

**Biological and cultural fly control options for organic dairies:
a project report to CERES Trust, 9 October, 2011.**

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It has long been known that stable fly (*Stomoxys calcitrans*) and house fly (*Musca domestica*) can spread bacteria and reduce dairy farm profits (Lissant-Cox et. al 1912, Freeborn et. al 1925, Taylor et al 2011). On organic dairies, waste disposal is the main fly control option, but time and labor are costly. It would help to know where filth fly maggots develop, so cleanup could be targeted most effectively. Filth flies develop in moist decaying organic material such as manure packs and spilled feed, and readily colonize soiled bedding in calf hutches (Schmidtmann 1988, Stafford 2008). Surveys in New York, Illinois and Nebraska indicated calf hutches were a primary source of filth flies on dairies (Meyer and Petersen 1983, Smith and Rutz 1991, Olbrich 2003). If true, calf bedding might be better managed to prevent fly production.

An additional option for fly control on organic dairies is biological control with beneficial parasitic wasps. Many species of non-pest wasps search for and kill fly pupae, the fly life stage after the maggot (Geden et. al 1992, Skovgard and Nachman 2004). The developing wasps feed on host fly pupae, which occur within a pupal case, called a puparium. Olbrich and King (2003) found that different kinds of wasps attacked different kinds of flies on one dairy farm in Illinois, and different kinds of wasps occurred in different locations on the farm.

Our project proposal included two objectives: Objective 1 was to survey organic dairies to determine what kinds of beneficial wasps occur naturally in the region. To learn more about the fly sources and kinds of wasps that occur in Minnesota and Wisconsin, we surveyed six organic dairies in July and August 2010 to determine (1) which kinds of organic debris substrates contain developing filth flies, (2) which species of filth flies occur in those substrates, and (3) what kinds of naturally occurring beneficial wasps were active in those substrates. This report summarizes our principal findings for this objective.

Objective 2 was to augment an independently funded project to determine why beneficial wasps in the genus *Spalangia* attack more filth flies in straw than in other bedding materials.

Unfortunately, designed experiments could not be completed, because of unforeseen difficulties in obtaining sufficient numbers of wasps, so no progress could be made on the second objective.

Materials and Methods. Six Organic Valley Co-op members were surveyed in 2010. Members were approached and asked if they would be willing to allow their farm to be sampled, and three were chosen in east-central MN and three others were in west-central WI. Individual farms were visited for a full day in late July or August. Each farmer gave us a brief walking tour of the farm, and follow-up scouting was used to identify locations where flies could be developing. Six kinds of sites were found on each farm: calf housing (hutches and pens), cow loafing areas, barnyard edges, spilled feed, manure piles or lagoon edges, and debris around hay bale feeders.

Organic debris from each kind of site was excavated with trowels and then immersed in water to float intact fly puparia to the surface. Up to 300–500 pupae from each substrate were returned to the lab to rear out and identify adult flies and beneficial wasps that emerged from the puparia within six weeks. Puparia from which nothing emerged were disregarded. Counts of flies and wasps were then analyzed to determine where flies and fly-killing wasps were most abundant.

Results. Viable filth fly pupae were found in calf pens on 100% of the six farms, in cow loafing areas on 83%, in barnyard edges on 67% , and in feed piles, margins of manure piles and lagoons, and hay bale feeders on 33% of the farms. Clearly, calf pens were most likely to be sources of stable flies and house flies.

A total of eight kinds of flies were reared from pupae from all farms combined, and five of them are illustrated in Figure 1. Stable flies and house flies represented 94% of the total (1,164 pupae). These two filth flies were most commonly collected from calf housing and edges of loafing areas, and less frequently in the four other kinds of debris sites. Other, less abundant flies were *Lespi nasoni*, black garbage fly (*Hydrotea aeneceus*), *Physiphora* sp. and an undetermined kind of sepsid gnat. These other flies are not pests of cattle and people, and they may help by decomposing the debris or eating pest fly maggots. Our results confirm that calf housing is an important source of stable flies and house flies on organic dairies, and support the idea that control of pest flies might be improved if bedding in calf housing were managed in ways to prevent fly development.

Nine different kinds of fly killing wasps were reared from the different kinds of flies, and four of the common ones are illustrated in Figure 1. In descending order of abundance, the wasps were *Spalangia* spp. (*S. endius*, *S. cameroni*, *S. nigroaenea*, and *S. nigra*), *Muscidifurax* spp. (*M. raptor*, *M. zaraptor*, and *M. raptorellus*) and *Urolepis rufipes*, all in the family Pteromalidae, and *Phygadeuon* sp. in the family Ichneumonidae. Note that “spp.” means multiple species, and “sp.” means one species undetermined.

We analyzed how many of the pest flies were killed by the different kinds of wasps (Table 1). Adult flies emerged from approximately one half to two thirds of the stable fly and house fly pupae, whereas the remaining 30 to 48 percent were killed by wasps. *Spalangia* spp. killed far more of both kinds of flies than did *Muscidifurax* spp. and the remaining species combined.

We also compared levels of wasp activity in the different kinds of fly breeding sites. Of the stable flies in different substrates, wasps killed 97% along manure pile and lagoon edges, 80% along loafing area edges, and 76% in calf housing. Of house flies, wasps killed 75% along manure pile and lagoon edges, 56% in calf housing, and 51% in loafing area edges. Levels of wasp activity in the remaining habitats were relatively lower.

Discussion. Stable flies and house flies were most abundant in soiled calf bedding, making young calf housing a major source of flies on all six farms in July-August, 2010. If possible, young calf housing should be cleaned once a week, and soiled material should be composted or spread thinly to prevent flies from completing their life cycle during the summer. Edges of loafing areas (occupied the previous winter) were also a major source of flies, so those sites should be cleaned up before the fly breeding season commences. In contrast, debris around barnyard edges and margins of manure piles and lagoons were not as productive, in part because levels of wasp activity were greater in those areas. These findings suggest that barnyard edges and pile and lagoon margins may be serving as reservoirs for naturally occurring beneficial wasps on the farms. More research in additional years and at more farms in the North Central region will be needed to more fully understand how dairy managers can use labor for sanitation more effectively to help control fly populations on their farms.

Information produced from this project. The data from this project were presented in a poster at the Midwest Organic and Sustainable Education Service (MOSES) conference in La Cross, WI, February 2011, and will also be presented in greater detail in Chapter II of Jessica Starcevich's Master of Science in Entomology thesis, University of Minnesota.

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Table 1. Numbers of intact fly puparia of different kinds obtained from six organic dairies in Minnesota and Wisconsin, 2010, and their fates as percentages (%) of totals of each kind. Percentages in rows may not add to 100 due to rounding.

Kind of fly	No. pupae collected	Adult fly	Kind of fly killing wasp		
			<i>Spalangia</i> spp.	<i>Muscidifurax</i> spp.	Other
Stable fly	654	69	29	1	0.3
House fly	402	52	43	5	0
Others	108	83	10	0	6
Total	1,164				

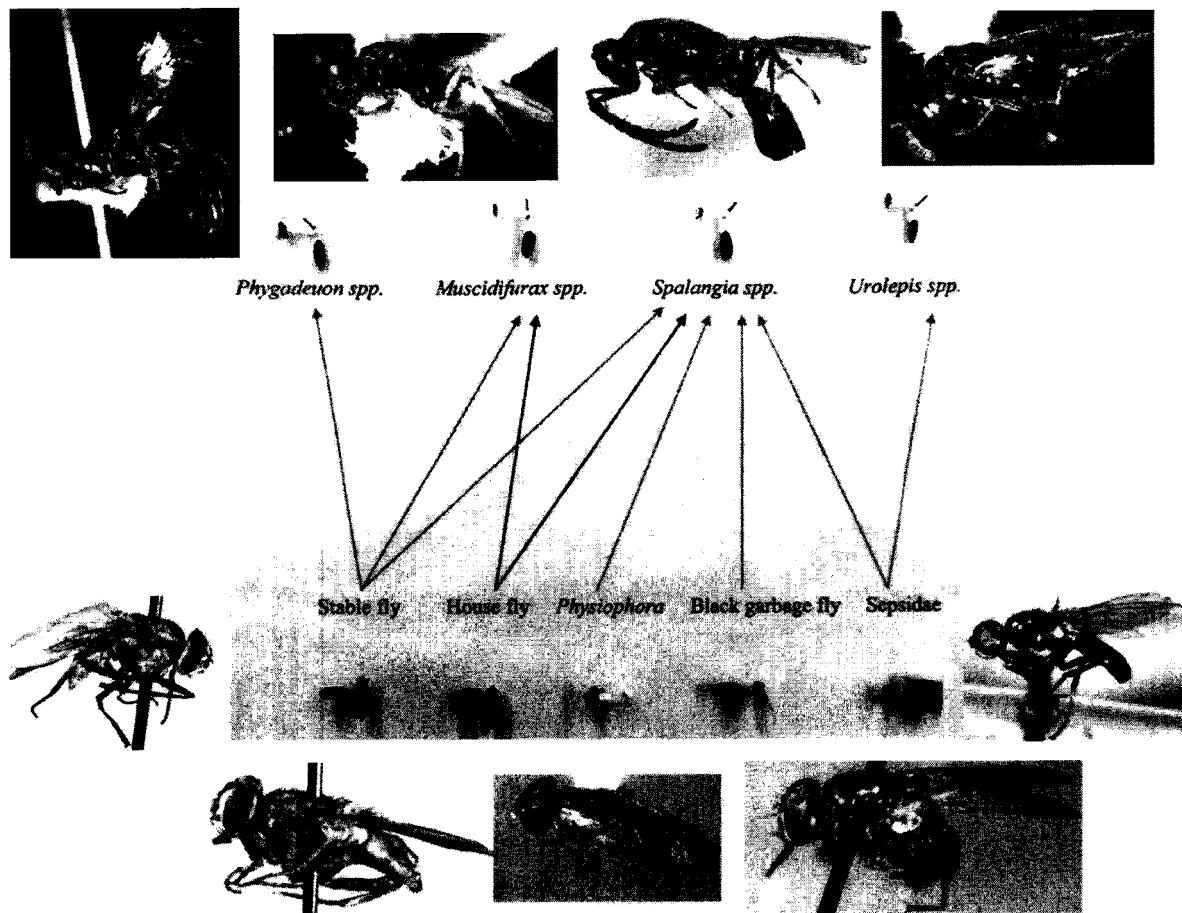


Figure 1. Close-up photographs of the principal filth flies (bottom row) and associated fly killing wasps (top row) obtained in surveys of six Organic Valley dairies in Minnesota and Wisconsin, 2010. Names in center diagram correspond with photographs, and arrows indicate which kinds of wasps were reared from puparia of the different kinds of flies. Specimens above or below names show actual sizes of puparia and corresponding fly or parasite that emerged from them.