

A COMPARISON OF GRAZING BETWEEN AN UNSHADED AND SHADED AREA
OF A STREAM

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ABSTRACT

The grazing of periphyton was compared between an unshaded area and an artificially shaded area in a northern Wisconsin stream, Tenderfoot Creek, located on the University of Notre Dame Environmental Research Center. Elevated artificial substrate tiles were compared to tiles on the stream bed.

Periphyton was exploited and was a limiting resource in the stream. Grazing increased diversity in the unshaded area by reducing the dominance of Tabellaria. Diversity decreased in the shaded area, causing the dominance of Cocconeis.

Baetis, Tricorythodes, Chironomidae, and Hydropsychidae were attracted to the unshaded tiles, while Stenacron was evenly distributed between the shaded and unshaded tiles. Stenacron was also the only species that was more numerous on the low tiles rather than the elevated tiles.

INTRODUCTION

Not many grazing experiments in natural streams have been conducted, possibly because it is difficult to exclude grazers that participate extensively in stream drift. Lamberti and Resh (1983) excluded the caddisfly Helicopsyche borealis, which is too heavy to be transported by stream drift. McAuliffe (1985) surrounded a substrate brick with a petroleum jelly "fence," because Glossosoma climb onto a stone surface after molting.

Studies have shown that grazing can greatly effect the periphyton density. In artificial streams, grazing by the snail Juga plicifera decreased biomass by thirty percent (Sumner and McIntire 1982). Lamberti and Resh (1983) and McAuliffe (1983) found grazing to exploit perphyton levels.

Grazing has been shown to prevent algal succession. Lamberti and Resh (1983), and Gregory (1980), demonstrated that grazed substrate remained a monolayer of diatoms, while on ungrazed substrate the diatoms were replaced by filamentous green algae. Eichenberger and Schlatter (1978) found that grazing prevented the succession from a mixture of filamentous green algae and diatoms to blue-green algae.

Some researchers have shown that certain morphologies of periphyton are grazed more readily, but not all research supports this view. Sumner and McIntire (1982) found the amount of the filamentous diatom Melosira varians to be 3.4 times more abundant in a ungrazed section, but Gregory (1983) suggests filamentous algae are frequently not

consumed by grazers. The small, closely adherent diatom Cocconeis has been found to be resistant to grazing (Patrick 1970; Hunter 1980; Kesler 1981; Moore 1977; Mecom and Cummins 1964), and to be heavily grazed (Brown 1961; Dickman and Gochbauer 1978).

Most experiments of the effect of grazing on periphyton have been in unshaded areas; few studies have addressed whether the effect is similar in a shaded area. Sumner and McIntire (1982) found that grazing in a lighted artificial stream increased algal diversity, while grazing in a stream with low light decreased algal diversity. Grazing in the lighted stream decreased the dominance of the pennate diatom Nitzschia linearis. In shade the lower periphyton amount was quickly depleted and N. amphibia, resistant to grazing, became dominant. However, N. amphibia was also found to be adapted to shade, as it also eventually dominated the ungrazed shaded control.

Shading may also effect grazer distribution. The densities of Baetis and other grazers were much lower in stream sections that flowed through forested areas (Thorup 1964). Grazers also colonize substrates with higher periphyton densities more rapidly (McAuliffe, 1983). The drift rate of Baetis rhodani increased as the mass of periphyton decreased (Bohle, 1978). However, Towns (1981) reported artificial shading in a stream had no effect on macroinvertebrate distribution.

The purpose of this experiment was to compare between

an unshaded and a shaded area : 1) the effect of grazing on periphyton, and 2) macroinvertebrate distribution.

MATERIALS AND METHODS

Experimental Design

Unglazed ceramic tiles 15x15 cm. were soaked in stream water one week prior to the experiment and used as artificial substrate.

A row of elevated tiles and a row of stream bed tiles were placed in an unshaded area of the stream. Similarly, another set of elevated and stream bed tiles were artificially shaded with a cloth that excluded about ninety-percent of the light.

The elevated tiles were supported by a two-inch grid wire mesh which was fastened to steel poles with electric fence insulators, which could be lowered with the stream level. The wire mesh formed a loose lip over the tile which prevented loss of the tile but allowed removal without disrupting the tile surface.

The experiment began June 1, 1990. Two randomly chosen tiles from each variable were sampled on June 12 (eleven days), June 25 (twenty-four days), and July 9 (thirty-eight days).

Insect Sampling

After lifting the tile carefully from the water the larger insects were removed with tweezers. The tile was swirled in a white enamel pan with tap water so the remaining insects could be removed from the pan with an eye dropper. No distinction was made between the bottom and top

of the tile. The insects were preserved in eighty percent ethanol and identified with keys by Hilsenhoff (Number 2), Wiggins (1977), and Edmunds et. al. (1976).

Algae Identification

The algae on one-quarter (56.25 square cm.) of the tile was removed with a razor blade. The algae was diluted to ten milliliters and preserved by adding fifty microliters of gluteraldehyde. Three out of fifty passes were counted on a slide which contained one milliliter. The count obtained from three passes is equal to the count per 33.75 square mm. The averaged numbers obtained from the two replicates were used in the graphs and tables. The algae were identified with books by Prescott (1978), and Dodd (1987).

Chlorophyll-a Measurement

The algae on one-quarter (56.25 square cm.) of the tile was scraped using a razor blade into a film canister, which is impermeable to light. Measurements were calculated in micrograms per square centimeter with a fluorometer according to Mackey (1990).

Biomass Measurement

The algae on one-half (112.5 square cm.) of the tile was removed with a razor blade, suction filtered to remove excess moisture, air dried for seventy-two hours, and weighed. The filter paper weight of 0.13 grams was subtracted.

RESULTS

The Effect of Grazing on Periphyton

Grazing quickly effected the standing crop of periphyton. Although an ungrazed control could not be achieved due to the high number of grazers participating in stream drift, a relatively small amount of grazing occurred on the elevated tiles during the first eleven days (Figure 1). In the unshaded area, the chlorophyll-a content on the low tiles was thirteen percent of the amount on the elevated tiles. Similarly, grazing decreased chlorophyll-a in the shaded area to seventeen percent.

A difference in the effect of grazing was seen throughout the experiment between the unshaded and shaded areas (Figure 2). The unshaded tiles contained a high amount of algae at eleven days, which decreased dramatically by twenty-four days, and somewhat more by thirty-eight days. The shaded tiles originally contained less algae, which decreased to almost nothing by twenty-four days, and underwent a dramatic increase by thirty-eight days.

Grazing effected the genus composition of the algae in the unshaded and shaded areas. Grazing increased diversity on the unshaded tiles, but decreased diversity on the shaded tiles. In the unshaded area, at eleven days Tabellaria is highly dominant (Fig. 3); diversity has increased by twenty-four days (Fig. 4), and continued to increase at thirty-eight days (Fig. 5). The percent composition of Cocconeis increases as Tabellaria decreases (Table I).

Although not as dominant as in the unshaded area, Tabellaria is also dominant in the shaded area at eleven days (Fig. 6). At twenty-four days, no species is dominant as grazing has eliminated almost all algae (Fig. 7). At thirty-eight days, diversity has decreased as Cocconeis exists in high amounts and is almost the only genera present (Figure 8). Cocconeis increases as Tabellaria decreases to a greater extent than in the unshaded area (Table II).

A filamentous green growth was visible with the naked eye on the unshaded elevated tiles at eleven days. As grazing increased, the filamentous green algae decreased (Fig. 9), and the growth on the tiles appeared thin and brown with patches of filamentous green growth. Almost no filamentous green algae grew on the shaded tiles.

More grazing occurred on the stream bed tiles at eleven days, and the elevated tiles at twenty-four and thirty-eight days, as shown by the amount of periphyton present besides the resistant genera Cocconeis (Fig. 10).

At eleven days, at which there was the greatest amount of algae, chlorophyll-a values were significantly correlated to counted periphyton. At twenty-four days the correlation was not significant, but chlorophyll-a and the counted values showed the same trends. At thirty-eight days, at which there was the least amount of periphyton, the chlorophyll-a values varied greatly and did not show the same trends as the periphyton counted (Table III).

The biomass values obtained were too low to give

information about the amount of periphyton present. The filter paper that held the algae weighed 0.13 grams, and the average biomass of the periphyton was 0.32 grams (Table III).

Macroinvertebrate Distribution

A greater number of Baetis, Tricorythodes, Hydropsychidae, and Chironomidae were found on the unshaded tiles. Stenacron was the only insect evenly distributed between the shaded and unshaded area (Fig. 11).

Baetis, Tricorythodes, Hydropsychidae, and Chironomidae were also more numerous on the elevated tiles, while Stenacron was more numerous on the stream bed tiles (Fig. 12).

Discussion

The Effect of Grazing on Periphyton

The great effect of grazing suggests that this stream is overgrazed and periphyton is a limiting resource. The reduction of chlorophyll-a on the unshaded, heavily grazed stream bed tiles to thirteen percent after eleven days is tremendous, and the reduction would have been measured as more if grazers had been excluded from the elevated tiles. Periphyton levels remain depressed throughout the study. Lamberti and Resh (1983), Sumner and McIntire (1982), and McAuliffe (1983) also showed a tremendous effect of grazing in streams.

Grazing increased diversity in the unshaded area by decreasing the dominance of the easily grazed periphyton. Diversity decreased in the shaded area by grazing of the periphyton to depletion and allowing the proliferation of a grazing resistant species. as also found by Sumner and McIntire (1982).

Grazers have a low degree of food selectivity and graze the periphyton easiest for the mouthparts to obtain (Lamberti and Moore, 1984). Filamentous diatoms extend from the surface; Sumner and McIntire (1982) reported the filamentous diatom Melosira varians was 3.4 times more abundant in ungrazed sections. Pennate diatoms are large and may grow epiphytically, as noted of Synedra ulna. Sumner and McIntire also found the pennate diatoms Synedra ulna, Nitzschia palea, Surirella angustata, and Nitzschia

linearis to be 3.0, 1.8, 1.7, and 1.2 times more abundant in ungrazed sections, respectively.

Cocconeis, on the other hand, is small, ovoid, and firmly attached to the surface (Moore, 1975). Many studies have found Cocconeis resistant to grazing (Patrick 1970; Hunter 1980; Kesler 1981; Moore 1977; Mecom and Cummins 1964). Cocconeis does not exist at high numbers at eleven and twenty-four days because it is probably inhibited by the pennate and filamentous periphyton. Periphyton that extends from the surface has better access to nutrients and can shade the surface (Sumner and McIntire, 1982). Only after the pennate and filamentous periphyton has been severely repressed at thirty-eight days can Cocconeis exist at high numbers.

In the unshaded area Tabellaria decreases in dominance but is not eliminated at thirty-eight days on the stream bed tiles. On the elevated tiles, which experience more grazing, Tabellaria has been eliminated and Cocconeis is increasing. As the periphyton continuously decreases, Cocconeis may also become dominant in the unshaded area.

On the shaded tiles, less periphyton can grow; thus the periphyton is almost eliminated by twenty-four days, and by thirty-eight days Cocconeis is present in high numbers. The greater amount of Cocconeis on the elevated tiles is probably due to the heavier grazing pressure on the elevated tiles which eliminated the grazed algae sooner and allowed Cocconeis more time to proliferate.

On the elevated tiles of eleven days, which were not highly grazed, it could be seen under the microscope that pennate diatoms were attached to the filamentous green Ulothrix and the filamentous diatom Melosira. Sumner and McIntire (1982) also found Melosira to be an important structural component on ungrazed tiles to which pennate diatoms were attached.

The filamentous green algae decreased as grazing increased, which is similar to the experiment of Lamberti and Resh (1983) which reported that ungrazed tiles grew filamentous green algae. The grazed tiles contained a mixture of green algae and diatoms, which was also reported by Eichenberger and Schlatter (1978).

Filamentous green algae was almost never found in the shaded area. Sumner and McIntire (1982) suggested that in unshaded areas so much algal growth occurs the substrate area becomes nutrient deficient. Filamentous algae therefore have an advantage as they can extend from the substrate to reach nutrients. In shading, nutrients are not depleted, and filamentous algae do not have an advantage.

Macroinvertebrate Distribution

A number of functional feeding groups are possible for the insects. Baetis, Stenacron, and Tricorythodes, can be either scrapers or collector-gatherers (Edmunds, Jensen, and Berner 1976). Chironomidae can be scrapers, collector-gatherers, or filter-feeders, and Hydropsychidae are filter-feeders (Merritt and Cummins 1984).

Baetis, Tricorythodes, and Chironomidae are probably more numerous on the unshaded tiles because the species are grazers in this stream and are attracted to the periphyton. Baetis and other grazers have been experimentally shown to colonize substrates with higher periphyton densities more rapidly (McAuliffe 1983). Thorup (1964) found densities of Baetis rhodani to be high in unshaded regions of a stream but dramatically lower in shaded regions. Although the Chironomidae found are probably not all grazers, a high number of them probably are since they were attracted to the unshaded area. Eichenberger and Schlatter (1978) found that Chironomidae effected the amount of periphyton in an artificial stream.

Stenacron, on the other hand, is distributed randomly between the unshaded and shaded areas, which indicates it is not grazing. It is possible that Baetis is exploiting the periphyton resource and preventing Stenacron from grazing. McAuliffe (1983) states that in order for exploitation to occur, organisms must depress the abundance of a renewable resource, which is occurring to the periphyton at Tenderfoot Creek.

The exploitation of the periphyton by Baetis, Tricorythodes, and Chironomidae, most of which collected were young instars less than two millimeters, emphasizes the importance of small organisms in effecting periphyton density.

A significant correlation was not found between number

of grazers and periphyton density because periphyton was being grazed to exploitation, and because of emergence of organisms.

Hydropsychidae were probably attracted to the greater amount of periphyton on the unshaded tiles to anchor their nets. The artificial substrate used was smoother than stream rocks because the stream rocks have undergone micro-erosion by bombardment with sediment particles. Oswood (1979) and McAuliffe (1983) found more Hydropsychidae on moss-covered rock.

A greater number of Baetis, Tricorythodes, Hydropsychidae, and Chironomidae were found on the elevated tiles, which indicates these organisms participate extensively in stream drift. Baetis is commonly a significant portion of stream drift (Edmunds, Jensen, and Berner 1976). Stenacron was found in greater numbers on the stream bed tiles, which is expected because its dorso-ventrally compressed body is an adaptation for living on the stream bed.

The grazing on the elevated tiles was low at eleven days, after which the amount of grazing on the elevated tiles exceeded the grazing on the stream bed tiles. Stream drift carried more grazers after June 12.

Suggested Improvements

To collect macroinvertebrates, after swirling the tile in the enamel with tap water, pour the water into a sieve, constructed with a funnel and fine mesh.

Sample the natural substrate with each collection, to see the effect of grazing that has progressed throughout the season.

Acknowledgements

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FIGURE LEGEND

- Figure 1. Grazing on the stream bed tiles dramatically reduced the periphyton level in eleven days.
- Figure 2. On the unshaded tiles, the periphyton quickly dropped to a low level and then gradually subsided. On the shaded tiles, the original amount of periphyton was less and after being reduced to near depletion the amount increased.
- Figure 3. The genera graphed are Tabellaria, Synedra, Nitzschia, Pinnularia, Cymbella, Cocconeis, Fragilaria, Melosira, Ulothrix, Scenedesmus, and others. On the unshaded tiles at eleven days Tabellaria is highly dominant; diversity is low.
- Figure 4. Unshaded, 24 days: Tabellaria is less dominant; diversity is increasing.
- Figure 5. Unshaded, 38 days: Tabellaria is barely dominant and Cocconeis amount has increased; diversity has continued to increase.
- Figure 6. Shaded, 11 days: Tabellaria is dominant.
- Figure 7. Shaded, 24 days: No genera is dominant; periphyton amount is very low.
- Figure 8. Shaded, 38 days: Cocconeis has become more dominant than Tabellaria was at 11 days; diversity has decreased.
- Figure 9. Filamentous green periphyton decreases as grazing increases. The low number on the elevated tiles of 11 days is deceptive because the strands in this sample were at least twice as long.

Figure 10. The periphyton levels are indicative of the amount of grazing; more grazing first occurred on the elevated tiles, later on the stream bed tiles.

Figure 11. The numbers of insects found throughout the entire experiment on the unshaded and shaded tiles are graphed. Baetis, Chironomidae, Hydropsychidae, and Tricorythodes were more numerous on the unshaded tiles. Stenacron was evenly distributed.

Figure 12. The numbers of insects found throughout the entire experiment on the elevated and stream bed tiles are graphed. Baetis, Chironomidae, Hydropsychidae, and Tricorythodes were more numerous on the elevated tiles. Stenacron was more numerous on the stream bed tiles.

Figure 1

Chlorophyll-a (Eleven Days)

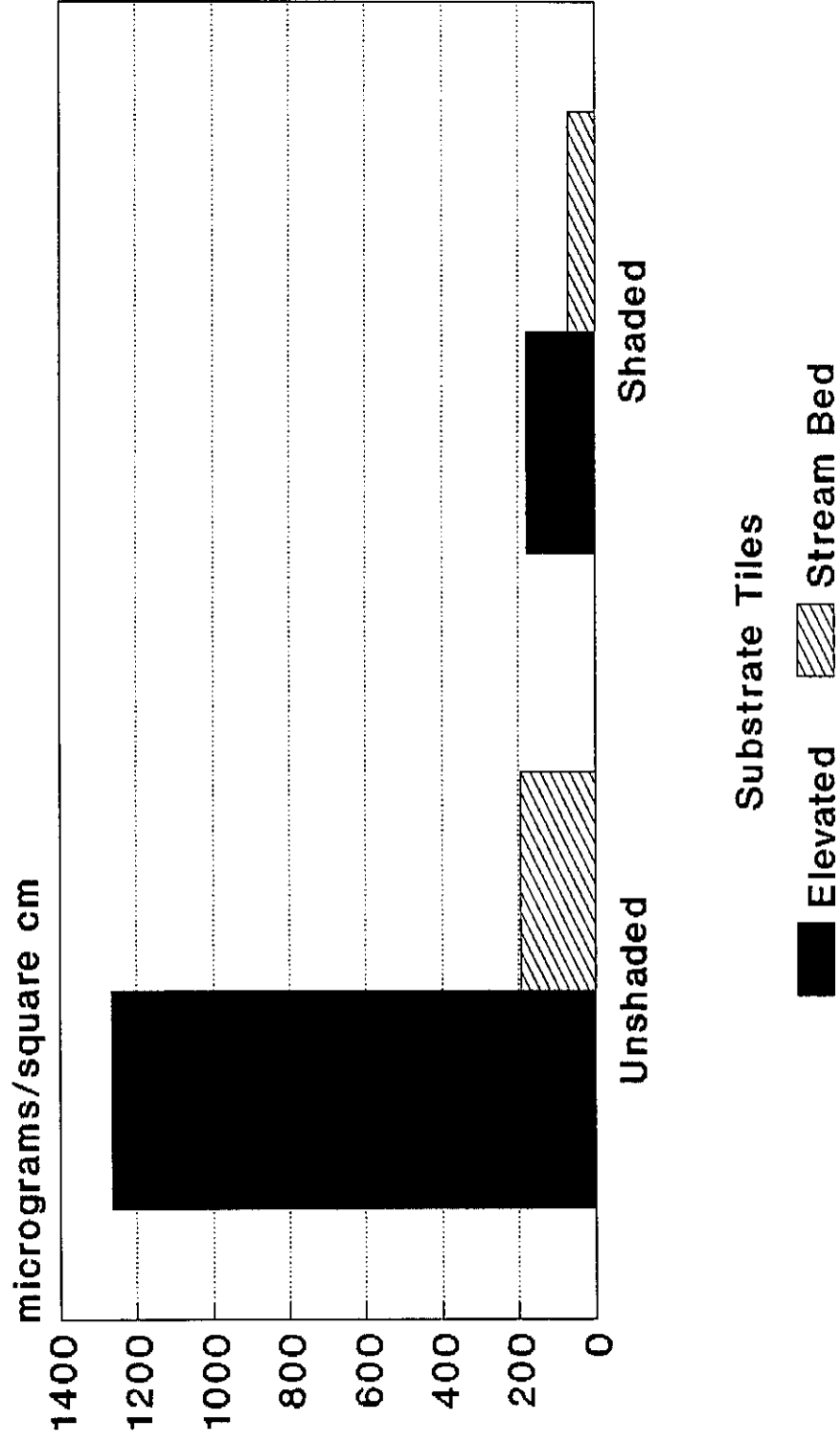


Figure 2

Total Periphyton

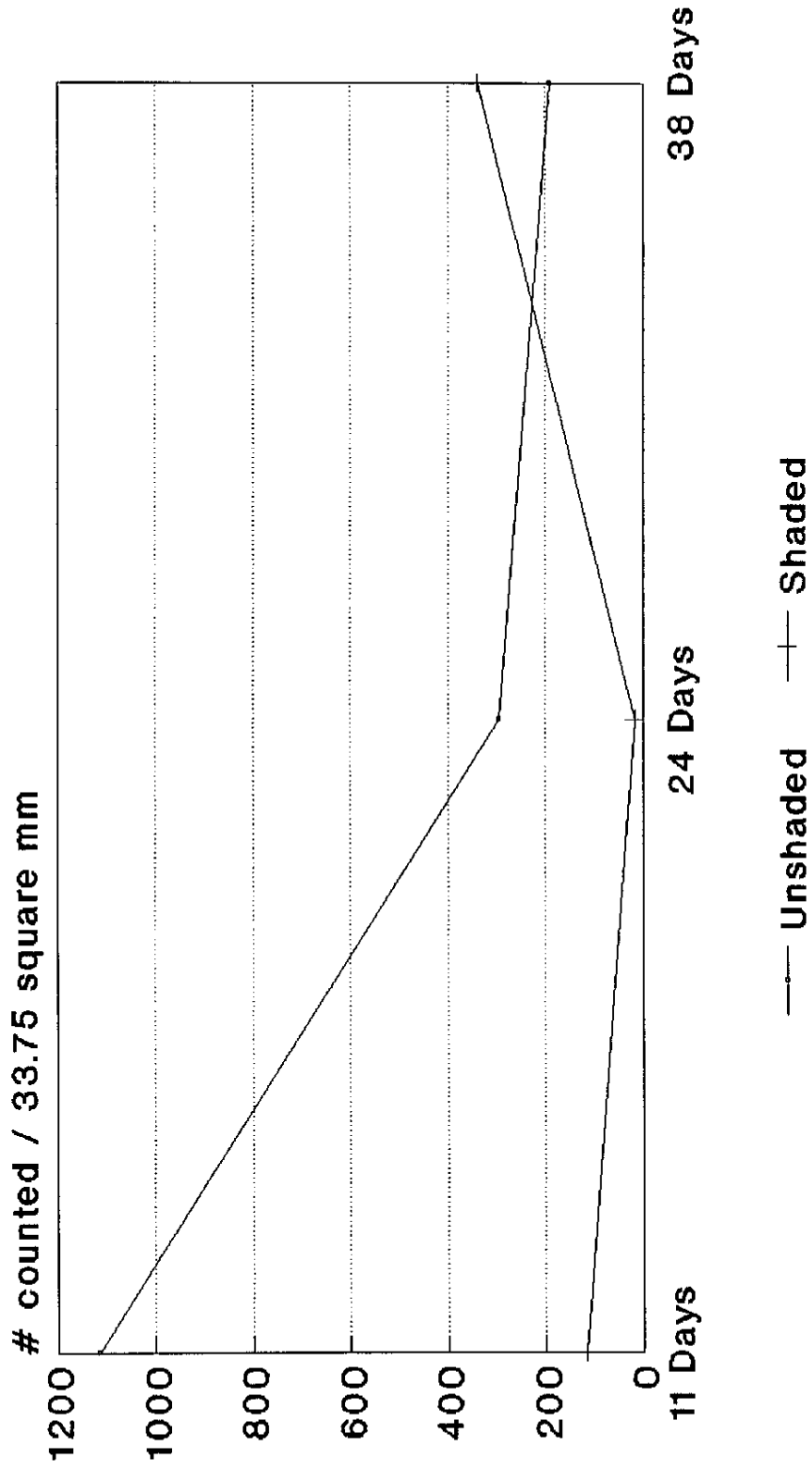


Figure 3

Eleven Days (Unshaded)

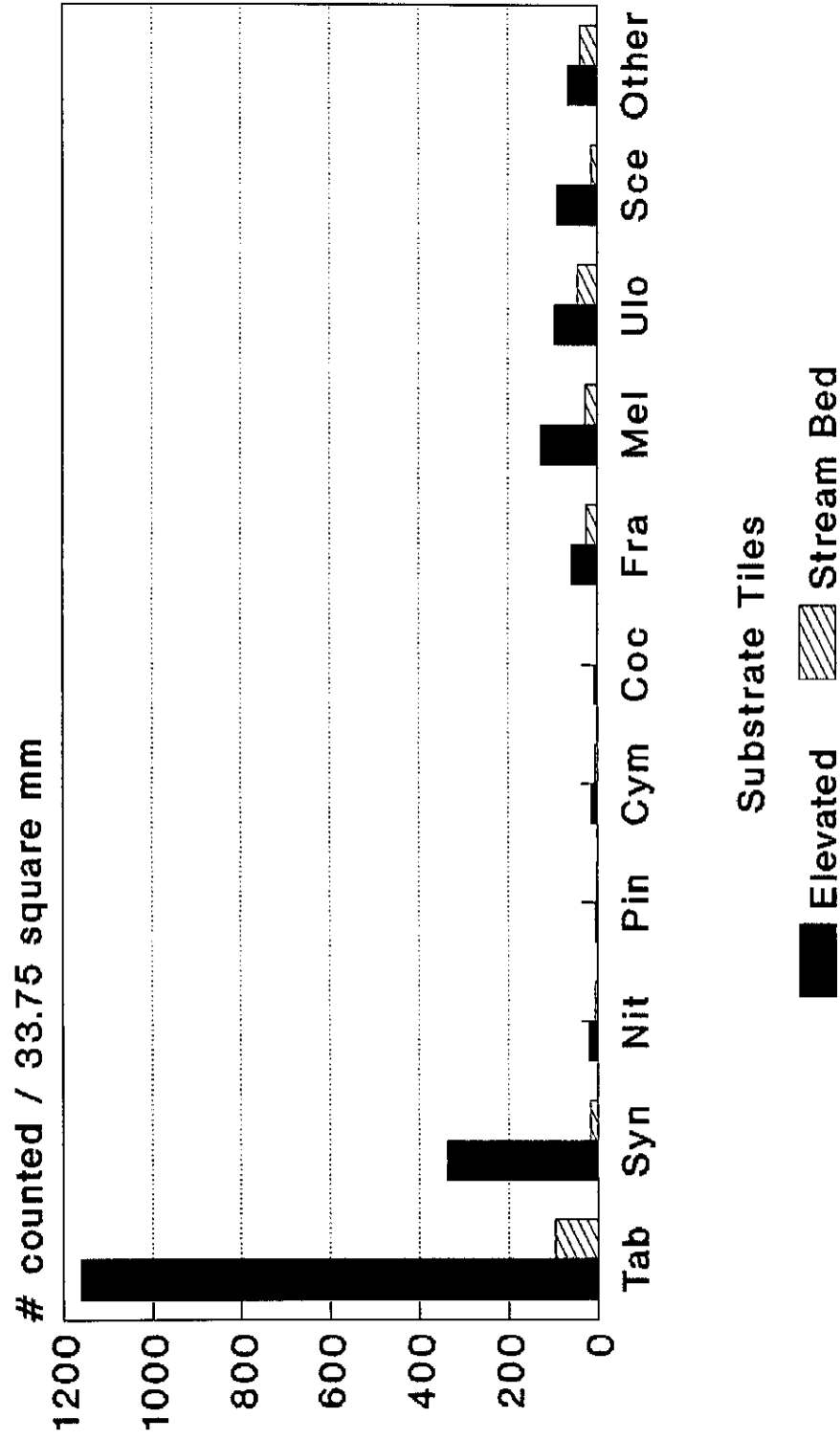


Figure 4

Twenty-four Days (Unshaded)

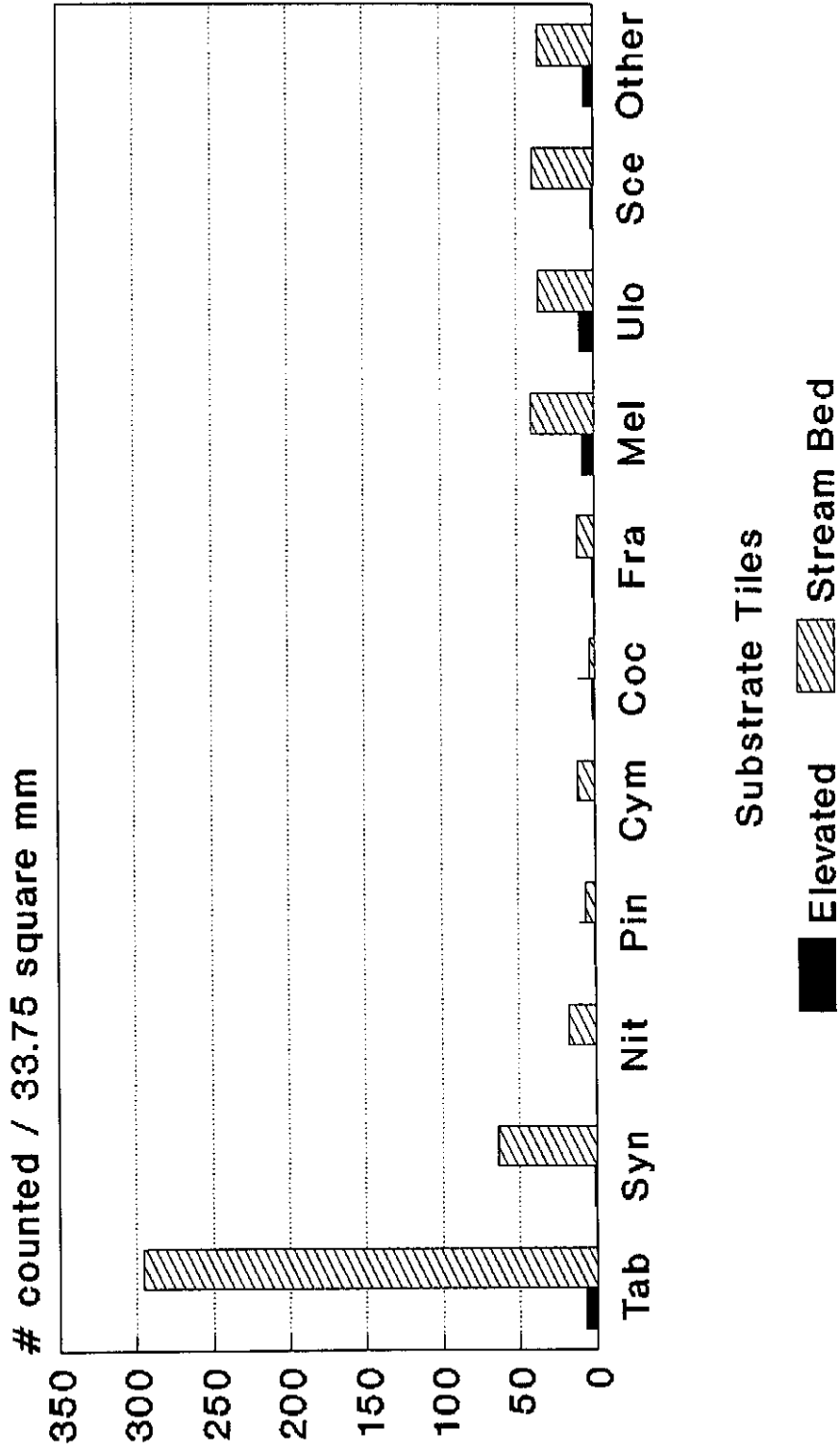


Figure 5

Thirty-eight Days (Unshaded)

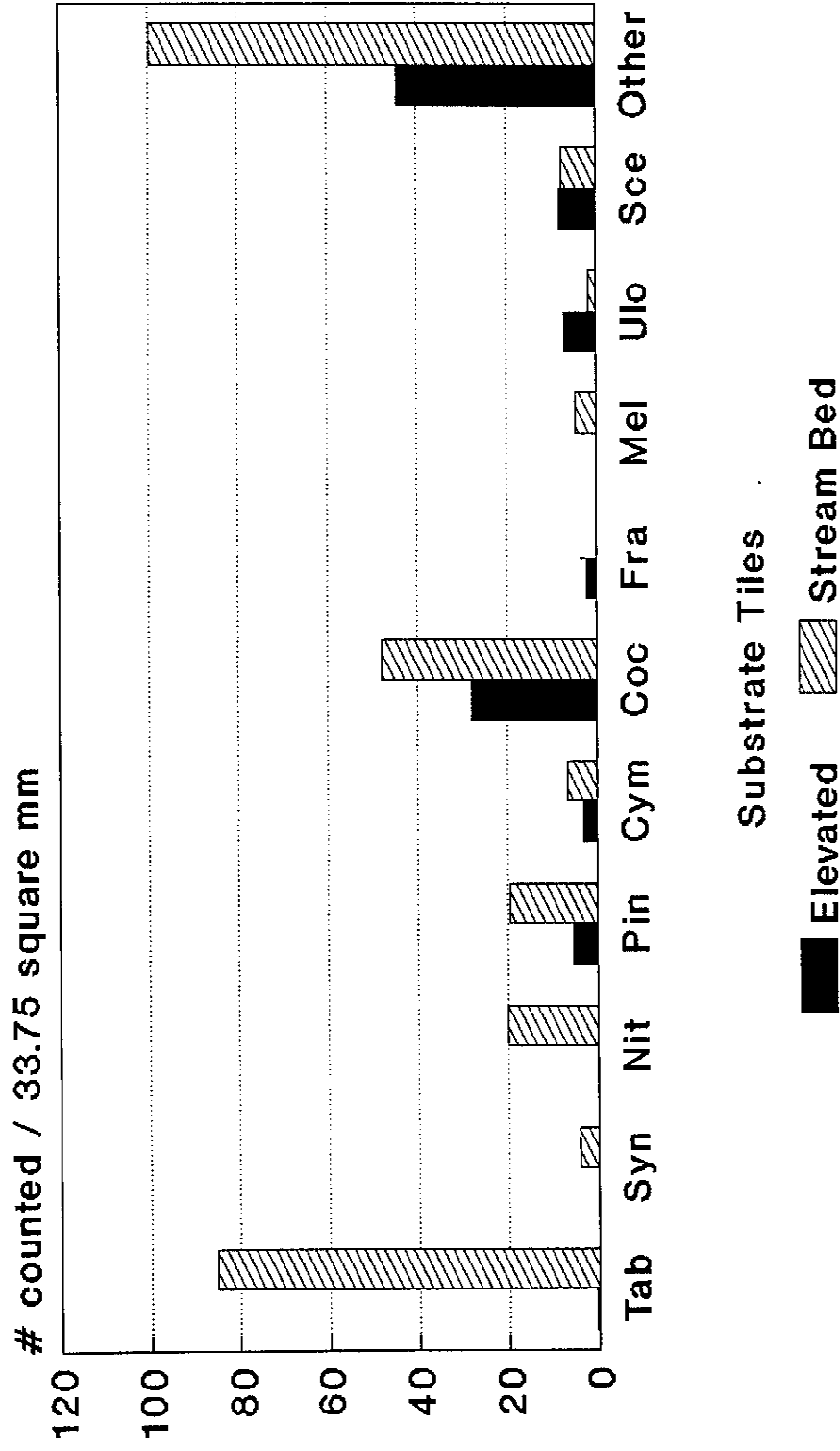


Figure 6

Eleven Days (Shaded)

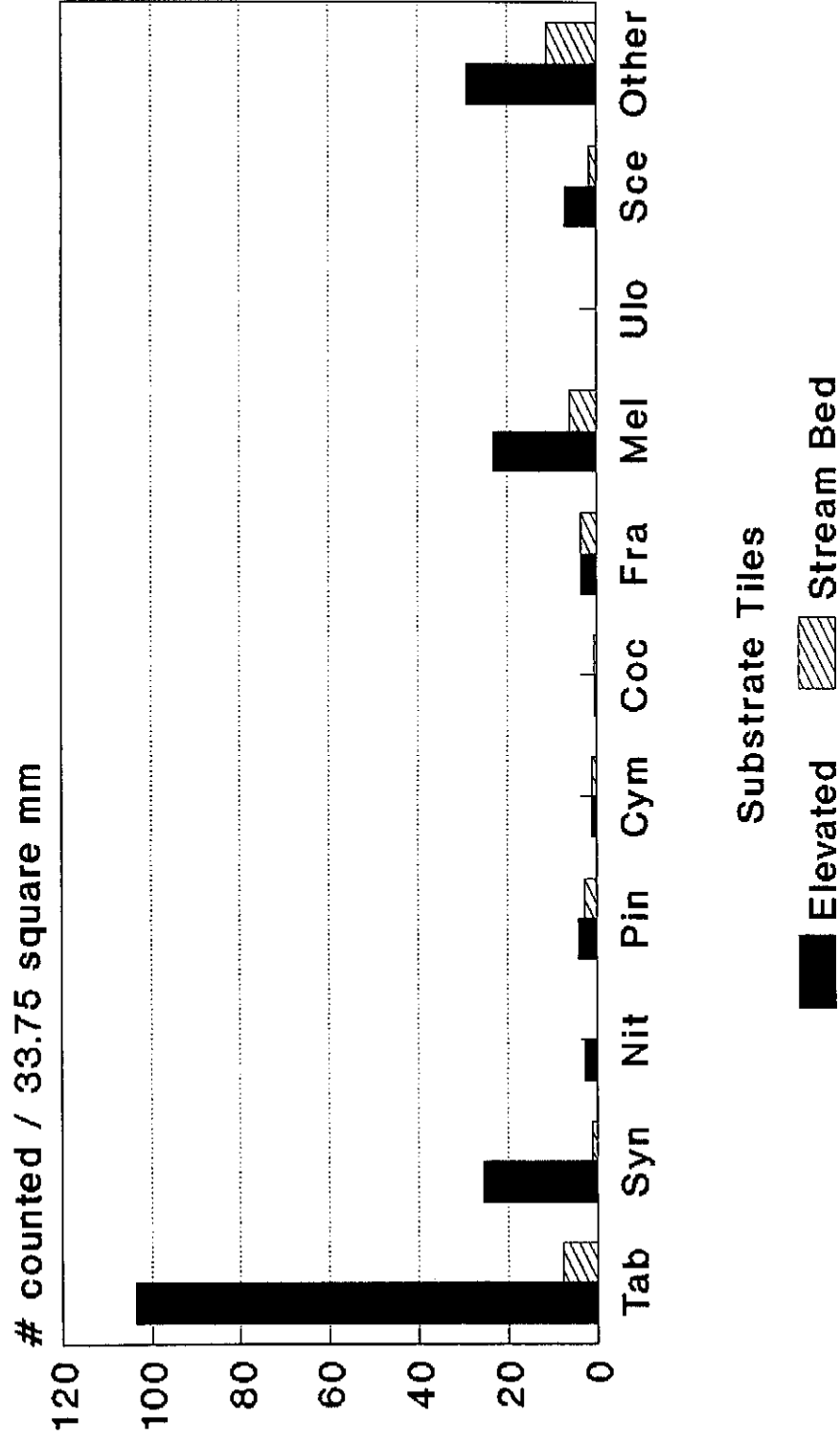


Figure 7

Twenty-four Days (Shaded)

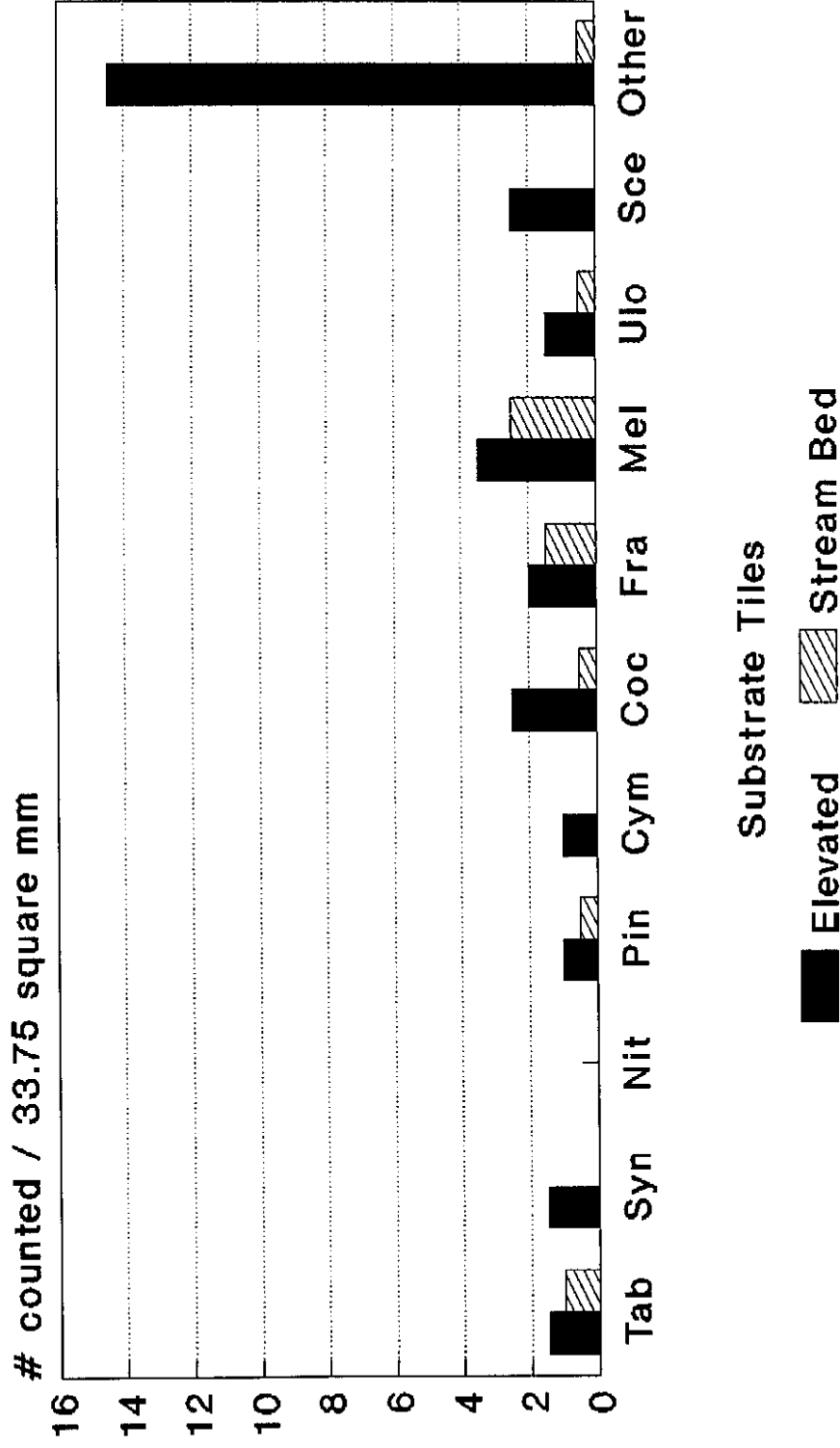


Figure 8

Thirty-eight Days (Shaded)

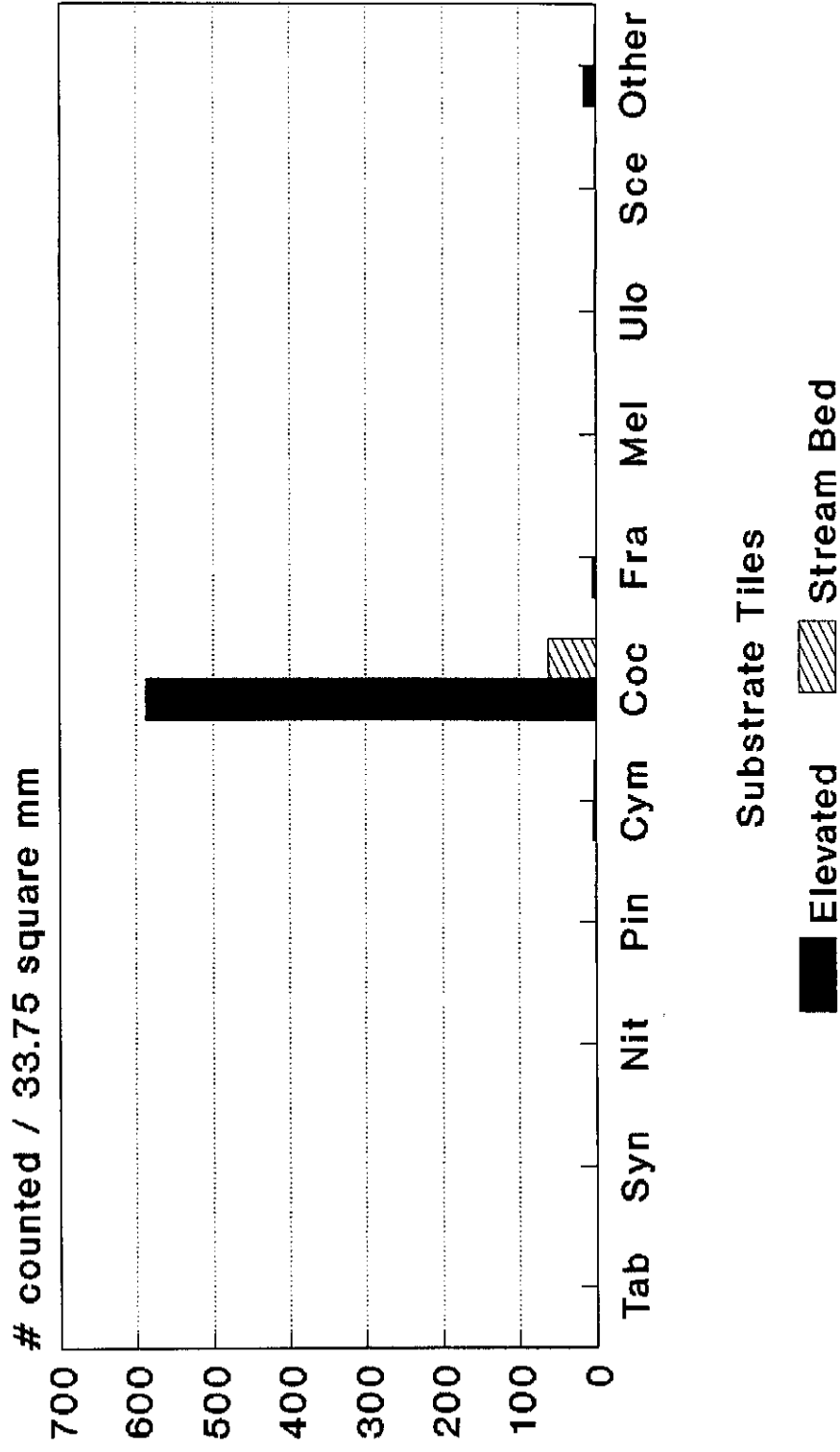


Figure 9

Filamentous Green Periphyton

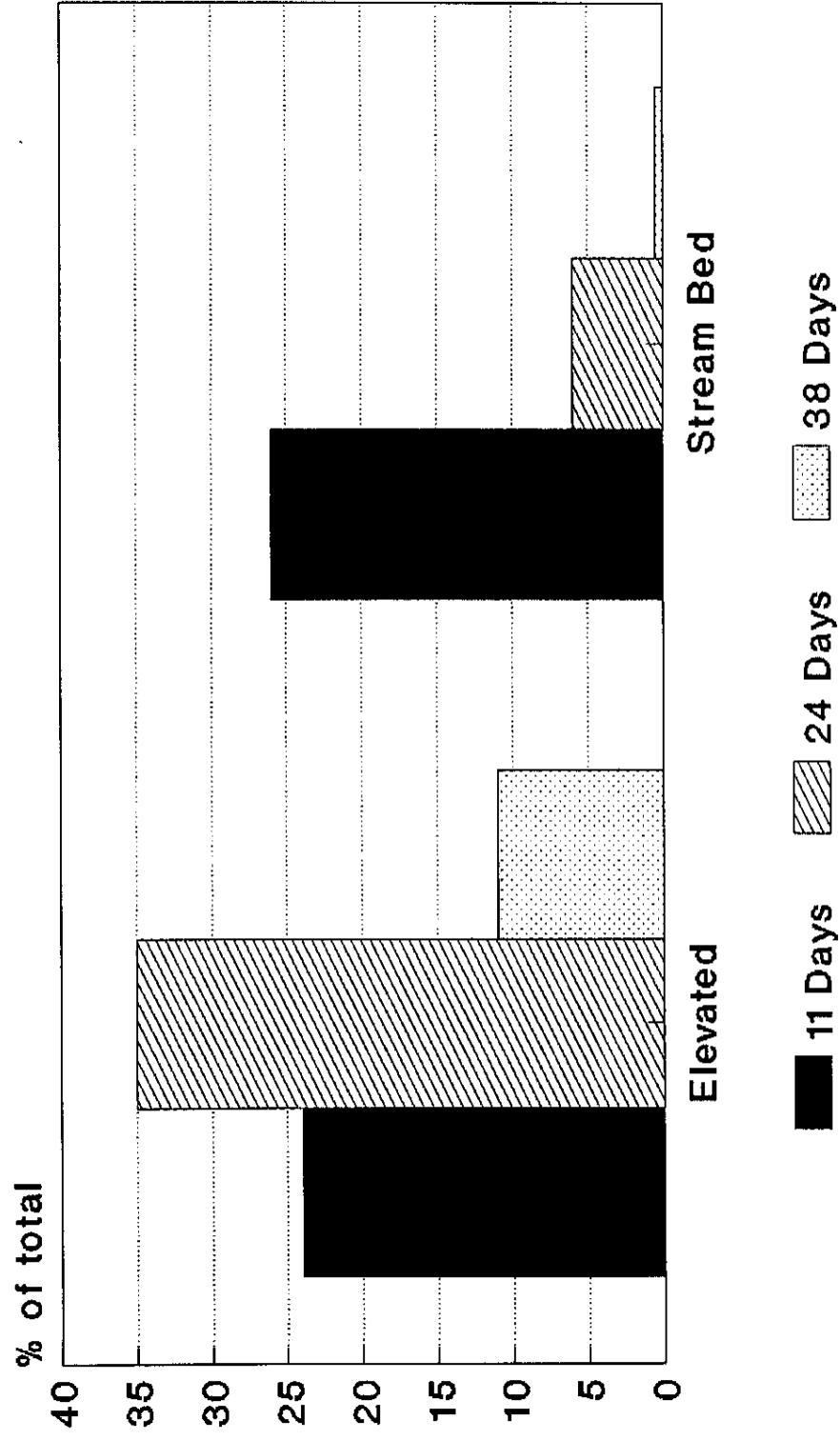


Figure 10

Periphyton other than Cocconeis

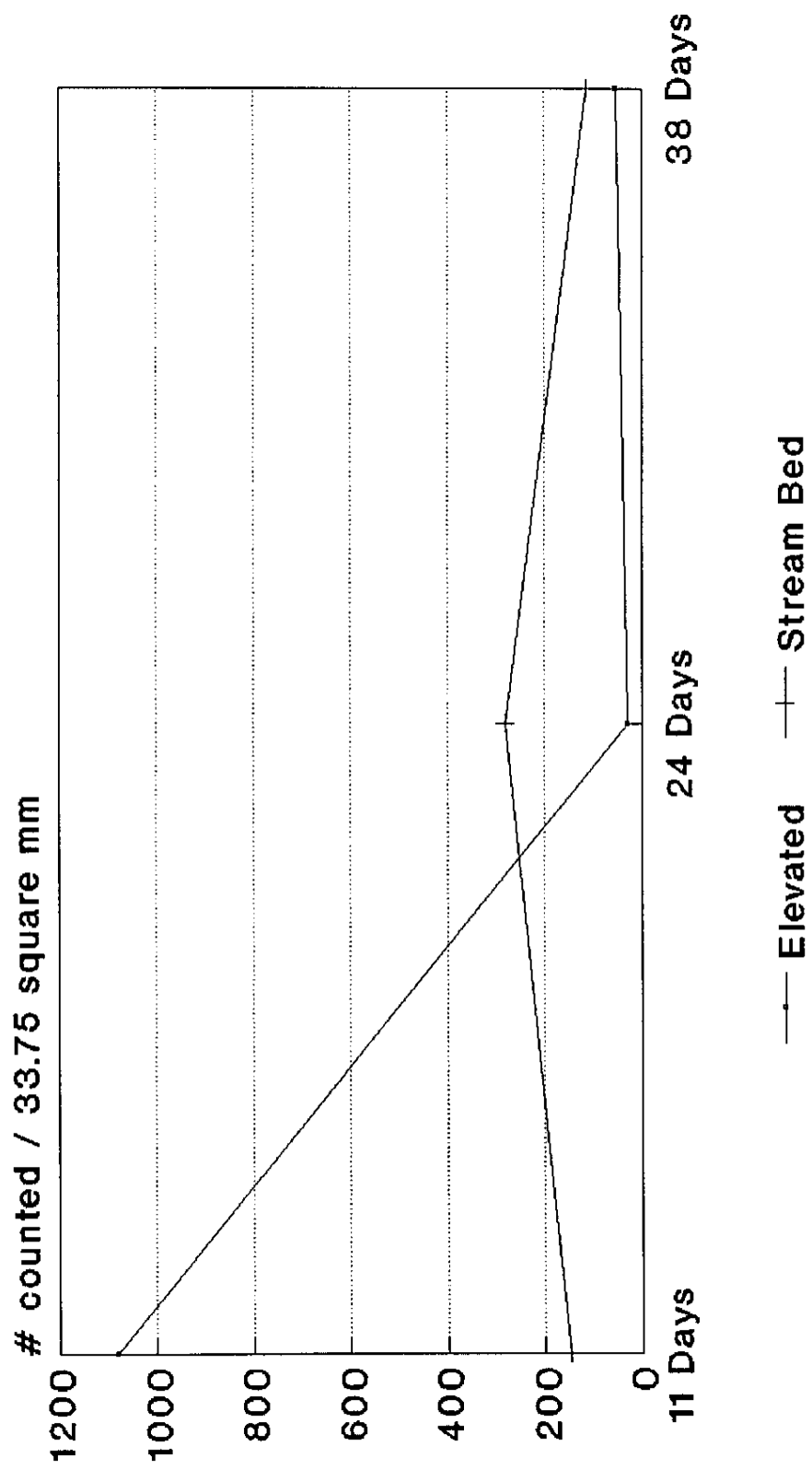


Figure 11
Insects (Unshaded / Shaded)

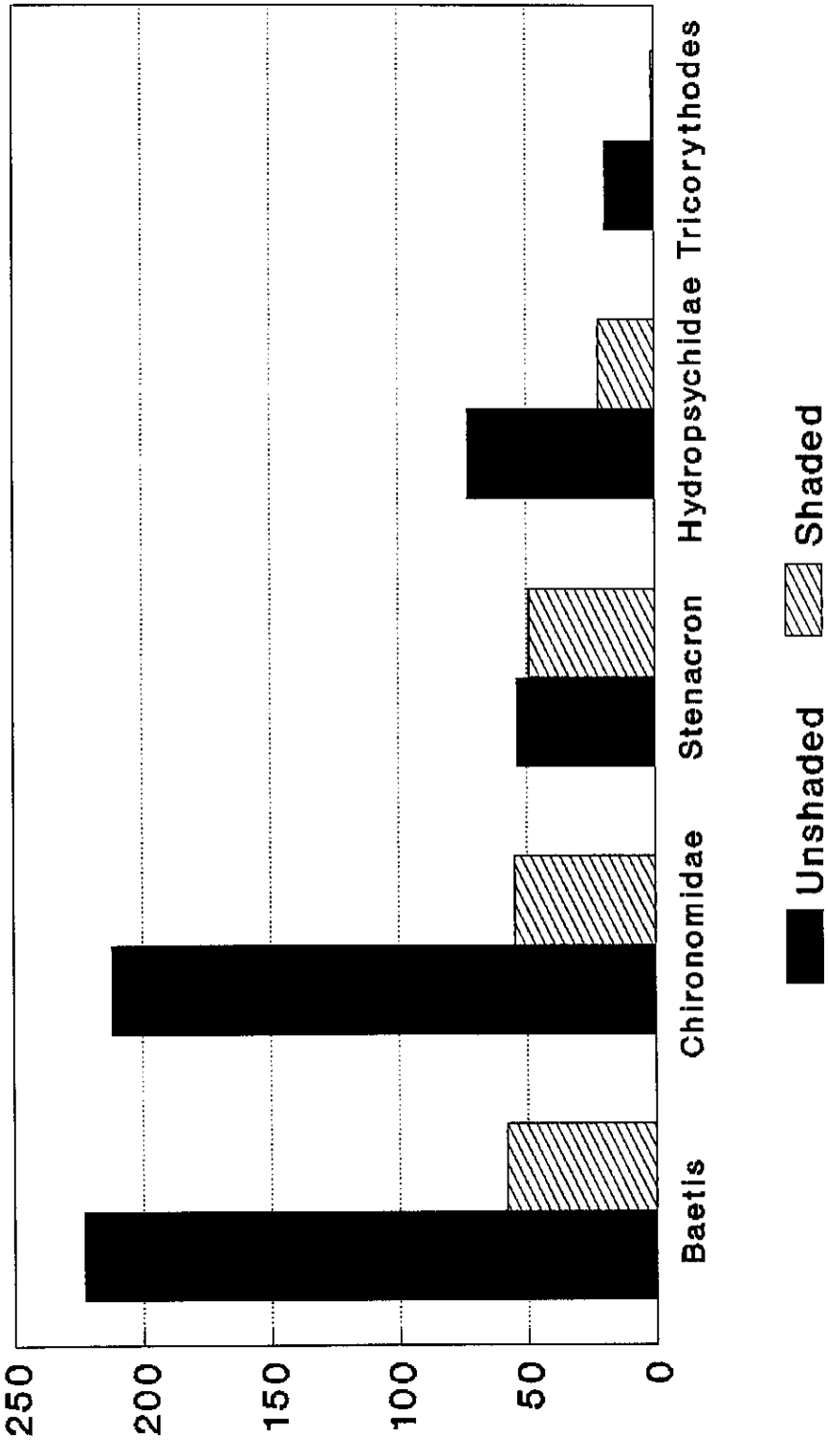


Figure 12

Insects (Elevated / Stream Bed)

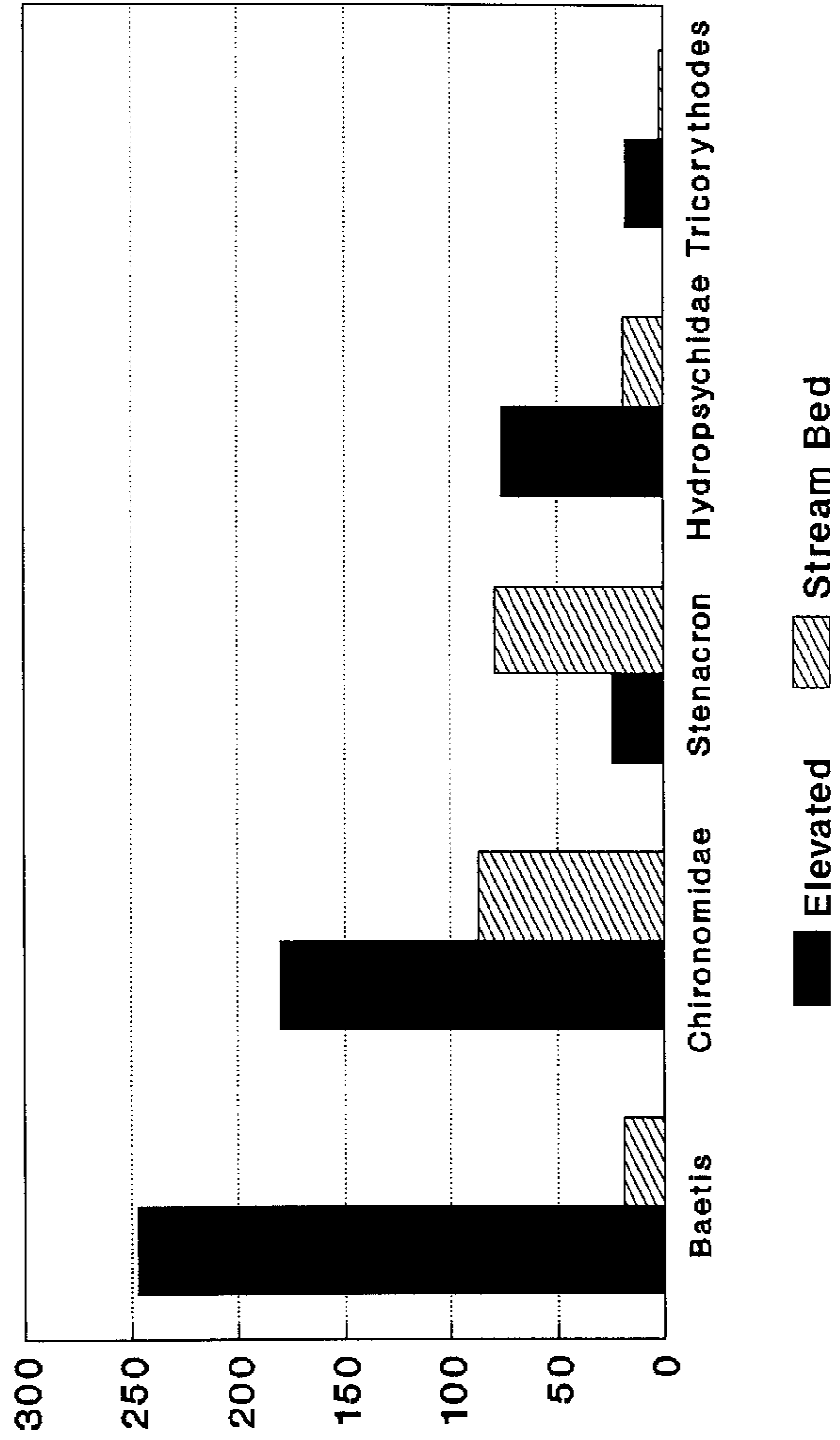


TABLE I

DOMINANT GENERA IN UNSHADED AREA

	<u>Algae</u> (33.75 square mm)	% <u>Tabellaria</u>	% <u>Cocconeis</u>
elevated, 11 d.	1968	59	1
stream bed, 24 d.	558	53	1
stream bed, 11 d.	262	36	-
elevated, 24 d.	34	19	3
stream bed, 38 d.	269	33	18
elevated, 38 d.	114	1	21

TABLE II

DOMINANT GENERA IN SHADED AREA

	<u>Algae</u> (33.75 square mm)	% <u>Tabellaria</u>	% <u>Cocconeis</u>
elevated, 11 d.	200	52	-
stream bed, 11 d.	35	22	1
stream bed, 24 d.	7	14	7
elevated, 24 d.	29	5	9
stream bed, 38 d.	67	-	93
elevated 38 d.	611	-	96

TABLE III
CHLOROPHYLL-A
 (micrograms / square cm)

	UNSHADED				SHADED			
	<u>elevated</u>		<u>stream bed</u>		<u>elevated</u>		<u>stream bed</u>	
11 days	2053	473	380	8	228	130	47	88
24 days	96	112	1690	130	140	77	310	38
38 days	888	575	124	187	213	11	41	148

TABLE IV
BIOMASS
 (grams)

	UNSHADED				SHADED			
	<u>elevated</u>		<u>stream bed</u>		<u>elevated</u>		<u>stream bed</u>	
11 days	1.11	0.08	1.33	0.41	0.03	0.17	0.14	0.01
24 days	0.05	0.02	1.14	1.61	0.03	0	0	0
38 days	0.07	0.13	0.10	0.30	0.01	0.01	0	0.27

TABLE V

PERIPHYTON (11 DAYS)
(33.75 square mm)

	UNSHADED				SHADED			
	<u>elevated</u>		<u>stream bed</u>		<u>elevated</u>		<u>stream bed</u>	
Total	3280	657	386	137	288	111	50	19
Diatoms	3044	462	279	78	280	101	48	18
Green	235	193	106	59	8	7	2	1
Tabellaria	2068	256	154	33	179	28	13	2
Fragilaria	81	30	34	12	4	3	7	0
Synedra	627	49	26	4	45	6	2	0
Melosira	151	97	34	17	26	20	6	6
Cocconeis	15	1	0	0	0	1	1	0
Pinnularia	4	3	1	0	1	7	4	1
Cymbella	13	10	4	5	2	0	1	1
Gyrosigma	4	1	0	0	1	3	0	0
Gomphonema	11	1	1	0	4	4	1	0
Frustulia	0	0	0	0	2	0	0	0
Nitzschia	26	8	9	1	2	3	0	0
Diatoma	0	0	2	0	0	6	9	4
Navicula	8	1	1	1	2	2	1	1
Scenedesmus	145	34	20	4	7	7	2	1
Ulothrix	33	154	43	45	0	0	0	0
Other Green	10	1	40	9	0	0	0	0
Filamentous								
Pediastrum	8	1	3	0	0	0	0	0
Closterium	4	1	0	1	0	0	0	0
Crucigenia	6	2	0	0	0	0	0	0
Anabaema	1	2	1	0	0	3	0	0

TABLE VI

PERIPHYTON (24 DAYS)
(33.75 square mm)

	UNSHADED				SHADED			
	elevated		stream bed		elevated		stream bed	
Total	34	34	478	638	21	36	4	10
Diatoms	20	22	415	535	17	29	3	9
Green	14	12	63	102	2	7	1	1
Tabellaria	5	8	270	321	3	0	2	0
Fragilaria	1	2	6	16	4	0	0	3
Synedra	1	1	49	79	3	0	0	0
Melosira	7	8	34	47	2	5	1	4
Cocconeis	2	0	3	2	1	4	0	1
Pinnularia	1	0	5	7	0	2	0	1
Cymbella	0	0	4	18	1	1	0	0
Gyrosigma	0	0	7	2	0	2	0	0
Gomphonema	0	1	5	9	0	0	0	0
Frustulia	1	1	11	12	0	0	0	0
Nitzschia	0	0	18	17	0	0	0	0
Diatoma	1	0	2	1	3	5	0	0
Navicula	0	1	0	1	0	0	0	0
Scenedesmus	2	0	34	45	2	3	0	0
Ulothrix	12	6	25	46	0	3	1	0
Other Green	0	6	0	5	0	0	0	0
Filamentous								
Pediastrum	0	0	3	3	0	1	0	1
Closterium	0	0	1	0	0	0	0	0
Crucigenia	0	0	2	0	0	0	0	0
Anabaema	0	0	0	3	2	0	0	0

TABLE VII

PERIPHYTON (38 DAYS)
(33.75 square mm)

	UNSHADED				SHADED			
	<u>elevated</u>		<u>stream bed</u>		<u>elevated</u>		<u>stream bed</u>	
Total	107	120	243	294	649	572	106	27
Diatoms	73	40	189	219	635	562	101	24
Green	28	80	54	74	14	8	5	3
Tabellaria	1	0	63	107	0	0	0	0
Fragilaria	1	3	0	0	6	1	0	0
Synedra	0	0	4	4	0	0	0	0
Melosira	0	0	4	5	0	0	0	0
Cocconeis	48	8	55	41	616	558	101	22
Pinnularia	6	5	24	15	1	0	1	0
Cymbella	0	6	5	8	5	2	3	1
Gyrosigma	0	1	1	1	0	0	0	0
Gomphonema	0	0	4	3	0	0	0	0
Frustulia	0	1	8	3	1	0	0	0
Nitzschia	0	0	15	25	0	0	0	0
Diatoma	0	0	1	0	0	0	0	0
Navicula	0	5	1	3	1	2	0	0
Scenedesmus	4	12	9	6	0	0	0	1
Ulothrix	2	12	2	1	1	2	1	0
Other Green	6	19	2	1	1	2	1	0
Filamentous								
Pediastrum	0	0	0	0	0	0	0	0
Closterium	0	0	1	0	0	0	0	0
Crucigenia	0	0	2	0	0	0	0	0
Anabaema	6	1	1	1	0	2	0	0

TABLE VIII

MACROINVERTEBRATES (11 DAYS)
(one tile, 225 square cm)

	UNSHADED				SHADED			
	<u>elevated</u>		<u>stream bed</u>		<u>elevated</u>		<u>stream bed</u>	
Baetis	5	0	0	0	0	0	0	0
Stenacron	0	0	2	2	0	0	0	1
Chironomidae	1	1	0	1	0	1	0	0
Perlesta	1	2	0	0	0	0	1	0
Gastropoda:								
Amnicola	0	1	4	2	0	2	2	25

TABLE IX

MACROINVERTEBRATES (24 DAYS)
(one tile, 225 square cm)

	UNSHADED				SHADED			
	<u>elevated</u>		<u>stream bed</u>		<u>elevated</u>		<u>stream bed</u>	
Baetis	107	85	4	1	35	15	0	3
Stenacron	0	0	7	0	0	0	6	3
Tricorythodes	8	5	0	0	1	0	0	0
Brachycerus	0	0	0	1	0	0	0	0
Cheumatopsyche	16	8	0	0	1	0	1	10
Hydropsyche	8	5	0	1	0	0	0	1
Chironomidae	105	14	16	12	14	2	2	3
Simuliidae	0	0	0	0	0	0	0	1
Perlesta	2	2	1	0	0	0	0	0
Nigronia	0	0	1	0	0	0	0	0
Gastropoda:								
Amnicola	1	0	5	0	4	0	0	0
Menetus	3	3	4	0	0	0	0	0

TABLE X

MACROINVERTEBRATES (38 DAYS)
(one tile, 225 square cm)

	UNSHADED				SHADED			
	<u>elevated</u>		<u>stream bed</u>		<u>elevated</u>		<u>stream bed</u>	
Baetis	10	4	7	0	1	0	2	2
Stenacron	4	10	14	15	9	1	16	13
Tricorythodes	8	5	0	0	0	1	0	0
Brachycerus	0	0	0	1	0	0	0	0
Cheumatopsyche	16	8	0	0	1	0	1	10
Hydropsyche	8	5	0	1	0	0	0	1
Chironomidae	30	3	29	0	3	6	6	18
Simuliidae	0	0	0	0	0	0	0	1
Perlesta	5	2	0	0	0	0	0	0
Nigronia	0	0	1	0	0	0	0	0
Gastropoda:								
Amnicola	1	0	5	0	4	0	0	0
Menetus	3	3	4	0	0	0	0	0