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The distribution of five species of flies (Diptera: Muscidae) over the bodies of dairy heifers in England

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Abstract

Five species of Muscidae were found to be commonly associated with dairy heifers in three areas in southern England. The biting flies *Haematobosca stimulans* (Mg.) and *Stomoxys calcitrans* (L.) were relatively rare and fed from the back, flanks and legs. The horn fly, *Haematobia irritans* (L.), was present in highest numbers; it rested on the back and fed on the legs, belly and occasionally on the teats. *Musca autumnalis* Deg. was found mainly on the head and had a restricted season. *Hydrotaea irritans* (Fall.) had a marked diurnal variation in activity, being most abundant in the morning and evening. It was found on the head but predominantly on the belly and teats. When judged by its site preference on cattle, it is the fly most likely to be involved in the transmission of summer mastitis.

Introduction

Several species of Muscidae are found as ectoparasites of cattle. These include the blood-sucking Stomoxyinae and others feeding from secretions and wounds. These flies are consistent in their occurrence on cattle and are present in large numbers during the summer months.

Various of the species found on cattle have been implicated in the transmission of bacterial pathogens. *Musca autumnalis* De Geer is linked with the spread of keratoconjunctivitis (Brown & Adkins, 1972) as is *Hydrotaea irritans* (Fallén). Both *Stomoxys calcitrans* (L.) and *H. irritans* may be implicated in one mode of transmission of ' summer mastitis ', an acute, necrotising infection of the udder especially in non-lactating animals, according to experimental infection (Tarry et al., 1978). Field-caught adults of *H. irritans* have been shown to carry the pathogens involved (Sorensen, 1974; Hillerton et al., 1983).

There is some evidence for a spatial distribution of each species on cattle. In North America, *M. autumnalis* is called the face fly partly because of its own distinctive face but also because it occurs mostly on the head of cattle, thus acting as a feeding distractant. *Haematobia irritans* (L.), the horn fly, occurs no longer around horns as they are absent from most commercial breeds of cattle, but on the backs of animals. *Haematobosca stimulans* (Meigen) is the remaining biting muscid found on cattle in Britain.

The predominant species of flies, their abundance and their distribution over the body of dairy heifers were investigated on three sites in southern England during 1982 with the aim of discovering any reasons for suspecting or rejecting the possible roles of these species in the transmission of summer mastitis.

Materials and methods

Three herds of in-calf heifers, on farms in Berkshire (National Institute for Research in Dairying), Wiltshire and Dorset, were monitored regularly during July, August and September 1982. The heifers were maintained on permanent pastures remote from farm buildings. Flies were counted on each of five parts of the body of ten heifers selected at random from each herd. Counts were made for only one side of each animal on each of several observations made in the summer of 1982.

Flies were caught for identification in hand-nets around the head, back and along the belly and legs of heifers. Subsequent to the identification of the different species of flies on or near the heifers, it was found to be relatively easy to identify them from 2–3 m, the distance at which they were counted. Difficulties were experienced only during twilight and for flies on the underside of the animal at other times of poor light.

Weather data was recorded using portable equipment loaned by the Meteorological Office, as frequently as fly counts were made. A permanent weather record was also made from a station set up at the Berkshire site. Temperature, relative humidity, wind speed, wind direction and a general weather description were recorded at each site. At the Berkshire site, maximum and minimum temperatures were recorded in addition.

Results

The general distribution of flies on the cattle observed was similar for all three sites. However, the total numbers found at each time of the day when counts were made varied over the summer for all sites (Fig. 1). This was a consequence of the life-cycles of the species involved, the management of the cattle and the weather. The heifers on the Wiltshire site were moved in early August to a different pasture and immediately had a lower fly load. A similar movement of the Dorset herd was made, and in addition, counts made for the Dorset herd on 19 August took place in heavy rain. The cattle at the Berkshire site were not interfered with in

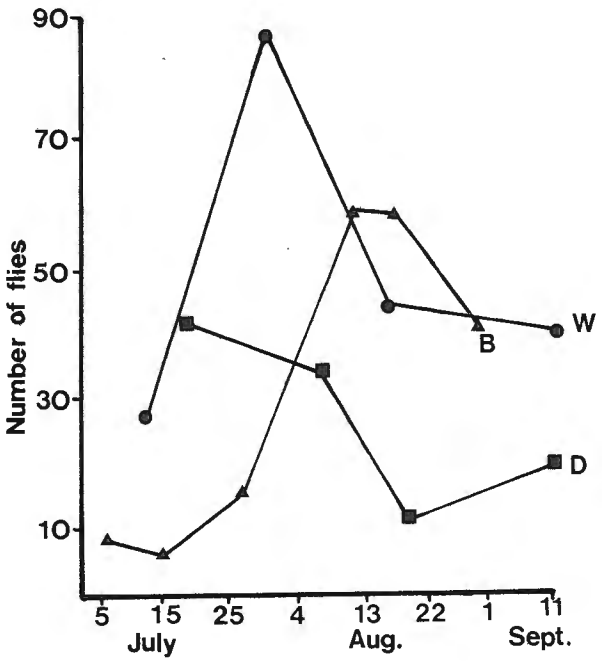

Fig. 1.—Variations in total fly numbers at 19.00 h per half animal for all three sites over the summer of 1982. (B, Berkshire site; D, Dorset site; W, Wiltshire site.)

any way, and most fly counts were made in similar weather conditions. It seems possible that, but for the above changes, the fly numbers at the Wiltshire and Dorset sites would have peaked sometime in August like the numbers at the Berkshire site. Observations on other sites have supported this.

As well as varying over the summer, the fly numbers varied considerably over the daylight hours. Typical diurnal variation is shown in Fig. 2. Numbers tended to be highest in the early morning and in the evening. At various times during the investigations, flies were caught for identification and other examinations. When caught during the morning, the flies were invariably wet, and often drowned, because of dew. Having found that the results in the morning were typically as shown in Fig. 2, all subsequent counting and fly capture took place in the latter half of the day.

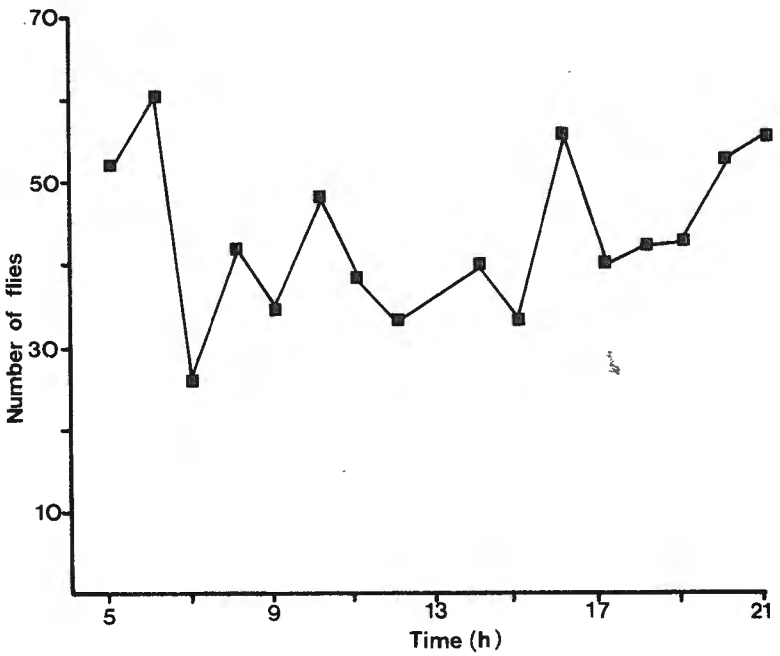

Fig. 2.—Variation in total fly numbers per half animal over the daylight hours on 19 July 1982 at the Dorset site.

The variation in total fly numbers over the season and over the day was the product of several factors. The peak numbers of individual species varied in both cases. *M. autumnalis* was found consistently on the head of animals, infrequently on the flanks and nowhere else, from mid-morning until late afternoon. There is probably a minimum temperature and other weather conditions necessary for *M. autumnalis* to fly but no data are available. The level of *M. autumnalis* challenge on the Berkshire site at 15.00 h when these flies were consistently around the cattle is shown in Table I. In the middle of August, the numbers dropped sharply, even though the temperature, relative humidity and general weather of the day were similar to those on the days of relative abundance in July. This may be a consequence of four consecutive nights with a minimum temperature of 4°C or lower on 13–16 August. The numbers of *M. autumnalis* did not recover, even though the weather improved considerably towards the end of August. The relative numbers of the other fly species found did not show this pattern.

H. stimulans was present in very small numbers only and was not found at all at the Wiltshire site. When it did occur, it was found only on the back or flanks of the heifers.

S. calcitrans showed a daily occurrence pattern like that of *M. autumnalis*, but it was

TABLE I. *Mean number of* Musca autumnalis *adults counted on one side of the face of ten heifers at the Berkshire site at 15.00 h*

Date	No. of flies	Weather	Temp. (°C)	Relative humidity (%)
15 July	2·1	Dull	19·4	78
26 July	2·3	Bright	19·8	65
27 July	3·8	Bright	17·9	51
14 August	0·4	Bright	19·0	56
16 August	0·8	Rain	18·7	66
20 August	0·5	Bright	16·8	63
29 August	0	Sunny	21·0	48

commonest in August. Small numbers fed during the afternoon and early evening on the flanks and legs. The numbers found on heifers were relatively small, possibly because of the remoteness of the cattle from farm buildings, but probably because they feed for only a short time and do not alight on cattle at other times. Large numbers of this species were seen all through the day sunning themselves on rocks and fence posts adjacent to the cattle.

Overall, *Haematobia irritans* was present most uniformly and in the largest numbers; as many as 300 adults were found on the back of a heifer in counts at hourly intervals for part of the day (Table II). The mean numbers were much lower because although some animals had extremely high fly loads, other heifers, even the next animal standing in direct contact, might have few or no flies at all. Also, during the next count, the fly load of any individual heifer might be entirely different. The reasons for these fluctuations are unknown.

TABLE II. *Mean numbers per half animal and range of* Haematobia irritans *on the backs of ten heifers at hourly intervals for part of the day at the Wiltshire site on 2 August 1982*

Time (h)	*Haematobia irritans*		Others*	
	Mean	Range	Mean	Range
14.30	40·6	1–134	1·0	0–4
15.30	35·1	2–83	0·2	0–1
16.30	28·2	2–57	0·4	0–2
17.30	41·8	10–120	0	—
18.30	45·5	15–170	0	—
19.30	60·1	19–160	0	—
20.30	42·2	13–65	0	—

* *Musca autumnalis* and *Stomoxys calcitrans*.

Variations in the numbers of *Haematobia* on the back of a heifer at any one time depend on the behaviour of the host and of the flies. The flies normally rested on the backs but fed on the underside of the animals. Feeding flies were most obvious when heifers were lying down, when large numbers could be seen along the mid-line of the belly and on the hair-lines and margins of the udder. When the cattle stood up, the flies took off in a cloud and alighted on the back of the animal. *Haematobia* adults left the cattle to oviposit in dung or to shelter during inclement weather or overnight. Not all left overnight however, as observation by torchlight at midnight revealed a few flies still on the backs of cattle.

When the cattle were standing, most *Haematobia* adults were on the back, but a small proportion (maybe 5–10%) might be found along the mid-line of the belly (Table III).

TABLE III. *Mean numbers per half animal of five fly species on five sites of the body of ten heifers at the Dorset site at 14.30 h on 9 August 1982* *

Species	Head	Back	Legs	Belly	Udder
Haematobia irritans	—	44·5	—	3·5	—
Musca autumnalis	3·6	0·2	—	—	—
Haematobosca stimulans	—	—	—	—	—
Stomoxys calcitrans	—	2·5	1·6	—	—
Hydrotaea irritans	1.6	—	—	12·8	1·4

* The weather was sunny, the temperature 20·4°C, the relative humidity 63%, and the wind speed 3·8 m/s.

Haematobia adults were observed feeding on the teats only very rarely, and at no time were any other biting flies found feeding on the teats.

Hydrotaea irritans was the species most closely associated with the underside of cattle and especially with the teats (Table III). Early in July, a very few males of *Hydrotaea irritans* were caught from cattle in the one observation then. Only females were caught and counted from mid-July onwards so all references to the occurrence and distribution of *Hydrotaea* are to females. A few *Hydrotaea* females were commonly found feeding from secretions on the head; this number increased in late August and September when the numbers of this species were highest and no *M. autumnalis* adults were around. Most *Hydrotaea* adults were found along the mid-line of the belly associated with *Haematobia*. The greatest concentration of flies was found on that region just anterior to the udder which is often pendulous, fatty or fluid-filled just prior to calving. From this region, the *Hydrotaea* females often moved to the teats. They were observed both on the teat ends and sides, and no marked preference for any part was noticed.

The total number of flies found on the belly of heifers varied over the day, being highest in the morning and evening (Table IV). This can be seen to be mostly due to a variation in the numbers of *Hydrotaea*. Normally, all the flies found on the teats were *Hydrotaea* and no *Haematobia* adults were found on teats during counts, although their numbers varied considerably (Table IV). Early in the morning and in the evening at the times of high fly numbers alighting on the animals, there was always a conspicuous swarm of *Hydrotaea* around the cattle and the observer also attracted this species.

TABLE IV. *Mean numbers of* Haematobia irritans *and* Hydrotaea irritans *observed on the belly and teats of ten heifers over the daylight hours of 19 July 1982 at the Dorset site*

Time (h)	Belly			Teats
	Haematobia	*Hydrotaea*	Total	*Hydrotaea*
05.00	—*	—*	13·1*	2·2
06.00	10·6	15·0	25·6	4·9
07.00	3·8	5·5	9·3	2·6
08·00	5·4	6·7	12·1	3·2
09.00	4·2	4·9	9·1	0·3
10.00	5·3	8·5	13·8	1·4
11.00	1·2	11·7	13·9	0·2
12.00	4·3	6·6	10·9	0·9
13.00	no observation made			
14.00	2·8	9·6	12·4	0·6
15.00	2·6	10·3	12·9	0·3
16.00	1·8	13·0	14·8	1·3
17.00	2·4	9·6	12·0	0·4
18.00	—†	—†	20·4†	0
19.00	3·5	13·7	17·2	4·1
20.00	—*	—*	20·3*	7·6
21.00	—*	—*	31·5*	2·8

* Light too poor to distinguish species.
† All animals lying down and flies in one clump so species could not be distinguished.

Discussion

Various insects have a more or less close relationship with cattle. This relationship and the species involved varies with the type of cattle, their environment, season of the year, time of day and probably many other factors. The main interest of the authors is the relationship between flies which may transmit bacterial pathogens, especially those responsible for summer mastitis, to cattle. Therefore, the distribution of Muscidae on cattle was examined over the part of the summer when the disease is most prevalent. Heifers were used as they are the most commonly affected group of cattle and often no fly control measures are used on them. Various pathogens have been shown to be carried by wild-caught flies (Brown & Adkins, 1972; Sorensen, 1974; Hillerton et al., 1983). It is important to know which flies to examine to look for pathogens. For any particular disease, this will depend on when the flies are close to or feeding on cattle, which species visit the relevant sites on sub-clinically or

clinically infected cattle and whether the flies subsequently visit the relevant sites on uninfected cattle whilst they still carry the pathogens.

The peak incidence of summer mastitis is in August, with cases also occurring in July and September. Those flies found during this period and associated with the teats are those most likely to be involved in the transmission of the pathogens.

The results shown here indicate that *M. autumnalis* is unlikely to be involved as it does not visit the underside of cattle and, in the last season, very few individuals were found on cattle when the disease incidence was highest. The latter finding is surprising as this is the ' autumn ' fly, so this may not be a typical result. This species is also restricted in its geographical location, being confined in Britain to the south. In the north, its niche is filled by one or more other species (Titchener et al., 1981).

Haematobosca stimulans and *S. calcitrans* can probably also be dismissed from involvement as they were not observed feeding near teats. *H. stimulans* has a limited geographical range in Britain, being found rarely in the south (it was not found at all at the Wiltshire site), but it is more prevalent in the north (Titchener et al., 1981) where it replaces *Haematobia irritans* as the commonest biting fly. It is not known whether it feeds under cattle on the belly or teats when its numbers are greater.

S. calcitrans may frequently be seen on the teats of animals, especially lactating cattle, near farm buildings. When it was found on or near heifers, it was never observed feeding from the teats. Also, it has a limited geographical range, similar to those of *M. autumnalis* and *Haematobia irritans*.

Haematobia irritans is very common on dairy cattle in the south of Britain, and may become detrimental to the health of the animals (Parsons, 1977). High loads certainly restrict weight gain in beef cattle in the USA, not by blood loss but by general irritation (Palmer & Bay, 1981). On dairy cattle, their detraction from the well-being of the host will normally be due to the local trauma they cause and primary damage from blood-sucking. It is possible that much other primary damage results from insects such as midges and mosquitoes but as yet no-one has reported this. During the present studies, biting flies such as tabanids (*Haematopota* and *Tabanus*) were very uncommon.

It is most probable, as previously suggested by Tarry (1979), that *Hydrotaea irritans* is a fly which will profit by feeding from primary damage sites. As it can carry the pathogens responsible for summer mastitis, it occurs at the correct time of year and it visits the site of infection, the circumstantial evidence for its involvement in the transmission of summer mastitis is strong. *Hydrotaea irritans* is also the only ' cattle ' fly common to the whole of Britain, and so, uniquely, it occurs in all those areas of Britain where summer mastitis occurs. This fly and the disease are uniquely co-incident in northern Europe also.

The aetiology of summer mastitis is not understood. Here, it has been shown that the behaviour of *Hydrotaea irritans* is consistent with it being involved. The primary damage, possibly caused by other flies, would need to occur at or before the time of its activity around cattle; although *Hydrotaea* could be the only cause of damage. The increases in *Hydrotaea* activity might be related to an increase of attractiveness resulting from primary damage. More information on the primary damage and the attractiveness of cattle to *Hydrotaea* is needed.

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