A complex predator population inside a good fly-tight house—coupled with careful manure and water management—can control flies in high-rise poultry houses.

Concrete walls from below-ground-level manure pit. Twenty-eight thousand birds are held at ground level. (Ranch 5—Waterford, Stanislaus County.)

Domestic fly problems in deep pit poultry houses

Lorry L. Dunning  Edmond C. Loomis  W. Stanley Coates  Fred C. Price

Construction of deep pit, high rise poultry houses has increased among California poultry producers. Some poultrymen have encountered tremendous initial fly outbreaks, others have experienced a continuous fly problem, and some have had no fly problems. This survey evaluates the various types of deep pit houses and determines why some have a domestic fly problem while others do not.

Procedures

Six houses varying in construction and manure levels were selected for a 1971-72 survey in Sonoma and Stanislaus counties (table 1). Nine manure sample areas were established in each house. Differences in light intensity, air currents, and accessibility were considered when selecting the sample areas. Activities and life stages of all insect species found were recorded.

At each station, a plywood board containing a pad of 5-inch x 8-inch white cards was hung in potential fly-resting areas. Fly specks (fecal spots) on these cards were counted.

Manure was inspected mainly for fly larvae. Manure was placed in a one-gallon cardboard carton with a trap on the top to capture any adult insects that emerged from the sample. To recover immature insects, manure from two light and two dark areas was placed in Berlese funnel traps and processed in the laboratory.

Moisture was measured 5 to 6 inches
Air intake pads cooled by water and exhaust fans spaced alternately along each side of poultry house. (Ranch 1—Santa Rosa, Sonoma County.)

below the crusted surface at each station. Temperatures were recorded with a potentiometer at the top two inches, the center, and the bottom layers of the manure. Air temperatures were recorded at bird level and just above the manure in the pit. A Gossen Lunasix Pro Photographic light meter with a foot candle scale measured light at each station and at bird level.

Findings

Domestic fly populations were more numerous at ranches 1, 3, 4, and 6; production was extremely light at ranches 2 and 5. Of the fly species produced, Muscina stabulans (false stable fly) and the little house fly, Fannia canicularis, were most common; other species found were blow flies (Calliphoridae) and the housefly, Musca domestica. Of the six ranches, 2 and 5 had the greatest density of predaceous beetles and mites (table 2).

Manure remained wet and sloppy on all ranches. Average moisture content ranged from 82 percent in May to 56 percent in January. A relatively dry crust three to four inches thick occurred on manure opposite fan discharge locations. Limited composting was observed in areas opposite some fan locations, but did not prohibit fly egg laying and larval development.

Ranch 2 had the highest foot candle rating (1.13) and ranch 3 had the lowest (0.04) at pit level; ranch 5 was the brightest at the cage level, followed by ranches 1 and 4, 2 and 6, and 3. Adults and larvae of flies and predators were less numerous in the darkest corners of the pits.

Ventilation and construction

House design and fan placement had the greatest influence on domestic fly production. Houses designed to be "fly tight" prevented the development of large fly populations. At ranch 4, flies entered through cooling chambers at the pit and bird levels of the house. A rapid decrease in fly density occurred after the air portals were screened. Ranch 3 had sliding end-doors which were usually left open. Also, the ¼-inch plywood siding at the pit level was too thin to hold the manure inside; the sides had burst and the manure that escaped to the outside attracted a tremendous fly population.

Fan placement influenced manure condition and parasite-predator relationships. The parasite, predator, scavenger, and manure mite (Acarina) populations were closely related to the condition of the manure. Dry manure areas near the fans had the most predators and mites.

At ranch 3, the exhaust fans were at bird level and the air intake under the eaves of the roof, giving adequate ventilation for the birds but not assisting in manure drying. Ranch 5 had exhaust fans at both the bird and pit levels and air intake under the eaves. The pit was below the soil level and had concrete sides. At the two end sets of fans, semicircular areas that reached approximately half-way across the house dried to the...
point that a person could walk over the
manure.

The exhaust fans were in the peak of the
roof at ranch 4. Cooling chambers for
air intake were supplied with mist nozzles to
cool the air as it passed through the cham-
ber. Air intake portals were at the pit level
and below the eaves. These portals offered
excellent ventilation for the birds but did
not dry the manure across the width of the
pit.

At ranch 4, during February and March, bottom manure readings were not
more than 74°F, and between 63° and 71° F,
approaching air temperature, at the middle
and upper layers. Temperature readings at
ranch 2, however, show a high bottom-
manure temperature of 89° when the aver-
age air temperature was 63°F, leading to
some drying of droppings.

Ranches 1, 2, and 6, equipped with
exhaust fans at the pit level and air intake
at the eaves, provided the greatest oppor-
tunity for manure drying. Manure dried in
semi-circular areas near the fans. On all
ranches, however, the centers of the pits
never developed a crust.

Manure formed dry cones only on
ranch 6 because of efforts to prevent water-
ers from dripping. On some ranches, large
wet spots were formed by leaking waterers,
increasing manure moisture and output of
ammonia. On ranch 3, manure was too
deep and liquefied to continue sampling.

Predators

The relative high moisture content of
all manures on the six ranches falls within
the developmental requirements of preda-
tors (50 to 70 percent moisture) as estab-
lished by Peck and Anderson (1969). Over
20 species of arthropod predators have been
found in manure on California poultry
ranches. Studies have shown that many of
these are voracious feeders on fly eggs,
larvae, and pupae (Legner and Olton, 1968;

Various numbers of beetles were
found on all ranches throughout the present
study: a Tenebrionid beetle, *Alphitobius
laevigatus*, a valuable predator and dung
excavator; a histerid beetle, *Carcinops
quatuordecimstriatus*, and a Staphylinid
beetle, *Philonthus* sp., both predators; and
other predators in lesser numbers.

Numerous other insects were found:
there were insect scavengers which fed on
grain fungi and debris; *Dermestes maculatus*
larvae burrowed into wood and styrofoam
insulation for pupation sites; and there were
nine mite species. A large group of mites
(Parasitoidae) was represented by the pre-
daceous mite, *Macrocheles muscaedomesticae*
(Macrocheilidae), which feeds on fly eggs
and larvae. *Digamasellus longiusculus* (Di-
gamasellidae), also a predator, was seen in
moderate numbers. According to Krantz
(1970) a number of parasitoid families
include mites that use insects for trans-
portation (phoresy) and do not harm their
hosts. Some of the mites found in this study
could be both phoretic and predaceous
depending on different fly stages of de-
velopment.

**TABLE 1. Descriptions of Deep Pit Poultry Houses Surveyed for Domestic Fly Production,**
**California, 1971**

<table>
<thead>
<tr>
<th>Ranch No.</th>
<th>No. of birds and age</th>
<th>House type</th>
<th>Fan location and pads</th>
<th>Cage rows and density</th>
<th>Manure level and general remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>SONOMA COUNTY (1)</td>
<td>Santa Rosa</td>
<td>30,000 26 wk</td>
<td>40 x 450' cement floor, Pit above ground</td>
<td>8 + 9, 36&quot; fans/side @ pit level, Pads under eaves.</td>
<td>4 sets of 4 cage rows ea. 4 birds/cage. 5 in. @ start.</td>
</tr>
<tr>
<td>Petaluma</td>
<td>35,000 40 wk</td>
<td>50 x 466' dirt floor, Pit above ground</td>
<td>10 + 11, 36&quot; fans/ @ pit level, Pads under eaves.</td>
<td>5 sets of 4 cage rows ea. 4 birds/cage. 2 1/2 ft. @ start (8 mo.) 32 open type houses with 215,000 birds.</td>
<td></td>
</tr>
<tr>
<td>Petaluma</td>
<td>5,000 36 wk</td>
<td>28 x 195' dirt floor, Pit above ground</td>
<td>3 fans (2-48&quot; &amp; 1-24&quot; dia.) @ bird level in center-one side. Pads under eaves.</td>
<td>2 double rows, 1/2 row each side wall. 4 birds/cage. 3 ft. @ start. 3/8 in. plywood house. Two open-type houses with 6,000 birds.</td>
<td></td>
</tr>
<tr>
<td>STANISLAUS COUNTY (4)</td>
<td>E sacol</td>
<td>30,000 34 wk</td>
<td>60 x 480' dirt floor, Pit above ground</td>
<td>14, 48&quot; fans atop roof center. Double wall cooling chamber, no pads.</td>
<td>5 sets of 4 cage rows ea. 8 birds/cage. 2 ft. @ start, air intake at pit &amp; bird level.</td>
</tr>
<tr>
<td>Waterford</td>
<td>28,000 76 wk &amp; 32 wk</td>
<td>40 x 482' dirt floor, 9-ft. pit below ground.</td>
<td>4-2, 48&quot; fans on one side, 3 @ cage level &amp; 1 @ manure level repeated except center with 2 @ cage level. Pads under eaves.</td>
<td>4 sets of 4 Keneco cages. Mounted to form A line. 5 birds/cage. 2 ft. @ start.</td>
<td></td>
</tr>
<tr>
<td>Turlock</td>
<td>100,000 3 houses 52 wk</td>
<td>56 x 420' dirt floor, Pit above ground.</td>
<td>9 + 10, 36&quot; fans/side, alternate @ pit level. Pads under eaves.</td>
<td>5 sets or 4 cage rows ea. 5 birds/cage. 2 1/2 ft. @ start.</td>
<td></td>
</tr>
</tbody>
</table>

*The predaceous beetle *Tenebrionidae, *Alphitobius laevigatus*, was found in great numbers on some of the study ranches.*
With natural populations of arthropods in deep pits, it is not surprising that domestic fly populations were low on ranches 2 and 5. At ranch 5, the manure along the walls and near the fans contained a moving mass of Tenebrionid beetles. Introductions of beetles were made from ranch 5 to ranches where predator populations were low (table 2).

Denser fly populations occurred at ranches 1 and 6 because the ranches had low predator populations. Dense fly populations infested ranch 6 in the spring when the pit was cleaned and predators were removed. On ranch 1, a new house attracted a considerable fly population which was not controlled until predator-laden manure from a house only 50 feet away was introduced.

A complex predator population inside a good "fly-tight" house, coupled with good manure management and water control, are necessary for good fly control. This was readily seen at ranch 4 when the air portals were screened and beetles introduced.

Rats and mice, tunneling under the edge of one house allowing water and manure to seep from the pit, caused masses of fly larvae to develop.

Conclusions

Deep pit houses can be odor and fly free if managed properly. The poultryman should:

- Design house and fan placement for proper air movement.
- Prevent dripping water.
- Discard dead birds and broken eggs in proper containers; in the pit they encourage fly development.
- Control rats and mice.
- Save old manure with high predator populations when cleaning the pit. Failure to do this may result in several weeks' delay in establishing a new predator population.
- Do not use larvicides in the pit if mites and predator populations are to be maintained. Axtel (1968) showed deleterious effects of 12 insecticides on predaceous mite populations in poultry manure. If necessary, careful application of certain acaricides can be made above the pit with no effect on predators in the manure below.

<table>
<thead>
<tr>
<th>Ranch No. (months inspected)</th>
<th>Domestic flies*</th>
<th>Other insects†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fannia</td>
<td>Musca</td>
</tr>
<tr>
<td>1. (April-June)</td>
<td>85</td>
<td>3</td>
</tr>
<tr>
<td>(June-October)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12 month total</td>
<td>85</td>
<td>3</td>
</tr>
<tr>
<td>2. (April-June)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>(July-October)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>(Dec-March)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12 month total</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>3. (April-June)</td>
<td>161</td>
<td>0</td>
</tr>
<tr>
<td>(July-October)</td>
<td>6</td>
<td>72</td>
</tr>
<tr>
<td>(Dec-March)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12 month total</td>
<td>167</td>
<td>72</td>
</tr>
<tr>
<td>4. (May-June)</td>
<td>1640</td>
<td>173</td>
</tr>
<tr>
<td>(July-Sept)**</td>
<td>826</td>
<td>10</td>
</tr>
<tr>
<td>(Dec-March)</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>12 month total</td>
<td>2474</td>
<td>1</td>
</tr>
<tr>
<td>5. (May-June)</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>(July-Sept)</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>(Nov-March)</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>12 month total</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>6. (May-June)</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>(Nov-March)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12 month total</td>
<td>99</td>
<td>5</td>
</tr>
</tbody>
</table>

*Adults and larvae combined.
†A = Anthocorid, adults of three species.
H = Histeridae: Carcinops quatuordecimstriatus and Saprinus sp., adults and larvae.
I = Ichneumonidae and Apanteles sp., adults.
S = Staphylinidae: Philothous sp., adults and larvae.
T = Tenebrionidae: Alphithogopus laevigatus, adults and larvae.
$Samples discontinued 10-27.
**Air intake portals screened August. Beetles introduced into pit.
†Birds removed August and pullets started again in November.

L. L. Dunnin is Staff Research Associate IV, Cooperative Extension, U.C. Davis; E. C. Loomis is Extension Parasitologist, U.C. Davis; W.S. Coates is Farm Advisor, Sonoma County; and F.C. Price is Farm Advisor, Stanislaus County.

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