Papp, 1992

Acta Zoologica Hungarica 38 (1—2), pp. 75—88 (1992)

FLY COMMUNITIES IN PASTURE DUNG: SOME RESULTS AND PROBLEMS (DIPTERA)

L. PAPP

Zoological Department, Hungarian Natural History Museum
H-1088 Budapest, Baross utca 13, Hungary

(Received 19 March, 1991)

Fly samples collected/reared from Hungary, Spain, Afghanistan, Mongolia, Kenya and Tanzania (cow-pats, horse/donkey dung, elephant dung) are studied for species composition and community structure; Shannon's diversity index (H'), evenness index (J') and two similarity indices (Czekanowski's and Renkonen's) were calculated. There are no rules in the type of diversity of the separate (individual) imago samples or of the flies reared from separate droppings. The differences in the sizes of populations of the fly species breeding in droppings are as high as (10^3)—10^4—(10^5); consequently, 10 to 100 thousands of specimens are to be collected on a given place in order to have a fair chance for obtaining rare species. Dominance data were tested to fit to the lognormal distribution.

A method is proposed to a) collect flies/dung samples on/from the separate droppings and identify the flies separately; b) extract results from the data based on the rules of sequential sampling up to a stage (i.e. over ten-thousand specimens) when a lognormal distribution is reached for the consequence of species. It is stressed that much more methods of quantitative (statistical) ecology must be also used in order to go further in understanding the structure and community organization of coprophagous fly communities. With 2 original figures.

The coprophagous flies on pastures have always attracted attention in dipterology, since fly larvae play an important (in some cases a key) role in the normal decomposition of cow-pats and the larvae of the haematophagous and secretophagous flies of veterinary importance develop in horse dung and cow-pats on pastures.

Several authors, recently LEGNER (1986) stressed that the interactions between dung inhabiting flies, their natural predators (parasitoids) and other insects breeding in dung are far more complex than anticipated or reported before. We plan to make a review of the biology and control of the pasture flies developing in dung elsewhere in the near future, so a bibliographical overview of the related questions will be given there. In this paper we concentrate to the problems of studies on community organization of dipterous species but it does not mean that we are not aware of the importance of population interactions of other insect and non-insect populations in the dung.

As regards the quantitative aspects of species composition, community structure or community organization, we are afraid, these are the least known aspects in studies of dung inhabiting flies on pastures. HAMMER (1941) performed fundamental investigations on dipterous species of veterinary importance in Denmark; he published invaluable data on the life-habits of the other species too, but nothing about the quantitative aspects (dominance or else). Some authors who measured the biomass of larval inhabitants of pasture dung (e.g. for their role in energy flow) paid little attention to the relative frequencies, community organization, etc. HARRIS & BLUME (1986) tabulated 196 dipterous species emerged from cow-pats in the U.S.A. (unfortunately, they listed only families with species numbers and not species names). One of their statements, that there are several species of Muscidae that breed in cattle droppings, and a few of these compete with horn fly and face fly for food, is somewhat questionable for me; I mean, the above relationship is a seldom realized possibility for a competition only (see below). There are rather few papers in the literature hitherto for quantitative studies in species composition, like that of NIBARUTA (1982) who studied dipterous community of cow-pats by rearing imagos; for the earlier literature see HAMMER (1941), PAPP (1971) and NIBARUTA (1982).

The present author commenced studies on imagos and larvae of coprophagous flies as a "production biological study" of the significance of flies breeding in cow-pats in Hungary (PAPP 1971), when cow-pats were regarded as "ecological units" (they are anything but not units). However, the author was eager to know the species composition of fly communities of droppings from the very beginning as well. In the last two decades fly samples were collected and identified from Hungary, Austria, Spain, Afghanistan, Mongolia, etc. on/from cow-pats, horse/donkey droppings, sheep droppings, etc. Hitherto more than 150 000 fly imagos have been identified. The species composition of dung on pastures of Hungary has become comparatively well known. In our Table 1 a list of the dipterous species which develop in pasture dung in Hungary is given; some species which have been reared from dung but not in pasture conditions are also included. Some faunistical, zoogeographical and production biological results of the works hitherto (PAPP 1971, 1976, etc., PAPP & GARZÓ 1985) can be summarized as follows: It was found that the droppings have no autochtonous faunas (independent of their geographic position and faunal "environment"), not even in Europe. The species composition of horse (donkey) droppings seems to be the least dependent on the geographical position. The larval communities are formed from progenies of female flies which once found that dropping and were ready to lay eggs there. That is, it seems obvious that not every specimen caught on a dropping represents a species-population developing there.

This paper is not to revisit all the data we possess on dung inhabiting flies but rather to make a step towards elaborating methods for studies in the community structure and organization of these flies.

MATERIALS AND METHODS

A majority of the primary data (identifications of species in fly samples) was published formerly (PAPP 1971, 1976), at least in a data matrix form, i.e. some materials collected/reared by the author are revisited below in order to illustrate the problems with these fly communities and to show a possible method we propose. Much more data in my previous papers (e.g. in PAPP & GARZÓ 1985) are still awaiting similar processing. Only a small part of the primary data (identifications) are published here first. Voucher specimens of the species are deposited in the Zoological Department of the Hungarian Natural History Museum, Budapest.

The values of relative frequencies, H' (Shannon's diversity index), J' evenness index and two similarity indices (Czekanowski's and Renkonen's) were computed by a domestic software developed for Commodore 64 microcomputers. The lognormal distribution was fitted (tested) with the *chi*-square statistic with LOGNORM. BAS program of LUDWIG & REYNOLDS (1988) on an IBM-PC. (We have found the lognormal distribution as the best fit to community (guild) composition of the flies on dung heaps, of the dung beetles on sheep pastures, of the drosophilid flies in low mountain valleys in Hungary, etc.)

RESULTS AND DISCUSSION

As we can see in Table 1, the number of species inhabiting pasture dung is very high, though not all of them develop in all kind of dung and not all of them occur in a given pasture in Hungary.

It was found earlier that the mean dry biomass of flies emerged from cow-pat samples is only 0.462% of the dry biomass of dung; the maximal value we measured (i.e. a possible case in nature) is 2.54%, i.e. 5.5 times more than the mean value (from PAPP 1971: Table II). This ratio is about 25 in sheep droppings on pastures in Hungary. Though this paper aimed at a study of community structure of dung inhabiting flies, we can always be aware of the fact that the size (abundance) of fly larval populations in dung are not limited by the amount of food — except for very rare occasions.

To illustrate a possible approach of a study in community composition, nine imago samples collected on horse or donkey droppings are shown in

Table 2 (1-1 samples from Hungary and Spain, two samples from Afghanistan and five samples from Mongolia). These are 51 species, all but seven have been collected in Hungary and may occur also in Spain or Afghanistan. All but two samples (Mongolia: No. 5, 8) were collected on individual droppings by covering them quickly with a net, i.e. the numbers represent all the fly visitors of the dropping. The values of the Shannon's diversity and evenness indices are extremely variable, the values of Czekanowski's similarity index are low to very low, even for pairs from the same country. The values of the Renkonen's similarity index (which compensate the differences caused by the uneven sample sizes) are usually higher but still vary considerably. The whole picture we have got is rather chaotic. We may have a feeling that these materials are too small, the differences in the local faunas are possibly significant and it would be better to exclude the species which are attracted by the dung smells but do not develop there.

Logically there are two possibilities to avoid the above mentioned inadequacies in sampling on dung: 1) to collect more dipterous imagos on a given piece of dung (pats, droppings); 2) to collect numerous dung samples for rearing flies, i.e. to exclude the populations of species which are attracted by dung smells but do not develop there.

In order to show an example for case 1, one large sample collected on elephant dung ("Tanzania: Morogoro region, Mikumi Tented Camp, Mikumi National Park, Feb 1, 1987, netting over excrement of elephant, leg. S. MAHUNKA") was identified to species (or at least selected into species). The results are as follows:

Sphaeroceridae (in a taxonomical order): *Ischiolepta flava* VANSCH. 1, *Ischiolepta vanschuytbroecki* L. PAPP 2, *Ischiolepta* sp. n. 3, *Lotobia elegans* VANSCH. 37, *Lotobia simia* SÉGUY (= kanongensis VANSCH.) 18, *Metaborborus flavior* VANSCH. 2 209, *Metaborborus stichosus* NORRBOM 36, *Gymnometopina clunicrus* DUDA 1, *Gymnometopina lucida* SÉGUY 9, *Norrbomia elephantis* L. PAPP 6, *Coproica ferruginata* STENH. 8, *Coproica* sp. n. 1, *Coproica* sp. 1. 664, *Coproica* sp. 2. 36, *Coproica* sp. 3. 21, *Coproica* sp. 4. 3, *Philocoprella* sp. n. 2, *Elachisoma afrotropicum* L. PAPP 202, *Elachisoma* sp. 1. 1, *Elachisoma* sp. 2. 1, *Trachyopella* sp. 1. 25, *Trachyopella* sp. 2. 14, *Trachyopella* sp. 3. 3, *Trachyopella* sp. 4. 3, *Spelobia* sp. 36, *S.* (*Bifronsina*) *bifrons* STENH. 266, *L.* (*Leptocera*) *nigra-group* sp. 1, *L.* (*Leptocera*) sp. 7, *Telomerina* sp. 2, gen. n.: 3 species, 4 + 3 + 2 ex.; flies other than sphaerocerids: Cecidomyiinae indet .1, Lestremyiinae indet. 1, Ceratopogonidae indet.: 5 spp., 6 + 3 + 1 + 1 + 1, Syrphidae indet. 1, Chloropidae indet.: 2 spp., 2 + 1, Musca sp. 1, Muscidae indet. 1, Calliphoridae indet. 1, Sepsidae indet.: 4 spp., 16 + 7 + 4 + 2. Altogether 3 677 specimens of 49 species.

The relative frequencies of the species were plotted against their rank in Fig. 1. An analysis of the results (incl. of the graph presented) suggests/indicates a smaller than required sampling size. In this sample *Metaborborus flavior* VANSCH. is overdominant (60.08%) *and* 16 species are represented by single specimens only. Though the fit of the sequence of species to the log-normal distribution is not bad, its modal octave is the 2nd one of the 13 octaves. It is quite sure that these 49 species observed represent a part of the possibly

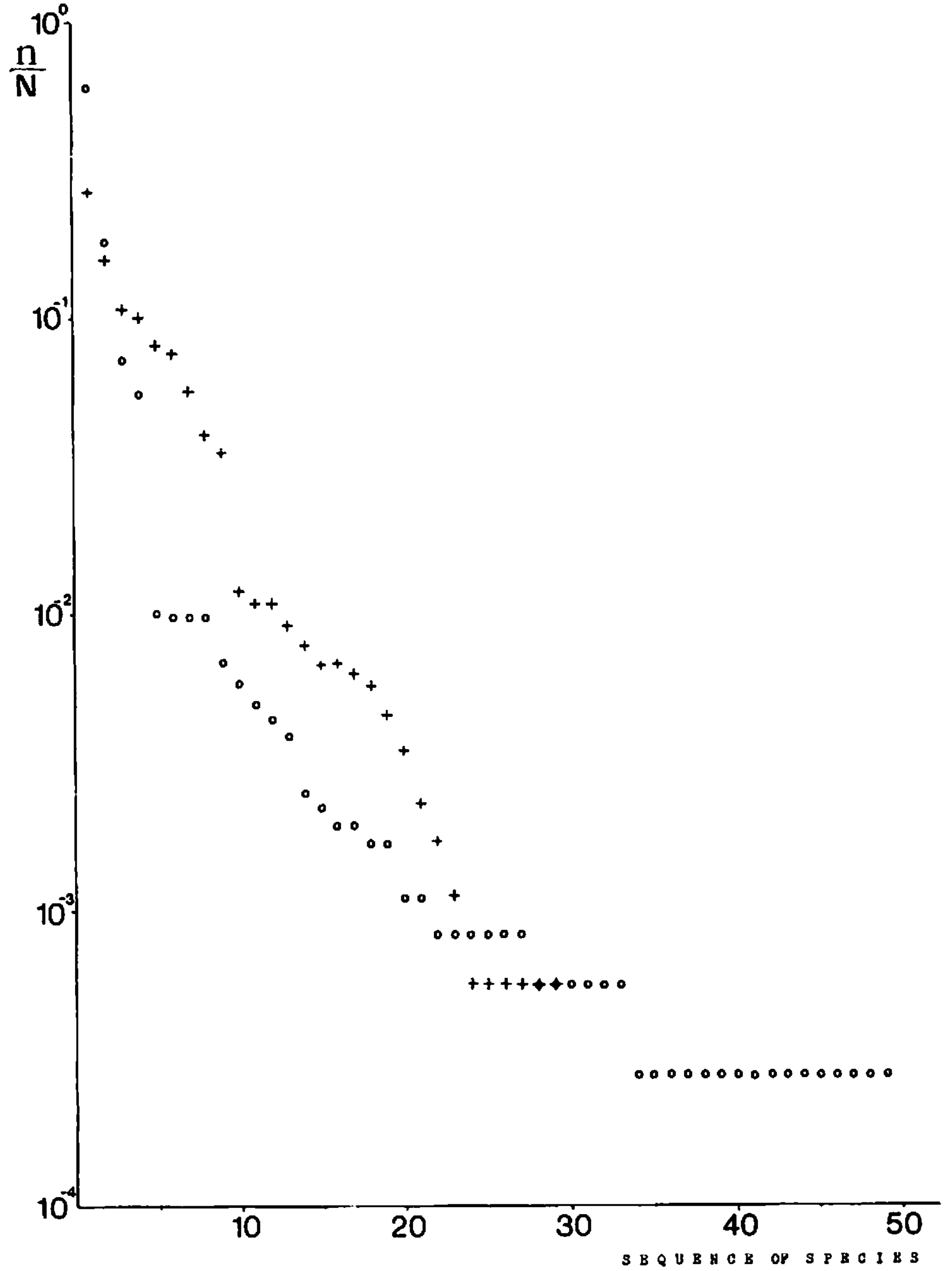

Fig. 1. Relationship between relative frequencies of species and their rank (from most common to most rare): in a fly sample collected on elephant dung in Tanzania (small circles, see in text) and in the fly community emerging from cow pats in Hungary (small crosses, sum of the nine samples of Table 3). Both indicate a smaller than required sampling size.

present species only. Indeed, LUDWIG & REYNOLD's (1988) formula of $S^* = 1.77 \cdot S_0/a$ predicts 86 species possibly present. (For the best fit of the sequence of species to the lognormal distribution $S_0 = 7.9$ with $a = 0.163$, or $S_0 = 8.0$ with $a = 0.164$, both with *chi*-square = 10.30.) It must be noted here, that it is not always the case of the collector's decision only to collect sample(s) large enough. Here is another sample collected on elephant dung in Africa:

North Kenya, Marsabit, on elephant dung, 18. 03. 1988, "Teleki Exped.", leg. A. VOJNITS, No. 208: *Norrbomia marginatis* (ADAMS) 29, *Norrbomia hypopygialis* (Rich.) 20 *Achaetothorax vojnitsi* sp. n. 4, *Achaetothorax rhinocerotis* (Rich.) or sp. n. 2, *Sepsis* sp. 2, *Coproica* sp. n. 1, *Musca* sp. 1, Muscidae indet. 1. 60 ex. of eight species. (A dominance of *Norrbomia* species shows that the dung was fresh, however, some other circumstances resulted in a scarce representation of specimens there.)

We may draw another lesson from the above data: a possible effect of the reduction or disappearance of the original populations of the African big ungulates and their replacement by domestic animals is that the dipterous and other insect species developing in their droppings will also disappear. However, considering the methodological problems discussed in this paper, it seems advisable not to risk any statement on the presence or absence of such an insect species below a given level of dominance in its community.

The other possibility of a better sampling on the structure of dipterous communities in dung is to collect dung samples of equal or subequal quantity in order to a) avoid populations which are attracted by the smells of dung but not develop there; b) avoid any subjective aspects of the collecting of imagos. Table 3 summarizes data of the flies reared from cow-pat samples of subequal weight (35—45 g dwt) from four localities in Hungary (with some omissions and corrections this is Table I in PAPP 1976). There are 1784 specimens of 29 species in nine samples. The values of the Shannon's diversity index and of the J' evenness index vary strongly. Czekanowski's similarity index between samples from the same locality is low to very low; if we reduce data per localities, the similarity values between localities are similarly low. The summarized numbers of specimens per species (No. 13 in Table 3) were used to calculate relative frequencies; the relative frequencies and the rank of species are shown on Fig. 1. They were also fitted to the lognormal distribution. The best fit is with $a = 0.176$, $S_0 = 4.0$ or 4.1 (instead of 6.0, observed), with *chi*-square = 6.00. S_0 is in the 5th octave of 10 octaves, S^* is 41, i.e. not too far from the observed 29. The graph presented fits rather well also to the logarithmic distribution (which seems rather usual case in this magnitude of sum of the specimen numbers in guilds of flying insects; observed e.g. also in drosophilid communities in Hungary). Summarily, we feel that this method is better than just to collect imagos on dung but the sample size is smaller than required.

In order to fulfil the requirement of samples of larger size, the data published by PAPP (1971, Table 2) were revisited from another point of view. Our Fig. 2 shows the relationship between relative frequencies of the species and their rank. The sequence of species in dominance follows a lognormal distribution (and obviously not a logarithmic distribution). Its parameters are: $S_0 = 4.8$ (instead of 8.0, observed), a = 0.182 to 0.185, *chi*-square for all these values is 9.59*. Its modal octave is the 6th of the 14 octaves, Ludwig & Reynolds' formula predicts $S^* = 46.68$, i.e. 47 species are possibly present instead of 38 species observed. Indeed, at the right edge of the graph there lies the 5th order of minorities, where representatives of several other species may lie hidden but this sample size of 12 631 is not enough yet to have a single representative specimen of them to be involved. I must stress that the last four species (each represented by a single specimen) are not accidental visitors but all the four develop exclusively in dung: *Ischiolepta pusilla*, *Telomerina pseudoleucoptera* ("*Limosina* sp." in PAPP 1971), *Hydrotaea albipuncta* and others are always so rarely emerging from dung samples in Hungary.

If one looks at the original table of rearing data, the pattern of the specimens of the dipterous species emerged are quite the same, i.e. as chaotic as in our Table 2 above. That is, one horse dropping or cow-pat is not a unit at all but if we collect systematically numerous samples on a given pasture, our results will be reliable and repeatable (at least for the dominant and subdominant species). I must remind my readers here that these 12 631 specimens were reared from 54 dung samples collected on a pasture of ca. 5 hectares. One month is enough to spend for collecting cow-pats samples and rearing flies from them, another month is required for a small team of Diptera taxonomists for the identification of the flies. Since the differences in the sizes of populations of the species of this guild of pasture dung inhabiting flies are as high as $10^3 - 10^4$ (or possibly 10^5), we must collect 10 000 or more specimens to have an "adequately" large sample. There is another problem, too. If females of all coprophagous species were of the same fertility, the probability of finding fresh droppings were the same for every fly specimen, and all the populations were of the same mortality, our collecting results would not depend on the number of collected droppings in cases of adequately large samples. However, these are not fully realistic requirements. In addition, if one collects too many specimens at a given locality, he/she will not be able to identify them. We have a better chance for a good representation of species if we collect smaller but numerous samples.

Here we made a review of the species of one guild only. One can imagine how many thousands of flies (or other insects) we must collect in the frame of

* The level of fitness to the three curves is $0.50 < P < 0.70$ for all, in the case of the last one it is nearly 0.70, i.e. very good.

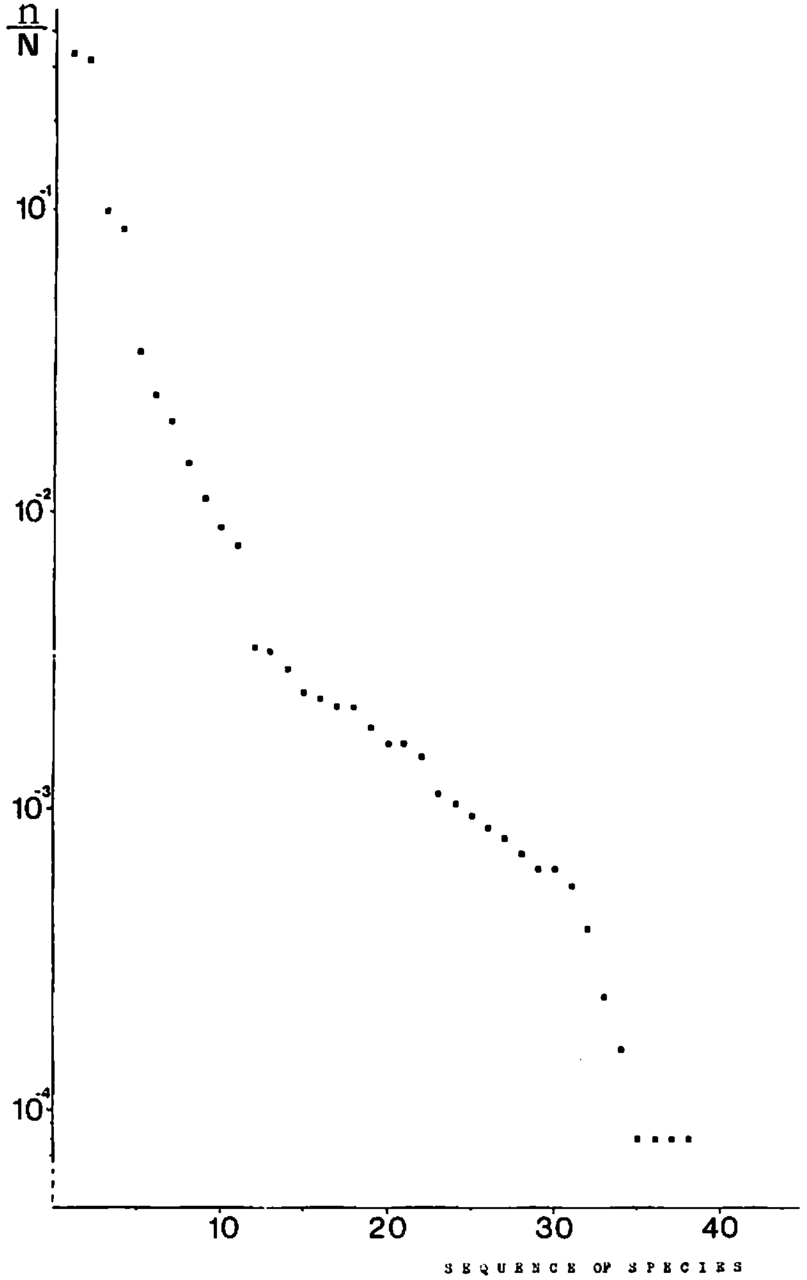

Fig. 2. Relationship between relative frequencies of the species and their rank in the fly community developing in cow pats on a pasture of Aranyosgadány, Hungary (sum of 54 samples, 12 631 ex., see Table II of Papp 1971). The sequence of species in dominance follows a lognormal distribution, see more in text.

the so-called "classical" faunistical work in order to produce faunal lists, which would include the true rare species in fair numbers as well, since the number of the guilds are so numerous in a given area, e.g. in a national park, or even in a country.

CONCLUSIONS

As a consequence of the extremely large differences in the abundance (i.e. the sizes of populations) of species in the same guild of flying insects, even if we want to produce only "simple" faunal lists (e.g. for a national park) we have to collect several 100 000-s of flies in order to have a fair chance for obtaining representatives of rare species.

It is to be feared that we are unable to collect and identify "adequately" large samples of coprophagous flies: the differences in the sizes of populations of these species breeding in droppings are as high as $10^4 - 10^5$.

In the present circumstances of research, all the future collecting or sampling work must be planned more cautiously. Our present formula is,

a) collect flies on separate droppings and identify them separately;

b) extract results from the data based on the rules of sequential sampling (if necessary and possible) up to the stage when a lognormal distribution is reached for the sequence of species. We have to regard "the smallest detectable population size" as 1 at this stage. We must use much more methods of the "arsenal" of quantitative (statistical) ecology in order to know more about the structure and community organization of coprophagous fly communities.

REFERENCES

HAMMER, O. (1941): Biological and ecological investigations of flies associated with pasturing cattle and their excrements. — *Vidensk. Meddr dansk naturh. Foren.* **105:** 141—393.

HARRIS, R. L. & BLUME, R. R. (1986): Beneficial insects inhabiting bovine droppings in the United States. — In: PATTERSON, R. S. & RUTZ, D. A. (eds): *Biological control of muscoid flies, Misc. Publ. Ent. Soc. Am.* **62:** 10—15.

LEGNER, E. F. (1986): The requirement for reassessment of interactions among dung beetles, symbovine flies, and natural enemies. — In: PATTERSON, R. S. & RUTZ, D. A. (eds): *Biological control of muscoid flies, Misc. Publ. Ent. Soc. Am.* **62:** 120—131.

LUDWIG, J. A. & REYNOLDS, J. F. (1988): Statistical ecology. A primer on methods and computing. — John Wiley & Sons, New York-Chichester-etc., pp. 337.

NIBARUTA, G. (1982): Étude écologique des Diptères associés aux excréments de la vache domestique en milieu tempéré. — *Rev. Écol. Biol. Sol.* **19** (2): 203—223.

PAPP, L. (1971): Ecological and production biological data on the significance of flies breeding in cattle droppings. — *Acta zool. hung.* **17** (1—2): 91—105.

PAPP, L. (1976): Ecological and zoogeographical data on flies developing in excrement droppings (Diptera). — *Acta zool. hung.* **22:** 119—138.

PAPP, L. & GARZÓ, P. (1985): Flies (Diptera) of pasturing cattle: some new data and new aspects. — *Folia ent. hung.* **46** (2): 153—168.

Table 1

Dipterous species developing in pasture dung in Hungary

Anisopodidae:

Sylvicola cinctus Fabr.
fenestralis Scop.

Bibionidae:

Bibio johannis L.
spp.
Dilophus antipedalis Meig.
bispinosus Lundst.
febrilis L.
humeralis Zett.

Scatopsidae:

Ectactia clavipes Lw.
Rhegmoclema halteratum Meig.
Colobostema nigripenne Meig.
Holoplagia albitarsis Zett.
sp.
Reichertella nigra Meig.
Scatopse notata Meig.
Coboldia fuscipes Meig.
Swammerdamella brevicornis Meig.

Cecidomyiidae:

10 to 20 species
of low importance

Sciaridae:

more than 10 species
(mainly in old dung)

Psychodidae:

Tinearia alternata Say
Psychoda sp.

Chironomidae:

unknown number of species
(probably more than 10 spp.)

Ceratopogonidae:

8—10 species

Stratiomyidae:

Microchrysa flavicornis Meig.
polita L.
Chloromyia formosa Scop.
Sargus cuprarius L.
iridatus Scop.
(rarely other 1—2 species)

Empididae:

Drapetis: 2—3 spp.
Crossopalpus: 5—6 spp.

Syrphidae:

4—5 spp. (mainly in stables)

Phoridae:

8—10 spp. in old dry dung

Sepsidae:

Meroplius minutus Wied.
Nemopoda nitidula Fall.
pectinulata Lw.
Ortalischema albitarse Zett.
Saltella nigripes R.-D.
sphondylii Schrank
Sepsis biflexuosa Strobl
cynipsea L.
duplicata Halid.
flavimana Meig.
fulgens Meig.
neocynipsea Mel. et Spul.
orthocnemis Frey
punctum Fabr.
thoracica R.-D.
violacea Meig.
Themira annulipes Meig.
leachi Meig.
lucida Staeg.
minor Halid.
nigricornis Meig.
Themira putris L.
superba Halid.

Ulidiidae:

Physiphora demandata Fabr.
Ulidia erythrophthalma Meig.

Platystomatidae:

rarely, 2—3 spp.

Heleomyzidae:

Oecothea fenestralis Fall.
praecox Lw.
Tephrochlamys rufiventris Meig.
(other 8—10 rare species)

Sphaeroceridae:

Sphaerocera curvipes Latr.
Ischiolepta nitida Duda
oedopoda L. Papp
pusilla Fall.
scabricula Halid.
vaporariorum Halid.
Lotobia pallidiventris Meig.
africana Beck.
Lotophila atra Meig.

Table 1 (cont'd)

Sphaeroceridae (cont'd)

Copromyza equina Fall.
similis Coll.
Borborillus costalis Zett.
hispanicus Duda
nitidifrons Duda
somogyii L. Papp
sordidus Zett.
szelenyii L. Papp
uncinatus Duda
vitripennis Meig.
Alloborborus pallifrons Fall.
Crumomyia nigra Meig.
Coproica acutangula Zett.
dentata L. Papp
digitata Duda
ferruginata Stenh.
hirticula Coll.
hirtula Rond.
lugubris Halid.
pusio Zett.
vagans Halid.
Philocoprella italica Deem.
quadrispina Laur.
Elachisoma aterrimum Halid.
bajzae L. Papp
kerteszi Duda
pilosum Duda
Trachyopella atomus Rond.
coprina Duda
lineafrons Spuler
leucoptera Halid.
melania Halid.
straminea Roh. & Marsh.
Halidayina spinipennis Halid.
Chaetopodella scutellaris Halid.
Leptocera caenosa Rond.
Paralimosina fucata Rond.
Pullimosina heteroneura Halid.
Spinilimosina brevicostata Duda
Opalimosina albinervis Duda
calcarifera Roh.
collini Rich.
denticulata Duda
mirabilis Coll.
simplex Coll.
Telomerina flavipes Zett.
pseudoleucoptera Duda
Spelobia (E.) ochripes Meig.
Spelobia (B.) bifrons Stenh.
Spelobia clunipes Meig.
luteilabris Rond.
palmata Rich.
pseudosetaria Duda
(rarely other 5—10 spp.)

Drosophilidae:

rarely, 1—2 spp.

Milichiidae:

Madiza glabra Fall.
Desmometopa m-nigrum Zett.
sordidum Fall.
Leptometopa latipes Meig.
niveipennis Strobl

Carnidae:

Hemeromyia anthracina Coll.
Meoneura flavifacies Coll.
freta Coll.
hungarica L. Papp
minutissima Zett.
neglecta Coll.
prima Beck.
other 4—5 rare spp.

Scathophagidae:

Scathophaga scybalaria L.
stercoraria L.
(rarely other 1—2 spp.)

Fanniidae:

rare on pastures, mainly in stables

Muscidae:

Muscina stabulans Fall.
Azelia aterrima Meig.
cilipes Halid.
nebulosa R.-D.
parva Rond.
triquetra Wied.
zetterstedti Rond.
Hydrotaea aenescens Wied.
albipuncta Zett.
armipes Fall.
dentipes Fabr.
floccosa Macq.
glabricula Fall.
ignava Harris
irritans Fall.
meteorica L.
pellucens Prsth.
tuberculata Rond.
velutina R.-D.
Mesembrina meridiana L.
mystacea L.
Polietes domitor Harris
lardaria Fabr.
meridionalis P. & Ll.
Musca autumnalis De Geer
(domestica L.)
larvipara Prtsh.
osiris Wied.
tempestiva Fall.
Morellia aenescens R.-D.
asetosa Bar.
hortorum Fall.
simplex Lw.

Table 1 (cont'd)

Muscidae (cont'd)

Neomyia cornicina Fabr.
viridescens R.-D.
Pyrellia rapax Harris
vivida R.-D.
Eudasyphora cyanella Meig.
cyanicolor Zett.
zimini Hennig
Dasyphora albofasciata Macq.
penicillata Egger
pratorum Meig.
(Stomoxys calcitrans L.,
in stables only)
Haematobia irritans L.
titillans Bezzi
Haematobosca atripalpis Bezzi
stimulans Meig.
Mydaea corni Scop.
urbana Meig.
Myospila meditabunda Fabr.
Hebecnema umbratica Meig.
Graphomyia maculata Scop.
Brontaea pappi Mihályi
humilis Zett.
tonitrui Wied.
(and some other rare species)

Anthomyiidae:

Paregle cinerella Fall.
radicum Meig.
Hylemya strenua Macq.
variata Macq.
Calythea albicincta Fall.
(and ca. other 10 spp.)

Calliphoridae:

1 or 2 species only

Sarcophagidae:

Ravinia striata Fabr.
Bercaea haemorrhoidalis Fall.

Altogether 270—280 species of 26 dipterous families

Table 2

Fly samples collected on horse/donkey dung on pastures

No.	1	2	3	4	5	6	7	8	9
					Mongolia 1971				
	Hungary Újszentmargita 27. 08. 74	Spain P. Andraitx 25. 05. 72	Afghanistan Kabul 30. 04. 74	Afghanistan Kabul 03. 05. 74	Altan Bulak 13. 07	Ulan Baator 11. 07	Ulan Baator 21. 07	Cecerleg 23. 07	Cecerleg 24. 07
Ceratopogonidae sp. 1	1	—	—	—	—	—	—	—	—
sp. 2	—	—	5	—	—	—	—	—	—
Chironomidae sp.	—	—	1	—	—	—	—	—	—
Sepsis flavimana	—	—	—	—	47	4	40	42	5
fulgens	—	—	—	4	—	—	—	—	—
neocynipsea	—	—	—	—	—	—	5	—	1
orthocnemis	—	—	1	—	—	—	—	—	—
thoracica	27	—	7	—	4	—	1	—	12
Sphaerocera curvipes	—	3	—	—	—	—	—	3	—
Ischiolepta horrida	—	—	—	—	5	—	2	—	—
I. vaporariorum	—	5	—	—	—	—	—	—	—
Lotobia pallidiventr.	1	4	—	—	4	5	4	10	—
Richardsia mongolica	—	—	—	—	22	—		—	2
Lotophila atra	—	20	—	45	—	—	—	—	—
Borborillus costalis	—	—	—	—	883	189	41	13	81
crypticus	—	—	—	—	5	7	1	—	1
hispanicus	2	2	—	—	—	—	—	—	—
micropyga	—	—	—	—	24	—	—	1	—
nitidifrons	—	1	—	—	—	—	—	—	—
somogyii	—	—	—	—	13	2	2	—	—
sordidus	1	1	—	—	2	1	—	—	—
uncinatus	—	—	—	—	—	—	—	2	—
Coproica acutangula	81	—	—	—	174	4	94	799	74
dentata	—	—	—	—	48	71	13	23	9
digitata	104	613	—	—	—	—	—	—	—
ferruginata	5	3	—	—	—	—	—	—	—
hirticula	31	1	—	—	—	—	—	—	—
lugubris	13	—	8	—	—	—	—	—	—
pusio	—	—	—	—	—	5	—	5	—
vagans	—	—	53	—	—	—	—	—	—
Elachisoma aterrimum	2	2	—	—	—	—	—	—	—
kerteszi	—	1	—	—	—	—	—	—	—
Philocop- mongolica	—	—	—	—	—	—	1	—	—
rella rectiradiata	—	—	—	—	—	—	2	—	—
H. spinipennis	1	—	—	—	—	—	—	—	—
Chaetop. scutellaris	7	—	—	4	—	—	—	—	—

Spelobia clunipes		—	—	—	64	—	—	—	3	—
palmata		—	13	—	—	—	—	—	—	—
simplicipes		—	42	—	—	—	—	—	—	—
villosa		—	2	—	—	—	—	—	—	—
Pullim. heteroneura		—	9	1	—	—	—	—	—	—
Meoneura setipyga		—	—	—	—	7	1	—	—	—
Scathophaga stercor.		1	—	—	—	—	—	—	—	—
Paregle cinerella		109	—	47	23	—	—	—	—	—
Musca autumnalis		1	—	—	—	—	—	—	—	—
osiris		1	—	—	—	—	—	—	—	—
Neomyia cornicina		1	—	—	—	—	—	—	—	—
Myospila meditabunda		—	—	—	10	—	—	—	—	—
Azelia parva		1	—	—	—	—	—	—	—	—
Muscidae sp. 1		—	—	2	3	—	—	—	—	—
sp. 2		—	—	—	—	1	1	10	15	2
		390	722	125	153	1239	290	216	916	187
Number of species		19	16	9	7	14	11	13	11	9
Specimens/species		20.5	45.1	13.9	21.9	88.5	26.4	16.6	83.3	20.8
Sh.-W. diversity		1.8545	0.7249	1.3797	1.4553	1.0898	1.0646	1.6669	0.6168	1.3013
Evenness		0.6298	0.2615	0.6279	0.7479	0.4130	0.4440	0.6499	0.2572	0.5923
Similarity (Czekanowski)	2	0.2050								
	3	0.2408								
	4	0.0994		0.1799						
	6					0.3388				
	7					0.2735	0.2767			
	8					0.2394	0.0912	0.5476		
	9					0.2482	0.4193	0.6650	0.1868	
(Renkonen)	2	0.2817								
	3	0.3688								
	4	0.1683		0.1663						
	6					0.7381				
	7					0.4315	0.3098			
	8					0.2228	0.0867	0.5476		
	9					0.6578	0.5177	0.6857	0.4725	

Table 3

Flies reared from cow-pats (Hungary); samples of subequal weight (35—45 g dwt)

Species	Locality and date									Σ
	Csévharaszt			Szentendre		Apaj	Aranyosgadány			
	12.05	23.05.		18.07.		6.09.	06.08.			
Cecidomyiidae indet.	—	—	—	—	—	—	4	6	4	14
Psychoda sp.	—	9	2	—	—	—	—	—	1	12
Cricotopus sp.	—	—	—	—	1	—	132	—	—	133
Sargus iridatus Scop.	—	10	—	—	—	—	—	—	—	10
Drapetis aenescens W.	—	—	—	1	—	—	—	—	11	12
Phoridae indet.	—	—	—	—	—	—	1	—	—	1
Saltella sphondylii	—	—	—	—	—	—	—	—	1	1
Sepsis biflexuosa St.	5	37	143	—	—	1	—	—	—	184
Sepsis cynipsea L.	8	—	8	—	—	—	—	—	—	16
Sepsis fulgens Hoffm.	—	37	236	1	—	—	—	—	—	274
Sepsis orthocnemis	113	14	6	3	6	—	—	—	—	142
Sepsis thoracica R.-D.	2	—	8	20	25	4	10	27	3	99
Sphaerocera curvipes	—	1	—	—	—	—	—	—	—	1
Ischiolepta pusilla	—	—	—	—	—	—	—	8	—	8
L. pallidiventris Mg.	—	—	—	—	—	—	—	17	4	21
Coproica lugubris	16	1	1	38	54	—	10	14	43	177
Elachisoma aterrimum	—	—	—	—	—	—	1	—	3	4
Ch. scutellaris Hal.	—	—	—	—	—	—	1	2	—	3
Chloropidae indet.	1	—	—	—	—	—	—	—	—	1
Neomyia cornicina	—	—	—	21	—	51	—	—	—	72
Musca autumnalis Deg.	288	6	15	66	27	76	—	—	—	478
Musca tempestiva Fll.	—	—	—	19	—	—	—	—	—	19
Myospilla meditabunda	11	—	1	4	3	—	—	—	—	19
Morellia hortorum	—	—	1	—	—	—	—	—	—	1
Hydrotaea armipes	—	—	2	—	—	—	—	—	—	2
Hebecnema umbratica	3	—	2	—	—	—	—	—	1	6
Fannia sp. (♀)	—	1	—	—	—	—	—	—	—	1
Paregle cinerella Fll.	—	—	—	20	19	23	—	—	—	62
Ravinia striata Fabr.	—	—	—	11	—	—	—	—	—	11
	445	116	425	204	135	155	159	74	71	1784

Sample No.	1	2	3	4	5	6	7	8	9	13
Sh.-W. diversity	1.0183	1.6699	1.1393	1.9374	1.5359	1.1252	0.6907	1.4986	1.3642	2.3636
Evenness	0.4635	0.7600	0.4585	0.8079	0.7893	0.6991	0.3550	0.8364	0.6209	0.7019
Similarity (Czekanowski) *2*	0.0856									
3	0.0874	0.3290								
5				0.6490						
8							0.1546			
9							0.1565	0.3866		

	10 (1—3)	11 (4+5)
11	0.2083	
12 (7—9)	0.0465	0.3390