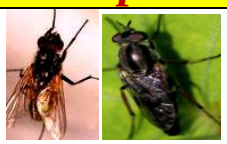
Management of flies and maggots

These pests include:

	House flies, soldier flies and other non-biting flies can and often do become a problem in poultry buildings. They do not bite or feed on the pet animals or humans but may carry pathogens because of their habit of feeding on kitchen waste, dead birds and other waste materials.		**MEALWORM BEETLE**
	**ANTS** Argentine ant, carpenter ant, fire ant, odorous house ant, pavement ant, pharaoh ant, pine tree ant, thief ant, velvety tree ant		**MOLES**
	**CARPET BEETLES** fur beetle, varied carpet beetle		**OPOSSUMS**
	**FIREBRATS**		**RACCOONS**
	**FLEA**		**RED SPIDERS**
	**FLIES**		**SPIDER BEETLE**
	**FRUIT FLIES** blue bottle fly, green bottle fly, house fly		**WOODLOUSE**
	**HORNET**		**WASP**
	**WOOLLY BEAR**		**WOODWORMS** Death watch beetle, furniture beetle
	**Bedbugs** The common bedbug and several other closely related insects feed on poultry. They are flat, wingless, bloodsucking insects about 1/5 inch long when fully grown and have a very distinctive pungent odor when crushed. Bedbugs feed at night, hiding and laying eggs behind insulation, in wall cracks, loose boards, nests and other dark areas during the day. At night they move to sleeping birds and suck their blood. Small, dark fecal dots around cracks, roosts, and on eggs are observed frequently. Bedbugs can be carried into houses by pet animals and birds; they also can become a pest of people. Control must be directed inside the houses, using the materials suggested for residual fly control		**WEEVIL** Kitchen waste is an excellent development material for fly larvae. Flies and odor coming from poorly managed buildings will be a menace.

Fly Control

- House flies are the most persistent and common pest, although other species such as blow flies and little house flies are present.
- House flies do not bite humans, but are severe nuisances, and can spread some diseases.
- House flies are present because of kitchen waste, unkempt sinks, food spilled over the carpets etc., which are ideal breeding materials.
- Floor management is most important for house fly reduction.
- Chemical controls are valuable, but should be considered secondary to waste management practices.

Effective and economical fly control depends on:

- Good sanitation practices to remove fly breeding areas,
- Proper use of insecticides to kill adult flies,
- Treatment of floor, sinks, drains with an insecticide to control flies and maggots if needed, and
- Good management practices throughout the year, especially in controlled environment buildings.
- The first, most important step in fly control is prompt and regular removal of waste material where flies breed.
- Flies lay eggs on wet, decaying material.
- This includes kitchen waste, Garden waste, spilled food, unkempt sinks, ill maintained drains, droppings of insects and animals.
- The maggots that hatch from these eggs cannot develop in any dry materials.
- Keep floor, sinks dry.
- Repair water leaks, both in water supply lines and building roofs.
- Soldier fly infestations usually start around the outside of open buildings where rain and snow have blown onto the organic waste and made it wet.
- If good sanitation practices are followed, less insecticide will be needed and that used will be more effective.

CURRENT PRACTICES OF FLY CONTROL

- Acceptable fly control in houses requires strict attention to sanitation and manure management, supplemented with the use of insecticides as baits, residual sprays and spot treatment of manure for maggot control.
- **Baits** consist of an insecticide and an attractant, which serves to draw flies to the insecticide.
- Start spreading the bait as soon as flies begin to be numerous.
- Place bait where flies congregate during the day — window ledges, doorways, on the floor between cages, etc.
- During the first four or five days, scatter **dry bait** heavily enough that it can be seen.
- Continue to put out bait each day for the next week, using smaller amounts than for the first application.
- After the first 10 days, apply bait every two to four days to those places where the most flies were killed during the initial baiting.
- To make **liquid bait**, mix the proper amount of insecticide with water and add sugar, corn syrup or molasses.
- Follow the directions on the container label.
- Use a sprinkling can to spread the bait on the floor.
- On a dirt floor or where the floor is dirty, apply the bait on pieces of burlap, cardboard, etc.
- Apply new, fresh bait every two to four days.
- Continue to use bait regularly during the summer.
- Don't stop as soon as fly numbers are knocked down.
- If you do and the numbers build up, you will have to start all over again with the heavy initial baiting.

- **Residual sprays** leave a deposit of insecticide that the fly contacts when it lands on the treated surface.
- Residual sprays will remain effective for a few days up to several weeks.
- Apply the first spray around doors and windows, walls, ceilings and rafters in late spring or early summer as soon as flies begin to be a problem.
- Repeat applications as needed.
- Apply 1 gallon of spray per 500 to 1,000 square feet of surface.
- On unfinished wood, brick or concrete surfaces, wettable powder formulations will give longer lasting control than emulsifiable concentrates.

***Entomophthora muscae* complex.**

- Adult house flies are susceptible to infection with the fungal pathogens *Entomophthora muscae* and *E. schizophorae*, which typically kill the flies 4-6 days after exposure to conidia.
- Flies become infected when exposed to conidia discharged from cadavers of infected flies.
- The intensity and duration of conidial discharge and the survival of conidia depends on temperature and relative humidity (Mullens and Rodriguez, 1985; Krasnoff *et al.*, 1995; Six and Mullens, 1996; Madeira, 1998; Kalsbeek *et al*., 2001a).
- Natural epizootics are common in the fall months in temperate regions, with infection rates commonly exceeding 50% (Mullens *et al*., 1987b; Watson and Petersen, 1993; Steinkraus *et al*., 1993; Six and Mullens, 1996).
- Although *E. muscae* is an important natural regulator of fly populations; it remains unclear whether this pathogen can be manipulated as a biopesticide.
- Mass-rearing methods have been developed to produce large numbers of infected flies and field releases of *E. muscae* and *E. schizophorae* have resulted in increased disease prevalence (Kramer and Steinkraus, 1987; Steinkraus *et al*., 1993; Geden *et al*., 1993; Six and Mullens, 1996).
- The impact of releases on fly control may be dampened by the need for high fly populations to sustain epizootics (Geden *et al*., 1993) and by the ability of the flies to mitigate the effects of infection by resting in warm areas to raise their body temperature (behavioral fever) (Kalsbeek *et al*., 2001b; Watson *et al*., 1993).

***Beauveria* and *Metarhizium*.**

- Field populations of house flies and stable flies usually have low rates of infection with *B. bassiana* and *M. anisopliae* (Steinkraus *et al*., 1990; Skovgaard and Steenberg, 2002).
- In laboratory bioassays, larval and adult flies are highly susceptible to these entomopathogens.
- Virulence varies widely depending on strain and formulation, and adult house flies are particularly susceptible to sugar baits with *B. bassiana* conidia (Kuramoto and Shimazu, 1992; Geden *et al*., 1995; Watson *et al*., 1995; Darwish and Zayed, 2002; Lecuona *et al*., 2005).
- Laboratory and field data indicate that use of entomopathogenic fungi is compatible with other natural enemies including *C. pumilio* and the parasitoids *Spalangia cameroni* and *Muscidifurax raptor* (Geden *et al*., 1995; Kaufman *et al*., 2005; Nielsen *et al*., 2005).
- Although much of the research in this area has concentrated on *B. bassiana*, some strains of *M.anisopliae* have been demonstrated to have superior performance against both adult and larval house flies (Mishra *et al*., 2011).
- Data on efficacy under field conditions are limited but encouraging.
- Watson *et al*. (1996) applied *B. bassiana* to the inside walls of calf hutches and observed up to 47% infection among house flies in the treated hutches.
- Kaufman *et al*. (2005) found that space sprays with *B.bassiana* in poultry houses provided fly control comparable to that observed in houses treated with pyrethrin.
- Three weekly aerosol conidial applications in Venezuelan poultry sheds provided 100% control of adult flies, although fly populations recovered quickly once treatments were stopped (Cova *et al*., 2009a,b).

- *B. bassiana* is commercially produced for fly control in the US under the trade name BalEnce (http://www.terregena.com).
- One disadvantage of *B. bassiana* and *M. anisopliae* is the rather long time that is required to kill the host, typically 4-6 days. However, a recent comparison of 34 strains identified several with LT50's of less than 24 hours (Mwamburi *et al*. 2011a). Such rapid kill rates would place *B. bassiana* biopesticides in a more competitive position relative to conventional chemical insecticides.
- Further increases in kill rates could be achieved by genetic modification of the pathogen to accelerate cuticular penetration. The potential for this approach was demonstrated by Fan *et al*. (2010), who fused a *Bombyx mori* chitinase to a protease in *B. bassiana*.
- The chimeric pathogen was substantially more virulent than the wild-type, presumably because of improved binding and delivery of proteases to the target cuticle.
- This is an exciting development that could lead to significant improvements in efficacy of biopesticides based on this agent.

Bacteria

- Early work with *Bacillus thuringensis* against filth flies was encouraging.
- For instance, considerable maggot control was achieved by feeding *Bt* spore formulations to cattle and chickens and thereby delivering the bacteria to fly breeding sites in manure (Burns *et al*., 1961; Miller *et al*., 1971).
- Promising results were also obtained by mixing *Bt* directly with fly breeding substrates (Rupes *et al*., 1987).
- In these early studies, exotoxin-producing *Bt* strains were used, and flies were more susceptible than most other insect orders to the exotoxin (Carlberg, 1986).
- However, resistance to exotoxins developed quickly in house flies that were already resistant to chemical insecticides (Harvey and Howell, 1965; Wilson and Burns, 1968).
- Moreover, safety concerns over vertebrate toxicity led to a prohibition on the use of exotoxin-containing *Bt* products in the US in the mid 1980's (McClintock *et al*., 1995; Tsai *et al*., 2003).
- When the focus shifted to *Bt* strains that do not produce beta-exotoxins the results with flies were often disappointing, possibly because the discovery process favored strains producing delta-endotoxins with high activity against Lepidoptera (Al-Azawi and Jabbr, 1989; Lonc *et al*., 1991; Sims, 1997).
- Indrasith *et al*. (1992) identified several strains with good activity against adult house flies.
- Subsequently, Johnson *et al*. (1998) identified other strains with activity against house flies and determined that the endotoxin Cry1B was found in all the *Musca domestica*-active strains.
- The Cry1B endotoxin may be the key item in the activity of these strains for higher flies (Zhong *et al*., 2000; Lysyk *et al*., 2010).

Botanicals

- Essential oils are generally known to have fumigant insecticidal properties, and the mode of action may involve elements of acetylcholinesterese inhibition and octopaminergic effects (Isman, 2000).
- Additional effects can be seen in behavior modification (attraction/repellency) and contact toxicity for different life stages (Koul *et al*., 2008).
- Natural oils are complexes of many biologically active constituents including terpenes, acyclic monoterpene alcohols, monocyclic alcohols, aliphatic aldehydes, aromatic phenols, monocyclic ketones, bicyclic monoterpenic ketones, acids, and esters (Koul *et al*., 2008).
- The composition of oils from a particular plant species can be affected by the plant tissues extracted, cultivar variation, climatic and growth conditions, and the methods used for extraction and analysis.
- For this reason, there have been considerable efforts to examine the effects of individual components that are common to those essential oils known to have insecticidal properties (Isman, 2000; Koul *et al*., 2008).

- Preparations of plant materials have long been used to kill or repel flies.
- Over 100 years ago, Howard (1911) described a method for making a fly adulticide from quassia (*Quassia amara*) wood that he had seen in "old dispensaries".
- He also pointed out that "the butchers in Geneva have from time immemorial prevented flies from approaching… by the use of laurel oil".
- Essential oils of bay laurel (*Laurus nobilis*) include large 1,8-cineol (eucalyptus) and linalool fractions (Palacios *et al*., 2009b).
- With the advent of synthetic chemical insecticides there was little research on botanical extracts until resistance problems in house flies became acute in the 1970's.
- Sharma and Saxena (1974) evaluated the effects of a range of individual terpenoids on house flies and found a wide variety of effects.
- Some acted as attractants but had inhibitory effects on embryonic or larval development (eugenol and fernesol) whereas others repelled gravid females and inhibited embryonic/larval development.
- Fly responses to terpenoids were highly dose-dependent, and some were attractive at low concentrations but repellent at high ones.
- Larvicidal effects of the tested materials were modest at all doses.
- In another study, neem extracts and refined azadirachtin were moderately toxic to larvae of the horn fly (*Haematobia irritans*), but doses required to control house fly larvae were deemed too high to be practical at the time (Miller and Chamberlain, 1989).
- Khan and Ahmed (2000) later observed up to 85% mortality of adult house flies after exposure to neem extract, which suggests that this product warrants further study.
- Ezeonu *et al*. (2001) found that extracts of sweet orange peels (*Citrus sinensis*) were effective as fumigants against adult flies.
- Malik *et al*. (2007) provided an excellent review of the status of botanicals against house fly at that time.
- In the past few years there has been renewed interest in the topic of essential oils for fly control.
- Palacios *et al*. (2009a,b) examined the efficacy of essential oils of 21 medicinal and edible plants against house fly.
- Of the edible plants, essential oils from orange peel and eucalyptus leaves were the most toxic to flies; the principal components of these oils were limonene (92.5%) and 1,8-cineole (56.9%), respectively.
- Of the medicinal plants, the most toxic to house flies were those whose essential oils were high in pulegone, menthone, limonene, and 1,8-cineole. In a survey of 34 plants conducted by Pavela (2008), essential oils of rosemary (*Rosemarinus officinalis*) and pennyroyal mint (*Mentha pulegium*) had high activity against adult flies in both fumigant and contact toxicity assays.
- Pennyroyal mint was the most effective overall, and GC/MS analysis of the extract indicated that pulegone made up 83.3% of the extract. Pulegone is also highly toxic to larvae of *Aedes aegypti* L. (Waliwitiya *et al*., 2008).
- Oil of rosemary is high in pinene and 1,8-cineole (Jamshidi *et al*., 2009).
- Essential oils of peppermint (*Mentha piperita*) and blue gum (*Eucalyptus globulus*) were the most effective of 6 plant extracts examined by Kumar *et al*. (2011) and had both insecticidal and repellent properties.
- Application of an emulsifiable concentrate formulation of peppermint oil in field tests resulted in over 95% control of house flies (Kumar *et al*., 2011).
- The principal components of peppermint oil are menthone (20.9%) and menthol (41.5%) (Palacios *et al*., 2009b).
- As part of an assessment of plants native to Chile, Urzua *et al*. (2010) recently found that essential oils from *Haplopappus foliosus* (Asteraceae) had high activity against adult house flies; limonene was the most abundant component in the extract.
- Taken together, these results do not point to any single component of essential oils that stand out as the critical element that accounts for activity against house flies.

- Complex interactions may occur among major and minor constituents in an unforeseen manner that affect insecticidal activity.
- Similarly, mixtures of essential oils from different plants may have higher activity than individual extracts in ways that are difficult to predict.
- A new product on the US market, EcoExempt IC, is a combination of essential oils of rosemary and peppermint.
- Unpublished results in our laboratory indicate that this combination is effective as a space spray and a residual surface treatment for house fly adults.
- Judicious use of synergists could improve efficacy further.
- Addition of piperonyl butoxide can reduce the LC50 of essential oils and their individual constituents by several orders of magnitude (Waliwitiya *et al*., 2008).
- Further research on blends of essential oils and improved formulations and delivery systems could lead to substantial improvements in the performance of botanicals for house fly control.

Maggot Control.

- Normally Maggots will not develop if floors and sinks are kept dry.
- If maggots develop make spot applications of one of the recommended maggot sprays to the infested areas
- Apply as a coarse spray or with a sprinkling can.
- Apply approximately 1 gallon per 100 square feet of surface area.
- Maggots are something most people don't like to see in and around their home.
- Generally white and resembling a worm or caterpillar
- Most maggots have a tendency to "gross out" even the toughest of men.
- In most cases you will see hundreds if not thousands at one location and the way they move makes it appear as though 10 times as many are actually present.
- Maggots are almost always the young of some type of insect.
- Most commonly the young of some species of fly, maggots could be young beetles, moths or many other local and common insects.
- Virtually all insects hatch out young which will start its life as a type of worm-like creature.
- Fly larva – or maggots as they are more commonly known- will almost always be white.
- They might have a tan, brown or black head but most people just see white.
- This is due to the sheer numbers that most people will happen upon when they first find any in or around the home.
- Since many insects will start out in this form, there is neither common size nor location where they may be found.
- Maggots are generally associated with either garbage or a dead animal.
- However, they can readily feed on almost anything organic
- This list includes but is not limited to carpeting, wallpaper, food, couches, clothing, furniture, people hair, insects and animals, plants, fruit, vegetables, cooked meat or food, compost piles and just about anywhere in the buildings or immediately adjacent to it.
- Though maggots serve to "recycle" most any type of garbage or other decaying matter, most people don't want them in and/or around the buildings!
- Nature has a way of finding a place for most any living creature and maggots are no different.
- They are clearly responsible for the recycling of almost anything which is considered waste.
- There are even maggots which are so highly specialized that they can only eat certain types of waste.
- These species are so highly developed that the adult stages will actively seek out the special food requirement their young must have and only when such a food supply is found will they lay their eggs.
- Once the eggs hatch, the larva (maggot) doesn't even have to search for food.

- Most maggots will feed for a few days to a few weeks depending on species, and then it will migrate away from the food supply to seek a good location to undergo metamorphosis.
- This is the stage during which the "maggot" turns into the adult.
- This usually occurs inside a cocoon or shell like case in which the insect will literally transform into an adult.
- Once this stage is completed - which could take a week, a month or even a year - the adult will emerge with generally only two things in mind: finding a mate and then reproducing.
- Since there are many things in and around the home which can serve as food for maggots, all it takes is a fertile adult female laying some eggs and a local infestation can ensue.
- In general, the faster the food supply is likely to go bad and rot, the faster the life cycle of the maggots which will want to eat it.
- For example, over ripe fruit and vegetables may attract several types of flies which will be able to complete their life cycles under one week.
- Maggots may only need to feed for a day or two which insures the species will propagate - even if there is only a limited amount of food around on which to feed.
- On the other hand, fly maggots, like Blow Flies, will feed for a slightly longer time.
- Generally this type of maggot will feed on dead animals.
- They are commonly found in homes which had an animal die somewhere inaccessible.
- This is quite common due to the use of Rodenticide and the mistaken belief that the mice or rats that eat it will "go outside to seek water" or "dry up when they die so they don't release any odor".
- Nothing could be further from the truth!
- In fact, the most common cause of maggot problems in the home is due to flies which have been attracted to the rotting corpse of some animal.
- And the most common animal found are either rats, mice or squirrels with the most common cause of the animal death being contributed to the use of a rodenticide.
- When maggots are found in or around the buildings, they are usually found in one or two stages.
- Stage one infestations are when the maggots are found on the food they need to eat.
- This many times will be a dead animal that has died in the attic, crawl space, under a deck, in the wall or some other area. Once dead, it will begin to decay.
- This process releases gases and odors which will attract flies and other insects.
- These insects will start laying eggs on the body and larva could hatch in as little as a day or two.
- If the dead animal is large enough, the inhabitants of the structure will detect its presence because the smell will become stronger with every passing day.
- At some point there will a search for the source of the odor and if the animal is found, don't be surprised to find a lot of maggots as well.

REFERENCES

1. Abd-Alla, A. M. M., Vlak, J. M., Bergoin, M., Maruniak, J. E., Parker, A., Burand, J. P., Jehle, J. A. and Boucias, D. G. 2009.
   Hytrosaviridae: a proposal for classification and nomenclature of a new insect virus family.
   Archives of Virology, 154: 909-918.
2. Achiano, K. A. and Giliomee, J. H. 2005.
   Biology of the house fly predator Carcinops pumilio (Erichson) (Coleoptera: Histeridae).
   Biocontrol, 50: 899-910.
3. Ahmad, A., Nagaraja, T. G. and Zurek, L. 2007.
   Transmission of Escherichia coli O157:H7 to cattle by house flies.
   Preventive Veterinary Medicine, 80: 74-81.

4. Al-Azawi, B. and Jabbr, L. 1989.
The effects of different concentrations of Bacillus thuringiensis Berliner on house fly Musca domestica L.
Bulletin of Endemic Diseases, 30: 69-73.
5. Belton, P., Rutherford, T. A., Trotter, D. B. and Webster, J. M. 1987.
Heterorhabditis heliothidis: A potential biological control agent of house flies in caged-layer poultry barns.
Journal of Nematology, 19: 263-266.
6. Bloomcamp, C. L., Patterson, R. S. and Koehler, P. G. 1987.
Cyromazine resistance in the housefly (Diptera: Muscidae).
Journal of Economic Entomology, 80: 352-357.
7. Boxler, D. J. and Campbell, J. B. 1983.
Survey of resistance by housefly, Musca domestica L. (Diptera: Muscidae), to dichlorvos in Nebraska feedlots.
Journal of the Kansas Entomological Society, 56: 159-163.
8. Brizzard, B. L., Schnepf, H. E. and Kronstad, J. W. 1991.
Expression of the cryIB crystal protein gene of Bacillus thuringiensis.
Molecular and General Genetics, 231: 59-64.
9. Burns, E. C., Tower, B. A. and Wilson, B. H. 1961.
Effect of feeding Bacillus thuringiensis to caged layers for fly control.
Journal of Economic Entomology, 54: 913-921.
10. Butler, S. M., Gerry, A. C. and Mullens, B. A. 2007.
House fly (Diptera: Muscidae) activity near baits containing (Z)-9-tricosene and efficacy of commercial toxic fly baits on a southern California dairy.
Journal of Economic Entomology, 100: 1489-1495.
11. Carlberg, G. 1986.
Bacillus thuringiensis and microbial control of flies.
Journal of Applied Microbiology and Biotechnology, 2: 267-274.
12. Choi, C. S., Chung, Y. S., Kim, W. Y. and Chung, S. I. 2000.
Isolation of Bacillus sphaericus and Bacillus thuringiensis displaying insecticidal activity against mosquito (Culex pipiens) and house fly (Musca domestica).
Korean Journal of Veterinary and Public Health, 24: 169-180.
13. Coler, R. R. and Nguyen, K. B. 1994.
Paraiotonchium muscadomesticae n. sp. (Tylenchida: Iotonchidae) a parasite of house fly (Musca domestica) in Brazil and key to species of the genus Paraiotonchium.
Journal of Nematology, 26: 392-401.
14. Coler, R. R., Boucias, D. G., Frank, J. H., Maruniak, J. E., Garcia-Canedo, A. and Pendland, J. C. 1993.
Characterization and description of a virus causing salivary gland hyperplasia in the housefly, Musca domestica.
Medical and Veterinary Entomology, 7: 275-282.
15. Cova, L. J., Scorza, J. V., García, D. E., Cañizales, L. M., Guedez, C. C., Avendaño, M. L. and Medina, M. G. 2009a.
Efecto de Beauveria bassiana, Beauveria brongniartii y la aplicación de gasoil en el control de moscas caseras en galpones avícolas.
Avances en Investigación Agropecuaria, 13: 41-54.
16. Cova, L. J., Scorza-Dagert, J. V., Garcia, D. E., Cañizales, L. M., Guedez, C. C., Avendaño, M. L. and Medina, M. G. 2009b.
Efecto de Beauveria bassiana, Beauveria brongniartii en el control de moscas (Musca domestica) en condiciones de laboratorio y en galpones avícolas.
Boletin de Malariaologigia y Salud Ambiental, 49: 151-160.

17. Darwish, E. and Zayed, A. 2002.
Pathogenicity of two entomopathogenic hyphomycetes, Beauveria bassiana and Metarhizium anisopliae, to the housefly Musca domestica L.
Journal of the Egyptian Society for Parasitology, 32: 785-796.
18. Deacutis, J. M., Leichter, C. A., Gerry, A. C., Rutz, D. A., Watson, W. D., Geden, C. J. and Scott, J. G. 2006.
Susceptibility of field collected house flies to spinosad before and after a season of use.
Journal of Agricultural and Urban Entomology, 23: 105-110.
19. Ezeonu, F. C., Chidune, G. I. and Idedi, S. C. 2001.
Insecticidal properties of volatile extracts of orange peels.
Bioresource Technology, 76: 273-274.
20. Fan, Y., Pei, X., Guo, S., Zhang, Y., Luo, Z., Liao, X. and Pei, Y. 2010.
Increased virulence using engineered proteasechitin binding domain hybrid expressed in the entomopathogenic fungus Beauveria bassiana.
Microbial Pathogenesis, 49: 376-380.
21. Farkas, R., Hogsette, J. A. and Boerzsoenyi, L. 1998.
Development of Hydrotaea aenescens and Musca domestica (Diptera: Muscidae) in poultry and pig manures of different moisture content.
Environmental Entomology, 27: 695-699.