SYMPTOMOLOGY OF DISEASE IN FISH

I. Introduction.

The necessity and ability to recognize, cope with and control fish disease is self evident. The fishery worker must be able to answer any and all questions of ailments of the laymans pet aquaria fish and also be able to diagnose outbreaks of disease within his own hatchery stock. The latter, a matter which can spell the difference between success and economic disaster.

II. Coverage of Material and Approach of Subject.

It would be impossible to cover all phases of fish disease or even the symptoms of all disease within this short time, so by elimination of the Helminth parasites (fish are attacked by all classes of worms, e.g. Trematoda, Nematoda, Cestoda and Acanthocephala), with the exception of one fluke, and by ennumeration of only the most frequently occuring diseases, we will try to approach this problem of symtomology form the most easily accessible angle for one who is busy with other fisheries problems and cannot afford to compleely study the complicated life histories and life cycles of all possible diseases and infections of his fish. Rather than list the diseases by the causal organism, which would most probably not be known, we will classify the disease according to the symptoms produced. Also the etiology or patients history leading up to the disease and the prophylactic treament and control meaures will we mentioned.

III. Generalized Symptoms.

1. Difficulty of diagnosis and complications by secondary infection.
2. Ocular equlibrium.
3. Body color, pattern and character.

IV. Control Measures.

1. Panacea - NaCl solution. 3% solution for 15 minutes will kill most external parasites.
2. Bacteriacides - Copper Sulphate solution# and Potassium Permanganate solution, the strength of the solution depending upon

Addition of a small amount of salt to the Copper Sulphate solution will facilitate the fish's recovery, as the Copper will form an insoluble mass with the mucous of the gills, which is readily dissolved by the small amount of salt.

the species of fish and paraitic disease being controlled.

3. Protozoacides - 1:4,000 solution of Formalin (1 part formalin to 4,000 parts water.)
   Acetic acid solution (Use Glacial acetic acid when making up the solution, as the acidity of vinegar varies greatly.)
   Pyridylmercuric acid PMA.

4. Pond disinfectants - Cover entire pond with lime. 800 lbs/acre.
   Or paint entire pond with Potassium permanganate.

5. Miscellaneous -
   a. Argulus controlled by 1:10,000,000 Lindane.
   b. Tapeworms - 2 °/o Kamala in food for one week.
   c. Eye Fluke - kill all snails in ponds.

V. Specific Symptoms.

A. Epidermal Spotting.

1. White opaque spots on the epidermis. Small and soft at first, these later harden into grisle like projections and may cover the entire body. Fish appears as if covered with paraffin. If pox is removed, it leaves a bleeding wound. FISH POX
   Etiology unknown. Appears to be genetic.
   Control - remove and destroy all poxed fish.

2. White pimples on body surface and gills. Icthyopthirius multifilius
   Fish rub themselves against solid objects to dislodge the parasite (as with Gyrodactylus infection).
   Fish become sluggish in later stages of disease.
   A microscopic examination of an epidermal scraping is necessary for positive identification.
   1 mm ovoid ciliated protozoan see in rapid movement. Posseses a horseshoe shaped nucleus.
   Control - Hold fish in rapidly moving water until all miracidia have emerged. If this method is not practical, apply 3 °/o NaCl solution to pond. However, this treatment must be repeated at frequent intervals to catch the new emergents.

Drainage, liming and drying pond will kill all of the released and encysted stages.

3. White spots on epidrmis similar to Icthyopthirius, Sporozoans
This spotting may occur in the lateral line, under the scales, on the gill or in the body cavity. The The skin loses its lustre and the scales drop off. Drops of blood may appear on the denuded areas. Fish finally staggers around and dies.
A microscopic examination is necessary for determination. Caused by Myxobolids of which there are many different species. Possession of two polar capsules which contain a long thead rolled into a spiral which everts at germination and drills into the tissue of the host, is the distinguishing characteristic of the Myxobolids. No control measures are possible because of the tough pellicle.
Control - Remove and destroy all infected fish.

4. Very fine spotting on skin of fish. Protococaceae
These spots are hardly visible to the naked eye. A swelling is soon noticed as encapsulation by connective tissue takes place. These are plant-cells distinguished by the presence of chlorophyll and starch within the cells.

5. Grayish white spots on the head, gills fins and body. Columnaris disease
These spots are surrounded by a zone of reddish tinge. Appearance is similar to Saprolegnia, but lacks the fuzzy texture. No white line appears on fins as in Fin Rot. The color of the fish fades gradually and the fins become frayed and ragged as body lesions develop. The scales drop off and the dermis is destroyed. Caused by rough

handling and high temperature of water, and infection by Cytophaga columnaris, a myxobacterium. These are long slender rod shaped bacteria, surrounded by a secretory product, giving rise to a columar type structure of the lesion.
Responisble for Cotton Mouth in tropical aquarium fishes.
Control - 1:2,000 solution of Copper sulphate for 1 - 2 minutes as a preventive measure after handling. Sulfa drugs have been used to some avail, but best method is to destroy the infected fish.

6. White irregular blotches on head and dorsal surface. Trichodina discoida
The fins are badly frayed in heavily infected fish. Sluggishness and anorexia (loss of appetite) develop. A white transluscent film spreads over the body. Vaso dilation of the capillaries may also occur, giving a red appearance to the areas of heavy infection. Caused by a small rapidly moving microorganism with a denticulated aboral sucker. It feeds upon the Hyperplastic (excess growth of epithelium) cells. The symptoms actually benefit the parasite.
Control - 3 °/o NaCl dip until fish shows signs of distress. 1:500 Acetic acid. 1:4000 Formalin solution for 1 hour.

B. Cloudiness of the Skin and Presence of Slime.

1. Skin cloudiness on warm water fish. Chilodon cyprini
Fish lies on side, similar to Costia symptoms. Gills and fins also affected by cloudiness. Caused by a heart shaped ciliated protozoan. Moves rapidly of the body surface. Very prevalent in gold fish.
Control - 3 °/ o Na Cl
1:500 acetic acid for 1 minute
1:4,000 Formalin for 1 hour. This is the most effective treatment.

2. Blue gray slime on fins. Anoraxia (loss of appetite) Costia necatrix
Shriveling of the body and the head appear enlarged. The fish appears listless and the symptoms are epidemic in character, spreading to all alevins in the trough.
Caused by a small oval flagellate, which swims very rapidly with a rotating movement.
THIS IS PROBABLY THE MOST DESTRUCTIVE FISH ECTO-PARASITE.
However the diminutive size, often causes this organism to be overlooked.
Control - 3°/o NaCl for 15 minutes. Repeate 3 times every 2 days.
Lime pnd to destroy unattached organisms.

3. Turbidity of skin when viewed from fore and aft. Cold
The affected skin may eventually decay and fall off. This cold condition is similar to the human cold, caused by a rapid change in the temperature of the water or upon being transferred to a cold dipping solution. Secondary infection may result from the cold condition.
Control - Prevent occurence by gradual change of fish's environmental temperature to that of dip solution or new surroundings.

4. Abundant blue gray slime on fins of fish. Gyrodactylus elegans
The fish rub themselve to rid the fins of the parasites. This will eventually wear their fins down to stubs. Lesions result at the base of the fins. A microscopic examination of the slime will show Gyrodactylus or its relative Dactylogyrus.
This is one of the most serious pests of goldfish.
Control - 1:4,000 Formalin
1:500 acetic acid for 1 minute.

5. Blue slime covering trouts' entire body. Blue Slime Disease
Later this slime sloughs off and leaves a patched appearance. Recovery and reappearance each year in same fish is characteristic. Due to Biotin deficiency in diet.
Control - Feed liver to fish.

C. Fuzzy appearance of Epidermis.

1. Tuft of white threads radiating out 1/3 of an inch from the body. Passing debrie may adhere to these strands and give a dirty brown coloration to the strands. These filaments (hyphae and mycelium) penetrate the epidermis of the skin and enter the dermis as a secondary infection to trauma (injury) or other disease lesion. This fungus growth will then invade the muscle tissue and spread over the entive body surface, giving rise to necrosis (death) of surface tissues. This condition is fatal. Saprolegnia parasitica
Control - 3 °/o NaCl until fish is distressed
1:15,000 solution of Malachite green for 10 - 30 seconds.
1:180,000 sol. of Malachite in pond for 45 minutes.

D. Fins Rotten or Entirely Destroyed.

1. Disentegration of the fins or they may be completely destroyed. Fin Rot
First symptom is a white line developing on the lateral margin of the fin. This line gradually moves to the base of the fin and destruction closely follows its progress. Sores with glistenign white pus may develop at the base of the

fin and hence spread to the entire body. Resulting lesions appear as a clean excision of tissue had occurred. Cause is unknown.

Control - 1:2,000 Copper sulphate
1:1 formalin and malachite green used as a flush treatment in troughs.
Treatment must begin before deep tissue is affected. Remove and destroy all infected fish.

E. External Lesions

1. Open sores and lesions on the body. ULCER DISEASE
Begin as small white pimples, soon become papillary and break up into a lesion of the epidermis. Resulting lesions maybe 1/2 inch in diameter. The lesions are surrounded by a white margin and possess a reddish center. Fins also affected, but cartilaginous rays persist, where as the rays are also destroyed in fin rot. The ulcers develop inward and do not exted into deep muscle and appear clean looking (for ulcers). The lesion do not usually become fungused as do furuncles. Also furuncles break through from inside and are pus filled.
Caused by Hemophilus piscum.
Control - 1:2,000 solution of Copper sulphate.
Destroy fish and sterilize ponds and equipment.

3. Hemorrhagic spots on deep and shallow muscle, Furunculosis
developing into open lesions or furuncle beginning at the base of the fins and spreading outward. A dark spot appears between the dorsal and pelvic fin in young fish, due to the breakdown of connective tissue and the resulting hematoma (blood coagulation). These blood and pus filled lesions may be the size of a pea or up to the size of a nickle. The spleen is enlarged and a bright cherry red. The intestines are inflamed in the pyloric region.

Caused by Bacterium salmonicida which is present in the entire circualtory system and produces a generalized septicemia (blood poisoning). Does not develop on warm water fish.
Control - Destroy infected fish. Clean out the dead fish from the pond, as putrifaction releases the bacteria. Disinfect pond with potassium permanganate.

F. Exopthalmos

1. Outward bulging of eye from orbit due to gas bubbles in connective tissue of the socket. Small bubbles present in the fin capillaries and mouth agape due to bubbles in oral membranes. Cornea may be cloudy and the epithelium of the fins beginning to slough off. The fins tremble and there is a twitching of the body. Control - remove excess plants and thoroughly aerate water. Oxygen Superaturation

2. Similar symptoms produced by excess mitrogen in water Treat in same manner by aereation.

3. Exopthalmos, and kidney is dark with the tubules beginning to disintegrate. Hyaline (calcium deposits) casts are present and the coelomic cavity is fluid filled. Due to renal disfuction and poor Calcium metabolism. Calcium metabolism

4. Expthalmos also due to trematod infection behind eyeball.

5. Occurrence in Platypoecoelus the Platy and Xiphophorus. Tropical swordtail, is a result of hybridization and a genetically controlled melanoma of the choroid cells.

G. Intestinal Inflamation

1. Fish dart rapidly through the water. They may discharge a bloody slime from the anus. Frequent jumping out of the water and possible landing on the bank is and indication of some disturbance. Prolapse of the intestine may occur. The fish are dark in color. Gastritus

Caused by unsuitable or spoiled foods. Spoilage toxins will produce inflamation. Test for rancidity of food by heating a small amount of the food in a test tube with a small amount of water. The fatty acids will be released and possess a pungent odor if rancid or spoiled.

* H & I not included in the paper being copied.

H. Miscellaneous Symptoms.

1. Anorexia (loss of appetite). Gills swollen and congested. These gill filaments later fuse together forming a solid termination of the filaments. The gills are pale in color and will soon develop a fungus infection which soon spreads up onto the head. Gill Disease

Causes irritation and hyperplasia (excess epithelial growth) of the gill filaments.

Caused by Branchiomyces sanguinis, a transparent bacteria that is very difficult to see and diagnose.

Control - 1: 2,000 Copper sulphate for 1 minute then transfer to running water.

1: 10,000 PMA also will work.

It is best to destroy the infected fish as the bacteria is present in the bloodsteams.

2. Salmonids staggering while swimming and swimming with quite some difficulty. They then float from side to side and cannot avoid obstacles while swimming. Complete loss of sense of balance. Stagger Disease

Caused by Icthyophorus hoferi a bacteria in the brain.
However, the heart may be the seat of infection and
enlarge and become scarred and rough and hard.
The internal organs are sprinkled with tubercles,
but the skin remains unaffected.
Disease is spread by feeding hatchery stock fresh
ocean fish.
Control by cooking the raw ocean fish.

3. Pin head condition and emaciated body. Octomitus salmonis
Growth rate retarddd. Whirling corkscrew
movements through water and fish flips from side
to side. There may be slight lesion on the gills.
A red spot appears on the belly, fins and gills due
to the capillary congestion.
Microscopic examination of the intestine show a small
pear shaped flagella parasite possessing eyespots
and locomotor flagella.
Control - 2 °/o Calomel added to diet
2 °/O Carbarsone to diet. This is more
effective and has no toxic action.

4. Dark coloration of the tail. Young fish whirl in Whirling Disease
convulsive rapid movements and always in same direction.
Fish may jump from the water and then sink slowly
to the bottom. After recovery an other seige of
attacks may appear.
Caused by Leptospora cerebralis infection in inner ear.
Epidemic disease.
Infection on one side of head only results in "Crossbeak
fish".
No Control. Remove all affected fish.

5. Red spot on floor of mouth near second gill arch. Goiter
Followed by external swelling between the gills. The
swelling appears to be a red cone shaped tumor. The
thyroid gland of the fish is not capsulated in
epithelium and this gives on the false impression of a

malignant tumor.
Caused by Iodine dificiency in diet.
Control - Addition of Iodine to diet and release to natural habitat.
1 tablespoon of Lugol's solution to 50 lb. food.
Shrimp meal, clam meal, haddock meal and cod liver meal are rich in Iodine.

6. Fish become very dark in color. Lipoid Degeneration
Floats listlessly at the surface of the water.
Gills are very light in color due to anemia.
Blood flow is mil upon cutting a vessel.
Stomach empty except for a pale yellow fluid.
Serous fluid also in the abdomen similar to exopthalmic condition.. But here the liver is a yellowish gray.
Caused by over feeding dry animal meals which are rich in fats.
Control - Don't over feed fry concentrated feeds.
Reduce feeding in cold weather.
Change diet reglarly for variety. Feed Iron and blood meal to combat anemia. Addition of choline will help aleviate symptoms.

BIBLIOGRAPHY

Allison L.N.	Prevention and treatment of parasitic disease in fish. Transactions of the American Fisheries Sociey, 1953; pp 221-228.
Davis H .S.	Care and Diseases of Trout. U. S. Bureau of Fisheries Report. No.35; 1937.
	Culture and Diseases of Game Fish. Univ. of Calif. Press. 1953.
Gordon M.	The Genetics of Fish Diseases. Transactions of the American Fisheries Society, 1953.
Griffen P.	The Nature of Bacteria Pathogenic to Fish. Ibid. pp 241-253
Halver J. E.	Fish Disease and Nutrition. Ibid pp 254-261.
Moore E.	Study of Trout Disease. Transactions of the American Fisheries Society, 1923.
Snieszko S. F.	Therapy of bacterial Fish Diseases. Ibid 1953, pp 330-341.
Watson S. W.	Virus diseases of fish. Ibid 1953, pp330-341.
Plehn M.	Manual of Fish Diseases. 1924, Schweizerbarth Stuttgart.

Note: An almost complete bibliography of all present works on fish disease is contained in the 1953 Transactions of American Fisheries Society.

POSITIVE ROUGH FISH CONTROL

CHEM-FISH SPECIAL

CHEM-FISH SPECIAL

Newest Improvement i

ROTENONE F

The use of rotenone as a means of collecting fish is not new. For many years the natives of certain tropical and sub-tropical countries used the pulverized roots of rotenone bearing plants to poison fish. These plants belong to the legume family; the same family to which our garden peas and beans belong. The scientific names of the most common of these rotenone bearing legumes are Derris and Cube. Derris is native to Oceania, Southern Asia and Australia. Cube comes from South America.

Rotenone kills by cutting off the circulation in the region of the gills, and as a result the blood stream is not able to supply the various organs of the body with oxygen. The fish die of suffocation when the capillaries in the gills shrink to a diameter which does not permit the passage of the oxygen bearing blood. "Generally speaking, aquatic insects, crustacea and other types of invertebrates are less sensitive to the action of rotenone than are fish. People, cows, horses, sheep, pigs, chickens, cats, dogs, snakes, frogs and other vertebrates are not affected when they swim in or drink water treated with rotenone."*

Only in recent years has rotenone been used extensively in this country as a fish poison. Its widespread use was brought about by fisheries biologists seeking to control fish populations to favor the production of game fish. Previously, nets had been used to crop off rough fish populations and make room for more desirable fish. Such fish as carp, suckers, perch, gizzard shad and many others, were too abundant in many waters and took up space and food that could better be utilized by game fish. Poisoning or partial poisoning as a control measure was found to be cheaper than

*U. S. Dept. of Interior, Fishery Leaflet #350, August, 1949, page 5.

...t in ...E FISH TOXICANTS

netting. Because it is harmless to aquatic insects and warm blooded animals, rotenone was especially desirable.

Chemical companies soon recognized the possibilities in this new demand and made available a rotenone powder. Since then, competition has motivated a constant search to improve upon rotenone fish toxicants. The biologists want a poison that will kill efficiently under all natural conditions and with a minimum of cost and effort. Industry is trying to fulfill these requirements.

The powdered Derris and Cube roots were first used in large amounts to eradicate or control fish populations. The powdered product was a great advance over the use of nets for this purpose. With increased use, however, the powder was found to have some objectionable qualities. They were as follows:

1. The dry powder was very irritating to the nose and throat of the handlers.
2. It did not mix easily with water and made it necessary to use an excess of material to obtain a good kill.
3. Penetration of the powder into sub-surface waters was not good. Kills of bottom dwelling fish were unsatisfactory.
4. Results were poor in cold water. This greatly limited the effectiveness of the powder as to the season when it could be used and in the bodies of water in which it could be used.
5. Alkaline waters presented a problem. Very alkaline ponds often responded poorly to treatment and fish kills were unsatisfactory.

Search for Improved Toxicant

Industry continued to search for better products and better methods of dispersing them. Soon an emulsifiable rotenone liquid was developed and it found ready acceptance with conservation departments throughout the country. The emulsifiable material eliminated or partially corrected many of the bad features of the rotenone powder.

The liquid did not irritate the mucous membranes of those who used it. It was less bulky than the powder and could be dispensed easily with portable pumps and hand sprayers. Most important, however, was its capacity to penetrate deeper and colder water. This was due, at least in part, to being more miscible with water. For the same reason, dispersion was more even and resulted in a more uniform application. Better kills of fish were obtained. There was an immediate switch to this new, emulsifiable product by many conservation agencies; others soon followed.

Although the liquid rotenone was a great improvement, it still did not meet the need of many fisheries biologists. Their goal was a 100% kill in treated waters a majority of the time. Alkaline ponds in certain localities persisted in giving poor results. Fish kills in deep ponds and in cold water were still not as complete as in shallow ponds and warm water. The rate of dispersion for ordinary rotenone emulsives will vary according to the type of water. In cold water, they will not disperse readily or thoroughly and tend to conglomerate in globules. Because of this, it is not feasible to do fish control work during fall, winter or early spring. Many publications definitely state that waters should not have temperatures lower than 45° and preferably above 60° for treatment to be wholly effective.

The next step in the evolution of an improved rotenone fish toxicant was the addition of synergists. These in effect made the rotenone more toxic. Since the synergists were cheaper to produce, their use enabled the chemical companies to use less rotenone in their product and sell it for a cheaper price.

The Chemical Insecticide Corporation (CIC) believes it has achieved the next step toward developing a rotenone product which will give a 100% kill. This product is definitely superior to the emulsifiable rotenones that it and other chemical companies have been producing in the past. CIC has been manufacturing a 5% emulsifiable rotenone called Chem-Fish Regular. The new product is called Chem-Fish Special.

The material on the right is the raw derris root in the form in which it arrives from South America.

The rotenone bearing material is then extracted. The extract, which is a resin, is an amber material of the consistency of peanut brittle.

If the pure rotenone is rendered from the resin it appears as a white, powdery substance.

The bottle at the right contains Chem-Fish Special, the emulsifiable form of rotenone used as a fish toxicant.

Advantages of CHEM-FISH Special

Toxicity experiments in our Aquatic Laboratories indicated an increase in the rate of dispersion and the length of time it remained toxic. It also was equally effective in warm and cold water and in acid and alkaline water. Similar tests by other agencies upheld our own findings.

The advantages of Chem-Fish Special can be summarized as follows:

Chem-Fish Special readily disperses in water of varying hardness and temperature. It can be readily applied with ground and air equipment and does not require heavy agitation. The product flashes readily upon contact with water and its rate of descent, according to laboratory tests, is approximately ½ foot per minute in bodies of water varying from 35°F to 85°F. The rate of descent does not vary with the temperature. Chem-Fish Special will readily penetrate through the thermocline and will form a stable emulsion that will last for a minimum of 7 to 10 days. This will provide greater contact between live fish and the suspended active rotenoid product and will thereby result in greater fish control. It also means that the field season for fish control can be started earlier and extended later, thus attaining better use of field crews.

Rotenone, the primary active ingredient in all 5% rotenone emulsions, should occur in the same amount and potency in these emulsions. However, field and laboratory tests indicate that these emulsions do not behave alike. There are differences in speed of emulsification, ease of handling, rate of dispersion and effectiveness in water of various temperature, depth and hardness.

To what can these differences be attributed? By process of elimination, one must conclude that it is due to the other materials in the emulsion. The other ingredients consist of solvents, emulsifiers and carriers. Altering the kinds and proportions of these ingredients will alter the performance of the emulsion.

It is not by chance that Chem-Fish Special gives such excellent performance. The materials used have been carefully chosen and formulated to achieve the present results. The solvent and amount used was chosen for its tenacity for holding the rotenone in solution at a wide range of temperatures. The emulsifying agent is such that a finer particle is formed. A finer particle gives the emulsion a greater stability, and gives the rotenone itself more effective contact with the gill filaments of the fish. It can be understood that a large globule containing rotenone would not present the surface area to the gill filaments that 50 smaller globules would, (assuming that the 50 small particles in total equal the volume of the one large particle). This physical factor alone gives Chem-Fish Special greater potency. The potency is further augmented by an increased amount of pure rotenone extract. Because Chem-Fish Special is heavier than ordinary 5% emulsifiable rotenone liquids, it contains more rotenone. It is estimated that 100 gallons will contain approximately two more pounds of rotenone extract.

The story of the development of the ultimate in rotenoid fish poisons is not yet completed. We are aiming towards developing a product which will be capable of giving a 100% kill 100% of the time. The Chemical Insecticide Corporation will continue its efforts to improve its products. The acid test of each improvement, however, can be made only in the field by the many fisheries biologists who are a product's best critics. We encourage them to write for samples to test and are pleased to make our technical staff available to those who want help whenever possible.

Although most Fishery Biologists hope for a 100% kill in their eradication programs, this goal is often not attained. Some of the reasons for failure are listed below:

1. Ineffectiveness of the toxicant.
2. Inaccuracy in determining the amount of toxicant needed.
3. Method of application not efficient.
4. Environmental conditions present an interference.
    A. Presence and treatment of bottom springs and inlets.
    B. Extremes in chemical make-up of the water.
5. Resistant species present, such as members of the catfish family. (It usually takes 1 ppm instead of 0.5 ppm to kill catfish and bullheads.)

Wyoming Reports:

Chem-Fish Special Stays Toxic 49 Days at 44° F.

A detoxification test with a competitive 5% rotenone emulsive was made by the State of Wyoming. The following table indicates the character of the water used and the rates of detoxification. Both materials were used at a rate of 1 ppm.

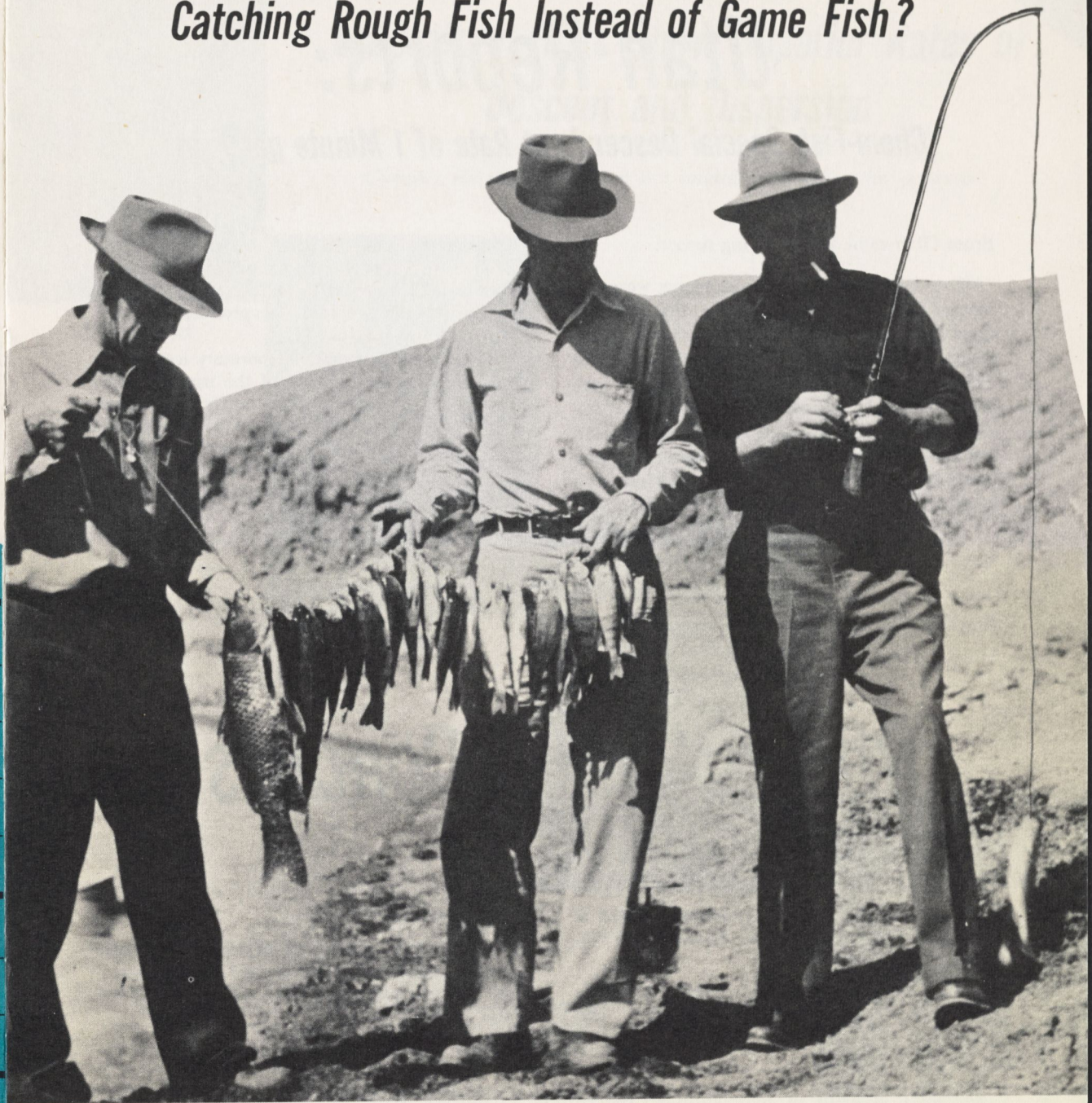
RESULTS OF DETOXIFICATION TEST:

WATER CHARACTERISTICS		COMPETITIVE PRODUCT	CHEM-FISH SPECIAL
Total dissolved salts		194 ppm	216 ppm
Methyl orange alkalinity		180 ppm	179 ppm
Dissolved oxygen		varied with temperature	varied with temperature
pH		7.6	7.3
Rotenone		0.05 ppm	0.05 ppm
Time Required in Days For Detoxification at Various Temperatures	26° C	7-14 Days *(6.5)	14-21 Days (4.2)
	18° C	14-21 Days (7.5)	28-35 Days (5.0)
	7° C	28-35 Days (8.6)	42-49 Days (5.9)

* Note: figures in parenthesis refer to the initial dissolved oxygen in ppm.

(Source: George Post, Federal Aid in Fish & Wildlife Restoration Project Wyoming FW-3-R, Quarterly Progress Report, 1 July, 1955).

Catching Rough Fish Instead of Game Fish?



Credit: H. R. Dick, Fish and Wildlife Service

The above catch of carp and rough fish could be replaced by game species if the pond were reclaimed by use of Chem-Fish Special. The presence of numerous rough fish competing for the available food supply greatly reduces the production of game fishes.

Utah Reports:

Chem-Fish Special Descends at Rate of 1 Minute per Foot!

From Utah came the following report:

"All our tests involving liquid rotenones were performed in 20 gallon glass aquaria. Fish used for these experiments were the Utah chub. All experiments were conducted in water temperatures of 72°F. Rate of vertical descent for an 18 inch depth averaged 1 minute per foot. Horizontal dispersion from undisturbed surface application averaged 20 minutes per foot. (These rates were based on the average time required for Utah chub to show first symptoms of rotenone poisoning.)

Concentrations of 0.25 ppm were sufficient to kill Utah chub. A concentration of 0.50 ppm remained toxic for 72 hours. The toxicant used was 5% Chem-Fish. In my opinion this product is suitable for rough fish control."*

With such good reports of laboratory tests it was not surprising that reports of the use of Chem-Fish Special in the field were equally satisfactory. We experienced a great amount of anticipation with its first few field trials. We were not disappointed. Chem-Fish Special proved definitely to be an improvement over the rotenone fish poisons previously marketed.

*(Source: Federal Aid to Fisheries Research, Utah Dept. of Fish and Game (John M. Neuhold, Research Biologist).

Rhode Island Concurs:

The fisheries biologist for the Rhode Island Dept. of Agriculture and Conservation was given a sample of Chem-Fish Special. A letter from him states:

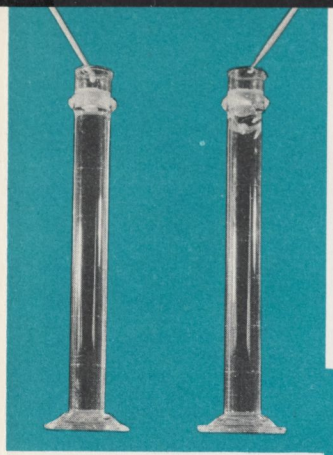
"We have not as yet had an opportunity to test the effectiveness of Chem-Fish Special on a field scale. The sample we received has been used in limited laboratory work.

It appears that the rate of descent is unusually good in graduated cylinders, and that the material has remained stable when stored under laboratory conditions."**

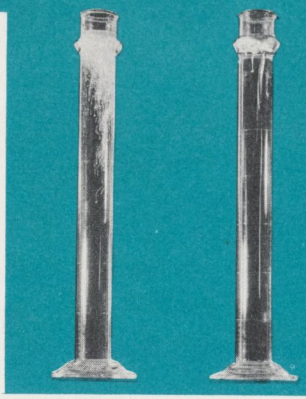
**(Source: R. I. Dept. of Agriculture & Conservation, Providence, R. I., Dr. Saul B. Saila, Fisheries Biologist (Letter of August 26, 1955).

Laboratory Tests Show Superior Rates of Descent and Dispersion

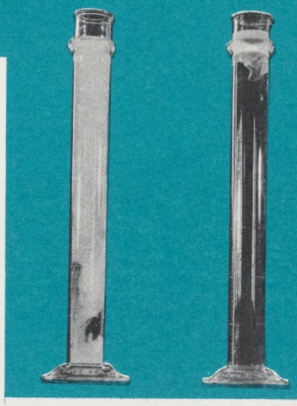
Compare the speed of descent and emulsification with other products.



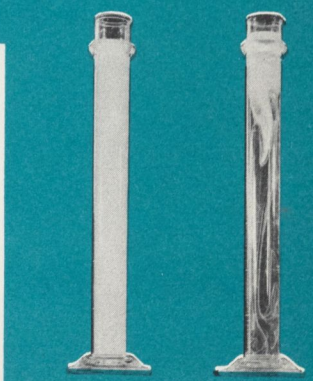
1 Second



30 Seconds



1 Minute



3 Minutes

In all the photos the cylinder at the left contains Chem-Fish Special. A competitive 5% rotenone has been utilized in the cylinder on the right. Equal amounts of undiluted emulsion were added simultaneously. A picture was taken at the time the emulsions were added and at subsequent intervals of 30 seconds, one minute and three minutes. The comparative speed and degree of emulsification is apparent from the photographs.

Cable Address:
CHEMSECT
METUCHEN

chemical insecticide corporation
30 WHITMAN AVENUE, METUCHEN, N. J. • LIberty 9-2300

Gentlemen:

The Interest in Aquatic Chemicals for eradication, selective control, and sampling of fish, as well as for the control of obnoxious weeds has stimulated considerable new efforts. Chemical Insecticide Corporation's technical staff has done effective work in these fields over the past several years, and we are pleased to enclose for your consideration, information on our CHEM FISH SPECIAL and CHEM PELS 2,4-D.

Both these products are rapidly coming into use as accepted specialty chemicals for one or more purposes.

It is hoped that you may find these products to be of interest and, if in the course of your regular employment or solely because of curiosity or interest in Biology, you would like to receive copies of other booklets and publications as they become available, we would appreciate your completing the enclosed card and returning it to us, so we may add your name to our mailing list.

If in any way we can help you with respect to your interest in these products, please feel free to contact us.

Very truly yours,

CHEMICAL INSECTICIDE CORPORATION

A. M. Livingston

A.M. Livingston
Manager

AML:ies
Enc.

1362

Cable Address:
CHEMSECT
METUCHEN

chemical insecticide corporation
30 WHITMAN AVENUE, METUCHEN, N. J. • LIberty 9-2300

PRODUCT DEVELOPMENT

CHEM PELS 2,4-D

CHEM PELS 2,4-D contain 10% active ingredients (low volatile ester 2,4-D) by weight. It is designed to control dicotyledonous, aquatic plants. The more common aquatic dicots (broadleaved flowering plants) are as follows: the family name of which they are a representative of is in parenthesis:

Water buttercup	(Ranunculaceae)
Smartweed	(Polygonaceae)
Water Chestnut	(Trapaceae)
Water lily	(Nymphaeceae)
Coontail	(Ceratophyllaceae)
Parrots Feather	(Haloragidaceae)

It is believed that other aquatic members of the above named families will also be more or less affected by CHEM PELS 2,4-D.

CHEM PELS 2,4-D were used experimentally by the Huron-Clinton Metropolitan Authority of Detroit, Michigan in 1956. Complete control of parrots feather was obtained by an application of 4 lbs./100 square feet, spread upon the ice in late spring.

The following year (1957) observations were made of the treated areas by the Huron-Clinton Metropolitan Authority personnel, and there was no evidence of any regrowth of the weeds that were prevalent prior to treatment.

Experimental laboratory and field data have confirmed similar findings in other areas throughout the United States.

To cite a typical example, the California Fish and Game Department treated 1/10 acre pond that was completely infested with Myriophyllum sp. The meximum depth of this pond was four feet. The material was distributed evenly over the surface of the pond at the rate of one pound per 100 square feet with a PCB spreader. Two weeks after application plant life in the treated area was completely destroyed.

To quote, "There was no sign of any damage or discomfiture to the fish (bluegill , largemouth bass, Gambusia) in the pond either from the chemical or from plant decomposition."

The Aquatic Biologist from the State of California also stated, "Although we did not try CHEM PELS at lower concentrations there is every indication that much lower treatments would accomplish the same results."

CHEM PELS 2,4-D are now available commercially for the eradication of undesirable aquatic vegetation.

Please address all correspondence to the Aquatic Division of the Chemical Insecticide Corporation, 30 Whitman Avenue, Metuchen, New Jersey, for further details.

So Goes Delaware!

The State of Delaware, was asked to give its findings on Chem-Fish Special, and replied to a questionnaire as follows:*

1. Rate of descent in waters of varying temperatures? — "Experimental tests indicate more rapid dispersal than the regular rotenone previously used."

2. Penetration of the thermocline?—"No thermocline in any of Delaware's waters."

3. Percent kill of fish and species? — "Effective against all warm water pond fish."

4. Length of time water remained toxic to fish?—"Indications from tests show water will remain toxic for 30 hours at 65 degrees Fahrenheit."

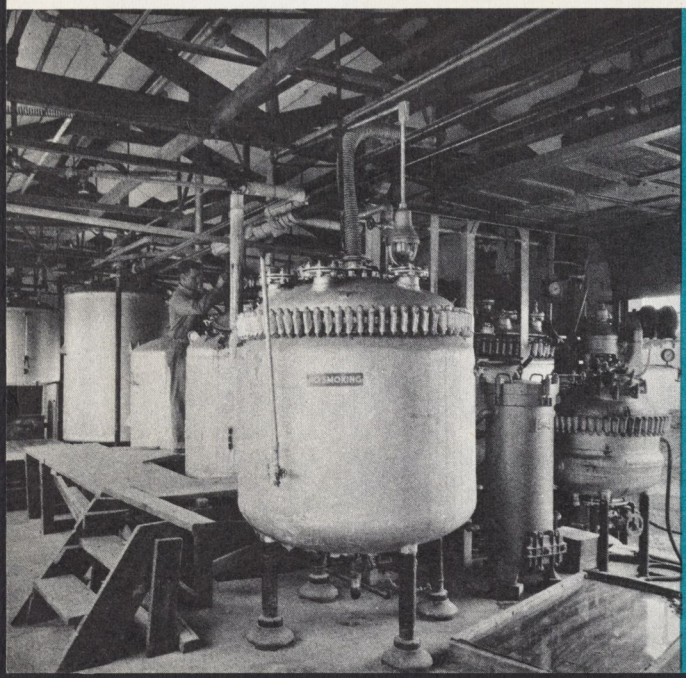
5. Effective on any other aquatic life, animal or plant?—"No comment as the effectiveness is not known."

6. Is product useful for:
   a: General rough fish control?—"Yes."

   b: Fish sampling?—"Yes."

   c: Stream use?—"Not known by us."

*(Source: Delaware Fish and Game Commission, Dover, Delaware, Jay Harmic, Aquatic Biologist (Letter of August 26, 1955).



View of rotenone extraction equipment at the Chemical Insecticide Corporation plant. Rotenone root is processed here. The rotenone resin is drawn from the still at the extreme right. The tray in the foreground contains solidified rotenone resin.

Oklahoma Reports:

Chem-Fish Special Kills Almost ... 95% Instead of 80%

* "In reference to your inquiry of 23 August concerning Chem-Fish Special, we used ten gallons of Chem-Fish Special on Rod & Gun Club South Lake, Carter County, Oklahoma, in a fish population manipulation experiment on 12 June, 1955. The lake comprises 18 surface acres—maximum depth 18 feet—average depth 6.4 ft.—115 acre-feet. 100 lbs. of 5% powdered cube root were applied in conjunction with the Chem-Fish Special in the open water (2 sacks dragged). Chem-Fish applied with power spray. It was intended to kill 80% of the population, but the actual kill was nearer 95%, as trapping later revealed.

The lake was extremely productive, containing an estimated (mark and recapture method) 875 lbs. of fish per surface acre.

SPECIES	LBS./ACRE
Bluegill	350
Gizzard Shad	330
Crappie	128
Redear sunfish	26
Largemouth bass	20
+ 5 other species	

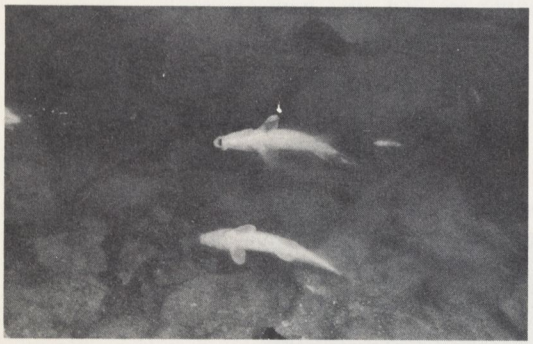
It was estimated that the Chem-Fish (10 gals.) would treat 60 acre-feet, and the powdered rotenone 30 acre-feet. Evidently, the Chem-Fish was more efficacious and covered about 80 acre-feet.

No thermocline. 74°F top, 70°F bottom, 18 ft. Fish in wire traps (crappie, bluegill, largemouth bass, carp) at 5, 8, 12, & 15 feet. Chem-Fish applied 0700-0800—Fish still alive in 12 & 15 foot depths at 1630—8 hours later. All fish dead at 0800 following morning."

* (Source: From Oklahoma Fish and Game Commission, Fishery Research Laboratory, Norman, Oklahoma; Robert M. Jenkins (Letter of August 25, 1955).

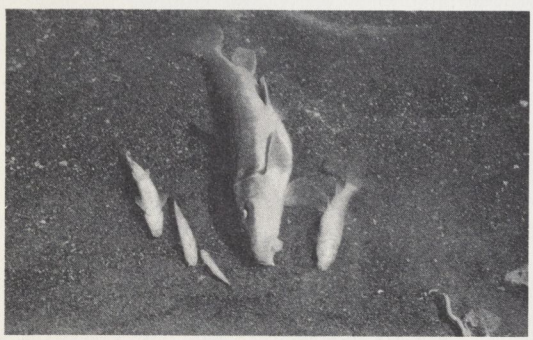
Colorado Reports:

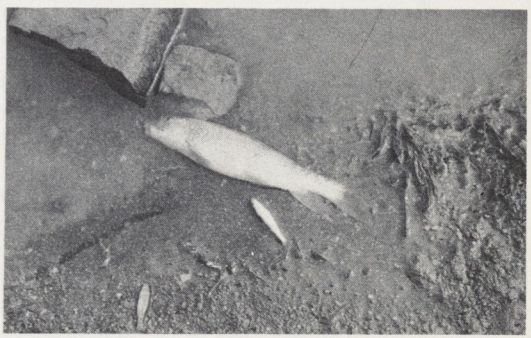
Chem-Fish Special "Starts Kill in Less Than 5 Minutes"



*"Before going into the questions in detail I would like to comment on my observations. First of all I would like to say it is the easiest to mix and to apply of any of the materials I have yet used. The rapidity with which the fish were killed was also of great interest to me. Many times fish were observed dying in an area, less than 5 minutes after application of Chem Fish. For these reasons I like it very much and hope that the Colorado Game and Fish Department will continue to see fit to use your product, or a similar one."

(Source: Colorado Cooperative Fisheries Unit, Fort Collins, Colo. Mr. Howard A. Tanner, Unit Leader (Letter of September 6, 1955).





After effects of using Chem-Fish Special in a Colorado Lake. This lake was 140 feet deep and contained 6000 acre feet of water.

North Carolina Reports:

Chem-Fish Special Kills "Much Higher Percentage" at Extremely Low Temperatures

In response to a letter of inquiry to North Carolina we received the following reply. We pass it on to you—

*"This is in reply to your letter of May 13 inquiring about the effectiveness of the Chem-Fish Special which we purchased from you some time ago.

We had only two opportunities to observe the effectiveness of this material and in neither case did we run a control using ordinary emulsifiable rotenone. However, in the more extensive fish sampling, approximately three-fourths acre of a high altitude mountain reservoir was sampled with water temperatures from 38 degrees at 20 feet to 64 degrees at the surface. In this particular case, we found Chem-Fish Special to be more effective than ordinary emulsifiable rotenone used on previous samplings at this exact same location approximately one year ago. Of course, the populations could have changed somewhat but the Chem-Fish Special seemed to bring up more rainbow trout, smallmouth bass, and some of the cold water minnows.

The other usage of the Chem-Fish Special was on a farm pond which had become populated with bluegills and in which the water temperature was approximately 55 degrees. An incomplete kill was obtained, although a much higher percentage of the population was killed than with ordinary rotenone at this extremely low temperature. Both of these tests were rather inconclusive; however, I believe they demonstrate that this material does have a definite place in both population eradication and population sampling."

*(Source: From North Carolina Wildlife Resources Commission, Raleigh, N. C., Duane Raver, Federal Aid Coordinator (Letter of May, 1955).

Warning:

CHECK WITH YOUR LOCAL AUTHORITIES FOR PERMISSION TO USE MATERIAL BEFORE APPLYING CHEM-FISH SPECIAL TO KILL THE FISH POPULATION. THE NEED FOR SUCH MEASURES SHOULD FIRST BE ASCERTAINED BY A QUALIFIED PERSON SUCH AS A STATE OR FEDERAL FISH BIOLOGIST. CONSULT YOUR STATE FISH & GAME DEPARTMENT FOR FURTHER INFORMATION.

CHEM-FISH SPECIAL IS AVAILABLE FOR SALE TO NON-GOVERNMENTAL AGENCIES AND GROUPS ONLY WHEN STATE APPROVAL ACCOMPANIES ORDER.

Other Chemicals From CIC to Help You Control Weeds in Your Area:

CHEM-SEN 56: *Aquatic Weed Killer* — For the control of submerged aquatics use Chem-Sen 56 *Aquatic Weed Killer,* a concentrated sodium arsenite liquid herbicide specifically compounded for aquatic use. Send for pamphlet — CHEM-SEN 56 Aquatic Weed Killer.

For the eradication of broad leafed, emergent, rooted plants, use Chem-Weed Aquatic (2,4-D +2,4,5-T).

Chem-Weed Herbicides by Chemical Insecticide Corporation

Chem-Weed 2,4-D — Control of annual broadleaf plants.

Chem-Weed 2,4,5-T — Control of 2,4-D resistant broadleaf weeds.

Chem-Weed Poison Ivy and Brush Killer — 2,4-D + 2,4,5-T for poison ivy and brush eradication.

Sodium TCA — For control of perennial grasses.

Chloro IPC — Control of weeds wherever onions and spinach are grown.

CHEMICAL INSECTICIDE CORPORATION

129 MONTAGUE STREET • BROOKLYN 1, NEW YORK
PLANT: METUCHEN, NEW JERSEY

POSITIVE ROUGH FISH CONTROL

CHEM-FISH SPECIAL

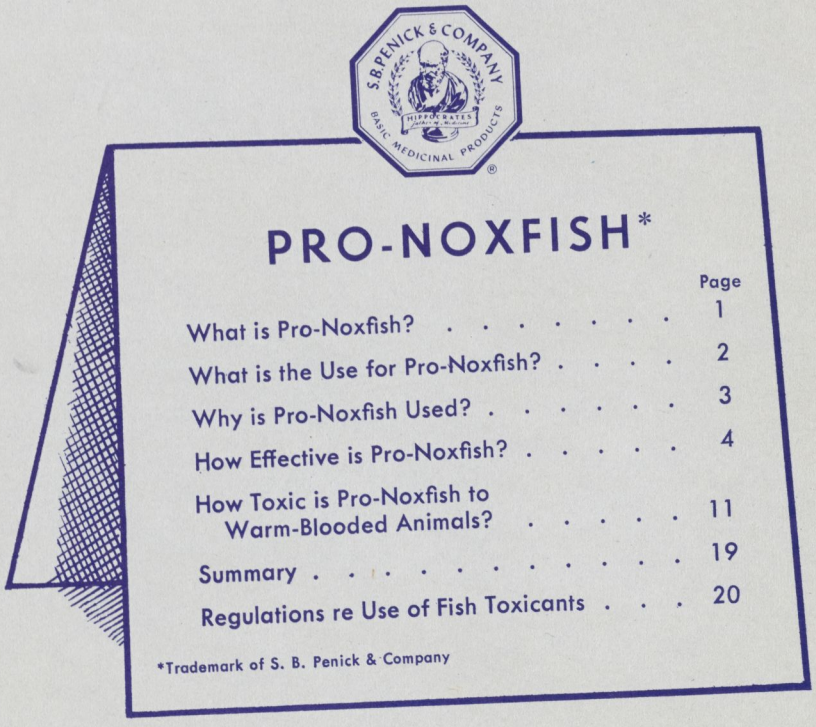
PRO-NOXFISH • PRO-NOXFISH • PRO-NOXFISH

S.B. PENICK & COMPANY
HIPPOCRATES
Father of Medicine
BASIC MEDICINAL PRODUCTS

S. B. PENICK & COMPANY

50 CHURCH STREET • NEW YORK 8, N. Y.

735 W. DIVISION ST. • CHICAGO 10, ILL.



PRO-NOXFISH*

*Trademark of S. B. Penick & Company

WHAT IS PRO-NOXFISH?

Pro-Noxfish is a newly developed fish toxicant, the result of a year's research in the laboratories of S. B. Penick & Company to find a better and more economical product for the control of undesirable fish.

After screening hundreds of combinations of Penicks Extract containing rotenone and possible activators, it was discovered that when sulfoxide[2] is added to rotenone,[3] a synergistic action occurs. We determined that a combination of 2.5% sulfoxide and 2.5% rotenone was as effective against fish as 5% rotenone. Sulfoxide is well-known as an activator for pyrethrins in insecticide sprays. Sulfoxide alone is not an effective fish toxicant, but when mixed with rotenone, it synergizes or activates it and makes it more effective. We could find no similar action with other pyrethrum synergists.

During this same period, the laboratory also found an improved emulsifier for Pro-Noxfish. When Pro-Noxfish is applied to the surface of a lake or pond, it settles and disperses quickly and evenly throughout all parts.

Pro-Noxfish weighs eight pounds per gallon and contains 2.5% rotenone, 5% other cube extractives and 2.5% sulfoxide.[4]

It is packed in 55, 30 and 5 gallon drums, and is available from S. B. Penick & Company, 50 Church Street, New York 8, New York, and 735 West Division Street, Chicago 10, Ill.

Handling of Pro-Noxfish requires the same precautionary measures which apply to pesticides in general, namely:

Avoid contact with skin and eyes. May be harmful if swallowed in sufficient quantity.

Do not pour, spill or store near fire or flame.

---

1 Trademark of S. B. Penick & Company.

2 U. S. Patent No. 2,486,445.

3 The formulation is made with Penick's Cube Extract added in amount sufficient to provide 2.5% or 5% rotenone in the finished product.

4 Application for patent pending.

WHAT IS THE USE FOR PRO-NOXFISH?

Some typical uses for Pro-Noxfish are:

To remove an over-abundance of undesirable species of fish.

To remove fish stunted by over-crowding.

To rehabilitate lakes or streams that have poor fishing due to off-balance fish populations.

To remove undesirable fish so that an adequate food supply is available for more desirable species.

To reduce by partial treatment populations of forage fish such as bluegills and to bring the pond into balance.

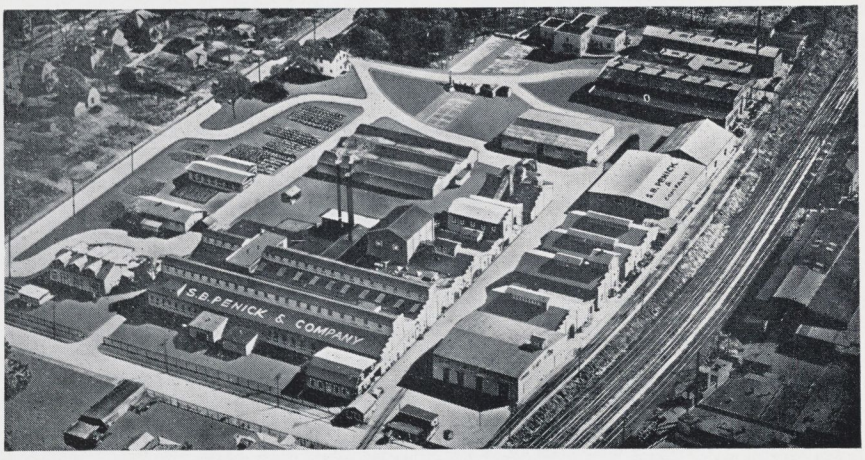
To create good fishing with a modest investment.

To restore balanced fish population.

To reclaim farm ponds, a necessity every four to eight years, as on an average they become over-populated in this period. When a pond reaches an over-crowded state, it must be rejuvenated through reclamation and restocking.

To restore aquatic vegetation in waterfowl feeding areas by removing carp which root out plants and which cause such turbidity that nothing can grow.

Manufacturing plant at Lyndhurst, N. J.



WHY IS PRO-NOXFISH USED?

To permit restocking with desirable species and to obtain balanced fish population.

To permit restocking with a species of game fish better suited to the environment.

To permit putting the lake or pond into correct balance so that fish of a fair size can again be caught.

To permit faster growth rate of restocked fish because of less competition for available food.

To permit, in cases of partial treatment, the remaining fish to develop faster through the thinning down of previous fish population which competed for the limited food supply.

To permit, by removing species of undesirable fishes and restocking with one or two desirable species, the channeling of the productivity of the body of water toward the production of a good crop of only desirable fishes.

HOW EFFECTIVE IS PRO-NOXFISH?

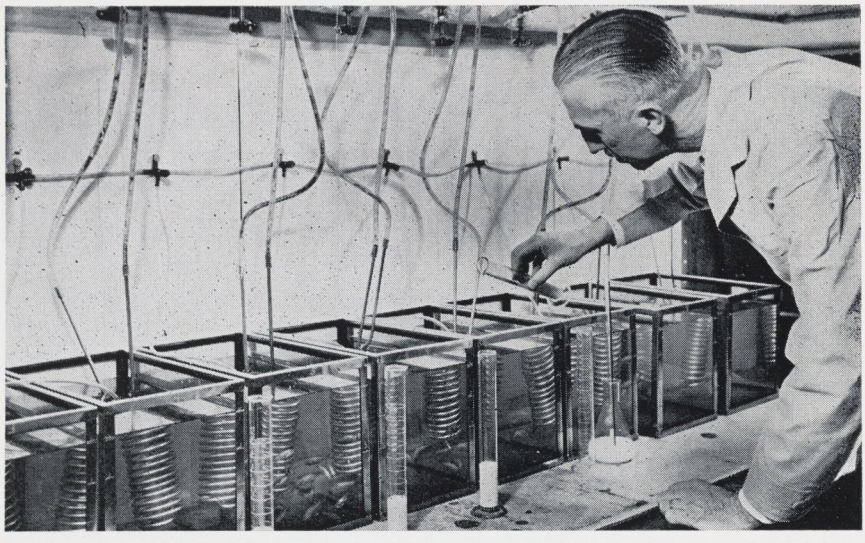
The effectiveness of sulfoxide as a synergist for rotenone was established in the Research Laboratories of S. B. Penick & Company using the common goldfish as test animals.

These fish, in five-gallon aquaria, were exposed to various concentrations of (1) rotenone, (2) sulfoxide and (3) a 50-50 mixture of rotenone and sulfoxide, and the number of dead fish were counted at the end of a 24 hour period. Dose-mortality curves were plotted using sixty fish per point and the concentrations causing 50% mortality (LD_{50} values) read from the graphs. These values serve as a basis for comparison of relative toxicities. The LD_{50} values are as follows:

Sulfoxide	1.6	ppm
Rotenone	0.0104	ppm
Rotenone-Sulfoxide	0.00565	ppm

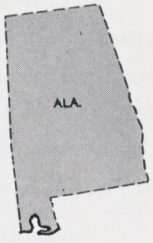
Sulfoxide alone is relatively non-toxic (a comparatively large dose is required for an LD_{50}). However, when a small amount of sulfoxide is added to rotenone, the latter's toxicity is increased. For a given effect, therefore, the amount of rotenone can be decreased if sulfoxide is added.

Section of aquaria bank at Penick Laboratories. Dr. Price is checking reaction of goldfish to Pro-Noxfish.



Large-scale applications of Pro-Noxfish confirmed laboratory fiindings. Reports on projects in Alabama, Florida and New Hampshire are reproduced on the following pages. You will observe that after the lake treated with Pro-Noxfish had been detoxified, Noxfish® was applied as a check. There was no evidence of any fish surviving the application of Pro-Noxfish.

Report on Use of Pro-Noxfish at Lake Jackson, Alabama



STATE OF ALABAMA

Department of Conservation

MONTGOMERY, ALABAMA

"This is in regard to the results obtained from the use of the 1,500 gallons of Pro-Noxfish which was purchased from your Company.

"This material was used in the renovation of Lake Jackson, which is a 372 acre lake averaging 10-feet in depth and located in South Alabama and North Florida. In addition to the open area of the lake, there are approximately 150 acres of marsh land that are partially flooded during heavy rains in the winter. However, at the time of renovation, the marsh land was practically dry and contained only a very small run-off but it maintains a fairly constant water level even during periods of extreme drought. It overflows into a nearby creek during times of high water.

"There is a marginal band of obnoxious vegetation about 50 to 100 feet wide consisting primarily of maiden can, but also containing pickerel weed, primrose, water lily and cat-tails, that extends around most of the shoreline.

"For several years prior to renovation, the lake afforded very little fishing. However, it has been used extensively for boating and swimming by people in the surrounding area.

"The results of several fish population studies indicated that Lake Jackson was heavily infested with rough fish; therefore, we concluded that the lake should be completely renovated. Therefore, on November 1, 1955, a total of 330 gallons of Pro-Noxfish was applied by an aircraft equipped

with a spray unit. The remaining 1170 gallons were evenly distributed over the lake surface by two airboats equipped with spray pumps. Approximately six hours (7:00 A.M.-1:00 P.M.) were required to apply the chemical. On the date that the Pro-Noxfish was applied the surface water temperature was 63°F.

"On November 10, 1955, a check was conducted to determine whether live fish remained in the lake. This was done by treating two 4-acre areas on each end of the lake with approximately 1 p.p.m. of Noxfish. Since this check did not reveal any live fish, it was apparent that a very effective kill resulted from the Pro-Noxfish treatment. However, one salamander which was not quite dead was picked up on this date.

"During the period that most of the dead fish were floating on the surface of the lake, which was about ten days after the initial treatment, a visual survey was conducted to determine the weight of fish per acre and species composition of the population that the lake had been supporting. This estimate which included those fish previously taken while they were still usable is as follows:

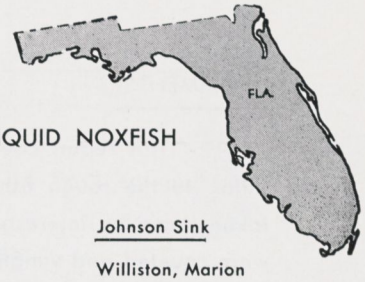
Species	*Pounds per Acre*	*Percentage of Total Weight*
Sucker	15	34.9
Gar	10	23.3
Bowfish	5	11.6
Catfish	5	11.6
Bass	3	7.0
Bream	2	4.6
Eels	3	7.0
Total	43	100.0

"From the studies obtained to date, we believe that the Pro-Noxfish was completely effective at 1 p.p.m. in eliminating all fish from Lake Jackson."

GAME AND FISH DIVISION
C. G. Hixon, Chief

By I. B. Byrd, Principal Biologist
Fish Management Section
December 19, 1955.

Report of Use of Pro-Noxfish at Williston, Florida



RESEARCH PROJECT — PRO-NOXFISH VS. LIQUID NOXFISH

Name of Lake:	Johnson Sink	Johnson Sink
Location:	Williston, Marion County, Fla.	Williston, Marion County, Fla.
Date of application:	July 30, 1955	August 8, 1955
Acreage:	11	11
Acre feet:	88	88
Deepest point:	12 ft.	12 ft.
Average depth:	8 ft.	8 ft.
Temperature of water-surface:	85°F.	83°F.
deepest point:	74°F.	74°F.
pH:	7.0	7.0
Condition of water:	clear	clear
Type of bottom:	Hard sand covered with about 4 inches of muck	Hard sand covered with about 4 inches of muck
Plant growth present:	None	None
Name of toxicant applied:	Pro-Noxfish	Liquid Noxfish
Quantity of toxicant applied:	15 gallons	15 gallons
Elapsed time until first showing of fish.	20 minutes	no fish

Pickup — 72 hours	*Weight*	*Number*	*Species*	*Weight*	*Number*	*Specie*
	1,280	1,000	chub sucker	0	0	0
	800	266	Florida gar (Lepisosteus platyrhincus)	0	0	0
	620	124	Bowfin (Mudfish) (Amia calva)	0	0	0
Total fish eradicated:		1,390			0	
Total weight of fish eradicated:	2,700			0		

COMMENTS——→

"COMMENTS:

"This report covers only the rough fish counted and weighed. In addition to the rough fish there were several hundred pounds of edible fish taken home by interested sportsmen who assisted with this project. No fish were counted and weighed until the 72 hour period was reached. At this time all fish were bloated and floating on the surface and this made counting and weighing much easier."

SIGNED: Edward A. Zagar
Address: Box 77 — Williston, Fla.

Carp taken by reclamation.

STATE OF NEW HAMPSHIRE
Fish and Game Department
34 Bridge Street
CONCORD

PRO-NOXFISH RECLAMATION

"CHAPIN POND, NEWPORT, was the pond we reclaimed with Pro-Noxfish. It had been reclaimed for brook trout in 1946 and had since become repopulated with horned pout. It was reclaimed on August 11, 1955, with Pro-Noxfish. The reclamation was done under most adverse weather conditions. I mention this because it was raining very hard throughout the application of the rotenone and it rained for the next two days which resulted in approximately six inches of water over a one and one-half foot dam, three days after the reclamation.

"Fifteen gallons of the Pro-Noxfish concentrate were mixed in a portion of 1 gallon to 20 gallons of water and sprayed over the entire surface of the pond by the use of gas-rotary pumps. A part of the shoreline was sprayed by the use of Indian pumps, the entire job being completed in approximately 2 1/4 hours.

The 24 hour pick-up was based on an estimate of one acre, due to the fact the physical condition of the pond prevented a complete pick-up. However, the dead fish appeared to be distributed over the bottom in a relatively equal proportion. The 48 hour check indicated that we had obtained a complete kill at the end of 24 hours.

Summary — Pro-Noxfish

Name of Pond:	Chapin Pond
Location:	Newport and Claremont, New Hampshire
Date of Application:	August 11, 1955
Acreage:	12 acres
Acre Feet:	77
Deepest Point:	12 feet
Average Depth:	6.4 feet
Temperature of Water:	Surface: 74° — Deepest Point: 72°
pH:	6.4
Condition of Water:	Clear
Secchi Disk Reading:	10.5 feet
Type of Bottom:	Mud and scattered rock and gravel
Plant Growth Present:	Submerged vegetation (Dense)
Amount of Pro-Noxfish Applied:	15 gallons
Concentration Approximately:	.58 ppm
Elapsed Time Until First Showing of Fish:	15 minutes

Pickup — 24 Hours:

Weight	*Number*	*Species*
5.75 lbs.	34	Brook trout
1.25 lbs.	1	Rainbow trout
408.00 lbs.	10,560	Horned pout

Total Fish Eradicated: 10,595
Total Weight of Fish Eradicated: 415 pounds

Pickup — 48 Hours:

Weight	Number	*Species*
	No other fish showing	

"The pond was checked at the end of 7, 14 and 21 days, and it was found to be still toxic to trout.

NOXFISH RECLAMATION

"The second reclamation was completed on September 8, four weeks after the Pro-Noxfish application. A similar amount, 15 gallons of regular Noxfish was used, and the pond was sprayed in the same manner as was done with the Pro-Noxfish. No fish were seen to have been killed during the entire operation. A 24 and 48 hour check indicated that the first reclamation with Pro-Noxfish, using a concentration of .58 ppm had given a total kill.

"I noted that we had obtained a high kill of salamanders on our first application with Pro-Noxfish. However, we did not obtain a complete kill since a few were seen to have survived and a few more were killed on the second reclamation with the regular Noxfish.

Summary — Regular Noxfish

Date Reclaimed:	September 8, 1955
Acreage:	12 acres
Acre Feet:	77
Deepest Point:	12 feet
Average Depth:	6.4 feet
Approximate Concentrate:	.58 ppm
Transparency:	10.5 feet
Species Killed:	No fish, only a few salamanders
pH:	6.6
Surface Water Temperature:	67° — At 10 feet: 66°

Remarks: The pond was lowered 18 inches prior to reclamation with regular Noxfish.

"24 and 48 hour checks indicated a complete kill on the fish was obtained on August 11.

"The pond was tested, over a 24 hour period, with live trout on October 18, 40 days after reclamation, and found to be clear."

Robert B. Knowlton, Supervisor
Fish and Game Distribution

October 24, 1955

HOW TOXIC IS PRO-NOXFISH TO WARM-BLOODED ANIMALS?

The user of any fish toxicant must consider the possibility that the treated water might be consumed by other animals, particularly farm animals and wild life, and perhaps humans, before neutralization of the toxicant has occurred. It is therefore important to know whether any toxic effects might result should such animals consume normal or even excessive amounts of the treated water. One must also take into account the possibility that wild life might be driven away from the treated ponds and lakes because of unpalatability of the water.

Such information with respect to Pro-Noxfish has been obtained by administering the material to several species of animals in single and repeated doses at levels which are equivalent to the consumption, in a single dose, of 100,000 gallons of treated water for a 150-pound man. The species of animals chosen for the tests are representative of those varieties most likely to have access to the treated water, namely fowl, rodents and ruminants. Chicks and ducklings were chosen as typical fowl, rabbits as an example of rodents, and sheep as characteristic of the ruminant group.

In preliminary acute (single dose) toxicity studies of Pro-Noxfish in 4-week old chicks, no deaths occurred at a dose of 6 cc./kg. This quantity of Pro-Noxfish would be contained in 1600 gallons of lake or pond water treated at the rate of 1 part per million. Thus, it would be necessary for chicks to consume treated water far beyond normal consumption in order to exhibit any toxicity.

TABLE I

Acute Oral Toxicity of Pro-Noxfish for Rabbits

Dose cc./kg.	*No. of Animals*	*No. of Deaths*
0.5	4	0
1.0	5	1
2.0	5	1
3.0	5	4
4.0	5	5
8.0	4	4

For rabbits, the non-lethal dose is approximately 0.5 cc./kg. This amount of Pro-Noxfish is contained in 132 gallons of 1 part per million treated water, or the equivalent of 9000 gallons for an adult human.

In addition to the single dose experiments described above, Pro-Noxfish was given daily to chicks, ducklings and lambs for 4 weeks, in the drinking water and made freely available to the animals at all times. Solutions were made up fresh daily. Concentrations of Pro-Noxfish were 0.5, 5.0 and 50 parts per million. The highest dose is 100 times that normally employed for fish eradication. Daily consumption of water was recorded, and the animals were weighed periodically to determine the amount and rate of growth. By recording daily water consumption, it was possible to determine the total quantity of Pro-Noxfish consumed.

There were 15 ducklings and 20 chicks at each dose level in the experiments done in the laboratories at the Wisconsin Alumni Research Foundation. In Table II are shown the average amount of water and Pro-Noxfish consumed per duckling throughout the 4 week period. Similar values for chicks are shown in Table III. There were no deaths among any of the ducklings and 1 chick in the control group died.

TABLE II

Total Water and Pro-Noxfish Consumption by Day-Old Ducklings During a 4-Week Period. 15 Ducklings per Group.

Dose of Pro-Noxfish	*cc. Water Consumed per Duckling per 4 Weeks*	*cc. Pro-Noxfish Consumed per Duckling per 4 Weeks*
Control	17,210	0
0.5 ppm.	16,780	0.0075
5.0 ppm.	16,160	0.0808
50 ppm.	15,080	0.753

TABLE III

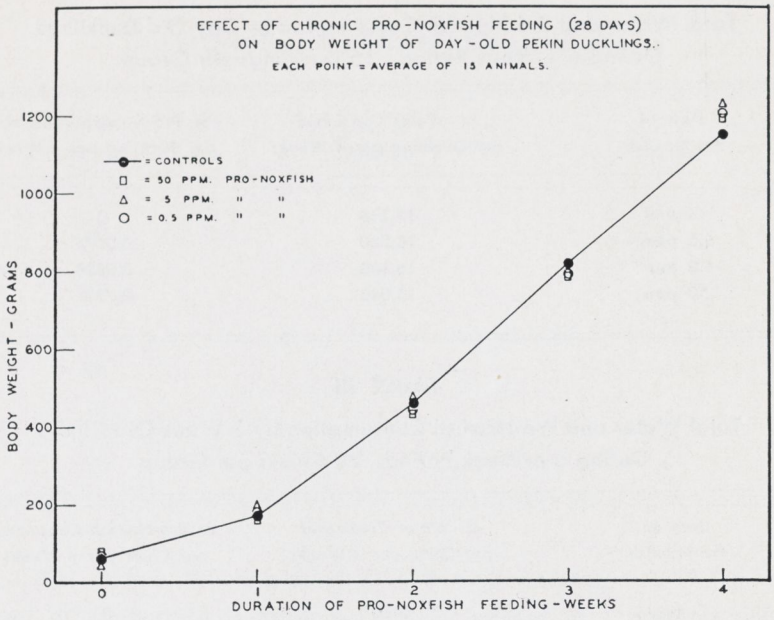
Total Water and Pro-Noxfish Consumption by 3-Week Old Chicks During a 4-Week Period. 20 Chicks per Group.

Dose of Pro-Noxfish	*cc. Water Consumed per Chick per 4 Weeks*	*cc. Pro-Noxfish Consumed per Chick per 4 Weeks*
Control	4010	0
0.5 ppm.	3880	0.00194
5.0 ppm.	3830	0.0191
50 ppm.	3880	0.194

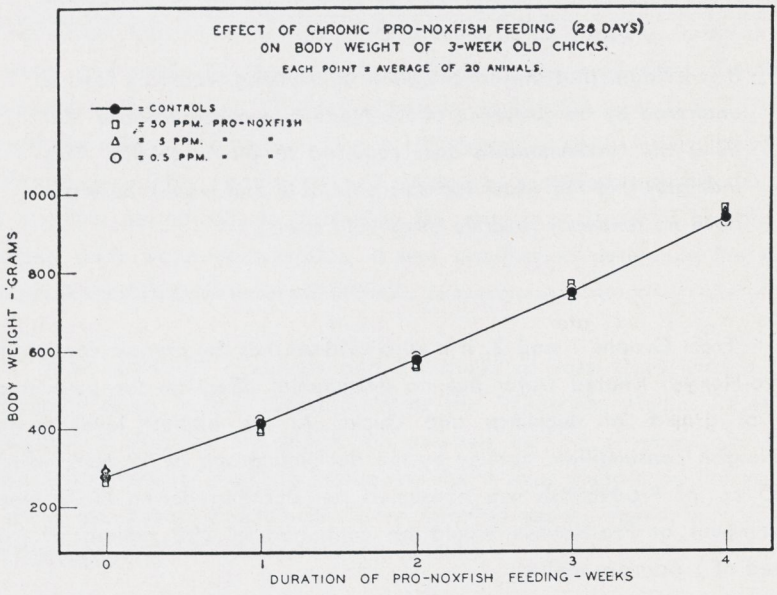
It is evident that the consumption of drinking water by fowl is unaltered by the presence of Pro-Noxfish in concentrations 100 times the recommended dose required to kill rough fish. This indicates that the water remains palatable and would therefore have no tendency to drive away wild fowl.

From Graphs 1 and 2, it is also evident that the chronic consumption of Pro-Noxfish treated water has no detrimental effect on the amount and rate of growth of ducklings and chicks. At the highest level of total Pro-Noxfish consumption, namely by the duckling group at 50 ppm. wherein 0.753 cc. of Pro-Noxfish was consumed per duckling during the 4 weeks, this amount of Pro-Noxfish would be contained in 200 gallons of water treated at 1 part per million.

Graph 1



Graph 2



The lamb chronic feeding tests were conducted on 56- to 7-month old animals. The Pro-Noxfish doses, at 0.5, 5.0 and 50 parts per million levels, were made available to the lambs in their drinking water and were made up fresh daily. There were 4 lambs in each test and control group. Each test group comprised 2 ewes and 2 rams, while the control group contained 3 ewes and 1 ram.

In Table IV are shown the average daily water consumption per lamb and the total 4-week Pro-Noxfish consumption.

TABLE IV

Daily Water and Total Pro-Noxfish Consumption by Lambs
During a 4-Week Period. 4 Lambs per Group.

Dose of Pro-Noxfish	*cc. Water Consumed per Lamb per Day*	*cc. Pro-Noxfish Consumed per Lamb per 4 Weeks*
Control	3445	0
0.5 ppm.	4400	0.074
5.0 ppm.	3340	0.48
50 ppm.	3720	5.4

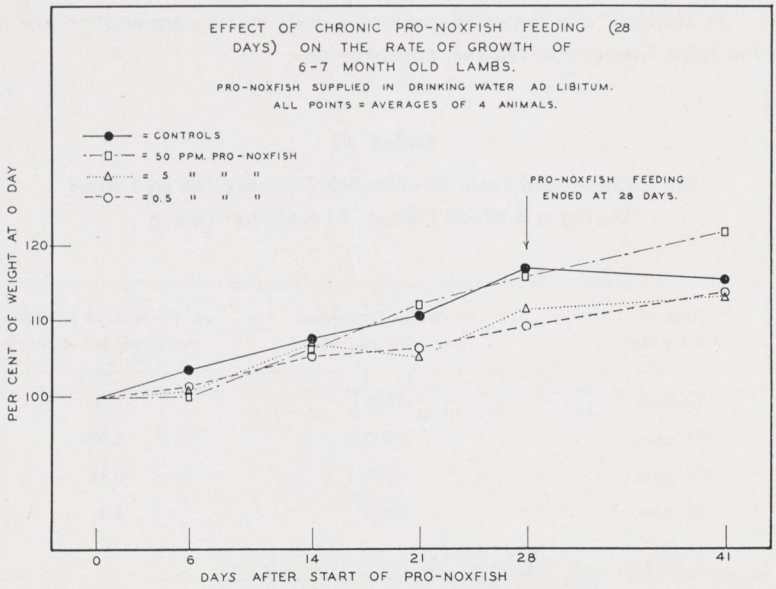
There were no deaths among any of the groups. Two lambs in the 50 ppm. group and 1 control animal were sacrificed about 1 month after the end of Pro-Noxfish feeding, and autopsies performed by the veterinarian. No pathological changes were observed.

The amount of water consumed by the experimental animals is no different than the controls and **indicates the satisfactory palatability of the treated water for ruminants.** The highest amount of Pro-Noxfish consumed, namely by the 50 ppm. group, at the rate of 5.4 cc. Pro-Noxfish for the 4 weeks, is contained in 1400 gallons of Pro- Noxfish treated water, 1 part per million.

The effect of chronic Pro-Noxfish feeding on the amount and rate of growth of the lambs was determined and is shown in Graph 3. Values are plotted in terms of per cent of original weight (weight on day before start

of Pro-Noxfish feeding). **The rate of increase in body weight at any dose level was not significantly different from control weights.** Comparative average weights of the various groups before, during and after Pro-Noxfish feeding are shown in the bar Graph 4 (Page 17).

Graph 3

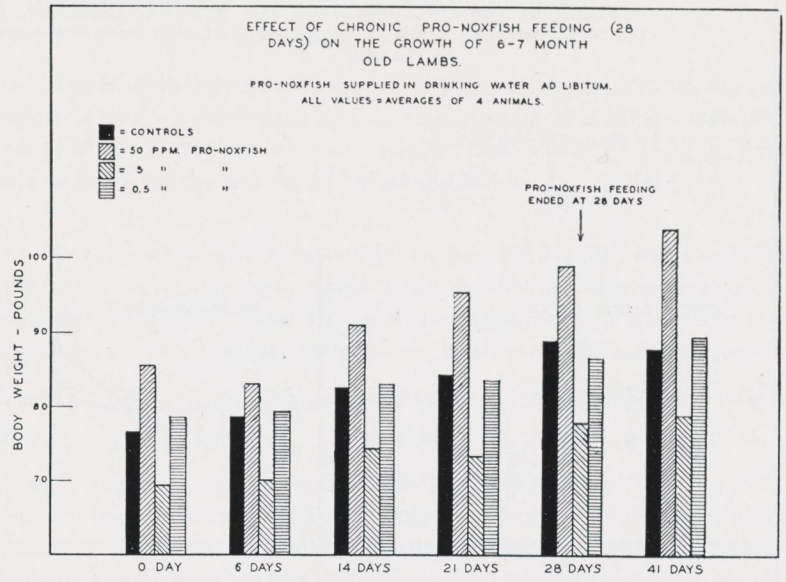


Further investigation of any possible toxic effect of Pro-Noxfish included a study of the blood picture of the lambs before, at the end of, and 2 weeks after chronic Pro-Noxfish feeding. The blood elements studied were:

1. Hemoglobin
2. Packed cell volume
3. Red blood cells
4. Methemoglobin
5. White blood cells
   a. Lymphocytes
   b. Neutrophiles
   c. Monocytes
   d. Eosinophiles

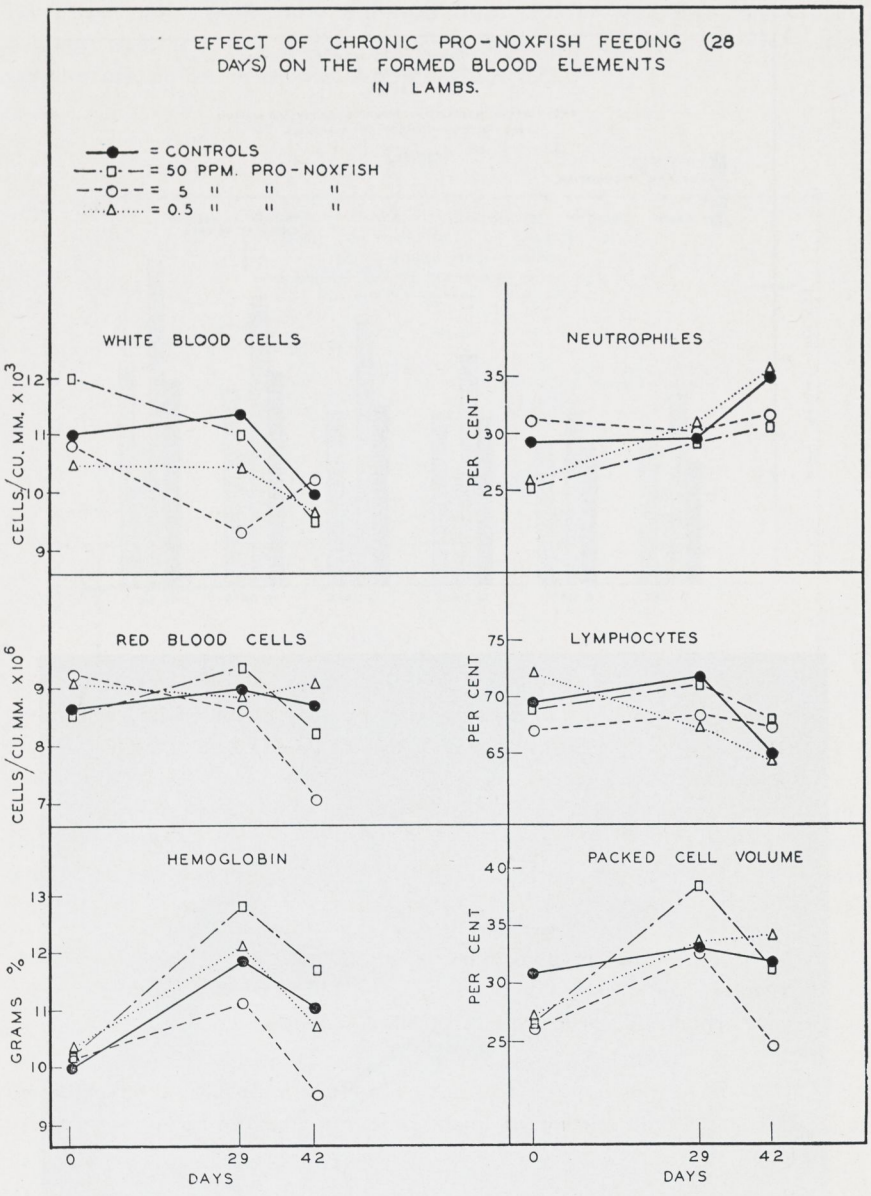
The blood studies were made by the School of Veterinary Medicine, University of Pennsylvania. The values for 1, 2, 3, 5, 5a and 5b listed above are shown in Graph 5. Items 4, 5c and 5d do not lend themselves to graphic presentation. **No effect of Pro-Noxfish on the blood of lambs could be demonstrated.**

Graph 4



Plotting depth of lake to determine volume of water
Photo by Leon Johnson, courtesy Fish Management Division, State of Wisconsin

Graph 5


EFFECT OF CHRONIC PRO-NOXFISH FEEDING (28 DAYS) ON THE FORMED BLOOD ELEMENTS IN LAMBS.
= CONTROLS
= 50 PPM. PRO-NOXFISH
= 5 " " "
= 0.5 " " "
WHITE BLOOD CELLS
CELLS/CU. MM. X 10³
NEUTROPHILES
PER CENT
RED BLOOD CELLS
CELLS/CU. MM. X 10⁶
LYMPHOCYTES
PER CENT
HEMOGLOBIN
GRAMS %
PACKED CELL VOLUME
PER CENT
0
29
42
DAYS

SUMMARY

Pro-Noxfish has no oral toxicity, either acute or chronic, for warm-blooded animals, as demonstrated in fowl, rodent and ruminant examples, at concentrations 50 to 100 times greater than would be used in treating ponds or lakes for the destruction of rough fish.

In the preliminary acute toxicity studies, Pro-Noxfish was administered as the undiluted concentrate. When these non-lethal doses are converted to the quantity of treated water (at 1 part per million) which would contain the same amount of Pro-Noxfish, the resulting volumes are as follows:

Chicks	1600 gals./kg.	equivalent to	109,000 gals./150 lb. man
Rabbits	132 gals./kg.	equivalent to	9,000 gals./150 lb. man

If it were assumed that humans would react quantatively like the rabbits, a human would have to drink 9,000 gallons of water containing 1 ppm. Pro-Noxfish as a single dose in order to consume the same quantity of Pro-Noxfish which was non-toxic to rabbits.

In the 4-week chronic toxicity studies, the highest doses of Pro-Noxfish used (with no detrimental effects) have also been recalculated into equivalent volumes of 1 ppm. Pro-Noxfish per kilogram of animal body weight, and for an adult human:

Chicks	84 gals./kg.	equivalent to	5,700 gals./150 lb. man
Ducks	1700 gals./kg.	equivalent to	115,000 gals./150 lb. man
Lambs	41 gals./kg.	equivalent to	2,800 gals./150 lb. man

Thus, an adult would have to drink 2800 gallons of 1 ppm. Pro-Noxfish treated water over a period of 4 weeks to equal the dose consumed by each lamb, and **which still produced no adverse effects.**

At the doses fed for 4 weeks, Pro-Noxfish produced no untoward effects on the blood picture of lambs, and no gross pathology was found at autopsy.

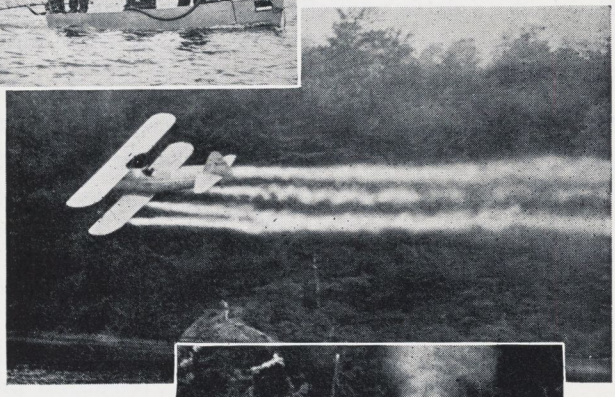
Chicks, ducklings, and lambs readily accepted Pro-Noxfish treated drinking water even at 50 ppm., thus attesting to its palatability. It is therefore reasonable to assume that wild life would not avoid such treated areas.

REGULATIONS RE USE OF FISH TOXICANTS

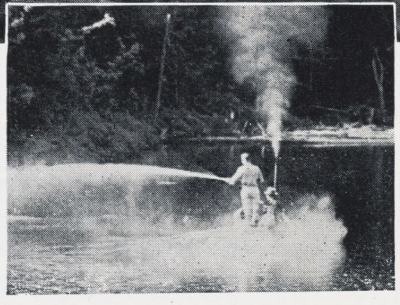
Most states have laws prohibiting the introduction of any foreign substance into lakes, ponds and other waters. The destruction of fish is also illegal. Private lake owners and others interested in reclamation should contact the proper authorities in their state to obtain permission. A list of the persons to be contacted is given on pages 21-24. No Noxfish or Pro-Noxfish will be sold without evidence of such permission having been granted.

In addition to the importance of complying with the legal requirements, owners of private waters should have the advice and aid of State Fishery or Conservation Departments before attempting thte eradication of fish, as good results can be obtained only when the methods of application and the dosages are correct.

Boom spray rig, courtesy of Phillips Wildlife Laboratory, Upton, Massachusetts.



Aerial aplication



Power spray rig, courtesy Dr. D. A. Webster, Cornell University, Ithaca, N. Y.

State of Alabama,
Department of Conservation,
Game and Fish Division,
Montgomery, Ala.
Att: Mr. I. B. Byrd, Principal Biologist
Fish Management Section

State of Arizona,
Game and Fish Commission,
Phoeniz, Arizona.
Att: Mr. Jack Hemphill,
Chief of Fisheries

State of Arkansas,
Game and Fish Commission,
Game and Fish Building,
State Capitol Grounds,
Little Rock, Arkansas.
Att: Mr. T. A. McAmis,
Director

State of California,
Department of Fish and Game,
926 J Street,
Sacramento 14, Calif.
Att: Mr. Alex Calhoun, Chief
Inland Fisheries Branch

State of Colorado,
Department of Game and Fish,
1530 Sherman Street,
Denver 5, Colo.
Att: Mr. J. D. Hart, Assistant Director
OR Mr. R. M. Andrews, Fish Manager

Connecticut State Board of Fisheries
and Game,
State Office Building,
Hartford, Conn.
Att: Mr. Douglas D. Moss, Chief
Division of Fisheries

State of Delaware,
Board of Game and Fish Commissioners,
Dover, Delaware.
Att: Mr. Norman G. Wilder,
Director of Conservation

State of Florida,
Game and Fresh Water Fish Commission,
Tallahassee, Florida.
Att: Mr. Don R. Luethy, Chief
Fisheries Division

Georgia Game and Fish Commission,
412 State Capitol,
Atlanta, Ga.
Att: Mr. Fred J. Dickson, Chief
Fish Management

State of Idaho,
Department of Fish and Game,
518 Front Street,
Boise, Idaho.
Att: Mr. James C. Cimpson, Chief
Fisheries Division

State of Illinois,
Department of Conservation,
State Office Building,
400 South Spring Street,
Springfield, Ill.
Att: Superintendent,
Division of Fisheries

Division of Fish and Game,
Indiana Department of Conservation,
311 West Washington St.,
Indianapolis, Indiana.
Att: Mr. Emmett L. Lewis,
Director

State Conservation Commission,
East 7th and Court Avenue,
Des Moines 9, Iowa.
Att: Mr. R. W. Beckman, Chief
Fish and Game Division

Director,
Forestry, Fish and Game Commission,
Pratt, Kansas.

Department of Fish and Wildlife Resources,
Frankfort, Kentucky.
Att: Mr. Minor E. Clark, Director
Division of Fisheries

Louisiana Wildlife and Fisheries Commission,
126 Civil Courts Bldg.,
New Orleans 16, La.
Att: Mr. George C. Moore, Chief
Fish and Game Division

Mr. Roland H. Cobb, Commissioner
Department of Inland Fisheries and Game,
State House,
Augusta, Maine.

State of Maryland,
Water Pollution Control Commission,
2114 N. Charles Street,
Baltimore 18, Md.
Att: Mr. Paul W. McKee,
Director

The Commonwealth of Massachusetts,
Department of Public Health,
73 Tremont Street,
Boston 8, Mass.
ALSO
Division of Fisheries and Game,
73 Tremont Street, Boston 8, Mass.

Mr. A. B. Cook, Jr., Assistant Chief
Fish Division,
Department of Conservation,
Lansing, Michigan.

Mr. James W. Kimball, Director
Division of Game and Fish,
Department of Conservation,
State Office Bldg.,
St. Paul 1, Minn.

Mr. Wade H. Creekmore,
Director of Conservation,
Game and Fish Commission,
P. O. Box 451,
Jackson, Miss.

Missouri Conservation Commission,
Monroe Building,
Jefferson City, Missouri.
Att: Mr. P. G. Barnickol, Chief Biologist
Fisheries Section

Chief Fisheries Division,
Fish and Game Department,
Helena, Montana.

Mr. Glen R. Foster,
Supervisor of Fisheries,
Game and Parks Commission,
State House,
Lincoln, Nebraska.

Nevada Fish and Game Commission,
P. O. Box 678,
Reno, Nevada.
Att: Mr. T. J. Trelease

Mr. Ralph G. Carpenter, 2nd,
Director of Fish and Game Department,
34 Bridge Street,
Concord, N. H.
ALSO
Water Pollution Commission,
17 Capitol Street,
Concord, New Hampshire.

William Coffin, Chief Protector,
New Jersey Division of Fish and Game,
230 West State Street, Trenton, N. J.
with copy to Mr. Roland Smith,
Senior Fisheries Biologist,
126 N. Main Street,
Milltown, N. J.

State of New Mexico,
Department of Game and Fish,
Santa Fe, New Mexico.
Att: Mr. Roy E. Barker, Chief
Fish Management

State of New York,
Conservation Department,
Aibany 1, N. Y.
Att: Mr. C. W. Greene, Chief
Bureau of Fish

State of North Carolina,
Wildlife Resources Commission
Raleigh, N. C.
Att: Mr. J. H. Cornell, Chief
Fish Division

North Dakota Game and Fish Department,
Bismarck, N. D.
Att: Mr. Dale L. Henegar, Chief
Fisheries Division

Division of Wildlife,
Department of Natural Resources,
1500 Dublin Road,
Columbus 12, Ohio.
Att: Mr. David Papier, Chemical
Fish Management Section

State Game and Fish Department,
State Capitol Bldg.,
Oklahoma City, Olka.
Att: Mr. John E. King, Chief
Fisheries Division

Pennsylvania Fish Commission,
Harrisburg, Pa.
Att: Mr. William C. Voigt, Jr.,
Executive Director

Chief, Fisheries Division,
Oregon Fish and Game Commission,
Portland, Oregon.

Rhode Island Division of Fish and Game,
Veterans Memorial Building,
Providence 2, R. I.

Mr. A. A. Richardson, Director
South Carolina Wildlife Resources Dept.,
Box 360,
Columbia, S. C.

South Dakota Dept. Game, Fish and Parks,
Fisheries Research Division,
Woonsocket, S. D.
Att: Mr. William D. Clothier,
Chief Fishery Biologist

Tennessee Game & Fish Commission,
Cordell Hull Building,
Sixth Avenue North,
Nashville 3, Tenn.
Att: Mr. Glenn Gentry, Chief
Fish Management Section

Chief, Fisheries Division,
Texas Game and Fish Commission,
Austin, Texas.

Mr. M. J. Madsen, Chief,
Fisheries Division,
Utah State Department of Fish & Game,
1596 West North Temple,
Salt Lake City 16, Utah.

Mr. George W. Davis, Director
State of Vermont,
Fish & Game Service,
Montpelier, Vermont.

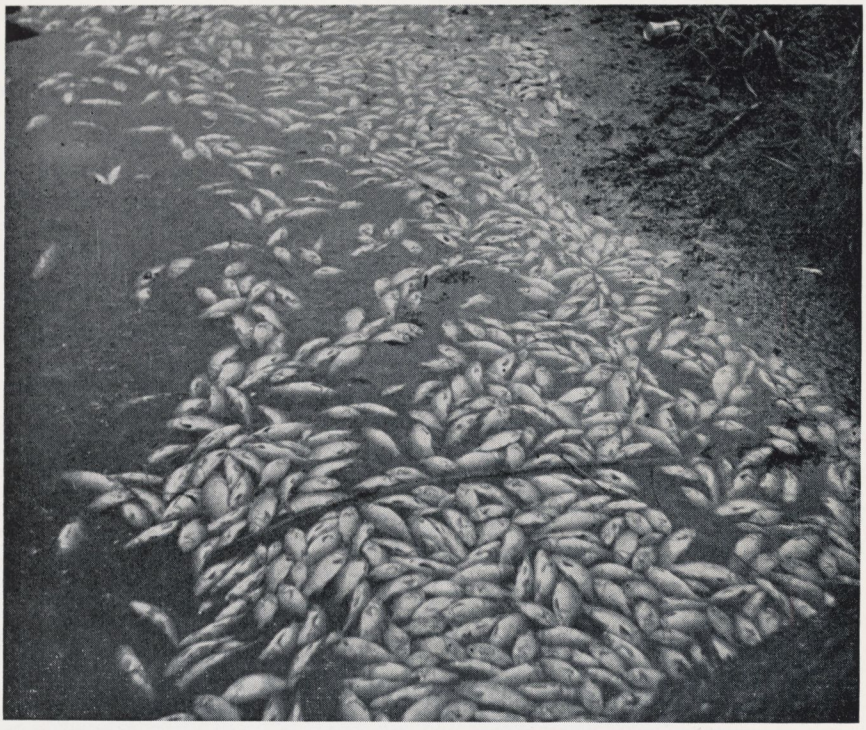
Mr. G. W. Buller, Fish Division,
Commission of Game & Inland Fisheries,
P. O. Box 1642,
Richmond 13, Virginia.

State of Washington,
Department of Game,
509 Fairview Avenue North,
Seattle 9, Washington.
Att: Mr. Robert C. Meigs, Assistant Chief
Fishery Management Division

State of West Virginia,
Conservation Commission,
Charleston, W. Va.
Att: Mr. Harry Van Meter, Chief
Division of Fish Management

State of Wisconsin,
Conservation Department,
Madison 1, Wisconsin.
Att: Mr. L. P. Voigt,
Conservation Director

State of Wyoming,
Game and Fish Commission,
Cheyenne, Wyoming.
Att: Mr. A. F. C. Greene,
State Fish Warden



The photograph shows the large numbers of badly stunted carp turned up by treating an over-populated pond. Approximately 95% of the carp were between six and seven inches in length and were four to five years old. The age was known later by inspection of the fish scales.

Courtesy Mr. Rudy Stinauer,
Fisheries Biologist,
State Fish Hatchery,
Pecatonica, Illinois.

PRO-NOXFISH

S.B. PENICK & COMPANY
HIPPOCRATES
Father of Medicine
BASIC MEDICINAL PRODUCTS ®

S. B. PENICK & COMPANY

50 CHURCH STREET • NEW YORK 8, N. Y.

735 W. DIVISION ST. • CHICAGO 10, ILL.

Cable Address:
CHEMSECT
METUCHEN

chemical insecticide corporation

30 WHITMAN AVENUE, METUCHEN, NEW JERSEY, U.S.A.

Phone: LIberty 9-2300

Gentlemen:

In past discussions, many State fishery biologist have related that numerous inquiries are received from local individuals each year requesting information on materials for use in aquatic weed or fish control in private lakes. The information which they desire concerns the material to use, application rates, cost and where it may be obtained. Many of these biologist indicated to us the desirability of having a source which supplies aquatic herbicides and fish toxicants to which these individuals could be referred directly for information.

Most of the biologists with whom we have discussed this problem have suggested a post card type inquiry which could be presented to individuals seeking information. We have incorporated these suggestions into the card which is enclosed for your review. A supply of these cards will be sent without charge to you upon your request. Individuals requiring information pertaining to aquatic weed or fish control may be given a card. Upon our receipt of these cards, we will supply all possible information directly to the individual. Further, our receipt of a card will indicate to us that you are aware of the particular problem involved. If you have any suggestions which you feel would improve this card, we would appreciate receiving them.

We are enclosing for your review current literature on our aquatic products which we hope you find of interest. If you desire additional information, we will be most happy to furnish it.

We would like very much to receive your views on this idea of supplying information, and will be looking forward to hearing from you regarding it.

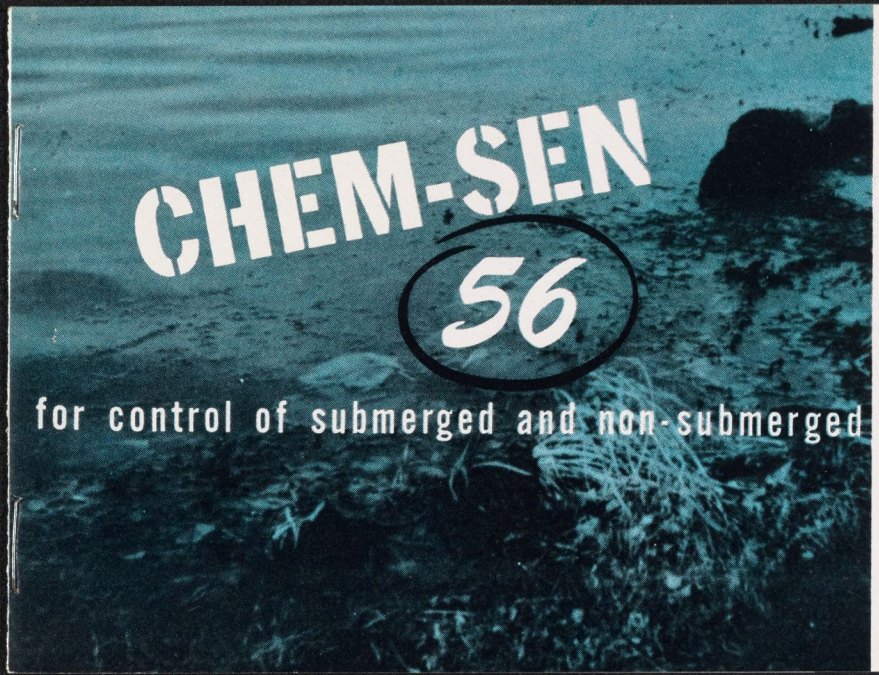
Sincerely,

CHEMICAL INSECTICIDE CORPORATION

Alex Montgomery
Aquatic Biologist

AM/kk
Encl.
CP2,4-D folder
CS56-bklet
#1380,1483,1381

1525



CHEM-SEN 56

for control of submerged and non-submerged aquatics in ponds and lakes . . .

CHEM-SEN 56

- Used by many fish and game commissions to control submerged vegetation
- A concentrated sodium arsenite liquid herbicide
- Specifically compounded to obtain maximum mixing with water
- Insures equal distribution throughout specified area
- Helps obtain optimal fish production
- Helps maintain recreational facilities
- Controls excessive vegetation

TYPES OF VEGETATION FOUND

Algae—Appear as scums, no roots or leaves

Submerged Rooted Plants—All growth is beneath surface of water

Emergent Rooted Plants—Rooted in bottom, but leaves emerge from surface of water (either floating or upright)

WHY CONTROL AQUATICS...

1. Stock water from ponds heavily infested with submerged aquatics is less palatable.
2. Swimming is unpleasant and almost impossible in heavily infested areas.
3. Fishing is poor.
4. Management for fish production is difficult.
5. Foul odor is created by decaying masses of plants (especially algae type).
6. Large masses of decaying vegetation consume excessive oxygen thereby killing fish.
7. Weed-free water is more readily available for fire protection.
8. Destroyed weeds release organic matter for production of food for fish.

In some ponds or lakes, particularly those which are shallow or in which the water level has been lowered, weeds may shade the water and help keep the water temperature low. This is especially true in trout ponds where water temperature is very important. Therefore, caution should be exercised before eradicating *all* types of vegetation.

CHEM-SEN 56

The following table shows various plant growths and the recommended herbicide and concentration for eradication.

DETERMINING THE PROPER HERBICIDE...

The growing habits of a particular type of weed to be eradicated should be known in order to resort to proper chemical treatment.

PLANT GROWTH	HERBICIDE	CONCENTRATION
Algae—Above surface	Chem-Sen 56	3 to 4 parts per million
Algae—Below surface	Copper Sulfate	½ part per million
Submerged Rooted Plants	Chem-Sen 56	2 to 4 parts per million
Broad Leaf Emergent Rooted Plants	Chem Weed Brush Killer (2,4—D+2, 4,5—T) 2 lbs. acid equivalent of each per gallon	1 gallon per acre
Narrow Leaf Emergent Rooted Plants	Sodium TCA—90 (Trichloroacetate)	80-100 lbs. per acre

APPLY CHEM-SEN 56 BY SPRAYING

- It is a very heavy liquid
- It will not drift except in very heavy currents
- For heavy infestation, spray in sections allowing 5-7 days between spraying. This allows for bacterial decomposition of killed aquatics *in each sprayed area beyond the point of heaviest oxygen demand.* Otherwise, too much decaying vegetation may remove too much oxygen from the water and the fish may die.

Dilute CHEM-SEN 56 sprays with enough water to give uniform coverage of area to be treated. Greater dilution beforehand will result in better coverage.

Apply CHEM-SEN 56 with hydraulic sprayer consisting of reservoir which holds solution and a pump which draws water from both lake or pond and chemical reservoir. Distribute over surface at 40-50 pounds pressure.

Treat shoreline areas first.

WHEN TO APPLY CHEM-SEN 56

Maximum kill is obtained when plants are in the most active stage of growth. CHEM-SEN 56 should be applied during the early part of summer when the maximum amount of arsenical is absorbed by plant cells.

HOW TO CALCULATE VOLUME OF WATER AND AMOUNT OF CHEM-SEN 56 TO BE USED

It is necessary to know the cubic foot volume of the area to be treated. The following is a simple method:

Multiply average length x average width x average depth

(Determine average depth by frequent soundings at regular intervals across body of water).

This gives volume in cubic feet (water weighs 62.5 pounds per cubic foot). Where there is considerable variation in the depth of water, the deeper area should receive a heavier application of CHEM-SEN 56.

$$\frac{\text{Total Cu Ft of Water} \times 62.5}{1{,}000{,}000} = \text{lbs. arsenic trioxide needed to render 1ppm}$$

$$\#\text{ppm needed for treatment} \times \text{lbs. arsenic trioxide needed to render 1ppm} = \text{Total pounds Arsenic Trioxide needed}$$

$$\text{Total pounds Arsenic Trioxide needed} \div 9 = \text{Gallons CHEM-SEN 56 to be applied}$$

FOR EXAMPLE: A Lake to be treated to render 3 ppm measures 100 feet long x 100 feet wide x 7 feet in depth. This gives us 70,000 cubic feet of water.

$$\frac{70{,}000 \times 62.5}{1{,}000{,}000} = 4.375 \text{ lbs. arsenic trioxide} \times 3 \text{ ppm} = 13.125 \text{ lbs. arsenic trioxide}$$

$$13.125 \text{ lbs.} \div 9 = 1.458 \text{ gallons of CHEM-SEN 56 to be applied}$$

(or in round figures 1½ gallons of CHEM-SEN 56)

9 IS THE NUMBER TO REMEMBER, MAKES CHEM-SEN 56 MORE ECONOMICAL

HOW CHEM-WEED BRUSH KILLER (2,4 — D + 2,4,5 —T) KILLS BROAD LEAF EMERGENT ROOTED PLANTS

CHEM-WEED BRUSH KILLER is absorbed by the leaves and translocated through the entire plant thereby killing the entire growth structure. It does not poison the plant. Rather, it stimulates certain physiological processes within the plant with the result that the food reserves are depleted before they can be replenished. The plant thus ceases to exist as a living organism. Since the leaves manufacture the plant food by photosynthesis and since the chemical is readily absorbed by the leaves and stems, the time of application is important. *The fast growing stage of the plant is the most vulnerable one.*

CHEM-WEED BRUSH KILLER WILL NOT KILL NARROW LEAF PLANTS SUCH AS GRASSES REFERRED TO AS MONOCOTYLEDONS

PREVALENT TYPES OF AQUATICS CONTROLLED BY CHEM-WEED HERBICIDES

Pondweed (*Potamogeton nodosus, Poiret*)

Curly-leaf pondweed (*Potamogeton crispus L.*)

Water milfoil (*Myriophyllum heterophlyllum Michx.*)

Parrot feather (*Myriophyllum brasiliense, Camb.*)

Hornwort or Coontail (*Ceratophyllum demersum*)

Waterweed, or Elodea (*Anacharis canadensis, Michx.*)

Waterplantain (*Alisma spp.*)

Arrowhead (*Sagittaria spp.*)

Watercrowfoot (*Ranunculus aquatilis L.*)

Leafy pondweed (*P. foliosus, Raf.*)

Fine-leaf pondweed (*P. filiformis, Pers.*)

Common poolmat or horned pondweed (*Zannichellia palustris*)

Naiad (*Naias flexilis and guadalupensis*)

Wildcelery (*Vallisneria Americans*)

Water stargrass or Mud Plantain (*Heteranthera dubia, Jacq.*)

Water Purslane (*Ludwigia palustris L.*)

Bladderwort (*Utricularia gibba L.*)

Certain other plants.

CHEM-WEED HERBICIDES

Chem-Weed 2,4-D—4 lbs. isopropyl amine salt

Chem-Weed 44%—3.34 lbs. of isopropyl ester of 2,4-D

2,4-D Sodium Salt—35% acid

Sodium TCA—90%

Potassium Cyanate 75%

Chem-Weed 2,4,5-T—for woody brush control—40%—2,4,5-T ester, low volatile

Chem-Sen 56

Chem-Weed Poison Ivy & Brush Killer—4 lbs. emulsifiable concentrate containing 2 lbs. of 2,4-D and 2 lbs. 2,4,5-T acid per gallon, low volatile ester.

Chloro IPC 40% Emulsifiable—containing 4 lbs. technical per gallon.

WARNING

- Chem-Sen 56 is an arsenical, very poisonous, and should be handled accordingly. Keep it away from water used for human or animal consumption. Do not permit spray to contact skin or clothing. If contact is made, wash immediately.
- A person poisoning the weeds or algae in his pond or lake should realize the legal responsibility to confine the poison water to his pond.
- Check with local authorities for permission for use of material. Consult your State Fish and Game Department for further information.
- There are some custom sprayers throughout the country that are technically trained in this field who would be glad to assist you with your problem. Write us for the names of custom sprayers in your particular area who are qualified to take care of your weed problems.

For control of undesirable (rough) fish—use Chem-Fish Special. Many fish and game departments use Chem-Fish Special to rapidly eliminate undesirable species. Detailed literature on its application is available to interested qualified groups.

CHEMICAL INSECTICIDE CORPORATION

129 Montague Street • Brooklyn 1, N.Y. • ULster 2-5200

— Manufacturers of —

AGRICULTURAL CHEMICALS • INSECTICIDES • WEED KILLERS • WOOD PRESERVATIVES • FUNGICIDES • RODENTICIDES

Problem is: _____ Rough Fish _____ Aquatic Weeds

Type of weeds: Broadleaf-Name of weed _____

Narrowleaf-Name of weed _____

Size of water (acres) area to be treated _____

Approximate average water depth _____

Remarks: _____

Please send information on the material, its cost & amount necessary to treat the above.

Name _____

Address _____

City _____ State _____

Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

FIRST CLASS PERMIT NO. 120, METUCHEN, N. J.

CHEMICAL INSECTICIDE CORPORATION

30 WHITMAN AVENUE

METUCHEN, N. J.

CIC

CHEMICAL INSECTICIDE CORPORATION
30 WHITMAN AVENUE, METUCHEN, NEW JERSEY U. S. A.

TECHNICAL DATA SHEET

CHEM WEED AQUATIC

CHEM WEED AQUATIC a combination of 2,4-D and 2,4,5-T low volatile esters with special emulsifying agents and solvents which are exceptionally effective in a wide range of water conditions. Chem Weed Aquatics will control emerged aquatic plants* which are commonly referred to as broad leafed plants.

DIRECTIONS FOR USE

The general dosage rate of Chem Weed Aquatic is one to two gallons per surface acre. A surface acre simply means the area of the lake in acres. The eradication of aquatic plants with Chem Weed Aquatic can best be accomplished when the weeds are making their most active growth. This period can most easily be recognized because the leaves are fully expanded and of large size and flowering has not started. The next most important consideration is even coverage of the toxicant (1--2 gallons of Chem Weed Aquatic is usually diluted in 100 gallons of H2O to give adequate distribution).

APPLICATION METHOD

The solution of Chem Weed Aquatic should be sprayed upon the projecting or upper surfaces of the weeds. A garden type hand sprayer may be used for small areas or a power driven sprayer may be used for large areas. A coarse droplet spray is preferred in order to avoid drift onto valuable trees, shrubs or flowers.

Let us now take a typical farm pond with an area of ½ acre where emergent weeds are a problem. We know the general formula of material require is:

1 to 2 gallons Chem Weed Aquatic per acre

Our lake contains a half acre and we would start with the minimum dosage of one gallon Chem Weed Aquatic per acre. Therefore, in this case, we would use ½ gallon Chem Weed Aquatic diluted with 50 gallons H_2O. Suppose we have a lake which contains an area of 3 gallons of Chem Weed Aquatic.

Chem Weed Aquatic is available in convenient handy 5 and 1 gallon containers.

* Emergent Aquatics are plants that are rooted in the bottom of the water. Its leaves either stand above or float on the surface of the water. This type includes spatterdock or yellow water lily, common water lily, lotus or water chinquapin, watershield, cattail, bulrush, and spikerush.

CHEMICAL INSECTICIDE CORPORATION
30 WHITMAN AVENUE, METUCHEN, NEW JERSEY U. S. A.

I

TECHNICAL DATA SHEET

CHEM FISH SPECIAL

The invasion of lakes and ponds by game fish destroying undesirable rough fish species has long been a source of irritation and aggravation to fishermen, pond and lake property owners.

These folks can breathe easier. Now a product has been developed that will make reclamation of infested bodies of water much easier and more economical.

This new chemical product is called Chem Fish Special. Its performance in exhaustive field tests has been outstanding and it is now widely used by many State Fish & Game Personnel because:

1. Chem Fish Special offers a high percentage of fish kill, and complete kill is now also possible.
2. Chem Fish Special readily disperses in waters of varying hardness and temperatures.
3. Chem Fish Special requires no special equipment for adequate and effective application.
4. Chem Fish Special readily penetrates through even the coldest layers of water and will form a stable emulsion that lasts from 7 to 10 days.

These unique characteristics will enable you to use this material from early spring until late fall and thereby you will be able to exercise more pinpoint fish control. Restocking of desirable game fish can normally be begun about three weeks after treatment.

DIRECTIONS FOR USE

To determine the amounts of Chem Fish Special needed for a lake or pond, one must calculate the acre feet present. This may be found by multiplying the area (in acres) by the average depth (in feet) which equals the Acre Feet. The general formula to follow in determinating the proper amount of Chem Fish Special to use is: 1 gallon Chem Fish Special per 6 acre feet. This gives a concentration of 0.5 ppm which is satisfactory and recommended for a good kill of most species of fish.*

The following example illustrates the method of calculating the proper amount of Chem Fish Special to use.

A typical farm pond which is 3 acres in area and has an average depth of 4 feet needs how many gallons of Chem Fish Special? You first determine the acre feet (area in acres) X depth (in feet): 3 acres area X 4 feet depth=12 acre feet. You know that under normal condisitons a .5 ppm concentration is desired. Therefore, one gallon of Chem Fish Special is needed for 6 acre feet. Therefore, we have 12 acre feet which would require two gallons of Chem Fish Special.

$$\frac{1 \text{ gallon}}{6 \text{ acre feet}} = \frac{X \text{ gallon}}{12 \text{ acre feet}}$$

$$6X = 12$$

$$X = 2 \text{ gallon Chem Fish Special}$$

When determining dosages, it is more important to maintain a long period of toxicity than to treat at a high initial concentrate. It would be better to treat several times at a lethal concentration than to treat at a concentration three times as strong. Therefore, under most circumstances begin with a 0.5 ppm concentration and follow the general recommendation of one gallon Chem Fish Special for each 6 acre feet at 0.5 ppm.

Chem Fish Special is available in convenient, handy 5 and 1 gallon containers.

*We are also including additional formulas that you will follow in specific cases where a higher ppm concentration is required such as:

a) When an abundance of bullheads or carp are present in moderate alkaline water use 0.7 ppm. Our forumla for a 0.7 ppm concentration would be one gallon Chem Fish Special per 4 acre feet.

b) When a pond is turbid, strongly alkaline and resistant species of fish are to be completely destroyed, one should use a concentration of 1 to 2 ppm. Our formula would then read one gallon Chem Fish Special per 3 acre feet is required for a 1 ppm concentration.

NOW! Clean Up Those Troublesome Water Weeds

with Chem-Pels 2,4-D

look at these features...

Chem Pels 2,4-D makes it possible for you to treat your individual lake front area. (spot treatments)

Chem Pels 2,4-D controls submerged and emergent broadleafed aquatic vegetation.

Chem Pels 2,4-D non-toxic to man and animals.

Chem Pels 2,4-D reported residual control up to two (2) years.

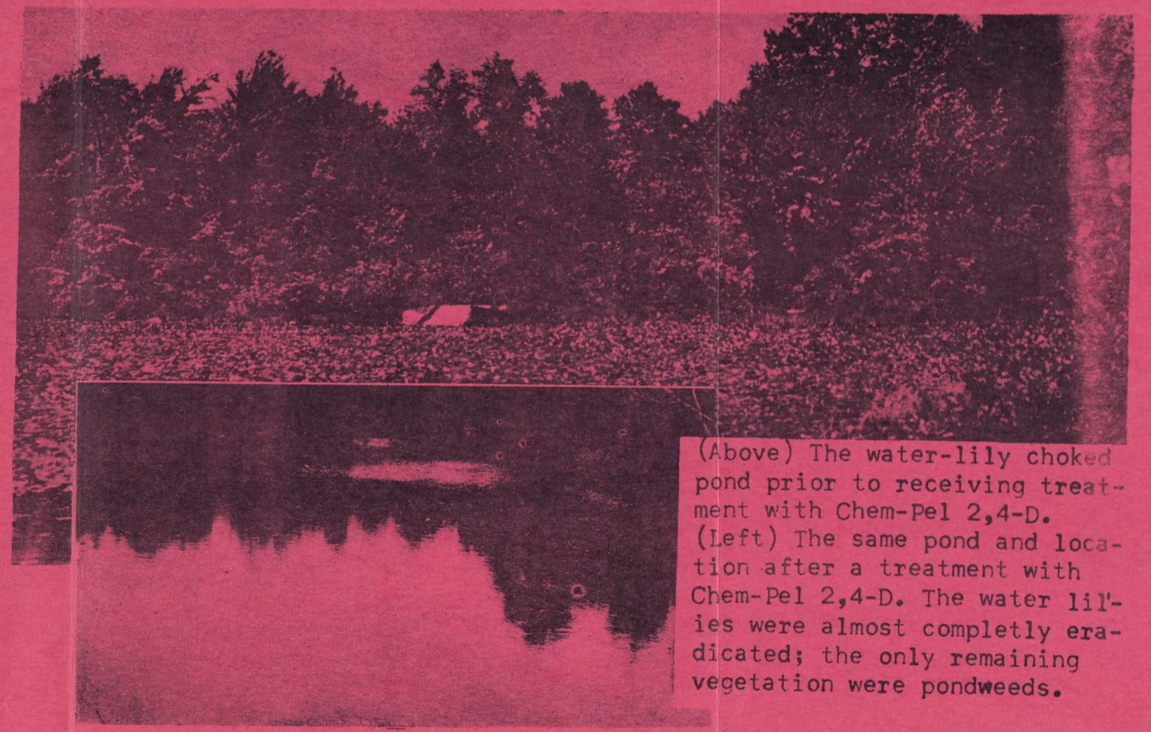
Chem Pels 2,4-D Solves "YOUR" Water Weed Problem

Water weeds greatly decrease the value of lake front property by creating smelly, unsightly weed areas, by producing mosquito breeding areas and by making all types of water recreation impossible. The CHEMICAL INSECTICIDE CORPORATION has recently developed a revolutionary new herbicide CHEM PELS 2,4-D which controls submerged and emergent broadleaf aquatic vegetation.

Chem Pels 2,4-D is a new type of pellitized aquatic herbicide whereby the active toxicant is both absorbed into the carrier by special impregnated process. This process insures constant and even release of the active engredient from the pellets over a long period of time.

A partial list of water (broadleafed) plants which have been controlled by Chem Pels 2,4-D are:

Water Buttercup
Smartweed
Water Chestnut
Water Lily
Coontail



(Above) The water-lily choked pond prior to receiving treatment with Chem-Pel 2,4-D. (Left) The same pond and location after a treatment with Chem-Pel 2,4-D. The water lilies were almost completly eradicated; the only remaining vegetation were pondweeds.

DIRECTIONS FOR USE

Chem Pels 2,4-D should be applied at the rate of 100 to 200 pounds per acre. They may be distributed on top of the ice in late winter or over the surface of the infested water areas during the active growing season of the weeds. Application time is not particu larly critical as results have been observed during all seasons, but generally the most effective and economical results are obtained during the active growing period of the weeds which is prior to the weeds go to flower or seed.

APPLICATION METHOD

The ease of application of Chem Pels 2,4-D makes is especially adaptable for individual selective control in specific areas. Now you can clean up your property where the pellets will disperse the active ingredients to the bottom of your area and eliminate your weeds. This is a particularly effective means of control for lake property owners who desire to clean up their particular swimming or boating area without enlisting all their neighbors who may or may

not be interested in improving their property. Heretofore, in order to eradicate weeds from a lake or pond, treatment had to be inaugurated in the entire area so that proper distribution and effective control could be realized. Chem Pels 2,4-D can be applied by broadcasting by hand in most cases or applied with a regular bellows type duster for exceptionally large areas. If applied during the winter months on ice, an ordinary garden fertilizer or seed spreader can be used. An ordinary Cyclone type seed spreader or similar machine is ideal for use, remembering to distribute the pellets evenly, also remembering to apply the pellets on a mild day rather than a windy day so that the pellets will remain on the ice and even distribution will be accomplished.

Chem Pels is available in convenient ready to use containers.

PRODUCT LIST

AQUATIC WEED KILLERS

CHEM PELS T

CHEM LIN 20% EMULSIVE

CHEMITE

PROTEX

DDT

CHEM HEX FORMULA T

CHLORDANE 73% EMULSIVE

CHEMATHION

CHEM FOOD

CHEM WEED 2,4-D

CHEM SEN 56

CHEM WEED POISON IVY KILLER

For Further Information on other Products Write

CHEMICAL INSECTICIDE CORPORATION
30 Whitman Avenue
Metuchen, New Jersey

CHEMICAL INSECTICIDE CORPORATION
30 WHITMAN AVENUE, METUCHEN, NEW JERSEY U. S. A.

TECHNICAL DATA SHEET
CHEM FISH REGULAR

The over population of ponds, lakes and streams with undesirable fish populations has long been a problem which has perplexed those people who are interested in fish management. Undersirable rough fish species or over population with certain stunted game fish populations surpress game fish production, and in most instances, destroy sports fishing. Now a product has been developed which will make the elimination of these undesirable fish populations much easier and more ecomomical. This product is CHEM FISH REGULAR.

CHEM FISH REGULAR is a standard 5% rotenone emulsive. It is in wide use by state and federal Game and Fish organizations and is a proven fish toxicant which may be relied upon for good results. It is recommended for all waters of normal depth and water quality where complete or partial fish eradication is desired. CHEM FISH REGULAR disperses readily and offers a high percentage of fish kill. Restocking of desirable game fish species can normally be begun about two to three weeks after treatment, depending upon the water temperature.

CONCENTRATIONS TO USE: For general eradication work in acid or slightly alkaline waters under ideal conditions, a concentration of .5 ppm by volume of CHEM FISH REGULAR should be used. Where resistant species of fish such as bullheads or carp are present, or in alkaline or turbid waters, concentrations of .7 to 1.5 ppm should be used if a complete kill is desired. These recommendations do not guarantee results, however, as excess water inflow (springs and seepage areas) and other environmental features which interfere can preclude a satisfactory kill. In general, it is more important to maintain a lethal doseage over a long period of time then to treat with a strong intial overdoes. Water temperatures between 50° F and 75° F are most conducive to good results. Generally speaking bullhead catfish, green sunfish, golden shiner, carp and top minnows are most resistant of all species. Where resistant species are present concentrations of 1 ppm and above should be used as a matter of course.

DIRECTIONS FOR USE: To determine the amounts of CHEM FISH REGULAR needed to poison a lake or pond, it is necessary to calculate the total acre feet to be treated. This may be found by multiplying the number of surface acres in the pond by the average depth (in feet). The amount of CHEM FISH REGULAR necessary to treat the total water area can then be determined by one of the following formulas:

1. One gallon of CHEM FISH REGULAR will treat 6 acre feet of water at a concentration of .5 ppm.

2. One gallon of CHEM FISH REGULAR will treat three acre feet of water at a concentration of 1 ppm.

CHEM FISH REGULAR should be evenly distributed on the lake surface in amounts commensurate with the particular water depths. For instance, deeper water areas should receive more of the toxicants. This material can either be premixed with water before using or used directly. It is recommended that the toxicant be mixed with 3 to 10 of water before application to assure even distribution. In deeper water areas, it is often desirable to let the concentrated chemical trickle into the propeller wash of an outboard motor. Adequate vertical and horizontal dispersion is assured through the mixing action of the motor. In treating unusually deep water areas it is recommended that a portion of the materials be pumped down into the lower water areas. Application can be made by gravity flow systems, power driven spray equipment, or hand pump spray units.

For more complete information concerning the treatment of your lake or pond, your local state or federal fisheries biologist should be consulted.

[1947 Bibl.]

United States Department of the Interior, J. A. Krug, Secretary
Fish and Wildlife Service, Albert M. Day, Director

Fishery Leaflet 58

Washington, 25, D. C. Rev. March, 1947

SOME PUBLICATIONS ON DISEASES AND PARASITES OF FISHES

Compiled in the Division of Fishery Biology

General

Davis, H. S.
1938 The use of Chlorine for disinfecting fish ponds. The Progressive Fish Culturist, No. 42, pp. 24-29.

1946 Care and diseases of trout. U. S. Department of the Interior Fish and Wildlife Service. Research Report No. 12, New, Revised Edition.

Fish, F. F.
1938 Simplified method for the prolonged treatment of fish diseases. Trans. Am. Fish. Soc. Vol. 68, pp. 178-187.
1939 Disease prevention in the trout hatchery. The Progressive Fish Culturist, No. 43, pp. 1-7.

Hofer, Bruno
1904 Handbuch der Fischkrankheiten. 384 pp. Munich.
1912 The Distribution and frequence of animal parasites and parasitic diseases in North American fresh-water fish. Trans. Am. Fish. Soc., 1911. pp. 207-241.

Johnstone, James
1924 Parasites and diseases of the Cod. Fisheries Investigations, Ministry of Aquiculture and Fisheries, Gr. Britain, Ser.II, Vol. 6, No. 7, pp. 14-27.

Mellen, Ida
1928 The treatment of fish disease. 31 pp. In Zoopathological Scientific Contributions of the New York Zoological Society on the Diseases of Animals. Vol.II, No. 1, Pub. by the Society, The Zoological Park, 1928.

Plehn, Marianne
1924 Praktikum der Fischkrankheiten, pp. 301-479, 21 pls., 173 text figs. E. Schweizerbart, Stuttgart.

Schäperclaus, Wilhelm
1941 Fischkrankheiten. Second edition, Gustav Wenzel & Sohn, Braunschweig, Germany

Bacteria

Bean, T. H.
1907 Fish diseases. 12th Ann. Rept. N.Y.E.F. and G. Comm. pp. 131-142. Contains translations from Hofer describing several bacterial diseases.

Belding, David L.
1927 Fish disease epidemics. Trans. Am. Fish. Soc. 1927, pp. 217-222.

Davis,H. S.
1922 A new bacterial disease of fresh-water fishes. Bull. U.S. Bur. of Fish. for 1921-22, Vol. 38, pp. 261-280, B. F. Doc. 924.
1927 Further observations on the gill disease of trout. Trans. Am. Fish. Soc. 1927, pp. 210-216.

Fish, F. F.
1934 Ulcer disease of trout. Trans. Am. Fish Soc. Vol. 64, pp. 252-258.
1946 Columnaris as a disease of cold-water fishes. Trans. Am. Fish. Soc., Vol. 73, pp. 32-36.

Furunculosis Committee
1930 Interim Report. H. M. Stationery Office, Edinburgh,65 pp.
1933 Second Iterim Report. H. M. Stationery Office, Edinburgh 81 pp.
1935 Final Report. H. M. Stationery Office, Edinburgh, 67 pp.

Garnjobst, Laura
1945 Cytophaga columnaris (Davis) in pure culture: a myxobacterium pathogenic to fish. J. Bacteriology, Vol. 49, pp. 113-128.

Gutsell, James S.
1947 Furunculosis and its treatment. Progressive Fish-Culturist Vol. 9, No. 1.

Ordal, E. J. and Rucker, R. R.
1944 Pathogenic myxobacteria. Proc. Soc. Exp. Biology and Medicine, City Coll. of New York, Vol. 56, pp. 15-18.

Patterson, J. Hume
1903 The cause of salmon disease. Fishery Board for Scotland, Salmon Fisheries, 1903, pp. 1-52.

Reed, G. B. and G. C. Toner
1941 Red sore disease of pike. Canadian J. Res. Sec. D. Zool. Sci. Vol. 19, pp. 139-143

Bacteria, cont'd.

Wolf, Louis E.
1938 Observations on ulcer disease of trout. Trans. Am. Fish. Soc. Vol. 68, pp. 136-151.
1940 Further observations on ulcer disease of trout. Trans. Am. Fish. Soc. Vol. 70, pp. 369-381.

Wright, Alice
1936 A report of the four years' experience with fin rot and some remarks on octomitiasis. The Progressive Fish Culturi No. 24, pp. 1-26.

Protozoa

Auerbach, M. .
1910 Die Cnidosporidien. Eine monographische studie. 261 p.

Davis, H. S.
1926 Octomitus salmonis, a parasitic flagellate of trout. Bull. U. S. Bureau of Fisheries, Vol. 42, 1926, 20 pp. 4 illus. (B. F. Doc. 988)
1942 A suctorian parasite of the smallmouth black bass, with remarks on other suctorian parasites of fishes. Trans. Am. Micr. Soc.,Vol. 61, pp. 309-327.

Fish, F. F.
1940 Formalin for external protozoan parasites. The Progressive Fish Culturist, No. 48, pp. 1-10.

1941 Notes on Costia necatrix. Trans. Amer. Fish. Soc. Vol.70, pp. 441-445.

Fischthal, Jacob H.
1944 Observations on a sporozoan parasite of the eelpout (Zoarces anguillaris), with an evaluation of candling methods for its detection. Jour. Parasit. Vol. 30, pp. 35-36.

Kudo, R.
1919 Studies of Myxosporidia. Illinois Biol. Monographs Vol.V, Nos. 3-4, pp. 265

Mueller, J. F.
1937 Some species of Trichodina (Ciliata) from fresh-water fishes. Trans. Am. Micr. Soc. Vol. 56, pp. 177-184.

Nelson, Clifford E.
1941 Carbarsone treatment for Octomitus. Progressive Fish Culturist. No.55 pp. 1-5

Protozoa, cont'd.

Surber, E. W.
1939 Scyphidia micropteri a new protozoan parasite of largemouth and smallmouth black bass. Trans. Am. Fish. Soc. Vol. 69, pp. 169-175.

1943 Scyphidia tholiformis, a peritrichous protozoan found on the gills and external surfaces of Micropterus dolomieu and Micropterus salmoides. Trans. Am. Fish. Soc., Vol. 72, pp. 197-203.

Fungi

Coker, W. C.
1923 The Saprolegniaceae, with notes on other water molds. 200 pp. Chapel Hill, N. C.

Davis, H. S. and Estelle C. Lazar
1940 A new fungus disease of trout. Trans. Am. Fish. Soc. Vol.70 pp. 264-271.

Foster, F.J.
1936 The use of malachite green as a fish fungicide and antisepti The Progressive Fish Culturist, No. 18, pp. 7-9.

O'Donnell, J. D.

1941 A new method of combating fungus infections. Progressive Fish Culturist. No. 56, pp. 18-20.

Worms

Ferguson, M. S. and R. A. Hayford
1941 The life history and control of an eye fluke. The Progressive Fish Culturist, No. 54, pp. 1-13.

Hunter, George W. III.
1942. Studies on the parasites of fresh-water fishes of Connecticut State Geological and Natural History Survey, Bull. No. 63, pp. 228-288.

Loosanoff, Victor L., and Engle, James B.
k943 Polydora in oysters suspended in the water. Biol. Bull. Vol. 85, pp. 69-78.

McKernan, D. L.
1940 A treatment for tapeworms in trout. The Progressive Fish Culturist, No. 50, pp. 33-35.

Mueller, J. F.
1936 Studies on North American Gyrodactyloidea. Trans. Am. Micr. Soc., Vol. 55, pp. 55-72.

Worms cont'd

Palmer, E. D.
1939 Diplostomiasis, a hatchery disease of fresh-water fishes new to North America. The Progressive Fish Culturist, No. 45 pp. 41-47.

Pratt, H. S.
1919 Parasites of freshwater fishes, Econ. Cir. Bur. of Fish. No. 42

Van Cleave, H. J. and J. F. Mueller
1932 Parasites of Oneida Lake Fishes. Part 1, Roosevelt Wildlife Annals, Vol. 3, No. 1, pp. 1-71.
1932a. Parasites of Oneida Lake Fishes, Part 2, Roosevelt Wildlife Annals, Vol. 3, No. 2, pp. 79-137.
1934. Parasites of Oneida Lake Fishes, Parts 3 and 4, Roosevelt Wildlife Annals, Vol. 7, No. 1, pp. 161-373.

Ward, H. B. and G. C. Whipple
1918 Fresh-water biology, 1111 p., New York City, Chap. 13, Parasitic flatworms. Chap 16, Parasitic round worms.

Copepods

Fasten, Nathan
1911-12. The brook trout disease at Wild Rose and other hatcheries. Biennial Rept. Wisconsin Fish. Comm. pp. 12-22.
1921 Studies on parasitic copepods of the genus Salminocola. Amer. Nat. Vol. 55, pp. 449-456. A general account of the life history and methods of control.

Wilson, C. B.
1916 Copepod parasites of fresh-water fishes and their economic relation to mussel glochidia. Bull. U. S. Bur. Fish. 1914, pp. 331-374.

Tumors

Gaylord, H. R. and M.C. Marsh
1914 Carcinoma of the thyroid in the salmonoid fishes. Bull. U. S. Bur. of Fisheries, 1912, pp. 365-524.

Johnstone, James
1915 Diseased and abnormal conditions of marine fishes. Trans. Liverpool Biol. Soc. Vol. 29, pp. 80-118. Contains a general discussion of malignant tumors in marine fishes.

Marine, David
1914 Further observations and experiments on goitre (so-called thyroid carcinoma) in brook trout (Salvelinus fontinalis). III. Its prevention and cure. Jour. Exp. Med., Vol. 19, pp. 70-80.

Marine, David, and Lenhart, C. H.
1910 Observations and experiments on the so-called thyroid carcinoma of brook trout (Salvelinus fontinalis) and its relation to ordinary goitre. Jour. Exp. Med. Vol. 12, pp. 311-327.

Tumors, cont'd

Young, George A. and Olafson Peter
1944 Neurilemomas in a family of brook trout. The American Journal of Pathology Vol. 20, pp. 413-419.

Viruses

Weissenberg, R.
1938 Studies on virus diseases of fish. I. Lymphocystis disease of the orange file fish (Aleutera shoepfi). Amer. J. Hyg. Vol. 28, pp. 455-462.
1939 II Lymphocystis disease of Fundulus heteroclitus. Biol. Bull. Vol. 76, pp. 251-255.
1939 III Morphological and experimental observations on the lymphocystis disease of the pike perch (Stizostedion vitreum). Zoologica, Vol. 24, pp. 245-254.

Unclassified

Loosanoff, Victor L, and Engle, James B.
1941 Little known enemies of young oysters. Sc. Vol. 93, p.328.

M'Gonigle, R. H.
1940 Acute catarrhal enteritis of salmonid fingerlings. Trans. Am. Fish. Soc. Vol. 70, pp. 297-303.

BEHAVIOURAL PATHOLOGY IN FISH: A QUANTITATIVE STUDY OF SUBLETHAL PESTICIDE TOXICATION

By RICHARD E. WARNER, KAREN K. PETERSON
AND LEON BORGMAN

Foundation of Environmental Biology, P.O. Box 561, Berkeley, and Department of Mathematics, University of California, Davis, California, U.S.A.

INTRODUCTION

The continued increase in use of the persistent pesticides over the last decade is well documented. Their widespread application in the control of disease-carrying and agriculturally important arthropods and other invertebrates has resulted in thousands of millions of kilograms of these materials being introduced into the environment. During 1962, in the United States alone, 177 800 000 kg of insecticides were used. Herbicides and fungicides were also applied in great quantity; according to Thimann (1964) the amounts of these totalled about half that for insecticides. Since the trend is for increased consumption, the total quantities released into the environment in 1965 will be substantially higher.

Some of the effects of these pesticides are known and well documented. The relative sensitivity of a variety of living systems to lethal concentrations has been studied in some detail (Doudoroff, Katz & Tarzwell 1953; Sawyer 1959; Pickering, Henderson & Lemke 1962). Less attention has been paid to physiological effects, and little is yet known of the ecological consequences of pesticides in natural water supplies, despite some excellent studies of the problem (Harrington & Bidlingmayer 1958; Prevost 1960; Cope 1961).

Even allowing for these recent gains, surprisingly little is yet known regarding the biological effects of pesticides. For example, in spite of the near-ubiquitous use of the organochlorine compounds for almost 20 years, their biochemical mode(s?) of action remains obscure. Recently O'Brien & Matsumura (1964) advanced a new hypothesis for the mode of action of DDT, attempting to reconcile the high level of toxicity of organochlorine compounds with their extreme resistance to biochemical degradation. Whether or not this new and interesting hypothesis proves correct, the significant fact remains that for years we have been introducing vast quantities of these compounds into the environment without knowing in detail the nature of their biological properties. We have tended to assume, when questions of potential danger to living systems are raised, that the toxic properties of pesticides are limited to those effects which are already well known through previous experimentation or trial-and-error activities.

The many-faceted problems of pesticide-altered ecosystems are even more complex. A review of the recent and current research on both field and laboratory aspects of microchemical contaminants makes one point very evident: we are today still working largely in an unknown and complex realm, our efforts dominated by the search for suitable means of measuring the effects which these compounds have on living systems. This search is the necessary first step. It is now clear that only after we have devised thoroughly adequate methods of measurement, capable of detecting physiological, behavioural and ecological changes due to sublethal concentrations of pesticides and other biocides, shall we be able properly to evaluate their impact on ourselves and our environment.

PRELIMINARY CONSIDERATIONS

Any biological process is a potential subject for bioassay. The criteria for choice of a suitable process are: (1) availability of adequate means for monitoring the process; (2) sensitivity of the process to toxication by the compound in question; and (3) complexity, accuracy, cost, and length of time per test. Despite this fact, there exists a strong predilection for use of those processes having 'obvious' survival value. This results from the apparent ease of extrapolation from laboratory to field situations. Thus, suppression of reproductive behaviour is often deemed a more meaningful indicator of toxication than increased excitability, perhaps simply because the presumed ecological effect is more apparent. If however we assume that deviation from the norm of any process consequent to micro-chemical toxication is deleterious—an assumption having considerable biological merit—the one type of change is not necessarily a more valuable indicator than another. Most, if not all, normal processes (whether physiological or behavioural) probably have distinct survival value to organisms in their natural habitats. The evolutionary theory of adaptation through natural selection is based on the principle that non-adaptive traits are selected against, and eventually removed from the population. If this reasoning is sound, then it can be assumed that all normal processes are of significance to the organism, and toxicant-induced aberrations of any sort are likely to be deleterious.

Thus, our conclusion that suppression of reproductive activities is of greater consequence to the organism than increased excitability, even though both results were produced in the laboratory, should be regarded with suspicion. This conclusion results from a value judgement which neglects the biology of the toxicated organisms. In all likelihood, successful application of any laboratory bioassay finding to the field situation will depend heavily upon verifying experiments conducted in the field.

THE PRESENT RESEARCH

The research reported here can be defined as a search for rapid objective and biologically valid methods for detecting some of the sublethal effects of pesticides upon living systems. First, the detectable thresholds of toxic effects must be considerably below those attained with currently available techniques. This has naturally meant working with organisms which were not dying, nor so seriously incapacitated that their sickness was grossly visible to the human eye. The choice also depended on length of time per test, number of personnel required, number of data obtained per unit time, and cost per test.

A major motive for such a search lay in the concept of 'toxic response syndromes'. Our hypothesis was that if a toxicant causes change in a sufficient number of responses, sufficiently quantitative data on these changes should permit us to predict the effects of that toxicant upon different living systems. Such assemblies of altered responses should permit both diagnosis of the general class (and perhaps species) of toxicant, and also potentially prediction of ecological effects of release of the toxicant into the environment. The exploration of any such possibilities required a methodology capable of detecting and quantitatively recording a variety of responses linked with various processes in living organisms.

Behavioural parameters were selected for several reasons.

(1) The behaviour (or activities) of an organism represents the final integrated result of a diversity of biochemical and physiological processes. Thus, a single behavioural parameter is generally more comprehensive than a physiological or biochemical parameter.

(2) Behaviour patterns are known to be highly sensitive to changes in the steady state of

ESTIMATING AND ACCOUNTING FOR THE QUANTITY OF BOTTOM FAUNA IN HIGHLAND STREAMS

DR. HENRY J. EGGLISHAW

A close correlation found between the distribution of most of the bottom fauna animals and the distribution of disintegrating allochthonic plant material (plant detritus) in stream riffles (Egglishaw, J. Anim. Ecol. 33, 463–476) now makes it possible to estimate the quantity of the bottom fauna from much fewer samples than has hitherto been considered necessary.

In the linear regression equations relating the quantities of bottom fauna to plant detritus in eight streams with similar substrates, the rates of change of bottom fauna on plant detritus ranged from ·015 to ·094 gm. wet weight of bottom fauna per gm. air-dried weight of plant detritus, and increased linearly with increase in the concentration of calcium ions ($P < ·01$). This increase is probably due to the plant detritus in the chemically richer streams decomposing more rapidly, and therefore becoming more quickly available as food for the bottom fauna, than in the chemically poorer streams. This suggestion is supported by the finding that the amount of bottom fauna per unit weight of submerged moss from these streams was much more similar, ranging from ·039 to ·059 gm. wet weight per gm. moss. A stream with a large amount of sand among the stones and gravel, filling the spaces that are in other streams occupied by the bottom fauna animals, had much less bottom fauna present than would be expected from the concentration of calcium ions and the amount of plant detritus present.

Reprinted from Rep. Challenger Society, 3, No. XVII, 1965