A REPORT ON ANALYSES OF PERIPHYTON COLLECTIONS FROM THE NORTH FORK AND THE MIDDLE FORK OF THE FLATHEAD RIVER

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by
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Abstract

Phycoperiphyton from natural substrates was collected in March 1976 at three stations on the North Fork and one station on the Middle Fork of the Flathead River. Microscopic analysis of the four collections revealed 7 genera of non-diatom algae and 28 genera of diatoms encompassing 85 separate diatom taxa. The composition and structure of algal associations in the two streams indicate that these waters were cool, circumneutral, lightly mineralized, well oxygenated, and relatively unpolluted with either nutrients or silt. Low diatom diversity values and sparse diatom growth suggest a relatively austere environment for diatoms. The uppermost North Fork site at the Canadian border was floristically the most distinct of the four sites, suggesting perhaps that it was the most pristine site in terms of water quality. An expanded baseline inventory and monitoring program is recommended.

Introduction

This report describes the benthic algal flora at four sites on the upper Flathead River in northwestern Montana. Three sites were located on the North Fork: "NFI" at the Canadian border, "NFII" at Polebridge, and "NFIII" at Big Creek. One site was located on the Middle Fork ("MFI") at its confluence with the North Fork.

Periphyton was scraped from natural substrates, generally rock, but including some wood in the Middle Fork, and preserved with Lugol's solution (7). Samples were collected on March 9 (NFI, NFII), March 10 (NFIII), and March 16 (MFI), 1976.

Methods

The relative abundance of non-diatom algae was estimated by scanning a wet-mount subsample under low dry (100X). Diatom percent relative abundance was determined using a modification of the proportional count method prescribed by EPA (5) and "Standard Methods" (1). Diatom diversity was calculated using two formulas:

Margalef's index (6)

$$D = \frac{s - 1}{\ln N}$$

Simpson's index (11)

$$SD = 1 - \sum_{i=1}^{s} \left(\frac{n_i}{N} \right)^2$$

where s is the number of taxa counted, N is the total number of individuals counted, and n_i is the number of individuals in the ith taxon.

Results

The approximate relative abundance of non-diatom algae at the four sites is presented in Table 1. Diatoms as a group dominated the flora at NFIII and MFI but were sparse at NFII and very sparse at NFI.

Percent relative abundance (PRA) values for diatom taxa from the four sites are given in Table 2. Altogether, 28 genera and 85 distinct taxa were recognized. Genera with the most taxa were Cymbella (12 taxa), Nitzschia (11 taxa), Achnanthes (10 taxa), Navicula (8 taxa), Fragilaria (6 taxa), and Gomphonema (6 taxa).

Percent relative abundance (PRA) values for major taxa[1] and other structural parameters of benthic diatom associations are listed in Table 3.

Numerically, the three most important taxa were Achnanthes minutissima, Gomphonema olivaceoides, and Cymbella minuta. Although much less common, the much larger taxon Didymosphenia geminata was a visual dominant at NFIII and MFI and probably accounted for a significant fraction of the total volume of the diatom associations at these sites.

[1]Major taxa are those comprising 10 percent or more relative abundance in one or more samples.

Table 2. Percent relative abundance of diatom taxa from the North Fork and the Middle Fork of the Flathead River, March 1976.

TAXA	STATION NFI	NFII	NFIII	MFI
Achnanthes deflexa	0.6	1.6	2.6	4.2
A. flexella				t
A. lanceolata	0.3	t	0.3	
A. lanceoloata var. dubia	t			
A. lapponica var. ninckei			0.3	0.9
A. levanderi				t
A. linearis			t	1.8
A. (marginulata?)				0.3
A. microcephala				t
A. minutissima	23.8	66.3	70.2	68.7
Amphipleura pellucida	0.3	t	t	t
Amphora ovalis				t

Table 2. Continued.

TAXA	NFI	NFII	NFIII	MFI
		STATION		
Anomoeoneis vitrea				0.3
Caloneis bacillum	t			
Cocconeis pediculus	3.3	t		
C. placentula var. lineata	3.9	1.6	0.6	t
Cyclotella bodanica			t	t
C. sp. #1				0.3
Cymatopleura solea	t		t	t
Cymbella affinis	1.1	0.8	t	t
C. cesatii				t
C. cistula		t	t	t
C. cymbiformis		t		
C. mexicana			t	t
C. microcephala	t	0.3	t	0.9
C. minuta	2.5	4.8	7.4	15.1
C. muelleri				t
C. naviculiformis				t
C. prostrata		t		t
C. sinuata	0.8	1.6	0.3	0.6
C. sp. #1		t		
Denticula tenuis var. crassula				t
Diatoma heimale	t	t	t	t
D. heimale var. mesodon	0.6	0.3	0.9	t
D. tenue var. elongatum			t	
Didymosphenia geminata		0.3	0.3	0.3
Epithemia adnata	t			
E. (emarginata ?)		t		
E. sorex	0.3	0.3		
E. turgida	t	t		
Fragilaria construens			t	
F. construens var. venter	t	1.1	0.6	0.6
F. crotonensis			t	
F. pinnata		t		t
F. vaucheriae	7.5	3.5	9.1	0.9
F. sp. #1	t			t
Frustulia rhomboides var. amphipleuroides	t			
Gomphoneis herculeana var. robusta		t	t	
Gomphonema (angustatum ?)			t	
G. dichotomum	0.8	1.9		
G. olivaceoides	44.0	14.7	2.1	2.7
G. septum	t		t	
G. ventricosum	t	t	0.3	
G. sp. #1			t	
Hannaea arcus	t	t	0.9	0.3
Hantzschia amphioxys		t	t	
Melosira (italica ?)			t	
Meridion circulare	0.3	t	0.3	t
Navicula(arvensis ?)	t			
N. aurora				t

Table 2. Continued.

TAXA	STATION NFI	NFII	NFIII	MFI
Navicula cryptocephala			0.3	
N. cryptocephala var. veneta	3.6	0.3	0.3	
N. pupula			t	
N. radiosa		t	t	t
N. tripunctata	t	t	t	
N. vulpina				t
Neidium iridis			t	
Nitzschia amphibia			t	
N. angustata var. acuta				0.3
N. dissipata	5.5	0.3	0.9	t
N. fonticola		t		1.2
N. kutzingiana	0.6	0.5	2.1	0.3
N. linearis		t	t	0.3
N. palea			t	t
N. recta			t	
N. sublinearis			t	t
N. sp. #1	t	t	0.3	
N. sp. #2	t			
Rhopalodia gibba	t	t		
Stephanodiscus carconensis var. pusilla				t
Surirella (linearis var. helvetica ?)				t
S. ovata				t
S. sp. #1	t			
Synedra ulna	0.3	t	t	t
S. ulna var. contracta			t	

t = trace; observed in floral scan but not encountered in proportional count

Table 3. Structural features of diatom associations from the North Fork and the Middle Fork of the Flathead River, March 1976.

PARAMETER	STATION NFI	NFII	NFIII	MFI
*PRA Major Taxa				
Achnanthes minutissima	23.8	66.3	70.2	68.7
Cymbella minuta	2.5	4.8	7.4	15.1
Gomphonema olivaceoides	44.0	14.7	2.1	2.7
PRA *Nitzschia* spp.	6.1	0.8	3.3	2.1
PRA Attached Species	81.0	93.4	84.0	95.2
PRA Motile Species	19.0	6.6	16.0	4.8
Total Taxa	38	40	49	50
Taxa Counted	19	17	20	19
Cells Counted	361	374	339	332
Margalef Diversity (D)	3.06	2.70	3.26	3.10
Simpson Diversity (SD)	0.736	0.534	0.491	0.502

*PRA = Percent relative abundance; major taxa are those comprising 10 percent or more relative abundance in one or more samples.

Discussion

Algae, particularly diatoms, are useful as monitors of water quality. Because they directly utilize dissolved minerals and nutrients in their metabolic processes, they are orders of magnitude more sensitive to changes in the ambient concentrations of these elements than either invertebrates or fish. They reproduce much faster than invertebrates or fish, hence their population response is more immediate. They are also less mobile and less able to evade the consequences of pollution. As biological organisms they integrate the effects of all the various physical and chemical factors to which they are exposed. The absence, or when present the relative abundance, of certain species and varieties may indicate specific water quality conditions. Collective parameters, such as diversity, may reflect the overall health of the biotic community.

Although the results from these analyses of Flathead River periphyton collections can and will be used to interpret water quality, it must be kept foremost in mind that these interpretations apply only on certain discrete dates and points of sampling. The flora and water quality may change considerably over the course of a year. Also, locally anomalous conditions may go undetected, or even worse, the collections themselves may be anomalous. However, for the purposes of this report, it is assumed that the flora is representative of the reach of river in question on the date of sampling.

Hydrurus foetidus, the commonest alga in the Flathead samples, is typical of cold mountain streams (12). It was more abundant at the upper stations (NFI, NFII) than the lower stations (NFIII, MFI), probably reflecting a natural longitudinal temperature differential. *Achnanthes minutissima* was the commonest diatom encountered. When abundant, as it was in all of the Flathead collections, it is indicative of a well-oxygenated environment (4). The second most common diatom was Gomphonema olivaceoides, which like H. foetidus, achieved its greatest abundance at NFI and NFII. This taxon "seems to prefer cool fresh water" (10) and the only other place in Montana where it has been found by this writer has been in the E. Rosebud River draining the Beartooth Plateau in southcentral Montana (unpublished data). The other major taxon was Cymbella minuta, which was significant only at MFI. C. minuta is generally considered an eurytopic species and is indifferent to moderate changes in pH, salinity, and organic content (8, 10). Certain less common taxa that serve as reliable markers of a cool, circumneutral water of low conductivity were encountered in the Flathead collections. Among these taxa were Cymbella cesatii (10), Didymosphenia geminata (also found in the E. Rosebud R.), and Gomphonema septum (first described by Moghadam (9) from Flathead Lake).

Cholnoky (3) reported that the relative abundance of Nitzschia spp. in a diatom community is proportional to the concentration of dissolved nitrogen compounds in the water and is therefore a suitable indicator of nitrogenous pollution. The mean PRA value for Nitzschia spp. in the Flathead samples is compared in Table 4 with analogous values from four other Montana streams subject to domestic and agricultural pollution.

Table 4. Mean PRA Nitzschia spp. for selected Montana streams. E. Gallatin datum from Bahls (2). All other data unpublished. The number in parenthese is the number of samples.

STREAM	PRA Nitzschia spp.
Flathead River (4)	3.1
E. Gallatin River (54)	49.5
N. Fork Dry Creek, Carbon Co. (8)	15.8
N. Fork Fivemile Creek, Carbon Co. (6)	20.6
Clark's Fork River (6)	21.4

These data appear to indicate that the upper Flathead River system does not suffer from nitrogenous pollution.

Given a stable substrate, a number of diatom taxa ordinarily assume an attached growth habit. With more unstable (silty) substrates, more and more motile and facultatively planktonic taxa are represented in the diatom association. The mean PRA of attached species in the last three waters in Table 4, which suffer to some degree from unnatural siltation, was 46.7. On the other hand, the mean PRA of attached species for the four Flathead samples was 88.4 (Table 3), whcih would tend to indicate that the upper Flathead tributaries do not have a silt problem.

Diatom species diversity indexes may also serve to mark pollution problems, but caution must be used in comparing stream to stream because of their different inherent abilities to support a varied diatom flora. Mean diatom diversity values for the Flathead collections are compared in Table 5 with analogous values from six other Montana streams.

Table 5. Mean diatom diversity values for selected Montana streams. E. Gallatin datum from Bahls (2). All other data unpublished. The number in parentheses is the number of samples.

STREAM	MARGALEF (D)	SIMPSON (SD)
Flathead River (4)	3.03	0.566
E. Gallatin River (54)	3.47	-----
N. Fork Dry Creek, Carbon Co. (8)	4.32	0.785
N. Fork Fivemile Creek, Carbon Co. (6)	4.63	0.814
Clark's Fork River (6)	4.82	0.888
Tongue River (6)	5.83	0.822
Poplar River (18)	6.50	0.849

Unlike the E. Gallatin River, the low diatom diversity in the Flathead is undoubtedly due to an austere environment for diatoms rather than to a severe pollution load. In contrast to the other waters listed, the

Flathead is much less mineralized and probably less conducive to diatom growth. This is substantiated by observations of sparse diatom growth at the upper two North Fork stations (NFI, NFII).

A cursory examination of the data in Tables 2 and 3 seems to reveal that the lowest North Fork station (NFIII) is floristically more similar to the Middle Fork station (MFI) than to the upper North Fork stations. This possibility was tested using a percentage similarity index proposed by Whittaker and Fairbanks (13):

$$PS = 100 - 0.5 \sum_{i=1}^{s} \left| a - b \right|$$

where s is the number of taxa counted, and a and b are the PRA values for a given taxon at stations A and B. Percent floristic similarity values for the six possible station pairs are listed in Table 6. Both

Table 6. Percent floristic similarity between stations on the North Fork and the Middle Fork of the Flathead River, March 1976.

STATION PAIR	PERCENT SIMILARITY
NFIII, MFI	83.75
NFII, NFIII	81.35
NFII, MFI	78.30
NFI, NFII	50.65
NFI, NFIII	40.30
NFI, MFI	31.35

NFII and NFIII proved to have more in common with MFI than with NFI. Therefore, of the four sites sampled, NFI is the most unique in terms of its diatom association.

Conclusions and Recommendations

The composition and structure of algal associations in the North Fork and Middle Fork of the Flathead River indicate that these waters are cool, circumneutral, lightly mineralized, and unpolluted. Low diatom diversity values and observations of sparse diatom growth suggest an austere environment for diatoms, particularly at the upper two North Fork stations. The uppermost North Fork site (NFI) was floristically distinct from the other two North Fork stations and from the Middle Fork site (MFI).

It is advised that a number of sampling sites be added on the South Fork (above and below Hungry Horse Reservoir) and on the upper Middle Fork. It is further recommended that these and the existing stations be sampled seasonally through one year of time and monitored annually thereafter.

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