

Some General Considerations on Housefly Rearing Techniques

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The only standard method for rearing houseflies (*Musca domestica* L.), the Peet-Grady method (*Soap Blue Book*, 1962), the official method of the Chemical Specialities Manufacturers' Association (CSMA), is already 35 years old (Grady, 1928). It is still the most widely-used method for rearing houseflies. Of the many other larval diets developed in the meantime (Sawicki & Holbrook, 1962) two are widely used: in Japan the larval medium is made of rice bran, horse manure (Nagasawa, 1956) or dog biscuits (Nagasawa, 1963), elsewhere, media made of milk with cellulose or agar as carrier are sometimes used (Hammen, 1956; Sawicki & Holbrook, 1962). Most of the larval media contain some yeast. The variations in adult diets are few; the adults are mostly fed on milk (Sawicki & Holbrook 1962).

The CSMA medium is undoubtedly a good larval medium, because houseflies in the wild state often breed on decomposing vegetable matter (Guyer et al., 1956). It has, however, a number of disadvantages, difficult to overcome. Although alfalfa is unlikely to vary to a great extent in the United States of America because the larval medium is supplied by one firm (*Soap Blue Book*, 1962), it can vary considerably elsewhere. There is also the danger of insecticidal residues in alfalfa; the Food and Drug Administration official tolerances for 1962 (*N.A.C. News and Pesticide Review*, 1962) allow 100 p.p.m. of methoxychlor and Sevin and 10 p.p.m. of diazinon in alfalfa. Outside the United States of America, where insecticidal residues are not controlled, alfalfa may contain much higher amounts of insecticides². Temperature control of the medium, which ferments (Wilkes et al., 1948; Silverman & Levinson, 1954) and the difficulty of separating the pupae from the medium (Basden, 1946; Moreland & McLeod, 1957) are some of the other disadvantages of the CSMA larval medium.

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² Kerr—personal communication, 1963.

The yeast, milk and agar medium (YMA) (Sawicki & Holbrook, 1962; Hammen, 1956) is in some respects better than the CSMA medium. It should not contain any insecticide at all, at least in the United States of America (*N.A.C. News and Pesticide Review*, 1962); there is no rise in temperature, and the separation of the pupae from the medium is easier. It is, however, often attacked by bacteria and fungi, and sometimes smells very badly. Also the yeast must be of good quality, and this and the high price of powdered agar make it probably more expensive than the CSMA medium. I do not know which of the two techniques needs less labour and is less unpleasant for the fly-rearing personnel. The Japanese medium is not considered here because rice bran is not universally available.

Ideally fly larvae should be reared in sterile conditions. The larval medium should contain only substances readily available in a pure state. The medium should be easy to prepare or to obtain ready mixed, be easy to handle and reasonably cheap. Large variations in seeding rate should produce small changes in yields or average weight of the pupae; the temperature changes during larval life should be small. It should be possible to separate the pupae from the medium with a minimum amount of handling, and of course both yield and average weight of the pupae should be at least as good as yields and average weights obtained with the commonly-used media.

It is not known which of the larval media is best suited for laboratory rearing of houseflies, because there has been no published comparison of larval diets and breeding techniques. In general, although a large number of papers have been published describing modifications (often very slight), of existing rearing media or techniques, there are no comparative studies and very few papers consider the conditions affecting the development of the larvae. An indirect comparison, based on data published by Moreland & McLeod (1957), who used bran-alfalfa 1:2 (382 g), yeast (7.5 g), dialysed malt

extract (6.25 g), and water (800 ml), and by Kuenen (1958), who used powdered skimmed milk (250 g), dried yeast (13 g), cellulose tissue (20 g), 0.1 N KOH (30 ml) and water (1000 ml) shows that at low seeding rates (2 eggs/g medium) yields and average weights for the media were about the same, i.e., 1.6 pupae/g medium. When the seeding rate was increased to 5 eggs/g. medium, the milk diet yielded more and larger pupae (4 per g, average weight 16.5 mg) than the vegetable medium (3 pupae per g, average weight 15.0 mg). The milk diet seems therefore better at higher seeding rates; this could make it more suitable as larval medium because yield and average weight depend less on seeding rate (with unskilled personnel, seeding rate is not always constant). The comparison given here is open to criticism because the strains of flies and environmental conditions differed, e.g., the rearing containers differed in size; this affects yields and average weight (Nagasawa, 1963). It shows, however, the need for a proper comparison of larval media.

Judging from the literature, housefly rearing is singularly free from epidemics. The main fly pathogens and parasites are: *Bacillus thuringiensis* var. *thuringiensis* Berliner (Hall & Arakawa, 1959), internal fungal parasites, e.g., *Empusa*¹ *muscae* Cohn (Madelin, 1960), and mites, e.g., *Macrocheles muscaedomesticae* Scapoli (Rodriguez & Wade, 1961). Other less common parasites and pathogens are listed by West (1951). So far, no bacterial infection and only one case of fungus, *Empusa muscae* Cohn (Baird, 1957), has been reported in the literature. Earlier literature reported mite infection from horse dung (Richardson, 1932); the substitution of alfalfa (Richardson, 1932) cleared this trouble. *Empusa muscae* Cohn was brought with insects collected in the field; (Baird, 1957); quarantine should prevent such infections. There are unfortunately very few

studies of the effect of fungi and bacteria on fly rearing (Silverman & Silverman, 1953), yet fungi and bacteria competing with the larvae for food probably cause more failures in rearing than all the other factors put together. The few remedies—sand (Born, 1954), *p*-hydroxy-benzoate (Hammen, 1956), or the seeding of the medium with the correct number of eggs (Wilkes et al., 1948)—are usually unsatisfactory.

Most of the larval media are made from natural products, which vary in quality. We have at various stages had difficulties with larval media; these were traced to old yeast or yeast of poor quality. For this reason it would be desirable, when discussing a larval diet to be used in many countries, to consider artificial diets, a number of which are already available (House & Barlow, 1958; Monroe, 1958).

A universally acceptable medium is highly desirable but a larval diet agreed to by fly breeders may not be acceptable to many strains of houseflies. Experience shows that even slight changes in diet or breeding conditions may cause upsets in fly colonies (Sawicki & Holbrook, 1962), because any breeding technique eliminates the insects least adapted to it. Keiding (1963) was unable to obtain pupae bred on YMA of the same average weight as those bred on CSMA, even though he tried to breed flies for a number of generations on YMA. When we received some of his strains of flies we had difficulties in maintaining them over the first few generations on YMA. On the other hand, flies from the Cooper Technical Bureau, bred there on the CSMA diet, adapted themselves to ours (YMA) without trouble. The difficulties in switching from one diet to another are some of the reasons why a comparison of larval diets could be very difficult.

The points mentioned here are but a few of those to be solved before fly-rearing techniques are put on a truly scientific basis. Till then—too often, unfortunately—the reasons for the failure in the development of a batch of flies must remain unknown.

¹ There is growing support for the recognition of *Entomophthora* Fresenius as the legitimate name for this genus, and for the relegation of *Empusa* Cohn to the status of a synonym.—ED.

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