*Lagoon D* was two small basins, totalling about three acres, attached to a large public institution. The pools had been in use for a number of years but produced no mosquitoes. The reason for this lay in their construction. The outline was rectangular, and the banks were lined with shale which gave footing to a scattered population of annual weeds, none of which extended below the water line. Accordingly wave action and native predators eliminated all larvae.

Chemical methods of larval control are uneconomic in sewage lagoons, as the normally residual larvicides degenerate rapidly in the highly polluted water, making repeated, heavy applications necessary. Fortunately, the environment may be so manipulated that the existing natural control factors become highly efficient.

The most effective deterrents to mosquito production in these pools are wave action and natural predators. Both are inhibited by the presence of emergent or floating vegetation. If the following points are observed in the construction and maintenance of sewage lagoons there is little likelihood that they will become sources of mosquitoes.

1. The area of the pools should be as large as possible, and the establishment of nearby windbreaks should be avoided, so that wave action may be encouraged.

2. The dykes should be wide enough on top to permit the passage of mowers and other maintenance machinery.

3. The banks should have a moderate slope, and if formed of soil, they should be planted to grass and kept mowed.

4. The water should be kept at sufficient depth to prevent the establishment of bottom-rooted vegetation.

5. There should be provision for a rapid draw-down of a foot or so, when this is compatible with the primary function of the pool, to destroy larvae by stranding.

6. Seepage or overflow should be carried away in deep, clear channels.

7. Emergent vegetation should be killed by herbicides or removed mechanically. Floating drift should be cleared away.

8. Coarse fish, such as carp, may be introduced as predators.

**Abstract**

Four sewage lagoons are described that illustrate in varying degree conditions that encourage mosquito production. Steps are outlined by which mosquito breeding in ponds can be prevented.

## CONTROL OF PESTS IN INSECT AND HERBARIUM CABINETS

G. J. SPENCER[1]

For some years I have worked on control of museum pests, chiefly *Anthrenus verbasci* (L.), the varied carpet beetle, which is also the most widespread household pest in Vancouver; *Attagenus piceus* Oliv., the black carpet beetle; *Perimegatoma (Megatoma) vespulae* Milliron, a parthenogenetic species which feeds indiscriminately upon herbarium specimens and dried insects; *Stegobium paniceum* (L.), the drug store beetle; and *Ptinus ocellus* Brown (=*tectus*). We do not yet contend

[1] University of British Columbia.

with *Anthrenus scrophulariae,* the buffalo carpet beetle, which is common as far west as Haney, or with *A. museorum,* the museum beetle, which is a pest in eastern North America. My experiments have employed sprays, baits, and fumigants.

**Sprays**

Before the university museum acquired steel cabinets, I sprayed 5 per cent chlordane once a year around the bases of our wooden cabinets. This was effective in keeping out *A. verbasci* and *A. piceus* but not *P. vespulae;* the adults of this species apparently fly indoors and must oviposit in cracks under the lids of wooden drawers. I have found dead adults on the glass tops of drawers.

Two per cent chlordane and 2 per cent heptachlor are effective applied with a 4-inch wide fine jet to susceptible places or painted on by hand with a 2-inch brush where spray vapour is undesirable. However, treating the edges and lids of drawers is a laborious process and is not very effective after three months.

**Baits**

Herbarium specimens are attacked by three species of beetles: *S. paniceum, P. ocellus* and *Perimegatoma vespulae*. Solutions of mercury bichloride have long been used against these pests in herbaria, but after about one year the mercury sublimes so that the flowers and buds are destroyed and sometimes the leaves.

Canned cat food, dried and pulverized is an excellent medium for rearing household insects. To prepare baits I used 4 per cent Paris green, i.e. ortho-arsenite of copper of about 53-63 per cent arsenious oxide content. This was thoroughly incorporated into 96 per cent wet cat food, which was then dried and pulverized, and put in containers in a deep enough layer that *A. verbasci* larvae could burrow under it. The culture was maintained at 70° F. The larvae readily ate the bait but did not become paralysed. In 24 hours, 8 per cent were dead; in 15 days, 23 per cent; in 3½ months, 88 per cent; and the last died in 4 months.

**Fumigants**

A block of histological embedding wax of 1½ cubic inches was kept on the surface of crude benzene hexachloride in a sealed jar for three weeks until it smelt fairly strongly. Two thin shavings of the wax were cut from the corners and placed in a tight, glass-topped tin box of 3 inches diameter with 25 *A. verbasci* larvae of various sizes taken at random. In 22 hours several were showing circus movements or ataxia which gradually spread until every one was affected and the larvae started to die off. After 17 weeks only one was alive but twitching. It was still in the same condition two weeks later. It appeared that 4 per cent of the larvae showed a degree of resistance to the vapour of benzene hexachloride given off from wax.

One half gram and one gram respectively of lindane (99 per cent gamma isomer) was thoroughly incorporated into 100 grams each of unpurified, natural, beekeepers wax, which was melted, stirred, poured into molds, cooled, and cut up into small pieces. The pieces were rolled by hand into half-inch diameter marbles. About one month after being made, the 'marbles' had a white bloom of lindane. They were transfixed with stout insect pins in the same way that moth balls are prepared for insect cabinets. Into the centre of two clean, empty insect drawers each of 538 cubic inch inside capacity, were stuck one marble each of 0.5 per cent and 1 per cent lindane with 50 *A. verbasci* larvae taken at random from a large culture. The drawers were checked daily.

In both drawers, the smallest larvae became paralysed in 24 hours. In 48 hours those nearest the wax marbles were on their backs, dead. Day by day paralysis affected the larvae; first they showed circus movements, then ataxia, and then they lay upside down apparently dead or occasionally twitching their legs. It became difficult to tell when larvae were really dead so that their reaction to light was used as an index. Ten inches from a 100 W globe the light was 180 foot candles; a beam concentrated through a 1½ inch reading glass at 10 inches was 600 f.c. and at 7 inches, 900 f.c. A severely paralyzed larva normally motionless on its back would slowly twitch its feet in 15 seconds at 600 f.c. and at 900 f.c. within 5 to 10 seconds. If no movement occurred at 900 f.c., the larva was declared dead. Within 30 days at 1 per cent lindane and 37 days at 0.5 per cent lindane, every larva was dead. In both drawers, two out of the 50 larvae survived nearly one week after the others died, again suggesting some resistance in 4 per cent of these insects.

One peculiar feature was the fact that about 25 per cent of the larvae pupated and produced beetles which seldom moved more than about an inch from the pupal case and invariably died upside down 24 hours after emergence.

A local collector complained about book lice infesting his cabinet of insects. I gave him lindane and wax which he made into marbles. He reported to me that 24 hours after these were pinned out every book louse was either paralysed or dead. This happened with fresh lindane marbles before the bloom appeared.

To test lindane vapour further, a 3-inch diameter petri dish, ½-inch deep, was carpeted with fine sand to give good footing, supplied with 7 dried grasshoppers and one bee and then stocked with 50 *A. verbasci* larvae. The petri dish was placed in the middle of an empty insect drawer into which had been dusted one gram of lindane of salt-shaker size. Within 19 hours some larvae had lost the ability to climb on to the food. In three days one was dead, several lay on their backs with legs twitching and the rest showed irregular and circus movements. In 31 days only 4 were alive. In 43 days only one showed any twitching under prolonged light of 600 f.c. and in 54 days this one was dead. Lindane vapour must take effect relatively fast because no larva attempted to chew the dead insects or to tunnel into them.

A test with the black carpet beetle and lindane showed that mature and nearly mature larvae of this species are more resistant than *A. verbasci* larvae. Into a cabinet drawer full of irregularly pinned-out large and small insects was dusted evenly one gram of coarse lindane crystals averaging 1mm x 0.5mm. Twenty-five mature and early mature *A. piceus* larvae were added. Within 24 hours they showed irregular back and forth, but not circus movements. In a few days some were dead or dying; after 12 days the remaining 19 were removed and placed in an empty petri dish in a clean untreated drawer to see if recovery occurred. Three survived after 28 days. These were transferred to a clean tin with normal food; 12 days later another one apparently recovered and was similarly transferred, with food. These recovered larvae were left undisturbed for 7 months and were then checked: the single one had died, and of the three larvae, one had transformed into a beetle which had died and the other two were paralysed, lying on their backs twitching when disturbed. Turned right side up, the larger one slowly burrowed into the food but the smaller seemed unable to burrow. It is likely that they had eaten some food during the 7 months.

Another 25 larvae from the same stock were put into the drawer with coarse lindane. The effect of the poison was more rapid than it had been on the first group. In 6 days most were dead or paralysed and 11 showed movement under 600 to 900 f.c.; one larva seemed stimulated and crawled slowly and incessantly; in 18 days this was the only survivor and it finally died on the 49th day.

These experiments show that 1 gram of lindane scattered on the floor of a drawer of insects will immobilise and eventually kill dermestid larvae and should prevent others from becoming established. One ounce of lindane will treat 28 drawers for a year.

## BACKGROUND FOR INTEGRATED SPRAYING IN THE ORCHARDS OF BRITISH COLUMBIA

J. MARSHALL
Research Station, Summerland, B.C.

The practical meaning of integrated spraying is the production of a maximum crop of high quality fruit with a minimum of pesticides. In controlling our orchard pests the idea is to work with Nature as closely as we can rather than to disregard her by relying blindly on preventive spraying and "shotgun" spray chemicals. The ultimate objective is to improve our competitive position, and stay in business.

In 1944 Country Life in British Columbia (28:6, 5) carried an unorthodox item on orchard pest control. Titled, "Is it advisable to spray for the three types of mites in B.C. orchards?", the article was a forerunner of a number of others, published elsewhere, that are helping to put orchard pest control on a logical basis. That early item drew attention to the importance of natural factors in controlling orchard pests. It pointed out that when a spray treatment kills beneficial species as well as pest species, it may, in the long run, do more harm than good. In local orchard circles the article aroused brief speculation. Then this entomological firecracker quietly fizzed out. Like the American Austin it was ahead of its time.

But, during the intervening years, things have been happening in the entomological world. In 1946 Pickett, Patterson, Stultz and Lord (Scientific Agriculture 26:11) published the first of a series of articles dealing with the influence of spray programs on the fauna of apple orchards in Nova Scotia. Their well documented work aroused considerable discussion. It stimulated inquiry in various other fruit growing areas; notably in Holland, Belgium, Great Britain and California. The outcome has been the firm realization that we cannot hope to subdue our orchard pests by any one method of control; and, in particular, that chemical control should be applied with caution. During the last 10 or 12 years this note of caution has been heavily underscored by the development of resistance to pesticides in a wide variety of noxious insects and mites.

For many years it had been known that insects might become resistant to such very different inorganic