The biological method and

Full utilization of the biological method in fly control requires the preservation of existing predatory and parasitic enemies in animal dung. The use of residual poisons to control adult flies did not interfere with natural enemy complexes in these tests. Alternating the removal of manure deposits, and abstaining from chemical treatment of manure were essential procedures in maintaining largest populations of predators and parasites.

Biological methods for fly control have been used in the past with varying degrees of success but the extent of control achieved has often been entirely adequate to preclude the necessity for integration of cultural and pesticidal control measures. In our present society, where fly breeding sources are often found close to human dwellings, the biological method alone has often been inadequate to meet the standards set by local health statutes. It is usually necessary to supplement, or add to, the existing natural balance between flies and their natural enemies. However, in almost all fly control programs, the cost can be considerably minimized if a general understanding of the breeding of flies and their natural enemies is obtained. Research at several campuses of the University of California during the past four years has resulted in an integrated plan for fly con-

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Common predatory histerid beetle, Carcinops pumilio (Erichson), shown feeding on the eggs of the common house fly.

Native scarab beetle, Ataenius californicus Horn, very active as a casual feeder on immature flies and excavator of animal dung.

Widespread species of staphylinid or rove beetle, Philonthus sordidus Gravenhurst.

Photos below show two of several predatory Anthocoridae or "bugs" widely active as egg predators. Here a nymph, left, and an adult, right, are shown piercing eggs of the common house fly.
integrated control of house and stable flies in California

trol that offers maximum effectiveness at a minimum cost in most fly-breeding situations at commercial dairy, poultry, feed-lot and stable environments.

Scientists studying the habits of adult house flies in Denmark and at Berkeley concluded that a very high percentage of emerging flies remained in the area of larval breeding long enough to come in contact with many surfaces that could be treated with residual insecticides or poison baits. If the application of such poisons was properly spread out over most of the fly resting sites, satisfactory control was achieved during peaks of fly populations. Such practices did not interfere with beneficial flies such as Ophyra.

Scientists at Illinois and Riverside, studying the resistance problem of flies to insecticides, concluded that development of resistance was slowed down considerably if the kill were directed against adult flies instead of larvae.

Research at the Department of Biological Control, Riverside, indicated that because of parasitism and physical mortality factors, fly larval counts were not adequate indicators of potential fly emergence, and showed conclusively that insecticides applied to the fly larvae at their breeding sites destroyed almost 100 per cent of the natural enemies, both predatory and parasitic. These natural enemies can contribute to more than 95 per cent destruction of fly populations. The reestablishment of such a natural enemy complex requires many months, during which time subsequent generations of flies are able to develop unchecked to the limits of their available food supply. This build-up leads to the requirement for more frequent applications of insecticides, and ultimately to increased dosages as resistance develops in the fly populations. This resistance is capable of spreading to adjacent areas so that every ranch in a valley may be affected.

The two types of natural enemies that can be used for biological control of flies include: (1) the predators that attack fly eggs, immature larvae, and some pupae; and (2) parasites that attack larvae and pupae.

Some predators spend their entire lives in the fly larval breeding sites (manure, garbage, decomposing vegetation), passing through various developmental stages themselves. Other predators spend a portion of their developmental period in the surrounding fields and reenter the fly breeding sites as full-grown adults.

Most predators are able to exist on alternative sources of food, such as fungi and dead organic matter when flies become scarce. This habit assures their persistence in a potential breeding site until conditions become more favorable for a fly population increase. All predators, merely by virtue of numbers (often thousands per gallon of manure) also aid in the aeration and hasten the rate of decomposition of the breeding site, finally making it unsuitable for fly breeding.

California’s principal predatory and scavenger species belonging to several insect families are: Staphylinidae (Oxytelus sculptus Gravenhurst, Philonthus...
of species prefer to attack robust, poten-
sting, and deposit eggs in their hosts. The
Parasites
next generation of flies, since more of the
parasite-killed sisters, but they transmit
weakling? not only find it more difficult
to increases in fly populations. By being
their own devcloprnental time in response
and pupae of flies. Parasites live in the
sites, attack young and full-grown larvae
and adults. Some of these were very active in cold
climates while others required intensely
hot and dry environments. By distributing
them through all climatic areas of the
state, it is expected that parasite activity
will be increased where it is now low,
and that winter fly problems on the
south coast can be reduced by the
addition of the cold-hardy species.

Several species of parasites are found in California on house and stable flies
Muscidifurax raptor Girault and Sanders (a large and a small type), Spalan-
gia cameroni Perkins, S. endius Walker, S. nigra Latreille, S. nigroaenea Curtis
and Aleochara sp. (see photo). The Fannia
species are active at all elevations in the state, only
the Aleochara sp., Stilplus and S.
nigroaenea appear to become prominent
above 4,000 ft. None of the native parasites and few of the predators, are very
active when the mean temperature drops below 60°F. There is comparatively less
activity between December and April. However, in most areas fly problems are
minimal during this period.

Prospects
A number of parasitic natural fly en-
emies obtained throughout the world are
now being introduced into California by
University scientists to strengthen the
existing natural enemy complex. The
species are: three reproducorily isolated
forms of Muscidifurax raptor from Porto Rico, Central and South America show-
ving varying characteristics of gregarious-
ness, fecundity and uniparentalism; Spal-
langia longepetiolata Boucek from East
Africa, Sphexigaster sp. from South Af-
rica, Tachinaphagus zealandicus Ash-
mead from Australia and New Zealand,
and Aleochara taeniata Erichson from
the West Indies.

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Predator complexes in animal excre-
ment in the Ethiopian and Neotropical
regions differ considerably from the
Holarctic region in the species they con-
tain. Future efforts will be directed to-
ward the introduction of key species into
California.

The "inundation" method involving
the periodic release of laboratory-reared
cultures of parasites in a direct attempt
to reduce the increasing fly populations,
some promise but must be investi-
gated further. Test results indicate that
effective use of the adapted complexes of
natural enemies is the best biological
control method at this time. Since peaks
in fly activity are correlated with sea-
sonal weather conditions in each locality,
these variations must be considered.

Otherwise, the method involves the
preservation of existing natural enemy com-
plexes in animal excrement by alternat-
ing the removal of manure, and
abstaining from chemical treatment of
the manure; and favoring coned manure
deposits for poultry. When frequent ma-
ure removal practices require stockpil-
ing in an adjacent area (environmental
poultry houses, dairy industry, etc.), a
high steeply sloping mound will assist
maximum natural enemy activity and
also be least suitable for fly breeding.

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and G. S. Olton is Graduate Student,
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M ASTITIS

Since 1955, the average herd size in
the Fresno County Dairy Herd Im-
provement Association (DHIA) has in-
creased from 105 to 256 cows per herd.
This expansion has been accompanied by
an increase in production of milk from
9,433 to 13,592 pounds and of butterfat
from 391 to 509 pounds per cow. Mastitis
is one of the problems in dairy manage-
ment which becomes more complex as
herd size increases. Clinical mastitis cases
may be recognized readily; however, it is
also of great economic importance to
determine which cows in a herd have
nonclinical cases of mastitis.

The Fresno County DHIA decided in
July, 1961 to use the California Mastitis
Test (CMT) in determining the degree of
mastitis within a herd. The CMT has
been well accepted and demonstrated
throughout the world as a simple, eco-

ocal, and practical method for esti-
mating the mastitis cell count in milk.

Bucket milk testing (milk samples by
the DHIA tester) proved to be an excel-
ent device for screening individual cows
in a herd. CMT scores were rated as fol-
ows: samples scoring negative (no
mastitis cells detected) and trace (N + T)
were combined into one group; samples
scoring one were listed separately; and
samples scoring two and three (2 + 3)
were also combined. Standardization pro-
cedures were established with quarterly
checks made on tester procedure.

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