

of interest and importance to learn the effects, both direct and indirect, of the increased inflow of sewage by way of the sanitary canal and the Des Plaines, upon the fishes and mollusks of the waters of the stream and systematic collections from it at various points on its course, under various conditions and at different times of the year."

The investigations of special interest to municipal engineers are those commenced in 1911, when chemical determinations and biological collections for an analysis of seasonal conditions on the upper Illinois and in related waters, were begun July 18th, and repeated at frequent intervals until Dec. 13th. Similar trips were made in Feb. and Mar., 1912, for a study of winter conditions; and in July, 1912, an elaborate series of oxygen determinations was made for the entire length of the river. Aug. 21st to Oct. 12th two such series were obtained for the upper Illinois; and in Nov. two more, for the whole system, with comparative tests for the Mississippi, below and above the mouth of the Illinois. The situations thus brought more or less closely into comparison were the sanitary canal at Lockport, the Des Plaines River at the same place and at its mouth (Dresden Heights), the Kankakee, just above its mouth, and the Illinois River at Dresden Heights, Morris, Marseilles (both above and below the dam which crosses the river there), Ottawa, Starved Rock, Peru, Hennepin, and Chillicothe. The distances of these points from the mouth of the Chicago River are approximately as follows, in miles: Lockport, 35; Dresden Heights, 53; Morris, 62; Marseilles, 80; Ottawa, 86; Starved Rock, 95; Peru, 102; Hennepin, 116; and Chillicothe, 145, ninety-two miles of this last-mentioned distance being on the Illinois River itself.

Finally, in Mar., 1913, samples of the bottom sediments were collected from all the five Illinois River dams, and from some other points in the main channel, for physical and chemical examination, with a view to ascertaining the condition of the river bottom when the river water has been for some months at or near the freezing point."

Messrs. Forbes and Richardson, for reasons stated, take the years 1897-8 and 1909-10 as the basis of comparison of the plankton production and quality of the waters. The above years are before and after the opening of the Drainage Canal, and, as in the former year the plankton was 3 c.c. per cubic metre of water and in the latter 5.07, "we have sufficient reason for concluding that the plankton production of the stream has been largely increased per unit of volume as a consequence of the opening of the drainage canal, and that, so far as the evidence goes, the ratio of the present yield to the former is at least as 5 to 3. Remembering, further, that the most important plankton product is that of the spring months, when the young fishes are hatching from the egg and are dependent upon the plankton organisms for their earlier growth as fry, we find a special significance in the fact that the plankton yield of the river for the months of March, April, May and June was 2.85 times as great in 1910 as it was in 1898.

"If to these facts concerning the increase, in recent years, in the percentage of plankton contained in the waters of the Illinois, we add those concerning an increase in the average volume and area of the waters themselves, we shall see that their total plankton must have been many times multiplied, and that the fisheries of the stream should feel the effects of this greater abundance of this important element of fish food.

"The importance of an abundance of organic matter in the water as a means of producing a rich plankton

is, in fact, so well known that growers of pond fishes in Europe deliberately manure their ponds to increase the supply of food for their fish; and there is considerable evidence, also, that the plankton of the Elbe is largely increased by the sewage of Hamburg and Altona poured directly into that stream."

The Des Plaines River near Lockport in Sept., 1911, was heavily loaded with sewage wastes, and septic organisms were at the maximum. "The most conspicuous of these was the well-known fungo-bacterium, *Sphaerotilus natans*, a filamentous form, which grows in long, loose, hanging tufts and branches in septic and polluted waters. The stony bottom of the Des Plaines, between Lockport and Dresden Heights, was carpeted with this plant, and with it were associated a considerable variety of *Protozoa*, all characteristic foul-water species."

Sir Rupert Boyees, F.R.S., the eminent English biologist and analyst, when giving evidence at the High Courts of Justice of England in an important Welsh river pollution case, stated that there are two kinds of sewage fungus—*Sphaerotilus* and *Leptomitus*. The first was probably known by the obsolete name of *Beggoatoa Alba*. It is like flock or cotton fluff, and flows in the water near the surface. It usually sticks to twigs in preference to stones and gravel, and the information given by Messrs. Forbes and Richardson is interesting in this respect.

The authors next describe the condition of the Illinois from Dresden Heights to Marseilles. "In July, 1911, it was in an especially saprobic or septic condition, culminating at Morris, if we may judge by the number of septic organisms in the plankton." "The most abundant of these were *Sphaerotilus natans*, detached filaments of which made about 90 per cent. of the number of the plankton organisms in this and the following section." "Flagellate, colorless *Protozoa*, which feed upon bacteria, were also extremely abundant in this section. The largest number of *Oikomonas termo*—a bacterium-eating protozoa—were found at Marseilles above the dam."

"In the Starved-Rock-Chillicothe section of the river the outstanding feature of the plankton was the marked increase in diatoms and other chlorophyll-bearing unicellular organisms, plant and animal, which became sufficiently abundant by the time Hennepin was reached to give the water a characteristic greenish tinge. This greening up of the water below La Salle was noticed, in fact, on a down-stream trip in June, 1910, and was conspicuous to the naked eye in both 1911 and 1912, most noticeably so at lowest water levels."

The dissolving oxygen of the water in the sanitary canal at Lockport ranged from 0.4 of one part per million on Nov. 1st, 1912, to 9.3 parts per million on Feb. 17th, 1912. As temperature has an influence on oxygen-dissolving capacity of waters, the above figures require to be reduced to the percentage of saturation at the temperature observed at the time when the test was made. Consequently, the first was equal to 3.5 per cent. of oxygen saturation and the latter equal to 64.9 per cent.; the average of six observations made was 4 parts per million, or 31.9 per cent. of saturation. Fish were found, but these were either dying or dead, overpowered by the toxic contents of the stream. There were no signs of animal life, and the only insects seen in or on the water were a back-swimmer (*notonecta*) and several water-boatmen (*corixa*), both of which, as they breathe air, can afford to be indifferent to the deficiency of oxygen.

(To be continued.)