POLSKA AKADEMIA NAUK
MUZEUM I INSTYTUT ZOOLOGII
FRAGMENTA FAUNISTICA
Tom 39 Warszawa, 31 I 1996 Nr 9

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Crane-flies (*Limoniidae, Diptera*) of Roztocze and of a part of "Puszcza Solska" (Kotlina Sandomierska)

Abstract. On the basis of investigations into the imagines of *Limoniidae*, the qualitative and quantitative composition and biotic diversity of some plant communities in Roztocze and in a part of Kotlina Sandomierska were compared. 121 species of crane-flies were collected in the investigated area. Six of them were recorded from Poland for the first time.

INTRODUCTION

The fauna of crane-flies (*Diptera, Nematocera, Limoniidae*) in Poland is not sufficiently known. Roztocze and Kotlina Sandomierska are regions not yet fullyinvestigated in this respect. The literature concerning crane-flies in Poland contains only two records of a few species occurring in Roztocze (KRZEMIŃSKI 1984, 1991).

The present research was carried out within a programme coordinated by the Institute of Zoology, the Polish Academy of Science in Warsaw.

The aim of this research was to study the species composition of the crane-fly fauna of some parts of south-eastern Poland and to define the zoogeographical characteristics of this fauna. The present study is a contribution to a more extensive research on regional diversification of the Polish fauna. The species composition and abundance of the crane-fly fauna in particular plant communities were compared.

The author is very grateful to Dr W. MIKOŁAJCZYK, Dr S. NIESIOŁOWSKI and Dr J. MAJECKI for rending their collections of *Limoniidae* accessible.

MATERIAL AND METHODS

The material studied comprised about 4000 imagines of *Limoniidae* coming from some 200 samples collected between 1986 and 1989. 146 of these samples formed a basis for most of the conclusions presented in this paper (Table I). The

remaining samples (about 50) were random ones, mostly collected using different, uncomparable methods. Therefore they were taken into consideration only to document the emergence periods of imagines and the locations of rare species.

An entomological net of 40 cm in diameter was used to collect samples. Sampling always lasted for 30 minutes in order to make results comparable. The material obtained, preserved in 75% ethanol, has been deposited at the Department of Invertebrate Zoology and Hydrobiology, the University of Łódź.

The species dominance in particular plant communities (D) was calculated as a percentage of specimens of particular species in proportion to all the specimens from a particular community. The frequency of occurrence of a species in samples (F) was calculated as a percentage of samples containing particular species in all the samples collected in a particular community. And the frequency of occurrence of a species in sites (C) – as a percentage of sites with particular species to the all sites of given community (Table I). The calculations for the material as a whole were made in the same way (Table II).

The species diversity of *Limoniidae* in particular plant communities was compared using the Shannon-Weaver index (TROJAN 1992).

The zoogeographical classification was based on papers by NOLL (1985), SAVČENKO (1989), SAVČENKO et al. (1992). The taxonomy and systematics are in accordance with "Catalogue of Palaearctic *Diptera*" (SAVČENKO et al.1992).

DESCRIPTION OF THE STUDY AREA

The study area included parts of two regions of south–eastern Poland: Roztocze and Kotlina Sandomierska (Fig. 1–A).

Roztocze consists of a range of hills running from the northwest to the south--east. The range of Roztocze does not stand out sharply from the adjacent regions. Its height increases gradually towards the southeast – from 300 m a.s.l. in its western parts to 390 m a.s.l. near the Polish-Ukrainian border. Roztocze adjoins Wyżyna Lubelska to the northeast without any clear borderline, whereas to the southwest it is separated from Kotlina Sandomierska by a distinct, steep edge, at some places even 100 m high.

From the physiographical point of view Roztocze is not a homogeneous region (WÓJCIKOWSKI, PACZYŃSKI 1986). Three subregions can be distinguished there: Western Roztocze, Central Roztocze and Southern Roztocze.

The investigations were carried out only in the subregions of Central Roztocze and the eastern part of Western Roztocze, called Roztocze Szczebrzeszyńskie (Fig. 1–B). Only four sites were situated outside this area: nos 1 (Southern Roztocze), 51, 52 and 53 (the western part of Western Roztocze).

The subregions mentioned above differ distinctly in respect of the relief. The forms most characteristic of Roztocze Szczebrzeszyńskie are narrow, long and deep valleys filled with loess. Hill ridges running along the valleys are dissected by a dense net of ravines 2–20 m deep (IZDEBSKI et al. 1992). The slopes of the ridges and the bottoms of the ravines are covered with deciduous forests, whereas the deforested tops of the ridges are usually used for cultivation.

Central Roztocze is far less sculptured; it comprises flat, levelled surfaces surrounded by vast valleys. The area looks like rather monotonous planes. Although large areas are cultivated, Central Roztocze is the most afforested subregion. According to WÓJCIKOWSKI and PACZYŃSKI (1986), the average afforestation there reaches about 50%. The biggest and the most interesting forest complexes, situated in the western part of Central Roztocze, have been protected

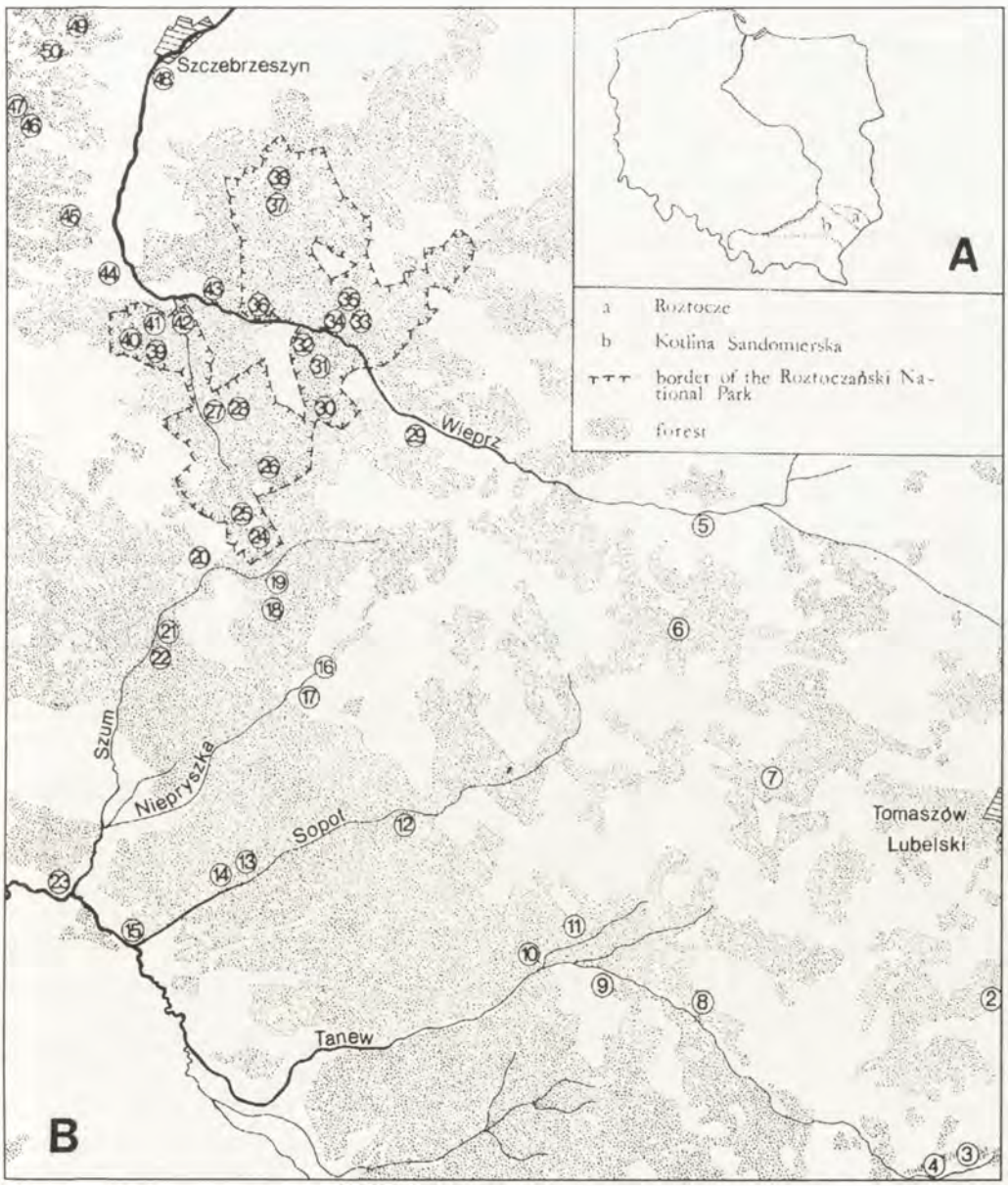

Fig. 1. Investigated area. A – Situation of Roztocze and Kotlina Sandomierska; B – Sampling sites

since 1974. At the moment, the Roztocze National Park comprises about 6800 ha of forests.

The Roztocze forests are directly connected with the extensive forest complexes situated in the northeastern part of Kotlina Sandomierska, called "Puszcza Solska" (= the Solska Primaeval Forest). Pine-fir forests with spruce and beech are dominant type of vegetation there. However, the present investigations were carried out mainly in communities associated with river banks.

The river system of the investigated area, particularly that of Roztocze, is rather poor. Roztocze is situated within the watershed of the Wieprz, Bug and San river--basins.

The main river is the Wieprz, which flows along the Central Roztocze massif. Farther on, it becomes a natural border between Central and Western Roztocze. The river receives larger tributaries only downstream of the town of Szczebrzeszyn, that is beyond the limits of Roztocze. The interior of Roztocze is characterized by almost complete lack of surface waters and by ground waters occurring at a great depth. This results from the geological structure of the area. The network of springs is also relatively poor (WÓJCIKOWSKI, PACZYŃSKI 1986). A somewhat better situation occurs only in the ridge zone, where the River Tanew and its tributaries begin. Because of steep slopes and cracked bed-rock in this region long reaches of, the rivers resemble rapid mountain streams, often forming small waterfalls over rock edges. The springs of these rivers are in the Central Roztocze area. Below the ridge zone the River Tanew and its right-side tributaries: Sopot, Jeleń, Szum and Niepryszka, flow through "Puszcza Solska". The mouths of the Sopot and the Szum which drain into the River Tanew, are situated southwest of the "Puszcza Solska" border. Some sites were situated along these rivers too (Fig. 1–B).

A list of respective sites and their descriptions are presented below. The symbols (letters and numerals) next to each sites determine its situation in the UTM square grid system. Most of the sites correspond to those proposed by a project of coordinators (LIANA et al. 1992); however the present numeration has been used for the needs of this paper only.

1. Siedliska near Hrebenne, the Tomaszów Lubelski forest inspectorate. FA 77. The station in Southern Roztocze, not indicated on the map of the investigated area. *Tilio-Carpinetum*, forest section no. 379 (1 sample).
2. "Uroczysko Muraczewski" (= the Muraczewski back woods) near Bełżec, the Tomaszów Lubelski forest inspectorate. FA 78. *Tilio-Carpinetum*, forest section 82 (1 sample).
3. Łukawica on the River Tanew. FA 67. River valley meadows along the spring section of the river, upstream of the village (2 samples).
4. Łukawica on the River Tanew. FA 67. Alder carr community on the river banks; tufts of grass and marsh marigold or clumps of alder on boggy ground, water stagnating in depressions (2 samples).
5. Majdan Wielki on the River Wieprz. FB 60. Low grasses and canary grass on wet river banks (3 samples).
6. "Uroczysko Zielone" (= the Zielone back woods) southeast of Krasnobród. FA 69. *Abietetum polonicum* (1 sample).
7. Ulów, the Tomaszów Lubelski forest inspectorate. FA 69. *Abietetum polonicum*, forest section no. 308, near the road from Tomaszów Lubelski to Józefów (2 samples).
8. Paary on the River Tanew. FA 68. Well insolated river banks covered with grasses and low herbaceous plants (3 samples).
9. Rebizanty on the River Tanew. FA 58. Shadowy, damp scrub on both river banks (4 samples).
10. The "Nad Tanwią" nature reserve. FA 58. *Ribo nigri-Alnetum* in the fork of the River Jeleń draining into the River Tanew (3 samples).

11. Susiec. FA 58. *Leucobryo-Pinetum*, near a tourist track between Susiec and the "Nad Tanwią" nature reserve (1 sample).
12. The "Czartowe Pole" nature reserve near Hamernia. FA 48. *Ribo nigri-Alnetum* in the River Sopot valley (2 samples).
13. Fryszarka on the River Sopot. FA 49. Well insolated meadow on the boggy banks (6 samples).
14. Fryszarka on the River Sopot. FA 49. *Ribo nigri-Alnetum* on the right river bank (7 samples).
15. Osuchy on the River Sopot. FA 38. Shadowy scrub on the river bank about 1 km upstream of its mouth (2 samples).
16. Józefów on the River Niepryszka. FA 49. The site situated within the town, around the spring. Open, insolated area with prevailing low synanthropic vegetation (2 samples).
17. Józefów on the River Niepryszka. FA 49. Low river-side vegetation on the boggy banks of the strongly meandering river, about 1,5 km downstream of the spring (3 samples).
18. Majdan Kasztelański on the River Szum. FA 49. *Ribo nigri-Alnetum* on the edge of the another forest situated southeast of the village (4 samples).
19. Majdan Kasztelański on the River Szum. FA 49. Dense, shadowy scrub on both river banks (4 samples).
20. Górecko Stare on the River Szum. FA 49. Scrub on the boggy, muddy bank of the river (2 samples).
21. Górecko Kościelne on the River Szum. FA 39. Dense scrub on a wet river bank upstream of a chapel situated on the water (1 sample).
22. Górecko Kościelne on the River Szum. FA 39. Very well insolated, open meadow on the left bank of the river downstream of the chapel (2 samples).
23. Szostaki on the River Tanew. FA 38. Scrub in the fork of the River Szum flowing into the River Tanew (4 samples).
24. The Roztocze National Park (RPN), "Uroczysko Międzyrzeki" (= the Międzyrzeki back woods) near Majdan Kasztelański. FA 49. *Vaccinio uliginosi-Pinetum*, forest sections nos 292 and 293 (1 sample).
25. The RPN, the Kruglik forest range. FA 49. *Vaccinio uliginosi-Pinetum*, forest section no. 284 (1 sample).
26. The RPN, the "Nart" nature reserve. FB 40. *Dentario glandulosae-Fagetum*, forest sections nos 264 and 265 (8 samples).
27. The RPN, the Biały Słup forest range. FB 30. *Ribo nigri-Alnetum*, forest section no. 213 (6 samples).
28. The RPN, the "Obrocz" nature reserve. FB 40. *Dentario glandulosae-Fagetum*, forest section nos 211 (1 sample).
29. Bondyrz on the River Wieprz. FB 40. Well insolated meadows on the left river bank upstream of the village (3 samples).
30. The RPN, the village of Lasowce. FA 49. *Dentario glandulosae-Fagetum*, forest section no. 232 (1 sample).
31. The RPN, the "Czerkies" nature reserve. FB 40. *Abietetum polonicum*, forest section no. 194 (3 samples).
32. Obrocz on the River Wieprz. FB 40. *Ribo nigri-Alnetum*, in the Wieprz valley between section no. 182 of the RPN and the river bed (1 sample).
33. The RPN, the Stokowa Góra forest range. FB 40. *Abietetum polonicum*, forest section no. 140 (2 samples).
34. The RPN, the Stokowa Góra forest range. FB 40. Scrub around the springs on the right bank of the River Wieprz (5 samples).
35. The RPN, the Stokowa Góra forest range. FB 40. *Dentario glandulosae-Fagetum*, the poor variety (1 sample).
36. Obrocz on the River Wieprz. FB 40. Dump scrub on the river bank in the village (2 samples).
37. The RPN, the Jarugi forest range. FB 41. *Dentario glandulosae-Fagetum*, forest sections nos 24 and 25 (5 samples).
38. The RPN, the Jarugi forest range. FB 41. *Tilio-Carpinetum*, forest section no. 13 (7 samples).
39. The RPN, the "Bukowa Góra" nature reserve. FB 30. *Dentario glandulosae-Fagetum*, forest section nos 175 and 176 (5 samples).
40. The RPN, the "Bukowa Góra" nature reserve. FB 30. *Abietetum polonicum*, forest section no. 164 (4 samples).
41. The RPN, the Bukowa Góra forest range. FB 30. *Leucobryo-Pinetum*, forest section no. 155 (3 samples).
42. The RPN, the town of Zwierzyniec. FB 30. Community related to wet alder forest, situated in the River Świerszcz valley, downstream of the Echo Ponds (4 samples).

43. Rudka near Zwierzyniec on the River Wieprz. FB 30. Scrub on the boggy river banks (2 samples).
44. Wywłoczka on the River Wieprz. FB 30. Scrub on the left river bank, near a small spring (1 sample).
45. Forest of Jeliczny Dół near the village of Turzyniec. FB 30. *Dentario glandulosae-Fagetum* in ravines (2 samples).
46. The forest of Cetnar near the Kawęczynek village. FB 31. *Dentario glandulosae-Fagetum* on the hill slopes (1 sample).
47. Forest of Cetnar near the village of Kawęczynek. FB 31. *Tilio-Carpinetum* (2 samples).
48. Szczebrzeszyn on the River Wieprz. FB 31. Vast meadows on the flat river banks (3 samples).
49. Ravines of Piekiełko near Szczebrzeszyn. FB 31. *Tilio-Carpinetum* on the ravine slopes (2 samples).
50. Kociuby Ravine near the village of Szperówka. FB 32. *Tilio-Carpinetum* (1 sample).
51. Hosznia Ordynacka. FB 22. Site in Western Roztocze, not indicated on the map of the investigated area. *Dentario glandulosae-Fagetum*, in the peasants' forests east of the village (2 samples).
52. Tarnawa. FB 13. Site in Western Roztocze, not indicated on the map of the investigated area. *Dentario glandulosae-Fagetum*, in the peasants' forests south of the village (3 samples).
53. Tarnawa. FB 13. Site in Western Roztocze, not indicated on the map of the investigated area. *Tilio-Carpinetum*, in the peasants' forests south of the village (2 samples).

The above mentioned sites can be classified according to a phytosociological criteria:

A. Coniferous forests (9 sites, 18 samples):
   - fir forests, *Abietetum polonicum* (site nos 6, 7, 31, 33, 40),
   - pine woods, *Leucobryo-Pinetum* (site nos 11 and 41),
   - marshy pine woods, *Vaccinio uliginosi-Pinetum* (site nos 24 and 25);
B. Linden-hornbeam forests, *Tilio-Carpinetum* (site nos 1, 2, 38, 47, 49, 50, 53; 7 sites, 16 samples);
C. Carpathian beech wood, *Dentario glandulosae-Fagetum* (site nos 26, 28, 30, 35, 37, 39, 45, 46, 51, 52; 10 sites, 29 samples);
D. Typical wet alder forests, *Ribo nigri-Alnetum*, and related communities (site nos 4, 10, 12, 14, 18, 27, 32, 42; 8 sites, 29 samples);
E. Shadowy river-side scrub (site nos 9, 15, 19, 20, 21, 23, 34, 36, 43, 44; 10 sites, 27 samples);
F. Insolated river-side meadows (site nos 3, 5, 8, 13, 16, 17, 22, 29, 48; 9 sites, 27 samples).

The stations mentioned in groups A–D have been studied in detail in the floristic and phytosociological respect (IZDEBSKI et al. 1992; LIANA et al. 1992). They were situated in forest communities.

Groups E and F require some comment. They comprise sites situated at the river banks or in the vicinity of springs. In the case of small and mosaically-scattered microhabitats the application of phytosociological criteria is very difficult, often impossible. However, these are habitats that must not be left out of this study of *Limoniidae* because this group of insects is characterized by specific behaviour. The praeimaginal stages of *Limoniidae* develop not only in different types of soil but also in stagnant and running waters. However, the most characteristic microhabitat of this group is the borderline between water and land. Since no praeimaginal stages were collected in this study, the division of the river-side habitats into shadowy scrub and insolated meadows seemed to be sufficient for determining the ecological preferences of imagines. These two types of habitat differ from each other in two characters, that is temperature and air humidity, that are most important for imagines of *Limoniidae*. Therefore, this simplification in the classification of the river-side communities has been adopted as more appropriate than a complete disregard of the ecological preferences of *Limoniidae*, which are strongly diversified in respect of their environmental demands; however, the knowledge of this subject is very poor.

RESULTS AND DISCUSSION

121 species of crane-flies were collected in the investigated area. 115 species have been listed in Table 1; the other six will be mentioned below, come from accidentally penetrated sites. They are as follows:

Table I. Occurrence of *Limoniidae* in particular plants communities (cf – coniferous forests; TC – *Tilio-Carpinetum* association; DgF – *Dentario glandulosae-Fagetum* association; RnA – *Ribo nigri-Alnetum* association; sr – shadowy river-side scrub; mr – insolated river-side meadows).

No.	Community / Species	cf				TC				DgF				RnA				sr				mr				N	Month	Number of sites	ZG
		N	D %	F %	C %	N	D %	F %	C %	N	D %	F %	C %	N	D %	F %	C %	N	D %	F %	C %	N	D %	F %	C %				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	PEDICIINAE																												
1.	*Ula bolitophila* Lw									3	1.1	3.4	10.0													3	V, VII	26	aP, bm
2.	*Ula mollissima* Hal.					2	1.0	12.5	14.3	8	2.9	24.1	**50.0**													10	V, VII, X	26, 30, 38, 39, 51, 52	wP
3.	*Ula sylvatica* (Mg.)	6	**9.7**	**27.8**	**55.5**	4	2.0	18.8	28.6	14	**5.0**	**31.0**	**70.0**	3	0.3	6.9	25.0	1	0.1	3.7	10.0					28	V, VII	6, 10, 12, 24, 26, 28, 31, 33, 34, 37, 39, 41, 45, 47, 51–53	aP
4.	*Dicranota* (D.) *bimaculata* (Schumm.)													3	0.3	10.3	37.5	19	2.0	22.2	30.0	48	3.7	**40.7**	**66.7**	70	IV–VI, X	3, 4, 8, 9, 13, 16, 19, 27, 29, 34, 42, 48	E
5.	*Dicranota (Paradicranota) robusta* Lundstr.																					1	0.1	3.7	11.1	1	IV	29	E, bm
6.	*Tricyphona* (T.) *immaculata* (Mg.)													47	4.3	4.1	**75.0**	75	**7.8**	**40.7**	**80.0**	39	3.0	**44.4**	**88.9**	161	V–VI, X	3–5, 8–10, 12–17, 19, 20, 22, 23, 27, 29, 32, 34, 36, 43	EmA
7.	*Tricyphona* (T.) *schummeli* Edw.	8	**12.9**	11.1	22.2																					8	V	24, 25	E, bm
8.	*Tricyphona* (T.) *unicolor* (Schumm.)													5	0.5	10.3	37.5					3	0.2	7.4	22.2	8	V	3, 4, 8, 14, 32	E
	HEXATOMINAE																												
9.	*Paradelphomyia (Oxyrhiza) fuscula* (Lw)													1	0.1	3.4	12.5									1	VIII	12	wP
10.	*Austrolimnophila (Archilimnophila) unica* (O.–S.)									8	2.9	6.7	10.0					2	0.2	3.7	10.0					10	V, VII	34, 45	H
11.	*Austrolimnophila (A.) ochracea* (Mg.)					14	**6.9**	**25.0**	42.9	32	**11.5**	**34.5**	**60.0**	6	0.6	10.3	37.5									52	V–VIII	4, 14, 26, 27, 30, 37–39, 46–50	wP
12.	*Epiphragma ocellare* (L.)	3	4.8	16.7	22.2	13	**6.4**	**31.3**	42.9	10	3.6	13.8	30.0	46	4.2	**41.4**	**75.0**	7	0.7	11.1	30.0	1	0.1	3.7	11.1	80	V–VII	7, 8, 10, 14, 18, 20, 21, 23, 26, 27, 32, 38–40, 42, 49, 52, 53	H
13.	*Adelphomyia punctum* (Mg.)									7	2.5	3.4	10.0													7	V	26	aP
14.	*Eloeophila maculata* (Mg.)													4	0.4	10.3	25.0	17	1.8	18.5	40.0	2	0.2	3.7	11.1	23	V–VI, VIII	9, 10, 20, 29, 34, 42, 43	wP
15.	*Eloeophila mundata* (Lw)													1	0.1	3.4	12.5									1	VI	10	E
16.	*Eloeophila submarmorata* (Verr.)													2	0.2	6.9	25.0	3	0.3	7.4	20.0	1	0.1	3.7	11.1	6	V, VII	10, 13, 14, 20, 21	wP
17.	*Eloeophila verralli* (Bergr.)																	3	0.3	7.4	10.0	1	0.1	3.7	11.1	4	V	23, 29	E, m
18.	*Euphylidorea phaeostigma* (Schumm.)	1	1.6	5.6	11.1																					1	V, VII	7	aP
19.	*Eutonia barbipes* (Mg.)													3	0.3	10.3	25.0					7	0.5	11.1	22.2	10	V–VII	3, 13, 14, 32	E
20.	*Idioptera pulchella* (Mg.)	9	**14.5**	5.6	11.1									1	0.1	3.4	12.5									10	V	4, 25	Ptb
21.	*Limnophila* (L.) *pictipennis* (Mg.)																	73	**7.6**	11.1	30.0	1	0.1	3.7	11.1	74	V, VIII	15, 16, 23, 36	Ptb
22.	*Limnophila* (L.) *schranki* Oosterbr. [= *L.* (L.) *punctata* (Schrk)]													68	**6.2**	20.7	37.5	68	**7.1**	**40.7**	**70.0**	157	**12.1**	**37.0**	**66.7**	293	V	3, 4, 8–10, 13–15, 19, 22, 23, 29, 34, 36, 43, 48	E
23.	*Neolimnomyia (Brachylimnophila) nemoralis* (Mg.)									4	1.4	6.7	20.0	42	3.9	**31.0**	**62.5**	10	1.0	14.8	30.0	2	0.2	7.4	22.2	58	V–VIII	4, 8, 13, 14, 18, 19, 23, 26, 27, 42, 43, 46	tP
24.	*Neolimnomyia* (N.) *batava* (Edw.)																					6	0.5	3.7	11.1	6	V–VI	22	E
25.	*Neolimnomyia* (N.) *filata* (Walk.)					1	0.5	6.3	11.3																	1	V	38	E
26.	*Phylidorea (Macrolabina) nigronotata* (Siebke)													7	0.6	6.9	12.5	21	2.2	18.5	40.0	46	3.6	18.5	**55.6**	74	V	8, 10, 13, 15, 20, 22, 23, 29, 36, 48	Ptb
27.	*Phylidorea (Paraphylidorea) fulvonervosa* (Schumm.)													8	0.7	10.3	25.0	4	0.4	7.4	20.0	2	0.2	7.4	22.2	14	V–VIII	3, 13, 14, 18, 21, 43	aP
28.	*Phylidorea* (*Ph.*) *ferruginea* (Mg.)													22	2.0	**27.6**	**75.0**	38	4.0	22.2	**60.0**	17	1.3	**29.6**	**55.6**	77	V–VI, VIII	4, 13–15, 17–19, 22, 23, 27, 29, 32, 34, 36, 42, 43, 48	EmA
29.	*Phylidorea* (*Ph.*) *nervosa* (Schumm.) [= *Ph. nigricollis* (Mg.)]													4	0.4	3.4	12.5	69	**7.2**	22.2	**50.0**	81	**6.3**	**44.4**	**66.7**	154	V–VI	3, 8, 10, 13, 15, 20, 22, 23, 29, 34, 43, 48	E
30.	*Phylidorea* (*Ph.*) *squalens* (Zett.)													2	0.2	6.9	25.0	4	0.4	3.7	10.0	10	0.8	18.5	33.3	16	V–VI	3, 13, 14, 18, 21, 22	E
31.	*Pilaria decolor* (Zett.)									1	0.4	3.4	10.0	5	0.5	3.4	12.5									6	VII–VIII	18, 26	wP,bm
32.	*Pilaria discicollis* (Mg.)													6	0.6	6.9	25.0	13	1.4	**25.9**	**50.0**	4	0,3	11.1	22.2	23	V–VIII, X	4, 8, 13, 19, 23, 27, 34, 36, 43	wP
33.	*Pilaria nigropunctata* (Agr.)													3	0.3	3.4	12.5									3	V	4	E, bm?
34.	*Pseudolimnophila lucorum* (Mg.)													9	0.8	3.4	12.5	16	1.7	11.1	20.0	2	0.2	3.7	11.1	27	V–VIII	4, 13, 43, 44	EmA
35.	*Pseudolimnophila sepium* (Verr.)													2	0.2	3.4	12.5	9	0.9	3.7	10.0	2	0.2	3.7	11.1	13	V–VIII	10, 22, 43	EmA
	ERIOPTERINAE																												
36.	*Crypteria limnophiloides* Bergr.									1	0.4	3.4	10.0													1	X	35	wP
37.	*Erioptera* (E.) *flavata* (Westhoff) [=*E.*(E.) *gemina* Tjed.]													4	0.4	10.3	25.0	2	0.2	3.7	10.0	55	4.2	11.1	22.2	61	V–VIII	3, 13, 14, 32, 43	EmA
38.	*Erioptera* (E.) *fuscipennis* Mg.													4	0.4	3.4	12.5	1	0.1	3.7	10.0	2	0.2	7.4	22.2	7	V–VII	3, 4, 13, 19	wP
39.	*Erioptera* (E.) *fusculenta* Edw.																	24	2.5	**29.6**	**50.0**	11	0.9	**25.9**	**55.6**	35	V–VIII	3, 5, 8, 13, 15, 16, 23, 36, 43, 44	EmA
40.	*Erioptera* (E.) *griseipennis* Mg.																	1	0.1	3.7	10.0					1	V	20	E
41.	*Erioptera* (E.) *limbata* Lw													1	0.1	3.4	12.5									1	VI	14	E
42.	*Erioptera* (E.) *lutea* Mg.					11	**5.5**	12.5	28.6	5	1.8	10.3	20.0	19	1.7	24.1	**50.0**	12	1.6	**25.9**	**50.0**	3	0.2	11.1	33.3	50	V–VII, X	3, 4, 8, 10, 14, 19, 20–22, 26, 32, 34, 38, 44, 50, 51	tP

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
43.	*Erioptera* (E.) *sordida* Zett.													1	0.1	3.4	12.5					2	0.2	7.4	22.2	3	V–VI	4, 8, 13	aP
44.	*Erioptera (Mesocyphona) bivittata* (Lw)																	2	0.2	3.7	10.0					2	V	36	tP
45.	*Gonempeda flava* (Schumm.)													9	0.8	6.9	12.5	76	**7.9**	11.1	30.0	1	0.1	3.7	11.1	86	V–VI	13, 14, 19, 20, 44	E
46.	*Scleroprocta sororcula* (Zett.)													1	0.1	3.4	12.5									1	V	10	E
47.	*Symplecta* (S.) *chosenensis* (Alex.)																	2	0.2	3.7	10.0					2	VI	34	tP
48.	*Symplecta* (S.) *hybrida* (Mg.)													2	0.2	6.9	25.0	5	0.5	7.4	20.0	2	0.2	7.4	22.2	9	V, VII	4, 5, 14, 15, 23, 48	H, O
49.	*Cheilotrichia* (Ch.) *cinerea* (Strobl) [= *Ch.* (Ch.) *exigua* Lack.]					4	2.0	6.3	14.3																	4	V	53	E, m?
50.	*Cheilotrichia* (Ch.) *imbuta* (Mg.)													12	1.1	10.3	25.0	4	0.4	11.1	20.0	1	0.1	3.7	11.1	17	VI–VII	13, 14, 23, 27, 44	tP
51.	*Cheilotrichia (Empeda) cinerascens* (Mg.)					5	2.5	18.8	42.9	6	2.2	10.3	20.0	1	0.1	3.4	12.5	1	0.1	3.7	10.0					13	V	4, 34, 38, 50–53	EmA
52.	*Cheilotrichia (Empeda) neglecta* (Lack.)													9	0.8	3.4	12.5	5	0.5	3.7	10.0	4	0.3	11.1	33.3	18	X	5, 13, 14, 34, 48	E
53.	*Erioconopa trivialis* (Mg.)													5	0.5	10.3	37.5	53	**5.5**	**37.0**	**50.0**	100	**7.7**	**44.4**	**77.8**	158	V–VI, VIII–X	3–5, 8, 13–17, 19, 23, 29, 32, 36, 43	wP
54.	*Hoplolabis (Parilisia) vicina* (Tonn.)																	35	3.7	**25.9**	40.0					35	V–VII	9, 23, 34, 36	wP
55.	*Ilisia maculata* (Mg.)									1	0.4	3.4	10.0	17	1.6	20.7	25.0	6	0.6	18.5	40.0					24	V–VII	4, 14, 19, 20, 26, 34, 36	wP
56.	*Molophilus* (M.) *appendiculatus* (Staeg.)					1	0.5	6.3	14.3	7	2.5	10.3	20.0	4	0.4	6.9	25.0									12	V, VII–VIII	14, 26, 37, 42, 53	EmA
57.	*Molophilus* (M.) *ater* (Mg.)													154	**14.1**	17.2	**50.0**	27	2.8	**29.6**	**60.0**	561	**43.3**	**25.9**	**55.6**	742	V	3, 4, 8–10, 13–15, 18, 19, 22, 23, 29, 34, 36	E
58.	*Molophilus* (M.) *bifidus* Goetgh.													5	0.5	6.9	25.0	2	0.2	3.7	10.0					7	V, VIII	4, 14, 43	EmA
59.	*Molophilus* (M.) *bihamatus* De Meij.													1	0.1	3.4	12.5	18	1.9	3.7	10.0	2	0.2	3.7	11.1	21	V	13, 14, 21	E
60.	*Molophilus* (M.) *cinereifrons* De Meij.									8	2.9	3.4	10.0					1	0.1	3.7	10.0					9	V–VII	26, 34	E
61.	*Molophilus* (M.) *crassipygus* De Meij. [= *M.* (M.) *ochrescens* Edw.]													7	0.7	3.4	12.5									7	VIII	42	E
62.	*Molophilus* (M.) *curvatus* Tonn.													1	0.1	3.4	12.5									1	V	14	E
63.	*Molophilus* (M.) *flavus* Goetgh.																	3	0.3	3.7	10.0					3	V	21	E
64.	*Molophilus* (M.) *maurus* Lack.																					10	0.8	3.7	11.1	10	V–VI	17	E
65.	*Molophilus* (M.) *medius* De Meij.													6	0.6	3.4	12.5	12	1.3	11.1	30.0	2	0.2	7.4	22.2	20	V–VIII	8, 13, 14, 34, 36, 43	E
66.	*Molophilus* (M.) *obscurus* (Mg.)																	2	0.2	3.7	10.0	4	0.3	3.7	11.1	6	V–VI	17, 43	wP
67.	*Molophilus* (M.) *ochraceus* (Mg.)									2	0.7	3.4	10.0	71	**6.5**	**27.6**	**62.5**	5	0.5	14.8	30.0					78	V–VII	4, 14, 15, 19, 23, 26, 27, 32, 42	wP
68.	*Molophilus* (M.) *propinquus* (Egg.)													10	0.9	3.4	12.5	24	2.5	**29.6**	**50.0**	9	0.7	**25.9**	44.4	43	V–VII	4, 5, 8, 13, 15, 19, 23, 29, 36, 44	tP
69.	*Molophilus* (M.) *repentinus* Starý													6	0.6	3.4	12.5	15	1.6	11.1	20.0					21	V	9, 10, 19	E
70.	*Molophilus* (M.) *serpentiger* Edw.													57	**5.2**	10,3	12.5	6	0.6	11.1	30.0					63	V	14, 20, 34, 36	E
71.	*Ormosia* (O.) *depilata* Edw.													53	4.9	**34.5**	**50.0**	43	4.9	22.2	40.0	11	0.9	18.5	**55.6**	107	V	3, 4, 8–10, 13, 14, 18–20, 22, 34, 48	E
72.	*Ormosia* (O.) *hederae* (Curt.)													3	0.3	3.4	12.5	2	0.2	7.4	20.0	15	1.2	7.4	22.2	20	V	5, 14, 15, 36, 48	EmA
73.	*Ormosia* (O.) *lineata* (Mg.)					5	2.5	12.5	28.6	14	**5.0**	6.7	20.0													19	V	26, 28, 50, 53	E
74.	*Ormosia* (O.) *ruficauda* (Zett.)													1	0.1	3.4	12.5									1	V	4	E, bm
75.	*Rhypholophus varius* Mg.																	8	0.8	7.4	20.0					8	X	20, 34	E
76.	*Tasiocera (Dasymolophilus) fuscescens* (Lack.)					1	0.5	6.3	14.3	1	0.4	3.4	10.0	1	0.1	3.4	12.5									3	V	26, 38, 42	E
77.	*Dicranoptycha livescens* Lw																	1	0.1	3.7	10.0					1	VII	9	E
78.	*Gnophomyia lugubris* (Zett.)													1	0.1	3.4	12.5									1	VI	27	tP
79.	*Gonomyia* (G.) *lucidula* De Meij.													3	0.3	3.4	12.5					1	0.1	3.7	11.1	4	VI	14	E
80.	*Gonomyia* (G.) *simplex* Tonn.													2	0.2	6.9	12.5									2	V	14	E
81.	*Gonomyia* (G.) *tenella* (Mg.)					1	0.5	6.3	14.3	2	0.7	3.4	10.0	2	0.2	3.4	12.5									5	V	2, 4, 51	E
82.	*Lipsothrix remota* (Walk.)													1	0.1	3.4	12.5	1	0.1	3.7	10.0					2	V, VIII	14, 43	E
	LIMONIINAE																												
83.	*Elephantomyia* (E.) *edwardsi* Lack.	2	3.2	5.6	11.1					5	1.8	6.7	20.0													7	V–VI	26, 39, 40	E, bm
84.	*Helius* (H.) *longirostris* (Mg.)					2	1.0	6.3	14.3					34	3.1	**27.6**	**75.0**	4	0.4	11.1	20.0	1	0.1	3.7	11.1	41	V–VI, VIII	4, 10, 13, 14, 18, 23, 32, 42, 43, 49	wP
85.	*Antocha* (A.) *vitripennis* (Mg.)																	1	0.1	3.7	10.0					1	V	21	EmA
86.	*Achyrolimonia coeiana* (Niels.)					1	0.5	6.3	14.3	2	0.7	3.4	10.0													3	V–VI	26, 38	wP
87.	*Achyrolimonia decemmaculata* (Lw)					2	1.0	6.3	14.3	3	1.1	10.3	30.3													5	V–VI	26, 37–39	wP
88.	*Atypophthalmus inustus* (Mg.)					1	0.5	6.3	14.3	12	4.3	17.2	40.0													13	VI–VII	26, 37, 39, 45, 53	tP
89.	*Dicranomyia* (D.) *autumnalis* (Staeg.)																					1	0.1	3.7	11.1	1	X	16	E, O
90.	*Dicranomyia* (D.) *chorea* (Mg.)					2	1.0	6.3	14.3	1	0.4	3.4	10.0													3	V	38, 51	H
91.	*Dicranomyia* (D.) *didyma* (Mg.)																	2	0.2	3.7	10.0					2	VI	23	tP
92.	*Dicranomyia* (D.) *distendens* Lundstr.																	1	0.1	3.7	10.0					1	V	21	H
93.	*Dicranomyia* (D.) *frontalis* (Staeg.)																					6	0.5	3.7	11.1	6	X	17	H
94.	*Dicranomyia* (D.) *mitis* (Mg.)									1	0.4	3.4	10.0													1	V	51	wP
95.	*Dicranomyia* (D.) *modešta* (Mg.)	5	**8.1**	11.1	22.2	15	**7.4**	**25.0**	**57.1**	14	**5.0**	17.2	30.0	20	1.8	**27.6**	**62.5**	33	3.4	14.8	40,0	36	2.8	22.2	**66.7**	123	V–VIII, X	4, 5, 8, 13, 14, 16–20, 23, 26, 27, 31, 33, 36, 38, 39, 42, 45, 47–49, 53	H

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
96.	*Dicranomyia (Idiopyga) stigmatica* (Mg.)									1	0.4	3.4	10.0													1	X	35	aP
97.	*Dicranomyia (Melanolimonia) morio* (Fabr.)									1	0.4	3.4	10.0					1	0.1	3.7	10.0	3	0.2	7.4	22.2	5	V	16, 23, 48, 51	wP
98.	*Dicranomyia (Numantia) fusca* (Mg.)													2	0.2	3.4	12.5	1	0.1	3.7	10.0					3	V	10, 34	H
99.	*Discobola annulata* (L.)									5	1.8	13.8	30.0					2	0.2	3.7	10.0					7	VII–VIII, X	26, 34, 37, 39	H, O
100.	*Discobola caesarea* (O.–S.)					1	0.5	6.3	14.3	1	0.4	3.4	10.0													2	VII	49, 52	aP
101.	*Discobola parvispinula* (Alex.)									1	0.4	3.4	10.0													1	VI, VIII–IX	26	tP
102.	*Libnotes (Afrolimonia) ladogensis* (Lack.)					1	0.5	6.3	14.3	12	4.3	3.4	10.0													13	V	26, 38	tP
103.	*Limonia flavipes* (Fabr.)	3	4.8	16.7	33.3	7	3.5	6.3	14.3	4	1.4	6.7	20.0	7	0.6	13.8	37.5									21	V–VI	4, 7, 14, 26, 27, 31, 33, 37, 38	wP
104.	*Limonia macrostigma* (Schumm.)									1	0.4	3.4	10.0	47	4.3	**51.7**	**87.5**	16	1.7	22.2	**60.0**	2	0.2	3.7	11.1	66	V–VIII, X	4, 8, 10, 14, 18, 20, 21, 23, 27, 32, 34, 36, 42, 44, 45	tP
105.	*Limonia nigropunctata* (Schumm.)					1	0.5	6.3	14.3	1	0.4	3.4	10.0													2	V–VI	26, 38	E
106.	*Limonia nubeculosa* Mg.	10	**16.1**	**27.8**	44.4	15	**7.4**	**31.3**	**57.1**	37	**13.3**	20.7	**50.0**	3	0.3	6.9	12.5									65	V–VIII, X	7, 18, 24, 26, 31, 37, 38, 40, 45, 47, 49, 51–53	H
107.	*Limonia phragmitidis* (Schrk) [= *L. tripunctata* (Fabr.)]	3	4.8	5.6	11.1	12	**5.9**	**25.0**	28.6	14	**5.0**	6.7	20.0	150	**13.8**	**27.6**	**62.5**	33	3.4	**25.9**	**70.0**	11	0.9	11.1	22.2	223	V–VI	4, 8, 9, 13, 14, 18–20, 23, 26, 27, 32, 33, 36–38, 43, 44, 49	tP
108.	*Limonia stigma* (Mg.)					4	2.0	12.5	28.6	1	0.4	3.4	10.0													5	VII	38, 46, 47	E
109.	*Limonia trivittata* (Schumm.)					2	1.0	12.5	28.6									1	0.1	3.7	10.0					3	V, VII	34, 38, 47	tP
110.	*Metalimnobia quadrimaculata* (L.)	1	1.6	5.6	11.1					1	0.4	3.4	10.0													2	V, VII	26, 33	H
111.	*Metalimnobia quadrinotata* (Mg.)	2	3.2	5.6	11.1	9	4.5	**25.0**	42.9	7	2.5	13.8	30.0	2	0.2	3.4	12.5	1	0.1	3.7	10.0					21	V–VII	1, 20, 26, 31, 39, 42, 47, 49, 52	tP
112.	*Microlimonia machidai* (Alex.)	1	1.6	5.6	11.1					1	0.4	3.4	10.0													2	VI–VII	7, 26	tP
113.	*Neolimonia dumetorum* (Mg.)	4	**6.5**	11.1	22.2	56	**27.7**	**37.5**	42.9	14	**5.0**	20.7	30.0	1	0.1	3.4	12.5									75	V–VII	1, 7, 26, 27, 31, 38, 39, 45, 53	E
114.	*Rhipidia maculata* Mg. [= *Rh. duplicata*]	4	**6.5**	5.6	11.1	3	1.5	12.5	28.6	3	1.1	10.3	30.3	2	0.2	6.9	25.0	2	0.2	7.4	20.0					14	V–VII, X	4, 7, 18, 20, 26, 43, 49–52	H
115.	*Rhipidia uniseriata* Schin.					1	0.5	6.3	14.3																	1	V	38	tP
Number of specimens		62				197				277				1042				949				1289				3816			
Number of species		15				30				43				67				63				47							
Number of samples				18				16				29				29				27				27		146			
Number of sites					9				7				10				8				10				9	53			

Explanations of symbols used in the table I:

N – number of specimens
D – species dominance in the material
F – species frequency in the samples
C – species frequency in the stations
ZG – zoogeographical classification
aP – amphipalaearctic species
bm – boreo-montane species
E – European species
EmA – European-Midasiatic species
H – Holarctic species
m – montane species
O – Oriental species
Ptb – transboreal species in Palaearctica
tP – transpalaearctic species
wP – western Palaearctic species

Pedicia (*P.*) *rivosa* (L.) – a European species with a wide range, typical in spring areas and ground-water seepages of cold water. One male specimen was caught on 10/06/87 at the River Jeleń, downstream of Susiec (FA 58).

Eloeophila trimaculata (ZETT.) – a European species of the boreal-montane occurrence; one male specimen was caught on 16/05/87 at the River Studzienica between Józefów and Kozaki (FA 48).

Idioptera linnei OOSTERBR. [= *I. fasciata* (L.)] – a species of transboreal occurrence. One male specimen was caught on 30/06/86 in the Roztoczański National Park at Kosobudy, forest section no. 61 (FB 40).

Hoplolabis (*Parilisia*) *areolata* (SIEBKE) – a European species; one male specimen was caught on 22/05/86 at the River Wieprz in Łęczna (FB 38).

Molophilus (*M.*) *griseus* (MG.) – a western Palaearctic species; one male specimen was cought on 22/05/86 at the River Wieprz in Łęczna (FB 38).

Dicranoptycha (*D.*) *fuscescens* (SCHUMM.) – a western Palaearctic species recorded in the following sites in Roztocze: ravines near Biała Góra not far from Tomaszów Lubelski (FA 79) on 2/07/86, 1 ♀; an oak forest association, *Potentillo albae-Quercetum*, near Kąty II (FB 41), on 25/05/87, 1 ♂ and on 20/07/89, 1 ♂.

The list of species from Roztocze presented in Table I contains 6 species recorded from Poland for the first time: *Pilaria decolor*, *Scleroprocta sororcula*, *Symplecta (S.) chosenensis*, *Molophilus (M.) maurus*, *Elephantomyia (E.) edwardsi* and *Libnotes (A.) ladogensis*.

The most common and/or the most abundant species in the investigated area were as follows: *L. schranki*, *T. immaculata* and *L. phragmitidis* (Table II). *D. modesta*, *E. ocellare*, *U. sylvatica*, *Ph. ferruginea* and *E. lutea* were comparatively frequently collected (in about 1/3 of the sites) but they occurred only singly. *M. ater* deserves special attention. This species reached the highest dominance, much higher than that of the other species. This phenomenon was caused by mass emergence of imagines (about 100 individuals in one sample). They were observed 5 times during the sampling; in many other cases only single representatives of the species were caught.

The dominance index (D) of all the other species not included in Table II, did not exeed 2%. This resulted from the great number of species recorded in proportion to the material as a whole. It is worth mentioning that in the material analysed 38 species (33% of all) were represented by one, two or three specimens.

However, the abundance and frequency of occurrence of species that were the most common and most abundant in the investigated area were significantly varied. These indices for paritcular plant communities are interesting and worthy of consideration (Table I). *T. immaculata* and *L. schranki* occurred only in biotopes associated with water because larvae of these species live in the banks of stagnant and running waters; they were not recorded in the forest communities (beech woods, linden-hornbeam forests, coniferous forests). Similarly, *Ph. ferruginea* a common but not abundant species, was also connected with the water habitat. *L. phragmitidis* was caught in all types of plant communities, but most abundantly and frequently in the humid microhabitats of wet alder forests and shadowy scrub at the river banks. Larvae of this species live in wet soil. An analysis of Table I has revealed ecological preferences of all more abundant crane-fly species.

Table II. Species dominance in the material (D), species frequency in the samples (F), and species frequency in the sites (C) of the most common and/or abundant species of crane flies

No	Index / Species	D %	F %	C %
1.	*Ula sylvatica*	0.72	13.7	**32.1**
2.	*Tricyphona (T.) immaculata*	**4.14**	**24.0**	**41.5**
3.	*Epiphragma ocellare*	2.06	**19.2**	**34.0**
4.	*Limnophila (L.) schranki*	**7.53**	18.5	**30.2**
5.	*Phylidorea (Ph.) ferruginea*	1.98	15.1	**32.1**
6.	*Phylidorea (Ph.) nervosa*	**3.96**	13.0	22.6
7.	*Erioptera (E.) lutea*	1.29	15.1	**30.2**
8.	*Gonempeda flava*	2.21	4.1	9.4
9.	*Erioconopa trivialis*	**4.06**	17.1	28.3
10.	*Molophilus (M.) ater*	**19.07**	13.7	28.3
11.	*Molophilus (M.) ochraceus*	2.01	8.9	17.0
12.	*Ormosia (O.) depilata*	2.75	14.4	24.5
13.	*Dicranomyia (D.) modesta*	3.16	**19.9**	**45.3**
14.	*Limonia phragmitidis*	**5.73**	17.1	**35.8**

An attempt has been made to characterize particular plant communities by the occurrence and abundance of the most characteristic crane-fly species and to evaluate the species diversity of the plant communities distinguished using the Shannon-Weaver index (TROJAN 1992). The respective values of this index (H') and other data characterizing the communities are presented in Figure 2.

The coniferous forests were the driest communities among the investigated ones. Both the number of species – 15, and the abundance of Limoniidae recorded there were the lowest: on the average 4 individuals in a sample (Fig. 2). In the coniferous forests the subfamily *Limoniinae* was well represented. Larvae of the majority of species belonging to this group live in different types of soil, litter and rotting wood; in general, they do not need such high humidity as the species of other subfamilies. The most abundantly represented species were *L. nubeculosa*, *T. schummelli* and *I. pulchella*. Larvae of the second and third species live in very wet soil, most often in swamps and peat-bogs. In the said coniferous communities they were caught only in two sites (24 and 25), situated in a marshy coniferous forest, *Vaccinio uliginosi-Pinetum*. Such a habitat is typical for these species, and that was also confirmed by research carried out in the Świętokrzyskie Mountains (WIEDEŃSKA 1991).

In the sites situated within linden-hornbeam forests, *Tilio-Carpinetum*, 30 species of *Limoniidae* were recorded. Here the most abundant were the following species: *N. dumetorum* – outside this type of forest found only sporadically;

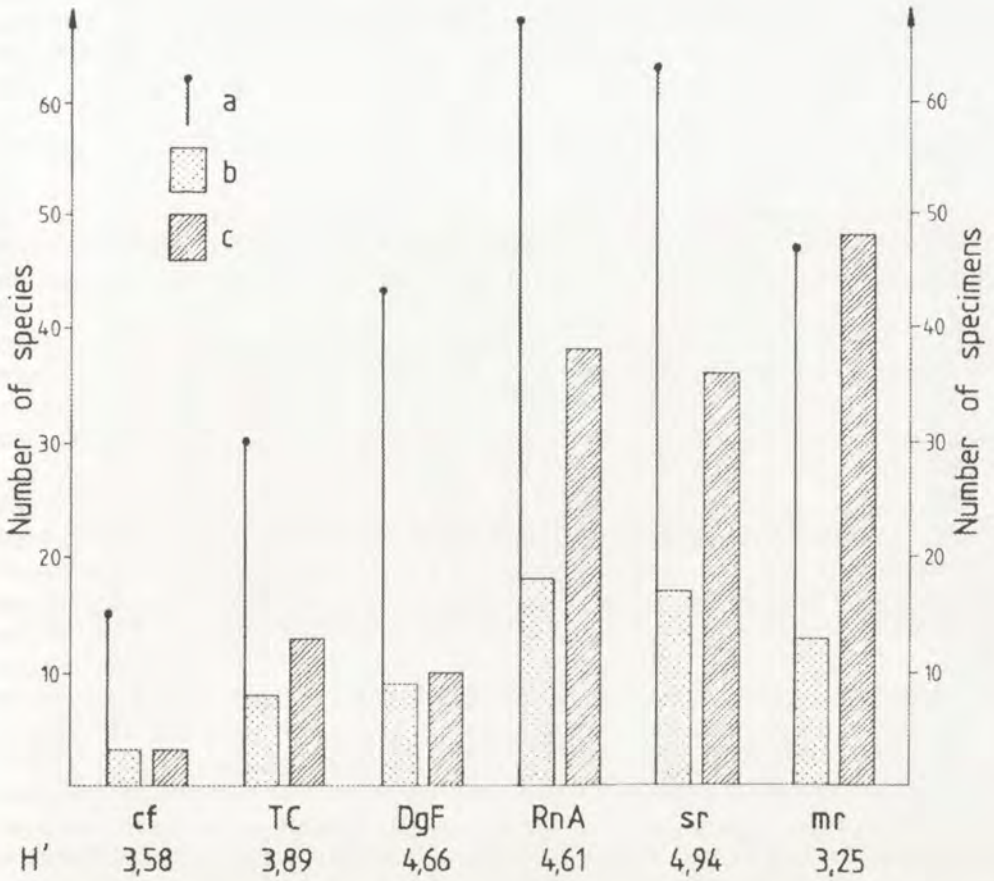

Fig. 2. Total number of species recorded in a given community (a), mean number of species in a site (b), mean number of specimens in a one sample from a given community (c) and Shannon-Weaver index of the species diversity (H'). (cf – coniferous forests; TC – *Tilio-Carpinetum* association; DgF – *Dentario glandulosae-Fagetum* association; RnA – *Ribo nigri-Alnetum* association;sr – shadowy river-side scrub; mr – insolated river-side meadows)

L. nubeculosa – a species characteristic for forest communities; *D. modesta* – occurring commonly everywhere. The *Tilio-Carpinetum* association was characterized by one of the lowest indices of species diversity (Fig. 2).

The limoniid fauna in the association of the Carpathian beech wood, *Dentario glandulosae-Fagetum*, merits special attention. 43 species were found there, but their average abundance was only 10 specimens per sample. The species diversity index in this community was one of the highest. In respect of biotic diversity, this association of *Limoniidae* of the Carpathian beech wood is second only to the limoniid association inhabiting very mosaic habitats of damp, shadowy scrub situated on river banks.

As in the other forest communities, the "soil" subfamily – *Limoniinae* – was a group of crane-flies most abundantly represented in a beech wood. Larvae of species belonging to other subfamilies live in litter, wood, mushrooms and also in soil. *L. nubeculosa* and *A. ochracea* dominated in the community described, whereas *U. sylvatica* was the most common but less abundant species. Other species, less numerous but characteristic for this community, are underlined in Table I.

The association a typical wet alder forest, *Ribo nigri-Alnetum*, is characterized by the index of species diversity of a value similar to that of the Carpathian beech wood. It should be stressed that in the group of sites representing this association the number of species (67) was considerably higher than recordet in the beech wood studied. It was the highest number of species recorded in the plant communities studied. In this group of sites the most abundant species were *M. ater* and *L. phragmitidis*, as well as *M. ochraceus*, *L. schranki* and *M. serpentiger*. The most common species (C = 75% or more) were *L. macrostigma*, *T. immaculata*, *E. ocellare*, *H. longirostris* and *Ph. ferruginea*.

Two last groups of sites – shadowy river-side scrub and insolated river-side meadows – strongly differed in their limoniid fauna from the former ones, because they were directly associated with rivers. Site groups were separated on the basis of their localization and the degree of insolation rather than on the basis of any phytosociological criteria. Typically aquatic and amphibiotic species of *Limoniidae* dominated in both groups of these sites. They were: *L. schranki*, *Ph. nervosa* and *E. trivialis*. Shadowy microhabitats were occupied by *T. immaculata*, *L. pictipennis* and *G. flava*. *M. ater* was the species distinctly preferring insolated river banks. Other, less numerous species frequently occurring there are underlined in Table I.

It should be pointed out that the values of the biotic Shannon-Weaver diversity index (H') of these groups of sites are at two extermities of the scale obtained (Fig. 2). The river-side shadowy scrub is characterized by the highest index of species diversity in comparison with all the plant communities investigated, whereas the index obtained for the insolated river-side meadows is the lowest. The latter habitats, when compared with other communities, show the highest homogeneity in respect of the crane-fly species composition. The distinctly mosaic structure of microhabitats within the river-side shadowy scrub (the fact which also made it impossible to use phytosociological criteria) was reflected in the rich structure of their crane-fly fauna that was expressed by the high value of the biotic diversity index.

The last question worth considering is the proportion of the different zoogeographical elements in the fauna of *Limoniidae* of Roztocze. For this discussion the species recorded by KRZEMIŃSKI (1984, 1991) from this region are also included. The following species were collected by this author at Susiec (FA 58): *Rhabdomastix (Sacandaga) laeta* (LW), *Ormosia (O.) clavata* (TONN.) and *Molophilus (M.) corniger* DE MEIJ. The fourth species, *Dicranomyia (D.) handlirschi* LACKSCH. was found at Zwierzyniec (FB 30).

Thus, the list of crane-flies found in the investigated region, comprises 125 species. Of these 112 are Palaearctic species, 10 are Holarctic species, 1 is Palaearctic-Oriental species and 2 are a Holarctic-Oriental species (Table I). Of

the Palaearctic species, 18 have the transpalaearctic distribution, 4 – the transboreal distribution, 8 – amphipalaearctic distribution, 22 – western-Palaearctic (= Euro-Foreasiatic) distribution and 12 – Euro-Midasiatic distribution. Of the investigated crane-flies the most abundant species were those of European distribution (48), that is 38% of all the species recorded in the studied area.

The proportion of montane and boreo-montane species (10) is rather low. Only 2 European species have montane distribution. The boreo-montane distribution is characteristic for 6 European, 1 western Palaearctic and 1 amphipalaearctic species (Table I). The geographical situation, the elevation above the adjacent regions, somewhat montane-like climate, relatively large areas covered by natural forest communities and other important features, make Roztocze a very interesting region of Poland. All the above – mentioned natural features are the reason why montane, boreal and steppe species of the flora and fauna can coexist in this area (LIANA et al. 1992, LIANA 1994, CMOLUCH et al. 1994, KUCHARCZYK 1994, WĄSOWSKA 1994). On the other hand, however a relatively poorly developed water system and ground-water tables situated at considerable depths (WÓJCIKOWSKI, PACZYŃSKI 1986) are factors limiting the occurrence of *Diptera* of the family *Limoniidae* in this area.

From the zoogeographical point of view, the crane-fly fauna of Roztocze is of the European type with a very small proportion of montane and boreo-montane species. This conclusion will require revision in the future when more precise data concerning the distribution of the Palaearctic species of *Limoniidae* are provided. Nevertheless, it should be pointed out that very similar proportions of the respective zoogeographical elements were observed in the fauna of *Limoniidae* in the Świętokrzyskie Mountains (WIEDEŃSKA 1991); both areas – Roztocze and the Świętokrzyskie Mountains – have 86 species in common. This fact illustrates a considerable uniformity of the fauna of both regions which belong to Prowincja Wyżyn Polskich (the Polish Uplands Province).

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STRESZCZENIE

[Tytuł: Muchówki z rodziny *Limoniidae* (*Diptera, Nematocera*) Roztocza i przyległych terenów Puszczy Solskiej (Kotlina Sandomierska).]

Celem pracy było ustalenie składu gatunkowego fauny kreślowatych (*Limoniidae*) wybranych krain południowo-wschodniej Polski, mianowicie Roztocza i przyległych terenów Puszczy Solskiej (rys. 1), określenie charakteru zoogeograficznego tej fauny oraz porównanie składu gatunkowego wybranych zbiorowisk roślinnych.

Oparto się na materiale wyłącznie postaci doskonałych, zebranych w latach 1986–1989. Materiał ujęty w tabeli I został zebrany porównywalnymi metodami (30 minut połowu siatką entomologiczną o średnicy 40 cm) i jest on podstawą większości rozważań. Pozostały, przypadkowy zbiór imagines (około 200 osobników w około 50 próbach) posłużył do udokumentowania terminów lotów owadów oraz do wykazania stanowisk gatunków nie ujętych w tabeli I.

Na badanym terenie stwierdzono występowanie 121 gatunków muchówek z rodziny *Limoniidae*. 115 gatunków wyszczególniono w tabeli I, pozostałe to: *Pedicia* (*P.*) *rivosa*, *Eloeophila trimaculata*, *Idioptera linnei*, *Hoplolabis (Parilisia) areolata*, *Molophilus* (*M.*) *griseus* oraz *Dicranoptycha* (*D.*) *fuscescens*.

Po raz pierwszy w faunie Polski odnotowano następujących 6 gatunków: *Pilaria decolor*, *Scleroprocta sororcula*, *Symplecta* (*S.*) *chosenensis*, *Molophilus* (*M.*) *maurus*, *Libnotes* (*Afrolimonia*) *ladogensis* oraz *Elephantomyia* (*E.*) *edwardsi*.

Najpospolitsze i/lub najliczniej reprezentowane na badanym terenie gatunki przedstawione są w tabeli II.

Scharakteryzowano również następujące zbiorowiska roślinne pod względem zasiedlających je gatunków *Limoniidae*:

A. bory, w tym:
– bór jodłowy, *Abietetum polonicum*,
– bór sosnowy, *Leucobryo-Pinetum*,

– bór bagienny, *Vaccinio uliginosi-Pinetum*;
B. grąd lipowo-grabowy, *Tilio-Carpinetum*;
C. buczyna karpacka, *Dentario glandulosae-fagetum*;
D. ols typowy, *Ribo nigri-Alnetum*;
E. zacienione zarośla nadrzeczne;
F. nasłonecznione łąki nadrzeczne.

Zbiorowiska leśne, wymienione w punktach A – D, zostały wyodrębnione według ścisłych kryteriów fitosocjologicznych. Natomiast punkty E i F obejmują stanowiska położone na brzegach rzek lub w pobliżu źródeł. Zastosowanie kryteriów fitosocjologicznych do takich niewielkich i mozaikowo rozmieszczonych mikrosiedlisk jest trudne, a często wręcz niemożliwe. Dlatego zastosowano tu duże uproszczenie, uznając, że jest to mniejszy błąd, niż całkowite pominięcie siedlisk związanych ze zbiornikami wodnymi, w których korycie rozwijają się stadia preimaginalne *Limoniidae*. Ponieważ jednak stadiów tych nie badano, uznano, że dla podkreślenia preferencji ekologicznych imagines wystarczający jest podział siedlisk nadrzecznych na zacienione zarośla i nasłonecznione łąki. Te dwie grupy siedlisk różnią się bowiem między sobą najistotniejszymi z punktu widzenia wymagań imagines cechami, mianowicie temperaturą i wilgotnością powietrza.

Interesująca jest również analiza różnorodności gatunkowej tych zbiorowisk, wyrażona wskaźnikiem Shannona-Weavera (TROJAN 1992). Wartości tego wskaźnika na tle innych danych charakteryzujących zbiorowiska podano na rysunku 2.

Bory są zbiorowiskami najbardziej suchymi. Stwierdzono w nich najmniejszą liczbę gatunków (15) i odławiano najmniej osobników (średnio w próbie 4 osobniki). Bory, podobnie jak grąd lipowo-grabowy (30 gatunków) cechuje jeden z najniższych wskaźników różnorodności gatunkowej.

Zbiorowisko buczyny karpackiej wyróżnia się jednym z najwyższych wskaźników różnorodności gatunkowej. Stwierdzono tu występowanie 43 gatunków *Limoniidae*.

We wszystkich wyżej wymienionych zbiorowiskach leśnych najlepiej reprezentowana jest podrodzina *Limoniinae*; larwy większości gatunków należących do tej podrodziny żyją w glebie, ściółce, drewnie lub grzybach.

Olsy charakteryzują się wskaźnikiem różnorodności gatunkowej o wartości zbliżonej do tegoż wskaźnika buczyny karpackiej. W tej grupie stanowisk stwierdzono największą liczbę gatunków *Limoniidae* (67) w porównaniu z pozostałymi zbiorowiskami roślinnymi.

W dwóch ostatnich grupach stanowisk dominowały wodne i amfibiotyczne gatunki kreślowatych. Próby pochodzące zarówno z łąk, jak i zarośli nadrzecznych należały do najobfitszych, mimo to wartości wskaźników różnorodności gatunkowej tych grup stanowisk leżą na dwóch krańcach uzyskanej skali (rys. 2).

Zarośla nadrzeczne cechuje najwyższy wskaźnik różnorodności gatunkowej, podczas gdy wartość tego wskaźnika w odniesieniu do łąk nadrzecznych jest najmniejsza. A więc łąki nadrzeczne wykazują największą jednorodność pod względem zasiedlenia ich przez *Limoniidae* w porównaniu z innymi, wyodrębnionymi w tych badaniach zbiorowiskami. Natomiast wybitna mozaikowość mikrosiedlisk

w obrębie zarośli nadrzecznych znalazła swoje potwierdzenie w strukturze zasiedlenia tych mikrosiedlisk przez kreślowate, wyrażonej wskaźnikiem różnorodności gatunkowej.

Z punktu widzenia zoogeograficznego fauna kreślowatych Roztocza jest fauną europejską (43% stanowią gatunki o zasięgu europejskim) z niewielkim udziałem gatunków górskich (dwa) i borealno-górskich (12). Podobieństwo proporcji elementów zoogeograficznych obserwowane w faunie *Limoniidae* Gór Świętokrzyskich (WIEDEŃSKA 1991) świadczy o znacznej jednolitości faun obu wymienionych regionów, wchodzących w skład Prowincji Wyżyn Polskich.

Redaktorzy pracy – doc. dr hab. A. Liana, dr W. Mikołajczyk