THE MARINE BIOLOGICAL STATION OF THE UNIVERSITY OF TEXAS.

BY CHARLES L. EDWARDS, AUSTIN, TEXAS.

ANY ONE familiar with the brilliant pioneer work of Agassiz, Pourtalès, and Brooks, together with their students, upon the fauna of the Gulf of Mexico and neighboring waters will gladly welcome the inauguration of any movement, however modest, to continue the exploration of the American Mediterranean. The successive summer expeditions sent from the Johns Hopkins University since 1887, to the different Bahama Islands and Jamaica, and the proposed establishment of the Columbus Station on the latter islands, are familiar to all interested in the work of this field.

An important part of the School of Biology, created in January, 1892, by the regents of the University of Texas, both as regards instruction and research, is the Gulf of Mexico Station. As a result of a brief preliminary survey which, at the request of the regents, I made last summer at Aransas Pass and Galveston, several facts of prime importance in locating a biological station became apparent. The low Texas coast is bordered by exceedingly shallow bays, from two to ten miles wide, cut off from the Gulf of Mexico by a very narrow sand-formation. This almost continuous stretch of sand, raised unevenly by innumerable dunes formed by the wind, is broken at eight places by narrow channels into seven islands, and at three other points partially unites with the mainland to form extended peninsulas. Its gulf shore is unindented, while, on the other hand, its bay shore-line is quite irregular. Vast areas of the bays are exposed at low tide, forming mud-flats; while even in Corpus Christi and Matagorda Bays the depth does not exceed fifteen feet. Since the mean tide is less than half a foot at most places in the bays, an advantageous location for a biological station must be contiguous to the free waters of the Gulf. Even then one must go from along most of the outer shore five miles to seaward, in order to reach the ten-fathom curve. Directly off the entrance to Galveston Bay this depth of less than ten fathoms extends for a distance of thirty miles.

Reaching from near the mouth of the Rio Grande along the extreme southern Texas coast for one hundred and fifty miles northward is Padre Island. The bay which it cuts off, Laguna Madre, is for the most part a vast mud flat, and the Padre itself is inaccessible. Farther north, at either Aransas Pass, where Corpus Christi and Aransas Bays empty into the Gulf, or at Pass Cavallo, the entrance to Matagorda Bay, would be, with a suitable building, an excellent location for the station. The entrance to Galveston Bay, while in some respects not having the natural advantages of the other two locations, yet is much more accessible. Here is a highly desirable building, which cost some $15,000, soon to be vacated by the Quarantine Department. Since this building belongs to the State, the Galveston location was recommended and a bill was introduced in the 23d legislature of Texas to set aside the present officers' quarters of the Quarantine Department at Galveston for the purposes of the Marine Biological Station of the University of Texas. With a further item of $5,000 for equipment, the bill was favorably reported from the Committee on Grounds and Buildings of the House, but, owing to the large number of measures having precedence, this bill, unfortunately, was not considered.

Besides a building fully supplied with the necessary aquaria, microscopes, reagents, etc., for laboratory study, and boats of light draught for work in the shallow water, it is planned, after the idea of Dohrn [1] for the Naples Station, to equip a seaworthy steamer as a floating station for deep-sea collection and observation in the waters of the Gulf of Mexico. For the wonderful possibilities of this field no addition to the eloquent testimony of A. Agassiz,[2] in his description of the work on the "Blake" expeditions, need be added.

[1] Bericht über die Zoölogische Station während der Jahre 1885–1892. Mittheil. Zoöl. Station, Neapel, 10 Bd., 1893, pp. 633–674.

[2] Three Cruises of the "Blake," Boston, 1888.

As Professor Whitman has so ably demonstrated in building up a national station for marine biology at Woods Holl, it is in generous coöperation that the science can best be advanced. The University of Texas extends a welcome to any investigator in the various lines of biology who may desire access to the fauna and flora of the Gulf of Mexico. Going from the various stations established by Agassiz, Brooks, Whitman, and others on the Atlantic and Gulf coasts, to that of Jordan on the Pacific, the investigator may have the enviable advantage of studying a special group of animals or plants under the most diverse geographical conditions. Once this migration, which in Germany is so enlarging and helpful to the student, is made possible among our biological stations, the great advantages are too apparent to need mention.

Since the best conditions are not this summer available for work on the Texas coast, it has been decided to hold the first session of the marine station in the Bemini Islands, Bahamas. Applications for admission will be received until June 20. Of investigators no special fee is required. For students not attending the University of Texas, there is a laboratory fee of $25. The necessary expenses for the session, including transportation from Austin and return, will approximate $100.

METHOD OF MAKING A SANITARY INVESTIGATION OF A RIVER.

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THE following programme of the investigation of the Hudson River and its tributaries has been worked out in our labors for the State Board of Health during the last four years, and may be of interest. The work commenced with an inspection of the shores of the river to determine the causes of certain nuisances which existed along its banks and to determine the method of abating these nuisances. These consisted principally of marshes or badly drained pools with some areas partly covered with water at high stages but open to the sun at low water. A few nuisances arising from the deposit of garbage or the discharge of sewage were also found. All these were evident on inspection and it was possible to abate most of them with little difficulty. In any other case the same would usually be true, except where there are large areas of bottom land which are overflowed by high water and are not well situated for drainage after the high stage is passed. It is possible, however, except in the largest watersheds, to drain much the largest part of such lands. There is no question that such bad conditions as are often found have a decided effect upon the salubrity of the neighboring lands, and that sooner or later treatment of the problem of drainage must begin and be carried through as rapidly as funds will permit.

Where a river is also used as a source of water supply, a much more detailed study must be made of its condition and possibilities. In the case of the Hudson, a study of the geology of the watershed was made to show what the inorganic chemical impurities of the water might be, the result being very favorable to the purity of the water, as much of the area is covered by the oldest formations and supplies but little inorganic matter of any sort. The southern tributaries of the Mohawk bring in more such matter, in the form of lime from the Helderberg and neighboring formations, than any other part of the watershed. Where the surface soil is made up of disintegrated rock it may have a beneficial effect upon the water by acting as a filter to remove some of the organic matter, or it may have a deleterious effect by adding much alkaline matter to water percolating through it. In some cases this may be so serious as to prevent the use of water from some parts of the watershed for water supply. In connection with this study of the geology goes the study of the organic pollution from vegetable sources, since much of this comes from marshes and swamps whose existence is due to the arrangement of the geological strata. There are cases where the amount of such pollution is excessive. It is probable, however, that there are very few cases where the swamps cannot be drained and thus

greatly improve the condition of the water. Much of the water from the upper Hudson and the northern tributaries of the Mohawk shows the effect of this sort of pollution, but the dilution from comparatively unpolluted sources is great enough to reduce it far below the objectionable point.

After this study, which usually is not very important, comes the study of the pollution by the population on the watershed. In investigating the purity of an established supply or in selecting a new one this is the most important study of all. We have approached the subject in three ways, keeping the results obtained by the three processes in juxtaposition so that they can be used as mutually explanatory. The first and, after sufficient experience in judging effects, the best method is by actual inspection of the polluting matters discharged into the stream. These matters consist of sewage, garbage, drainage from fertilized fields and other sources of animal matter, and the discharges from manufacturing establishments, some of which are chemicals and some putrescible organic refuse. In connection with this inspection goes a determination of the amount of water flowing in the stream at the point of entrance of the polluting matter. A careful study of the relative amounts of polluted liquid and river water with the proper consideration of the amount of pollution the water already contains and the character of the new supply will give a very clear idea of the condition of the resulting mixture. Detailed study by chemical and biological methods of typical conditions will bring one to the ability to determine by the inspection the probable condition of new streams in approximately the same circumstances. In our own case, having but little material obtained under the conditions existing in this country, it was necessary to make this detailed examination.

The second process applied to the river was, therefore, the chemical analysis of numerous samples from various places. It is usually considered that the elements determined in water analysis which denote the amounts of organic matter in different forms and the amount of salt are the important ones. The list included, therefore, albuminoid and free ammonia, nitrogen as nitrates and as nitrites, chlorine, oxygen absorbed, as well as the total solids, loss on ignition, color, appearance, and odor at 100° F.

The third process applied was the biological analysis of samples of water taken from the same places as those for chemical analysis and from many more. The biological analysis may be made with reference to the number and kinds of algæ, infusoria, and other microscopic animal and vegetable life, with reference to the numbers of bacteria, and with reference to the numbers of such species of bacteria as can be recognized as coming from sources which are dangerous or suspicious. All of these determinations will be valuable in deriving a basis for a definite opinion as to the character of the water. A few experiments were made under the first head, and it was found that as regards flowing water in rivers this determination was not as necessary as others, moreover, the methods of such analysis have been well elaborated by others, therefore it was left until a more convenient season. It is advisable to make this analysis on some samples, however, to secure the fullest knowledge possible.

As regards the determination of numbers of bacteria, it was soon discovered that in order to determine the relative amounts of pollution in the rivers at different places, it is necessary to reduce the possible sources of addition to the numbers of bacteria to a minimum. This is done by waiting until a rainless period, or nearly so, has intervened of sufficient duration to reduce the river to its low stage and then give time for the collection of the samples. It is possible by taking this precaution to show the increase in pollution by showing the increase in numbers of bacteria below the source of pollution. Rains, sharp and heavy or long continued, will wash into the stream much matter from the soil, abounding in bacteria, so that the indications of pollution from the constant flow of sewers and the like will be greatly obscured. It is probable, also, that it would be difficult to compare the purity of two streams in widely different parts of the country or in different conditions as to soil, slopes, area of watershed, etc., on account of the consequent variations in numbers from what may be called outside sources. Our work has shown the possibility of determining the relative increase in pollution in the flow of a single river when proper precautions are taken. One point to be mentioned is that where sewage is discharged into still water much of it will settle at once and samples taken near the surface will not show the full effect of its presence.

The numbers of bacteria, at least unless determined without the greatest care to eliminate all disturbing conditions, are not therefore so important an indication as is desired. It is well known that there are species of bacteria which exist under their most favorable conditions in the intestines of men and the higher animals, but will live for a greater or less length of time in other places. If the numbers of such bacteria could be ascertained the relative amount of pollution from such suspicious sources would be best determined. On the recommendation of Dr. Theobald Smith of Washington we tried the method of determining the numbers of *Bacillus coli communis*, by the fermentation-tube method. This bacillus was selected because it is the most common in fecal matter and its growth in such media as ordinary river water at ordinary temperatures is believed to be very slow, if there is any. The method suggested by Dr. Smith was found to be easily applicable in practice, and some very valuable results have been secured. It promises to be a most valuable aid in determining the pollution of water, and is especially valuable because it gives the statement of the serious part of the pollution, while all the other methods mentioned are open to the objection that they may reject a water which has a large amount of pollution not from dangerous sources, the water being, therefore, comparatively clean; while they may, on the other hand, pass as good water which shows but little actual amount, that amount being of a very suspicious nature.

Many of the results of the investigation whose programme is presented above, are given in the last four reports (tenth to thirteenth) of the N. Y. State Board of Health. A paper by Dr. Smith, giving the argument for the selection of *B. coli communis* as the index of pollution, is given in the thirteenth report. The investigation is not yet finished, and other reports will follow until sufficient data have been obtained to warrant a definite statement as to the condition of the water at the intakes of the various waterworks which draw from the lower parts of the rivers under investigation. It is believed that the work done shows that the programme given above is the proper one to follow, and this statement of it is therefore made with the hope that it will be found useful in other cases. Considerable experience in selecting conditions and in collecting samples and data will be necessary to make one expert in drawing definite conclusions from the results obtained.

NOTES AND NEWS.

THE museums and laboratories of the University of Pennsylvania are represented by a very considerable exhibit at the Columbian Exposition. The University has erected an inclosure on the space assigned to it in the gallery of the Liberal Arts Building, for which the design was contributed by the University School of Architecture. This forms the exhibit of that school. Within this space are contained various collections from the different departments. Notably the Veterinary and Biological. The latter contributes a psychological laboratory, which will be in operation during the summer. The Department of Archæology has sent collections from three of its sections, American, Babylonian, and Egyptian, which are now installed in the gallery. The large collection of games and religious objects contained in the Oriental Section of the Museum will be shown in the Anthropological Building.

— The present interest in subjects connected with the study of sociology has led Professor Charles R. Henderson of the University of Chicago to prepare "An Introduction to the Study of the Dependent, Defective, and Delinquent Classes," which will be published about June 1 by D. C. Heath & Co., Boston and Chicago.