geographers, few subjects are so broadening or furnish such a perspective for the world problems of our day. At the same time, the practical applications of geographic techniques are increasingly apparent. To the furtherance of these objectives these volumes make conspicuous contribution.

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SPECIAL ARTICLES

FISH MORTALITY PRODUCED BY OXYGEN DEFICIENCY

THE writers have had various cases of fish mortality brought to their attention during this past winter and have had an opportunity to investigate one rather large and unusual situation located at the ox bow of the Connecticut River about two miles down stream from Northampton, Mass., at the confluence with the Manhan River.

The separation of this ox bow from the main stream resulted from a freshet in 1840 which shortened the channel of the river by about three miles, cutting across the narrow end as illustrated (see cut). The

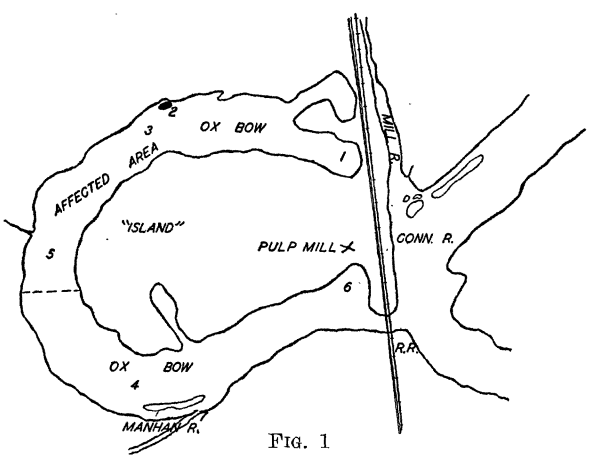

FIG. 1

Manhan joins the ox bow on the outlet side about one mile from the present junction with the Connecticut River. Several miles down stream at Holyoke, Mass., a large power dam exists that has slightly raised and sustained the general level of the river at this place.

During the past winter, the low temperatures in this locality were of quite a long duration. Still water was frozen over from early December to March 10. No thaws of sufficient intensity to break up the ice occurred during this interval.

On February 25 the attention of the writers was called to the large quantities of dead and dying fish at one small opening in the ice of approximately 250 to 300 square feet. This condition was known to have existed on February 23, when a local game warden was notified. At this place several hundred fish of various lengths and of the following species were found.[1]

[1] The writers are indebted to Dr. E. C. Driver, of Smith College, and Dr. R. E. Trippensee for additions to the list of fishes.

Ameiurus nebulosus (LeS.)	*Micropterus salmoides* (Lac.)
Eupomotis gibbosus (L.)	*Esox reticulatus* LeS.
Lepomis pallidus (Mitch.)	*Catostomus commersoni* (Lac.)
Pomoxis sparoides (Lac.)	*Anguilla chrysipa* Raf.
Perca flavescens (Mitch.)	Dace and shiners

Dead fish were observed at air-holes in other parts of the affected area. The large numbers and the wide range of species indicated that death was produced by extraneous causes. Some small fish (probably immature perch) were seen alive at the largest opening and were in no apparent distress.

Station No.	Dissolved O_2
1	0.8
2	0.8
3	0.8–1.6
4	1.6–6.0
5	0.4
6	9.8
7	7.9–8.7

Field determinations of the dissolved O_2 content of the water from February 25 to March 10 in the upper half of the ox bow (the affected area) showed 0.4 to 1.6 parts per million as opposed to 8.0 parts per million in the Manhan River. Near the junction of this river with the ox bow the dissolved O_2 varied from 1.6 to 6.0 parts per million. At the lower end of the ox bow, where the water probably was oxygenated by the Manhan and the operations of a nearby pulp mill, the waters contained 9.8 parts per million of dissolved O_2 on February 25. This last reading may have been affected by the wastes from the mill, but on the date of observation a number of fishermen were catching a few yellow perch at this place, all in apparently good condition. At no time were any dead fish found in this area. The dissolved O_2 showed diminution during the period of observation from February 25 to March 10, from 1.6 parts per million to 0.8 parts per million. The water showed a pH of 5.3 throughout, at all times.

This situation was partially relieved on March 10, because of accumulated rain water which broke through the ice, and completely relieved by the flood of the Manhan River on March 11. On March 10 the small fish formerly observed at the first opening were gone. At the time of the flooding, the extent of the

loss of fish became apparent, numbers of dead fish being observed around the edge of the affected areas.

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PATHOGENICITY AND VIRULENCE OF CERTAIN BACTERIA

INCIDENTAL to studies on the egg-propagation of certain filtrable viruses as previously reported[1, 2] opportunity was afforded for observing the effect of introducing several species of bacteria into developing eggs of the chicken and other domesticated fowl. At the outset the sensitivity of the embryo and its membranes to various filtrable viruses and to numerous toxic influences[3, 4, 5, 6] was reflected in the response to the injection of different concentrations of *Salmonella pullorum*. With given strains of freshly isolated *S. pullorum* the extent and severity of the lesion produced as well as the survival time of the embryo were quite definitely and uniformly correlated with the quantity of the inoculum and the virulence of the culture for baby chicks.

These results suggested the possible adaptability of the method of egg inoculation for determining the pathogenicity and for ascertaining the virulence of various strains and species of bacteria. In investigating this hypothesis the preliminary observations here recorded were confined to inoculations upon the chorio-allantoic membrane of eggs incubated 10 to 15 days prior to treatment. The cultures used represented 4 strains of *Brucella abortus,* var. *bovis* and *suis,* 3 strains of diplococci of equine origin, 3 strains of hemophilic bacteria isolated from the upper respiratory tract of young chickens, 8 species of Salmonella and 3 species of Pasteurella. Eggs employed as controls were injected with the sterile suspending medium or with suspensions of the various bacteria killed by heat. Proof of infection of the embryo and/or its membranes was established by the production of gross lesions and direct pure culture isolation of the organism inoculated.

The cultures of diplococci and hemophiles appeared virtually devoid of pathogenicity for the developing egg even in the relatively large quantities employed (as much as 0.2 cc of the undiluted 15 to 24-hour broth cultures). These 2 groups of organisms in other trials were not proved to possess specific pathogenic properties for the homologous host. Brucella, Pasteurella and Salmonella cultures were lethal to the embryo in very dilute concentrations, while the control suspensions of dead organisms produced no more than slight local injury to the extra-embryonic tissues and were seldom associated with the death of the embryo.

Marked differences in virulence for developing eggs were manifested between smooth stock and freshly isolated cultures of Salmonella and Pasteurella. Simultaneous comparative titrations with Pasteurella cultures on 2 to 10-day old chicks revealed a correlation in results, although much less definite and uniform than in the egg-inoculation method. The *P. avicida* culture, when inoculated subcutaneously, killed chicks in dosages 10^7 times smaller than were required with the *P. equiseptica,* while *P. cuniculicida* required larger doses than *P. equiseptica.* For eggs the *P. equiseptica* and *P. cuniculicida* required dosages approximately 10^4 times greater than did *P. avicida* to kill chicken embryos within 48 hours. Intracranial inoculations of the *P. avicida* and *P. equiseptia* strains into a group of 9 horses gave results which could be interpreted as validating the titrations upon eggs and chicks. However, the more uniform and accurate measurements of virulence obtained by egg inoculation as compared to animal inoculation emphasizes the superiority of the new method.

The delicacy with which differences of pathogenicity and/or of virulence among strains of certain bacteria may be determined by inoculating the developing avian egg suggest that this method may also be utilized to detect alterations in these characters among variants of a certain strain.

The potential value and adaptability of the developing avian egg for other phases of purely bacteriological investigation and experimentation is suggested by the findings here reported and in consequence of the simplicity of application and economy of the method.

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DOWNWARD SHIFT OF pH CAUSED BY ADDITION OF GLUCOSE TO BORIC ACID BUFFER SOLUTIONS

THE accompanying table was prepared for use in a study of O_2 consumption by yeast. It may be useful in other studies. In each test, to 20 ml of boric acid buffer solution (prepared according to Clark: "Determination of H ions," 2d ed., 1928; table 35) was added a known weight of glucose, as shown, and the resultant pH value (at 25°) was measured potentiometrically (quinhydrone electrode).

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