Journal of the Minnesota Academy of Science

Volume 46 | Number 1 Article 8

1980

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ABSTRACT—Populations of river bed diatoms were studied in the Snake River at Mora, Minnesota, at stations established above and below the outfall of secondary effluents. Diatoms were collected from experimentally submerged glass slides held in positon by substrate block samplers and enumerated from sedimentation chambers. The major species are given for each station to show their relative abundance and percentage frequency of occurrence.

Probably very few streams in the United States are not affected in some way by waste of our society. The population characteristics of such streams are studied by aquatic biologists in the assessment of various water quality parameters of the streams.

The attached algae of a stream, like other organisms, show varying degrees of pollution tolerance among their species. Their presence or absence may indicate the condition of a particular stream over lasting periods of time more effectively than would chemical analysis. Their attachment to the bottom of the stream bed places them under continuous exposure from upstream environmental conditions, whereas, chemical analysis may only provide a momentary picture of conditions at the particular time and place of sampling. For this reason various authors (Blum, 1957; Williams, 1964; Fjerdingstad, 1964; and Bahls, 1973) have described algae population associations as indicators of water quality.

Analysis through two sampling stations

Two sampling stations were established to assess the physical, chemical, and seasonal biological changes; station A, .3km above and station B, .25km below the secondary treated sewage effluent outfall at Mora, Minnesota (Fig. 1). Samples were obtained from these stations at 14-day intervals from June 6, 1971, to June 24, 1972. Standard glass slides, held in place on the river bed by grooves in pine boards embedded in concrete blocks, were used as the substratum from which diatoms were collected (Fig. 2). Diatoms were cleaned for identification by gentle boiling in concentrated HNO_3 and mounted in Hyraz (Weber, 1970). Identifications were made at 1000 X under oil emersion using the keys of Hustedt (1930), Smith (1950), and Whitford and Schumacher (1960). Diatoms used in enumeration were scraped into 30 cc vials, preserved in Lugol's solution, and transferred to 10 cc sedimentation counting chambers with a bottom plate area of 500 mm^2. Enumerations were made according to methods outlined by Schwoerbel (1970) and recorded as species numbers per mm^2 of substrate.

Composition of diatom flora

Twenty genera and 48 species of diatoms were collected and enumerated from the submerged glass slide samplers. Table 1 lists the species with the percentage frequency of their occurrence in all samples at stations A and B. Quantitatively, the diatom populations exhibited fluctuations consisting of two high density pulses, one in June of 1,819 cells/mm^2 and the other in October of 2,056 cells/mm^2. The remaining months were represented by fluctuating densities from these peaks and negligible cell densities from November to February. The most common diatoms exhibiting significant cell densities observed during the study period were as follows:

Acnanthes lanceolata (Breb.) Grunow
Cocconeis placentula Ehr.
Cymbella ventricosa Kutz.
Diatoma vulgare Bory
Gomphonema acuminatum Ehr.
Gomphonema olivaceum (Lyngbye) Kutz.
Gomphonema parvulum Kutz.
Melosira varians Agardh.
Navicula cryptocephala Kutz.
Navicula salinarum Grun.
Nitzschia dissipata (Kutz.) Grun.
Nitzschia palea (Kutz.) W. Smith

The major diatoms species and their mean abundance and rank are illustrated Table 2.

Seasonal and downstream populations

The diatom populations of the Snake River exhibited a seasonal variation with certain species, while others were perennial, occurring throughout the year, with exception to the negligible growths during winter. Nine species of the 48 species collected and enumerated during the study period were 90—100 percent frequent (Table 1). Seasonal variation in the Snake River diatom populations was fairly consistent with those reported on other rivers by Butcher (1932), Neel (1968), Gumtow (1955), and Blum (1956). *Cocconeis placentula* dominated summer populations with *Gomphonema* sp. becoming codominant in early fall. *Diatoma vulgare* was the dominant species in October while *Meridion circulare, Synedra ulna* and *Navicula cryptocephala* dominated cold-water spring populations. As waters warmed in May, *Cocconeis* again became dominant.

Bahls (1973) made intensive studies of the diatom community of the East Gallatin River in Montana, in responses to primary effluents wastewater. He determines the percentage similarity of community samples using the following formula:

$$PS_c = 100 - 0.5 \quad a\text{-}b$$

where a and b are the mean abundance (percent) which a given species contributes at stations A and B. He determined that the two least similar stations sampled were those immediately above and below the effluent outfall, 9m above

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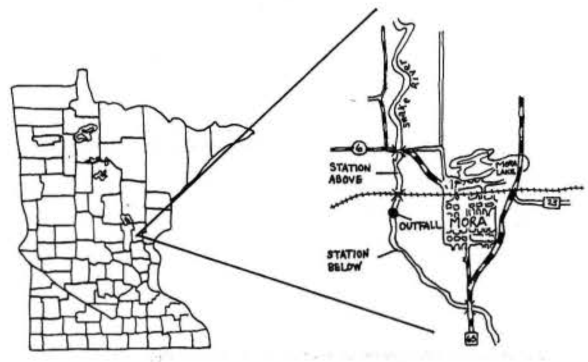

Fig. 1. Location of Snake River sampling stations

Table 1 — Diatom species collected at stations A and B in the Snake River and their percent frequency of occurrence.

SPECIES	STATION A PERCENT FREQUENCY	STATION B PERCENT FREQUENCY
Achnanthes exigua Krasske	30.00	33.33
Achanthes lanceolata (Breb.) Grunow	90.00	100.00
Amphora ovalis Kutz	30.00	22.22
Cocconeis diminuta Pant.	10.00	11.11
Cocconeis pediculus Ehr.	80.00	44.44
Cocconeis Placentula Ehr.	10.00	100.00
Cyclotella atomus Hust.	10.00	-----
Cyclotella meneghiniana Kg.	70.00	66.67
Cyclotella michiganiana Skvortzow	60.00	44.44
Cymatopleura solea (Breb). W. Sm.	10.00	11.11
Cymbella affinis Kutz.	30.00	33.33
Cymbella citula Grum.	40.00	33.33
Cymbella ventricosa Kutz.	90.00	88.89
Diatoma vulgare Bory	80.00	55.55
Epithemia turgida (Ehr.) Kutz.	20.00	22.22
Eunotia praerupta Ehr.	10.00	-----
Fragilaria construens (Ehr.) Grun.	50.00	66.67
Fragilaria crotonensis Kitton.	20.00	22.22
Gomphonema acuminatum Ehr.	100.00	88.89
Gomphonema augar Ehr.	30.00	22.22
Gomphonema bohemicum Reichett & Fricke	60.00	22.22
Gomphonema constrictum Ehr.	20.00	22.22
Gomphonema olivaceum (Lyngbye) Kutz.	60.00	66.67
Gomphonema parvulum Kutz.	30.00	33.33
Melosira distans (B.) Kg.	40.00	66.67
Melosira granulata (E.) Ralphs.	50.00	55.55
Melosira varians C.A. Agardh	80.00	77.78
Meridion circulare Agardh	20.00	22.22
Navicula capitata Ehr.	-----	11.11
Navicula cryptocephala Kutz.	100.00	100.00
Navicula cuspidata Kutz.	20.00	22.22
Navicula discussis Oestrup.	30.00	22.22
Navicula gastrum Ehr.	50.00	22.22
Navicula protracta Grum.	20.00	22.22
Navicula salinarum Grun.	100.00	100.00
Navicula similis Krabke	30.00	11.11
Navicula tripunctata Mull.	80.00	77.78
Nitzschia dissipata (Kutz.) Grun.	90.00	88.89
Nitzschia gracilic Hantzsch.	70.00	55.55
Nitzschia linearis W. Smith	80.00	77.78
Nitzschia palea (Kutz.) W. Smith	90.00	100.00
Nitzschia sigmoidea (Ehr.) W. Smith	10.00	-----
Stephanodiscus astraea (E.) Grun	-----	11.11
Surirella angustata Kutz.	40.00	44.44
Surirella tenera A. Schmidt	-----	11.11
Synedra acus Kutz.	40.00	44.44
Synedra ulna (Nitzsch.) Ehr.	90.00	88.88
Tabellaria floculosa (Roth) Kut.	-----	11.11

Table 2 — Major diatom species of the Snake River, mean abundance and rank*

SPECIES	STATION A	STATION B
Cocconeis placentula Ehr.	31.6 (1)	34.3 (1)
Gomphonema acuminatum Ehr.	8.5 (2)	6.5 (5)
Nitzschia dissipata (Kutz.) Grun.	8.1 (3)	7.8 (3)
Navicula cryptocephala Kutz.	7.9 (4)	8.8 (2)
Diatoma vulgare Bory	5.4 (5)	2.6 (13)
Synedra ulna (Nitzsch.) Ehr.	5.2 (6)	5.6 (6)
Achnanthes lanceolata (Breb.) Grunow	4.1 (7)	7.2 (4)
Gomphonema olivacuem (Lyngbye) Kutz.	3.5 (8)	1.7 (14)
Gomphonema parvulum Kutz.	3.5 (8)	3.4 (9)
Navicula salinarum Grun.	3.0 (9)	3.9 (7)
Melosira varians C.A. Agardh	2.8 (10)	2.9 (11)
Cymbella ventricosa Kutz.	2.8 (10)	2.7 (12)
Meridon circulare Agardh	2.7 (11)	3.0 (10)
Nitzschia palea (Kutz.) W. Smith	1.1 (12)	3.6 (8)
Cocconeis pediculus Ehr.	1.0 (13)	--------
Nitzschia linearsis W. Smith	1.0 (13)	1.0 (16)
Melosira granulata (E.) Ralphs	--------	1.1 (15)

*Unranked species are those that contributed less than 1.0 percent toward the mean abundance at that station. Rank values are shown in parentheses.

and 0.3km below. Using nineteen major taxa, he determined the percentage similarity of the above stream station and the station below the outfall as 51.8. This index was calculated for the Snake River diatoms using the seventeen major species (Table 2). The diatom flora of the two stations were very similar with PS_c of 90.3. This showed more similarity than Bahls (1973) most similar communities at 17.4 and 23.5km downstream station recorded at PS_c = 88.3. The importance of this discrepancy should be noted by future investigators attempting to correlate community similarities above and below sewage outfalls. Each river system may exhibit local differences in the expression of environmental influences. Bahls (1973) found that inorganic nutrients such as phosphate were increased by seven times at 0.3km below the primary effluent outfall and was expressed in dissimilar diatom community types. In the Snake River, inorganic nutrients such as phosphates increased by five times at .25km below the outfall of Secondary effluents, but diatom communities remained very similar. It is presumed that an effect would be illustrated, but perhaps much further downstream. Specific mixing actions of each river or other parameters may determine where such effects may be represented in each river system.

Fig. 2. Submerged glass slide substrate sampler. Diatoms collected for enumeration were from the slides on the upstream side. Leeward side slides provided added samples for identification purposes.

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