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A chemosterilant may be defined as a chemical compound that reduces or destroys fertility of the treated animal. There are a variety of compounds which have an anti-fertility effect, and these compounds may attack the reproductive process at any one of its many phases.

Chemosterilants have a good potential as a means of population control of pest animals, because the population may be reduced with little reproductive compensation which normally follows a reduction caused by killing. The number of young produced would be reduced by preventing reproduction or by causing early mortality; therefore, there would be little compensatory increase in reproduction following treatment. Treated animals would remain in competition with productive animals and prevent immigration into and replacement in the population by fertile animals (previously non-productive young). Also there would be little increase in survival rate of the young because competition from the adult population would not be changed. The use of chemosterilants is a practical method of control because it involves inexpensive materials, is easily applied, and can not be detected by the target animals.

Extensive research on chemosterilants has been and is being conducted on a number of species of insects. Populations of several species have been successfully controlled with the chemosterilant apholate (Chamberlain, 1962; Harris, 1962). The amount of research on the use of chemosterilants on birds has been meager. Davis (1962) conducted laboratory tests on starlings and found that as little as 0.1 rag of T.E.M. (triethylenemelamine) for 3 days would inhibit the growth of testes and ovaries. He also found that 0.1 mg per day for 3 weeks caused sexually mature testes to regress. A field experiment on red-winged blackbirds using treated cracked corn showed that T.E.M. caused a 20 to 45 per cent reduction in the number of nestlings (fewer nests and lower hatchability of eggs) in the treated populations (Vandenbergh and Davis, 1962). The size of testes of treated birds was reduced and there was no discernible effect on behavior. Sudan Black

B dye had an embryocidal effect on eggs produced by gulls fed treated bait (Wetherbee, et al., 1964). The anti-fertility effect of a number of compounds was tested on pigeons by Elder (1964). He found that T.E.M. was not effective, but he did find that an anticholesterol agent (SC-12937) inhibited ovulation for up to 3 months.

I selected apholate (an alkylating agent) to test control of reproduction in pigeons and evaluate the effects of reduced birth rate on population growth; however, effectiveness of the chemosterilant had to be assessed first. The acceptability of treated bait was investigated with 18 pigeons which were tested individually for nine different treatments of corn. The pigeons readily accepted treated bait at concentrations up to 1.0 per cent when presented with individual pieces of corn, but 0.3 per cent apholate was the highest concentration pigeons would accept in their daily food (60 mg per bird dosage). Next, the range of dosages that had an anti-fertility effect was determined. Five groups of pairs of pigeons, kept in indoor cages under constant laboratory conditions, were given different dosages (Table 1) in a one-day exposure (except 2 days for the group receiving the 101 mg dosage). Egg production was delayed and hatchability of eggs reduced in the groups receiving 20 mg to 101 mg of apholate per bird (Table 1). Also, the effect of the compound on the social behavior of pigeons was evaluated since an ideal chemosterilant should not change competitive behavior of sterilized birds. The behavior (24 types of sexual and agonistic behavior) of the same 5 groups of pigeons (Table 1) was observed for 10 minutes per group per day. Behavior was not seriously altered by the chemosterilant. Only at 101 mg per bird was there any observable effect on the level of behavior, whereas the frequency of behavior was not affected. Two types of sexual behavior were significantly less following treatment in the 101 mg group, but the reduction was a result of temporary toxic effects of apholate. The birds were inactive for the first week following treatment, but they gradually recovered after 2 weeks to the pre-treatment levels. Birds maintained their nest sites while they were infertile.

Having established that the chemosterilant was effective on pigeons, the compound was used to control reproduction in confined, freely-growing populations to determine the effect on population growth. Five similar populations of pigeons were started simultaneously in outdoor pens under semi-natural conditions. The populations were treated with 140 mg of apholate per bird at different times during the experimental period of 475 days (Table 2-I). The rate of increase of all the treated populations was significantly less than the non-treated population (Table 2-II) because the growth of the treated populations was temporarily halted for several months by the treatment. The change in growth of the treated populations was caused by a significant reduction in the birth rate for about 3 months following treatment. Birds became sexually inactive when treated (Table 2-III); no gametes (eggs) were

Table 1. The effect of different dosages of apholate on the reproduction of confined pairs of pigeons.

Dosage (mg/bird)	No. pairs	Time until 1st egg laid (wks.)	Time until 1st egg laid that hatched (wks)
0	2	3	3
8	3	3	3
20	2	5	9
60	3	5	14
101	2	7	14

Table 2. The effect of apholate (140 mg per bird) on various factors of confined, freely-growing population of pigeons.

	I	II	III	IV	V	VI
Population	Day of treatment	Mean % increase of population	Percent males sexually active (on 475th day)	Days after treatment until 1st egg laid	Days after treatment until 1st egg laid that hatched	Ave. no. deaths total no. (adult & yg.)
1	19	1.08	100	79	94	.024
2	_ (control)	2.53	100	_	_	.017
3	136	1.87	-	44	88	-
	352		91	52	105	.037
4	352	2.20	80	54	120	.015
5	450	1.87	0	-	-	.021

produced for 44 to 79 days (Table 2-IV) following treatment. Even after the treated birds began laying eggs, development of the eggs (embryos) was retarded for another 15 to 66 days (Table 2-V). During this period of infertility (88 to 120 days), treated birds maintained nest sites and incubated non-viable eggs, and their courtship and agonistic behavior was generally unchanged. The mortality rate (Table 2-VI) of the treated populations was not significantly increased by the treatment which supports the conclusion that the control of the population growth was due to a reduction in the birth rate.

The use of chemosterilants is an effective method to control the growth of populations of birds because it reduces the birth rate without affecting the status of the treated birds in the population. Sterile birds would remain in competition with fertile birds, thus preventing compensation in the population. This method of control is practical, humane, and effective in reducing populations of pest birds.

LITERATURE CITED

Chamberlain, W. F. 1962. Chemical sterilization of the screw-worm. J. Econ. Entomol. 55(2):240-248.

Davis, D. E. 1962. Gross effects of triethylenemelamine on gonads of starlings. Anat. Rec. 142(3):353-357.

Elder, W. H. 1964. Chemical inhibitors of ovulation in the pigeon. J. Wildl. Mgmt. 28(3):556-575.

Harris, R. L. 1962. Chemical induction of sterility in the stable fly. J. Econ. Entomol. 55(6):882-885.

Vandenbergh, J. G. and D. E. Davis. 1962. Gametocidal effects of triethylenemelamine on a breeding population of red-winged blackbirds. J. Wildl. Mgmt. 26(4):366-371.

Wetherbee, D. K., R. P. Coppinger, B. C. Wentworth and R. E. Walsh. 1964. Antifecundity effects of Sudan Black B and transovarian intravital staining in avian population control. Univ. Mass. Ag. Exper. Stat. Bull. No. 543: 1-16.

DISCUSSION

DELEGATE: Has there been any resistance to chemosterilants in rats or other vertebrates as there is in insects?

R. MCLEAN: No, chemosterilants have not been in wide, extended use which would be needed for resistance. Though the time required for insects to develop resistance is much shorter than it would be for vertebrates, it's possible that resistance to chemosterilants could occur. The most dramatic case of chemosterilant resistance is in the yellow fever mosquito and this was totally unexpected, and so far I think, unexplained.

DELEGATE: I wondered if anybody had ever done anything along these lines.

R. MCLEAN: Certainly from what I've seen, there are some individual differences in vertebrate susceptibility, and this right away leads to resistance. There were some animals, the 8 milligram group, which were not affected; others were. Right away, of course, these animals may have some resistant factors. But resistant populations would take a much longer period of time.

J. STECKEL: When you were feeding your birds on two separate occasions, your 136th and 352nd day, were you able to determine if there is a carryover, a length of carryover; are you going to get a bird that will be completely sterile?

R. MCLEAN: I didn't investigate this particular factor, so I can't make any conclusions. I think there were some individuals I noticed that did not come back into reproduction after the second time. There was an increased mortality rate I might mention at this time. I don't know whether this chemical is cumulative or not. I didn't test any of the toxic effects, so I don't know.

A. FRISHMAN: If apholate did become available to use for a control, say for pigeons, and you wanted to control a specific building, over how large an area would you have to have this material dispersed, in order to guarantee the control on that one building?

R. MCLEAN: Of course, the first thing you have to determine is where they feed, so you can bait them. And if they feed in a flock this would be much easier, and if they don't feed in a flock, it would be much more difficult. The feeding radius of that local flock or group will determine the baiting radius.

DR. SPEAR: I wonder if you would expand on your use of the word "population." We think of the word megalopolis: everything from here east is a continuous human population. Where are we drawing the line when we are talking of a bird population in this sense?

R. MCLEAN: Population ecologists would like to know, I'm sure. This depends I think if we have any boundaries to particular group of birds. In other words, there is no other interchange with any other groups of birds. You may have a large courthouse or something that has a couple of thousand birds on it. There may not be much interchange with other buildings or areas, and so could call this a population, because it is isolated and does have boundaries. This population develops and probably has pressures on it within this group. But again it depends on the way you're looking on it. If you're considering the whole city, then the pigeons in the whole city are really a population. It all depends on how far you focus your "microscope."

DR. SPEAR: You feel then that you could maintain a population on the courthouse at a level which would fend off invading numbers?

R. MCLEAN: Yes, it would. In other words you would keep enough of an adult population there to prevent any influx or replacement of individuals.

A. FRISHMAN: Apholate is an alkylating agent and under acidic conditions will break down. Did you have any problems in storage since you said you only used it twice a year?

R. MCLEAN: Yes, right. Apholate is a chemical which does break down. It's not a chemical that you can leave out. You do want a short exposure period, because you don't want to leave a toxic chemical, and this is very toxic, by the way, out for any long period of time. But you couldn't keep the chemical around. You'd have to keep the chemical in good condition if you wanted to use it again next year, the same chemical, or the same bag of compound.

T. STOCKDALE: Have you or Dr. Davis or anyone else tried this same chemical with passerine birds, particularly members of the Icterid or blackbird groups?

R. MCLEAN: Preliminary work on starlings, but this is the only species we have tried. We tried to do an LD_{50}. I can't remember the exact data; I think it was quite low for starlings compared to pigeons. It was something like 50 mg, LD_{50} starlings.

T. STOCKDALE: I'm thinking, if we could get a similar retarding in the nesting cycle, particularly with our summer populations of redwings in the Lake Erie marsh region, even a six to eight week delay of the first viable egg, would put the fledgling still in the nest at the time our corn is at its most susceptible stage. It looks like there are a lot of interesting aspects here.

R. MCLEAN: If you eliminate that first nesting, or delay it anyhow.