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Drosophilid assemblages in mountain creek valleys in Hungary (Diptera: Drosophilidae) I.*

By

L. PAPP

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Drosophilid assemblages in mountain creek valleys in Hungary (Diptera: Drosophilidae) I. - In 1988-90 apple-bait collections of Drosophilidae were made in four sites of low mountain creek valleys in N and NE Hungary (yielding more than 9,000 ex.). Representatives of 40 species were caught (31, 31, 36 spp./year), some of them are new to Hungary [1988 (n= 12): 6 to 18 spp./sample, 1989(n= 13): 7 to 16 spp./sample, 1990(n= 10): 5 to 21 spp./sample]; 8, 8, and 9 spp. were caught only once, 6, 5, and 7 spp. were represented by a single specimen.
The population frequencies in the assemblages changed profoundly from one year to another as a natural process. The population size ratio of the rare and the dominant species is supposed to be 1 to 10^3–10^4 or even higher. The S.-W. diversity index values are not high, evenness is highly variable (from medium to low). The differences in the assemblages of the collecting sites were analysed by some quantitative methods (Berger-Parker index, similarity indices: Czekanowski, Renkonen indices, dendrograms of the similarity indices). It was found that a good part of the drosophilid species is so rare that only an indefinite part of the extant rare species is to be detected at all in a given area. However, ratios of the populations of the dominant-subdominant, constant-subconstant species are hypothesized, with which more non-detected species are to be expected than behind population frequencies deformed by human activity.

INTRODUCTION

This study was made in order to test a well-known and very simple principle: any disturbance in an ecosystem is likely to be indicated earlier and more efficiently by changes in the structure of a community/communities rather than by abundance changes or presence/absence relations of individual species.

We selected two test-groups of flies: the so-called synanthropic flies (collections made with Gregor-Povolny's traps baited with human feces, results published elsewhere) and the drosophilids. Drosophilids were chosen because the Hungarian fauna is rather well known (see Papp and Pecsenye 1988) and the quantitative methods for population analysis are comparatively well elaborated (Bächli 1979). The extensive literature on the studies on the Palaearctic drosophilids is summarized by Bächli and Rocha Pité (1982).

Originally we intended to assess the deformation of the community structure of

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the dipterous assemblages by human activity. In the course of studies another aspect also arose: how to deal with the populations of rare species?

The faunistical results of collectings (species new for the Hungarian fauna) were published elsewhere (Papp 1992). All the voucher specimens are preserved in the collection of the Zoological Department, HNHM, Budapest (minutia-pinned, double-mounted, also those specimens which were originally kept in alcohol).

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MATERIALS AND METHODS

Baiting with fermenting fruits is one of the classical methods in drosophilid studies, so the literature on the results is vast (for a bibliographical review see Bächli and Rocha Pité 1982). Most of the studies of this kind in Europe was made by G. Bächli, who made not only extensive and interesting collectings but applied quantitative methods for population analysis.

In 1988-90 apple-bait collections were made in four localities of low mountain creek valleys in N and NE Hungary at an altitude range from 250 to 400 m a.s.l. These four valleys are affected by tourism to some extent: least at Aggtelek, most strongly at Magyarkút. All the four sites are comparatively well known as regards the faunistics of dipterous flies, e.g. they are characterized by a peculiar black brachypterous fly, the only pleciid species of Hungary, namely *Penthetria funebris* Meigen, 1804 (= *holosericea*). The four sites are:

Aggtelek National Park: Aggtelek, Ménes-völgy [=valley], Medvés-kert (below coded with **A**): below Ménes-forrás [source] and to 150 m downstream;

Bükk National Park: Miskolc, Garadna-patak völgye (below coded with **B**): 200-300 m above the Hámori lake;

Börzsöny Landscape Protection Area: Verőcemaros (changed to Verőce during the period of collectings), Magyarkút, Keskenybükki-patak völgye (below coded with **M**): out of the settlement (upstream);

Pilis Landscape Protection Area: Visegrád, Apátkúti-völgy (below coded with **V**): 150 m upstream of the hunting-seat.

When coding the samples, a letter for the site and five numbers for day (2), month (2) and year were used, e.g. A11090 is for the Aggtelek site on the 11th of September, 1990.

Fermenting apple bait (smashed apple of various kinds with some sugar added and fermented in lukewarm water for more than a week) was put on 40 x 40 cm square plastic sheets within a 10 m range of the creeks. The distance of one collecting point to another was at least 10 m, bait was put down at 15 to 18 places (4 to 5 deciliters to each) to gain one sample. Exposure time was usually half an hour. Drosophilids were-sweep netted for a period of two to three hours (mostly for three hours). In cases when during this period less than 100 specimens were captured, the collecting period was prolonged. The soil temperature at a depth of 5 cm, the air temperature

on the ground and the wind speed were always measured. (Not for the purpose to find any correlation between capture results and the meteorological data but in cases we captured less than expected, this way we had a slight chance to find the reasons.) In 1988 12 samples were collected, in 1989 13 samples, in 1990 10 samples. Other than these samples, several other drosophilid materials were caught (on oozing sap of an oak tree, on leaves and young twigs of oaks infested by *Kermes* coccids, on kitchen refuse (compost heap), etc. These dipterous materials served as sources to judge the species richness of the given site. Altogether 9,563 drosophilid specimens were collected and identified.

The taxonomical sequence and nomenclature follows the catalogue of Bächli and Rocha Pité (1984).

When analysing the samples, the Shannon-Wiener index (polynomial entropy), evenness index, Berger-Parker (dominance) index and the Jaccard index (species identity index) were calculated. Some other numerical methods were also applied: the results of two similarity indices the Czekanowski index (for similarities in abundance), and the Renkonen index (for similarities in dominance) are given. Similarity values were processed by a group linkage method using average linkage to gain dendrograms. The results using some more sophisticated methods will be published in a second paper (Izsák and Papp, in preparation), where a wider cenological (ecological) interpretation of the primary results will also be given.

RESULTS

The results are summarized in Tables 1 and 2.

Representatives of 40 species were caught (31, 31, 36 spp./year), some of them (*A. (Amiota) rufescens, Chymomyza caudatula, Drosophila (Sophophora) helvetica, D. (Sophophora) subsilvestris, D. (Drosophila) tsigana, D. (Drosophila) unimaculata*) are new to Hungary (for details see Papp 1992).

In 1988 six to 18 species/sample (n= 12) were collected, in 1989 seven to 16 spp./sample (n= 13), in 1990 five to 21 spp./sample (n= 10); 8, 8, and 9 spp. were caught only once, six spp./1988, five spp./1989, seven spp./1990 were represented by a single specimen.

The ratio of the population size of the rarest and the dominant species is actually 1 to 2,845; however, we can suppose a value of 1 to 10^4 or even higher for the rarest but not yet detected species.

The S.-W. diversity indices are never high, evenness is highly variable (medium to low) (Table 3). The highest diversity values - as a mean - were found at Magyarkút, the lowest ones at Aggtelek (the mean values of H' are **A**: 1.4773, **B**: 1.5347, **M**: 1.6920, **V**: 1.6347).

In 1989 the population size of *D. phalerata* and that of the related species ("yellow wild species", larvae mycophagous) were much lower than in 1988 as a consequence of the different climatic conditions of the consecutive years. Consequently, the relative frequencies of the "black species" (*D. (S.). obscura, D. (S.) subobscura*, larvae frugivorous, etc.) were higher (cf. Table 7/A); i.e. population frequencies in the assemblages profoundly changed from one year to another, probably as a natural process. Since the year of 1990 was a "intermediate one" compared to 1988 and 1989, the Czekanowski and Renkonen similarity values from the 1988 and 1989 samples

(tabulated similarly as given in Table 4 for 1990) were processed by a group linkage method using average linkage to gain dendrograms (Figs 1-2).

The pattern of the occurrence of species at the four sites is briefly exposed through values of the Jaccard index in Table 5. Since the number of the samples taken and of the specimens collected is very low at Visegrád, only the other three sites are comparable (to "test" the effect of this insufficiency, we "complemented" the Visegrád list with the three synanthropic species, which actually were not collected there). Aggtelek, the least disturbed area, is more similar to Magyarkút, the most disturbed area of the four, than to the Garadna valley (**B**), for the total and for the rare species, respectively.

The representation of the rare species at the four sites is illustrated in Table 6. The dominant species and the possible relation of the dominants to the number of the rare species are shown in Table 7.

To enable a rough estimate of the sample size needed for a higher number of species representation, we made a list for the highest number of species per sample with their actual number of specimens collected (Table 8). As we can see, 400 or more specimens in a sample seem to be necessary to stand for a better chance that a fair number of rare species is included.

For three sites the summarized frequencies of the species were ranked from the highest to the lowest on a logarithmic scale (Figs 3-5). The curves show a logarithmic tendency rather than a lognormal distribution, the size of these accumulated samples and the number of the species involved is too low for a fitness test. It is less precise but more easily perceiveable to order the species in logarithmic frequency categories, like this:

dominance	%	10-	1.0-	0.1-	0.01-	Σ
Aggtelek						
	spp.	3	13	10	5	31
	%	10	42	32	16	
Bükk N.P.						
	spp.	1	11	6	11	29
	%	3	38	21	38	
Magyarkút						
	spp.	3	6	15	10	34
	%	9	18	44	29	

It seems probable from the table that the least steep section of the curves is likely in the second or third frequency category.

DISCUSSION

Though the size of the 35 samples taken is rather uneven, we can suppose that the drosophilid assemblages in the low mountain creek valleys of Hungary are rich in species. The number of specimens of several species is smaller than in Western Europe (cf. e.g. Burla and Bächli (1991). The ratio of the rare species (those of unknown catchability) is rather high: in total five species were represented by a sing-

le specimen each, two species by two ex., four species by three ex., two species by six ex. and one species by seven ex. (Table 2).

The collecting data suggest that the effect of human impact on the drosophilid assemblages is detectable also at the least disturbed sites of Hungary: domestic species are found at the Ménes-forrás, Aggtelek. On the other hand, there are some of the rarest species in the habitats strongly deformed by human activity (Magyarkút).

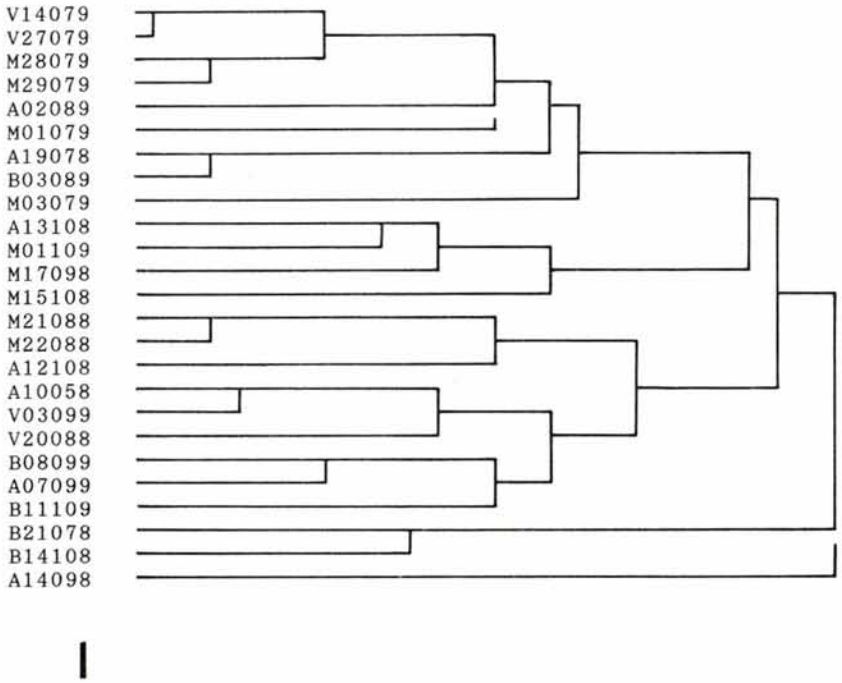
The frequencies in the assemblages changed extremely from one year to another.

Both dendrograms of the Renkonen index and the Czekanowski index, respectively, for 1988-89 define two groups: on the upper part of the dendrograms one can find those samples where the black "fruit breeding" species (*D. obscura, D. subobscura*) prevailed and the mushroom feeders were present in low numbers and in low frequencies (on the Czekanowski dendrogram 9 samples of the 13 are from 1989). On the lower part we find those samples where the numbers and frequencies of *D. phalerata, testacea, etc.* were high (on the Czekanowski dendrogram 8 samples of the 12 are from 1988). As for the partition of the samples at the lowest level, the only remarkable difference in the two dendrograms is with the sample of M30079, where all the three species of *D. phalerata, testacea* and *D. obscura* were subdominant (altogether nearly 87%). On the Renkonen dendrogram one sample (A12108) is found in a separated position: this is where *D. kuntzei* was strongly dominant by 66 %. Both dendrograms show a group of 4 samples where the "domestic" species were present with high dominance values.

This analysis does not prove any distinct separation of the samples according to collecting places or seasons.

It seems likely that though human activity also deforms the drosophilid assemblages in the mountain creek valleys. However, the small populations of the rare species can survive the acting disturbance of that size even in the "worst" of the four sites.

Below a certain level of frequency we lose power for judging the species richness: similarly to the situation found in other communities (dung heap flies, coprophagous flies on pastures, agromyzids in cereal crops, etc.): a good part of the drosophilid species is so rare (their populations are so small or their catchability is so low) that only an indefinite part of the extant rare species can be detected at all in a given area. This level of frequency depends mainly on the sample size. We are tending to believe that a majority of the dipterous species is rare (i.e. belongs to this category) at any site. However, ratios of the populations of the dominant-subdominant, constant-subconstant species are hypothesized, behind which more non-detected species are to be expected than behind population frequencies deformed by human impact. Although we are convinced that true ecological research must be focussed on the dominant-subdominant species for various reasons. We must also continue to develop more effective methods for a better understanding of the rare species as for their survival, population dynamics, density, life strategies, breeding substrates and so on.



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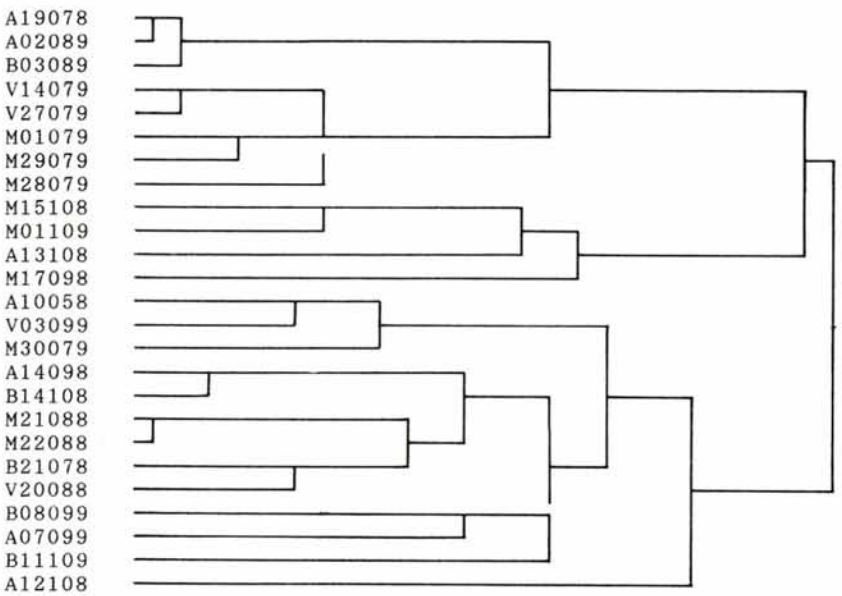
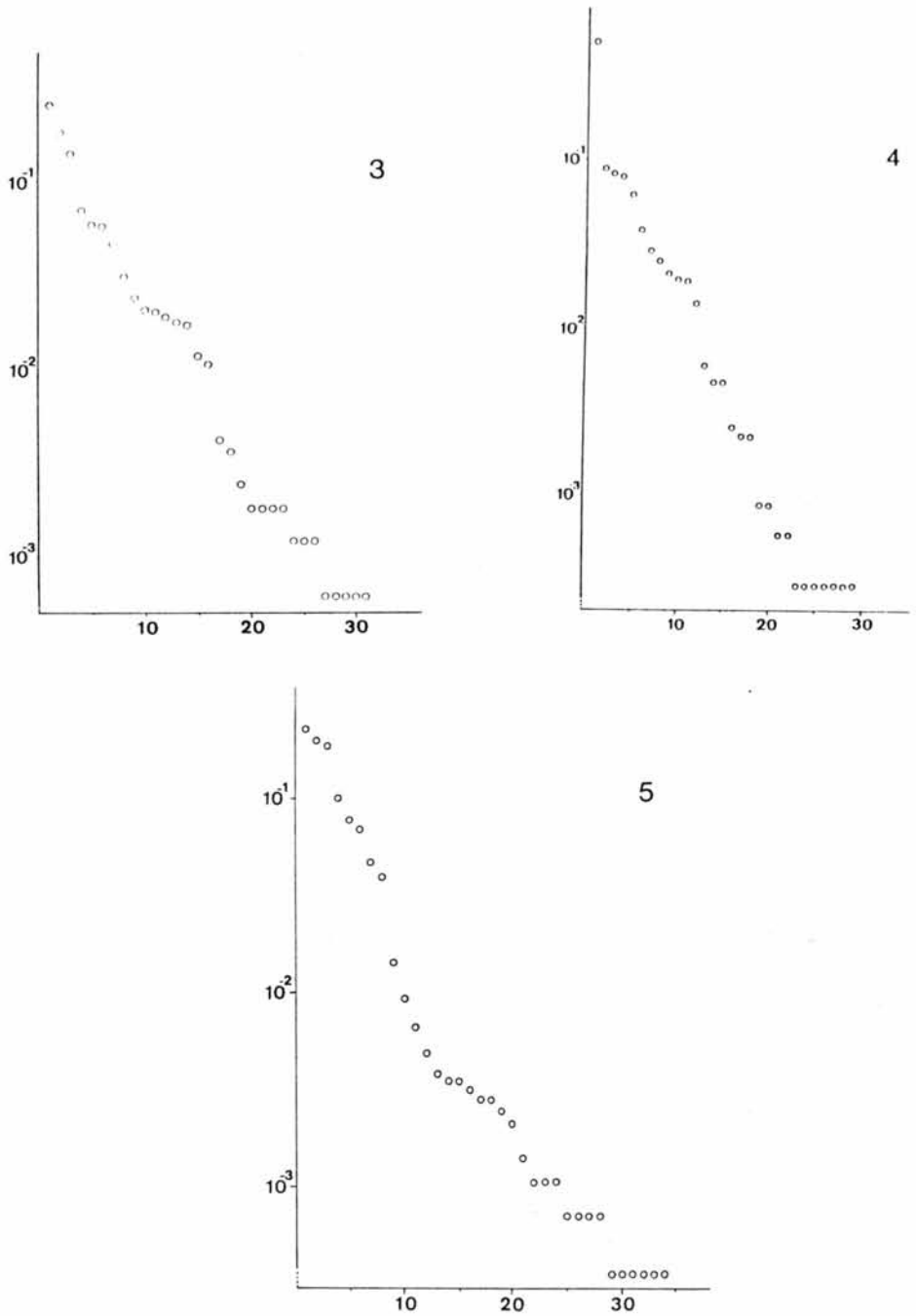


2

Figs 1-2. 1 = Dendrogram of the values of Czekanowski index (similarity in abundance) for samples from 1988–89; 2 = same for the Renkonen index values (similarity in dominance)



Figs 3-5. The summarized frequencies of the species ordered from the highest to the lowest on a logarithmic scale at Aggtelek (3), Miskolc, Garadna völgy (4) and Verőce, Magyarkút (5)

Table 1. Results of apple-bait drosophilid collectings in 1988–90.

Species	A10058	A19078	A14098	A12108	A13108	A02089	A07099	A15080	A11090	A25090	B21078	B14108	B03089	B08099	B11109	B16080	B13090	B27090
Stegana coleoptrata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stegana similis	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
A. (Amiota) alboguttata	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. (Amiota) basdeni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
A. (Phortica) semivirg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. (Phortica) variegata	1	4	1	0	0	2	15	5	2	0	2	1	0	3	2	1	0	0
Leucophenga maculata	0	0	0	1	0	0	5	91	0	0	1	0	0	0	0	1	0	1
Chymomyza amoena	0	1	0	0	0	0	0	2	0	0	2	0	3	2	0	10	0	0
Chymomyza caudatula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mycodrosophila poecilogastra	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Scaptomyza flava	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Scaptomyza graminum	5	3	0	1	1	0	0	24	0	1	30	0	7	5	0	7	1	0
S. (Parascaptomyza) pallida	1	58	0	0	1	13	1	25	0	0	176	0	28	0	0	17	0	0
D. (Lordiphosa) andalusiaca	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
D. (Lordiphosa) fenestrarum	3	12	0	1	0	0	0	2	0	0	67	0	23	0	0	11	0	1
D. (Hirtodrosophila) confusa	0	2	0	13	0	6	2	3	2	1	5	1	1	41	6	3	16	2
D. (Dorsilopha) busckii	0	0	0	0	34	0	0	0	0	0	0	0	0	0	0	0	0	1
D. (Sophophora) ambigua	0	1	0	0	0	0	0	3	0	0	0	0	0	1	0	0	0	0
D. (Sophophora) bifasciata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. (Sophophora) helvetica	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
D. (Sophophora) melanogaster	0	0	0	1	31	0	0	0	0	0	0	0	1	3	0	3	1	0
D. (Sophophora) obscura	12	248	0	3	2	70	4	85	0	0	66	6	185	4	0	32	0	1
D. (Sophophora) subobscura	12	45	0	2	1	10	4	4	0	0	47	4	12	2	0	3	0	0
D. (Sophophora) subsilvestris	0	0	0	0	0	1	34	0	18	0	0	1	0	16	1	0	2	1
D. (Sophophora) tristis	0	0	0	0	0	0	0	3	0	0	0	0	3	0	0	0	0	0
D. (Drosophila) funebris	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
D. (Drosophila) histrio	0	1	1	2	0	0	2	1	0	0	0	8	0	4	4	1	0	0
D. (Drosophila) hydei	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1
D. (Drosophila) immigrans	0	0	0	8	33	0	0	0	0	0	3	27	3	25	8	1	0	2
D. (Drosophila) kuntzei	4	2	1	236	2	2	29	16	12	2	17	26	4	26	7	20	27	9
D. (Drosophila) limbata	0	0	0	0	1	0	0	0	0	0	1	2	0	0	1	4	0	0
D. (Drosophila) littoralis	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
D. (Drosophila) phalerata	28	17	14	80	5	1	50	11	26	5	466	942	5	53	43	118	122	23
D. (Drosophila) testacea	36	8	0	7	0	0	2	64	0	1	128	92	0	2	10	32	7	13
D. (Drosophila) transversa	0	0	2	1	0	0	0	3	0	0	24	65	0	0	0	0	0	0
D. (Drosophila) unimaculata	0	0	0	1	0	1	0	0	1	0	33	24	0	7	39	28	39	141
D. (Drosophila) tsigana	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Drosophila sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. (Hirtodrosophila) oldenbergi	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0
A. (Amiota) rufescens	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Total number of specimens	104	403	20	357	115	107	148	366	61	10	1070	1200	276	195	121	294	216	196
Species/sample	10	14	6	14	12	10	11	21	6	5	18	14	13	16	10	19	9	12
Specimens/species	10.4	28.8	3.3	25.5	9.6	10.7	13.5	17.4	10.2	2.0	59.4	85.7	21.2	12.2	12.1	15.5	24.0	16.3
Berger-Parker dominance index	.346	.615	.70	.661	.296	.654	.338	.249	.426	.50	.436	.785	.670	.272	.355	.401	.565	.719

Table 1.

Species	M21088	M22088	M17098	M15108	M01079	M28079	M29079	M30079	M01109	M18080	M19080	M23090	V20088	V14079	V27079	V03099	V07090
Stegana coleoptrata	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stegana similis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. (Amiota) alboguttata	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
A. (Amiota) basdeni	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
A. (Phortica) semivirg	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
A. (Phortica) variegata	0	0	0	0	2	11	6	0	0	0	0	0	0	5	3	1	0
Leucophenga maculata	2	5	1	0	0	0	0	0	0	0	0	0	0	3	3	0	0
Chymomyza amoena	1	2	0	0	0	0	0	0	0	0	7	0	0	2	5	0	0
Chymomyza caudatula	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Mycodrosophila poecilogastra	3	2	0	0	0	1	0	0	0	0	0	0	0	5	12	0	0
Scaptomyza flava	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scaptomyza graminum	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
S. (Parascaptomyza) pallida	5	12	0	0	15	0	4	0	0	3	2	0	21	2	3	0	0
D. (Lordiphosa) andalusiaca	0	0	0	0	0	3	0	0	0	1	0	0	1	0	0	0	0
D. (Lordiphosa) fenestrarum	0	1	0	0	1	2	2	0	1	0	0	0	0	1	1	0	0
D. (Hirtodrosophila) confusa	53	50	0	1	1	0	1	0	0	4	1	1	6	26	35	5	17
D. (Dorsilopha) busckii	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0
D. (Sophophora) ambigua	0	0	0	0	0	1	0	2	0	3	4	0	0	1	1	0	2
D. (Sophophora) bifasciata	2	1	0	0	0	0	0	0	0	4	2	0	1	0	0	0	0
D. (Sophophora) helvetica	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
D. (Sophophora) melanogaster	1	2	11	81	0	5	3	7	26	29	24	10	0	0	0	0	17
D. (Sophophora) obscura	4	0	5	5	18	82	115	111	4	96	124	1	4	83	60	3	8
D. (Sophophora) subobscura	2	5	6	54	40	71	124	2	30	145	47	8	1	61	53	2	7
D. (Sophophora) subsilvestris	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
D. (Sophophora) tristis	0	0	0	0	0	0	3	0	0	11	13	0	0	0	1	0	0
D. (Drosophila) funebris	0	0	0	0	0	0	0	0	2	1	2	3	0	0	0	0	0
D. (Drosophila) histrio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. (Drosophila) hydei	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
D. (Drosophila) immigrans	1	5	54	12	9	50	25	32	26	2	5	0	0	11	7	0	4
D. (Drosophila) kuntzei	74	35	2	1	0	3	4	2	2	4	3	3	2	0	3	4	7
D. (Drosophila) limbata	0	0	5	0	3	0	0	0	5	0	0	1	0	0	0	0	0
D. (Drosophila) littoralis	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0
D. (Drosophila) phalerata	207	137	26	20	7	48	32	83	9	35	50	3	37	5	17	33	87
D. (Drosophila) testacea	39	8	0	4	7	5	13	113	4	20	71	0	2	6	11	24	6
D. (Drosophila) transversa	1	1	1	5	0	1	0	1	0	1	0	0	0	0	1	0	1
D. (Drosophila) unimaculata	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
D. (Drosophila) tsigana	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Drosophila sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
D. (Hirtodrosophila) oldenbergi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A. (Amiota) rufescens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total number of specimens	395	268	111	186	104	287	333	353	112	363	358	32	75	213	216	72	158
Species/sample	14	16	9	11	11	15	13	9	12	18	17	10	9	15	16	7	11
Specimens/species	28.2	16.8	12.3	16.9	9.5	19.1	25.6	39.2	9.3	21.2	21.1	3.2	8.3	14.2	13.5	10.3	14.4
Berger-Parker dominance index	.524	.511	.487	.436	.385	.286	.372	.320	.268	.399	.346	.313	.493	.390	.278	.458	.551

localities	A	B	M	V	Σ
Stegana coleoptrata	0	0	1	0	1
Stegana similis	0	2	0	0	2
A. (Amiota) alboguttata	2	0	1	0	3
A. (Amiota) basdeni	0	1	1	0	2
A. (Phortica) semivirgo	0	0	3	0	3
A. (Phortica) variegata	30	9	19	9	67
Leucophenga maculata	97	3	8	6	114
Chymomyza amoena	3	17	10	7	37
Chymomyza caudatula	0	0	0	1	1
Mycodrosophila poecilogastra	1	0	6	17	24
Scaptomyza flava	0	1	0	0	1
Scaptomyza graminum	35	50	2	0	87
S. (Parascaptomyza) pallida	99	221	41	26	387
D. (Lordiphosa) andalusiaca	2	0	4	1	7
D. (Lordiphosa) fenestrarum	18	102	7	2	129
D. (Hirtodrosophila) confusa	29	75	112	89	305
D. (Dorsilopha) busckii	34	1	3	0	38
D. (Sophophora) ambigua	4	1	10	4	19
D. (Sophophora) bifasciata	0	0	9	1	10
D. (Sophophora) helvetica	1	0	2	0	3
D. (Sophophora) melanogaster	32	8	199	17	256
D. (Sophophora) obscura	424	294	565	158	1441
D. (Sophophora) subobscura	78	68	534	124	804
D. (Sophophora) subsilvestris	53	21	2	2	78
D. (Sophophora) tristis	3	3	27	1	34
D. (Drosophila) funebris	1	1	8	0	10
D. (Drosophila) histrio	7	17	0	0	24
D. (Drosophila) hydei	3	1	2	0	6
D. (Drosophila) immigrans	41	69	221	22	353
D. (Drosophila) kuntzei	306	136	133	16	591
D. (Drosophila) limbata	1	8	14	0	23
D. (Drosophila) littoralis	2	1	3	0	6
D. (Drosophila) phalerata	237	1772	657	179	2845
D. (Drosophila) testacea	118	284	284	49	735
D. (Drosophila) transversa	6	89	11	2	108
D. (Drosophila) unimaculata	3	311	1	1	316
D. (Drosophila) tsigana	0	2	1	0	3
Drosophila sp.	0	0	1	0	1
D. (Hirtodrosophila) oldenbergi	20	0	0	0	20
A. (Amiota) rufescens	1	0	0	0	1
Total	1691	3568	2902	734	8895

Table 3. Shannon-Wiener diversity index (second row) and evenness index (third row) of the 35 samples

A10058	A19078	A14098	A12108	A13108	A02089	A07099	A15080	A11090
1.7577	1.3330	1.0791	1.0887	1.6506	1.2402	1.7738	2.1561	1.3350
0.7633	0.5051	0.6022	0.4125	0.6642	0.5386	0.7397	0.7082	0.7451

A25090	B21078	B14108	B03089	B08099	B11109	B16080	B13090	B27090
1.3592	1.8451	0.9047	1.2794	2.1154	1.6919	2.0625	1.3136	1.0649
0.8445	0.6384	0.3428	0.4988	0.7630	0.7348	0.7005	0.5978	0.4286

M21088	M22088	M17098	M15108	M01079	M28079	M29079	M30079	M01109
1.4302	1.6028	1.5138	1.5477	1.8376	1.8296	1.6102	1.4687	1.8566
0.5419	0.5781	0.6890	0.6455	0.7664	0.6756	0.6278	0.6684	0.7472

M18080	M19080	M23090	V20088	V14079	V27079	V03099	V07090
1.7782	1.9107	1.9173	1.4294	1.7446	2.0432	1.3609	1.5954
0.6152	0.6744	0.8327	0.6505	0.6456	0.7369	0.6994	0.6654

Table 4. Similarity indices of samples from 1990
(Renkonen index: for similarity in dominance values;
Czekanowski index: for similarity in abundance values)

Renkonen index

	A15080	A11090	A25090	B16080	B13090	B27090	M18080	M19080	M23090	V07090
A15080	1	0.0956	0.2475	0.4120	0.1190	0.1636	0.3804	0.4894	0.1241	0.1960
A11090	0.1265	1	0.6557	0.4994	0.6097	0.1950	0.1185	0.1508	0.2188	0.5160
A25090	0.0532	0.2254	1	0.6034	0.7361	0.2398	0.1736	0.2508	0.2188	0.6823
B16080	0.3879	0.2366	0.0658	1	0.6165	0.3520	0.3164	0.4209	0.2406	0.5683
B13090	0.1306	0.3105	0.0885	0.6980	1	0.3915	0.1555	0.1879	0.2234	0.7153
B27090	0.1352	0.2802	0.0874	0.3225	0.3932	1	0.1834	0.2102	0.1652	0.2302
M18080	0.3813	0.1509	0.0483	0.3196	0.1762	0.1610	1	0.6862	0.4797	0.3478
M19080	0.4945	0.1432	0.0489	0.4141	0.2160	0.1552	0.6879	1	0.3401	0.3759
M23090	0.0603	0.1505	0.2857	0.0982	0.0645	0.0877	0.1367	0.1436	1	0.3525
V07090	0.1603	0.3379	0.1071	0.5221	0.6364	0.2373	0.3301	0.3798	0.2632	1

(Renkonen values higher than 0.5, Czekanowski values higher than 0.3 are underlined)

Table 5. Similarity in species composition at the four sites: a) general; b) for species with relative frequencies lower than 0.5 %(values by "addition" of three domestic species are bracketed)

a) total number of species		A	M	B	V		b) A	M	B	V
31	**A**	1	0.757	0.714	0.606 (0.697)	**A**	1	0.591	0.500	0.333
34	**M**		1	0.703	0.600 (0.686)	**M**		1	0.500	0.350
29	**B**			1	0.545 (0.636)	**B**			1	0.222
22	**V**				1	**V**				1

Occurrence of the 40 species at the four sites (1988-90):

ABMV	18 species
ABM	6
AMV	2
AB	1
AM	2
BM	2
MV	1
A	2
B	2
M	3
V	1

Table 6/A. Species with relative frequencies lower than 0.5 %per site (incl. *D.(S.) subsilvestris*, which is represented by a somewhat higher total frequency but this is a result from a high number in a single sample; * is for the domestic species)

	A	B	M	V
Stegana coleoptrata			+	
Stegana similis		+		
A. (Amiota) alboguttata	+		+	
A. (Amiota) basdeni		+	+	
A. (Amiota) rufescens	+			
A. (Phortica) semivirgo			+	
Chymomyza amoena	+	+	+	+
Chymomyza caudatula				+
Mycodrosophila poecilogastra	+		+	+
Scaptomyza flava		+		
D. (Lordiphosa) andalusiaca	+		+	+
*D. (Dorsilopha) busckii	+	+	+	
D. (Sophophora) ambigua	+	+	+	+
D. (Sophophora) bifasciata			+	+
D. (Sophophora) helvetica	+		+	
D. (Sophophora) subsilvestris	+	+	+	+
D. (Sophophora) tristis	+	+	+	+
*D. (Drosophila) funebris	+	+	+	
D. (Drosophila) histrio	+	+		
*D. (Drosophila) hydei	+	+	+	
D. (Drosophila) limbata	+	+	+	
D. (Drosophila) littoralis	+	+	+	
D. (Drosophila) tsigana		+	+	
Drosophila sp.			+	
D. (Hirtodrosophila) oldenbergi		+		
Total	16	14	19	8

Table 6/B. Representation of the rare species (incl. *D.(S.) subsilvestris*)

	A	B	M	V	Σ
species below 0.1 % relative frequency	7	6	10	3	15
species below 0.5 % relative frequency	16	14	19	7	25
total number of species recorded	31	29	34	22	40
number of domestic species	5	5	5	2	5
number of samples taken	10	8	12	5	35
total number of specimens collected	1691	3568	2902	734	8895

Table 7/A. The groups of the dominant species in the three years of collectings

	number of samples taken			
dominant species	1988	1989	1990	Σ
yellow, mycophagous spp.	8	5	5	18
black, frugivorous spp.	1	8	3	12
domestic species	3	0	1	4
other species	0	0	1	1
	12	13	10	35

Table 7/B. The indicative value of the dominant species for the total number of species in samples.

dominant species	n	Berger-Parker dominance index	number of species in samples mean	maximum
domestic species	4	0.296--0.487	10.5	12
D. kuntzei	1	0.661	14	14
D. phalerata	15	0.272--0.785	11.4	19
D. testacea	2	0.320--0.346	9.5	10
D. obscura	8	0.249--0.670	15.1	21
D. subobseura	4	0.268--0.399	13.5	18
D. unimaculata	1	0.719	12	12
	35		12.086	21

Table 8. Samples where a high number of species were found (1988-90)

sample	number of species	number of specimens
A15080	21	366
B16080	19	294
M18080	18	363
B21078		1070
M19080	17	358
M22088	16	268
V27079		216
B08099		195

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Author's address: Dr. László PAPP
Zoological Department
Hungarian Natural History Museum Baross u. 13
H- 1088 Budapest
HUNGARY