Effects Of A Diquat Plus Cutrine Combination On Invertebrates In Inglis Reservior

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INTRODUCTION

Numerous new compounds for controlling nuisance aquatic plants are now available. Vast areas of the aquatic environment are subjected to these new herbicides with little investigation of effects upon the animal constituents within these aquatic ecosystems. Although chemical control of aquatic macrophytes is a widely accepted practice (4, 6, 9, 11), much interest and concern has been generated over effects on other components of aquatic environments (1, 7). Questions concerning herbicidal effects on fish and fish food organisms have been raised.

The primary objective of the Florida Game and Fresh Water Fish Commission was to document possible shifts in the invertebrate population of Inglis Reservoir after a herbicidal application.

MATERIALS AND METHODS

Test site. This study was part of an extensive aquatic plant eradication program undertaken by the Florida Game and Fresh Water Fish Commission and the Corps of Army Engineers on Inglis Reservoir, west coastal Florida. The primary macrophyte treated was hydrilla (*Hydrilla*

verticillata Casp.) which had become established in nuisance proportions within the reservoir.

An area of approximately 70 surface acres (694.2 acre-feet) was selected for treatment with a 6,7 dihydrodipyrido (1,2-a:2',1'*c*) pyrazinediium ion (diquat) and triethanolamine complex of copper sulfate (cutrine) combination. The treatment plan called for an application of 1.0 ppmw diquat mixed with 0.14 ppmw cutrine.

Inglis Reservoir was treated on August 19, 1970 under contract from the Florida Game and Fresh Water Fish Commission.

Sampling procedure. A procedural plan was adopted that would sample invertebrate populations prior to and following chemical treatment in Inglis Reservoir. To insure adequate representation of macroinvertebrate population, samples were taken from surface, mid-depth (7 to 10 ft) and bottom (15 to 20 ft) vegetation. Due to the vegetational substrate predominating in the reservoir, traditional sampling methods proved unsatisfactory. Instead, a sweep net and SCUBA (Self Contained Underwater Breathing Apparatus) equipment were employed to simplify collection and reduce sampling error. At each water column level, vegetation, primarily hydrilla, was cut and packed carefully into a sweep net and then taken to a boat where the contents were washed in a sieving bucket. This procedure was repeated six times to complete one sample. Each sample contained approximately the same amount (6.71 cu. ft.) of vegetation. Samples were labeled, preserved, and transported to the laboratory to be extracted from the vegetation and identified (8). Although invertebrates were identified to generic level, insufficient numbers necessitated broader taxonomic grouping to facilitate comparisons of before and after treatment samples.

RESULTS AND DISCUSSION

Major invertebrate components of the study area prior to treatment were members of the taxonomic grouping Oligochaeta, Arachnida, Crustacea, Trichoptera, and Diptera. Except for oligochaetes and arachnids, numbers declined subsequent to herbicide application. Chironomids predominated in the samples taken, with an initial decline from 1272 (befort treatment) to 405 (7 days following herbicide application). Crustaceans and trichopterans also exhibited population declines, but to a lesser extent than dipterans (Figure 1). Invertebrate components which seemed to benefit most from vegetation treatment were oligochaetes, gastropods, and arachnids; their numbers increased as the effects of treatment became evident (Figure 2). The increase in decomposing plant matter and

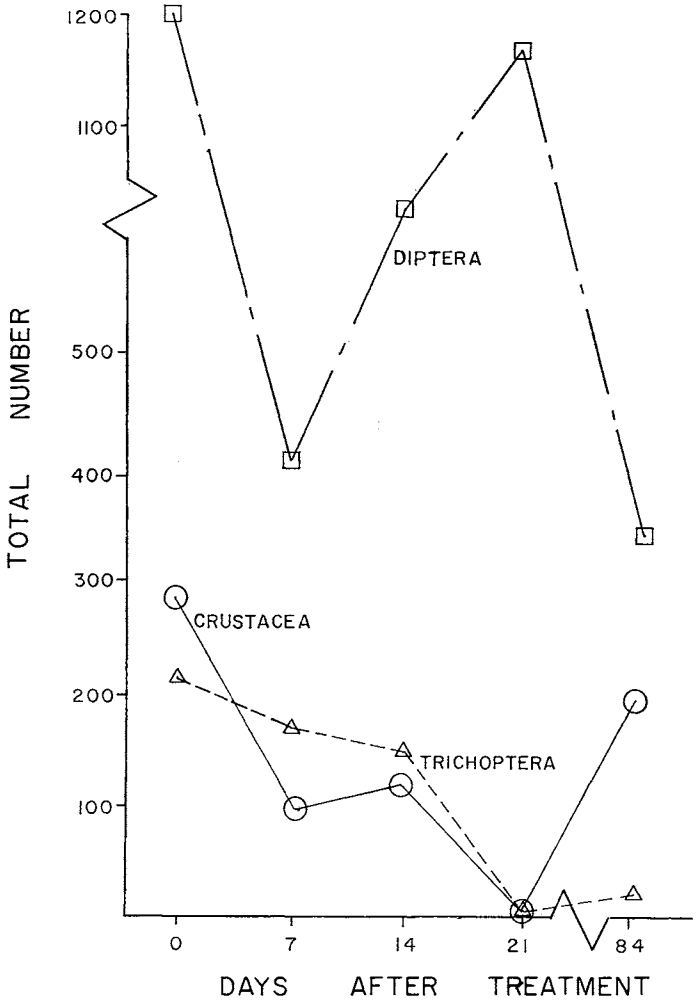

Figure 1.—Invertebrate taxons that were adversely affected by herbicidal treatment.

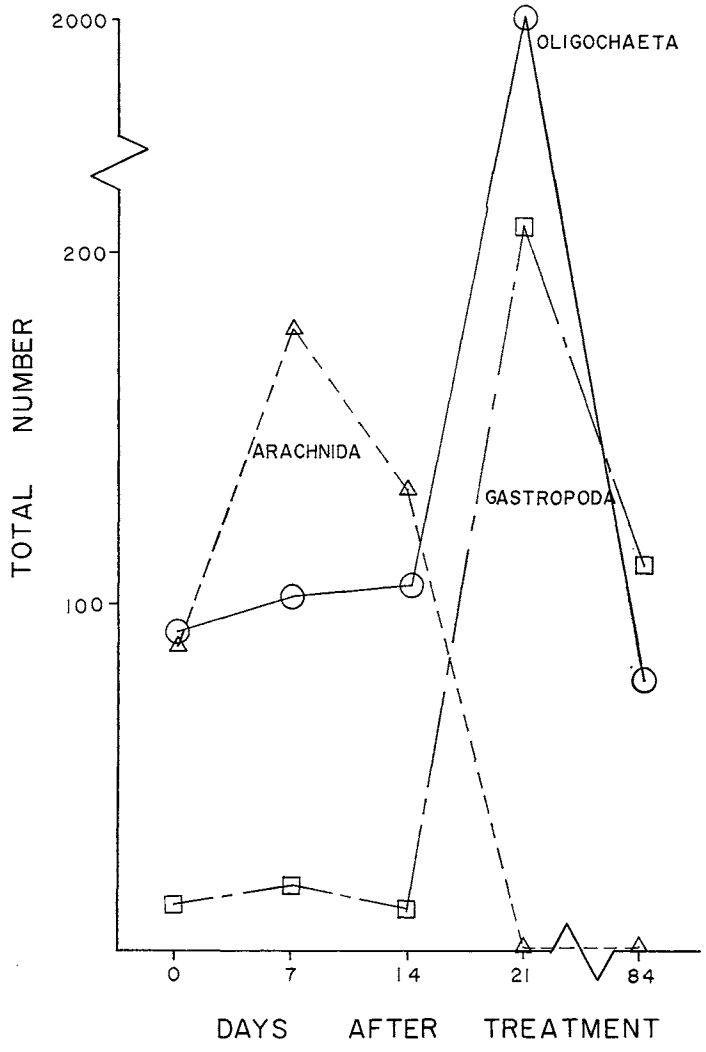

Figure 2.—Invertebrate populations responding positively to herbicidal treatment with diquat plus cutrine.

availability of organisms to predation, appeared to be the dominant factors regulating increase in these organisms. Ephemeropterans, although collected in small numbers prior to and during the early part of treatment, demonstrated a pronounced population increase on the 84th day. This rise was more likely due to a natural cyclic response of the order, than to any direct or indirect herbicidal effect.

Several other invertebrate groups were encountered in this study, but their numbers were so few that they comprised a minor percentage of the total invertebrate population. These included representatives of Turbellaria (*Dugesia* sp.), Odonata (*Zygoptera*), Hemiptera (*Enallagma* sp. and *Pelocoris* sp.), and Coleoptera (*Hydroporus* sp., *Coptotomus* sp., and *Hydrocanthus* sp.).

The combination of diquat plus cutrine eliminated approximately 75% of the vegetation within 84 days. Visual effects became evident on the 3rd day subsequent to treatment, with 5% of the vegetation beginning to decompose and fragment. Plant reduction continued at a moderate rate with herbicidal control on days 7, 13, 21, and 84 being 15, 35, 50 and 75%, respectively.

Herbicidal effect upon the invertebrate fauna was moderate with a decline following treatment and resurgence to a population peak on the 21st day (Figure 3). A two-way comparison (two-way AOV) indicated the effect of herbicidal treatment upon invertebrate numbers over time was non-significant (Table 1). There was, however, a highly significant effect ($F_{6\ .\ 70} = 2.66^{***}$) of herbicidal treatment on taxons and their response to treatment and plant annihilation.

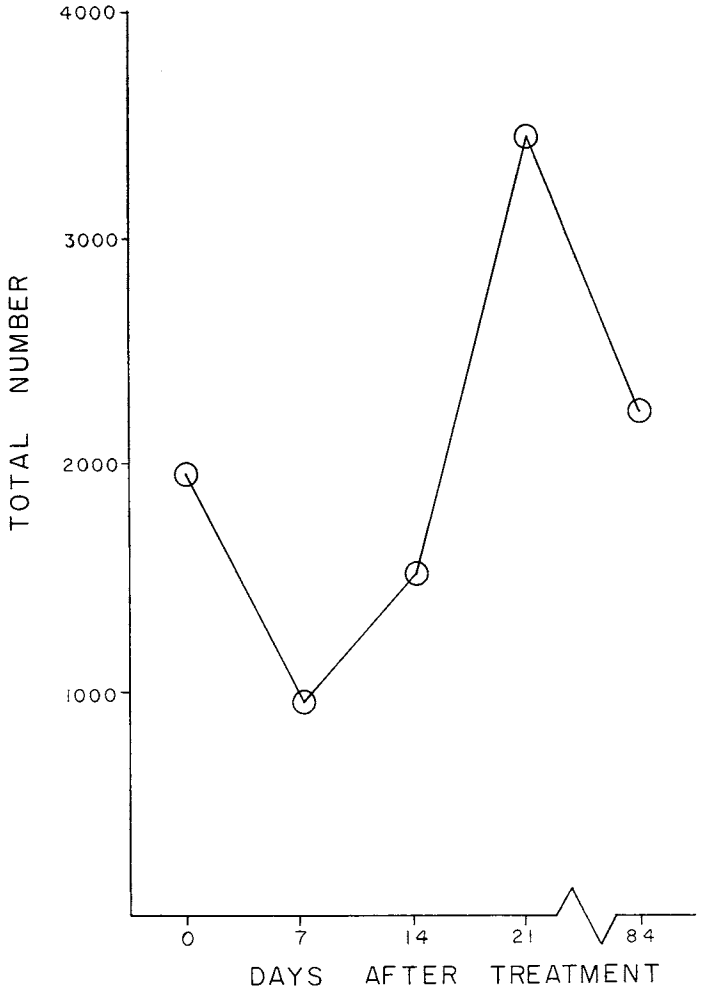

Figure 3.—Invertebrate faunal response to a diquat plus cutrine treatment of Inglis Reservoir.

TABLE 1.—INVERTEBRATES IN INGLIS RESERVOIR BEFORE AND AFTER TREATMENT WITH DIQUAT PLUS CUTRINE.

Taxons	Total Number of Invertebrates[a]				
	Before Treatment	Days after Treatment			
		7	14	21	84
Oligochaeta	90	102	106	2017	80
Gastropoda	16	20	15	221	111
Arachnida	88	171	135	0	1
Crustacea	297	101	128	4	210
Ephemeroptera	49	2	21	19	1510
Trichoptera	206	172	148	5	23
Diptera	1272	405	963	1153	342

[a]Each value is the combination of three samples.

A Duncan multiple range test was used to find differences between taxons. A significant difference was found to exist between Diptera and oligochaeta and the other taxons sampled. All other taxonomic differences were found to be nonsignificant.

CONCLUSIONS

From the stand point of total invertebrate numbers, herbicide treatment of Inglis Reservoir with a diquat plus cutrine mixture appeared to have a moderate effect on the invertebrate fauna. This was evident from the slight decline and rapid resurgence in total numbers subsequent to treatment.

Invertebrate response to chemical treatment could be associated directly with herbicide toxicity or indirectly from the change in dominant habitat. Diquat has been shown to be toxic to a variety of invertebrates, especially crustaceans (2, 3, 12). Crustacean response in Inglis Reservoir appeared to demonstrate this diquat toxicity. Because cutrine is a relatively new herbicide, little is known about its effect on aquatic inhabitants. Preliminary investigations indicate cutrine has little effect upon invertebrate populations (10). Elimination of dominant habitat was considered the principal factor affecting invertebrate populations within the study area. Diquat does not directly affect some insects, but the resultant habitat destruction is a critical factor in insect decline or displacement (4).

Invertebrates in Inglis Reservoir were subjected to a moderate habitat change resulting from herbicide application. The diquat plus cutrine mixture exhibited a subtle mode of action upon the vegetation; plant stems became soft and very pliable with leaves fragmenting and settling to the bottom. Control was only 75% complete which may have accounted for the invertebrates ability to withstand total annihilation resulting from chemical treatment.

From this study it appears that application of diquat plus cutrine had little lasting effect upon total invertebrate numbers in Inglis Reservoir. There was, however, a significant effect upon taxonomic groups comprising the invertebrate fauna prior and subsequent to herbicide treatment.

Caution should be used when projecting these results to other instances of herbicide application. Resultant ef-

fects to the invertebrate fauna would depend on the herbicide used and time of treatment. Whether the resulting faunal changes would be beneficial or detrimental to other aquatic organisms would depend on food habits, selectivity, and availability.

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