I have already suggested in an article entitled, "A Continuing Universe," published in *Popular Astronomy,* Vol. XXXVI, No. 6.

As Dr. Moulton well remarks, many minds seem to have a horror of an unending past or future, or of infinite space; yet in these very conceptions surely we have the most promising solution of the riddle of the universe. Though we can not understand all the processes, we may rest assured that Nature is not growing old, but is ever rising from the ashes of its past to renew its youth in immortal vigor.

J. G. PORTER

CINCINNATI OBSERVATORY,
APRIL 10, 1929

CHEMICAL TRAINING

THE sketch of the distinguished career of Thomas Burr Osborne (SCIENCE, April 18) recalls an incident of his early manhood, when he had just received his appointment as assistant in analytical chemistry at Yale but had not yet reached his doctorate. The quality of thoroughness, the "do-it-right" attitude, the meticulous care with which he carried on his experimentation, his intellectual integrity all showed themselves in 1883 when in a discussion carried on by a group of young people at a summer resort he exclaimed, "Training in a chemical laboratory does more to develop sound ethics than Sunday School lessons can ever do." One can not help asking whether present-day instructors are insisting that strict integrity more surely leads to success than cleverness in "getting by" does. That is one heritage from Thomas Burr Osborne.

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SPECIAL CORRESPONDENCE

OPPORTUNITIES FOR RESEARCH OFFERED AT THE BIOLOGICAL LABORATORIES OF THE BUREAU OF FISHERIES

THE fisheries biological laboratories of the United States Bureau of Fisheries at Woods Hole, Mass., Beaufort, N. C., and Fairport, Iowa, will reopen for the summer's activities on June 17.

In accordance with the long-established policy of the bureau, facilities for research will be afforded at the various stations to independent investigators in addition to the bureau's regular staff. But the opening of the stations this year is especially worthy of being called to the attention of the scientific public, for extensive improvements and alterations in buildings, grounds and equipment completed during the last two seasons make these facilities more attractive than ever before.

The advantages of the stimulating surroundings at Woods Hole, where association with the great Marine Biological Laboratory and use of its library may be had, need not be stressed here. The fisheries laboratory, however, in addition to the usual advantages of any well-situated marine biological station, such as convenient supply of marine animals and plants, the common laboratory equipment and running sea-water, offers unusual opportunities for combining experimental work in the laboratory with field observations on ocean ecology. Such problems, for example, as studies of the factors controlling migration of the animal plankton, the richness of chemical foodstuff in sea-water compared with fluctuating abundance of the phytoplankton, and an almost unlimited number of problems of the same general type involving experimental work on the one hand and field work at sea on the other, might be cited as opportunities peculiar to this station. In addition to newly finished oceanographic and physiological workrooms and chemical storerooms at the laboratory, the service of such floating equipment as the bureau's sea-going steamer *Albatross II* and steamer *Phalarope,* which base at Woods Hole during part of the year, two smaller launches and several rowboats may be obtained. Furthermore, the chance to participate in a "going" program of fishery biology, such as studies that the bureau is now making on the bionomics of marine fisheries of the North Atlantic region, should prove attractive.

Owing to the increased demand for these accommodations, it has become necessary to make careful selection of those who are granted the privileges of the laboratory. Applications made well in advance are reviewed by a committee, and preference is given to those investigators who work along lines of especial interest to the bureau and who have shown ability for energetic and productive research.

Less well known to the younger generation is the fisheries biological laboratory at Beaufort, N. C. Since before the Civil War, the comfortable little city of Beaufort has been a favored resort for biologists, and the present biological station, opened for research in 1902, has been occupied almost continuously during the summer season in exploration and research. The station is situated on Pivers Island about 150 yards from the mainland in Beaufort Harbor and consists of a two-story frame laboratory building, 70 feet long and 42 feet wide, with two-story wings each 52 feet long, surrounded by porches. There are also adjacent to the main building a mess hall, power house, carpenter shop, boat house and terrapin-rearing house, and along the shores are constructed 15 large concrete enclosures for the rearing of terrapin. During the past year all of these buildings have been thoroughly renovated and additional equipment installed. The salt-water and fresh-water supplies have been modernized, the electrical system renewed and hot and cold running water provided for the dormitory rooms, which occupy the wings of the building. Compressed air and artificial gas are now supplied to the laboratories. An equally important improvement has been the installation of a central steam-heating plant, which makes the whole laboratory building comfortable for occupancy throughout the entire year. At the present time a residence for the director and his family is under construction.

The floating equipment of the laboratory has also been brought to a high standard of efficiency during the past year. A comfortable, sea-going motor cruiser and a smaller speed boat have been placed in commission and two other launches attached to the station have been rebuilt. The larger vessel is equipped with a laboratory, hoisting gear, nets, dredges and the usual oceanographic apparatus. About a dozen rowboats are provided for the use of the investigators. Dr. Henry Van Peters Wilson, veteran zoologist of North Carolina and a regular visitor at the Beaufort station, describes the laboratory as follows:

> The station has at its door the open ocean and fine sea beaches. Within what may be called the harbor, which is large and beautiful, passing east and west into sounds, are sand shoals, mud flats, and salt marshes. The tide brings in an excellent plankton. The whole fauna is varied and abundant, and, what is of the first importance, easily accessible to the individual collector. Moreover, through the work of biologists during the past fifty years it is sufficiently known to be usable for many sorts of investigations. The association of Beaufort with the general growth of American biology, as may be seen from the long list of published investigations carried on here, is interesting and stimulating. The laboratory is unusually comfortable and convenient . . . the summer climate is healthy and pleasant and the temperature and purity of the harbor water make collecting a pleasure. Beaufort is now easily reached by rail and hard-surface highway.

The fisheries biological laboratory at Fairport, Iowa, was established in 1910 as a center for research in fresh-water biology and aquiculture. Situated on a 60-acre plot of land with a ⅖-mile frontage on the Mississippi River, 8 miles north of Muscatine, Iowa, the station serves as a base for operations for a large part of the scientific work of the Bureau of Fisheries in the Mississippi Basin. The station has a number of buildings. The main laboratory, constructed of concrete, stone and brick, with ground dimensions approximately 100 by 55 feet, was erected in 1920 following the destruction by fire of the original frame building. This building, which has a fully finished basement, two full stories and a finished third story over the center and larger portion of the building, affords accommodation for 16 investigators and includes a well-lighted library, chemical laboratory, store room, museum, tank and aquarium rooms, and, in addition, dormitory rooms for men and women investigators. Several small cottages for families are provided near-by. On its property there are over 30 ponds, mostly earthen, varying from 1/10 of an acre to over 3½ acres in area. Water is supplied in abundance from two systems—the natural river water, which is pumped into a large storage reservoir and flows thence by gravity to the several ponds, and filtered river water, which is stored in low and high pressure cisterns for domestic and laboratory use. The buildings are lighted by electricity.

The large artificial ponds, the holding basins and the tank-house, all supplied with running river water, offer ample space with a variety of controllable conditions for experimental animals under observation. In a word, all reasonable needs for research in fresh-water biology are met.

The outstanding advantages of the Fairport station for work in fresh-water biology, however, come from the richness of the available fauna. In the Mississippi itself are representatives of all the living groups of ganoid fishes and many species of bony fishes as well, an interesting plankton and a considerable number of the larger invertebrates, among which the pearly mussels, the pulmonate mollusca and the May-flies are represented by many species. The ponds on the reservation and the sloughs and backwaters of the river offer several series of habitats, which during the summer months teem with the smaller invertebrates and plankton, including the fresh-water bryozoan Pectinella and many species of insects. These complexes are attractive for ecological and life-history studies. The fishes and amphibians of the region present an inviting field for the parasitologist, particularly as the ponds on the reservation are adapted to the following of host-cycle investigations.

A primary activity as a bureau station is the propagation of pearly fresh-water mussels, but no less significant are its functions in experimental fish culture as a branch of the expanding field of aquiculture and in the promoting both of a fuller utilization of water products and a broader interest in the protection of aquatic resources. Dr. Winterton C. Curtis, whose work, largely conducted at this station years ago with Doctor Lefevre on the mussels of the Mississippi River System, qualifies him to speak with authority, states:

"The station is better equipped for studies in fresh-water biology than any similar establishment in the

United States and perhaps in the world. It has the further advantage of not being owned by a local institution, as is the case with the summer stations of universities of this part of the country. There is every reason why it should become the most important center of summer biological work in the Mississippi Valley."

At all three of the bureau's stations, laboratory privileges, including either a private laboratory or a research table, the use of aquaria, glassware, the simpler laboratory apparatus and chemicals or reagents in moderate quantities, as well as dormitory space in the residence quarters, are provided to qualified independent investigators without charge. The Woods Hole laboratory will be open to private investigators from June 17 to September 14, but both the Beaufort and Fairport laboratories will be open for research in the future throughout the entire year. At Woods Hole the privileges of the Marine Biological Laboratory mess are accorded to the workers at the fisheries laboratory, while at the other two laboratories a cooperative mess is in operation during the summer season. The government provides fuel and labor for the preparation of meals, and the cost of the food is divided proportionately among the investigators. Applications for research privileges in these laboratories may be made direct to the Commissioner of Fisheries, Washington, D. C.

HENRY O'MALLEY,
Commissioner

WASHINGTON, D. C.

SCIENTIFIC BOOKS

Hydraulic Laboratory Practice, edited by JOHN R. FREEMAN, consulting hydraulic engineer. Published by the American Society of Mechanical Engineers, 1929. Cloth 9 x 12 in., pp. xxi + 868. 996 illustrations. $10.00.

THE flow of water, even in the simplest case, is a very complex phenomenon, and consequently the laws derived from theoretical hydrodynamics furnish only to a very limited extent a means of solving the hydraulic problems arising in practice, because the conditions must be highly idealized if the problem is to be amenable to mathematical treatment. Hence hydrodynamics has been called upon to furnish formulas which apply approximately to general types of problems, these formulas containing coefficients whose values can not be determined theoretically but can be found from experiment for a given set of conditions. Hydraulic engineers have used such laws in the design of hydraulic structures ever since hydraulics first merited the name of a science. However, in hydraulic design it frequently happens that the conditions to which a given formula apply differ so widely from those for which numerical values of the coefficients in the formula have been determined experimentally that the selection of the proper values for these coefficients is nothing more than an intelligent guess.

A more powerful method of solving complicated hydraulic problems, that of conducting model tests on a small-scale copy of the full-scale structure, was first utilized in a scientific way about sixty years ago, when William Froude applied this method in his epoch-making advance in the science of ship resistance. This was followed in 1875 by tests of a model of the Garonne River by Fargue in France and about ten years later by tests of a model tidal estuary by Osborne-Reynolds. In order that the results from such model tests may be used scientifically to predict the characteristics of the full-scale structure it is necessary that all parts of the model structure and the processes taking place in it shall be dynamically similar to the corresponding parts of the prototype in nature.

The nucleus of the theoretical foundation of dynamical similarity exists in Newton's "Principia" (1687) and was utilized in physics by Savart (1825) and by Cauchy (1829). In 1847 Bertrand clothed Newton's definition of dynamical similarity in mathematical language and derived the fundamental relation between the ratios of corresponding lengths, times, masses and forces in the natural structure and in the model. The theoretical foundation for model experiments was thus laid. The theory has been developed still further in Germany, England and the United States from somewhat different points of view, the Germans proceeding from a consideration of the differential equations of motion or from the dimensional forms of the forces involved, while the English and Americans have used the methods of dimensional analysis.

With the opening of the twentieth century, model experimentation in connection with fluid flow increased by leaps and bounds. The applications to aerodynamics are too well known to require comment here. But only since about 1926 has it become generally known in this country that a corresponding development has been going on in Europe in connection with hydraulic problems under the leadership of Engels, of Dresden; Möller, of Braunschweig; Rehbock, of Karlsruhe; Krey, of Berlin; Thoma, of Munich, and others.

In 1926 appeared the German edition of the book "Die Wasserbaulaboratorien Europas" sponsored by the eminent American hydraulic engineer, John R. Freeman, who brought about its publication in his