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By

Yun-An Tang and Tung-Pai Chen

TAIPEI, TAIWAN, CHINA

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INTRODUCTION

It is generally recognized by fisheries biologists that the chironomid larvae form an important item in the food of young and adult fishes, and the growth of this group of insects in fish ponds is considered beneficial. However, the occurrence of these larvae in milkfish ponds was considered undesirable and the control of these larvae was considered one of the major problems by Tang and Chen (1957), when they carried out experiments on the fertilization of milkfish ponds and found that these larvae in the pond bottom competed with milkfish for food (benthonic algae) and destroyed the "algal beds"[1].

The Tainan Fish Culture Station of the Taiwan Fisheries Research Institute has been conducting experiments on the control of chironomid larvae in milkfish ponds since 1955. The major objective of these experiments is to search for selective poisons which would be toxic to the chironomid larvae at a minimum concentration and, at the same concentration, non-toxic to the milkfish and also harmless to the growth of the benthonic algae in the pond. The use of technical γ-BHC dust at the concentrations of 0.08 to 0.1 p.p.m. as a method of control was first recommended to the fish farmers by the Station in 1956. A year later, an improved method by the use of Diazinon dust at the concentrations of 0.06 to 0.08 p.p.m. was recommended. These methods have been rapidly adopted. It is estimated that an amount of approximately 1,000 to 1,500 metric tons of 1.0 to 1.5 per cent technical γ-BHC and Diazinon dusts has been used in milkfish culture in Taiwan annually since 1957.

The search for more effective chemicals and methods to combat the chironomid larvae in milkfish ponds is, as in all plant protection work in agriculture, a never-ending task. This paper reports the methods which have been developed by the Station and widely used by the fish farmers throughout the Island during the past years. Available data regarding the occurrence of these larvae in milkfish ponds are also presented.

The experimental work described in this paper is a part of the cooperative program undertaken by the Taiwan Fisheries Research Institute and the Chinese-American Joint Commission on Rural Reconstruction with the purpose of improving the milkfish cultural practice in Taiwan. The work was done at the Tainan Fish Culture Station, and the facilities necessary to the carrying out of the study were made available by the Joint Commission's financial assistance.

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[1] The term "algal beds" is used to designate the thin layer of stiff mud rich in vegetable gelatins at the topmost layer of the bottom soil formed by repeated desiccations of the alternating algal and sediment laminae in a period of years.

SECTION 1

GROWTH HABITS OF CHIRONOMID LARVAE IN MILKFISH PONDS

A. GENERAL DESCRIPTION

The larvae of this chironomid, ***Tendipes*** **(=*Chironomus*) *longilobus*** Kieffer[1], are cylindrical, deep red in colour, and of about 10 mm. in length. They occur in great concentration and construct numerous tubes to form a network among the algal mats on the surface of the pond bottom. The tube is fragile and composed of fragmented algae cemented together with salivary secretion. But in the water supply canals beside the ponds where no algae are present on the bottom, fine silts are the principal material for their tube construction. The larvae are strictly herbivorous and feed entirely upon algae and other decayed organic matters. The eggs of this chironomid are deposited in strings of jelly attached to weeds, stones, and other solid objects on the water surface along the side of the pond. The eggs are oval in shape and measure about 280 μ in the long diameter. They are arranged in one row in the jelly strings. These eggs usually hatch within 3 days at a temperature of approximately 30^0 C. The newly-hatched larvae are colourless and live in the masses of jelly-strings for a few days. They then burrow in the pond bottom and begin to live on the benthonic algae. At this stage, the larvae have become brilliant red in color.

B. ENVIRONOMENTAL REQUIREMENTS

Fisheries biologists are generally aware that the larvae of most species of chironomid in fresh water occur in shallow water areas (see also Tang, 1954) and thrive in vast number on the bottom exceedingly rich in decayed organic matters. The natural environments of milkfish ponds, as described by Schuster (1952) and Tang and Chen (*op cit.*), apparently fulfill these requirements except that the water of this type of ponds is brackish.

Investigations made in the years 1955 and 1956 have proved that salinity is a determining factor governing the occurrence of these larvae in milkfish ponds. The fluctuations of salinity in ponds shown by daily records and an analysis of 1,296 bottom samples taken weekly by a modified Ekman dredge (Figure 1) from ponds at various locaities in Tainan throughout the fish rearing season from April to November are given in Figure 3. From this figure, it will be observed that, during the period from April to June, due to the increase of natural evaporation caused by the rise of temperature and the continuance of dry weather, the salinity of pond water increased from the normal of 35 per mille to approximately 70 per mille. During this period, few chironomid larvae could be found in these ponds. This scarcity of the larvae was probably due mainly to the rise of salinity to a point these larvae were unable to tolerate. With the coming of the rainy

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[1] This species of chironomid was identified by Dr. James E. Sublette, Southwestern State College, Louisiana, U.S.A. He also informed the writer that the original description was somewhat incomplete but from the illustration of the male genitalia the identification was positive. The original description of this species was published in "Tendipedids (Chironomids) de Formosa. Annles Musei Nationalis Hungarici, Vol. XIV, P. 107"

season in June-July, however, the salinity of pond water lowered rapidly due to dilution by rain water. The salinity at this time declined to 35 to 20 per mille, and the chironomid larvae appeared immediately and reached the highest peak of abundance. The highest record of these larvae from one pond during this period in 1956 was 40,982 individuals with a weight of 69.68 grams per square meter of bottom. In average, it ranged from 20 to 50 g./m^2 or 200 to 500 kg./ha. The chironomid adults (midges) and their egg strings could also be found in numerous numbers among the weeds of the pond margin during this period. With the continuance of the rainy season, the salinity of the pond water further dropped to approximately 5 per mille in the latter part of September, when the growth of these larvae was reduced to a minimum quantity. This diminished growth was probably due in part to the dropping of salinity to an extent too low to allow these larvae to thrive. With the passing of the rainy season in the early part of November, the salinity of the pond water rose rapidly again. This rise of salinity came to an end at the latter part of November when the fish rearing season was over. The growth of these larvae during this period correspondingly increased with the rise of salinity in the beginning and decreased again in the middle part of this period when the minimum water temperature dropped below 25^0 C. Finally they disappeared entirely from the ponds at the end of fall when the minimum water temperature dropped below 20^0 C.

Field observations in the water supply canals where the salinity was kept constantly at about that of normal sea water, found very small number of these chironomid larvae even in early April, when the minimum water temperatures rose to above 25^0 C.

The abundance of these larvae in the milkfish ponds during the rainy summer season was associated with the food materials available. The bottom sample analyses made in 1956 showed that the heavier the growth of the benthonic algae, the greater was the abundance of these chironomid larvae.

The only predatory organism to these chironomid larvae found in milkfish ponds was the larvae of a hydrophilid, *Berosus* (*Enoplurus*) *fairmaiyei* Zaitzev[1]. These hydrophilid larvae occurred regardless of the fluctuations of salinity but increased in number with the increase of the occurrence of the chironomid larvae. Because these predatory hydrophilid larvae occurred only in limited quantity in milkfish ponds, no repressive effect upon the change of the chironomid larvae population could be found.

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[1] According to the identification made by Dr. Hugh B. Leech, California Academy of Science.

Fig. 1. A modified Ekman dredge for the quantitative study of bottom organisms in milkfish ponds has been designed and was used in the past four years. This apparatus is very efficient and convenient for use in shallow waters with hard bottom mud.

Fig. 2. A method for the application of pesticides in milkfish ponds has been developed and is being widely used by fish farmers throughout the Island. In operation, one man (right) handles the raft and another (left) deals out the diluted preparation as evenly as possible to cover the entire pond area.

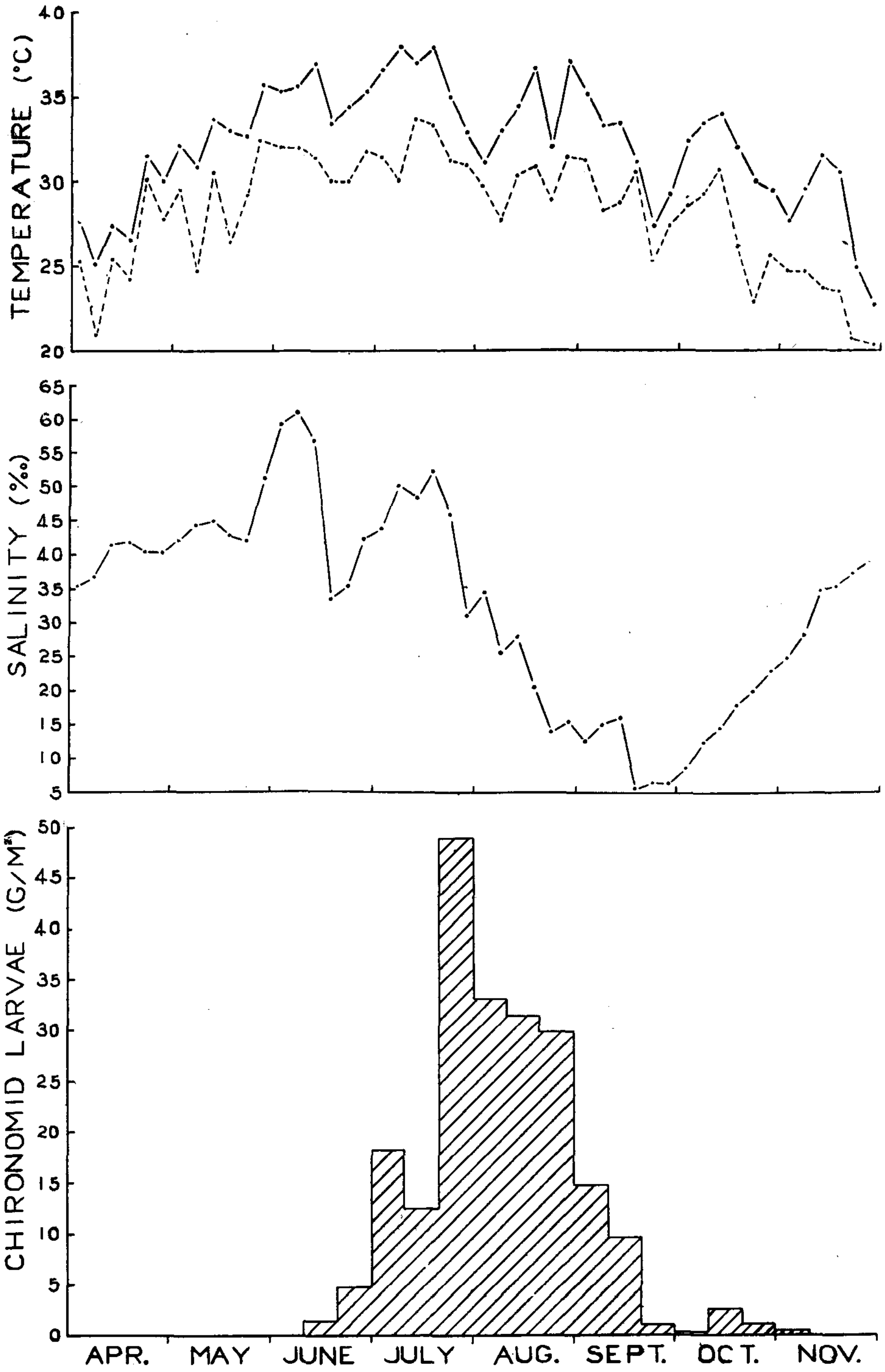

Fig. 3. Occurrence of chironomid larvae (*Tendipes longilobus*) in relation to the fluctuations of salinity and temperature in milkfish ponds during the fish rearing season from April to November in 1956. ——•—— maximum temperture; — — • — — minimum temperture.

SECTION II

EVALUATION OF CHIRONOMID LARVAE CONTROL IN MILKFISH CULTURE

A. CHIRONOMID LARVAE AS A NOXIOUS INSECT IN MILKFISH CULTRE

The fish population in milkfish ponds is exclusively composed of the various size groups of the species ***Chanos chanos*** (Forskal). They are strictly herbivorous, and their diet in brackish-water ponds under harvestable size is exclusively the benthonic algae consisting of the various species of the filamentous blue-green algae and diatoms (Schuster, 1949). In managing the milkfish ponds, one of the most important procedures is to properly apply the fertilizers to the ponds for the purpose of increasing the growth of the benthonic algae (Tang and Chen *op. cit.*). Many workers have indicated that the growth of the benthonic algae is directly proportional to the milkfish production in ponds (Markus, 1941; Yamamura, 1942, etc.). Accordingly, any organism which consumes these benthonic algae or hinders their growth in milkfish ponds should be considered as undesirable. The chironomid larvae in the milkfish pond, as their food habit and tube making behavior indicate, are obviously noxious insects in milkfish culture. Due to the fact that they occur in the pond bottom in great concentration, the control of these larvae in milkfish ponds is of prime importance to the fish farmers.

Schuster (*op. cit.*) has briefly mentioned that a vast number of chironomid larvae occurred in certain period in the milkfish ponds of Indonesia and were considered as beneficial to the consistency of bottom soil, since he often found the soil pierced by millions of very small holes and mistook that these holes were made by the chironomid larvae. After an intensive study of the growth of the bottom fauna in the milkfish ponds of Taiwan, it has come to light that the oligochaetes (a group of bottom organisms next in dominance to the chironomid larvae in milkfish ponds) are responsible for making the holes in the bottom soil. As the chironomid larvae occur only on the topmost layer of the pond bottom and their tubes are constructed only on the mats of the benthonic algae, their influence on the soil consistency is apparently small.

B. BENEFITS FROM CHIRONOMID LARVAE CONTROL IN MILKFISH CULTURE

1. Elimination of Milkfish's Food Competitors From Ponds

The chironomid larvae in milkfish ponds mainly consume, as described in the previous section, the algae and vegetation detritus among the algal mats on the surface of the bottom, which are exactly the feeds prepared for the milkfish. Because these larvae occur in tremendous number, the quantity of benthonic algae lost by their consumption is appreciable. It is estimated that during the early part of the rainy season when these larvae attain the estimated quantity of 200 to 500 kg/ha., the daily loss of benthonic algae is approximately 30 to 60 kg/ha.

2. Prevention of the Loss of Organic Matter Content From Pond Bottoms

The importance of organic matter content in the bottom soils for the growth of benthonic algae in milkfish ponds has been stated by Schuster (*op. cit.*). The chironomid larvae in the bottoms of milkfish ponds, besides consuming the benthonic algae, also feed on the organic matters, particularly the vegetable gelatins extracted by the desiccation of the algae in the topmost layer of the bottom soil, when the tender algae are insufficient or exhausted. They convert the algae and other organic matters into animal protein to grow and finally emerge from the pupal stage to become chironomid adults. Consequently, the amount of algae and organic matters consumed by them would not be returned to the ponds.

3. Protection of "algal beds"

One of the environmental requirements for the growth of the benthonic algae in milkfish ponds is the formation of the "algal beds". The importance of the "algal beds" for the growth of these algae in the milkfish ponds of Taiwan has been described by Tang and Chen (*op. cit.*). Fish farmers in Taiwan usually pay a great deal of attention to the treatment of these beds in their management practice. The "algal beds" must be reformed by subaerial desiccation when they attain a colloidal condition. During the rainy summer season, many factors, such as typhoon and freshet, may bring about the destruction of these beds, but the occurrence of these chironomid larvae is considered as one of the causes that invariably bring them to ruin. Especially in the early part of the rainy season when the larvae appear in great concentration, these beds are usually broken down by numerous perforations made by their tubes. After the "algal beds" are destroyed by these larvae, the milkfish ponds would suffer a series of damages: (1) The algal mats would separate easily from the pond bottom as a result of wave action and float to the surface forming the scums; (2) The filamentous bluegreen algae which form the main part of the benthonic algae would wither or die; (3) The plant nutrients would be released from the bottom soil and dissolved in the water to become available to the plankton algae; (4) The fertilizers and the remains of feed materials in the pond would turn to stimulate the plankton bloom. In the event of plankton bloom in the pond water, the damage would be more serious, because the tremendous number of these suspended organisms would prevent the growth of the benthonic algae by shutting out the sunlight (Tang and Chen, *op. cit.*) and reduce the capability of maintaining large fish population in ponds by the depletion of the dissolved oxygen. It would appear that the elimination of these chironomid larvae from the bottoms of milkfish pond is important for prolonging the growth period of the benthonic algae and help maintain the supply of natural food during the rainy season.

C. EFFECT OF CONTROL OF CHIRONOMID LARVAE ON FISH PRODUCTION

In order to obtain the information regarding the effect of the eradication of these chironomid larvae from milkfish ponds on fish production, experiments were conducted at the experimental ponds of the Station in 1957 and 1958 and showed that complete control of these larvae by the application of insecticides during the period when they infested the ponds resulted in an increase of milkfish production from 20 to 35 per cent within that period. The fish farmers in Taiwan now generally recognize that, with the use of insecticides to eliminate these noxious larvae in milkfish ponds, approximately 1/2 to 2/3 of the quantity of fertilizers and feeds used during the infestation periods in the previous years of no control treatment would be quite enough to maintain an average standing crop of about 2,000 kg./ha. from each fish rearing season[1]. In other words, by the use of insecticides to control these chironomid larvae in milkfish pond, approximately 1/3 to 1/2 of the quantity of fertilizers and feeds could be saved during the period of infestation each year.

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[1] Detail information concerning the methods and materials for the fertilization and supplemental feeding and the standing crop of a fish rearing season in the milkfish ponds of Taiwan was given by Chen (1952) and, Tang and Chen (*op. cit.*)

SECTION III

METHODS OF CONTROL

In the search for preparations which are to be recommended as selective poisons for the control of these chironomid larvae in milkfish ponds, it is not only necessary that the chemical should be as effective as possible against these larvae, but also its toxicity to mikfish should be very slight and it should not have harmful effect on the growth of the benthonic algae in the pond under the same natural environments. Therefore, this experiment should consist of two steps: (1) test on toxicity of various insecticidal products to chironomid larvae and milkfish for preliminary screening to obtain the preparations with the highest effectiveness against the chironomid larvae and the greatest safety to the milkfish and (2) trial use of these selected preparations in ponds to observe the growth of benthonic algae as well as the production of milkfish in water with these chemicals.

In recent years, a number of synthetic insecticides have been placed on the market for use in plant protection and sanitation. Most of these products are highly toxic to various groups of insects at very low concentrations. But, at the same time, the toxicity of these chemicals to other cold- and warm-blooded animals is also high. The fish farmers should be careful in handling these materials, as they are toxic to fish as well as humans even at low concentrations.

A. PRELIMINARY SCREENING OF INSECTICIDES BY TOXICITY EXPERIMENT

1. Experimental Procedures

The methods used in determining the lethal dosage of various chemicals to the chironomid larvae and milkfish in laboratory were based on the principles of the bio-assay methods described by Doudoroff (Doudoroff *et al*, 1951). The water was supplied from a canal connected with the sea. This sea water was pumped to a concrete tank through a series of gravel and sand filters and distributed to each test container by piping. The container was made of concrete and could hold 260 litres of water. When the chironomid larvae were used as test animals, the bottom of the container was filled with 3 to 5 cm. of silts taken from the milkfish ponds so that the environments of the test container would represent as nearly as possible the actual conditions as encountered in ponds. The test larvae were placed in the container for 24 to 48 hours, in order to allow them to complete their tubes and live there for a while; then the preparation was added. These chironomid larvae were collected from the bottom of the milkfish pond during the period of infestation, but the mikfish fingerlings were from the nursery ponds of the Station and had been reared for 3 to 5 weeks starting from the fry stage. These fingerlings measured from 30 to 60 mm. in total length and each weighed from 0.5 to 1.5 grams. The experiments were usually run for 96 hours for both the chironomid larvae and milkfish fingerlings. But some of the experiments with the preparations developed from chlorinated hydrocarbons, such as DDT, Dieldrin, etc., which have a tendency to accumulate in the organisms were run for one week or longer. Becaue of the lack of constant-temperature control equipment, the test temperatures indicated in these experiments varied with the change of weather condition, ranging from 28° to 34°C. A study of the record of the temperature fluctuations during the periods when the ponds were infested with these larvae showed that this range of test temperatures was satisfiactory for the purpose of this experiment. The salinity of the water was regulated to 25 to 30 per mille by dilution with tap water, in order to obtain the salinity suitable for the growth of these larvae under natural condition.

The lethal dosages of preparations are expressed in numbers to indicate the percentage of mortalities of the test animals (e.g. LD_{100}, the dosage at which 100 per cent of the test animals died within a specific period of exposure). They are to indicate the upper and lower limits of concentration that the test animals can tolerate. The median lethal dose (LD_{50}) as commonly expressed in pharmacological studies is apparently unnecessary for the purpose of this experiment. All chemical concentrations expressed in this paper are based on the basis of active ingredients, not on the products as formulated by the manufacturer.

2. Toxicity Ratio of LD_0 for Milkfish to LD_{100} for Chironomid Larvae

The toxicity ratio of LD_0 for milkish to LD_{100} for chironomid larvae is the ratio of the minimum disabling dosage for mikfish to the minimum effective dosage against chironomid larvae. Based on the results of laboratory bio-assays, the value of the ratio "LD_0 for milkfish: LD_{100} for chironomid larvae" of a preparation is a factor indicating the degree of safety to milkfish for that particular preparation used for chironomid larvae control in milkfish ponds. The greater the value of this ratio, the higher will be the degree of safety to milkfish.

Any chemical used to combat the chironomid larvae infestation in milkfish ponds must be free of harmful effect on the milkfish. Therefore, the determination of the values of the ratio "LD_0 for milkfish: LD_{100} for chironomid larvae" of the preparations is not only a means for preliminary screening the large and diverse series of insecticidal products, but it also enables the fisheries workers to arrive at safe and effective concentrations for the selective poisoning of these larvae in ponds.

The results of our laboratory experiments on toxicity of various insecticides to the chironomid larvae are given in the Appendix Tables 1-L to 31-L and those of parallel trials to milkfish fingerlings are presented in the Appendix Tables 1-F to 31-F. The LD_{100} for chironomid larvae and the LD_0 for milkfish of various insecticides for 48 and 96 hours respectively are summarized in Table 1. The values of the ratio "96-hour LD_0 for milkfish: 48-hour LD_{100} for chironomid larvae" of these preparations are also listed in this Table. The range of the values of this ratio shown in this Table is from 0.001 to 250. It is obvious that the preparations which have the values of this ratio of less than 1 are absolutely unusable for the selective poisoning of these larvae. The value of 1 is a hypothetical safety range under laboratory condition. Practical control experiments in ponds have shown that, with manual application of the preparations, even when the value of this ratio was approximately 5, some milkfish were killed by being trapped in the concentrations of greater than the LD_0, or, in some cases, decreased feeding or distress due to intoxication might be noticed with the result of retarded growth (based on the results of the control experiments in ponds with emulsified Diazinon and Malathion dust). Therefore, the value of this ratio of 5 is set as the critical safety range for preparations used for control of chironomid larvae in milkfish ponds. Accordingly, the preparations which have the values of this

Table 1. Summary of Comparative Tests of Various Insecticides for Toxicity to Milkfish and Chironomid Larvae

Insecticides	Formulation	Minimum disabling dosage (96-hr. LD_0) for milkfish fingerlings in p.p.m.	Minimum effective dosage (48-hr. LD_{100}) against chironomid larvae in p.p.m.	Value of safety factor
DDT[1]	Dust	0.075	0.75	0.1
DDT[1]	Wettable Powder	0.05	0.75	0.06
DDT[1]	Emulsion	0.05	0.75	0.06
Technical γ-BHC	Dust	1.25	0.1	12.5
Technical γ-BHC	Emulsion	0.25	0.1	2.5
Lindane (99% γ-BHC)	Dust	0.1	0.075	1.3
Chlordane	Dust	0.05	1.5	0.03
Chlordane	Emulsion	0.05	1.5	0.03
Heptachlor	Dust	0.1	1.5	0.06
Heptachlor	Emulsion	0.05	1.5	0.03
Toxaphene	Dust	0.01	0.5	0.02
Toxaphene	Emulsion	0.005	0.5	0.01
Aldrin	Dust	0.1	1.5	0.06
Aldrin	Emulsion	0.1	1.5	0.06
Dieldrin	Dust	0.05	1.0	0.05
Dieldrin	Emulsion	0.01	1.0	0.01
Endrin	Dust	0.0005	0.5	0.001
Endrin	Emulsion	0.0005	0.5	0.001
Chlorbezilate	Emulsion	0.005	2.0	0.002
Ethyl Parathion	Dust	0.001	0.025	0.04
Ethyl Parathion	Emulsion	0.0005	0.025	0.02
Methyl Parathion	Emulsion	2.5	0.05	50.0
Tetraethyl Pyrophosphate	Emulsion	0.005	0.1	0.05
Orthomethyl Phosphoramide	Emulsion	0.01	0.1	0.1
Malathion	Dust	0.5	0.1	5.0
Malathion	Emulsion	0.25	0.1	2.5
Diazinon	Dust	0.75	0.075	10.0
Diazinon	Emulsion	0.5	0.075	6.6
Dipterex	Emulsion	25.0	0.1	250.0
Dipterex	Wettable powder	25.0	0.1	250.0
Chlorthion	Emulsion	1.5	0.075	20.0

[1] DDT remained toxic to milkfish for more than one month in any formula.

ratio of less than 5 were excluded from the practical control experiment in the field.

B. CONTROL EXPERIMENT

1. Methods and Equipment

The control experiments were conducted in 24 ponds each year from 1955 to 1958 during the periods when the ponds were infested with these larvae. These ponds were the experimental ponds of the Station. They varied from $^1/_8$ to 4 hectares in size and had a total area of 42 hectares. The preparations used in the experiments were those selected by the preliminary screening test in laboratory and whose safety values had been proved to be satisfactory. Furthermore, as the preparations recommended to fish farmers for use should be low in cost and safe to handle, the selected preparations which were available locally and had less toxicity to man and other mammals were tested first in the control experiments.

For determining the effects on milkfish production in ponds treated with insecticides at a given concentration, the growth of the benthonic algae was examined in the field as well as in laboratory under the microscope following each treatment. The amount of food taken by the milkfish in ponds containing the preparation at a minimum concentration necessary for the eradication of the chironomid larvae was also observed for 3 to 5 days.

For applying the preparations to milkfish ponds, a bamboo raft was employed. This work was done by two persons: one was responsible for handling the raft and another was to apply the diluted preparation to cover the whole pond area as evenly as possible (Fig. 2). We found that this manual method of application was convenient and inexpensive. The amount of preparation required for a certain pond area at a given concentration could be determined accurately and easily, because the bottoms of milkfish ponds in Taiwan are so flat and well leveled that the volumes of pond water could be calculated with ease.

2. Results

(a) Benzene Hexachloride. The gamma isomer of benzene hexachloride or hexachlorcyclohexane (γ-BHC) is developed from the chlorinated hydrocarbon group of insecticides and said to be less toxic to man and other mammals than the others, but there is a tendency for it to accumulate in the organisms when it is applied continuously. According to our laboratory bio-assays, the LD_{100} of the technical γ-BHC dust for the chironomid larvae was 0.1 p.p.m. for 48 hours at the water temperature of 31 ± 2.5°C and salinity of 30.1 per mille; by parallel test, the LD_0 of this preparation for milkfish fingerlings was 1.25 p.p.m. for 96 hours. However, when the concentration of this preparation reached approximately 0.5 p.p.m., the test fingerlings were obviously in distress 3 hours after the treatment. The value of the safety factor to milkfish of this insecticide in dust form turned out to be 12.5. The toxicity of technical γ-BHC in the form of an emulsion to milkfish, however, was approximately 5 times higher than that in the dust form, but there was no discernible difference in its toxicity to the chironomid larvae. Consequently, the technical γ-BHC in the form of an emulsion is considered unsuitable for this purpose because of its lower degree of safety to the milkfish (see Table 1).

The application of technical γ-BHC dust at a concentration of 0.08 p.p.m. to the ponds in the early part of the rainy season when the salinity of the pond water was at 30 per mille or more was found effective to eliminate the chironomid larvae in the pond bottom, whereas in the latter part of this season when the water salinity dropped to 25 per mille or less, a concentration of 0.1 p.p.m. was required. Application of these concentrations, however, was incapable of killing the eggs and newly hatched larvae of the chironomid in the jelly-strings. Laboratory observations showed that when this preparation was applied at the concentration within the limit of the LD_0 for milkfish, the eggs and newly-hatched larvae were unaffected. One application of this preparation remained effective for approximately 3 weeks; applications, therefore, should be repeated at intervals of 3 to 4 weeks. The total number of applications required during the period when the ponds are infested is 4 to 6.

Investigations in the practical application of technical γ-BHC dust in ponds during the past 4 years indicated that within the recommended concentrations of from 0.08 to 0.1 p.p.m., 4 to 6 applications of this insecticide during the period from June to October had no harmful effect on the growth of milkfish as well as the benthonic algae. Examinations of the stomach contents of milkfish in ponds treated with technical γ-BHC dust as evenly as possible at the recommended concentrations showed that, in more than 98 per cent of the milkfish, their stomachs were full of food within 48 hours after the treatment. It would appear that the preparation at the low concentrations as stated would not retard the growth of the milkfish. The application of technical γ-BHC dust at a concentration of 0.75 p.p.m. in early spring before the ponds were stocked with fish, however, killed all the benthonic algae within 24 hours after the treatment. In the event of the death of these algae caused by the application of γ-BHC, the surface of the pond bottom would turn gray in colour and would be barren of algae for at least 5 to 7 weeks even under favourable condition.

Shrimps are very susceptible to insecticides. In ponds treated with γ-BHC at a concentration of approximately 0.03 p.p.m. in any form, the small shrimps (mostly *Caridina denticulata* de Haan) which entered the ponds with the admittance of sea water were completely killed within a few hours after the treatment. Milkfish fry are very sensitive to chemicals too. It was demonstrated in small mud ponds that milkfish fry with a body length of less than 16 mm. could not tolerate technical γ-BHC at a concentration of 0.01 p.p.m. The other bottom organisms in ponds such as the oligochaetes and polychaetes were able to survive the recommended concentrations of γ-BHC, except the hydrophilids (*Berosus fairmairei*) both in the adult and larval stages.

Because of its low cost and ease and safety of handling, the technical γ-BHC dust has gained popularity with the fish farmers in Taiwan for use in milkfish ponds. However, it has an important disadvantage in that the technical γ-BHC has an unpleasant odour, and this odour would be imparted to the milkfish. Due to the fact that this group of compounds have cumulative effect, the odour in the fish flesh following the treatment would persist for at least 3 weeks. This gives the fish farmers a great deal of inconvenience in harvesting the fish by gilling, since the gilling of milkfish in ponds during the period from June to October in Taiwan is usually made at approximately 3-week intervals. The limitation on the time for harvesting the fish due to the γ-BHC treatment sometimes brings the fish farmers financial loss because of market fluctuation.

The use of Lindane (containing 99 per cent of γ-BHC as active ingredient) instead of γ-BHC would reduce the unpleasant odour in the fish flesh. But because the safety factor of this preparation to milkfish is smaller than that of the technical γ-BHC (see Table 1) and the local cost of Lindane is extremely high (approximately 25 times higher than the technical γ-BHC), this material is not recommended.

With the continuance of γ-BHC application in milkfish ponds in the fourth year (1958), the development of resistance by these larvae to the toxicity of gamma isomer has been confirmed. This is especially true in the latter part of the rainy season when the salinity of the pond water is lowered to less than 25 per mille. At present, concentrations of from 0.1 to 0.12 p.p.m. of this insecticide are required in order to have the same effectiveness as the concentrations of 0.08 to 0.1 p.p.m. in previous years. Because of the gradual reduction of the degree of its safety to milkfish, it may be assumed that with the continued use of this insecticide in milkfish ponds, it may become unsuitable for this purpose after some years.

(b) *Diazinon* Thiophosphoric acid-[2-isoprophyl-4-methyl-pyrimidyl-(6)]-diethlester known by the trade name of Diazinon is said to have insecticidal properties similar to those of other organic phosphorous compounds such as Parathion, TEPP, etc., but less toxic to man and other mammals than the others. The LD_{50} of this insecticide for rat is 150-350 mg./kg. in emulsion and 220-270 mg./kg. in wettable powder when administered orally (from a pamphlet issued by J.R. Geigy S. A., 1954).

Toxicity test in the Tainan Station showed that the LD_{100} of Diazinon in the form of dust for chironomid larvae was 0.075 p.p.m. for 48 hours at the temperature of 32.5±2.5°C and salinity of 26.9 per mille and about the same concentration in its emulsified form under similar environmental condition. By parallel experiment on milkfish fingerlings, the LD_0 of this insecticide was 0.75 and 0.5 p.p.m. in the forms of dust and emulsion respectively for 96 hours of exposure. The values of the safety factor to milkfish of this insecticide are, based on our laboratory bioassays, 10 and 6.6 in dust and emulsion formulations respectively.

When ponds were treated with Diazinon dust at the concentrations of 0.06 and 0.08 p.p.m. in the early and latter parts of the rainy season respectively, the larvae of this chironomid were killed but their eggs and newly-hatched larvae enveloped in the jelly-strings were able to survive. Toxicity test in the laboratory showed that the eggs and newly-hatched larvae survived normally in the jelly-strings even when these jelly strings were soaked in a solution containing Diazinon at the strength of 3 p.p.m. The duration of effectiveness of this insecticide against these larvae when applied at the concentrations as recommended was found to be somewhat shorter than that of the use of γ-BHC. Experience has shown that repeated applications of this insecticide during the period when the ponds are infested with these larvae are required at intervals of approximately 2 to 3 weeks.

Stomach content analyses of milkfish samples taken from the ponds treated with Diazinon dust at the recommended concentrations showed that there was no difference in the quantities of food eaten by milkfish in the treated and untreated ponds. However, it was revealed that with the application of Diazinon in the form of emulsion at the stated concentrations, more than 50 per cent of the milkfish in ponds had empty stomachs in the 72 hours following the treatment. It is apparent, therefore, that this treatment would retard the growth of milkfish due to the decrease in the amount of food eaten.

The ten-pounder, *Elops saurus* L., which enters the milkfish ponds with the admittance of sea water or mixed with the milkfish fry during stocking, is very susceptible to the poisonous effect of Diazinon. When ponds were treated with emulsified Diazinon at the stated concentrations, more than 80 per cent of these fish could be killed, especially at the salinity of 30 per mille or more, when these fish could be completely eliminated without injuring the milkfish. With the application of this insecticide in the dust form within the stated concentrations, however, only the small ten-pounders with a body length of about 15 cm. or less could be killed, and this killing was also limited to the condition when the water salinity was 30 per mille or more. When the strength of Diazinon dust was increased to 0.1 p.p.m., its toxicity to milkfish and ten-pounders in ponds was almost the same as the emulsified form. Because of its low commercial value and predatory habit, the ten-pounder is an undesirable fish in milkfish ponds, and therefore, it is recommended that, during the rainy season of summer, when the salinity of pond water drops below that of the normal sea-water (This species of fish could not tolerate salinity of 60 per mille or more in ponds), one to two applications of either the emulsified or dust formulations of this insecticide be made for the purpose of eliminating this piscivorous fish.

The small shrimps found in the ponds were unable to tolerate Diazinon even at a concentration of 0.01 p.p.m. in any form. Although these small shrimps in milkfish ponds do not interfere with the culture of fish, yet they are considered undesirable because they have no commercial value and themselves are also of no food value to the fish in ponds. The oligochaetes and polychaetes were able to survive in the ponds containing Diazinon at the concentrations as stated in both the dust and emulsified formulations, but the hydrophilids, *Berosus fairmairei,* died.

When emulsified Diazinon was applied to ponds at the concentration as high as 10 p.p.m., the growth of the benthonic algae was unaffected. Similar result was obtained by the use of Malathion or Ethyl Parathion. Presumably, the question of harmful effect to algae by the use of this group of organic phosphorous compound may be overlooked.

(c) *Methyl Parathion, Chlorthion and Dipterex.* 0, o-dimethyl-0-p-nitrophenyl thiophosphate, 0, o-dimethyl-0(3-chloro-4-nitrophenyl)-thiophosphate and Dimethyl trichlorohydroxyethyl phosphonate are known as Methyl Parathion (E 605 Methyl Ester), Chlorthion and Dipterex by their trade names respectively. These phosphoric acid esters are said to have high insecticidal properties, but only slight toxicity to man and other mammals, and are therefore suitable for extensive use in insect pest control in various fields. The LD_{50} figures of toxicological value for rat per os are 625 mg./kg. of both Chlorthion and Depterex, and 10-15 mg./kg. of Methyl Parathion (from a communication from Farbenfabriken Bayer).

In our laboratory bio-assays, the 48-hour LD_{100} concentrations of Methyl Parathion, Chlorthion and Dipterex emulsions for chironomid larvae were 0.05, 0.075 and 0.1 p.p.m. respectively; by parallel trial, the corresponding figures of the 96-hour LD_0 concentrations for milkfish were respectively 2.5, 1.5 and 25.0 p.p.m. The values of the safety factor to milkfish of Methyl Parathion, Chlorthion and Dipterex are 50, 20 and 250 respectively.

The effects of these insecticides on the growth of the benthonic algae and other desirable and undesirable organisms in ponds by practical control experiment of large scale have not been studied. But from the results of previous experiments on the effect of the insecticidal thionophosphates such as Ethyl Parathion, Malathion and Diazinon upon the growth of the benthonic algae, these insecticides seem to be promising preparations for use in this field. However, a satisfactory and economical method for the control of these larvae in milkfish ponds should be worked out in order to reduce the number of applications during the period of infestation. Therefore, further control experiments in ponds with the preparations which have acceptable value of safety factor to milkfish are needed to determine the prolongation of their effect against these larvae following each treatment. Further control experiments with these preparations are also needed to determine the concentrations at which the eggs and newly-hatched larvae of this chironomid can be killed. If these eggs and newly-hatched larvae in ponds could be completely eliminated by the preparations at a concentration within their safety ranges to both the milkfish and benthonic algae, fewer applications would be necessary.

SUMMARY

An investigation on the bottom fauna in the milkfish ponds of Taiwan was carried out in 1955 and 1956, and it was found that the larvae of ***Tendipes*** (= ***Chironomus***) ***longilobus*** Kieffer were the predominant organisms on the surface of the pond bottom. Their occurrence was limited to the period from June to November, when the salinity of the pond water was lower than that of normal sea water due to dilution by rain. They flourished in the early part of this period when the water salinity ranged from 20 to 35 per mille; whereas in the latter part of this period when the salinity was lowered to approximately 5 per mille, they occurred in very small quantity. They disappeared entirely from the ponds when the minimum water temperatures dropped to less than 20°C at the end of fall.

The abundance of these larvae in milkfish ponds varied with fluctuations of the water salinity and with availability of food materials produced in ponds. In the milkfish ponds of Taiwan, the average quantity of these larvae in 1956 ranged from 200 to 500 kg./ha. in the early part of the rainy season and 30 to 150 kg./ha. in the latter part.

The occurrence of these chironomid larvae in the bottoms of milkfish ponds is undesirable because they compete with the milkfish for food (benthonic algae) and destroy the "algal beds" by the formation of millions of tubes which cause perforations in the algae in the pond bottom.

Experiments on the selective poisoning of these larvae on the pond bottoms were conducted in the years from 1955 to 1958. In a search for selective poisons, 18 insecticides with 31 formulations were screened by comparative toxicity tests in the laboratory.

The safety factors of the preparations to milkfish were obtained by dividing the 96-hour LD_0 for milkfish fingerlings by the 48-hour LD_{100} for chironomid larvae. The factor of 5 was considered to be the critical safety factor for using these preparations to control chironomid larvae in milkfish ponds, basing on the results of the control experiments in ponds by manual application. The preparations which had the value of this factor smaller than this critical safety factor were considered unsuitable and excluded from further control experiments in ponds.

By manual application of the technical γ-BHC dust at the concentration of 0.08 to 0.1 p.p.m. in ponds, the chironomid larvae in the pond bottoms were eradicated, but no harm to the growth of milkfish as well as the benthonic algae inhabiting the same ponds was evidenced. The total number of applications of this insecticide needed during the period when the ponds were infested with these larvae was found to be from 4 to 6. The disadvantages of the use of technical γ-BHC in milkfish ponds are: (1) the impartation of unpleasant odour to the fish flesh and (2) the development of resistance of the chironomid larvae to this gamma isomer.

The application of Diazinon dust at the concentration of 0.06 to 0.08 p.p.m. as a method of control was found satisfactory. But because the effectiveness of this insecticide to the chironomid larvae is of short duration, the cost of using this insecticide in milkfish ponds is relatively high.

The application of Diazinon emulsion in the same concentrations as the dust was found to retard the growth of milkfish in ponds by reducing the amount of food taken, though its effect on the chironomid larvae was almost the same. The use of this preparation in milkfish ponds has a further advantage in that it could eliminate the piscivorous ten-pounder (*Elops sursus*) without injuring the milkfish.

The shrimp (*Caridina denticulate*), hydrophilid (*Berosus fairmairei*), and the fry of milkfish within a body length of 16 mm. were unable to tolerate the γ-BHC or Diazinon at the recommended concentrations, but the oligochaetes and polychaetes in the pond bottoms were able to survive. The eggs and newly-hatched larvae of this chironomid contained in the masses of jelly-strings were able to survive the treatment even when the concentrations of these insecticides were up to their limits of LD_0 for milkfish fingerlings.

The benthonic algae, especially the filamentous blue-green algae, were killed completely in ponds by the application of γ-BHC at the concentration of 0.75 p.p.m. in early spring before the ponds were stocked with fish. But the application of Diazinon, Malathion and Parathion Ethyl, even up to 10.0 p.p.m., did not affect these algae.

By the complete control of the chironomid larvae with γ-BHC or Diazinon in milkfish ponds, about $^1/_3$ to $^1/_2$ of the quantity of fertilizers and feeds could be saved during the period from June to October when the ponds are infested with these larvae each year (in comparison with untreated ponds).

Experiments are still in progress in a search for more effective and economical methods for combating these larvae in milkfish ponds. If the eggs and the larvae of this chironomid in all growing stages could be completely eliminated by the treatment with a preparation which has acceptable value of safety factor to both the milkfish and benthonic algae, smaller number of applications would then be required.

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APPENDIX

Table 1-F. Toxicty of DDT emulsion to milkfish fingerlings, October 22-29, 1955

Concentration in p.p.m.	Number of fingerlings	Percentage dead at various exposures in hours							
		3	6	12	24	48	72	96	192
1.0	10	20	50	70	80	100	100	100	100
0.75	10	10	30	50	80	90	90	100	100
0.5	10	0	0	0	10	10	60	80	100
0.25	10	0	0	10	30	30	50	60	60
0.1	10	0	0	0	10	10	10	20	20
0.075	10	0	0	0	10	10	10	10	10
0.05	10	0	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0	0
Temperature (°C.)					29.0	28.0	28.5	—	28.5
Salinity (o/oo)					26.4	—	—	—	29.5

Table 2-F. Toxicity of DDT dust to milkfish fingerlings, October 11-18, 1955

1.0	10	0	0	20	50	90	100	100	100
0.75	10	0	0	10	10	30	60	80	80
0.5	10	0	0	0	20	50	50	60	60
0.25	10	0	0	0	0	10	30	30	30
0.1	10	0	0	0	0	10	10	20	20
0.075	10	0	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0	0
Temperature(°C.)					32.0	31.0	30.5	29.5	29.0
Salinity (o/oo)					25.2	—	—	—	27.8

Table 3-F. Toxicity of DDT wettable powder to milkfish fingerlings, October 2-9, 1955

1.0	10	10	30	50	90	100	100	100	100
0.5	10	0	0	30	70	70	70	70	100
0.1	10	0	0	0	10	30	30	30	30
0.05	10	0	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0	0
Temperature (°C)					30.5	30.0	31.5	31.0	—
Salinity (o/oo)					27.4	—	—	—	28.5

Table 4-F. Toxicity of Lindane (99% γ-BHC) dust to milkfish fingerlings, October 3-7, 1957

2.0	10	0	0	40	100	100	100	100	—
1.5	10	0	0	20	100	100	100	100	—
1.0	10	0	0	20	40	40	40	40	—
0.5	10	0	0	20	20	20	20	20	—
0.1	10	0	0	0	0	0	0	0	—
Control	10	0	0	0	0	0	0	0	—
Temperature (°C)					30.5	—	—	—	—
Salinity (o/oo)					28.4	—	—	—	—

Table 5-F. Toxicity of technical γ-BHC emulsion to milkfish fingerlings, September 27-30, 1955

Concentration in p.p.m.	Number of fingerlings	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
1.25	10	50	90	100	100	100	100	100
1.0	10	40	70	80	90	100	100	100
0.75	10	10	30	50	70	70	70	70
0.5	10	0	0	10	20	20	20	20
0.25	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					30.0	28.0	30.0	32.0
Salinity (o/oo)					28.8	—	—	29.6

Table 6-F. Toxicity of technical γ-BHC dust to milkfish fingerlings, September 18-21, 1955

2.25	10	0	20	50	80	100	100	100
2.00	10	0	0	30	70	70	70	70
1.75	10	0	10	20	40	40	40	40
1.5	10	0	0	10	20	20	20	20
1.25	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					31.5	31.5	30.0	31.0
Salinity (o/oo)					29.8	—	—	30.4

Table 7-F. Toxicity of Chlordane emulsion to milkfish fingerlings, August 3-6, 1957

1.5	10	60	70	90	100	100	100	100
1.0	10	20	40	80	100	100	100	100
0.5	10	0	0	20	60	70	70	70
0.1	10	0	0	10	20	20	20	20
0.05	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					29.5	28.5	29.5	—
Salinity (o/oo)					25.8	—	—	—

Table 8-F. Toxicity of Chlordane dust to milkfish fingerlings, July 19-22, 1957

1.5	10	40	80	100	100	100	100	100
1.0	10	0	0	30	90	100	100	100
0.5	10	0	0	40	70	70	70	70
0.1	10	0	0	0	20	20	20	20
0.05	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					32.0	—	29.5	26.5
Salinity (o/oo)					23.4	—	—	28.9

Table 9-F. Toxocity of Heptachlor emulsion to milkfish fingerlings, September 12-15, 1957

Concentration in p.p.m.	Number of fingerlings	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
1.5	10	40	50	60	80	100	100	100
1.0	10	30	40	40	70	70	70	70
0.5	10	10	20	20	40	40	40	40
0.1	10	0	0	10	10	20	20	20
0.05	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					32.0	30.5	—	32.0
Salinity (o/oo)					27.3	—	—	29.0

Table 10-F. Toxicity of Heptachlor dust to milkfish fingerlings, August 21-24, 1957

2.0	10	0	40	50	80	100	100	100
1.5	10	0	0	20	60	100	100	100
1.0	10	0	20	20	30	30	30	30
0.5	10	0	0	0	10	10	10	10
0.1	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					31.0	31.0	31.5	—
Salinity (o/oo)					27.6	—	—	—

Table 11-F. Toxicity of Toxaphene emulsion to milkfish fingerlings, September 26-29, 1957

0.5	10	30	70	80	100	100	100	100
0.1	10	0	50	50	80	100	100	100
0.05	10	0	0	40	60	60	60	60
0.01	10	0	0	0	20	20	20	20
0.005	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					29.5	—	—	28.0
Salinity (o/oo)					27.1	—	—	27.8

Table 12-F. Toxicity of Toxaphene dust to milkfish fingerlings, September 19-22, 1957

1.0	10	20	60	100	100	100	100	100
0.5	10	0	40	80	100	100	100	100
0.1	10	0	0	30	70	70	70	70
0.05	10	0	0	20	20	20	20	20
0.01	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					31.0	31.5	31.5	32.5
Salinity (o/oo)					25.2	—	—	26.5

Table 13-F. Toxicity of Aldrin emulsion to milkfish fingerlings, August 16-19, 1956

Concentration in p.p.m.	Number of fingerlings	Percentage dead at various exposures in hours						
		3	6	12	24	43	72	96
1.5	10	20	40	80	100	100	100	100
1.0	10	10	30	50	80	80	80	80
0.5	10	0	10	20	30	30	30	30
0.1	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					32.0	30.5	32.0	32.0
Salinity (o/oo)					26.5	—	—	26.9

Table 14-F. Toxicity of Aldrin dust to milkfish fingerlings, August 3-6, 1956

1.5	10	0	10	50	100	100	100	100
1.0	10	0	0	20	50	60	60	60
0.5	10	0	0	0	20	20	20	20
0.1	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					29.5	23.5	29.5	30.5
Salinity (o/oo)					27.5	—	—	28.1

Table 15-F. Toxicity of Dieldrin emulsion to milkfish fingerlings, September 19-22, 1956

1.5	10	40	50	80	100	100	100	100
1.0	10	20	40	40	70	100	100	100
0.5	10	0	10	30	50	60	60	60
0.1	10	0	0	20	30	30	30	30
0.05	10	0	0	0	10	10	10	10
0.01	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					31.5	31.0	32.0	32.5
Salinity (o/oo)					27.2	—	—	27.9

Table 16-F. Toxicity of Dieldrin dust to milkfish fingerlings, September 2-5, 1956

1.5	10	10	20	90	100	100	100	100
1.0	10	0	0	60	80	100	100	100
0.5	10	0	0	20	60	60	60	60
0.1	10	0	0	10	20	20	20	20
0.05	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					31.5	32.5	28.5	27.5
Salinity (o/oo)					23.1	—	—	23.9

Table 17-F. Toxicity of Endrin emulsion to milkfish fingerlings, October 10-13, 1956

Concentration in p.p.m.	Number of fingerlings	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
0.01	10	10	40	70	100	100	100	100
0.005	10	0	0	80	80	80	80	80
0.001	10	0	0	50	60	60	60	60
0.0005	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					30.0	29.5	30.0	32.5
Salinity (o/oo)					30.2	—	—	31.0

Table 18-F. Toxicity of Endrin dust to milkfish fingerlings, September 30-October 3, 1956

0.01	10	0	0	30	100	100	100	100
0.005	10	0	0	10	80	80	80	80
0.001	10	0	0	20	30	30	30	30
0.0005	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					30.0	32.0	30.5	30.5
Salinity (o/oo)					26.1	—	—	26.8

Table 19-F. Toxicity of Chlorbezilate emulsion to milkfish fingerlings, October 24-27, 1956

1.0	10	0	0	60	80	100	100	100
0.5	10	0	0	0	80	80	80	80
0.1	10	0	0	0	20	40	40	40
0.05	10	0	0	10	10	30	30	30
0.01	10	0	0	0	10	10	10	10
0.005	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					29.0	28.5	29.5	25.5
Salinity (o/oo)					30.7	—	—	31.2

Table 20-F. Toxicity of Orthomethyl Phosphoramide emulsion to milkfish fingerlings, October 16-19, 1956

0.1	10	20	40	80	90	90	90	90
0.05	10	0	20	60	80	80	80	80
0.01	10	0	0	30	30	30	30	30
0.005	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					30.5	29.5	29.0	29.0
Salinity (o/oo)					29.5	—	—	—

Table 21-F. Toxicity of Ethyl Parathion emulsion to milkfish fingerlings, September 14-17, 1956

Concentration in p.p.m.	Number of fingerlings	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
0.05	10	30	50	90	100	100	100	100
0.01	10	20	30	50	80	80	80	80
0.005	10	0	0	20	50	50	50	50
0.001	10	0	0	10	20	20	20	20
0.0005	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					30.0	32.5	32.5	32.0
Salinity (o/oo)					26.1	—	—	16.9

Table 22-F. Toxicity of Ethyl Parathion dust to milkfish fingerlings, September 9-12, 1956

0.05	10	10	30	70	90	100	100	100
0.01	10	0	20	50	70	70	70	70
0.005	10	0	10	20	20	20	20	20
0.001	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					33.0	32.5	31.4	32.0
Salinity (o/oo)					26.8	—	—	—

Table 23-F. Toxicity of Methyl Parathion emulsion to milkfish fingerlings, October 3-6, 1958

4.0	10	0	20	60	80	100	100	100
3.5	10	0	20	40	60	60	60	60
3.0	10	0	0	10	20	20	20	20
2.5	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					30.0	29.0	29.5	28.0
Salinity (o/oo)					27.8	—	—	—

Table 24-F. Toxicity of Tetraethyl Pyrophosphate emulsion to milkfish fingerlings, October 11-14, 1956

0.5	10	60	80	100	100	100	100	100
0.1	10	20	40	80	90	90	90	90
0.05	10	0	0	30	30	50	50	50
0.01	10	0	0	0	20	20	20	20
0.005	10	0	0	0	0	0	0	0
Control		0	0	0	0	0	0	0
Temperature (°C)					30.0	30.0	32.5	32.5
Salinity (o/oo)					29.5	—	—	—

Table 25-F. Txicity of Diazinon emulsion to milkfish fingerlings, July 2-5, 1957

Concentration in p.p.m.	Number of fingerlings	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
1.5	10	20	30	60	100	100	100	100
1.25	10	20	20	50	90	90	90	90
1.0	10	0	0	0	40	50	50	50
0.75	10	0	0	20	30	30	30	30
0.5	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					33.5	33.5	33.5	33.5
Salinity (o/oo)					28.8	—	—	—

Table 26-F. Toxicity of Diazinon dust to milkfish fingerlings, June 27-30, 1957

1.5	10	0	0	60	100	100	100	100
1.25	10	0	0	0	70	70	70	70
1.00	10	0	0	0	30	30	30	30
0.75	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					33.5	34.5	—	33.5
Salinity (o/oo)					26.9	—	—	—

Table 27-F. Toxicity of Malathion emulsion to milkfish fingerlings, June 27-30, 1956

1.75	10	20	30	70	90	100	100	100
1.25	10	10	20	50	60	60	60	60
0.75	10	0	0	20	20	20	20	20
0.25	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					33:0	34.5	—	33.5
Salinity (o/oo)					29.2	—	—	—

Table 28-F. Toxicity of Malathion dust to milkfish fingerlings, July 23-26, 1958

2.0	10	20	20	60	100	100	100	100
1.5	10	0	10	50	70	70	70	70
1.0	0	0	0	30	40	40	40	40
0.5	0	0	0	0	0	0	0	0
Control	0	0	0	0	0	0	0	0
Temperature (°C)					29.5	29.5	30.5	30.0
Salinity (o/oo)					26.6	—	—	—

Table 29-F. Toxicity of Dipterex emulsion to milkfish fingerlings, October 2-5, 1957

Concentration in p.p.m.	Number of fingerlings	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
40.0	10	60	90	100	100	100	100	100
35.0	10	60	80	80	80	80	80	80
30.0	10	0	0	20	30	30	30	30
25.0	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					31.0	—	32.0	—
Salinity (o/oo)					29.2	—	—	—

Table 30-F. Toxicity of Dipterex wettable powder to milkfish fingerlings, October 9-12, 1957

40.0	10	80	90	100	100	100	100	100
35.0	10	0	40	60	60	60	60	60
30.0	10	0	0	20	20	20	20	20
25.0	10	0	0	0	0	0	0	0
Control	10	0	0	0	0	0	0	0
Temperature (°C)					30.5	—	—	29.5
Salinity (o/oo)					27.6	—	—	—

Table 31-F. Toxicity of Chlorthion emulsion to milkfish fingerlings, October 22-25, 1958

3.5	10	20	30	80	90	100	100	100
3.0	10	20	20	50	70	70	70	70
2.5	10	0	20	30	30	40	40	40
2.0	10	0	0	10	20	20	20	20
1.5	10	0	0	0	0	0	0	0
Control		0	0	0	0	0	0	0
Temperature (°C)					31.0	—	—	32.0
Salinity (o/oo)					26.8	—	—	—

Table 1-L. Toxicity of DDT emulsion to chironomid larvae, October 22-29, 1955

Concentration in p.p.m.	Number of larvae	Percentage dead at various exposures in hours							
		3	6	12	24	48	72	96	192
1.0	300	35	70	80	100	100	100	100	100
0.75	300	25	40	65	80	100	100	100	100
0.5	300	10	40	55	75	85	85	85	85
0.25	300	0	10	40	45	45	45	45	45
0.1	300	0	0	20	20	20	20	20	20
0.075	300	0	0	10	15	15	15	15	15
Control	300	0	0	0	0	0	0	0	0
Temperature (°C)					29.5	28.0	28.5	28.5	28.5
Salinity (o/oo)					26.4	—	—	—	29.5

Table 2-L. Toxicity of DDT dust to chironomid larvae, October 11-18, 1955

0.75	300	30	65	90	90	100	100	100	100
0.5	300	0	50	55	60	75	75	75	75
0.25	300	0	10	30	45	35	45	45	45
0.1	300	0	20	20	30	30	30	30	30
0.075	300	0	0	0	15	20	20	20	20
0.05	300	0	0	5	10	10	10	10	10
Control	300	0	0	0	0	0	0	0	0
Temperature (°C)					32.0	31.0	30.5	29.5	29.0
Salinity (o/oo)	300				25.2	—	—	—	27.8

Table 3-L. Toxicity of DDT wettable powder to chironomid larvae, October 2-9, 1955

0.75	300	30	45	70	90	100	100	100	—
0.5	300	30	35	65	75	75	75	75	—
0.25	300	10	25	35	45	45	45	45	—
0.1	300	0	5	25	25	25	25	25	—
0.075	300	0	0	10	10	10	10	10	—
0.05	300	0	0	0	0	0	0	0	—
Control	300	0	0	0	0	0	0	0	—
Temperature (°C)					30.5	30.0	31.5	31.0	—
Salinity (o/oo)					24.4	—	—	28.0	—

Table 4-L. Toxicity of Lindane (99% γ-BHC) dust to chironomid larvae, October 3-7, 1957

0.1	100	0	25	55	95	100	100	100	—
0.075	100	0	20	25	75	100	100	100	—
0.05	100	0	0	30	50	65	65	65	—
0.025	100	0	0	5	25	40	40	40	—
0.01	100	0	0	5	15	15	15	15	—
Control	100	0	0	0	0	0	0	0	—
Temperature (°C)					30.0	—	—	—	—
Salinity (o/oo)					28.6	—	—	—	—

Table 5-L. Toxicity of technical γ-BHC emulsion to chironomid larvae, September 27-30, 1955

Concentration in p.p.m.	Number of larvae	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
0.1	300	40	40	75	80	100	100	100
0.075	300	25	60	65	75	85	85	85
0.05	300	15	20	45	55	55	55	55
0.025	300	0	0	15	20	20	20	20
0.01	300	0	0	0	0	0	0	0
Control	300	0	0	0	0	0	0	0
Temperature (°C)					30.0	28.0	30.0	32.0
Salinity (o/oo)					28.8	—	—	29.2

Table 6-L. Toxicity of technical γ-BHC dust to chironomid larvae, September 18-21, 1955

0.1	300	10	30	75	95	100	100	100
0.075	300	0	15	80	90	90	90	90
0.05	300	0	20	45	65	65	65	65
0.025	300	0	0	25	30	30	30	30
0.01	300	0	0	5	5	5	5	5
Control	300	0	0	0	0	0	0	0
Temperature (°C)					31.5	31.5	30.0	32.0
Salinity (o/oo)					29.7	—	—	30.4

Table 7-L. Toxicity of Chlordane emulsion to chironmid larvae, August 3-6, 1957

2.0	100	20	50	60	100	100	100	100
1.5	100	10	25	40	70	95	100	100
1.0	100	5	10	20	30	40	40	40
0.5	100	0	0	15	25	25	25	25
0.1	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					29.5	28.0	29.5	—
Salinity (o/oo)					25.0	—	—	—

Table 8-L. Toxicity of Chlordane dust to chironomid larvae, July 19-22, 1957

1.5	100	5	15	40	85	100	100	100
1.0	100	0	5	10	40	55	55	55
0.5	100	0	5	10	20	30	30	30
0.1	100	0	0	0	10	10	10	10
0.005	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					32.0	—	29.5	26.5
Salinity (o/oo)					28.4	—	—	28.9

Table 9-L. Toxicity of Heptachlor emulsion to chironomid larvae, September 12-15, 1957

Concentration in p.p.m.	Number of larvae	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
1.5	100	20	25	30	70	70	100	100
1.0	100	5	10	25	30	75	75	75
0.5	100	0	10	10	25	40	40	40
0.1	100	0	0	10	10	15	15	15
0.05	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					32.0	30.5	31.0	32.5
Salinity (o/oo)					27.3	—	—	28.1

Table 10-L. Toxicity of Heptachlor dust to chironomid larvae, August 21-24, 1957

1.5	100	15	35	65	100	100	100	100
1.0	100	15	15	40	60	90	90	90
0.5	100	0	0	10	55	65	65	65
0.1	100	0	0	10	40	40	40	40
0.05	100	0	0	0	10	10	10	10
Control	100	0	0	0	0	0	0	0
Temperature (°C)					31.0	31.0	31.5	31.0
Salinity (o/oo)					27.6	—	—	27.8

Table 11-L. Toxicity of Toxaphene emulsion to chironomid larvae, September 26- 9, 1957

0.5	100	10	35	70	85	100	100	100
0.1	100	0	25	55	60	60	60	60
0.05	100	0	0	20	25	25	25	25
0.01	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					29.5	—	—	28.0
Salinity (o/oo)					27.1	—	—	27.8

Table 12-L. Toxicity of Toxaphene dust to chironomid larvae, September 19-22, 1957

0.5	100	0	5	30	70	100	100	100
0.1	100	0	0	30	55	75	75	75
0.05	100	0	0	0	25	30	30	30
0.01	100	0	0	0	10	10	10	10
Control	100	0	0	0	0	0	0	0
Temperature (°C)					31.0	31.5	31.5	32.5
Salinity (o/oo)					25.2	—	—	26.5

Table 13-L. Toxicity of Aldrin emulsion to chironomid larvae, August 16-19, 1956

Concentration in p.p.m.	Number of larvae	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
1.5	100	25	40	75	90	100	100	100
1.0	100	0	10	30	65	65	65	65
0.5	100	0	0	5	20	20	20	20
0.1	100	0	0	0	5	5	5	5
Control	100	0	0	0	0	0	0	0
Temperature (°C)					32.0	30.5	32.0	32.0
Salinity (o/oo)					26.5	—	—	26.9

Table 14-L. Toxicity of Aldrin dust to chironomid larvae, August 3-6, 1956

1.5	100	0	0	55	80	100	100	100
1.0	100	0	0	15	50	55	55	55
0.5	100	0	0	5	20	30	30	30
0.1	100	0	0	5	5	5	5	5
Control	100	0	0	0	0	0	0	0
Tempearture (°C)					29.5	28.5	29.5	30.0
Salinity (o/oo)					27.2	—	—	27.9

Table 15-L. Toxicity of Dieldrin emulsion to chironomid larvae, September 19-22, 1956

1.5	100	30	35	50	100	100	100	100
1.0	100	15	30	65	90	100	100	100
0.5	100	0	5	20	40	65	65	65
0.1	100	0	0	15	20	30	30	30
0.05	100	0	0	10	10	10	10	10
0.01	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					31.5	31.0	32.0	32.5
Salinity (o/oo)					28.1	—	—	28.9

Table 16-L. Toxicity of Dieldrin dust to chironomid larvae, September 2-5, 1956

1.0	100	0	10	45	90	100	100	100
0.5	100	0	0	55	65	70	70	70
0.1	100	0	0	10	25	35	35	35
0.05	100	0	0	0	20	20	20	20
0.01	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					31.5	32.5	28.5	27.5
Salinity (o/oo)					28.1	—	—	28.9

Table 21-L. Toxicity of Ethyl Parathion emulsion to chironomid larvae, September 14-17, 1955

Concentration in p.p.m.	Number of larvae	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
0.025	100	30	30	80	90	100	100	100
0.01	100	0	30	50	65	65	65	65
0.0075	100	0	0	25	30	30	30	30
0.005	100	0	0	10	10	10	10	10
Control	100	0	0	0	0	0	0	0
Temperature (°C)					30.5	32.5	31.5	32.0
Salinity (o/oo)					26.1	—	—	26.9

Table 22-L. Toxicty of Ethyl Parathion dust to chironomid larvae, September 9-12, 1956

0.025	100	10	25	80	95	100	100	100
0.01	100	0	0	45	65	80	80	80
0.0075	100	0	5	15	45	55	55	55
0.005	100	0	0	0	20	25	25	25
0.0025	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					33.0	32.5	31.0	32.0
Salinity (o/oo)					26.8	—	—	—

Table 23-L. Toxicity of Methyl Parathion emulsion to chironomid larvae, October 3-6, 1958

0.075	100	20	70	90	100	100	100	100
0.05	100	10	40	75	85	85	85	85
0.025	100	0	10	40	50	55	55	55
0.01	100	0	10	25	25	25	25	25
0.0075	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					30.5	29.5	29.5	29.0
Salinity (o/oo)					27.8	—	—	—

Table 24-L. Toxicity of Tetraethyl Pyrophosphate emulsion to chironomid larvae, October 11-14, 1956

0.1	100	20	60	85	90	100	100	100
0.05	100	0	0	30	45	45	45	45
0.01	100	0	0	0	20	20	20	20
0.005	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					30.0	30.0	32.5	32.5
Salinity (o/oo)					29.5	—	—	—

Table 17-L. Toxicity of Endrin emulsion to chironomid larvae, October 10-13, 1956

Concentration in p.p.m.	Number of larvae	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
0.5	100	20	50	75	100	100	100	100
0.1	100	10	25	60	60	75	75	75
0.05	100	0	0	10	40	40	40	40
0.01	100	0	0	10	15	15	15	15
0.005	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					30.0	29.5	30.0	32.5
Salinity (o/oo)					30.0	—	—	31.0

Table 18-L. Toxicity of Endrin dust to chironomid larvae, September 30-October 3, 1956

0.5	100	10	25	55	95	100	100	100
0.1	100	0	0	10	45	70	70	70
0.05	100	0	0	0	30	45	45	45
0.01	100	0	0	5	15	25	25	25
0.005	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					30.0	32.0	30.5	30.5
Salinity (o/oo)					26.1	—	—	26.8

Table 19-L. Toxicity of Chlorbezilate emulsion to chironomid larvae, October 24-27, 1956

2.0	100	0	10	40	80	100	100	100
1.5	100	0	0	0	40	50	65	65
1.0	100	0	0	0	25	40	40	40
0.5	100	0	0	0	10	15	30	30
0.1	100	0	0	0	10	15	15	15
Control	100	0	0	0	0	0	0	0
Temperature (°C)					29.0	28.5	29.5	25.5
Salinity (o/oo)					30.7	—	—	31.2

Table 20-L. Toxicity of Orthomethyl Posphoramide emulsion to chironomid larvae, October 16-19, 1956

0.5	100	20	35	55	100	100	100	100
0.1	100	0	30	90	95	95	95	95
0.05	100	0	20	45	65	75	75	75
0.01	100	0	0	0	30	30	30	30
0.005	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					30.5	29.5	29.0	29.0
Salinity (o/oo)					29.5	—	—	—

Table 25-L. Toxicity of Diazinon emulsion to chironomid larvae, July 2-5, 1957

Concentration in p.p.m.	Number of larvae	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
0.075	100	30	55	100	100	100	100	100
0.05	100	30	45	80	90	90	90	90
0.025	100	0	20	45	45	45	45	45
0.01	100	0	0	10	10	10	10	10
Control	100	0	0	0	0	0	0	0
Temperature (°C)					33.0	33.5	33.5	33.5
Salinity (o/oo)					27.5	—	—	—

Table 26-L. Toxicity of Diazinon dust to chironomid larvae, June 27-30, 1957

0.075	100	0	25	100	100	100	100	100
0.05	100	0	15	55	75	85	85	85
0.025	100	0	0	15	25	25	25	25
0.01	100	0	0	0	10	10	10	10
0.0075	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					33.5	34.5	—	33.5
Salinity (o/oo)					26.9	—	—	—

Table 27-L. Toxicity of Malathion emulsion to chironomid larvae, June 27-30, 1956

0.125	100	25	55	90	100	100	100	100
0.1	100	20	20	45	95	95	95	95
0.075	100	0	10	30	65	65	65	65
0.05	100	0	0	20	25	25	25	25
0.025	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					33.0	34.5	—	33.6
Salinity (o/oo)					29.2	—	—	—

Table 28-L. Toxicity of Malathion dust to chironomid larvae, July 23-26, 1958

0.125	100	10	20	75	100	100	100	100
0.1	100	5	20	70	90	100	100	100
0.075	100	0	30	65	65	65	65	65
0.05	100	0	0	25	30	30	30	30
0.025	100	0	0	5	10	10	10	10
0.01	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					29.5	29.5	30.0	30.0
Salinity (o/oo)					26.6	—	—	—

Table 29-L. Toxicity of Dipterex emulsion to chironomid larvae, October 2-5, 1957

Concentration in p.p.m.	Number of larvae	Percentage dead at various exposures in hours						
		3	6	12	24	48	72	96
0.1	100	45	70	100	100	100	100	100
0.075	100	0	25	65	85	85	85	85
0.05	100	15	20	35	55	55	55	55
0.025	100	0	0	10	15	15	15	15
0.01	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					31.0	—	32.0	—
Salinity (o/oo)					29.0	—	—	—

Table 30-L. Toxicity of Dipterex wettable powder to chironomid larvae, October 9-12, 1957

0.1	100	10	40	70	100	100	100	100
0.075	100	30	30	65	80	80	80	80
0.05	100	0	0	30	60	60	60	60
0.025	100	0	0	25	25	25	25	25
0.01	100	0	0	0	0	0	0	0
Control	100	0	0	0	0	0	0	0
Temperature (°C)					30.5	—	—	32.0
Salinity (o/oo)					27.6	—	—	—

Table 31-L. Toxicity of Chlorthion emulsion to chironomid larvae, October 22-25, 1958

0.075	100	20	30	85	100	100	100	100
0.05	100	0	15	50	75	75	75	75
0.025	100	0	0	25	30	30	30	30
0.01	100	0	0	0	5	5	5	5
Control	100	0	0	0	0	0	0	0
Temperature (°C)					31.0	—	—	32.0
Salinity (o/oo)					26.8	—	—	—

Index of chemical names of the essential entity of insecticidal products which are listed under trade names in Tables 1-F to 31-F and 1-L to31-L.

Trade name	Chemical name in the essential entity	No. of Table
DDT	2. 2-bis (*p*-chlorophenyl)-1, 1, 1-trichloroethane	1-F to 3-F and 1-L to 3-L
Gamma BHC	1, 2, 3, 4, 5, 6-hexachlorocyclohexane	5-F, 6-F, 5-L and 6-L
Lindane (99% γ-BHC)	ditto	4-F and 4-L
Chlordane	1, 2, 4, 5, 6, 7, 8, 8-octachloro-4, 7-methano-3*a*, 4, 7, 7*a*-tetrahydroindane	7-F, 8-F, 7-L and 8-L
Heptachlor	1, 4, 5, 6, 7, 8. 8-heptachloro- 3*a*, 4, 7, 7*a*--tetrahydro-4, 7-methanoindene	9-F, 10-F, 9-L and 10-L
Toxaphene	Chlorinated camphene containing 67% to 69% chlorine.	11-F, 12-F, 11-L and 12-L
Aldrin	1, 2, 3, 4, 10, 10-hexachloro-1, 4, 4*a*, 5, 8, 8*a*-hexahydro-1, 4, 5, 8-endo-exo-dimethanonaphthalene	13-F, 14-F, 13-L and 14-L
Dieldrin	1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4*a*, 5, 6, 7, 8, 8*a*-octahydro-1, 4, 5, 8-endo-exo-dimethanonaphthalene	15-F, 16-F, 15-L and 16-L
Endrin	1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4*a*, 5, 6, 7, 8, 8*a*-octahydro-1, 4, 5, 8-endo-endo-dimethanonaphthalene	17-F, 18-F, 17-L and 18-L
Chlorobezilate	Ethyl 4,4'-dichlorobezilate	19-F and 19-L
Octamethyl pyrophosphoramide	Pyrophosphoryl tetrabisdimethylamide	20-F and 20-L
Ethyl parathion	0, 0-diethyl-0,-*p*-nitophenyl thiophosphate	21-F. 22-F, 21-L and 22-L
Methyl parathion	0, 0-dimethyl, 0-*p*-nitrophenyl thiophosphate	23-F and 23-L
Tetraethyl pyrophosphate	Tetraethyl pyrophosphate	24-F and 24-L
Diazinon	0,- [2-isopropyl-4-methyl-pyrimidyl(6)] 0-, 0-diethyl phosphorothioate	25-F, 26-F, 25-L and 26-L
Malathion	S-1:2-bis (ethoxycarbonyl) ethyl 0, 0-dimethyl dithiophosphate	27-F, 28-F, 27-L and 28-L
Dipterex	0, o-dimethyl, 2, 2, 2-trichloro-1-hydroxyethane phosphonate	29-F, 30-F, 29-L and 30-L
Chlorthion	0-(3-chloro-4-nitophenyl) 0, 0-dimethyl thiophosphate	31-F and 31-L

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