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THE HOUSE-FLY PROBLEM

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It is significant that in 1954, the 100th anniversary of professional entomology in the United States, the house fly, one of man's oldest insect enemies, still is a major problem. This emphasizes the remarkable ability of insects to survive by adapting themselves to drastic changes in environment.

HISTORY AND IMPORTANCE

House flies have been a part of human environment in all periods of recorded history (Exodus 8:23) (17). Ancient peoples undoubtedly accepted them and merely brushed them aside. During colonial times there was a general feeling of tolerance toward the house fly, and this attitude still persists among some people even today.

The house fly was first associated with disease as early as 1577 (4), and attention was called to the spread of gangrene by flies during the Civil War (5). With the experience of the American troops in the Spanish-American war and the British troops in the South African war, there came a period of incrimination. Between 1910 and 1915 there was a period of popular education which resulted in better sanitary conditions. During World War II the necessity for combating filth-borne diseases was again brought into focus, and in areas of hostilities insecticidal sprays, mostly DDT, were the principal tool. This development ushered in a new era, and immediately following the war many people believed that man's battle against the house fly was at an end. Such was not the case.

LIFE AND SEASONAL HISTORY

Recent research shows that continuous breeding (10) as far north as New York is an important means by which the house fly survives the winter. Activity begins at about 44° F, and the optimum is 91° F (11). Thus the seasonal cycle is closely associated with the rising temperature in the spring and falling temperature in the fall. In temperate zones, near optimum temperatures prevail for long periods.

Incubation of the egg may require 24 hours or less; first-stage larvae may molt in another 24 hours; about the same time is spent in the second stage; and third-stage larvae take from three to nine days to transform to pupae. The pupal period may be as short as three days. Thus the minimum cycle is about eight days (17). Adults may live as long as 91 days at 60° F.

An adult female is capable of laying four to six masses of eggs averaging 120 eggs each. Devoe (2) has estimated at from 325,923 to 200,000,000 the number of summer decendants which may result from a single mated pair.

Larval food is as diverse as the materials on which oviposition occurs. There is no record of eggs being deposited on a substance which will supply no nourishment to the larvae. Animal excrements (3) are the preferred larval food, with animal wastes and pen litter next in choice. Pig dung is preferred over horse and cow dung. Chicken manure is suitable only when moist.

The flight range of the adult may be as great as 20 miles (19). This ability, coupled with a short life cycle and an enormous reproductive capacity, makes it possible for flies to disperse over wide areas in a very short time. Such a general dispersion is unusual, however, as attractive feeding and oviposition sites near the place of emergence are numerous.

CONTROL

Control may logically be divided into two functions: prevention of larval development, and control of adult populations.

PREVENTION

Sanitation is the principal means of combating the house fly outside of buildings, and aids materially in reducing the number of flies inside. On farms animal manures are the principal sites of breeding and if allowed to accumulate

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for eight days can produce a generation of flies. Larval development can effectively be prevented by removing the manure twice weekly and scattering it over fields, or it may be stored in vertical-sided manure pits and treated.

Borax in the ratio of 11 ounces to 8 bushels of manure is an effective manure treatment, but may be injurious to crops if used in excess. A combination of calcium cyanamid and superphosphate, using one-half pound of each to a bushel of manure, gives almost complete control of fly breeding. These chemicals also add nitrogen and phosphorous to the manure.

CONTROL OF ADULT POPULATIONS

Screening of windows and doors provides an effective barrier to the entrance of flies, but some always manage to gain entrance. The old fly swatter is still a useful tool for killing a few flies inside homes. If the flies are numerous, fly traps, fly papers, electrocutors, poison baits, or insecticidal sprays may become necessary.

Prior to the development of DDT, pyrethrum in refined kerosene was the principal insecticide used. As a space spray this was applied with a small plunger-type hand sprayer. It is effective only against those flies contacted at the time of application.

DDT, because of its residual properties, provided a method that was effective for a long period of time. It was so effective that scarcely a fly was seen during some seasons (6) and some authorities thought that this was the final answer to house-fly control. Its dramatic effectiveness was to some degree responsible for a general relaxation of sanitation practices that formerly had been the primary weapon against flies.

RESISTANCE

The miraculous control of the house fly was short because resistance to DDT soon developed. Resistance was first reported in 1947 from Italy (16), and since that time has been recorded in all areas of the world. Flies resistant to DDT also exhibited initial resistance to the other chlorinated hydrocarbons, even though they had not been exposed to them. Resistance soon reached a level where the amount of material required for satisfactory kill exceeded practical limits. Until late summer of 1953 there was no satisfactory material for residual application.

Many proposals have been put forth in an effort to explain resistance (6, 14, 18) none of which can account for all details. The most logical explanation is on the basis of population genetics. Killing all the susceptible flies results in a concentration of flies having the factor for resistance. This explanation is substantiated by the fact that with some laboratory cultures resistance could not be established by exposure to sub-lethal concentrations, thus demonstrating that resistance is not an "acquired" characteristic in the strict sense of the word (1).

While it is generally conceded that genetic factors are responsible for the development of resistance, it is still necessary to understand why the insecticide is no longer toxic to the fly. Physiological experiments have shown that flies can detoxify DDT to non-toxic DDA and DDE. There are some discrepancies (12). Further studies also show a difference in the amount of cytochrome oxidase, an enzyme important in the final steps of oxidative metabolism (13, 15).

Recent evidence indicates that resistance is eventually lost (8). The practical value of this fact is not yet evident, but it may mean that infrequent use of the chlorinated hydrocarbon insecticides may be permissible.

CONTROL OF RESISTANT FLIES

The need for control of resistant flies has been, and is still to some degree, one of the most pressing entomological problems of recent years. Materials exhibiting synergistic effects with DDT and other similar compounds were thoroughly investigated (9). Such combinations were effective for a short time only, as resistance to them developed also. More recently (7) DDT-resistant flies have not been able to become resistant to the organic phosphate compounds such as TEPP, parathion or malathion. Some slight resistance, up to seven fold, has been noted, but no further resistance developed after 26 additional generations. This is within practical limits.

As resistance to the organic phosphates is of a low degree and will not increase, considerable effort has been made to develop methods of application suitable for using these compounds. Parathion-impregnated twine, liquid-TEPP bait, dry-sugar baits with Bayer L 13/59, and others which are considered either too toxic to mammals to be applied as a residual treatment, or which are lacking residual properties, have been tested.

Several newer compounds, all organic phosphates, are receiving experimental trial. Some are showing excellent promise and may be the practical answer to resistance and satisfactory control. The residual properties, while not as good as DDT was in the early days, are much better than that of compounds currently recommended. Some of these compounds are diazinon, chlorothion, L 23/59, and L 21/199.

RECOMMENDATION

Sanitation is, as it always has been, the method of first importance in fly control. Direct control measures are supplementary only. Malathion in the proportion of 2 gallons of 50 per cent concentrate plus 12 to 20 pounds of sugar is currently recommended as a residual treatment, except in dwellings. Screening, pyrethrum space sprays, and swatting should not be overlooked as a means of combating the fly in the home.

SUMMARY

The house fly, because of its world-wide distribution and its close association with man and filth-borne diseases, presents a problem of importance to everyone. Its short life cycle, high fecundity, long flight range, and its ability to develop in a wide assortment of media makes it a difficult pest to control. Residual DDT application gave near-perfect control until the flies became resistant. However, the development of resistance re-emphasized the necessity for a return to sanitation measures which always will remain the first line of defense against the house fly.

Recent experimental work indicates that a high degree of resistance is never developed when the flies are exposed to the organic phosphates. This offers some hope that a satisfactory method of direct control will be developed.

Direct control measures should be considered supplementary to sanitation. New methods such as insecticide-impregnated twine, liquid baits, and dry-sugar baits may be useful in certain situations, and the old fly swatter remains a useful and important implement of house-fly control.

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