The grass-dwelling arthropod communities of the coastal reserve "Randu pļavas" in Latvia

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Abstract

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In 1994, the grass-dwelling arthropods of the littoral meadows of the coastal reserve Randu meadows ("Randu pļavas") in Latvia were investigated. Arthropods were collected by entomological sweep net within 7 types of habitats with different moisture regime. Diptera dominated among the insects and was represented by 40 families. Low numbers of other groups (Coleoptera, Heteroptera, and Auchenorrhyncha) commonly abundant within inland meadows were explained by specific ecological conditions of the seashore meadows. Numbers of most of arthropod groups and characteristics of community structure (number of families, Shannon's diversity index H', equitability index E and Margarlef's index I_M) had unimodal distributions on a moisture gradient.

Key words: grass-dwelling arthropods, seashore meadows, taxonomic diversity.

Introduction

Arthropods, among them insects, are one of the most abundant and important components of terrestrial ecosystems. However, they have been ignored in most studies associated with management and monitoring of biodiversity of nature reserves. The reserve Randu meadows ("Randu pļavas"), founded as a botanical and ornithological reserve, in Latvia is not an exception in this respect. At present, 531 plant species (Gemste et al, 1991) and 44 species of nesting birds (Lipsbergs et al., 1985; Vīksne, 1994) have been recorded from this area and 36 species of plants are protected by the Red Data Book of Latvia (Andrušaitis et al., 1985). The data available on insects are fragmentary (Spuris, 1966; Elberg, 1968; Rēdliha, 1968; Grinbergs, 1976; Eitminavichute et. al., 1976; Kuznetzova, 1987).

In this article, the taxonomic structure and distribution of grass-dwelling arthropods within different habitats of the Randu meadows are analysed.

Material and methods

The nature reserve Randu meadows is a 100-300 m wide band of littoral meadows (198.2 ha), stretching 4.5 km to the south from the Estonian border to the village Kuiviži in the northern Gulf of Riga. The area is a mosaic of local depressions, lagoons and man-made ditches, interspersed with elevated dunes. This pattern is reflected also by vegetation. Associations of hydrophylous and hygrophylous species can be found next to xerophylous meadow communities and dune vegetation.

The investigations were performed in May - July of 1994. No special set of permanent sample plots was used. Insects were collected within areas of 200–300 m^2 of relatively homogenuous dominant vegetation which have been selected randomly during the current rout survey. Three such surveys were conducted during the season. Entomological sweep net was used. One sample included arthropods from 50 sweeps. In total, 33 samples containing about 16 800 individuals were collected. A list of dominant plant species of the sampled territory was made each collection time. All sample sites were empirically classified to 7 habitat groups. For each group, the numbers of samples was approximately proportional to the area occupied by the particular vegetation within the investigated area. The habitats were arranged to represent a soil moisture gradient:

- xerophytic dune habitats (4 samples) dominated by dune vegetation *Calamagrostis epigeios, Cakile maritima, Elymus arenarius, Phragmites australis.*
- xerophytic meadows (3 samples) dominated by xerophytes *Festuca ovina, Luzula spp., Carex arenaria, Galium verum.*
- xeromesophytic meadows (2 samples) dominated by typical xerophytes mixed with mesophytes *Anthoxanthum odoratum, Poa pratensis, Vicia cracca, Achillea millefolium.*
- mesophytic meadows (7 samples) dominated by mesophytes *Dactylis glomerata, Festuca rubra, Galium album, Trifolium repens, Trifolium pratense.*
- hygromesophytic meadows (6 samples) dominated by typical mesophytes mixed with higrophylous species such as *Sesleria coerulea, Carex disticha, Deschampsia caespitosa, Filipendula ulmaria.*
- hygrophytic meadows (9 samples) dominated by *Carex disticha, C. nigra, Geranium palustre, Galium palustre.*
- moist reed thickets (2 samples) dominated exclusively by *Phragmites australis*.

Only 8 taxonomic groups of arthropods were considered in the collected material: Aranei, Diptera, Hymenoptera, Coleoptera, Lepidoptera, Heteroptera, Homoptera (Auchenorrhyncha), Orthoptera. The groups: Odonata, Trichoptera, Thysanoptera, Psocoptera, and Homoptera (Aphidina, Psyllina) were ignored since the collection method was not suitable for quantitative estimates of those insects.

Community indices of grass-dwelling insects were examined on the family level.

Shannon's species diversity index H' and equitabiliy index E were calculated for pooled data of each habitat group (Pesenko,1982):

$$H' = -\sum_{i=1}^{s} (n_i/N)\log_2(n_i/N) \; ; \quad E = H'/\log_2 S,$$

where n_i/N - proportion of the i-th family in the collection (i=1,2,3, …, S), S - number of families in the collection. Since different habitat groups had different numbers of samples, the values of H' may be affected by the total numbers of collected individuals. Therefore the Margarlef 's index I_M was also calculated as a measure of diversity per individual (Pesenko, 1982):

$I_M=(S-1)/\ln N$.

Results

Grass-dwelling arthropods of the Randu meadows were dominated by Diptera (fig. 1).

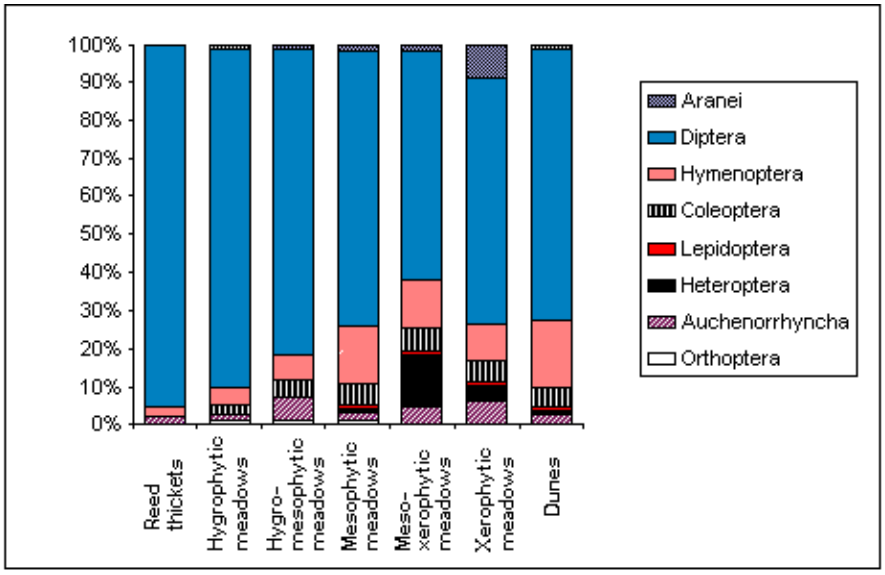

Fig. 1. Distribution of relative abundance of arthropods of different groups along a moisture gradient in the reserve "Randu pļavas".

Therefore, the distribution of the total numbers of arthropods on the moisture gradient reflected that of Diptera (fig. 2). Their numbers and percentages of individuals increased in moister habitats (fig.1, 2). The lowest relative abundance of Diptera was recorded towards the meso-xeric end of the moisture gradient (fig. 1).

Numbers of individuals of other taxonomic groups were much lower compared with Diptera (tab.1; fig. 2). Most of the groups (e. g. Hymenoptera, Coleoptera, Heteroptera, Lepidoptera) increased in relative abundance in mesic habitats (fig. 1). Spiders (Aranei) had the highest numbers and percentages of individuals in the xerophytic habitats (fig. 1, 2).

Hymenoptera showed two peaks of distribution of numbers of individuals: within the meso-xeric segment of the moisture gradient and in dunes. Cicadas (Auchenorrhyncha) increased in hygromesophytic and mesoxerophytic habitats, but beetles (Coleoptera), bugs (Heteroptera), butterflies (Lepidoptera), and grasshoppers (Orthoptera) showed higher abundances in a wide range of mesic sites.

A total of 40 families of Diptera were found (tab. 2), dominated by family Chironomidae with the highest absolute and relative numbers of individuals in hygrophytic meadows (fig. 3). Muscidae prefered moist habitats. Bibionidae were most abundant in mesoxerophytic

meadows, but numbers of Phoridae and Empididae were the highest in mesophytic habitats. Chloropidae were abundant in a wide range of habitats.

Hymenoptera were the second most abundant group of insects in the Randu meadows having 11 families. Chalcidoids, which are small parasitoid wasps dominating among Hymenoptera (tab. 2), were not identified to the family level.

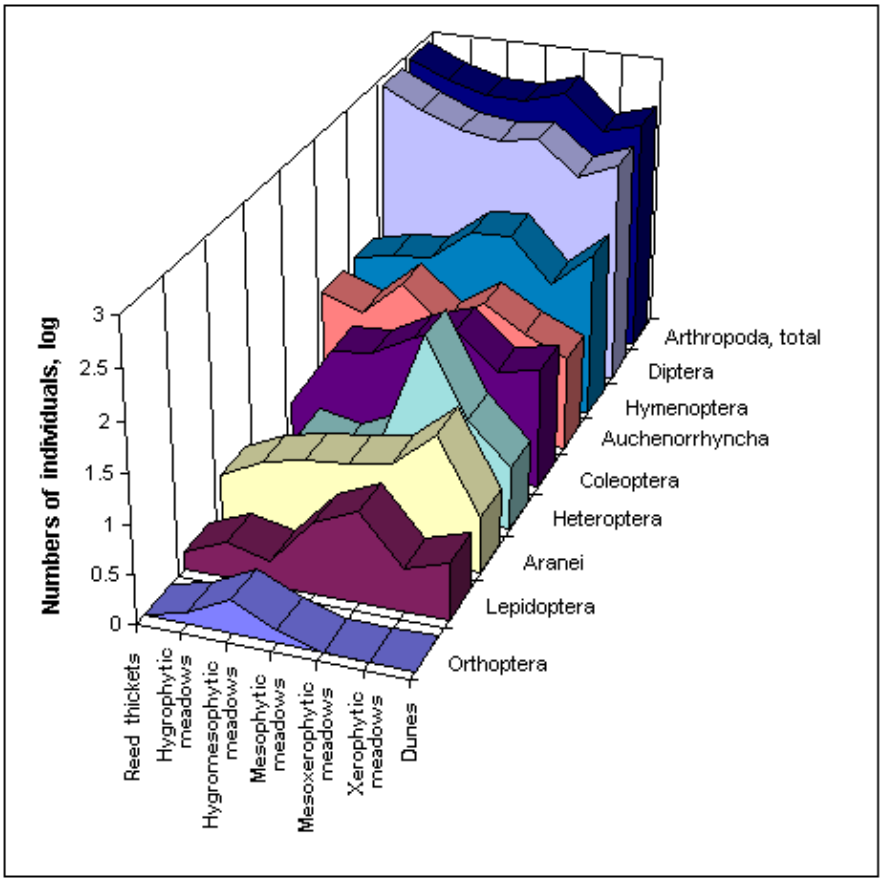

Fig. 2. Distribution of mean numbers of arthropod individuals along a moisture gradient in the reserve "Randu pļavas".

Beetles (Coleoptera) had 19 families with very low numbers of individuals (tab. 2). Bugs (Heteroptera) had 6 families with low numbers of individuals, except Miridae in mesoxerophytic meadows (tab. 2). Orthoptera (2 families) had the lowest numbers of individuals in the Randu meadows (tab. 2).

The highest numbers of insect families was recorded within the mesic habitats (fig. 4). The community indices Shannon's diversity index H' and equitability index E for family structure of insects showed clearly unimodal distribution on the moisture gradient (fig. 5). Only the Margalef's index showed lower values in mesoxerophytic sites, evidently due to a very small number (2) of samples.

H', E and I_M for family structure of Diptera showed similar trends. However, the decrease of values of the indices in mesoxerophytic meadows was more pronounced (fig. 5).

Table 1
Mean number of arthropod individuals (per 50 sweeps) collected in different habitats of the reserve "Randu pļavas" in May-July of 1994

Arthropod group	Reed thickets	Hygrophytic meadows	Hygromesophytic meadows	Mesophytic meadows	Mesoxerophytic meadows	Xerophytic meadows	Dunes
Orthoptera	-	0,3	1,2	0,3	-	-	-
Auchenorrhyncha	19,5	13,3	33,0	14,0	27,5	15,0	9,0
Heteroptera	-	3,2	2,4	4,3	78,0	11,0	3,5
Lepidoptera	0,5	1,3	0,8	4,3	7,5	1,7	2,8
Coleoptera	2,0	12,3	13,4	23,7	34,0	14,0	17,8
Hymenoptera	21,0	26,5	29,2	63,5	69,0	23,0	56,8
Diptera	832,0	510,3	346,8	304,2	349,0	158,3	232,8
Aranei	2,5	4,8	6,0	7,0	8,5	21,3	2,8
In total:	877,5	572	432,8	421,3	573,5	244,3	325,3

Table 2
Mean numbers of insect individuals (per 50 sweeps) collected in different habitats of the reserve "Randu pļavas" in May-July of 1994

Insect group	Reed thickets	Hygrophytic meadow	Hygromesophytic meadows	Mesophytic meadows	Mesoxerophytic meadows	Xerophytic meadows	Dunes
1	2	3	4	5	6	7	8
Orthoptera							
Acrididae	-	0,2	1,2	0,3	-	-	-
Tetrigidae	-	0,1	-	-	-	-	-
Heteroptera							
Lygaeidae	-	0,4	-	-	-	-	-
Miridae	-	1,7	2,0	3,0	69,5	8,7	0,5
Nabidae	-	0,8	-	0,8	6,0	0,3	-
Rhopalidae	-	0,2	0,2	0,5	2,5	2,0	3,0
Scutelleridae	-	0,1	-	-	-	-	-
Tingidae	-	-	0,2	-	-	-	-
Coleoptera							
Apionidae	-	0,4	0,6	1,5	2,0	0,3	-
Cantharidae	1,0	4,0	3,2	1,8	3,5	-	1,3

continuation of table 2

1	2	3	4	5	6	7	8
Carabidae	-	-	-	0,2	-	-	-
Chrysomelidae	0,5	0,5	1,4	0,7	-	0,7	7,3
Coccinellidae	-	-	-	1,0	3,0	4,3	-
Cryptophagidae	-	-	0,2	-	-	-	0,5
Curculionidae	-	1,4	1,2	3,3	4,0	0,3	0,5
Cyphonidae	-	0,8	0,4	0,2	-	-	-
Elateridae	-	-	0,2	0,3	1,0	0,7	-
Helodidae	-	0,5	-	0,3	-	0,7	-
Lagriidae	-	-	-	-	0,5	0,3	0,3
Malachidae	-	0,2	0,2	0,5	3,5	0,7	2,5
Melyridae	-	0,2	0,2	1,0	0,5	-	3,5
Mordellidae	-	-	0,2	0,2	0,5	0,3	-
Nitidulidae	0,5	1,9	1,4	0,2	1,0	0,3	-
Oedemeridae	-	0,5	0,2	1,2	6,0	5,3	1,5
Scarabaeidae	-	-	-	-	-	-	0,5
Scolytidae	-	-	0,2	-	-	-	-
Staphylinidae	-	0,3	0,6	0,2	-	-	-
Coleoptera indet.	-	1,6	3,2	11,2	8,5	-	-
Hymenoptera							
Aphidiidae	0,5	0,5	2,8	3,2	4,5	1,7	2,3
Apidae	-	-	0,4	0,2	-	-	-
Braconidae	-	0,6	1,4	3,2	5,5	1,7	1,3
Cephidae	-	0,1	-	-	-	-	-
Ceraphronidae	0,5	0,4	1,2	1,5	2,5	0,7	1,5
Chalcidoidea (the rest)	17,0	8,9	12,0	42,0	42,0	15,7	47,0
Cynipidae	0,5	0,6	1,6	2,0	-	0,7	1,8
Diapriidae	-	0,1	0,8	-	-	-	-
Ichneumonidae	2,0	0,5	0,8	1,0	2,5	-	0,8
Mymaridae	-	1,5	2,4	1,8	-	-	-
Platygastridae	0,5	13,0	5,4	8,5	9,0	2,3	2,3
Tenthredinidae	-	0,3	0,4	0,2	3,0	0,3	-
Diptera							
Nematocera							
Bibionidae	-	1,7	0,2	6,8	36,0	6,3	0,3
Cecidomyiidae	0,5	6,8	1,4	1,0	6,0	2,7	4,3
Ceratopogonidae	6,5	8,1	11,2	7,3	8,5	4,7	0,8
Chironomidae	750,0	391,0	222,0	155,0	165,0	66,7	90,0
Culicidae	0,5	9,0	17,0	7,5	-	-	2,0
Limoniidae	-	0,3	0,4	0,2	-	0,3	0,3
Scatopsidae	11,5	3,0	6,8	1,5	4,0	0,3	3,3
Sciaridae	2,0	18,0	10,0	11,5	8,0	5,7	0,5

continuation of table 2

1	2	3	4	5	6	7	8
Simuliidae	2,5	-	-	-	-	0,3	-
Tipulidae	0,5	-	0,4	0,5	0,5	-	-
Diptera							
Brachycera							
Agromyzidae	1,5	3,0	8,6	7,8	5,5	1,7	2,3
Anthomyiidae	-	1,8	0,6	2,8	14,5	3,7	2,8
Anthomyzidae	3,5	0,2	0,2	-	-	-	1,5
Asilidae	-	-	-	0,2	-	-	-
Asteiidae	-	-	-	3,2	1,0	2,0	28,8
Calliphoridae	1,5	0,7	0,2	1,2	-	-	-
Calobatidae	-	-	-	-	-	-	0,3
Chamaemyiidae	-	0,7	0,4	6,7	1,5	14,3	-
Chloropidae	12,5	9,6	31,4	8,7	28,5	18,7	53,3
Dolichopodidae	1,0	4,1	4,8	2,2	0,5	-	1,8
Drosophilidae	-	-	-	-	1,0	0,3	-
Empididae	3,5	14,3	9,2	16,5	8,0	3,7	8,0
Ephydridae	3,5	5,5	2,0	2,7	4,0	1,7	0,3
Lauxanidae	-	-	-	-	1,0	-	-
Muscidae	23,0	12,5	8,0	21,8	-	12,0	8,5
Opomyzidae	-	0,1	-	-	-	-	-
Ottitidae	1,5	1,5	0,4	0,2	-	-	17,0
Phoridae	3,0	5,0	7,6	27,2	6,0	0,7	3,3
Diptera							
Cyclorrhapha							
Pipunculidae	1,0	-	-	0,2	-	1,3	0,8
Psilidae	-	-	-	-	-	-	0,3
Sarcophagidae	0,5	0,1	-	0,3	-	-	-
Scatophagidae	-	3,2	-	0,2	-	-	-
Sciomyzidae	0,5	1,7	0,8	5,2	2,0	0,3	0,3
Sepsidae	-	0,3	1,0	0,7	-	-	-
Sphaeroceridae	-	0,7	0,4	0,2	-	0,3	-
Syrphidae	1,5	4,5	1,6	3,5	1,0	2,0	1,3
Tabanidae	-	0,2	-	-	-	-	-
Tachinidae	-	0,1	-	0,2	-	-	-
Tephritidaee	-	-	0,2	-	-	1,3	-
Therevidae	-	-	-	-	-	-	0,3
Diptera indet.	-	2,6	-	1,5	7,0	7,3	1,3

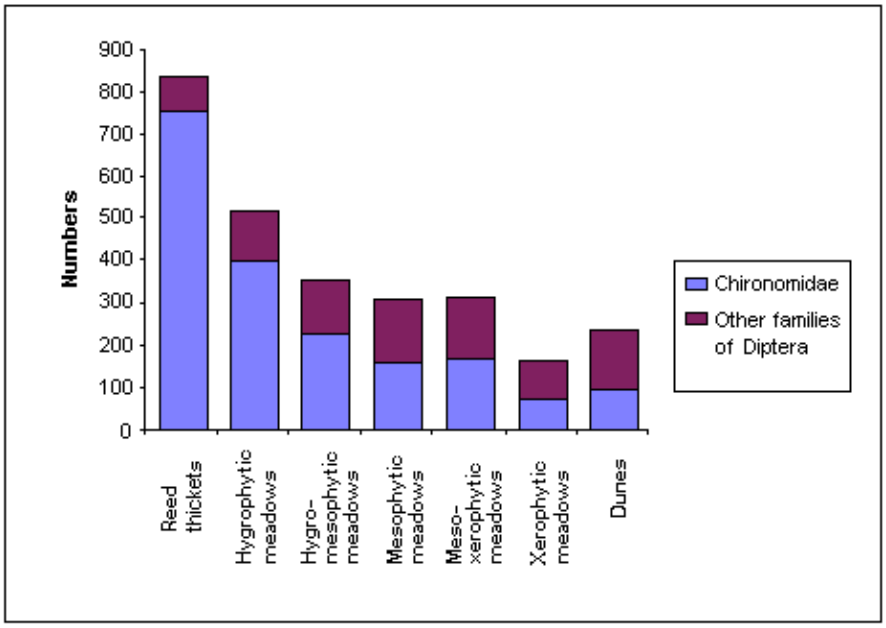

Fig. 3. Distribution of mean numbers of Diptera and of percentage of chironomids along a moisture gradient in the reserve "Randu pļavas".

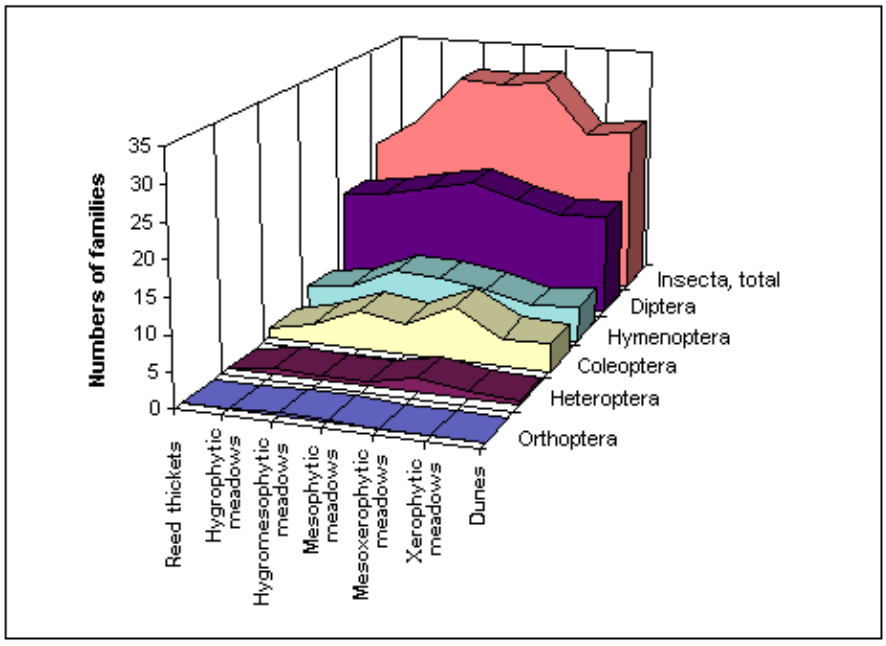

Fig. 4. Distributions of mean numbers of families of selected groups of insects along a moisture gradient in the reserve "Randu pļavas".

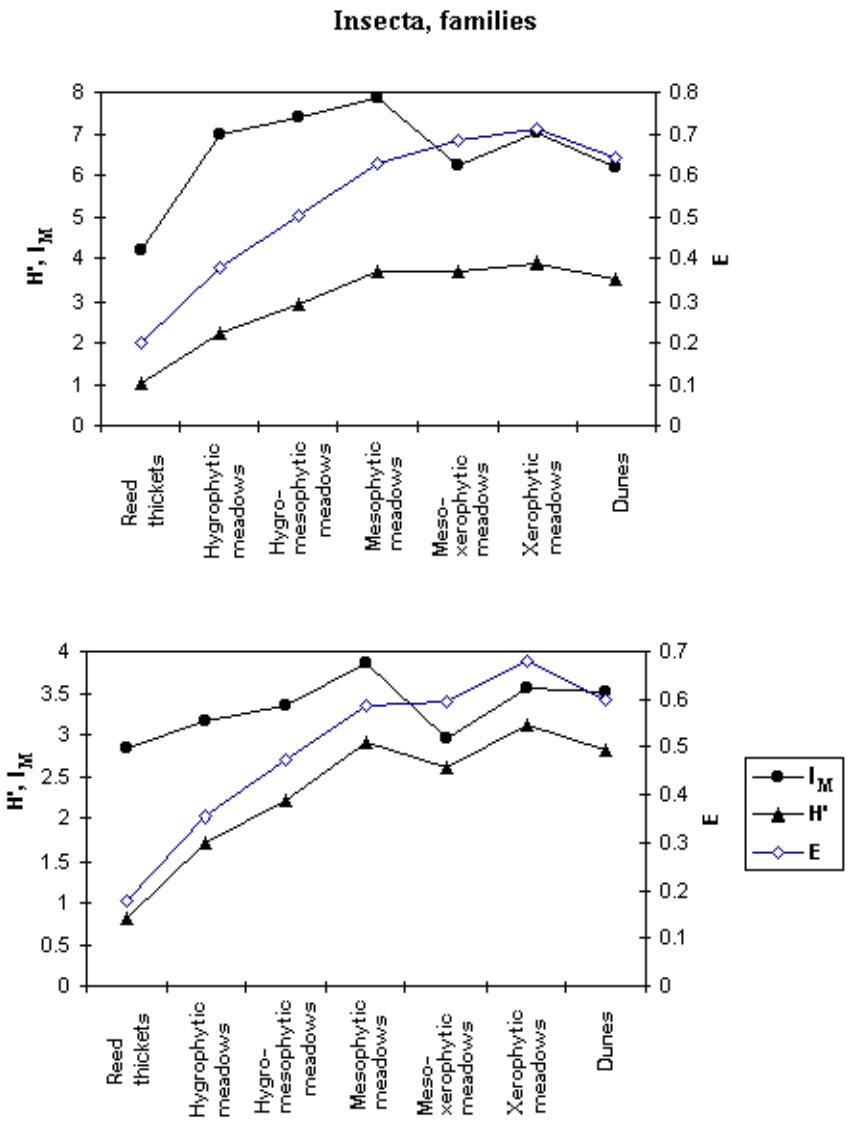

Fig. 5. Shannon's species diversity index H', equitability index E and Margalef's index I_M calculated for family structure of insects and Diptera along a moisture gradient in the reserve "Randu pļavas".

Discussion

There are no major differences in the general community composition of grass-dwelling arthropods in the Randu meadows and mesophytic cultivated inland meadows dominated by *Dactylis glomerata* (Karps et. al., 1989). In both cases, Diptera dominated and had the similar numbers of families (40 and 42, respectively). Numbers of beetle families found in the Randu meadows (19) also did not much differ from that of the inland meadows (17).

The second most abundant insect group in the littoral meadows was Hymenoptera. The cultivated meadows had much higher numbers of cicadas and bugs, pushing Hymenoptera in

the third place. Diptera of the Randu meadows were dominated by Chironomidae, but within the inland meadows by Chloropidae followed by Anthomyiidae and Chironomidae.

The high numbers of Chironomidae in the Randu meadows can be explained by the presence of numerous small ditches and lagoons in which their larvae develop. Chloropidae in the Randu meadows were abundant in a wide range of various habitats, due to their trophic association with species of wild cereals, a common component of grassland vegetation. Beetles were not among the dominant insects of the littoral meadows but within the inland meadows the numerous weevils (Curculionidae) and leaf-cutting beetles (Chrysomelidae) much increased their dominance.

The specific community structure of the grass-dwelling insects of the Randu meadows can be explained by ecological conditions. The soils of the most part of the meadows are subjected to inundation, especially during storms and periods with abundant precipitation. High moisture and increased salt concentrations of soils may be limiting to some insect groups.

The wide spectra of habitats within the relatively small area of the reserve involves large amplitudes of environmental factors, especially moisture. Distributions of species abundances on strong environmental gradients are generally unimodal, excepting when strong competition is involved (Whittaker, 1975). In our studies, not only the numbers of most of investigated taxonomic groups, but also characteristics of insect community (family numbers, diversity indices), showed unimodal distributions on the soil moisture gradient, with the maximum values being mainly found in the mesic part.

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Kopsavilkums

1994. gadā veikti zāles stāva posmkāju pētījumi Randu pļavās. Posmkāji kvantitatīvi uzskaitīti, izmantojot entomoloģisko tīkliņu, 7 dažādās pļavu asociācijās ar dažādu augsnes mitrumu. Starp kukaiņiem dominēja divspārņi (Diptera) (40 dzimtas). Salīdzinot ar Latvijas iekšzemes pļavām, skaitliski mazāk konstatēts vaboļu (Coleoptera), blakðu (Heteroptera) un cikādu (Auchenorrhyncha), ko varētu izskaidrot ar palielināto augsnes mitrumu un sāļainumu Randu pļavās. Vairumam lielāko posmkāju grupu indivīdu un dzimtu skaitam, Šenona sugu dažādības indeksa H', izlīdzinātības indeksa E un Margalefa indeksa I_M vērtībām, kas aprēķinātas pēc dzimtu struktūras, ir unimodāls sadalījums uz mitruma gradienta.

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