CHEMICAL AND BACTERIOLOGICAL EXAMINATION OF THE LONDON WATERS*

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IN the spring of 1916, when the growth of Fragillaria and Asterionella was very active, a great many laboratory experiments were carried out to see how far multiplication took place in non-algal affected water when artificially "seeded" with very small amounts of water in which algæ or other growths were flourishing, and also what conditions favored and inhibited the occurrence of these changes. In 1917 the matter was again investigated and further information obtained, and the novel procedure was adopted of micro-photographing the growths in the water so as to yield a permanent quantitative and qualitative record of what had actually taken place. There was a time when filtration difficulties were put down to the presence of fish spawn in the water. We now know differently, and within limits can even imitate artificially the operations of Nature, and study the factors favoring or inhibiting the development of algal and other growths. It must not be supposed that the hard Thames, Lee and New River waters are alone susceptible to these growths. In the winter of this year the experiment was tried of inoculating a very soft moorland water with 1 per cent. of Banbury (Walthamstow) reservoir water, which at that time was fostering the growth of Asterionella.

Algal Growths

The size of algal and other growths in water varies according to circumstances, chiefly unknown. For example, sometimes Cyclotella may be so relatively large that it is apt to be confused with Stephanodiscus, and sometimes the converse is true. In much the same way Asterionella may occasionally take on a larger mode of growth.

The water in King George's reservoirs developed a peculiar color in 1916, which persisted until the autumn of 1917, when the south reservoir cleared, but the north reservoir water is still (1918) abnormal in color. Seen in a bottle the color was hardly visible, but when viewed in bulk in the reservoirs it had a decidedly reddish-purple tint. When alum was added to the water, the flocculent precipitate produced was decidedly pink in color. Under the microscope minute cells, like cocci, embedded in a gelatinous material were observed, and there can be little doubt that the red colorization was due to the presence of a Palmella-like growth, comparable to that producing the phenomenon known as "red snow." (? Protoccus Nivialis or Palmella Cruenta). It has frequently been pointed out that in algal treatment the offending growths can be destroyed, yet the risk may remain of other and more resistant growths taking their place. A notable instance occurred in 1917 during the continuous treatment of No. 1 reservoir at the West Middlesex Works with copper sulphate (1 in 4 millions). The growths (Fragillaria, Asterionella, Stephanodiscus, filamentous confervoid growths, etc.) affecting the neighboring reservoirs were almost completely held in check, but a fresh growth, composed of such excessively minute cells that they pass readily through four folds of fine linen, developed abundantly and caused serious blocking of the filters. Incidentally, this result shows that linen filtration results cannot always safely be compared with slow sand filtration.

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In August, 1915, a very decided growth of Stephanodiscus occurred in the Stoke Newington reservoirs, causing rapid choking of the filter beds. At the beginning of July, 1917, a very similar growth (Cyclotella) began to develop, but the part played was no longer a passive one. By a judicious combination of chlorine and copper sulphate treatment the filtration difficulties were entirely overcome, no water was wasted, and the use of the reservoirs as settling and purifying agents was practically continuous. The procedure was to shut off the west reservoir for a few days, whilst it was being treated with copper sulphate (1 in 2 millions), and to short-circuit chlorinated water through the east reservoir on to the filter beds. A recrudescence of the growth occurred later on more than one occasion, but it was each time dealt with in a similarly successful manner.

During the January, 1918, flood, when the River Thames was at its worst (January 16-27), Staines stored water was used for filtration purposes. Fortunately the water was in a very good condition, but emphasis must again be laid on the fact that almost insuperable filtration difficulties might arise if the Staines water was badly affected with algal growths coincidently with a heavy Thames flood. It is perfectly true that in the late autumn and in the winter months, when floods are most likely to occur, the growths in the Staines reservoirs are usually at a minimum, but the 1903 summer floods are not easily forgotten. Whilst dealing with Staines reservoir water, attention should be directed to the rather abundant growth in the water, especially about June, 1917, of Glenodinium. In this year (1918) advantage was taken of the mid-January floods to test the "resistance to filtration" of the River Thames daily and also to obtain pictorial records of the state of the water.

It may be practically impossible to close the "intakes" during the whole of a flood, but there is no good reason why the worst water should not be excluded from the storage reservoirs. The chemical and bacteriological qualities of flood water have been so frequently dealt with in previous reports that all that need be said here is that on January 18th, 21st and 22nd the color of the River Thames was actually 428, 452 and 420 respectively, as against an average color of 71 (1906-16). The admission of water of this quality into storage reservoirs is a most undesirable "leavening" process. Our knowledge of growths in reservoir water may be limited—our knowledge of most things is necessarily imperfect, but so far as it goes, it points unequivocally to the exclusion of impure flood water.

Growths in River and Stored Water

In previous reports it has been explained that river water usually contains so few living growths that any difficulty experienced in its filtration is largely due to the presence of amorphous dead matter (*e.g.*, mud and silt). Unless then developmental changes occur in the storage reservoirs, it might be expected that the suspended matters would largely settle out and the outlet water from the reservoirs filter extremely well. This indeed is found to be true in the cases of some of the reservoirs (notably Walton and Chelsea). On the other hand, if developmental changes do occur in the reservoirs, the gain in settlement of the dead suspended matters may be largely, if not entirely, lost by the blocking effect of the new living growths.

Walton and Chelsea are excellent examples of reservoirs which, for some reason or another, have not, so far, favored any luxuriant algal or other growths. The average "filtration figures" based on the examination of samples collected bi-weekly for the calendar year 1917