

Bacterial Community Dynamics and Species Diversity of Slime Producing Bacteria at Selected Sites on the Ohio River

DONALD A. HENDRICKSON

Department of Biology, Ball State University, Muncie, Indiana 47306

Introduction

This study deals with the seasonal population trends of bacteria in the Ohio River intake water at Cardinal Plant, Clifty Creek Station, Kyger Creek Station and Tanner's Creek generating facilities from May, 1978 through April, 1979. A weekly comparison was made between slime forming total aerobic bacteria and slime forming aerobic bacteria and between gram negative aerobic bacteria and slime forming gram negative aerobic bacteria.

Study Sites

The study sites chosen for this study were all located on the Ohio River in the southern part of Ohio and Indiana. These sites were selected because they were all locations of electric generating facilities that had previously experienced slime buildup in their condenser tubes; Cardinal Plant located near Brilliant, Ohio; Kyger Creek Station near Gallipolis, Ohio; Tanner's Creek Plant near Lawrenceburg, Indiana; and Clifty Creek Station near Madison, Indiana.

Methods and Materials

- A. Sample Collection for Bacteriological Analysis
Triplicate samples of intake water were collected weekly in sterile Nalgene bottles. These samples were packed in blue ice and shipped in 2 inch styrofoam packing by UPS to our laboratory.
- B. Bacteriological Analysis:
Bacteriological analyses of the samples were prepared by making serial dilutions of all the samples with phosphate buffered water. One tenth ml of the serial dilutions was plated on Standard Methods Agar and MacConkeys Agar. The plates were incubated at ambient temperature (22°C) for five days.

Results

Seasonal Bacterial Populations

Bacterial population numbers in intake water varied seasonally from May, 1978 through April, 1979 (FIGURES 1-8). The total bacterial population fluctuated widely from about 10,000/ml to near or in excess of 100,000/ml.

Total slime bacterial population numbers in intake water at all sites were generally much lower than total bacterial population numbers except from late July through early November, 1978 when they were quite similar (FIGURES 1, 3, 5, 7). Total slime bacteria at all stations was usually less than 20% of total bacterial population except during the July to November period when they made up about 50 to 95% of the population.

Total gram negative bacteria were usually about a factor of 10 lower than total bacteria with few exceptions (FIGURES 2, 4, 6, 8). Population levels never exceeded 100,000/ml and they commonly fluctuated above and below 10,000/ml.

Total gram negative bacterial population levels in intake water at sites were similar to total gram negative bacterial levels from June through September

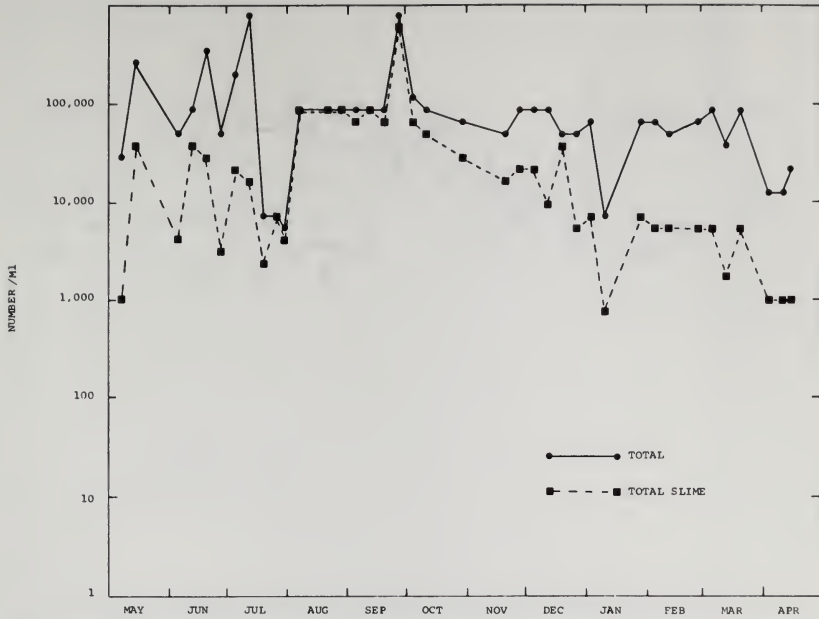


FIGURE 1. Bacterial population dynamics (total and total slime) at Cardinal Plant, May, 1978 through April, 1979.

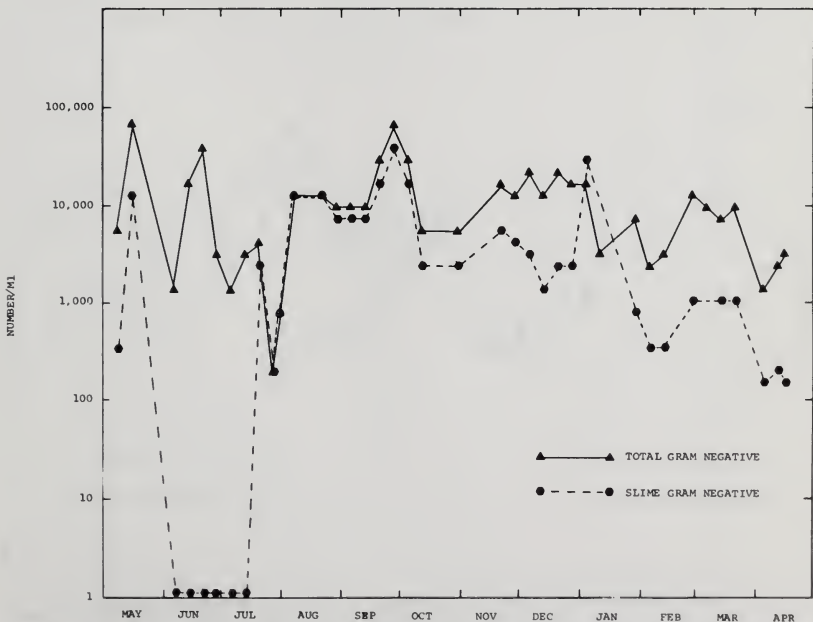


FIGURE 2. Bacterial population dynamics (total gram negative and slime gram negative) at Cardinal Plant, May, 1978 through April, 1979.

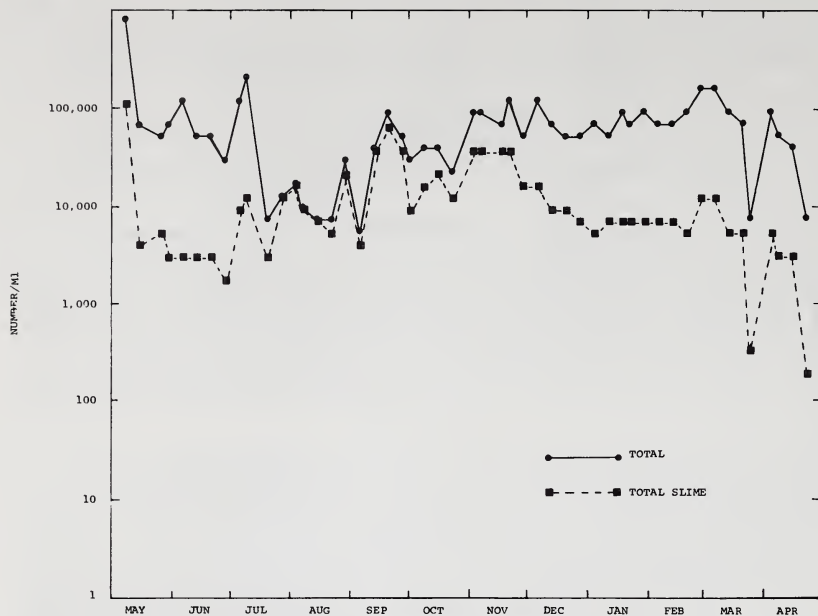


FIGURE 3. *Bacterial population dynamics (total and total slime) at Clifty Creek Station, May, 1978 through April, 1979.*

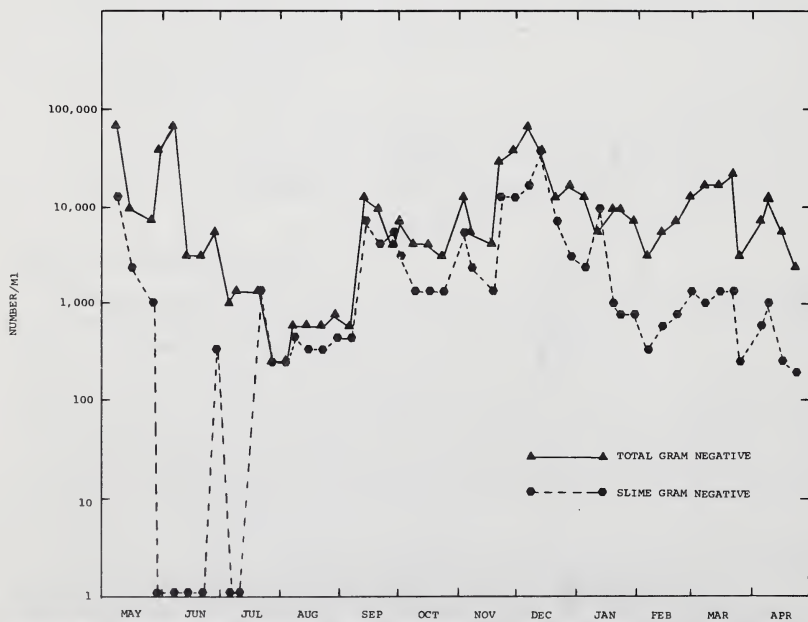


FIGURE 4. *Bacterial population dynamics (total gram negative and slime gram negative) at Clifty Creek Station, May, 1978 through April, 1979.*

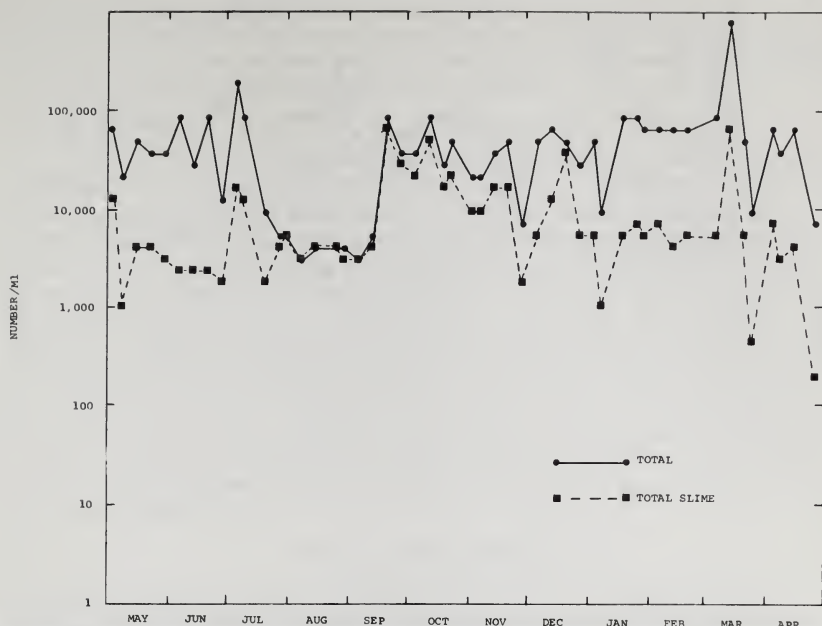


FIGURE 5. *Bacterial population dynamics (total and total slime) at Kyger Creek Station, May, 1978 through April, 1979.*

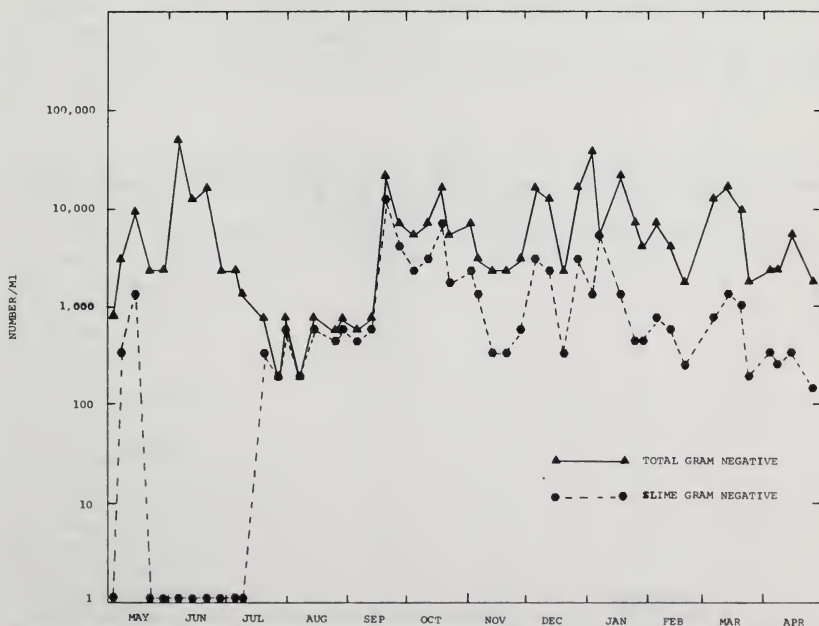


FIGURE 6. *Bacterial population dynamics (total gram negative and slime gram negative) at Kyger Creek Station, May, 1978 through April, 1979.*

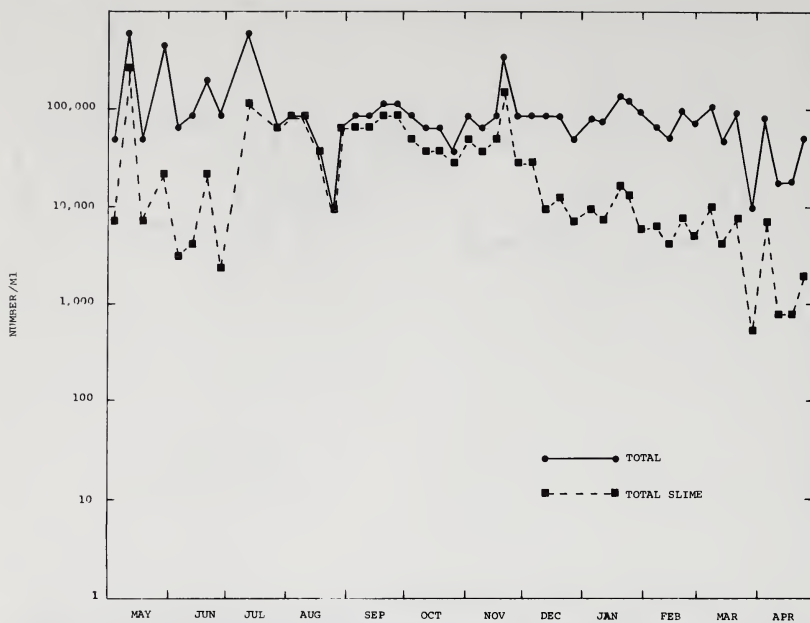


FIGURE 7. *Bacterial population dynamics (total and total slime) at Tanner's Creek Plant, May, 1978 through April, 1979.*

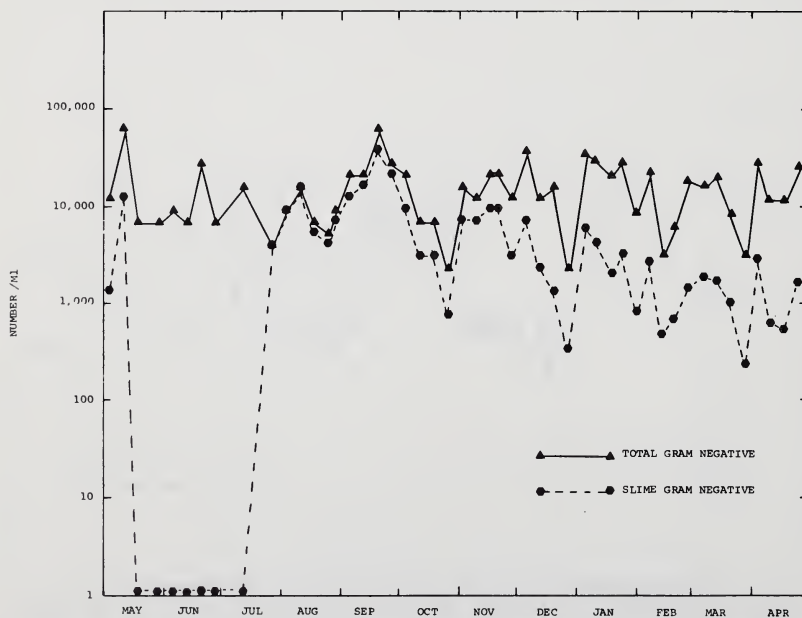


FIGURE 8. *Bacterial population dynamics (total gram negative and slime gram negative) at Cardinal Plant, May, 1978 through April, 1979.*

(FIGURES 2, 4, 6, 8). The number of slime gram negative bacteria also tended to drop relative to total gram negative bacteria from October, 1978 through April, 1979, although population levels were never below 100/ml.

Species Dominance

In addition to isolating and counting total aerobic bacteria, total aerobic slime producing bacteria, gram negative bacteria isolated on MacConkeys agar, and slime producing bacteria isolated on MacConkeys agar, all slime producing bacteria isolated were identified by API rapid diagnostic procedure. Frequency of occurrence of bacteria isolated is shown in TABLE 1. The most frequently isolated slime producing bacterium was *Pseudomonas fluorescens*. Greatest species diversity occurred in the cooling water of all plants from mid July to early September. A change in species composition was observed during this reporting period. *Acinetobacter calco*, var *anitrat.*, a *Bacillus* species and various *Pseudomonads* were not present at the beginning of the reporting period but were dominant later. The genus *Enterobacter* occurred in all plants during the summer reporting period. In addition to the seasonal variation in species composition at each reporting site, there were also variations in species composition between study sites for the same reporting date.

Discussion and Conclusions

Bacteriological data and river water temperature were collected from May 1, 1978 to April 30, 1979 at four electric generating facilities on the Ohio River: Cardinal Plant, Clifty Creek Station, Kyger Creek Station, and Tanner's Creek Plant. Major conclusions are as follows:

1. Total bacterial numbers were variable between about 10,000/ml and 100,000/ml during the sample period.
2. Total slime bacteria dominated bacterial populations from mid July through September.

TABLE 1. Frequency of occurrence of slime forming bacteria isolated in the cooling waters of Cardinal Plant, Clifty Creek Station, Kyger Creek Station and Tanner's Creek Plant.

	CARDINAL	CLIFTY	KYGER	TANNER'S
<i>Acinetobacter calco</i>				
var. <i>anitrat.</i>	80 ^a	90	83	67
<i>Aeromonas spp.</i>	43	31	25	39
<i>Alcaligenes spp.</i>	95	73	87	98
<i>Bacillus spp.</i>	28	27	38	24
<i>Enterobacter agglomerans</i>	8	6	2	31
<i>Enterobacter spp.</i>	10	21	12	25
<i>Flavobacterium breve</i>	1	1	1	6
<i>Flavobacterium spp.</i>	10	21	12	25
<i>Moraxella spp.</i>	3	4	4	6
<i>Pasteurella multocida</i>	10	21	0	20
<i>Pseudomonas aeruginosa</i>	15	4	12	29
<i>Pseudomonas fluorescens</i>	100	75	94	82
<i>Pseudomonas multiphilia</i>	5	25	4	6
<i>Pseudomonas paucimobilis</i>	5	15	8	6
<i>Pseudomonas spp.</i>	95	98	92	67
<i>Xanthomonas spp.</i>	3	33	0	0

a = percent of samples containing bacterium

3. The greatest bacterial species diversity occurred in the cooling water of all plants from mid July to early September.
4. A change in slime bacterial species composition of the cooling water occurred at all reporting stations during the reporting period. Variations in species composition between the sample sites for the same reporting date were also observed.

Acknowledgements

This work was funded by American Electric Power Service Corporation, Ohio Valley Electric and Indiana-Kentucky Electric Corporation.