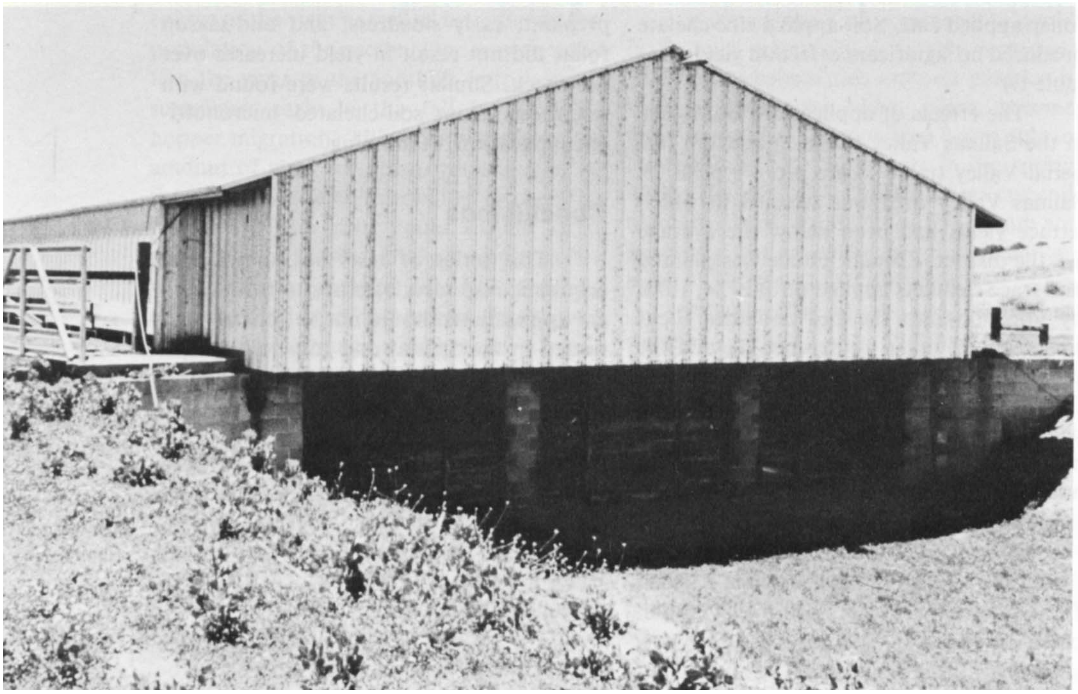
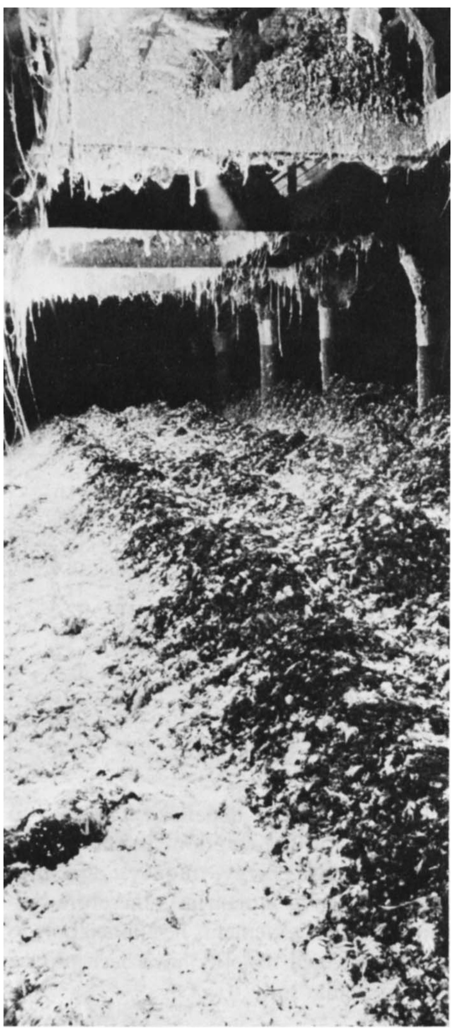


Concrete walls from below-ground-level manure pit. Twenty-eight thousand birds are held at ground level. (Ranch 5—Waterford, Stanislaus County.)

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.



Three-year accumulation of manure in below-ground-level pit. Note rodent barriers on posts. Cats are usually kept in pits for rodent control. (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.

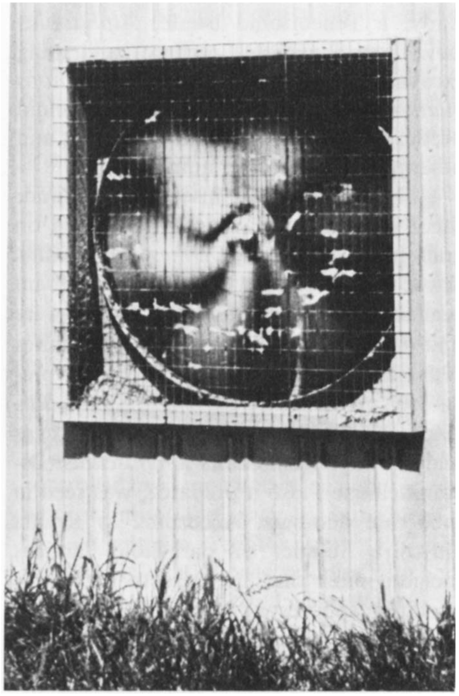
Procedures

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.

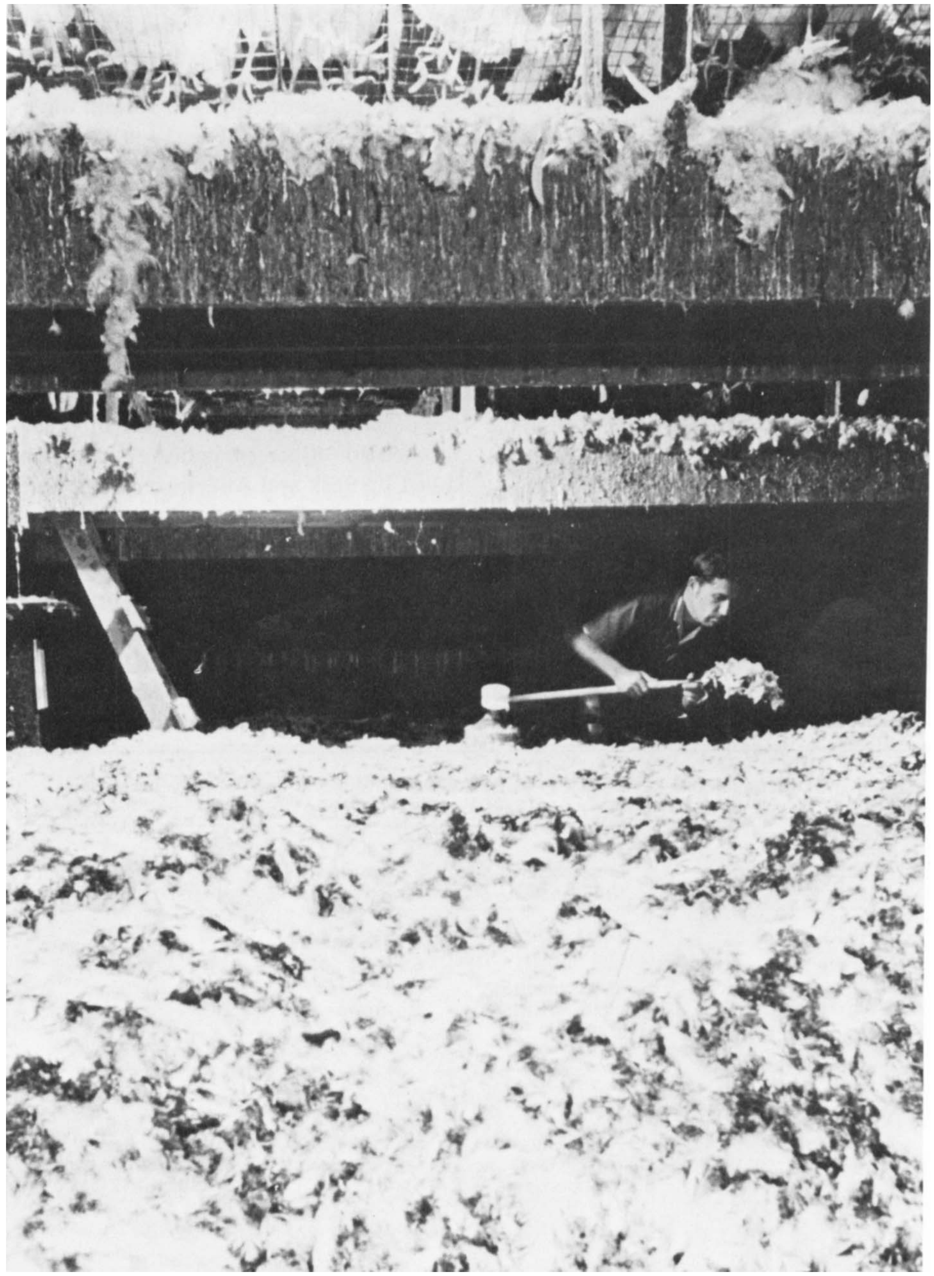
At each station, a plywood board containing a pad of 5-inch x 8-inch white cards was hung in potential fly-resting areas. Fly specks (fecal spots) on these cards were counted.

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.)



Author in hip boots during monthly inspection. Note adult-fly counting card on post at base of ladder and one-gallon emergence cage sitting on manure. (Ranch 4—Escalon, Stanislaus 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 chamber. 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 average 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 opportunity 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 waterers 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 liquified to continue sampling.

Predators

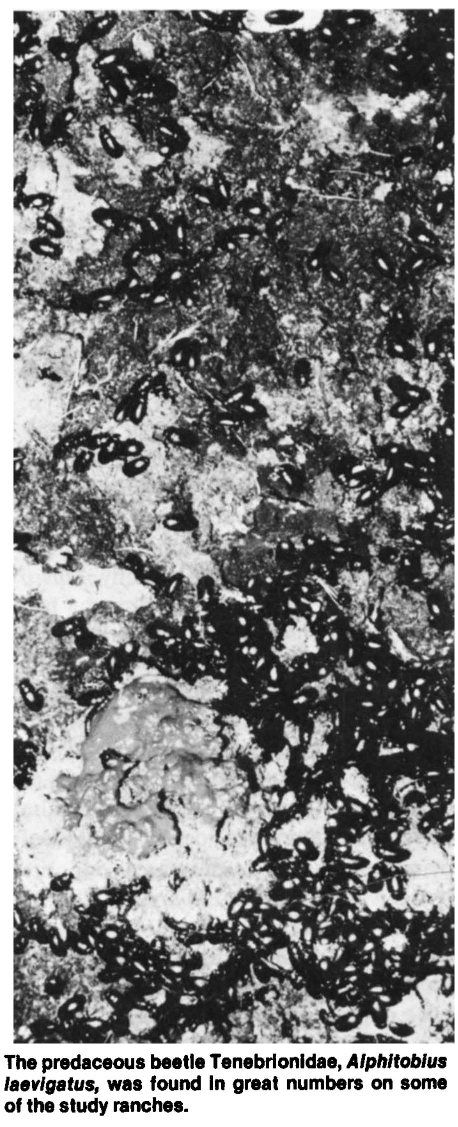
The relative high moisture content of all manures on the six ranches falls within the developmental requirements of predators (50 to 70 percent moisture) as established by Peck and Anderson (1969). Over 20 species of arthropod predators have been found in manure on California poultry ranches. Studies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

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 (Parasitoidea) was represented by the predaceous mite, *Macrocheles muscaedomesticae* (Marcochelidae), which feeds on fly eggs and larvae. *Digamasellus longiusculus* (Digamasellidae), also a predator, was seen in moderate numbers. According to Krantz (1970) a number of parasitoid families include mites that use insects for transportation (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 development.

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

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



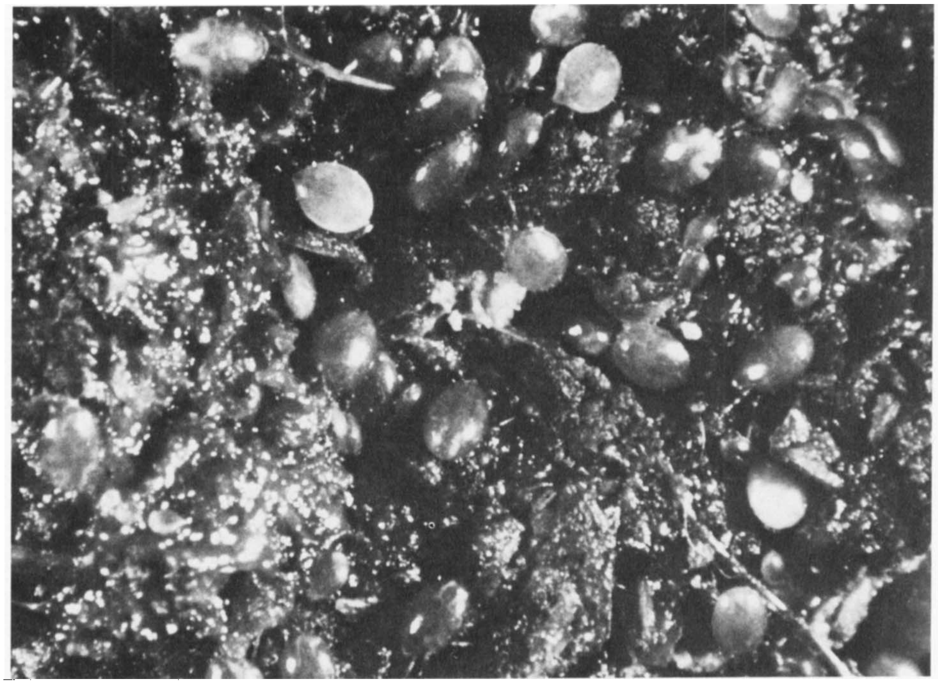
The predaceous beetle Tenebrionidae, *Alphitobius laevigatus,* was found in great numbers on some of the study ranches.

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.



The predaceous mites known to feed on fly eggs were found in abundance; most were Macrochelidae and Uropodidae.

TABLE 2. Total Number of Domestic Flies, Fly Predators, and Parasites Found in Poultry Manure Samples Placed in Berlese Emergence Cages. Sonoma and Stanislaus Counties, California, 1971-72

Ranch No. (months inspected)	Domestic flies*				Other insects†				
	Fannia	Musca	Muscina	Blow fly	A	H	I	S	T
1. (April-June)	85	3	178	15	0	0	6	0	6
(June-October)	0	0	0	0	8	6	2382	23	40
(Dec-March)	0	0	0	0	0	15	6283	86	470
12 month total	**85**	**3**	**178**	**15**	**8**	**21**	**8671**	**109**	**516**
2. (April-June)	3	40	0	0	0	4	4361	1104	4
(July-October)	0	0	0	0	1	24	4820	272	1978
(Dec-March)	0	0	0	0	0	2	2903	75	453
12 month total	**3**	**40**	**0**	**0**	**1**	**30**	**12084**	**1451**	**2435**
3. (April-June)	161	0	1115	232	6	40	1346	154	4
(July-October§)	6	72	106	1	0	2	238	50	9
(Dec-March)	0	0	0	0	0	0	0	0	0
12 month total	**167**	**72**	**1221**	**233**	**6**	**42**	**1584**	**204**	**13**
4. (May-June)	1640	173	1000	19	324	2	122	199	48
(July-Sept**)	826	10	258	63	16	34	2864	262	431
(Nov-March)	8	0	0	0	102	24	4044	224	3717
12 month total	**2474**	**183**	**1258**	**82**	**442**	**60**	**7030**	**685**	**4196**
5. (May-June)	3	1	0	0	0	1	2675	580	2972
(July-Sept)	2	0	0	0	57	3	1394	124	5663
(Nov-March)	1	0	8	0	0	16	3329	5	10610
12 month total	**6**	**1**	**8**	**0**	**57**	**20**	**7398**	**709**	**19245**
6. (May-June)	2	5	3	0	20	371	7414	94	768
(July-Sept‡)	0	0	0	0	33	112	9225	46	217
(Nov-March)	97	0	15	0	0	3	264	0	340
12 month total	**99**	**5**	**18**	**0**	**53**	**486**	**16903**	**140**	**1325**

*Adults and larvae combined.
†A = Anthocoridae, adults of three species.
H = Histeridae: *Carcinops quatuordecimstriatus* and *Saprinus Sp.*, adults and larvae.
I = Ichneumonidae and *Apanteles sp.*, adults.
S = Staphylinidae: *Philouthus sp.*, adults and larvae.
T = Tenebrionidae: *Alphitophagus 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.

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 adulticides can be made above the pit with no effect on predators in the manure below.

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