The Relationship of Coliform Populations to Certain Physico-Chemical Parameters in the Indian River-Banana River Complex

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In a continuing study of pollution in the Indian River-Banana River Complex (1), it was of interest to determine the distribution of several pollutants in the surface waters of a large segment of the lagoonal system. Numbers of coliforms were correlated with concurrent studies of the levels of nitrate, phosphate, dissolved oxygen and salinity along a 70 mile segment of the Indian River, and along the entire length of the unrestricted part of the Banana River.*

METHODS AND MATERIALS

Surface water samples were collected in clean bottles from predesignated points in the rivers. In the Banana River the 10 sample points were approximately 3 miles distant from each other. In the Indian River 24 samples were collected, each at a selected channel marker or other easily identified location as described in another publication (2).

100 ml of each water sample, and a suitable dilution thereof, were filtered through presterilized millipore filters. The filter wafers were then placed on filter pads contained in millipore culture dishes, and saturated with Endo's medium (Difco) (3). The dilutions were prepared in 100 ml sterile, de-ionized water blanks. After suitable incubation, coliform colonies were counted. For purposes of this presentation, as was done previously (1), all of the lactose fermenting, gram negative bacilli which grew on this medium were considered to be coliforms.

Dissolved oxygen was determined by the Alsterberg (4) modification of the Winkler Method except that phenylarsene oxide was substituted for sodium thiosulfate. Nitrate-Nitrite was estimated colorimetrically with alpha-napthol and sulfanic acid (5), and phosphate, by the formation of phosphomolybdic acid (5). Salinity was determined potentiometrically as described by McCall (2).

EXPERIMENTAL

The coliform populations are related to salt levels in the Indian River in Figure 1, in which is indicated increased numbers of coliforms in areas of decreased salinity.

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*KSC limits entry into that part of the Banana River north of the NASA Causeway.

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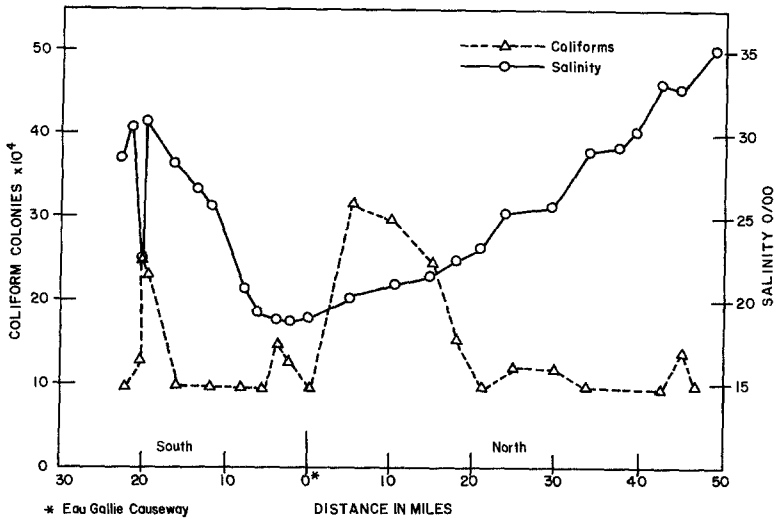

Figure 1. Relationship between Salinity and Coliforms in the Indian River.

This inverse relationship appeared in a small area of the southern river at Sebastian Creek; and in a substantial area beginning at a point about 5 miles south of, and extending to about 20 miles north of, the Eau Gallie Causeway. Both areas include non-saline waterways which empty into the lagoon. In addition to "fresh" water, several of these waterways carry effluents from large sewage treatment plants.

The relationship between salinity and coliform populations in the Banana River are depicted in Figure 2. This lesser lagoon originates at the Eau Gallie Causeway and proceeds north for about 35 miles, about 30 of which are open for boating.

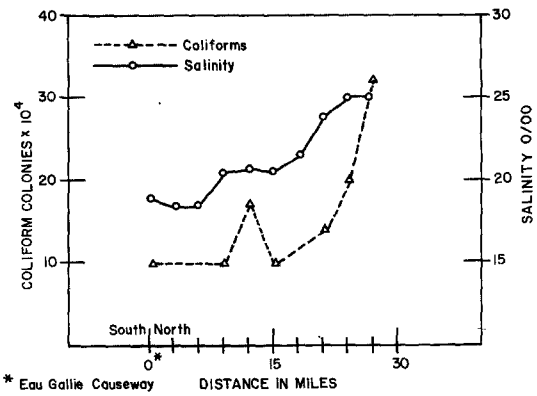

Figure 2. Relationship between Salintiy and Coliforms in the Banana River.

The Coliform population was consistently low during the first 10 miles, but spiked sharply during the next 5. Progressing northward from the Merritt Island Causeway (S.R. 520), both salinity and numbers of coliforms increase, the latter rather sharply. In the area of the Bennett Causeway, about 5 miles north of Merritt Island Causeway, are located locks which control the water flow from Port Canaveral,and the Barge Canal. The contributions that these features might make to salinity and coliform populations in the northern part of the lagoon is not clear. They are, however, the only significant structures in this part of the waterway other than the Bennett and NASA Causeways.

With respect to the chemical and physical parameters investigated, dissolved oxygen remained at near saturation except for one point in the Indian River near the Merritt Island Causeway where it decreased by 10 micrograms per ml. There was no apparent relationship between dissolved oxygen levels and the other factors measured.

The relationship between phosphate and nitrate levels in the Indian River is shown in Figure 3.

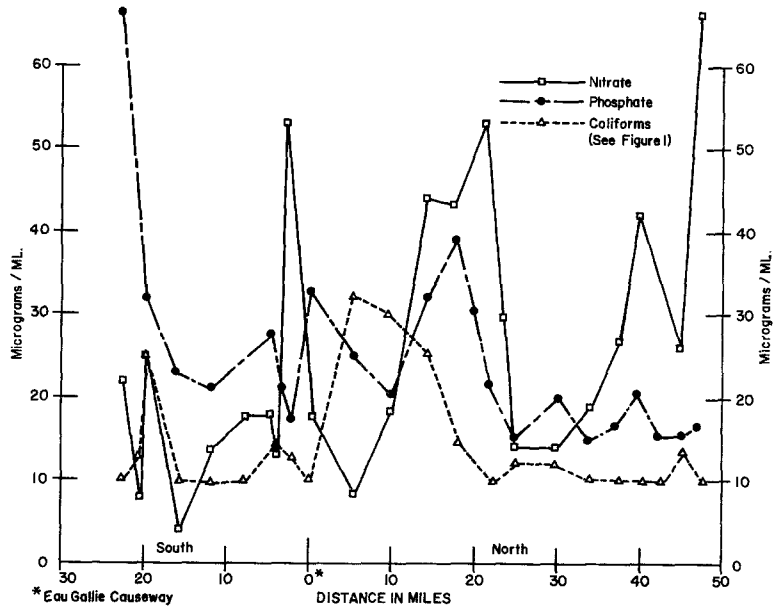

Figure 3. Distribution of Nitrates and Phosphates in the Indian River.

The phosphate level appeared highest in the area of Sebastian Creek, whereas the nitrate level was only moderately increased. Sebastian Creek drains a substantially agricultural area which is fertilized regularly. Proceeding northward, the curves for both ions dropped rapidly then ran essentially parallel for about 10 miles. At this point, about 6 miles south of the Eau Gallie Causeway (0 on the Abcissa), and associated with an increase in coliforms (Figure 1), there began a sharp

drop in the phosphate level and a major rise in the nitrate level. These conditions spanned the 6 mile interval in which are located the outfalls of 2 fairly large, and several small sewage treatment plants.

A second phosphate peak occurred concurrently with a nitrate peak at a location 17 miles north of the Eau Gallie Causeway. This is also an area of citrus farming with attendant chemical fertilization. During the next 4 miles the phosphate level again dropped sharply, but the nitrate level continued to increase. The water in this 4 mile interval also receives sewage treatment plant effluents.

Levels of both ions decreased sharply at the 25 mile mark and remained low until the 36 mile mark when the nitrate level rose, and peaked at the 40mile mark in the Titusville area. It decreased to a moderate level at the 45 mile mark than increased sharply near the north end of the lagoon. The concurrent phosphate levels were low, and fluctuated only within narrow limits.

Figure 4 depicts the nitrate-phosphate relationship in the Banana River.

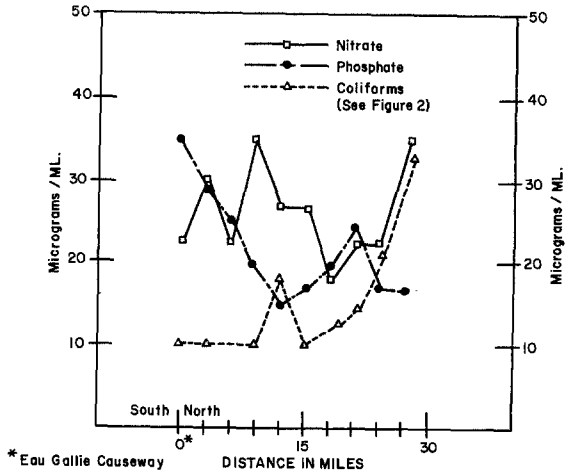

Figure 4. Distribution of Nitrates and Phosphates in the Banana River.

Paralleling that of the Indian River, the phosphate level dropped sharply in the first 12 miles. In the same interval, the nitrate level peaked at the 3 mile mark and again at the 9 mile mark. It then decreased moderately and remained even until the 15 mile mark was reached. The area covered by the nitrate peak encompasses several large residential areas, Patrick Air Force Base, and Cocoa Beach with their attendant sewage treatment plants. In addition, Sykes Creek (New Found Harbor) has its southern terminus in this area. There occurred also a peak in coliforms at the 12 mile mark.

In the area of the second phosphate peak, 21 miles north, the nitrate level was moderately increased. While the phosphate level decreased, the nitrate level remained moderate then rose sharply at the NASA Causeway. In the area of the nitrate plateau ther is a sewage treatment plant a Cape Canaveral, and in the area of

sharp rise are the Barge Canal, Port Canaveral, NASA Causeway and the terminal point for unrestricted boating. In the terminal area there also occurred a sharp increase in the number of coliforms,

In considering these data, certain re-interpretations of the nitrate-phosphate relationship are possible, For example, high levels of phosphate seem to occur in areas of agricultural activity; runoff of that used in soil enrichment. A similar situation in the Cochin Backwater was described by Sankaranarayanan and Qasim (6). High nitrate levels can be associated with high density population areas and the effluents from sewage treatment facilities. When levels of both ions are increased a combination of agriculture and high population is usually demonstrable. However, the pathways by which these ions are utilized in the river are not yet clear.

It is also of some significance that large numbers of coliforms were not found at any sample site at which the nitrate level exceeded 35 micrograms per ml or the salinity exceeded 25 mg per ml. That there were relatively few coliforms found in areas receiving the effluents from large sewage treatment plants probably reflects efficient chlorination of those effluents.

ACKNOWLEDGEMENT

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