AQUATIC HERBICIDES — NEW POSSIBILITIES

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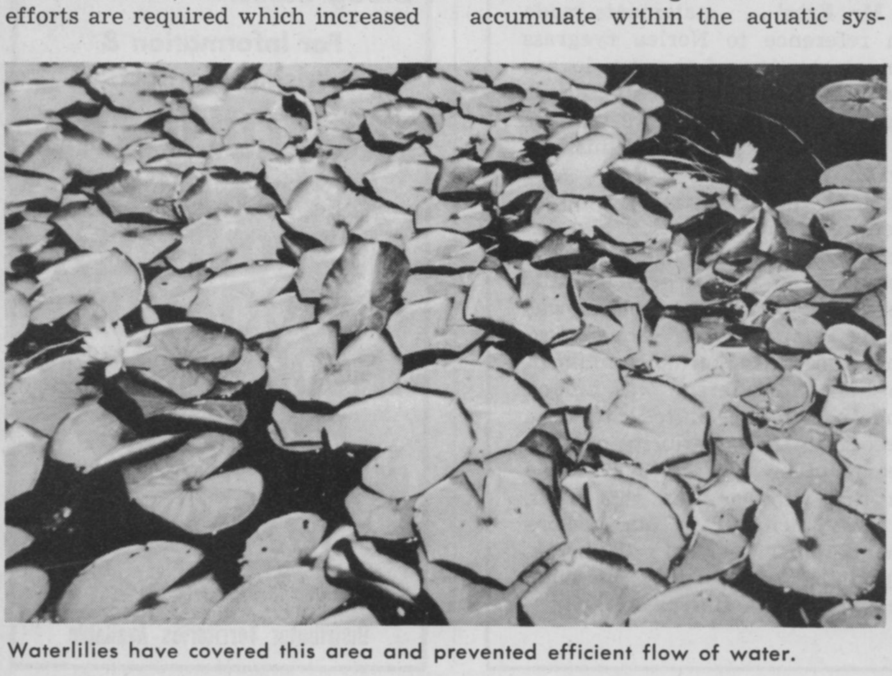
SINCE about 1967 the development of aquatic herbicides has been considerably curtailed. This has been due in part to the collection of data which indicates that some pesticides, primarily the organo-chloro insecticides, have been accumulating in various segments of the environment and have been producing various undesirable effects.

Further, a recent report indicates that 2,4,5-T formulations when fed to rats at high rates cause teratogenic effects. A general awareness has developed that the chemical age is introducing agents into the environment that are detrimental to the environment. Since these reports implicate pesticides, the registration of many aquatic herbicides have been reevaluated.

Furthermore, additional research efforts are required which increased the cost of development of aquatic herbicides. Aquatic herbicides have a rather limited monetary return and the increased costs have resulted in reduced developmental work on new aquatic herbicides. In fact, additional data is now required to support the continued use of aquatic herbicides.

At this point, there is little evidence which indicates that aquatic herbicides have been detrimental to the aquatic environment or that residues have been accumulating, except for arsenic and copper. However, sodium arsenite and copper sulfate have been widely used for the control of submersed aquatic plants and algae, respectively. Since arsenic and copper are metals, only the chemical composition of these metals can change and these will accumulate within the aquatic system. To date, there has not been any indication that in ponds and lakes the bottom soil accumulations of arsenic and copper have been detrimental. There are reports that copper has decreased fish production.


Waterlilies have covered this area and prevented efficient flow of water.

Aquatic heribicides containing arsenic or copper should not be classed with the organic-type aquatic herbicides such as endothall, diquat or 2,4-D, since the latter apparently undergo decomposition to various products which may be metabolized further and become part of the carbon component within the aquatic system. It should be pointed out that while 2,4-D and silvex are organo-chloro herbicides there is indication that these compounds are being degraded and they have not accumulated in any segment of the aquatic environment.

In several recent studies at the Natural History Survey it was found that the butyl ester of 2,4-D, which is toxic to fish, did not appear to have any direct toxicity to several bethnic organisms and the 2,4-D was rapidly removed from the water. Usually some ester or salt derivative of 2,4-D is used in the herbicide formulations. The esters of 2,4-D are more toxic to fish than salts.

In our laboratory we observed that 2,4-D and 2,4,5-T (acid) were not readily absorbed by bluegills. It has been shown that the butoxy ethanol ester of 2,4-D was more readily absorbed from water than the 2,4-D acid; however, the esters of 2,4-D and silvex were rapidly hydrolyzed within the aquatic environment. This indicates that fish exposed to an application of an aquatic herbicide containing 2,4-D or silvex would not accumulate much 2,4-D or silvex since the exposure of the fish to the esters would be very short; even with a longer period of exposure to the acid, little would be absorbed by fish.

This further suggests that any contamination of an aquatic environment with a herbicide containing 2,4-D, 2,4,5-T or silvex would not present a great potential for hazard, since the esters would be rapidly hydrolyzed and fish would be exposed longer to the acid form. This does not mean that trouble could not develop, when extreme excesses of phenoxy herbicides entered the aquatic environment. But potential danger would be minimized.

The Natural History Survey continues to investigate the effects of available aquatic herbicides and to attempt to develop techniques for the control of aquatic plant species which have been difficult to control.

One such species is spatterdock, *Nuphar advena,* a member of the waterlily family. Spatterdock is quite common in the southern part of Illinois. It had been reported to be controlled by the use of granular 2,4-D. However, I was advised that spatterdock was not being controlled with 2,4-D. Thus, we investigated the effect of 2,4-D, 2,4,5-T and silvex on spatterdock over a two year period and although a severe reduction in the stand occurred, the plants were not eliminated from the treated areas.

During the summer of 1968, we learned that a post emergent application of dichlobenil (Casoron) was effective against spatterdock. In late summer we applied dichlobenil against spatterdock and the plants were severely damaged. Unfortunately we could not continue these observations the following spring nor make early spring applications of Casoron on spatterdock.

Recently it was reported that postemergence applications of dichlobenil on waterlilies at rates of 5 lb ai/A applied during periods of active growth in June and July gave excellent results, and that spatterdock was controlled with applications of 8-10 lb ai/A. Since dichlobenil has been registered for preemergence use only, the Thompson-Hayward Company is seeking a change in the registration to include these postemergent uses of dichlobenil for spatterdock and waterlily.

Spatterdock, also known as yellow waterlily or cowlily, has a broadly notched leaf a little longer than wide. The lobes are somewhat pointed, spreading from a 45 to 80° angle. The petiole, or leaf stalk, holds the leaves nearly erect. However, the leaves may float on the water surfice. It has a yellow flower and a somewhat globular fleshy fruit containing many seeds. Spatterdock has an underground thick, spongy root stock or stem which has to be killed for control of plants.

Another species which had not responded to suggested rates of herbicide applications was water stargrass, *Heteranthera dubia.* Water stargrass, also called mud plantain, has ribbon-like leaves and the stems and leaves are long and flexible and trail through the water. Water stargrass closely resembles a submersed *Potamogeton* spp. but can readily be distinguished from them by the lack of a definitive mid-vein in the leaves, and, in the late summer, by the characteristic yellow star-like flower.

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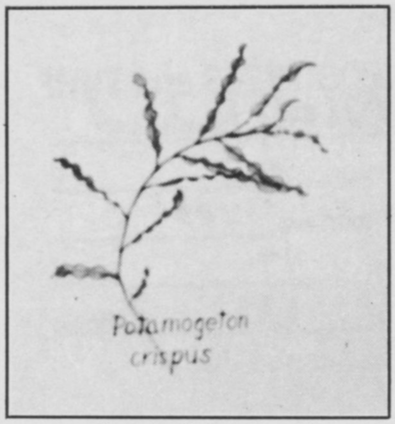
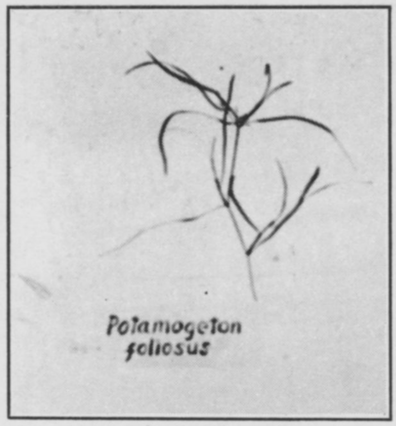
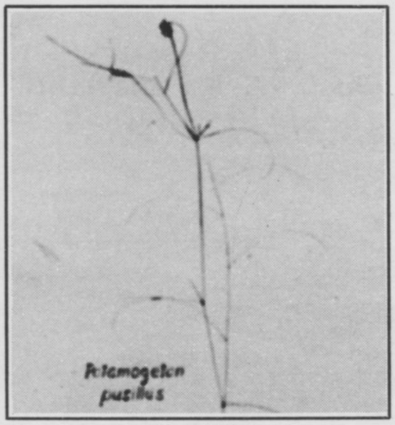
COMMON AQUATIC WEEDS



Curlyleaf Pondweed

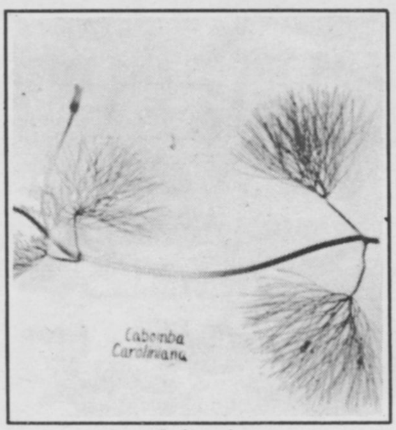


Leafy Pondweed

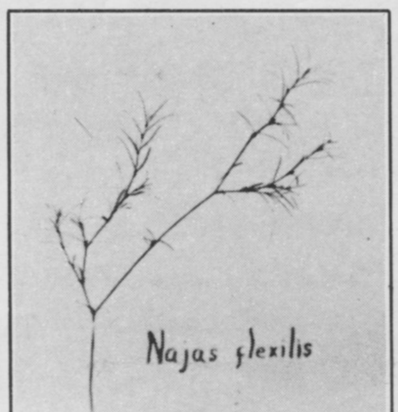


Small Pondweed

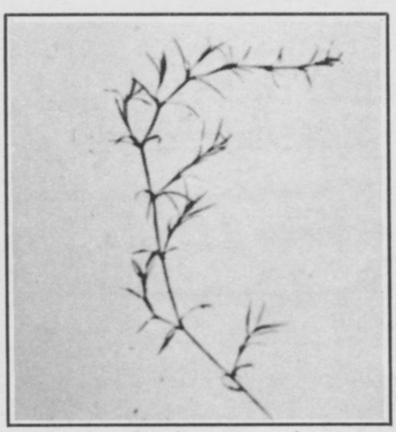

Waterstar grass

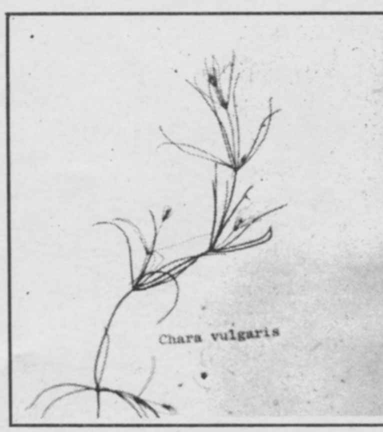


Cabomba



Slender Naiad


Southern Naiad



Chara

ILLINOIS RESEARCH *(from page 27)*

Sodium endothall was reported to have controlled water stargrass at rates of 2 to 3 ppm. Data from southern Illinois indicated that water stargrass was not being controlled by sodium endothall at high rates. We found that diquat cation (Diquat) at 1 ppm and potassium endothall (Herbicide 273) at rates of 5 ppm eliminated water stargrass from the treated areas. *Note — We did not apply sodium endothall against water stargrass for comparison. Hence, the potassium salt of endothall must be used for water stargrass control.)*

Some of our early investigations on the control of cabomba, *Cabomba caroliniana* using granular 2,4-D or silvex were not successful. Later investigations indicated that cabomba was eliminated from the test areas using the granular isooctyl ester of 2(2,4-dichlorophenoxy) propionic acid. However, 12 weeks were required before the cabomba plants were eliminated.

We have continued our interest in the control of cabomba and reinvestigated the effects of granular 2,4-D and silvex on cabomba. While we have not obtained real definitive data, our results suggest that granular 2,4-D and silvex suppress or retard the development of cabomba during the growing season. Cabomba develops late in the growing season
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Table 1. Various aquatic weeds controlled with aquatic herbicides in tests conducted by the Illinois Natural History Survey.

Group and Species	Chemical, active ingredient or free acid equivalent	Experimental or Tested Rate of application	Remarks
EMERGENT			
Spatterdock *Nuphar advena*	dichlobenil	6 lb ai/A 3 lb-4% Granules* per 440 ft²	Spread on the water surface
Waterlilies *Nymphaea* spp.	dichlobenil	5 lb/ai/A	Spread on the water surface
SUBMERSED PLANTS WITH ALTERNATE LEAF ATTACHMENT			
Curlyleaf Pondweed	Hydrothol-47 (L) (di-N,N,-dimethylcocoamine salt of endothall)	0.5 ppm (endothall content)	Apply on or below the water surface
Potamogeton crispus	diquat copper-triethanolamine complex	0.25 ppm diquat equal volume of copper-triethanolamine complex	Apply or or below the water surface
	Hydrothol-47 (10% G)	100 lb/A	Spread on the water surface
Leafy Pondweed *P. folious*	Hydrothol-47 (10% G)	100 lb/A	Spread on the water surface
Small Pondweed *P. pusillus*	Same as for leafy pondweed	100 lb/A	Spread on the water surface
Waterstar grass	diquat cation	1 ppm or 2 gal/ surface A	Apply on or below water surface
(Heteranthera dubia)	endothall potassium salt (4 lb/gal or 10% G)	5 ppm	Apply on or below water surface
SUBMERSED PLANTS WITH WHORIED OR OPPOSITE LEAF ATTACHMENT			
Cabomba *Cabomba caroliniana*	2,4-D ester (20% G)	2-3 lb/440 ft² 200-300 lb/ surface A	Apply on or below water surface
Slender Naiad *Najas flexilis*	Hydrothol-47 (L)	2 ppm (endothall content)	Apply on or below the water
Southern naiad *N. quadalupensis*	Hydrothol-47 (L)	2 ppm (endothall content)	Apply on or below the water surface
ALGAE THAT RESEMBLE TRUE PLANTS			
Chara *(Chara spp)*	Hydrothol-47 (10% G) copper-triethanolamine complex	100 lb/surface A 0.5-1 ppm	Spread on the water surface
ALGAE			
Filamentous	Hydrothol-47 (10% G) copper-triethanolamine complex	100 lb/surface A 0.5-1 ppm (copper content)	Spread on the water surface

*The formulation currently available may contain 10% dichlobenil.

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and blooms in central Illinois in late July or early August. An extensive stand may not be visible in the water in June, which makes the evaluation of the effects difficult, and the 12 weeks covers most of the growing season.

Rechecking data of previous experiments indicated a supression or retardation of the growth of cabomba apparently has occurred. Thus, if the control of cabomba is desired, an application of 200 to 300 lb of granular 2,4-D per surface acre, of a formulation containing 20 lb of 2,4-D acid per 100 lb, may supress the growth of cabomba.

Some aquatic plant control investigators observed that a diquat-copper sulfate combination was useful when neither herbicide alone was effective. They tested the diquat-copper sulfate combination on aquatic plants susceptible to diquat and found that the diquat-copper complex was very effective and that lower rates of diquat could be used.

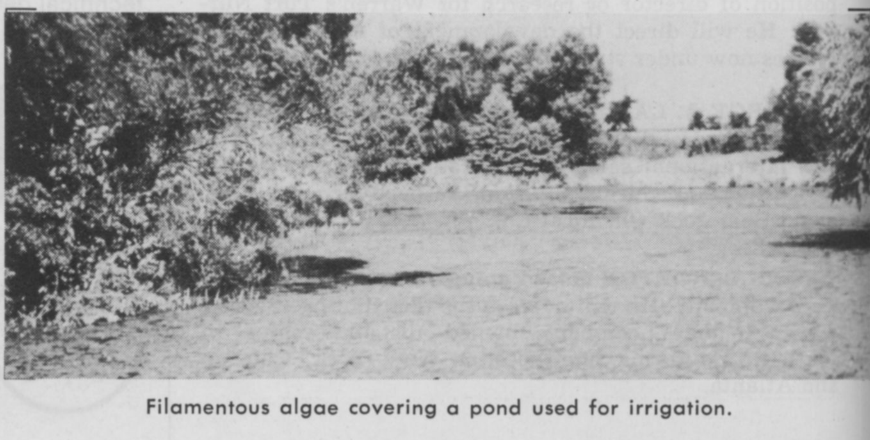
The volume of the diquat-copper sulfate mixture was determined by first estimating the necessary amount of diquat to treat a given area of *Potamogeton* spp. at the rate of 0.5 ppm, then taking ½ the necessary amount of diquat and mixing it with an equal volume of Cutrine (a copper sulfate triethanolamine formulation distributed by Applied Biochemists, Inc., Mequon, Wisconsin) finally diluting the complex with water and applying it under the water in the usual manner.

We were able to eliminate curlyleaf pondweed *P. crispus* at a rate of 0.25 ppm of diquat. We have not tested this diquat-copper complex widely against the more-difficult-to-control aquatic plants such as American elodea, *Elodea canadensis,* southern naiad, *Najas quadalupensis,* slender naiad, *N. flexilis,* bushy pondweed, *N. gracillima* or coontail, *Ceratophyllum demersum.* For the control of these plants, a rate of 1 ppm of diquat cation (Diquat) is required.

Hydrothol-47 a product of the Penwalt Corporation has been recommended as an aquatic herbicide, primarily as an algaecide. Hydrothol-47 is toxic to fish and has had very limited use for the control of submersed aquatic plants. Recently in southern Indiana, 100 lb of granular Hydrothol-47 per surface acre of water with a minimum average depth of 4 feet and maximum average depth of 6 feet, gave very good control of several potamogetons. No loss of fish was reported.

During 1971 we applied 100 lb of granular Hydrothol-47 to a one acre pond containing a mixed stand of potamogetons, a relatively heavy stand of filamentous algae and some chara, *Chara vulgaris.* Leafy pondweed, *P. foliosus* was severely damaged in 3 days and small pondweed, *P. pusillus* was eliminted in 5 days. Four days after application heavy rains caused an influx of water, resulting in a one-foot increase in water depth. Sago pondweed, *P. pectinatus,* was not damaged and the stand of filamentous algae was reduced. There was not sufficient chara to obtain an adequate evaluation of the effect of this rate of application of Hydrothol-47 against it. *(Note—I have been advised that in southern Indiana experiments, stands of sago pondweed, chara and filamentous algae were eliminated by this rate of application of Hydrothol-47.)*

In previous experiments we had found that liquid Hydrothol-47 was effective against southern naiad, and chara, but at rates of 2 ppm endothall content. Should Hydrothol-47 be effective against the **Najas** spp and chara, it should give an additional aquatic herbicide for use in the control of these very abundant aquatic plants.



Filamentous algae covering a pond used for irrigation.