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A survey of the flies breeding in poultry manure, and their potential natural enemies

by

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The identity and relative abundance of the flies breeding in manure accumulations below caged hens in poultry houses was established at several sites in the Eastern Cape by regular sampling over a period of five months. These flies included *Musca domestica* Linnaeus, *Fannia leucosticta* (Meigen), a species of *Leptocera*, *Sepsis lateralis* Wiedemann, species of Cecidomyiidae, two *Desmometopa* species, a *Sphaerocera* species, a species of the Eristalini, *Chrysomya putoria* (Wiedemann), *Stomoxys calcitrans* (Linnaeus), *Muscina stabulans* (Fallén), *Rhinia apicalis* (Wiedemann), *Fannia albitarsus* Stein and *Ophyra capensis* (Wiedemann). House flies breeding in the manure are predominately *Musca domestica calleva* Walker, the typically outdoor subspecies.

The regularly-occurring non-Dipteran component of the manure fauna was a pseudoscorpion; a spider; mites, including *Macrocheles muscaedomesticae* (Scopoli); several beetles, amongst them two species of *Atholus*, one of *Philonthus*, *Dermestes maculatus* De Geer and *Alphitobius diaperinus* (Panzer); two moths, *Monopis* sp. and *Pyralis farinalis* Linnaeus; the predatory ants *Dorylus helvolus* (Linnaeus) and *Pheidole* sp. and two hymenopteran parasitoids, *Spalangia endius* Walker and *Muscidifurax raptor* Girault & Saunders.

INTRODUCTION

The accumulated manure under the cages in poultry houses provides good conditions for fly breeding. A variety of other insects and arthropods, including potential natural enemies of the flies are also associated with these manure accumulations. A study of this community is in progress and the results of an investigation of the identity and relative importance of the flies, together with notes on the other arthropods, is presented here. The prospects for integrated control of these flies are considered to be good (Weidhaas & Morgan 1977; Axtell 1981) and control by augmentative release of parasitoids is already practised with variable, though promising results elsewhere (Legner 1981; Morgan 1981).

MATERIALS and METHODS

Manure samples from three poultry farms were compared over a five-month period; Farm A in the Albany District (33° 32′ S, 26° 34′ E), Farm B in the Bathurst District (33° 34′ S, 26° 43′ E) and Farm C in the Ciskei (33° 24′ S, 27° 08′ E). Two collections were also made at each of two other farms, Farm D near Port Elizabeth (33°

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54′ S, 25° 09′ E), and Farm E near East London (32° 53′ S, 27° 53′ E). Sampling was later resumed at Farm B for a 22-month period. The distance of the farms from the coast varied from 2 km (Farm C) to 16 km (Farm E). At Farm A insecticide had been applied to the manure until just before the study period but was not used again. Insecticide was not normally used at Farm C, while at Farms B and D, walls or uprights were treated and mist spraying was practised when necessary at Farm E. The manure at Farms A and D was mostly dry, while at the other three farms leakage from drinking water dispensers produced varying, and often considerable, areas of wet manure.

The sampling method chosen takes into account the extremely patchy distribution of the fly larvae and puparia. An outer and an inner row of manure in a single house was selected for sampling at each farm. Manure samples, each of 18 ℓ, were taken with a garden trowel at intervals along the rows from all parts of the manure, half from areas adjacent to wet patches, and half from the drier parts. Puparia, rather than larvae, were collected since they give a better reflection of the expected adult population. Samples were taken every three weeks.

Puparia were extracted from the samples by flotation on water. The floating material was collected, washed on a sieve of 1 mm mesh aperture, dried in an air current and placed in emergence cages. A considerable quantity of floating organic matter was removed with the puparia during flotation, and the heat produced by its fermentation may kill puparia in the closed emergence traps. The trap (Fig. 1) used here holds this material in a thin-walled black polythene bag, suspended so as to give maximal surface exposure to the surrounding air. This together with the muslin panels in the funnel, prevented overheating. Tests showed that, with rare exceptions, the flies moved up into the retaining jar.

The emergent adult flies were identified and counted and notes made on the other arthropods in the manure samples. The house flies were further identified to subspecies, using the paralobus of the male genitalia (Paterson 1964).

RESULTS and DISCUSSION

Species present, their relative abundance and comparison of farms

The fly species that were bred from manure taken from the five poultry farms are listed in Table 1, which also shows their relative abundance and (for Farms A, B and C) the number of times each species was represented in a sample. A few species from the families Psychodidae, Stratiomyidae, Phoridae, Calliphoridae and Sarcophagidae were represented in samples only once or twice and were not included.

The flies included cosmopolitan species such as *Musca domestica* Linnaeus, *Muscina stabulans* (Fallén), *Stomoxys calcitrans* (Linnaeus) and *Fannia canicularis* (Linnaeus). An interesting characteristic of the study area was the very low representation of *F. canicularis* in poultry manure samples although it was plentiful in the nearby homesteads. In North America *F. canicularis* reaches pest proportions in poultry houses (Loomis *et al.* 1968; Legner & Dietrick 1974). *S. calcitrans* also appears to be more numerous in poultry manure in North America (Legner & Olton 1971; Morgan *et al.* 1981) than in the Eastern Cape. All of these species are regarded as important in America (Anderson & Poorbaugh 1964a; Legner *et al.* 1973) and Britain (Conway 1973) although climate affects their occurrence or relative importance in different areas (Legner & Olton 1971). *Ophyra capensis* (Wiedemann) occurs in poultry houses in Brit-

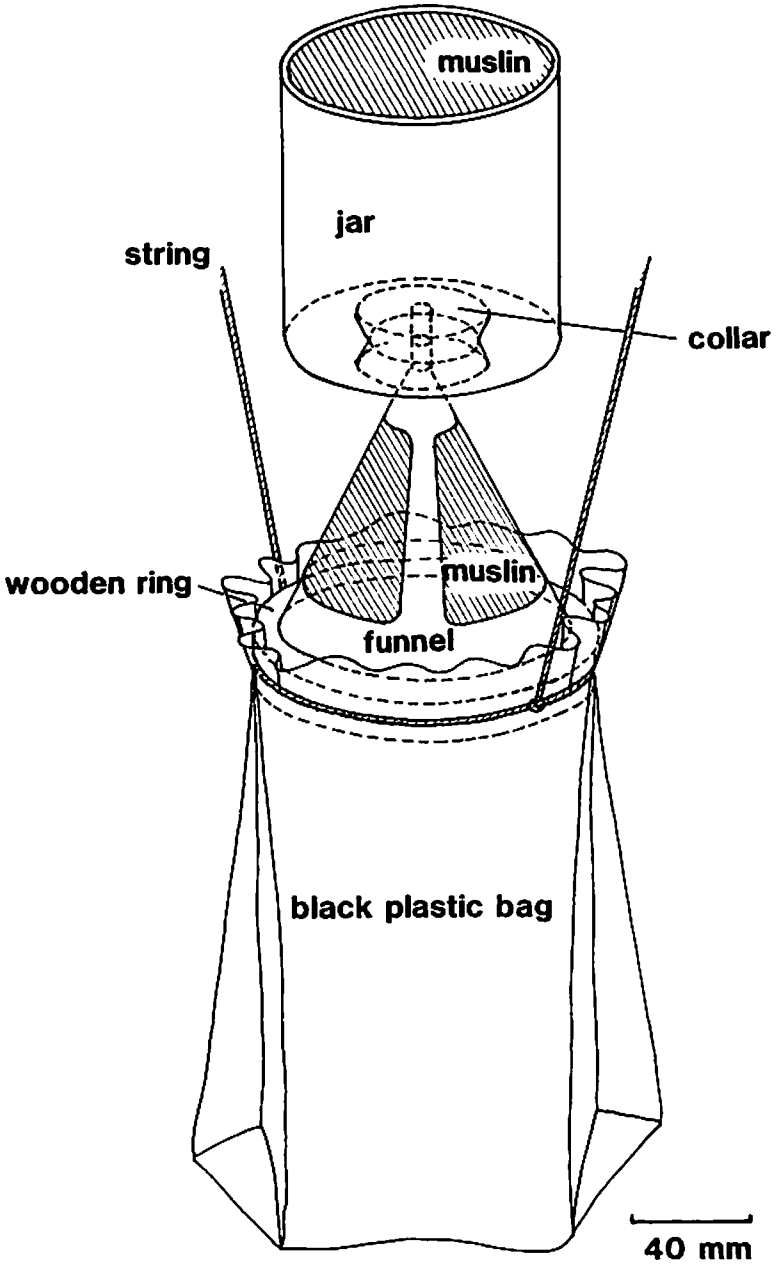

Fig. 1. Emergence cage for dung-breeding flies. The polythene funnel is glued to the wooden ring from which the polythene bag is suspended. An external groove on the wooden ring facilitates the tieing on of the bag. The polythene jar is attached to the funnel by a tightfitting collar of foam plastic.

TABLE 1. Total numbers and incidence of the flies bred from manure at five poultry farms. N = total number from all samples. R = number of times represented in samples.

	Initial five month survey of five farms								Further 22 month survey at		Percentage of total numbers all species
	Farm A[1] N	A[1] R	Farm B[1] N	B[1] R	Farm C[1] N	C[1] R	Farm D[2] N	Farm E[2] N	Farm B[3] N	B[3] R	
CECIDOMYIIDAE	152	4	687	4	41	6	1	0	18	8	7,5
SYRPHIDAE (Eristalini)											
1 species	2	1	12	3	11	4	0	0	601	27	5,3
SEPSIDAE											
Sepsis lateralis Wiedemann	0	0	318	6	106	7	0	28	655	26	9,3
SPHAEROCERIDAE											
Leptocera sp.	26	4	581	5	817	6	100	108	1 324	30	24,8
Sphaerocera sp.	11	3	0	0	21	5	0	5	22	13	0,5
MILICHIIDAE											
Desmometopa spp.	262	6	59	3	2	2	1	37	43	13	3,4
Sp. A	0	0	0	0	0	0	0	0	91	17	0,8
FANNIIDAE											
Fannia leucosticta (Meigan)	28	2	40	6	43	7	59	16	616	30	6,7
Fannia albitarsus Stein	2	1	8	1	2	2	0	0	12	4	0,2
Fannia canicularis (Linnaeus)	0	0	0	0	0	0	0	0	37	7	0,3
MUSCIDAE											
Musca domestica Linnaeus	208	7	383	7	1 379	5	325	323	1 740	29	36,6
Muscina stabulans (Fallén)	0	0	0	0	35	4	0	0	4	1	0,3
Ophyra capensis (Wiedemann)	1	1	2	1	1	1	0	0	106	20	0,9
Helina lucida (Stein)	0	0	0	0	0	0	0	1	32	10	0,3
Stomoxys calcitrans (Linnaeus)	5	3	3	2	0	0	0	2	13	9	0,2
CALLIPHORIDAE											
Rhinia apicalis (Wiedemann)	7	1	0	0	30	2	0	0	117	9	1,3
Chrysomya putoria (Wiedemann)	3	2	3	2	1	1	0	0	192	16	1,7

[1]7 samples taken [2]2 samples taken [3]32 samples taken

ain (Conway 1973) while another species *O. leucostoma* (Wiedemann), is reported from America (Legner *et al.* 1973).

As far as the more numerous species were concerned, the samples from the five farms were very similar (Table 1). When both numbers and representation in samples were taken into account, Cecidomyiidae, *Leptocera* sp., *Fannia leucosticta* (Meigen) and *M. domestica* were amongst the five most abundant species on Farms A, B and C. *Sepsis lateralis* Wiedemann fell into this category on Farms B and C, and *Desmometopa* spp. at Farm A. The two samples from each of Farms D and E showed *Leptocera* sp., *M. domestica*, *F. leucosticta* and *S. lateralis* to be numerous. The apparent paucity of species at these two farms requires confirmation by further sampling.

Differences also occurred between Farms A, B and C. *M. stabulans*, very poorly represented or absent elsewhere, was quite common at Farm C, while *S. lateralis* was not collected at Farm A. The relatively low number of *Leptocera* sp. at Farm C was also striking. These differences cannot yet be explained.

The relative abundance of the various flies breeding in poultry manure in combined samples of Farms A, B and C is shown in Fig. 2. *M. domestica*, *F. leucosticta*, *Leptocera* sp. and *S. lateralis*, the two species of *Desmometopa* taken together and the Cecidomyiidae were most important in terms of both representation in samples and absolute numbers. The Eristalini species and *Sphaerocera* sp. were the next most important. The remaining six species, though too numerous for their presence to be accidental, were less frequently encountered in samples. *F. canicularis*, *Helina lucida* (Stein) and an unidentified Milichiid sp. A, were found in small numbers at Farm B during the second survey, and should perhaps be included in the last group.

The families Sepsidae, Sphaeroceridae and Milichiidae contain species which enter houses, often in large numbers (Oldroyd 1964; Smith 1973). If any of the present species behave in this way they might possibly become important as nuisance flies. *M. domestica* and *M. stabulans* certainly enter houses and *F. leucosticta* may also do so. Numbers and habits make *M. domestica* here, as elsewhere, the major problem fly in this group.

The large numbers of Sepsidae, Spaeroceridae and Milichiidae may also be of importance in reducing the numbers of the serious pest flies if there is competition or some other interaction between the larvae. The larvae of *M. stabulans* are facultative predators of the larvae of other Diptera (Anderson & Poorbaugh 1964b) as are those of *O. capensis* (Conway 1973).

Subspecific status of the house flies

House fly populations in southern Africa consist either of *Musca domestica calleva* Walker, found typically out of doors though in the general vicinity of mans' dwellings or other foci of his activity, and hybrids between this subspecies and *Musca domestica curviforceps* Saccà & Rivosecchi, which, like pure *M. d. curviforceps*, are found inside buildings or in their immediate vicinity. Non-hybrid populations of *M. d. curviforceps* are increasingly rare and are found only in remote areas where *M. d. calleva* does not occur (Hulley 1979).

M. d. calleva and hybrid populations show important differences in behaviour (Hulley 1975, 1979) and it is necessary to characterize those which breed in poultry houses. The use of paralobus value for this purpose is described in Paterson (1964). The paralobus values in samples of male flies from Farms A-E are shown in Table 2.

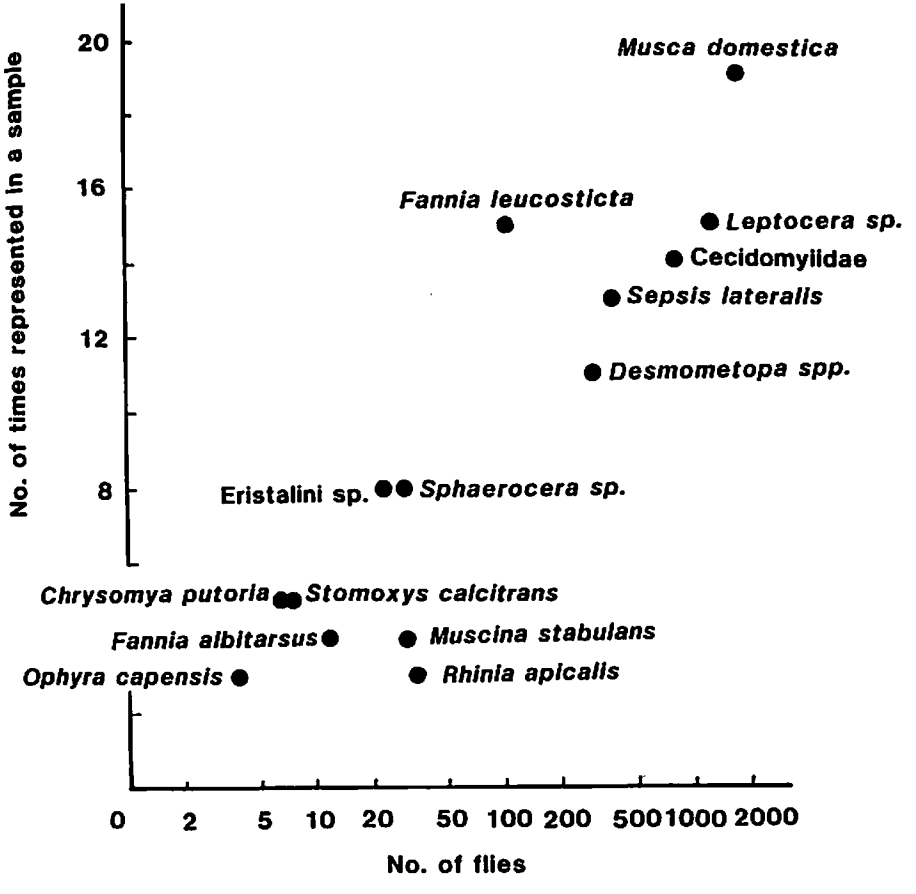

Fig. 2. Total numbers, and representation of flies in seven samples from each of Farms A, B and C.

The distributions of paralobus value of typical samples of each of the subspecies and of their hybrids are also given in Table 2 for comparison.

M. d. calleva populations, rather than hybrid ones, were the dominant breeders in poultry manure in the study area. The paucity of paralobus-5 values in the poultry manure samples indicates that the hybrid populations in the study area may have had a lower proportion of *M. d. curviforceps* genes than those in the example of a hybrid population from Machadodorp. The hybrid element was strongest at Farm C.

TABLE 2. Paralobus values of *Musca domestica* from poultry houses (Paralobus value is an arbitrary score (1–5) assigned to the paralobus of the male genitalia on the basis of shape).

		Frequencies of Paralobus values (%)					
	Date	1	2	3	4	5	N
Farm A.	24.10.78	74	14	4	4	4	50
	14.12.78	78	6	6	6	6	18
	5.4.79	72	11	6	6	6	18
Farm B.	14.12.78	70	20	5	—	5	20
	5.4.79	88	6	2	2	2	50
Farm C.	25.1.79	72	23	4	—	—	47
	4.4.79	60	20	14	6	—	80
Farm D.	2.4.79	84	14	2	—	—	49
Farm E.	7.12.78	97	3	—	—	—	30
	23.4.79	88	2	4	6	—	52
MACHADODORP (25° 41′ S. 30° 15′ E) *Musca domestica calleva* Walker		98	2	—	—	—	50
hybrid domestic population		—	5	27	46	22	41
BHOKWENI (27° 22′ S. 32° 02′ E) (near Jozini, N. Zululand) *Musca domestica curviforceps* Saccà and Rivosecchi		—	—	—	2	98	40

Other arthropods

The commonly occurring arthropods other than Diptera are listed in Table 3. The pseudoscorpion, *Withius kaestneri* (Vachon), was present in all samples, often in great numbers. They were observed eating various flies in emergence cages, but whether this was scavenging or predation is not known. Peck & Anderson (1969) reported the presence of pseudoscorpions in poultry manure in California.

A small linyphiid spider, *Ostearius melanopygius* (Cambridge), was also present in very large numbers at times. No observations have been made on their habits.

Macrocheles muscaedomesticae (Scopoli) and five or six other as yet unidentified mites were regularly present in manure samples. *M. muscaedomesticae* is of potential importance in natural control of houseflies (Willis & Axtell 1968; Axtell 1981).

An unidentified dermapteran was common at Farm E. Legner & Olton (1970) recorded Dermaptera in poultry manure from several parts of the world and suggested that they may be of possible importance in natural control of flies (Legner & Olton 1968).

TABLE 3. Arthropods, other than Diptera, commonly found in poultry manure in the Eastern Cape.

Pseudoscorpionidae
Withius kaestneri (Vachon)

Araneida
Ostearius melanopygius (Cambridge)

Acarina
Macrocheles muscaedomesticae (Scopoli)
4–6 other species not as yet identified

Dermaptera
Unidentified species

Hemiptera
Unidentified heteropteran species

Coleoptera
Coelostoma sp. (Hydrophilidae)
Carcinops troglodytes (Paykull) (Histeridae)
Atholus geminus Erichson (Histeridae)
Atholus rothkirchi Bickhardt (Histeridae)
Philonthus sp. (Staphylinidae)
Dermestes maculatus De Geer (Dermestidae)
Alphitobius diaperinus (Panzer) (Tenebrionidae)
Gnathocerus cornutus (Fabricius) (Tenebrionidae)
Tribolium confusum du Val (Tenebrionidae)

Lepidoptera
Monopis sp. (Tineidae)
Pyralis farinalis Linnaeus (Pyralidae)

Hymenoptera
Spalangia endius Walker (Pteromalidae)
Muscidifurax raptor Girault & Sanders (Pteromalidae)
Pheidole sp. (Formicidae)
Dorylus helvolus (Linnaeus) (Formicidae)

Some beetles in poultry manure are considered important in natural control of flies in the United States of America. These include species of *Philonthus* (Staphylinidae) and *Carcinops* (Histeridae) (Peck & Anderson 1969) found there, and the tenebrionid, *Alphitobius diaperinus* (Panzer) (Legner & Olton 1968). The latter was very common in poultry manure in the Eastern Cape. The presence of two other tenebrionids *Gnathocerus cornutus* (Fabricius) and *Tribolium confusum* du Val is probably explained by the presence of spilled poultry food in the manure. A survey of the Coleoptera and other predators and scavengers in manure on a world wide basis, which includes some collections from Johannesburg, was made by Legner & Olton (1970).

Two species of moth were regularly present in samples. These were a pyralid, *Pyralis farinalis* Linnaeus, very probably associated with the spilled poultry food, and a tineid, a species of *Monopis*, a genus some members at least of which are associated with bird nests and feed on animal fibres (Common 1970; Pinhey 1975). Legner *et al.* (1975) reported the presence of another tineid, *Tinea fuscipunctella* Haworth from poultry manure in California.

The two pteromalid wasp parasitoids of house flies in the study area, *Spalangia endius* Walker and *Muscidifurax raptor* Girault & Sanders, are both species which have been released against house flies in the United States of America, the former having proved most effective there (Morgan *et al.* 1981; Morgan 1981). *Spalangia cameroni* Perkins was not found in the study area.

Two species of ant were regularly present in the manure, *Dorylus helvolus* (Linnaeus) and *Pheidole* sp., both of which might have some effect on the fly fauna. In Hawaii *Pheidole megacephala* Fabricius was reported attacking fly larvae in poultry manure (Illingworth 1923).

It has been calculated that a laying hen produces about 45 kg of wet droppings a year (Axtell 1981). In poultry houses containing high densities of hens, the manure accumulation is accompanied by the prospect of considerable fly breeding. Large numbers of synanthropic flies are an unpleasant nuisance if not controlled and the possibility of the spread of disease in both man and poultry cannot be neglected, especially where installations are, or may become, surrounded by residential areas. The prospect of integrated pest management using natural enemies of the flies is an economically attractive alternative to control by insecticides alone. The variety of arthropods already present in the manure offers promise in this respect, and compares favourably with the reported situation in Britain (Conway 1973) and North America (Illingworth 1923; Anderson 1964) where control by inundative release of wasp parasitoids is already practised. Further prospects for biological control of nuisance flies in dung are considered by Axtell (1981) and other contributors in the same publication.

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CORRECTION: The sphaeroceridae are incorrectly named–*Leptocera* sp. = Coproica spp., and *Sphaerocera* sp. = *Ischiolepta* sp.