sirup or nectar and will incapacitate bees for a few hours in quantities that are even less than the indicated L/D-50 amounts. Tetraethyl pyrophosphate and parathion in particular are highly toxic to bees when the chemicals are ingested. All three phosphates killed bees through contact with dusts or treated surfaces, indicating that, if bees come in contact with the dusts or treated surfaces, while working on plants, loss of bees may occur. Furthermore, surfaces covered with dusts or sprays containing parathion will kill bees through fumigant action when bees do not come into contact with the treated surfaces. This action is quick enough and lasts over a sufficiently long period to make this compound a potential hazard to pollinating insects if it is applied when plants are in bloom. The residual action of parathion apparently is longer than that of TEPP and, consequently, has greater killing power.

Aqueous solutions of hexaethyl tetraphosphate and tetraethyl pyrophosphate lose their toxicity within one to three days, depending on their concentrations, and in this regard will create a far less hazardous situation for bees than other insecticides with longer residual action.

Since it appears that the phosphates can be used effectively at very low concentrations, as compared with many of the older insecticides, and their residual action is of shorter duration, the potential hazards to beekeeping will not be serious if the phosphates are applied prior to or after the blooming period of plants which are attractive to bees. Only large-scale applications of the phosphates can reveal their actual relation to beekeeping and to pollinating insects in general.

Mosquito Larvae

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SINCE THE DISCOVERY that DDT was a phenomenal mosquito larvicide it has been rapidly replacing the other two formerly used materials, oil and paris green. Many other new insecticides have been suggested for use on mosquito larvae but they have not been definitely proven superior to DDT and at present they are at a disadvantage on a cost basis. Since February, 1947 laboratory larvicide tests have been conducted to observe the mode of action of various insecticides and to compare the susceptibility of different species of mosquitoes. Materials used have included DDT, DDD, chlorinated camphene—Toxaphene—chlordan, benzene hexachloride, and parathion. All of these were extremely toxic to mosquito larvae but the only one definitely of a higher order than DDT was parathion.

Early fourth instar larvae were transferred on a net-covered wire loop from rearing pans to heavy china cups. The cups were of two sizes, holding 100 cc and 200 cc but with liquid the same depth in each type. Ten larvae were used in the smaller cups and 20 in the larger. The two species used in the tests with parathion were *Culiseta incidens* (Thomson), reared in the laboratory from egg rafts, and *Aedes squamiger* (Coquillett), collected as early instars in brackish water and reared in 0.5% NaCl—sodium chloride—solution. While being reared, the larvae were fed a mixture of ground dog biscuit and yeast, and appeared to thrive on this diet. The test period was 48 hours without food, the *C. incidens* in distilled water and the *A. squamiger* in 0.5% NaCl solution. Dilutions of DDT were prepared from a stock mixture of 20 grams of technical grade made up to 100 cc in xylene containing 10% Triton X-100. A graduated 1 cc pipette was used to transfer the DDT to the test cups from dilutions of 1 to 10,000 and 1 to 1,000,000 by weight in distilled water (disregarding weight of the solvent and emulsifier). Parathion dilutions were prepared in the same manner except that the stock solution contained 1 gram of insecticide (96% to 98% pure) made up to 100 cc in xylene and Triton X-100.

TABLE 1—Toxicity of Parathion and DDT Emulsions to C. Incidens (Thomson); Water Temperature About 23° F.; Length of Tests 48 Hours

Larvicide and dilution by weight in water	Number of tests	Total number of larvae	Per cent mortality
Parathion			
1–30 million	3	60	100.0
1–50 million	5	100	100.0
1–100 million	5	100	91.0
1–200 million	3	50	26.0
1–400 million	1	20	5.0
DDT			
1–10 million	2	40	100.0
1–30 million	5	100	88.0
1–50 million	5	100	44.0
1–100 million	5	100	8.0
1–200 million	2	40	2.5
1–400 million	1	20	0
Checks	5	100	0

TABLE 2—Toxicity of Parathion and DDT Emulsions to A. Squamiger (Coquillett); Water Temperatures About 23° F.; Length of Test Period 48 Hours

Larvicide and dilution by weight in water	Number of tests	Total number of larvae	Per cent mortality
Parathion			
1–50 million	5	50	100.0
1–100 million	10	100	98.0
1–200 million	10	100	17.0
1–400 million	10	100	5.0
1–800 million	2	20	5.0
DDT			
1–1 million	2	20	100.0
1–10 million	10	100	80.0
1–30 million	10	100	65.0
1–50 million	10	100	47.0
1–100 million	10	100	5.0
1–200 million	2	20	0
Checks	10	100	1.0

Earlier experiments had emphasized the extreme care needed to insure chemical cleanliness of the test cups. It was found that washing in tap water followed by two rinsings in benzene sometimes left a toxic residue. The entirely satisfactory method finally employed was to rinse the cups in tap water, scrub them three times with paper toweling and hot detergent solution, and place them in a drying oven for an hour at 100° C.

Toxicity tests comparing parathion with DDT are given for *C. incidens* in table 1 and for *A. squamiger* in table 2. Mortality was determined by assuming on the basis of previous tests that larvae which were unable to coördinate their movements; that is, to come to the surface, to go to the bottom, or to swim in a normal manner, were destined to die and would not survive even if transferred to ideal rearing conditions.

As shown in table 1, parathion is completely toxic at a dilution of 1–50 million as compared with DDT at 1–10 million. The median lethal dose for parathion falls between 1–100 million and 1–200 million, whereas that for DDT falls between 1–30 million and 1–50 million.

Aedes squamiger appears to be more resistant to DDT than *C. incidens* under conditions of the test as shown in table 2, but the two insecticides have the same relative position. Parathion is completely toxic at a dilution of 1–50 million as compared with DDT at 1–1 million. The median lethal dose for parathion falls between 1–100 million and 1–200 million, whereas that for DDT approximates 1–50 million.

The feasibility of using parathion as a mosquito larvicide will depend on numerous factors still unknown. Two important items are the cost of the material and its residual properties. The effect of parathion on fish and other beneficial water life, and its pupicidal qualities are other points to be investigated.

Spring Dwarf Nematode

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The spring dwarf nematode, *Aphelenchoides fragariae* (Ritzema Bos), causes a disease of strawberry that is commonly known as dwarf or crimp.

The nematodes infest the leafbuds and cause distortion and crinkling of the leaves as well as reduction of the leaf size. Fruit buds are also attacked resulting in blinding of the buds, accompanied by reduction in fruit yield. The spring dwarf nematode does not invade the plant tissue but feeds upon the external leaf surfaces within the folded buds. This nematode has been found infesting strawberries in fields located at Escalon and Irvington. It is also reported to occur in strawberry fields in Centerville, Morgan Hill, and Watsonville. At Escalon and Irvington approximately 80% to 95% of the plants are infested with this pest. The number of nematodes per leafbud varies from a few to as many as 8,000.

There is, at the present time, no satisfactory method of controlling spring dwarf nematode in the field. Clean planting stock and rogueing of infested plants are suggested as the most practical control methods by workers in the eastern United States where this nematode is an important pest of strawberries. Rogueing does not appear to be practical in California because of the high percentage of plants infested with the nematode.

Preliminary laboratory tests indicated that parathion was toxic to larvae of the root-knot nematode. Since the nematicides that are commonly used in the fumigation of soil are extremely toxic to living plants, it was thought that parathion might be a possible means of controlling spring dwarf nematode on infested strawberry plants in the field. On October 23, 1947, a single row of strawberries was sprayed with 15% wettable parathion powder, at the rate of 0.45 pound of parathion per 100 gallons of spray mixture. Four ounces of "Ultrawet" wetting agent were added per 100 gallons of spray mixture. This spray was applied at 200 pounds pressure. Samples from treated and untreated plants were examined three weeks after application of the parathion. Fifteen leafbuds from the sprayed and unsprayed plants were dissected in a syracuse watchglass and the number of nematodes per bud recorded. When large numbers of nematodes were present, aliquot samples were taken. The sprayed buds averaged 108 nemas per bud as compared to 498 nemas per bud in the unsprayed plants.

On November 13, 1947, one half of the previously sprayed row was treated with parathion at the rate of 0.5 pound of parathion per 100 gallons. The parathion was contained in a 25% wettable powder. Four ounces of Du Pont spreader-sticker were added per 100 gallons of spray mixture. This spray was applied at 200 pounds pressure. On November 24, 1947, 11 days after the last treatment, the plots were again sampled and the number of live nematodes per bud recorded. These results are given in table 1.

TABLE 1

Number of Live A. Fragariae in Strawberry Leafbuds from Single Sprayed, Double Sprayed, and Unsprayed Plants

Bud No.	Untreated	Single treatment 0.45 lb. Oct. 23	Two treatments 0.45 lb. Oct. 23, 0.5 lb. Nov. 13
1	625	2680	0
2	9280	30	0
3	189	340	0
4	172	0	0*
5	1760	0	0
6	2	0	0
7	1280	920	1
8	0	0	0
9	0	0	0
10	2280	280	0
Average per bud	1558	425	0.1

* Nematodes not present in sample.

TABLE 2

Number of Live A. Fragariae per Leafbud in Untreated and in Treated Plants Receiving Two Parathion Sprays, One Oct. 23 and One November 13

Bud No.	Untreated	Two treatments	
		Sample 1	Sample 2
1	960	7060	0
2	1620	782	200
3	1100	1	0
4	440	0	87
5	1860	0	7
6	480	300	4
7	21	2	0
8	320	0	280
9	118	1	20
10	436	5	780
Average per bud	735	815	137

Additional buds were examined from the plants that had been sprayed with two applications of parathion. Occasionally buds were found that contained a few *A. fragariae* that exhibited slight movement. However, these nemas appeared to have been affected by the treatment since this species is normally very active when placed in water.

On December 3, 1947, 20 days after the last treatment additional samples were taken from the strawberries that had received two spray treatments with parathion. Results obtained from these samples are given in table 2.

Additional counts were made on the sample taken on December 3, 1947, by tearing apart 10 sprayed and 10 unsprayed buds in 400 ml. of tap water and counting the number of nematodes