Effects of Sewage Effluent on the Ecology of Swan Lake, Grand Teton National Park, Wyoming

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In the summer of 1956 a weekly sampling program was initiated to determine the effects of the introduction of the effluent from a secondary sewage treatment plant upon the ecological conditions in Swan Lake, Grand Teton National Park, Wyoming. The chemical analyses included the determination of dissolved oxygen, free CO_2, alkalinity, pH, phosphates, nitrates, nitrites, and ammonia. The study of biotic features emphasized the analysis of plankton and bottom fauna populations. Coliform counts were also made.

Use of a newly constructed trailer park and public camp grounds at Colter Bay was initiated in June, 1956. The sewage from these installations undergoes primary and secondary treatment and the effluent enters the north end of Swan Lake. The first flow of sewage effluent probably entered the lake in late June or early July, 1956. No measure was obtained of the rate of flow into the lake.

Dissolved oxygen at the three sampling stations (surface and bottom) varied between 3.0 and 6.5 ppm. with but slight differences between stations and between surface and bottom waters until July 17 when the oxygen content in the surface water at Station 3 rose to 8.1 ppm., dropped to 6.1 and 7.0 on August 1 and 7 respectively and then rose again to 8.7 and 8.3 on August 14 and 21, respectively. This condition is explained by the plankton bloom observed at Station 3 at this time (see below). A low O_2 of 2.1 was measured in the bottom water at Station 3 on August 7.

The CO_2 concentration and pH were nicely correlated with the oxygen content and plankton conditions at Station 3. Free CO_2 varied between 2 and 9.5 ppm. during the summer then reached a low of 1 ppm. in the surface water at Station 3 on August 14, and a high of 12.5 in the bottom water at Station 3 on August 7. The pH remained quite constant at all stations during the summer, varying between 7.0 and 7.45, then rose to 7.6 and 7.7 in the surface water, Station 3 on August 14 and 21 respectively, and a low of 6.9, bottom Station 3, August 7.

Laboratory analysis of the oligonutrients (phosphates and nitrogen compounds) showed a very low nutrient content in the lake in general. Right at the outlet of the sewer pipe a very high nutrient content could be measured but this high content disappeared very rapidly and was practically gone outside a radius of some 150 feet from the sewer pipe outlet.

The population of benthic organisms was similar to that found in 1955. A mean density of 53.5 organisms per 6 inch dredge sample at Station 1, and 34.3 organisms per dredge sample at Station 3 compared almost exactly (probably by coincidence) with the figures obtained in 1955. These mean figures consisted of a mean of 34 per cent oligochaeta, 27 per cent Tendipedidae, 37 per cent Chaoborus and 2 per cent Mollusca at Station 1, and 37 per cent oligochaeta, 11 per cent Tendipedidae and 52 per cent Chaoborus at Station 3.

The net phytoplankton was found to consist primarily of the following genera: Astrionella, Staurostrum, Dinobryon, Ceratium, Mallomonas and Volvox. Zooplankters found in the samples were predominately the rotifers Keratella cochlearis, Polyarthra sp., Trichocerca sp. and Pedalia sp. Common crustaceans were Daphnia sp., Ceriodaphnia laticaudata, Bosmina longi rostris and Cyclops bicuspidatus.

Only a small percentage of the plankton samples taken in 1956 have been analyzed quantitatively. Only one definite trend has been definitely established: coincident with the chemical conditions noted which were indicative of a large amount of photosynthetic activity in the surface water at Station 3 in late August, counts showed a bloom of the unicellular green alga Mallomonas reaching a density of an estimated 474,000 cells per liter on August 8 at Station 3. In general this bloom of Mallomonas, followed closely by a less conspicuous bloom of Volvox, began near the outlet of the sewer pipe in early August and continued through the month and brought about the chemical conditions noted above. More detailed quantitative analysis of the plankton samples will be required before the history of the algal blooms resulting from the fertilizing effect of the sewage effluent can be described in detail.

Tentatively it would appear that, as a result of the rather complete mineralization of the raw sewage by the treatment plant, and the remarkable ability of the organisms and suspended organic materials in Swan Lake to absorb and metabolize the nutrients being introduced, no catastrophic changes in the ecology of Swan Lake may be anticipated if the rate of inflow of sewage effluent does not exceed that which occurred in 1956.

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