kidney and the spleen weight by S. Ðvarc method of morphophysiological indicators (1958, 1968). We measured the internal organs of five males and one female: the heart, the lungs, the craw, the liver, the kidney, the spleen, small and large intestines, the caecum, the ileum. The mean weight of investigated wolves' males' heart was 336.8±48.29 g, of female – 246.7 g. The relative weight of wolves' heart was 9.4±0.29% (9.4%). The weight of lungs was 420.5±42.48 g (361.5 g). The weight of investigated wolves' liver was 815.9±66.67 g (671.1 g). The mean weight of right kidney was 118.9±11.64 g (88.7 g), of left kidney – 126.9±12.95 g (92.8 g). The mean weight of spleen was 76.5±9.85 g (64.4 g). The mean length of the intestine of investigated bodies was 533 cm, of female – 491 cm.

Key words: wolf, *Canis lupus*, internal organs, morphometric.

Renata Špinkytė-Bačkaitienė, Kęstutis Pėtelis. Lithuanian University of Agriculture, Forest Faculty, Studentų 11, Akademija LT-53361, Kauno r., Lithuania; e-mail: renata_shpy@yahoo.com

Introduction

The major part of wolves' morphometric data cover measurement of cranial, skin and body weight (Baleišis, 1992, 1997; Prūsaite, 1961; Lietuvos fauna, 1988; Okarma, Buchalczyk, 1993). Some data is about length of body, tail, foot and ear (Prūsaite, 1961; Lietuvos fauna, 1988). Morphometric data of Lithuanian wolves' internal organs are not available. The internal organs of wolves' were measured in Belarus, Aktiubinsk district and in Altai (Бибиков, 1985).

The aim of this study is to perform the morphometric analysis of wolves' internal organs and to compare these data.

Methods

There were measured internal organs of six wolves' hunted during February of 2006 year (totally 20 individuals were hunted during the season). The wolves were shoot in South Lithuania. We measured the internal organs of five males and one female: the heart, the lungs, the craw, the liver, the kidney, the spleen, small and large intestines, the caecum, the ileum. Precision of measurements was 1.0 mm and 0.1 g. The procedures were done in specialized laboratory of Lithuanian Veterinary Academy.

During dissection we defined the sex of animals. We were compared data of the heart, the lungs,

the liver, the kidney and the spleen weight by S. Đvarc method of morphophysiological indicators (Шварц, 1958; Шварц и др., 1968). The length and width of the heart, the length and the width of right and left kidneys, the length of small and large intestines, the caecum, the ileum were measured. The craws were weighed as well as the length of spleen was measured and width was measured in tree places. The craws weighed with content of them.

The data were processed by Statistics 6 program. Average and the standard error of mean were calculated. We also calculated relative weight as the ratio of organ and body weight multiplied by 100.

Results

Investigative wolves were separated according sex. The mean weight of males was 35.9 kg, and of females – 26 kg. The maximum weight of male was 42 kg as well as the minimum – 25.5 kg.

The mean weight of investigated wolves˙ males˙ heart was 336.8±48.29 g, of female – 246.7 g (table 1). The heart of males was 1.4 times higher female. The mean width (data of females are presented in the brackets) of heart was 8.6±0.49 cm (8.0 cm), length – 11.2±0.62 cm (11.0 cm). The weight of wolves˙ lungs was 420.5±42.48 g (361.5 g). The weight of craws varied from 373.0 g till 604.3 g, the mean – 454.7±39.55 g. The weight of investigated wolves˙ liver was 815.9±66.67 g (671.1 g). The mean weight of right kidney was 118.9±11.64 g (88.7 g), of left kidney – 126.9±12.95 g (92.8 g). The mean length of right kidney was 9.8±0.39 cm (8.7 cm), the width –4.8±0.29 cm (4.5 cm); respectively of left kidney –10.0±0.47 cm (8.6 cm) and 5.5±0.53 cm (4.5 cm). The mean weight of spleen was 76.5±9.85 g (64.4 g), the average length was 25.0±2.59 cm (20.1 cm), the average width –6.3/4.5/5.3 cm (6.0/4.5/4.5 cm).

It is typical big relative weight of heart. The relative weight of investigated wolves˙ heart was 9.4±0.29% (9.4%) (table 2). Sophisticated structure of lungs determines effective circulation of oxygen and comparatively little relative weight – 11.7±0.52% (13.9%). It is massive wolves˙ liver, which relative weight –22.7±0.84% (25.8%). Relative weight of kidney was 6.8±0.19% (6.9%), of spleen – 2.1±0.10% (2.5%).

The mean length of the intestine of investigated bodies was 533 cm, of female – 491 cm. the length of small intestine was 447.7±10.93 cm (417 cm), of caecum – 14.3±1.40 cm (11 cm), of large intestine – 71.7±2.88 cm (63 cm) (table 3).

Discussions

Comparatively big wolves˙ heart shows that these animals are very mobile and adapted to hard long strains. Well developed, healthy heart determines qualitative circulation of blood. Therefore any defects determine wolves˙ mortality during natural selection. The example from Belarus proves it.

Table 1. Data of internal organs˙ absolute weight

Organ	Absolute weight, g	
	male	female
Heart	336.8±48.29	246.7
Lungs	420.5±42.48	361.5
Craw	454.7±39.55	338.1
Liver	815.9±66.67	671.1
Kidney	118.9±11.64/126.9±12.95*	88.7/92.8*
Spleen	76.5±9.85	64.4

* Weight of right and left kidney

Table 2. Relative weight of internal organs of the Wolves

Organ	Relative weight, %	
	male	female
Heart	9.4±0.29	9.4
Lungs	11.7±0.52	13.9
Liver	22.7±0.84	25.8
Kidney	6.8±0.19	6.9
Spleen	2.1±0.10	2.5

Six wolves were shot in the years of the population number depression. The heart index of these wolves was especially high – 13.5% (Бибиков, 1985). The heart weight of investigated wolves is in intermediate position between wolves from Belarus and Altai (table 4).

Big liver is typical for wolves. Comparative weight of Lithuanian wolves˙ liver weight is close to wolves˙ from Altai. The weight of Lithuanian wolves˙ kidney is the most close to wolves˙ kidney from Belarus.

Table 3. The data of intestines˙ absolute length

Intestine	Length, cm	
	male	female
Small intestine	447.7±10.93	417
Ileum	7.2±0.64	6
Caecum	14.3±1.40	11
Large intestine	71.7±2.88	63

Table 4. Comparison of Lithuania and Russia wolves˙ (male) internal organs weight

Organ	Comparative weight, %			
	Lithuania	Belarus (n = 76)	Aktiubinsk (n = 73)	Altai (n = 51)
Heart	9.4±0.29	9.4±0.32	7.50	10.8±0.28
Lungs	11.7±0.52	12.8±0.49	-	-
Liver	22.7±0.84	24.0±0.82	23.9±4.49	22.8±0.84
Kidney	6.8±0.19	6.6±0.19	5.40	5.9±0.19
Spleen	2.1±0.10	2.4±0.09	-	2.2±0.12

* Weight of right and left kidney

Conclusions

The internal organs˙ parameters of Lithuanian wolves are close to Russian wolves. It is presumptive that differences of internal organs in the different localities are determined by living conditions in the specific territory and shows differentiation of the species.

Acknowledgments

We are grateful for methodological assistance and help during measurement process for L. Daugnora from Lithuanian Veterinary Academy.

References

Baleišis R. 1992. Lietuvos medžioklės trofėjai (Hunting Trophies of Lithuania). Vilnius. 66 p.

Baleišis R. 1997. Lietuvos medžioklės trofėjų rejestras (Roll of Hunting Trophies of Lithuania). Vilnius. 78 p.

Lietuvos fauna (Lithuanian Fauna). 1988. Vilnius, 295 p.

Okarma H., Buchalczyk T. 1993. Craniometrical characteristics of wolves (*Canis lupus* L.) from Poland. Acta Theriologica 38(3):253-262.

Prūsaitė J. 1961. Lietuvos vilkų morfologinė charakteristika ir jų paplitimas (Morphologic Characteristic and Distribution of Lithuanian Wolves˙). Lietuvos TSR mokslų akademijos darbai, serija C, 1 (24):161-176.

Бибиков Д. И. 1985. Волк (Wolf). Москва, 606 с.

Шварц С. С. 1958. Метод морфофизиологических индикаторов в экологии наземных животных (Method of Morphophysiological Indicators in Ecology of Animals). Зоол. Журн. 2: 161-173.

Шварц С. С., Смирнов В. С., Добринский Л. Н. 1968. Метод морфофизиологических индикаторов в экологии растений и животных (Method of Morphophysiological Indicators in Ecology of Plants and Animals). Тр. ин-та экологии растений и животных УФ АН СССР. 58: 3-368.

Acta Biol. Univ. Daugavp. 6 (1-2) 2006
ISSN 1407 - 8953

PREDATORS AND HERBIVORES BEETLES (COLEOPTERA) NATURALLY OCCURRING ON STRAWBERRY (LATVIA)

Valentīna Petrova, Zigrīda Čudare, Raimonds Cibuļskis

Petrova V., Čudare Z., Cibuļskis R. 2006. Predators and herbivores beetles (Coleoptera) naturally occurring on strawberry (Latvia). *Acta Biol. Univ. Daugavp., 6 (1-2): 155 - 159.*

A list of 118 species Coleoptera of 19 families and 74 genera recorded from Latvian strawberry has been compiled using earlier publications and author's own data. Forty-four species known as pests (from those 23 known as strawberry pests), 70 species are predators, and pantophages, 3 species are phytophages and one species saprophages-phytophages. Seven species found for the first time in Latvia and two species are new for Baltic countries. The families Staphylinidae, Carabidae, Curculionidae had the highest number of species are with 35, 27, 13, respectively.

Key words: Coleoptera, predators, herbivores, Latvian strawberry

V. Petrova, Z. Čudare, Institute of Biology, University of Latvia, Miera str. 3, Salaspils, LV-2169, Latvia, e-mail: valentina-2003@inbox.lv, zigrida@email.lubi.edu.lv

Raimonds Cibuļskis; Institute of Systematic Biology, Daugavpils University, Vienibas str. 13 – 229, LV-5401, Daugavpils, Latvia; e-mail: arvids.barsevskis@biology.lv; raimonds.cibuļskis@biology.lv

Introduction

Plant traits may affect both herbivores and predators, and interactions between predators and their prey may be was altered to produce indirect ecological effects (Whitham et al. 2003).

The beetles are important components of the any agroecosystems. According to data of the last checklist of Latvian coleopterans (Telnov, 2004), up to now in Latvia known about 15 000 species of Coleoptera, but there is lack of knowledge on the structure of the coleopterans, especially beneficial, habituated into strawberry agrocenosis.

The species compound of the strawberry invertebrates studied in Latvia mainly during the period between 1930 and 1976. Before our study, almost 40 strawberry pests including beetles, mites, nematodes, and millipedes founded feeding on strawberry. Among them 15 beetles: *Anthonomus rubi* (Hbst.), *Otiorhynchus ligustici* (L.), *Otiorhynchus ovatus* (L.), *Philopedon plagiatus* (Schall.), *Phyllobius pomaceus* Gyll., *Neocoenorrhinus germanicus* (Hbst.), *Chaetocnema concinna* (Marsham), *Galerucella tenella* L., *Melolontha hippocastani* L., *M. melolontha* L., *Agriotes lineatus* L., *A. obscurus* L., *A. sputator* L., *Harpalus rufipes* (Deg.) were

observed on cultivated strawberry (Čakstiņa, 1962; Ozols, 1963; Pūtele, 1970; Dūks, 1976). Species *Batophila rubi* Payk. was found on the wild strawberry (Pūtele, 1971).

In present paper the total data of the previous and new observations on the species compositions of the injurious and beneficial beetles found into strawberry plantings are given.

Material and Methods

This study based on materials collected mainly on commercial strawberry fields at the Pure Horticultural Research Station (PHRS) (north-western part of Latvia), and particularly in the Riga's District (central part of Latvia). Coleopteran fauna investigated in 1997-2004. The material collected by sweep netting and pit-fall trapping. Third author of this paper determined species of Carabidae and fourth of Staphylinidae. The taxonomy of beetles based on checklist of Latvian beetles according to D. Telnov (2004).

Results

In total, 118 species of Coleoptera of 19 families and 74 genera known on strawberry (Table 1). Hundred ten species were recorded by authors during investigation period (1997-2004), 101 from those were identified to species, and eight others were identified to genus. Seven species are new for Latvia and two species from those are new for Baltic countries.

From observed 110 beetle species on strawberry during 1997-2004 thirty-six species (32,73% from all beetles) known as plant pests and from those 15 species (41,67% from all plant species) known as strawberry pests; 70 species (63,64% from all beetles) are predators, and pantophages, 3 species (2,73%) are phytophages, 1 (0,9%)-saprophage-phytophage.

Herbivorous fauna represented by 16 families. In Latvia in 1970-2004 were registered 13 weevil species with the more frequent five strawberry pest-species: *A. rubi*, *Chlorophanus viridis* (L.), *O. ovatus*, *P. pomaceus*, *Ph. maculicornis* Germ. However, family Chrysomelidae represented by 11 species but was the more numerous from phytophagous families in seasons 2001-2002 (3% from total Coleoptera and 24% from total phytophagous families) with three the more frequent strawberry pest-species: flea beetle *C. concinna*, leaf beetles *G. tenella* and *Galeruca tanaceti* L. The others phytophagous families represented by the less species – 1-2 and were less numerous. The family Elateridae had the more frequent strawberry pest-species click beetle *Athous niger* (L). The family Scarabaeidae had the more frequent strawberry pest-species leaf beetle *Phyllopertha horticola* L.

Beneficial fauna represented by predatory families: Cantharidae, Coccinellidae, Carabidae, Staphylinidae and partly by Silphidae. The families had the highest number of species are Staphylinidae and Carabidae with 35, 27 species respectively. According to the received data of monitoring in 2001, the caught predatory beetles dominated as over amount of kinds (82.4 %), and in amount of the caught individuals (92 %) in comparison with herbivorous beetles. In the season 2000-2002 between May, and July predatory beetles of Coccinellidae, Staphylinidae, Carabidae were active and numerous. In 2001 the most common and the more numerous on strawberry were three predaceous carabids *Broscus cephalotes* (L.), *Calathus erratus* (Sahbl.), *Poecilus versicolor* (L.) and four rove beetles *Aleochara laevigata* Gyll., *Amischa analis* (Grav.), *Anotylus rugosus* (F.), *Atheta fungi* (Grav.), also two ladybugs *Coccinella septempunctata* L., and *Coccinella quinquepunctata* L.

Discussion

In 2000-2005 by authors: Petrova et al. (2000), Barðevskis, Petrova (2001), Cibuļskis, Petrova (2002), Petrova et al. (2005) published fifty-one species of scarabaeids, chrysomelids, staphylinids, weevils, and carabids from strawberry.

Table 1. List of Coleoptera species from strawberry recorded (1930-2004) in Latvia.

Family	Species		Family	Species	
Anthicidae	*Notoxus monoceros* L.	pest	Carabidae	*Amara bifrons* (Gyll.)	pant
Apionidae	*Neocoenorrhinus virens* (Hbst.)	pest		*Amara consularis* (Duft.)	pant
Attelabidae	*Compsapoderus erythropterus* (Gmelin)	pest		*Amara erratica* (Duft.)	pant
Rhynchitidae	*Pselaphorhynchites germanicus* (Hbst.)	pest-str		*Amara familiaris* (Duft.)	pant
Curculionidae	*Anthonomus rubi* (Hbst.)	pest-str		*Amara ingenua* (Duft.)	pant
	Ceuthorhynchus floralis (Payk.)	pest		*Amara municipalis* (Duft.)	pant
	Chlorophanus viridis (L.)	pest-str		*Amara spreta* Dej.	pant
	Hypera spp.	pest		*Amara strenua* Zimm.	pant
	Otiorhynchus ligustici (L.)	pest-str		*Bembidion lampros* (Hbst.)	pred
	Otiorhynchus ovatus (L.)	pest-str		*Bembidion properans* (Steph.)	pred
	Philopedon plagiatus (Schall.)	pest-str		*Bembidion quadrimaculatum* (L.)	pred
	Phyllobius argentatus (L.)	pest-str		*Broscus cephalotes* (L.)	pred
	Phyllobius maculicornis Germ.	pest-str		*Calathus ambiguus* (Payk.)	pred
	Phyllobius pomaceus Gyll.	pest-str		*Calathus erratus* (Sahlb.)	pred
	Rhinoncus bruchoides (Hbst.)	pest		*Calathus melanocephalus* (L.)	pred
	Sitona lineatus (L.)	pest		*Carabus cancellatus* Ill.	pred
	Tychyus picirostris (F.)	pest		*Carabus nemoralis* Muell.	pred
Chrysomelidae	*Altica* sp.	pest		*Harpalus affinis* Schrank	pred
	Asiorestia sp.	pest		*Harpalus latus* (L.)	pred
	Batophila rubi Payk.	pest		*Harpalus rufipes* (DeG.)	pant
	Cassida nebulosa (L.)	pest		*Harpalus smaragdinus* (Duft.)	pred
	Chaetocnema concinna (Marsham)	pest-str		*Poecilus cupreus* (L.)	pred
	Galerucella pusilla (Duft)	pest		*Poecilus versicolor* (L.)	pred
	Galeruca tanaceti L	pest-str		*Pterostichus melanarius* (Ill)	pred
	Galerucella tenella L.	pest-str		*Synuchus vivalis* (Ill.)	pred
	Gastrophysa polygoni (L.)	pest		*Trechus quadristtriatus* (Schrank)	pred
	Longitarsus parvulus (Payk.)	pest	Staphylinidae	*Aleochara bipustulata* (L.)	pred
	Longitarsus suturellus (Duft.)	pest		*Aleochara laevigata* Gyllenhal	pred
	Phyllotreta flexuosa (Ill.)	pest		*Aloconota gregaria* (Erichson)	pred
Elateridae	*Adrastus pallens* (Fabr.)	pest		*Amischa analis* (Grav.)	pred
	Agriotes lineatus L.	pest-str		*Amischa decipiens* (Sharp)	pred
	Agriotes obscurus L.	pest-str		*Amischa nigrofusca* (Stephens)	pred
	Agriotes sputator L.	pest-str		*Anotylus nitidulus* (Grav.)	pred
	Athous niger (L.)	pest-str		*Anotylus rugosus* (Fabr.)	pred
Kateretidae	*Kateretes pedicularius* L.	pest-str		*Atheta fungi* (Grav.)	pred
Lathridiidae	*Corticaria* sp.	pest-str		*Atheta* sp.	pred
Leiodidae	unidentified species	ph		*Dinaraea linearis* (Grav.)	pred
Mordellidae	*Mordellistena pseudonana* Ermisch	pest		*Gyrohypnus scoticus* (Joy)	pred
	Mordellistena sp.	pest		*Ilyobates subopacus* Palm.	pred
Nitidulidae	*Meligethes aeneus* (Fabr.)	pest-str		*Ischnosoma splendidum* (Grav.)	pred
Phalacridae	*Olibrus aeneus* (Fabr.)	ph		*Lathrobium fulvipenne* Grav.	pred
	Olibrus pygmaeus (Sturm)	ph		*Lathrobium geminum* Kraatz	pred
Scarabaeidae	*Melolontha hippocastani* L.	pest-str		*Mycetoporus bimaculatus* Lacord.	pred
	Melolontha melolontha L.	pest-str		*Mycetoporus lepidus* (Grav.)	pred
	Phyllopertha horticula L.	pest-str		*Mycetoporus longulus* Mannerh.	pred
Silphidae	*Nicrophorus vespilloides* Herbst.	pant		*Mycetoporus* sp.	pred
	Silpha tristis Mën.	sap-ph		*Ocypus fuscatus* (Grav.)	pred
	Thanatophilus sinuatus Fabr.	pest-str		*Ocypus picipennis* (Fabr.)	pred
Tenebrionidae	*Lagria hirta* (L.)	pest		*Oligota pumilio Kiesenwetter*	pred
				Oligota punctulata Heer	pred
				Oligota pusillima (Grav.)	pred
Cantharidae	*Cantharis fulvicollis* (Fabr.)	pred		*Oxypoda vicina* Kraatz	pred
	Cantharis paludosa (Fallen)	pred		*Oxypoda* sp.	pred
Coccinellidae	*Adalia decempunctata* (L.)	pred		*Parocyusa rubicunda* (Erichs.)	pred
	Coccinella (Adalia) septempunctata L.	pred		*Philonthus atratus* (Grav.)	pred
	Coccinella quinquepunctata L.	pred		*Phylonthus umbratilis* (Grav.)	pred
	Propylea quatuordecimpunctata L.	pred		*Stenus similis* (Herbst)	pred
	Psyllobora (*Thea) vigintiduopnctata* (L.)	pred		*Tachinus rufipes* (L.)	pred
	Subcoccinella vigintiquatuorpunctata (L.)	pest		*Tachyporus chrysomelinus* (L.)	pred
				Tachyporus nitidulus (Fabr.)	pred
Carabidae	*Amara aenea* (DeG.)	pant		*Xantholinus linearis* (Olivier)	pred

Designation: (pest-str) strawberry pest, (pred) predatory, (pant) pantophages, (ph) phytophages, (sap-ph) saprophages-phytophages)

Nine species: *O. ligustici*, *P. plagiatus* from Curculionidae, *N. germanicus* from Rhynchitidae, *M. hippocastani*, *M. melolontha* from Scarabaeidae, *A. lineatus*, *A. obscurus*, *A. sputator* from Elateridae, *B. rubi* from Chrysomelidae) that were found on strawberry by earlier authors (Čakstiņa, 1962; Ozols, 1963; Pūtele, 1970; Dūks, 1976), have been not recorded by authors of this late investigation.

Six species of rove beetles: *Amischa analis* (Grav.), *A. nigrofusca* (Steph.), *Ilyobates subopacus* Palm, *Mycetoporus bimaculatus* Lac., *Oxypoda vicina* Kraatz and the one carabid *Amara erratica* (Duft.) are new for Latvian fauna and two rove beetles: *Oligota punctulata* Heer and *O. pumilio* Kiesenwetter are new for Baltic countries (Barðevskis, Petrova, 2001; Cibuļskis, Petrova, 2002).

Analysis of the results obtained during our study and the reviewing of the literature data show that the strawberry pest compound in Latvia characterised by widespread and widely known species: *A. rubi*, *O. ovatus*, *O. ligustici*, *Ph. maculicornis* (Curculionidae), *G. tenella*, *G. tanaceti* (Chrysomelidae), *M. hippocastani*, *M. melolontha* (Scarabaeidae) known as important strawberry pests. They recorded in various European countries (Kriþanovsky O.L. (ed.), 1974; Cross and Easterbrook, 1998; Łabanowska B.H., Bielenin A., 2002).

Thus, species like strawberry bud weevil *A. rubi* is the most important direct strawberry pest in Latvia. Its occurrence is sporadic, but considerable variation in damage occurs from year to year. According to E. Ozols (1963), *A. rubi* caused difficulties on strawberry in Latvia before 60th. In 1977 in Latvian strawberry by *A. rubi* have been destroyed from 30 to 50% of strawberry flower buds on PHRS strawberry plantings (Petrova et al., 2000), but at last years (2001-2002) only 10-11% (Petrova et al., 2005). In Poland and Sweden the weevil *A. rubi* may damage from a few up to 60% of strawberry buds (Łabanowska 1997, Svensson 2002). In Estonia the greatest injuries were observed in 1983-1987 when 25-36.4% of flower buds were damaged, but at the beginning of 1994 the injury reduced by 5% (Kikas & Libek 2002).

Such phytophagous beetles as *C. viridis*, *O. ovatus*, *P. pomaceus*, *G. tenella*, *P. horticola* caused damage to berries and leaves only into local areas.

The predaceous and pantophagous beetles especially Carabidae and Staphylinidae are very important because they represent biotic control factors, which maintain pest species at low densities. Their abundance and their diversity may be excellent indicator of environmental quality in Latvian strawberry cenosis.

Acknowledgements

We are grateful for determination some coleopterans to following authors: D. Telnov and R. Cinitis (Entomological Society of Latvia), B. Korotjaev (Curculionidae) and V. Semjanov (Coccinellidae) (Institute of Zoology RAS). The authors would like to thank, Director A. Bite and assistant V. Laugale, of the Pure Horticultural Research Station for their help with organising the strawberry field trials. Special thanks for their help on the field to biologists A. Hramejeva and I. Samsone. This study was a part of a project supported by grants 96 0284 and 03 0957 of the Latvian Council of Science

References

Barðevskis A., Petrova V. 2001. *Amara erratica* (Duft.) - a new species of ground beetles (Coleoptera: Carabidae) for fauna of Latvia. *Acta Biol. Univ. Daugavp.* 1(1): 26-27.

Cibuļskis R., Petrova V. 2002. New species of rove beetles (Coleoptera: Staphylinidae) in fauna of Latvia from Pūre. *Acta Biol. Univ. Daugavp.*, 2 (1-2): 103-104.

Cross J.V., Easterbrook M.A. 1998. Integrated management of flower pests of strawberry.

Integrated Plant Protection in Orchards. *"Soft Fruits", IOBS/WPRS Bull.* 21 (10): 81-87.

Čakstiņa, T. 1962. [Pests and diseases of the small garden plants]. Latvian State Publishing House, Riga: 1-221 (in Latvian).

Dūks, V. 1976. [Strawberries]. Liesma, Riga, 1-175 (in Latvian).

Kikas A., Libek A. 2002. Observations on strawberry blossom weevil (*Anthonomus rubi*) damage to 4 cultivars in Estonia (1978-2000). - *Acta Horticulture, ISHS*, 567(2): 699-700.

Kriþanovsky O.L. (ed.) 1974. [Insects and mites that are crop pests]. Science, Leningrad, Vol. 2: 1-335 (in Russian).

Łabanowska B.H. 1997. Control of the strawberry blossom weevil (*Anthonomus rubi* Hbst.) on strawberry. - *Journal of Fruit and Ornamental Plant Research,* 5(3-4): 157-162.

Łabanowska B.H., Bielenin A. 2002. Infestation of strawberry cultivars with some pests and diseases in Poland. *Acta Horticulture, ISHS*, 567(2): 705-708.

Ozols E., 1963. [Agricultural Entomology]. (2 edn.), Latvian State Publishing House, Riga: 1-511 (in Latvian).

Petrova V., Čudare Z., Šteinīte I. 2000. Invertebrates fauna on strawberry in Latvia. *Proc. Latvian Acad. Sci*. Sect. B, **54**, 3(608): 79-84.

Petrova V., Čudare Z., Laugale V., Jankevica L., 2005. Occurrence and biodiversity of weevils (Coleoptera, Curculionidae) on strawberry and observations of the blossom weevil (*Anthonomus rubi* Herbst) damage to 13 strawberry cultivars. *Acta Biol. Univ. Daugavp.* 5(1): 27-34.

Pūtele, V., 1970. [The soil flea beetles Chaetocnema Steph. in Latvian SSR]. On the materials of the 7th Baltic Plant Protection Conference. Jelgava, (1): 20-25 (in Russian).

Pūtele, V., 1971. [Little-known flea beetles in Latvia]. *LLA Raksti*, 42: 76.-86 (in Latvian).

Telnov D. 2004. Check-List of Latvian Beetles (Insecta: Coleoptera). Compendium of Latvian Coleoptera, (2 edn.). Riga, "Petrovskis & Co", vol. 1: 1-114.

Whitham T.G., Young W.P., Gehring C.A., Schweitzer J.A., Shuster S.M., Wimp G.M., Fischer D.G., Bailey J.K., Lindroth R.L., Woolbright S., Kuske C.R., 2003. Community and ecosystem genetics: a consequence of the extended phenotype. *Ecology* 84: 559-573.