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EFFECT OF ANTIMYCIN ON
INSTREAM MUSSEL POPULATIONS

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DEPARTMENT OF NATURAL RESOURCES

RESEARCH

REPORT 84

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By ~~W. Wills Flowers - Dept. of Natural Resources~~
William L. Hilsenhoff

ABSTRACT

Dept. of Natural Resources
Technical Library
3911 Fish Hatchery Road
Fitchburg, WI 53711 - 5397

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Antimycin treatments of 6 varying concentrations were conducted on the adult freshwater mussel populations (Unionidae) along 2 miles of the Ashippun River in the summer of 1974. A die-off over about 2 months occurred at normal teleocidal dosages, 7 ppb or above. Severity of population die-off and the date of peak mortality varied from species to species. The toxicant effect of antimycin was temperature dependent.

INTRODUCTION

This study was proposed by the Wisconsin Department of Natural Resources to further investigate effects of antimycin treatment programs on instream populations of adult freshwater mussels (Unionidae). Laboratory mortality studies on three species were completed by Antonioni (1974) and Coble (1974, pers. comm.). The only field study was done by Bratley and Mathiak (1972) on a 380-ft section of the East Branch of the Rock River, showing that following a 15 ppb treatment of antimycin, a long-term die-off of mussels occurred with different species exhibiting different mortality levels. The present study was designed to further investigate these results on a longer section of river using six concentrations of the toxicant. Specific objectives were to: determine species susceptibility for a relatively large number of species in a field situation, determine the point of peak mortality for different species following exposure to antimycin, and determine the lethal concentration for those species exposed in a field situation.

STUDY AREA DESCRIPTION

The location of the experiment involved 2 miles of the Ashippun River, 2 miles north of Oconomowoc and just west of Monterey, which has a large mussel population. Intervals of 300 ft were measured off and staked to provide reference. Six such stations, or 1,800 ft established a section (Fig. 1). Flow surveys were conducted at the beginning and end of each section to establish the volume of water to be treated. The river had a flow of 21 cfs in the treated sections. Temperature and pH were taken three times on the day of treatment at 9:30 a.m., 1:30 p.m. and 4:00 p.m. Water temperature remained 72°F but pH was 8.3, 8.4 and 8.5 respectively.

In addition to the treated sections, a 300-ft length of river above section one was surveyed and used as an untreated control. The substrate in the upstream control and the upper half of the first treated interval consisted of pebbles and coarse gravel. The remaining intervals in section one had fine gravel or sand substrates with a few muddy areas near shore. In section three, clams were found in sand and gravel bottoms which were often in deep channels bordered by shallow mud banks. Section five had a sand and gravel substrate in the upstream half with sand and mud bottom in the remainder. Throughout the sections were dense beds of Potamogeton and other rooted vegetation; in several places these beds covered much of the river bottom.

METHOD

Treatment took place between July 29 and August 1, 1974 in sections 1, 3 and 5. Concentration levels were set at 5, 10, 15, 20, 25 and 30 ppb. The uppermost station in each treated section received 854 ml, to establish a concentration of 5 ppb. At each subsequent downstream interval the concentration was increased by 5 ppb to provide the six desired test concentrations. The 55-gallon drip barrels theoretically should have run out in 8 hours but actually ran for an average of about 5½ hours, during which constant inspection was required to clear air locks in the barrels. This meant concentration levels had to be increased by a factor of 1.4 to approximate the actual concentration in the river (Table 1).

To prevent chemical overlap between treated sections, one part per million potassium permanganate was established as the level necessary to detoxify 30 ppb antimycin, and added to the river downstream from each treated section. Forty-two pounds of potassium permanganate in crystal form were used to detoxify each replicate. We found that mixing was not complete in the barrels, leading to the belief that detoxification might not have taken place. Stream vegetation absorbed an undetermined amount leading to further doubts about detoxification. Live fish were observed in the untreated sections of the river on the day following treatment, indicating detoxification was at least partially successful.

One week after treatment, and weekly for two months thereafter, dead mussels were removed from the treated sections, identified and counted. Prior to treatment, dead mussels had been removed from sections 1, 3 and 5. Dead mussels were easily located as most were lying on their sides on the surface of the river bottom and those still buried had an unnaturally wide gape between the valves. At the end of two months, mortality had ceased. At this time, living mussels remaining in the treated sections and the control station were counted, and the percent mortality for each species was calculated. Because of the difficulty in sampling populations of living juvenile mussels, these animals (less than 1 in long) were omitted from mortality calculations. Mortalities were analyzed by multiple regression techniques to determine the effects of the different concentrations of antimycin. For the 6 common species mortalities were pooled by species within each section. The average of the three pooled mortalities was corrected for the mortality of the species in the control station using Abbott's formula (Abbott 1925). An analysis of variance was done on these pooled mortalities using the arcsin transformation (Snedecor and Cochran 1967). The analysis of variance tested for significant differences in mortality among the six species being considered. To determine if mortality between any two species was significant, Duncan's multiple range test was used.

RESULTS AND DISCUSSION

The total number present at each station in each treated section and the percent mortality of each species is given in Table 2. The following five species were not common enough to give statistically meaningful data and are omitted from further consideration: Pleurobema cordatum (Ohio pigtoe), Antodontoides ferussacianus (cylindrical paper shell), Alasmidonta marginata (elk toe), Lampsilis ventricosa (pocketbook), Actinonaias ellipsiformis (ellipse). Statistically meaningful results were achieved for the following species: Amblema costata (three ridge), Fusconaia flava (pigtoe), Lasmigona complanata (white heel splitter), Strophitus rugosus (squawfoot), Anodonta grandis (floater), Lampsilis siliquoidea (fat mucket).

Multiple regression analysis failed to show any significant effects of antimycin concentrations on mortality. This suggests that all the dosages used were above (or, in the case of A. costata, below) a lethal threshold. Dead mussels found below the permanganate barrels indicated that within 300 ft of application, detoxification had not yet occurred.

Average mortalities for each species, corrected with Abbott's formula, are shown in Table 3. However, the upstream control station was not comparable to the treated sections in two respects. The bottom was made up of large pebbles, in contrast to the gravel or sand bottoms of the other sections. In addition, the control station and the upper third of the first station (7 ppb antimycin) in Section 1 showed freshly stirred up areas of bottom during the survey period. It is not known what caused this but possibly release of water from Monterey Mill Pond was involved. In any case, F. flava suffered unusually high mortality, giving the negative result in Table 3. Statistical tests (F tests) showed significant differences in mortality among the species and between the treated sections. The species differences are due to differences in response to antimycin while section differences are due to non-uniform mussel distribution, possibly caused by differences in substrates. The differences in average mortality among the six common species are compared in Table 4. It is interesting to note that the two species least affected, Amblema costata and Fusconaia flava, belong to the subfamily (Unioninae), considered the most primitive by many authors.

Table 5 and Figures 2 and 3 show the numbers of dead mussels, including juveniles, collected each week. Peak mortality occurred in the first week for Lampsilis siliquoidea and from 3 to 5 weeks after treatment for the other species. All but 5 of the siliquoidea collected during the first week were juveniles. This apparently severe mortality of juveniles could not be confirmed due to the lack of an estimate of the total juvenile population.

An unusual depressed mortality appears for the five species presented in Figures 2 and 3 during the fourth week of the post-treatment investigations. Water clarity decreased to a point that made it difficult to locate mussels. As a result the rise towards peak mortality is not entirely clear. It appears that peak mortality takes place on or about the fifth week after treatment for F. flava and L. complanata and on or about the third week after treatment for S. rugosus and A. grandis.

A problem in this study was the massive growths of rooted aquatic plants in most stations. It was impossible to systematically sample all these beds but several small areas were investigated and the only mussels present were Amblema costata and Fusconaia flava. Since these mussels had the lowest mortalities, omitting weed beds from the study probably made little difference in the final results.

Antonioni (1974) found in her laboratory studies that Elliptio dilatatus (also Unioninae) was less affected by antimycin than was Lampsilis siliquoidea. Coble (pers. comm.) has found no effects of antimycin on Lasmigona costata and Lampsilis siliquoidea at 11°C, supporting Antonioni's findings that the effects of antimycin are temperature dependent. This suggests that the effects of antimycin on mussels in the Ashippun River were terminated by falling water temperature. Since Bratley and Mathias (1971) did not give percent mortality for individual species, their results cannot be compared with our study.

SUMMARY

When mussels were exposed to antimycin at normal teleocidal dosages, 7ppb or above with summer treatment conditions, a die-off lasting approximately two months occurred. The severity of the die-off varied from species to species, as did the point of peak mortality. We found that lethal concentrations for all species exposed, other than A. costata, were apparently below the first test concentration of 7ppb. Mussels in the subfamily Unioninae (which includes most commercially valuable species) seem to be least affected while the Anodontinae and Lampsilinae suffer moderate to severe mortality.

RECOMMENDATIONS

This study indicates several areas where more research is needed. Lethal concentration thresholds for various species could be determined, preferably under laboratory conditions where dosages are exactly known. The mode of action of antimycin on mussels is unknown and investigation of this should yield interesting results.

Further field studies could generate additional meaningful data with less effort if the mussels were placed in baskets and suspended in water being treated. Mussels needed for such experiments could be collected from one place and tested in any river where antimycin was being used for fish control. In this way, mussels could be tested under field conditions without poisoning productive mussel beds and without the difficulties of getting accurate population estimates caused by vegetation and bottom irregularities.

It would also be valuable to conduct tests at a range of temperatures between 32°F and our test temperature to determine to what extent the antimycin effect is temperature dependent.

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Edited by Ruth L. Hine

About the Authors: R. Wills Flowers was a graduate student with the Department of Entomology, UW-Madison, Richard M. Johnson, Biologist with the Wisconsin DNR, Horicon; William A. Hilsenhoff, Professor of Entomology, UW-Madison.

TABLE 1. Actual and theoretical concentrations of antimycin used in the Ashippun River mussel project.

Station No.	Antimycin(ml)	Theoretical Concentration	Actual Concentration
1	854	5 ppb	7 ppb
2	854	10 ppb	14 ppb
3	854	15 ppb	21 ppb
4	854	20 ppb	28 ppb
5	854	25 ppb	35 ppb
6	854	30 ppb	42 ppb

TABLE 2. Total populations and percent mortalities (exclusive of juveniles) for mussels in experimental area of Ashippun River. (Presented in order of lowest to highest mortality.)

Statistically Meaningful	Section Treated	S T A T I O N												Control	
		1		2		3		4		5		6			
		(7 ppb)		(14 ppb)		(21 ppb)		(28 ppb)		(35 ppb)		(42 ppb)			
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
<u>Amblema costata</u> (Three ridge)	1	10	0	17	0	65	0	19	0	2	0	19	0	13	0
	3	56	2	31	3	50	0	11	0	50	2	19	0		
	5	317	0	21	5	29	0	28	0	117	1	43	0		
<u>Fusconaia flava</u> (Pigtoe)	1	7	28	18	17	58	5	14	40	1		12	8	4	80
	3	8	25	30	13	11	27	5	20	37	16	43	14		
	5	96	7	28	18	11	0	28	7	92	2	27	7		
<u>Lasmigona complanata</u> (White heel splitter)	1	13	8	33	9	17	6	7	0	0		14	7	7	0
	3	10	30	16	25	18	22	6	33	27	22	11	36		
	5	6	33	1	100	2	0	3	33	9	56	6	0		
<u>Lampsilis siliquoidea</u> (Fat mucket)	1	3	33	10	0	5	40	3	50	2	0	15	20	19	10
	3	2	100	2	100	3	0	0		7	71	1	100		
	5	5	80	0		4	75	1	0	5	100	7	57		
<u>Anodonta grandis</u> (Floater)	1	0		15	33	12	58	6	67	3	67	22	64	12	25
	3	9	100	7	57	7	100	3	33	27	85	12	67		
	5	27	96	11	73	5	80	18	67	17	82	8	100		
<u>Strophitus rugosus</u> (Squawfoot)	1	19	79	43	70	36	78	10	60	3	100	29	90	5	20
	3	8	75	13	92	3	100	8	62	5	80	31	100		
	5	28	96	7	86	4	75	7	100	30	97	6	100		
<u>Not Statistically Meaningful</u>															
<u>Actinonaias ellipsiformis</u> (Ellipse)	1	1	0	1	0	0		0		0		0		2	0
	3	0		0		0		0		0		0			
	5	0		0		0		0		0		0			
<u>Lampsilis ventricosa</u> (Pocketbook)	1	2	50	0		0		0		0		0		1	0
	3	0		1	0	0		0		0		1	0		
	5	0		0		0		2	0	0		1	0		
<u>Pleurobema cordatum</u> (Ohio pigtoe)	1	0		0		0		0		0		1	0	0	
	3	1	0	2	0	0		0		1	0	2	0		
	5	0		0		0		0		1	100	2	0		
<u>Alasmidonta marginata</u> (Elk toe)	1	0		0		0		0		0		0		0	
	3	0		0		0		1	100	0		1	100		
	5	3	100	1	0	0		1	100	0		0			
<u>Anodontoides ferussacianus</u> (Cylindrical paper shell)	1	1	100	2	100	1	0	3	100	1	100	0		0	
	3	0		0		0		1	100	0		0			
	5	1	100	0		0		0		1	100	0			

TABLE 3. Percent mortalities of the six most common mussels in the control and treated sections, corrected with Abbott's formula.

	Control		Treated Sections*		
	Percent Mortality	No. Animals Present	Percent Mortality	No. Animals Killed	Corrected Mean
<u>Amblema costata</u>	0	13	.6	4	.6
<u>Fusconaia flava</u>	80	4	11.6	60	-3.4
<u>Lasmigona complanata</u>	0	7	22.2	52	22.2
<u>Strophitus rugosus</u>	20	5	86.9	277	83.6
<u>Anodonta grandis</u>	25	12	73.0	174	64.0
<u>Lampsilis siliquoidea</u>	10.5	19	54.2	106	48.8

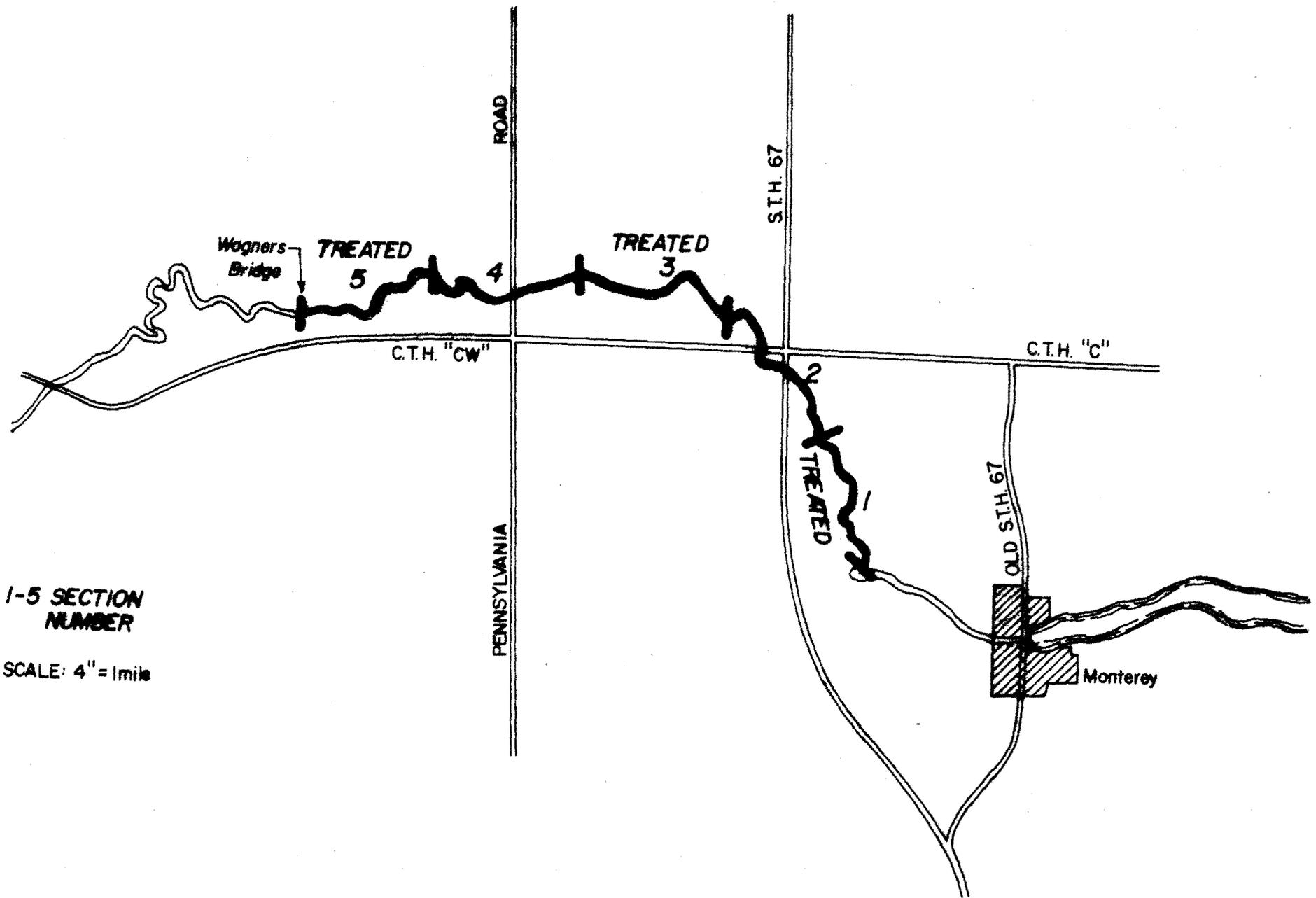
*Means pooled over all concentrations.

TABLE 4. Duncan's Multiple Range Test. (Any two species not underscored by the same line have significantly different mortalities at the 5% level.)

A. costata F. flava L. complanata L. siliquoidea A. grandis S. rugosus

TABLE 5. Numbers of dead mussels from the six most common species found in the three treated sections in the Ashippun River following antimycin treatment.

	Weeks after treatment								
	1	2	3	4	5	6	7	8	9
<u>Amblema costata</u>	0	1	0	0	1	1	1	0	0
<u>Fusconaia flava</u>	0	6	8	11	20	7	4	2	2
<u>Lasmigona complanata</u>	0	6	9	6	15	5	2	9	0
<u>Strophitus rugosus</u>	5	46	69	41	61	36	7	7	5
<u>Anodonta grandis</u>	4	54	25	20	39	20	11	0	1
<u>Lampsilis siliquoidea</u>	67	18	5	4	5	3	3	0	1



1-5 SECTION NUMBER

SCALE: 4" = 1 mile

Figure 2. Numbers of dead *F. flava* and *L. complanata* found in treated sections of the Ashippun after treatment.

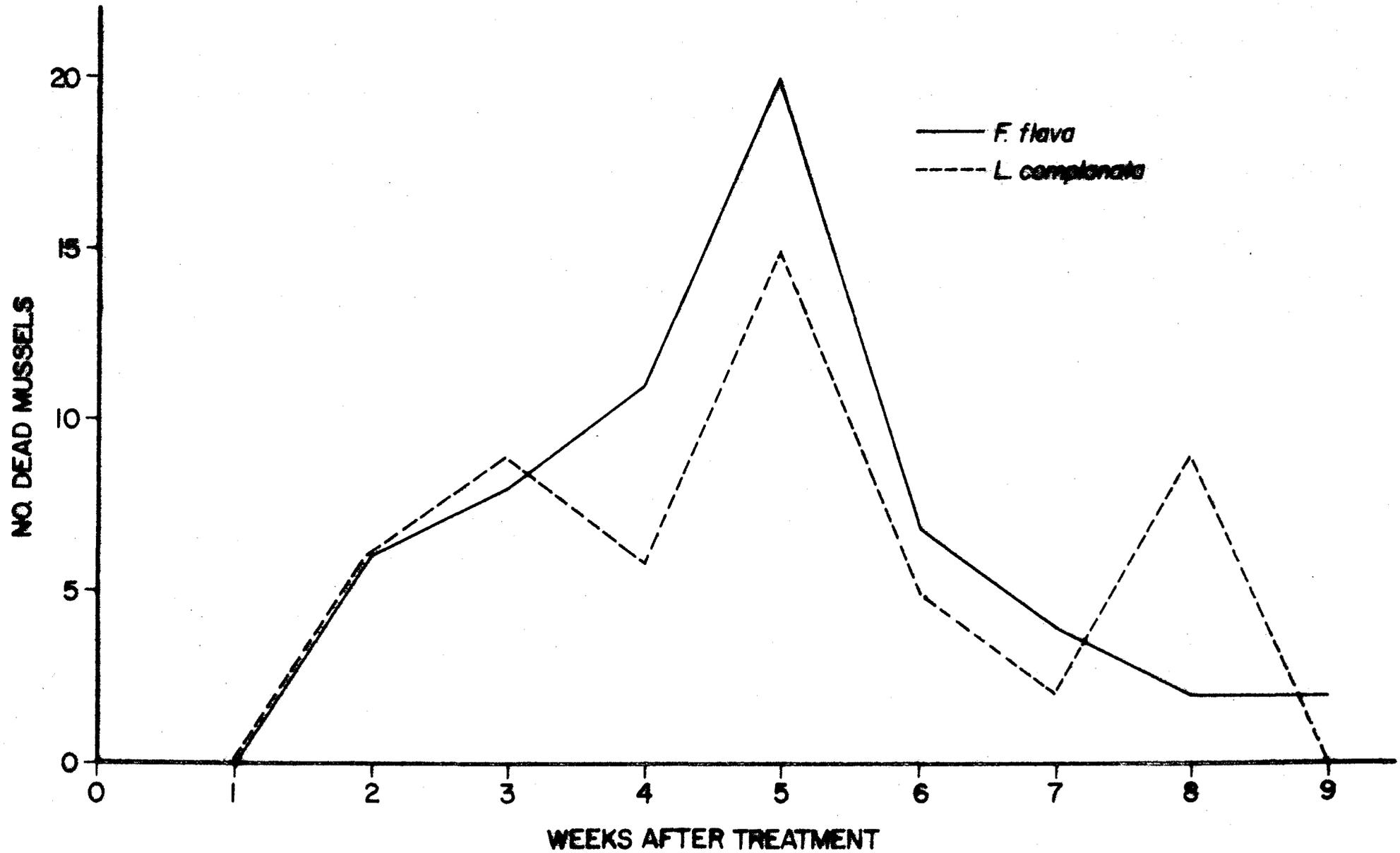
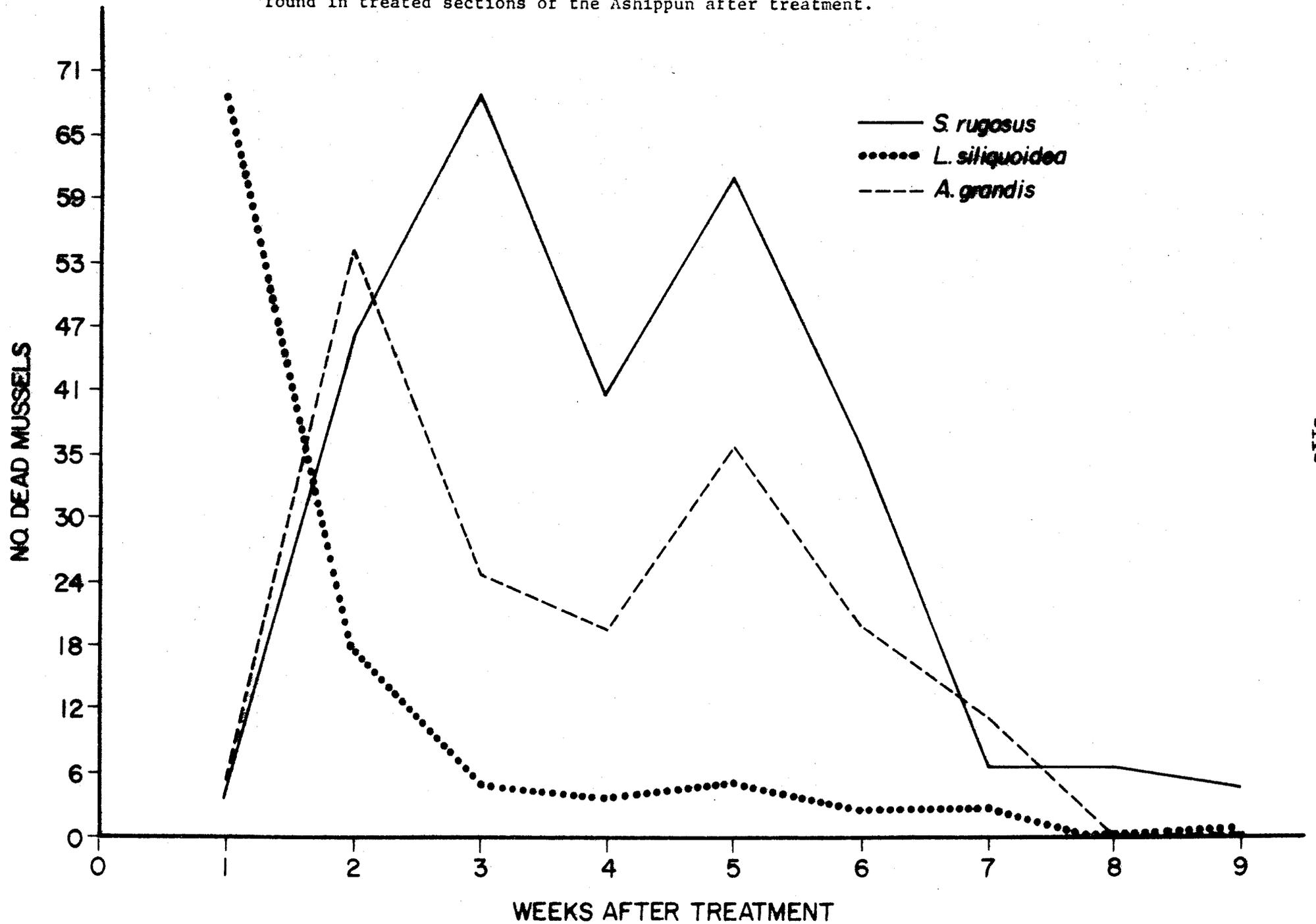


Figure 3. Numbers of dead *S. rugosus*, *A. grandis* and *L. siliquoidea* found in treated sections of the Ashippun after treatment.



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