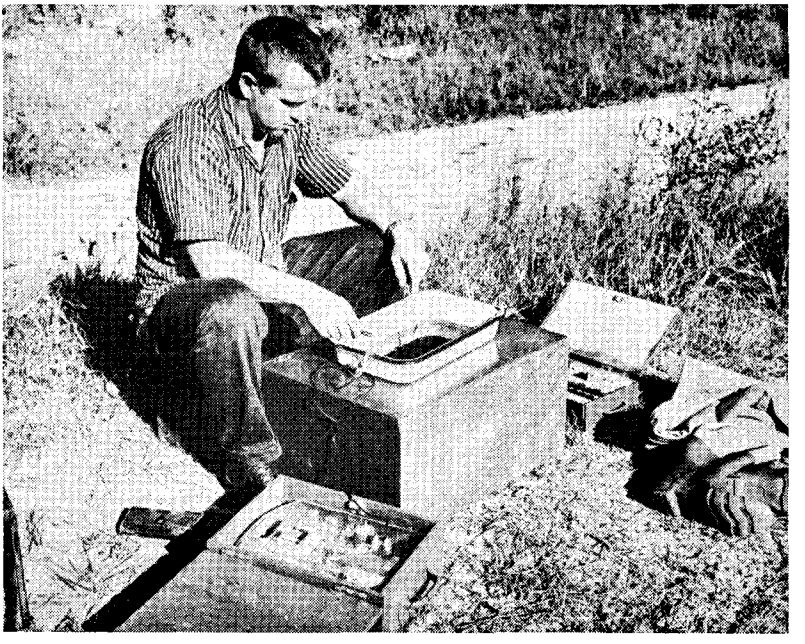
DISCUSSION

The electrical stimuli has produced muscular contractions in all types of macrobenthos thus far observed. The dragonflies and damselflies ordinarily exhibit the least reaction when shocked and often only the legs will contract when the probe is applied. This contraction, however, still is sufficient to draw attention to the specimens even though they may be well hidden beneath debris. Electrical stimuli produce violent contractions of oligochaetes, midge larvae, and similar small organisms. Snails and caddis flies may be located by the movement of the animal within the case or shell. When the current if applied often organisms will be seen emerging from under the bark of dead twigs and from similar hideouts where, undoubtedly, they would be missed by usual methods of picking.

VALUE OF ELECTRICAL STIMULUS

Electrical stimuli are recommended to effect the rapid and efficient picking of living macrobenthos from bottom samples. The advantages of electrical stimuli for picking live organisms from bottom samples may be summarized as follows: (1) electrical stimuli materially reduce the time required for thorough picking, (2) the small, readily portable apparatus is inexpensive to construct, (3) the unit is very adaptable and it may be adjusted to fit any particular situation.



PRELIMINARY RESULTS OF HERBICIDES TESTED ON CERTAIN AQUATIC PLANTS IN FLORIDA

By C. L. PHILLIPPY
Hyacinth Control Division, Lakeland, Florida

ABSTRACT

A screening program to determine the effects and best methods of applying new developments in herbicides on noxious aquatic weeds is a part of the efforts of the Florida Game and Fresh Water Fish Commission to improve its aquatic weed control program.

The program included tests that attempted to duplicate the problems encountered by field crews applying chemicals for weed control.

The herbicides tested were Endothal (disodium 3, 6-endoxohexahydrophthalate), Forron (2,3,5-trichlorophenoxyacetic acid propylene glycol butyl ether esters), Crop Rider (2-ethyl hexyl ester of 2, 4-dichlorophenoxyacetic acid), Weed Rap 20(2-ethyl hexyl ester of 2, 4-dichlorophenoxyacetic acid), Urox (3(p-chlorophenyl)-1, 1-dimethylurea trichloracetate), 50-51 (sodium arsenite), 50-52 (sodium arsenite), 2, 4-DA Pellets (isopropylamine salt of 2, 4-dichlorophenoxyacetic acid), 2, 4, 5-T Pellets (iso-octyl ester of 2, 4, 5-trichlorophenoxyacetic acid), and M-1500 (2(2, 4, 5-trichlorophenoxy) propionic acid).

Preliminary results of the tests conducted during the screening program of 1960 indicated that Urox gave good control of *Pistia stratiotes* when applied at the rate of 22.5 and 11.25 pounds active ingredient per acre. M-1500, a silvex material, gave good control of *Najas guadalupensis* when applied at the rate of 2.5 and 1.55 p.p.m. Some control of *Najas guadalupensis* and *Potamogeton illinoensis* was obtained by Endothal. None of the herbicides tested on *Myriophyllum* sp. and *Polygonum* sp. gave any indication of control.

INTRODUCTION

The Florida Game and Fresh Water Fish Commission, as a part of its efforts to increase the effectiveness of its extensive Hyacinth Control Division program, has been engaged in testing the effects of herbicides and the methods of applying them on aquatic vegetation.

Numerous references to the use of herbicides for the control of various aquatic weeds occur in the literature. However, few of them are concerned with the specific problems which occur in Florida. A few of the conditions frequently not adequately considered in reported recommendations for chemical control of aquatic vegetation are the prolonged growing season, the types of vegetation not common elsewhere, the vast shallow water areas, a high natural fertility, and an important sport fishery.

Luethy (1954) found 2, 4-D amine mixed with water and 2, 4-D ester mixed with oil to be effective for control of water hyacinth, *Eichornia crassipes*, a floating aquatic plant found in a large number of lakes and rivers in Florida. Copeland and Woods (1958) found 16 pounds of Dowpon per acre would successfully control cattails, *Typha latifolia* and 0.4 p.p.m. of Kuron gave good control of spatterdock *Nuphar* sp.

Recent developments of new chemicals and modifications of established herbicides made it desirable to test their usefulness against these vegetation types as well as against submerged aquatic plants and the more resistant floating species such as water lettuce, *Pistia stratiotes*.

A chemical, if it is to be recommended for extensive control of aquatic vegetation by inexperienced individuals, should be simple to apply, harmless to humans, reasonably harmless to fish and to bottom organisms, and it should be relatively inexpensive. These features are particularly desirable since more and more requests for recommendations to control plants on beaches, in swimming areas, around docks, and for boat trails are being received. This increased number of requests for such information has shown that results of these studies will be increasingly important to the Florida aquatic weed control program.

Procedures and Methods

Aquatic vegetation treated with the various herbicides during this screening program were grouped together in the following categories: (1) floating, (2) emergent, (3) submerged.

Floating vegetation plots (Table I) were comprised of water lettuce. Four of these were set out in Kibler's Pit, south of Lakeland and they measured ninety feet by one hundred feet in water ranging from two inches to ten feet deep. They were located in two small coves in such a manner as to utilize the shore areas as natural barriers on three sides. An artificial barrier composed of native bamboo stock from two to four inches in diameter was placed on the fourth side in order to prevent intrusion of untreated plants into the plot area. One other plot was set out in Lake Agnes. This plot was not isolated in the manner described above because the entire stand of water lettuce was treated.

The chemicals used included Urox (3(p-chorophenyl)-1, 1-dimethylurea trichloracetate), Forron (2,4,5-trichlorophenoxyacetic acid propylene glycol butyl ether esters)and granular 2, 4-Da(isopropylamine salt of 2, 4-dichlorophenoxyacetic acid).

Emergent vegetation plots (Tables II and III) set out during this screening program were located at Merrits Mill Pond, east of Marianna, and Williams Lake in Leesburg. Vegetation in the plots located at Merritts Mill Pond consisted of smartweed, *Polygonum* sp. The plots located at Williams Lake consisted of spatterdock, *Nuphar* sp.

Chemicals used on this type of vegetation included granular 2, 4-DA (isopropylamine salt of 2, 4-dichlorophenoxyacetic acid), granular 2, 4, 5-T (iso-octyl ester of 2, 4, 5-trichlorophenoxyacetic acid) and M-1845, liquid silvex (2(2, 4, 5-trichlorophenoxy) propionic acid).

Submerged vegetation plots (Tables IV, V, VI, and VII) consisting of bushy pondweed, *Najas quadalupensis,* were located at Merritts Mill Pond; Lake Carola, downtown Sanford; Lake Lucille, Ft. Myers Shores; Lake Catherine, Arcadia, and several bait ponds of Southern Fish Culturists at Leesburg.

Other submerged vegetation included the plots treated at Lake Tyner in southeast Orlando which contained coontail, *Ceratophyllum demersum,* in association with spatterdock, *Nuphar sp.* A pure stand of the submerged pondweed, *Potamogeton illinoensis,* was located in Bait Pond No. 4 of the Southern Fish Culturists, east of Leesburg. Water hyssop, *Bacopa* sp., parrot's feather, *Myriophyllum* sp., and bladderwort, *Utricularia* sp. were the submerged aquatic plants treated in plots located at Lake Tsala Apopka near Inverness.

Chemicals used on the submerged vegetation included liquid and granular endothal (disodium 3, 6-endoxohexahydrophthalate), M-1845 M-1500, liquid and M-1499 granular silvex (2(2, 4, 5-trichlorophenoxy) propionic acid), granular 2, 4-D (2-ethyl hexyl ester of 2, 4-dichlorophenoxyacetic acid), granular 2, 4-DA (isopropylamine salt of 2, 4-dichlorophenoxyacetic acid) 50-51 and 50-52 sodium arsenite granules.

Liquid chemicals were measured, mixed with carriers consisting of either oil or water, and applied by means of a John Bean, Model K-33, spray pump mounted in a 14 foot plywood boat powered by an 18 h.p. Johnson outbroad motor. The granular materials were broadcast by hand or by use of a "pellet thrower' which was developed by personnel of the Hyacinth Control Division.

The size of the plots varied from .2 acre to 5 acres. It was believed that the application of test herbicides on large test areas would stimulate spraying problems encountered by field personnel of weed control crews. The equipment and spraying techniques employed during this study were similar to those used by the Hyacinth Control Division. The amount of "spray drift" and mixing qualities of the carriers with the various herbicides were noted during the applications.

Two types of plots were used to test the several herbicides for this screening program. The first type included small lakes and ponds which were treated completely with the various herbicides. The Bait Ponds at Leesburg, Lake Carola in Sanford, and Lake Lucille in Ft. Myers Shores are examples of this type of plot.

The second type of plot was a measured area within a larger body of water and was treated without regard for the adjacent water space. The purpose for this second type of plot was to attempt to find chemicals suitable for clearing relatively small portions of aquatic plant areas. Plots set out on Merritts Mill Pond, Lake Catherine and Lake Tsala Apopka were examples of this type plot.

Identification of plants treated with the various herbicides were made from keys in Fassett (1940), Muenscher (1944), and Eyles and Robertson (1944).

The effectiveness of the herbicides in controlling the various aquatic plants was determined by an estimate of degree of kill over a six-week period. Observations were made weekly and if the treatment looked effective, they were continued for several months. The kill was expressed on a 0 (no control) to 10 (complete control) scale. (See Tables I, II, III, IV, V, VI, and VII.)

Results

Of the three different herbicides tried on five water lettuce plots (Table I), Urox produced a control rating of 10 in two 0.2 acre plots.

Two plots treated with Forron at 4 pounds and 5 pounds active ingredient per acre produced a control of 0.

Granular 2, 4-DA at the rate of 10 pounds active ingredient per acre gave a control of 0 on the evaluation scale.

Of the two plots which contained smartweed at Merritts Mill Pond, one was treated with granular 2, 4-D and the other with granular 2, 4, 5-T. (See Table II.)

The size of both plots was 0.2 acre and the rate of application for each was 87 pounds of active ingredient per acre. The control evaluation on both was 0.

The spatterdock plot treated in Williams Lake was 2.9 acres in size and averaged 6.6 feet in depth. Liquid Silvex (6 pound material) was applied at the rate of .5 p.p.m.w.[1] A control evaluation of 0 was given this plot after two months of observations. (See Table III.)

The results of herbicides tested on bushy pondweed are found in Tables IV. Those plots treated with granular endothal at 0.5 p.p.m.w., 1.5 p.p.m.w., and 2.0 p.p.m.w. produced excellent results since the evaluations were 10 for the plots at these concentrations.

Three other plots of bushy pondweed treated with granular endothal at 1.0 p.p.m.w., 16 p.p.m.w., and 36 p.p.m.w. gave 0 control in each instance.

The Lake Lucille area had approximately 2 acres of bushy pondweed (70% coverage), three small stands of white water lily, *Nymphaea odorata* in the south quarter of the lake, and 0.5 acre of cattails, *Typha latifolia* on the west, south and northeast shores. The bushy pondweed and white water lily were completely eradicated by liquid silvex (6 pound material) applied at the rate of 1 p.p.m.w. The cattails located on the south shore of the lake were eradicated apparently because they had been saturated with the mixture of silvex and water at the time of application. The numerical evaluation for the control of these three aquatic plants was considered as 10 with this concentration of silvex.

Lake Carola which had a 90% cover of bushy pondweed in association with pennywort, *Hydorcotyle umbelleta* and green algae was completely cleared with one treatment of liquid silvex (6 pound material) at a concentration of 1.5 p.p.m.w.

Pond No. 2 of the Southern Fish Culturists which was completely covered with a pure stand of bushy pondweed also was cleared with 2.5 p.p.m.w. of granular 20% silvex.

A 0.2 acre plot of bushy pondweed was marked off on the west shore of Merritts Mill Pond and treated with 2.3 p.p.m.w. with granular 20% silvex. The plot was observed for 6 weeks with no sign of a control being effected. Three additional plots 0.2 acre in size were marked off along the east shore of Merritts Mill Pond. These areas were treated with granular 20% 2, 4-D at concentrations of 1.5, 2.0, and 2.5 p.p.m.w. A rating of 0 was given to these three plots after 6 weeks of observations.

Two 0.1 acre plots were marked off in a good stand of parrots feather, water hyssop, and bladderwort found in a bay of Lake Tsala Apopka, (Table VI). These two 0.1 acre plots were treated with two different formulations of granular 20% sodium arsenite at the rate of 10 p.p.m.w. The area was observed for two months with no control of this submerged vegetation being detected.

Two 0.2 acre plots were marked off adjacent to the above plots in the same stand of parrots feather, water hyssop, and bladderwort. One of these was treated at the rate of 4 p.p.m.w. with granular 20% silvex and the other was treated at the rate of 1.0 p.p.m.w. with the same material. The results of herbicides tested on these two plots were given an evaluation of 0 after two months of observation.

Application of granular 5% endothal at the rate of 1 p.p.m.w. made on Pond No. 4 of the Southern Fish Culturists containing pondweed, resulted in an exaluation of 10 within three weeks. (See Table V.)

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[1] Parts per million by weight. The concentration of a herbicide in a treated water area expressed in pounds of active ingredient or acid equivalent per million pounds of water.

CONCLUSION

1. Twenty-eight plots were established on nine different types of aquatic plants to observe the reactions of ten herbicides.
2. Urox applied at the rate of 3.75 pounds active ingredient per acre mixed with 50 gallons of oil, effectively controlled water lettuce. This treatment is now being recommended by the Hyacinth Control Division for the control of water lettuce in Florida.
3. Bushy pondweed was successfully eradicated by spraying infested areas with silvex (6 pound material) at rates as low as 1 p.p.m.w. Investigations are continuing on the use of silvex for control of submerged and emergent type aquatic plants.
4. Granular endothal showed good to fair results in controlling Najas and good control of pondweed in one instance.
5. Future screening of herbicides in Florida should include work on mixed vegetation plots, for example, submerged and emergent type associations to determine an effective herbicide for general use.

ACKNOWLEDGEMENTS

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TABLE I.

RESULTS OF HERBICIDES USED ON FLOATING VEGETATION.

—Water Lettuce—

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	*Rate* Lbs/Acre*	*Control*
Kibler Pit	2, 4-DA Pellets	2/2/60	10 lbs.	None	10	0
Kibler Pit	Urox	2/8/60	192 oz/15 gal	Kerosene	22.5	10
Lake Agnes	Forron	11/21/60	32 oz/15 gal.	Water	4	0
Kibler Pit	Forron	11/30/60	64 oz/10 gal.	Water	5	0
Kibler Pit	Urox	11/30/60	96 oz/10gal.	Kerosene	11.2	10

* Active ingredient

TABLE II.

RESULTS OF HERBICIDES USED ON EMERGENT VEGETATION.

—Smartweed—

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	*Rate* Lbs/Acre*	*Control*
Merritts Mill Pond	2,4-DA Pellets	7/9/60	5 lbs.	None	87	0
Merritts Mill Pond	2,2,5-T Pellets	8/1/60	5 lbs.	None	87	0

* Active ingredient

TABLE III.

RESULTS OF HERBICIDES USED ON EMERGENT VEGETATION.

—Spatterdock—

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	*Rate* Lbs/Acre*	*Control*
Williams Lake	M-1845	12/13/60	281 oz/100 gal.	Water	.5 p.p.m.	0

* Active ingredient

TABLE IV.
RESULTS OF HERBICIDES USED ON SUBMERGED VEGETATION.
—Bushy Pondweed—

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	*Rate* Lbs/Acre*	*Control*
Leesburg Pond No. 5	Endothal Pellets	9/2/60	.9 lbs	None	.5 p.p.m.	10
Leesburg Pond No. 3	Endothal Pellets	3/20/60	1.5 lbs.	None	1.0 p.p.m.	10
Leesburg Pond No. 2	Endothal Pellets	9/2/60	2.8 lbs.	None	1.5 p.p.m.	10
Leesburg Road Pond	Endothal Pellets	9/2/60	11.0 lbs.	None	2.0 p.p.m.	10
Leesburg Pond No. 3	Endothal Pellets	9/2/60	3.7 lbs.	None	2.0 p.p.m.	7
Leesburg Pond No. 1	Endothal Pellets	9/2/60	1.5 lbs.	None	1.0 p.p.m.	0
Lake Catherine	Endothal Pellets	8/26/60	5.0 lbs.	None	16.0 p.p.m.	0
Lake Catherine	Endothal Pellets	8/26/60	11.0 lbs.	None	36.0 p.p.m.	0
Lake Lucille	M-1845	10/6/60	640 oz/150 gal.	Water	1.0 p.p.m.	10
Lake Carola	M-1500	5/19/60	640 oz/60 gal.	Water	1.5 p.p.m.	10
Leesburg Pond No. 2	M-1499	6/20/60	1.0 lbs.	None	2.5 p.p.m.	10
Merritts Mill Pond	M-1499	7/9/60	25.0 lbs.	None	2.3 p.p.m.	0
Merritts Mill Pond	2,4-D Pellets	7/9/60	13.5 lbs.	None	1.5 p.p.m.	0
Merritts Mill Pond	2,4-D Pellets	7/9/60	17.0 lbs.	None	2.0 p.p.m.	0
Merritts Mill Pond	2,4-D Pellets	7/9/60	21.0 lbs.	None	2.5 p.p.m.	0

* Active ingredient

TABLE V.
RESULTS OF HERBICIDES USED ON SUBMERGED VEGETATION.
—Pondweed—

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	*Rate* Lbs/Acre*	*Control*
Leesburg Pond No. 4	Endothal Pellets	3/22/60	1.5 lbs.	None	1.0 p.p.m.	10

* Active ingredient

TABLE VI.
RESULTS OF HERBICIDES USED ON SUBMERGED VEGETATION.
—Water Hyssop, Parrot's Feather and Bladderwort—

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	*Rate* Lbs/Acre*	*Control*
Lake Tsala Apopka	50-51	6/19/60	50.0 lbs.	None	10.0 p.p.m.	0
Lake Tsala Apopka	50-52	6/19/60	50.0 lbs.	None	10.0 p.p.m.	0
Lake Tsala Apopka	M-1499	6/19/60	10.0 lbs.	None	4.0 p.p.m.	0
Lake Tsala Apopka	M-1499	6/19/60	3.0 lbs.	None	1.0 p.p.m.	0

* Active ingredient

TABLE VII.
RESULTS OF HERBICIDES USED ON SUBMERGED VEGETATION.
—Coontail—

Location	*Chemical*	*Date*	*Concentration*	*Carrier*	*Rate* Lbs/Acre*	*Control*
Lake Tyner	Endothal Pellets	4/13/60	2.5 lbs.	None	1.0 p.p.m.	0

* Active ingredient