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REPORT

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ATTRIBUTABLE TO THE

CONTAMINATION OF DRINKING-WATER BY MEANS OF IMPURE ICE.

BY A. H. NICHOLS, M.D.

OF BOSTON.

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Rye Beach is an attractive and popular seaside resort upon the coast of New Hampshire, about fifteen miles distant from the north-eastern corner of Massachusetts; during the months of July and August of each year it is thronged with visitors from the large cities.

At the beginning of the season of 1875, there broke out among the guests of one of the large hotels of this place, a somewhat extensive, though comparatively mild epidemic. Being the only practising physician in the vicinity, I was requested by the proprietors of the hotel to make a detailed investigation as to the causes of the disorder. The results of this examination revealed a novel and commonly unsuspected source of contamination of drinking-water, and they have, therefore, seemed to me worth communicating to the Board of Health. The disorder in question may be comprehended under the general term disturbance of the digestive system, characterized by a sensation of giddiness and nausea, vomiting, diarrhœa, severe abdominal pain, all of which was accompanied by fever, loss of appetite, continued indigestion, and mental depression. The epidemic, although confined within very limited boundaries, baffled for a considerable time all efforts to trace the trouble to any specific cause; while the *origo mali*, when ultimately detected, proved to be contained in an article of ordinary consumption, usually considered as above suspicion as regards innocuousness. The first few cases coming under observation did not attract particular attention, inasmuch as the symptoms manifested did not differ essentially from those noticed among the visitors in previous years, and

induced by drinking the well-water of the place, which, especially when the wells are low, is strongly impregnated with sulphate of lime, carbonate of lime, and magnesia. It very soon became apparent, however, that the trouble was limited to the inmates of a single hotel, accommodating about 300 guests, whereas the occupants of another public house, containing rooms for about 200, and distant but one-eighth of a mile, were enjoying an absolute immunity from all illness; nor was any similar trouble known among the neighboring cottages, containing at least 500 visitors.

This peculiar grouping of the patients rendered it, therefore, tolerably certain that the whole disorder must be referred to some specific, local origin, to be sought for in the immediate vicinity of the hotel; and popular opinion pointed very strongly, from the outset, to the drinking-water. This was drawn from several wells, all sunk in an elevated ridge, and safely removed from drains, cesspools, dung-heaps, or other source of pollution. It was also ascertained, upon inquiry, that, in some instances, those persons affected, having apprehended trouble from the use of the water, had carefully limited themselves since their arrival to other beverages, but, as afterwards transpired, had not hesitated to use ice, either melted or otherwise.

With respect to the drainage of the house, it appeared that during the previous winter the services of competent engineers from Boston had been secured, under whose supervision an elaborate and complete system of sewerage had been recently constructed, by means of which all the discharge from the various sinks and water-closets was conveyed directly into the ocean. The point of discharge of this sewer was at a safe distance from the house, while the sewer itself was securely trapped and ventilated in such a manner as to preclude the idea of the escape of any foul gas within the house.

Attention was next directed toward the cooking utensils, but all the articles pertaining to the kitchen were found to be scrupulously clean, nor did it appear that any agent or utensil was employed in the preparation of the food which would in any way tend to produce the symptoms complained of. Furthermore, the milk-supply was investigated, and found to be of unquestionable purity.

The process of elimination was in this manner continued, until at length suspicion became directed to the supply of ice furnished to the house. It may be mentioned at this point, that a large portion of the ice consumed in this town is gathered from shallow ponds, formed during the winter by the flooding of meadows, and, therefore, contains as a rule, more or less grass and other vegetable matter, and is consequently far less transparent than the article commonly supplied in our large cities. I was not particularly surprised, then, to find that the ice in this case was rather impure and opaque, and that it contained numerous foreign substances varying in size, and apparently of vegetable origin.

The theory that the outbreak, now increasing in extent and severity, was dependent upon the ice-supply, was suddenly strengthened by some pretty direct evidence, of which the following examples may be given:—

1. A resident of the place, upon being questioned upon the subject, volunteered the testimony that during the previous winter he had taken home some ice from the same pond where the ice-supply of the hotel was obtained, and having consumed a portion with the view of testing it, had experienced nausea and distress for the remainder of the day, which led him to decide that it was unfit for use.

2. Several persons affirmed that they detected a decidedly disagreeable odor emanating from the ice as it melted.

3. Two gentlemen having taken a quantity of ice with them upon an excursion, and drunk the water formed from it, were made violently ill.

4. The atmosphere of the house in which the suspected ice was stored was found to be decidedly offensive.

5. When some of the melted ice-water was poured into a glass, and held in front of a dark-colored object, a strong light striking the glass from one side, it was found to be decidedly discolored, and charged with suspended matter.

A visit was now made to the pond, and the condition of things here found removed all doubt as to the exceptional foulness of the water from which the ice was formed.

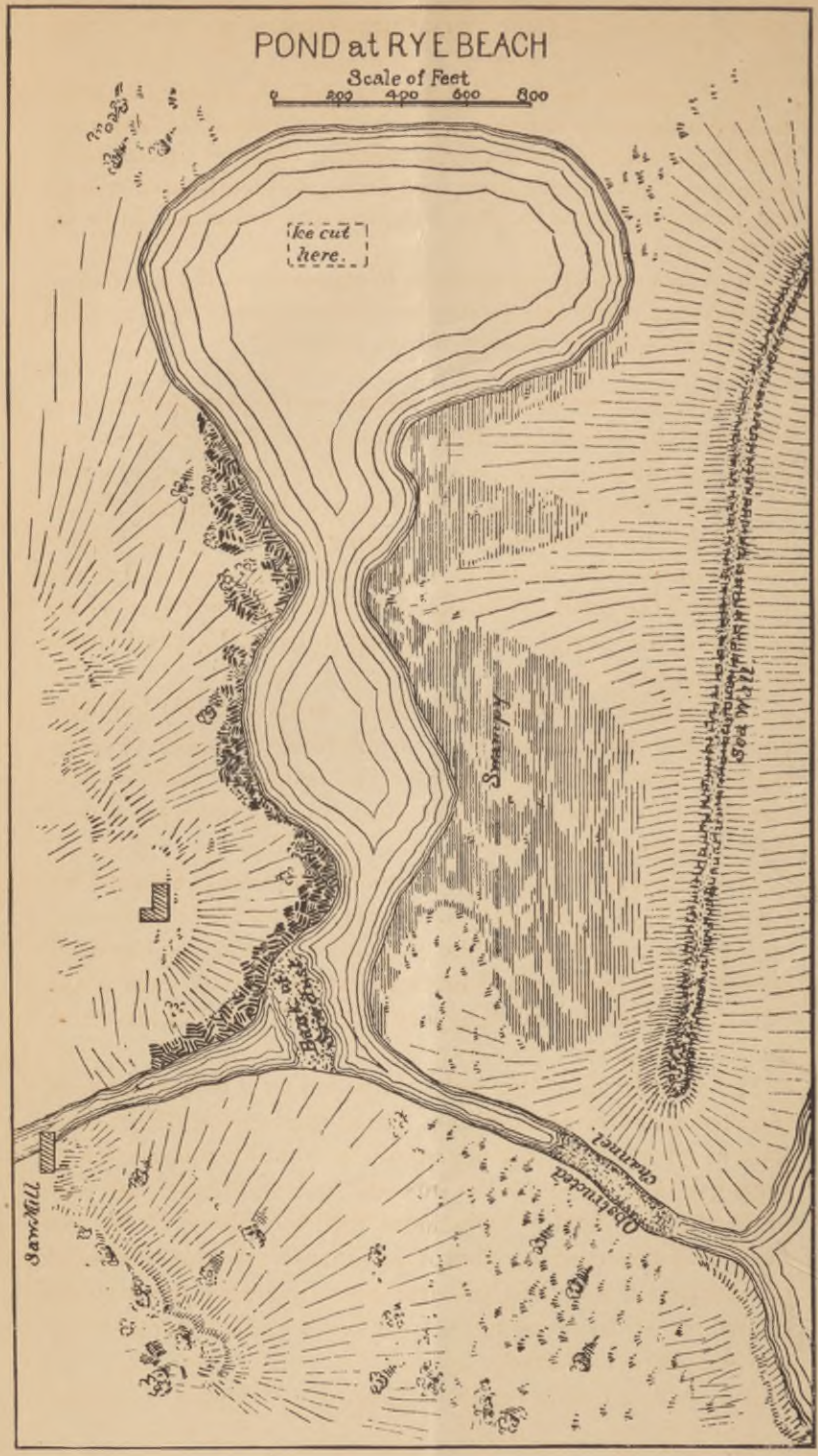
This pond is a flooded marsh, of irregular outlines, about two-thirds of a mile in length, and varying in width from 200 to 800 feet, with a uniform depth of about two feet. The

source of the water-supply was a small brook entering the lower end of the pond (bringing down all the sawdust from two neighboring saw-mills), and several springs said to be situated at the upper end. There had formerly existed an artificial channel, by means of which was maintained a direct communication between the pond and the ocean; but for the past two years this channel had been filled up with sand and stones thrown up during heavy storms by the action of the sea, which drives in here with extreme violence. Of late, therefore, the water of the pond has become practically stagnant, although a small quantity constantly percolates a bank of gravel separating the pond from the ocean.

A glance at the lower end of the pond was sufficient to demonstrate the source of the foulness of the water, for at this point, a space of about 500 long and 150 feet wide, directly in front of the mouth of the brook, was occupied by a homogeneous mass of putrescent matter, composed of *marsh mud* and *decomposing sawdust*. The water in the vicinity of this bank was discolored black, and when stirred up emitted an intolerably offensive odor. Several large houses are situated at no great distance from this end of the pond, the occupants of which, upon being questioned, asserted that when the water was stirred up by the rowing of boats, or ruffled by a wind blowing in the direction of the houses, the air was not unfrequently polluted to such an extent as to render it necessary to close the windows. Of course there could be no question but that this foul matter held in suspension in the water was conveyed by currents and winds to every part of the pond, and in sufficient quantity to render the water in every part absolutely unfit for drinking purposes.

In order to obtain further evidence as to the admixture of this foul matter with the ice, a quantity of the ice having been cleansed from all surface impurities was placed in a tub to melt, and the water thus obtained was poured into a fresh demijohn, sealed and forwarded for analysis to Prof. W. R. Nichols, who reported as follows:—

"The water contains in suspension a considerable quantity of vegetable matter more or less decayed, and possesses a slightly disagreeable odor, which becomes more evident if the water is warmed.


POND at RYE BEACH
Scale of Feet
0 200 400 600 800
Ice cut here.
Stream
Obstructed
Channel
Saw Mill

"Of the organic matter which is suspended in the water, and which may be removed by filtration, a portion, consisting of the larger and heavier particles, settles somewhat readily. Another portion, being more finely divided, remains for an indefinite time diffused through the water, and would be drunk by any one using the ice in the ordinary way.

"I do not think it unreasonable to suppose that the presence of this decaying organic matter may have been instrumental in bringing about the unpleasant results you have observed."

A sample of water was likewise taken for examination from the pond in question. This sample was obtained from the central portion of the pond, in the early morning, when no air was stirring, and the water being quite calm and undisturbed by undercurrents, the greater portion of any matter held in suspension would at that time be precipitated to the bottom of the pond. Consequently, the sample taken would represent the purest water obtainable from the pond under any circumstances.

The numerical results of these analyses are herewith appended. For the purpose of affording a means of comparison, there are also presented the results of analyses of a sample of ice supplied by the Boston Ice Company, and of the Cochituate water.

The subjoined sketch of the pond (drawn by Edward K. Clark, C. E.,) will serve to convey an idea of the general outline and character of the pond, the location and relative extent of the bank of sawdust and marsh mud by which the water was fouled, and the portion of the pond from which the ice was taken.

The proprietors of the hotel, impelled by a proper sense of the responsibility resting upon them, rendered willing assistance in ferreting out the source of the trouble, and as soon as suspicion was directed towards the ice, its further use was promptly prohibited. Coincident with this disuse of the ice, there was observed an abrupt amelioration in the symptoms of nearly all who had hitherto been ill, while during the remainder of the season, no fresh cases of this character are known to have occurred.

The evidence thus collected seems to render it almost

certain, that the illness in question was induced by the consumption of ice contaminated by decomposed organic matter.

As to the actual, or relative, number of those made ill in this manner, no exact estimate can be made, for the symptoms were, as a rule, not sufficiently severe to necessitate the aid of a physician.

As an approximate estimate of the extent of the mischief produced, it may be said in round numbers, that the ice was consumed in variable quantities during a period of six weeks by five hundred individuals. Of these, twenty-six adults were known to manifest grave, continued, and characteristic symptoms. A large number, probably the majority, of the guests drank the contaminated water with apparent impunity. In some, although decided illness was induced during the first two or three days after their arrival, an habituation to the water seemed to be afterwards acquired, and they enjoyed a subsequent immunity from all trouble. In the case of several, on the other hand, the stomach seemed to resent with ever-increasing emphasis the presence of the foul water, nor was relief obtained until after the patients had quit the place. Thus many who had come from a long distance with the hope of strengthening and improving their physical condition, returned home depressed, and without even having preserved the health they previously had.

It is worthy of remark, that no person under the age of ten was known to be affected by the impure ice.

Great responsibility devolves upon those who undertake to provide food and drink for large numbers of individuals, and to such the above experience inculcates the importance of giving especial attention to the purity of the drinking-water, and guarding against every possible source of contamination.

The notion that ice purifies itself by the process of freezing, is not based upon trustworthy scientific observation. On the contrary, it is utterly wrong in principle to take ice for consumption from any pond the water of which is so fouled as to be unfit for drinking purposes.

Numerical Results of Analyses.

COMPONENT PARTS.	ICE TAKEN FROM CONTAMINATED POND AT RYE BEACH.*				ICE SUPPLIED BY BOSTON ICE COMPANY.†	
	Results expressed in parts per 100,000.		Results expressed in grains to U. S. gallon.		Results expres'd in parts per 100,000.	Results expres'd in grains to U. S. gallon.
	Unfiltered.	Filtered.	Unfiltered.	Filtered.	Unfiltered.	Filtered.
Ammonia,	0.0208	0.0213	0.0121	0.0124	0.0045	0.0026
Albuminoid ammonia,	0.0704	0.0165	0.0410	0.0096	–	–
Inorganic matter,	7.80	6.88	4.55	4.01	0.45	0.26
Organic and volatile matter,	5.72	2.84	3.33	1.66	0.31	0.18
Total solid residue at 212 deg. Fahrenheit,	13.52	9.72	7.88	5.67	0.76	0.44
Chlorine,	–	3.23	–	1.88	Trace, less than 0.02	Less than 0.012
Oxygen required to oxidize organic matter,‡	–	0.334	–	0.495	0.033	0.019

* Small amount of nitrates.

† Trifling amount of suspended matter.

‡ Determined by permanganate of potash.

Numerical Results of Analyses—Continued.

COMPONENT PARTS.	WATER TAKEN FROM POND AT RYE BEACH.*		Cochituate Water. Mean of a number of determinations. Results expressed in grains to U. S. gallon.
	Results expres'd in parts per 100,000.	Results expres'd in grains to U. S. gallon.	
Ammonia,	0.0197	0.0115	0.0020
Albuminoid ammonia,	0.0597	0.0348	0.0068
Inorganic matter,	64.96	37.88	1.61
Organic and volatile matter,	8.00	4.66	1.22
Total solid residue at 212 deg. Fahrenheit,	72.96	42.54	2.83
Chlorine,	34.00	19.83	0.18
Equivalent to chloride of sodium,	56.03	32.68	–
Oxygen required to oxidize organic matter,	1.28	0.75	–

* Residue blackens strongly when heated. Evidently a large amount of organic matter.