St. Jerome's Creek from 1880 to 1885; while the most conclusive and irrefragable evidence is that obtained as the results of experiments instituted by Professor Brooks and Messrs. Blackford and Mather during the present year.

The maximum efficiency of the cultch is not realized in any of the old forms of collectors, for the reason that the cultch cannot be kept clean; second, because both sides of the cultch cannot be exposed to the passing fry; third, because the fry cannot be forced to pass over and amongst the cultch repeatedly; fourth, because the cultch has hitherto been scattered over too great an area, and throughout only two dimensions of a body of water, namely, its horizontal extent, whereas it is possible to do far more; that is, to avail ourselves of the possibility of obtaining spat throughout the three dimensions of a body of water charged with embryo oysters in the veliger condition. These are good and sufficient reasons for my assertion that cultch has hitherto been wastefully and unscientifically applied.

The new method outlined above will be explained in detail, with plans drawn to scale, in an extended illustrated article of mine now ready for publication by the U. S. fish commission. In fact, as a result of scientific inquiry, it has come about that there may be applied a more effectual means of diminishing the mortality and frightful waste of oyster embryos, which occur under the stress of those natural conditions which determine the 'struggle for existence.' This result was predicted at the close of a lecture delivered in 1883 by Professor Huxley, in these words: "I, for my part, believe that the only hope for the oyster-consumer lies first in oyster-culture, and, second, in discovering a means of breeding oysters under such conditions that the spat shall be safely deposited. And I have no doubt that when those who undertake the business are provided with a proper knowledge of the conditions under which they have to work, both these objects will be attained."

JOHN A. RYDER.

PASTEUR AND HYDROPHOBIA.

PASTEUR'S communication upon the treatment of hydrophobia by inoculation, to which reference was made in a recent number of *Science* (Nov. 6), is fully and authoritatively reported in the *Comptes rendus* of Oct. 26. His present results are based upon a series of experiments upon rabbits and dogs, extending over a period of three years. So numerous have been these experiments, and so uniform and certain their results, that he has no hesitation in applying these results to other animals, including man.

Pasteur finds, that if a rabbit be inoculated by trepanning the skull, and placing beneath the dura mater a bit of spinal cord from a dog which has died of rabies of the streets (*rage des rues*), the animal always develops hydrophobia after a period of incubation of about fifteen days. If from the spinal cord of this first rabbit a second be inoculated in a similar way, and from the second rabbit a third, and so on in regular series, it is found that the period of incubation becomes shorter and shorter, until, after the virus has thus passed through forty to fifty rabbits, the duration of incubation is reduced to seven days. The incubation has remained at this point for a series of ninety inoculations, and it shows no tendency further to decrease. The virus has now reached its highest degree of intensity, and it remains of a constant quality. It is possible, therefore, to have such a pure virus of rabies at all times at disposal.

If portions of the spinal cord of rabbits which have died of this intense rabies be cut out with every precaution to prevent contamination, and if these portions of cord be suspended in a dry atmosphere, the virulence of the poison progressively disappears until it is completely extinguished. The time required for the extinction of the virus varies somewhat with the thickness of the cord, but especially with the temperature. The lower the external temperature, the longer the virus lasts. To preserve the cords, Pasteur places them in flasks, in which the air is rendered dry by bits of potash in the bottom of the flasks. It is possible, therefore, to have the virus of rabies in all degrees of intensity.

In order to render a dog refractory to hydrophobia, it is necessary to inoculate him with a series of spinal cords from rabbits dead of rabies, beginning with cords containing the weakest virus, that is, the cords longest preserved, and ending with cords containing the most intense virus, that is, cords preserved only one or two days. The animals are inoculated every day with cords representing successively each day or each two days of preservation. The inoculation is effected by injecting beneath the skin a Pravaz syringeful of sterilized bouillon in which a fragment of the spinal cord has been rubbed up. In this way complete immunity to the disease is established; so that, after the treatment is finished, the animal can be inoculated either subcutaneously or beneath the dura mater, with the most intense rabid virus, and no symptoms of hydrophobia appear. Pasteur has fifty dogs, of all ages and of all races, which in this way, without a single failure, he has rendered refractory to hydrophobia. The treatment is effectual even if it be applied after the dog has been

bitten by a rabid animal. Experiments are now in progress to determine how long an interval may elapse before the treatment ceases to be effectual. This interval is at least a number of days.

In the case of the boy Joseph Meister, who was successfully treated by this method, Pasteur began the inoculation sixty hours after the reception of severe bites by a rabid dog. The first inoculation was with a portion of spinal cord which had been preserved fifteen days. The treatment lasted for ten days; in all, thirteen inoculations were made, each one with a cord one day fresher than that used in the preceding inoculation; at the last inoculation there was used a cord preserved only one day, and containing a virus which produced rabies in a rabbit in seven days; that is, a virus more malignant than that in the bite of a dog affected with the rabies of the streets. The boy was kept under observation, and at the time of Pasteur's communication — three months and three weeks after the bite — no symptoms had developed.

After Pasteur's communication, Vulpian advised that a service be organized for the treatment of rabies by Pasteur's method.

Pasteur is unable to explain in what way immunity is produced by his method of inoculation. He thinks that the virus is altered in quantity rather than in quality by his method of preserving the cords. He notes the interesting fact, that, if the cords are preserved in a moist atmosphere of carbonic acid, with oxygen excluded, the original virulence remains unchanged, even after several months.

The full details of Pasteur's experiments upon animals, with description of symptoms and of *post-mortem* examinations, will be awaited with great interest. It is a matter of regret that we are not informed as to the nature of the virus, which, indeed, does not seem to have been discovered. It is probable that Pasteur's studies in this direction will lead to fruitful results.

A large number of observations are necessary in order to establish the efficacy of Pasteur's treatment of hydrophobia in human beings. His results certainly warrant a belief that, if the treatment be begun soon after the reception of the poison, this otherwise most hopeless and dreadful disease can be prevented. Should this belief become a proven fact, then Pasteur will merit the gratitude of all mankind.

THE PLAINS OF BRITISH AMERICA.

Striking contrasts present themselves to the experienced eye between the plains of British America, through which the lately finished Canadian Pacific railway has laid its tracks, and those crossed by any of the transcontinental lines in the United States. In the first place, they are larger. It is more than 1,000 miles from where the forested granites of Keewaydin dip under the Silurian prairie-floor in the Red River valley to the first escarpments of the Rocky Mountains. In Kansas it is hardly half as far between the wooded region and the foot-hills of Pike's Peak.

Another feature is the prairie-like look of it all, save certain far-western tracts. The grass is dense and long, flowering herbage is profuse. West of the South Saskatchewan this gives place to a greater, more 'plains' like scantiness of vegetation, to be sure, but nowhere is the bareness and aridity of the southern plains equalled.

This is due to the greater moisture in earth and air, and to the extraordinary fertility of the soil; Manitoba producing an average of 21½ to 22 bushels of wheat to the acre, or 4 to 5 bushels in excess of the average of any other similar space on the continent. The soil is coal-black, and declares its richness at first sight. Dr. Robert Bell, of the Canadian geological survey, discussed the causes of this fertility before the Canadian royal society, May 23, 1883. He pointed out that the materials were the best possible, having been derived from the glacial drift of the north, mingling sand and gravel with the cretaceous marls spread over all British America. Having this favorable constitution, Dr. Bell assigns to the moles the chief agency in the formation of the thick top-layer of vegetable mould which is now the joy of the farmer. In the Assiniboine valley the moles have thrown up almost every foot of the soil into hummocks, each containing a large shovelful of earth, and burying completely the grass and vegetation over a space a foot or more square. The vegetable matter thus buried decays, and becomes incorporated with the soil; so that the process is analogous to ploughing under the soil. This work of the moles not only enriches, but refines the soil. In making their burrows, they select the finer material and cast it up to the surface, leaving behind the coarser. The effect of this is similar to that alleged by Darwin of the earthworms (which do not exist in the north-west territories), since, in the course of time, all the stones are buried. Their labor is supplemented by that of the gophers, spermophiles, and badgers, the last named digging deeply, and heaving up large quantities of gravelly subsoil, which the moles work into and improve, while all bury much vegetable rubbish as nests and food. This beneficent animal agency nearly ceases, however, when the elevated hard and stony 'third steppe,' called the Grand Coteau du Missouri, is reached, and when the mountains are approached, where the soil is clayey.