and Mr. Clayton points out that observations in the high regions of the atmosphere afford criteria for determining which of the four types of instability is most predominant in a cyclone.

The kite observations at Blue Hill seem to show according to Mr. Clayton that the first type of instability is not all important, but it must be remembered that these kite observations do not extend beyond 3000 meters above sea level, and although Mr. Clayton considers also the balloon observations which have been made in Europe, still we think that his conclusion is more or less tentative (as no doubt Mr. Clayton intends it to be) but he seems to lose sight of the fact that the vertical stability theory, No. 1, requires a high pressure area in the higher regions to be directly above a low pressure area at the earth's surface. Thus Mr. Clayton seems to think that the observations of March 24, 1899, showing a low pressure area near the earth's surface in Italy and a low pressure area in the upper air over Finland, is against the vertical instability theory. Further, after a cyclone has been some time under way the upward current near the center of the cyclone would undoubtedly produce a mass of warm air extending to enormous altitudes immediately above the center and that, therefore, the absence of a cold stratum within the range of the observations is not decisively against the vertical instability theory.

Furthermore, the force of Dr. Hann's objection to the preponderating influence of the third type of instability, that cyclones are more frequent and more violent in winter than in summer, is weakened by the fact that our position with reference to the polar and equatorial winds is very different in winter than it is in summer so that the influence of the fourth type of instability is greatly different at these two seasons and may mask the effect of the third type.

The probability is that one type of instability may preponderate in one place or one season and another type in another place or season.

The present writer is inclined to think that as a rule, the first type of instability furnishes the energy of cyclonic movement and that the fourth type determines the line of progress or the path of the cyclone; that the second type of instability is the cause of the local disturbances which occur in the region just ahead of a cyclone such as tornadoes and thunder storms; and that the third type of instability contributes greatly to the violence of these local disturbances.

W. S. F.

APPLIED SCIENCE IN MUNICIPAL WORK.

THE city of Marshalltown, Iowa, has just issued in pamphlet form, the 'preliminary data for the design of a proposed sewage system' which illustrates in an unusually satisfactory manner, the rare case in which municipal authorities have displayed enough of wisdom and of familiarity with the resources of their country to bring to bear upon their problems of construction, the best scientific knowledge available. The committee of the city council applied to Professor Marston, the civil engineer, Professor Weems, the chemist and Professor Pammel, the botanist of the University of Iowa, for advice, and under their direction the data reported were collected. The work of the survey in detail, was done by trained students, largely, and the drawings were made by Miss Wilson. The city of Marshalltown paid all expenses and its officials seem to have heartily seconded the endeavor of the chemists and engineers of the University.

The city has a population of 12,000 and is the county seat of Marshall Co., and the commercial center of a rich agricultural country. There is some manufacturing, the principal shops of the Iowa Central Railroad and large beet-sugar manufacturing establishments being located there. The sewer system contains about ten miles of sewers and laterals. Water is supplied from drive-wells and to the amount of about 1,300,000 gallons per day, the glucose and packing houses taking a large fraction of that used for other than domestic purposes. It contains about 300 parts solid matter in the million, mainly lime and magnesia salts. Deeper wells of artesian character, belonging to the glucose company, show about 900 parts solid matter, of which about two-thirds seem to be lime and magnesia salts and fifteen per cent. organic matter, although the wells are 300 feet in depth. The city water in May, 1899,

showed 1040 bacteria per c.c. The sewage is passed into the Iowa River, which flows, at a minimum, about 3,250,000 gallons per twenty-four hours and contamination by sewage is at all times serious. Where thus contaminated, its color is dark, its odor offensive and its mean content of bacteria at times as high as about 100,000 per c.c. and probably more. The outcome of litigation directed against the city by residents of the country below, along the banks of the stream, has been the determination of the city to adopt a system of purification of the sewage and it is to this end that the experts of the University were consulted.

It was promptly discovered that the glucose sewage was very different from that of the city, in respect to content of bacteria, as was to have been expected. Its bacteria ranged up to, in one case, nearly ten millions per c.c. While not unwholesome when fresh, it is subject to putrefaction of a seriously objectionable character. The packing-house sewage also contains large quantities of bacteria and has a characteristic composition. The result of intermixture of these various kinds of sewage is a peculiarly offensive and troublesome compound.

In seeking the best remedy for this state of affairs at Marshalltown, the data printed in the report were gathered. The work included a study of the topography of the country, of the character of the soil, the available materials for construction, of filtering and settling tanks and the costs of labor and material. It is stated that the works should be completed before November of the present year.

In the performance of the work of the consulting chemists and bacteriologists, the methods of the Massachusetts Board of Health were usually followed.

R. H. THURSTON.

'ARROWPOINTS, SPEARHEADS AND KNIVES OF PREHISTORIC TIMES.'

UNDER the above title, Professor Thomas Wilson, Curator of the Division of Prehistoric Archæology of the U. S. National Museum, occupies pages 811 to 988, of the Report of the Museum for 1897. Sixty-five plates and two hundred and one text figures accompany the paper. The whole is also run by the Government Printing Office, as a reprint bearing the date 1899.

Much material is brought together in this paper, besides copious references to the literature and sources of information. The chipped objects of the palæolithic period are touched upon, and sections are devoted to the origin, invention and evolution of the bow and arrow; superstitions concerning arrowpoints; flintmines and quarries of Europe and America; caches; material for points and its microscopic examination; the manufacture of points; and scrapers, grinders and straightners used in making shafts for arrows and spears. Fifty-seven pages and a proportional number of plates and figures are devoted to Mr. Wilson's classification of points for arrows and spears which is under the four main divisions, leaf-shaped, triangular, stemmed and peculiar forms. Knives and wounds made by points are also discussed. Flint mines and quarries, caches, large implements and the making of arrowpoints described by explorers and travelers are the subjects included in appendices A, B, C and D.

Some of the illustrations are familiar to readers of archæologic literature, who are glad to have them brought, together with the new illustrations, under one cover.

The manufacture of arrowpoints was seen as late as the summer of 1898 by several members of the Jesup North Pacific Expedition in the Thompson Valley, British Columbia, but in a few years it will be an industry of the past, at least in regions accessible to the body of students of archæology. Dr. Wilson has introduced a number of quaint pictures of a flint knapper engaged in chipping gun flints at Brandon, Suffolk, England.

HARLAN I. SMITH.

DIETARY STUDIES OF UNIVERSITY BOAT CREWS.

PROFESSOR W. O. ATWATER and Mr. A. P. Bryant have prepared an interesting bulletin on the above subject, published through the Office of Experiment Stations, U. S. Department of Agriculture. Their results, together with the comparison of other dietary studies, are summarized in the following table: