PHILIPPINE ISLANDS

BUREAU OF SCIENCE PRESS BULLETIN NO. 87

THE PHILIPPINE BUREAU OF SCIENCE

BY

ALVIN J. COX
DIRECTOR OF THE BUREAU OF SCIENCE

MANILA
BUREAU OF PRINTING
1918

THE GOVERNMENT OF THE PHILIPPINE ISLANDS
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES
P.I. BUREAU OF SCIENCE
MANILA

Bureau of Science Press Bulletin 87[1]

THE PHILIPPINE BUREAU OF SCIENCE

By ALVIN J. COX
(*Director of the Bureau of Science*)

TWENTY-ONE PLATES

Probably no government other than that of the Philippine Islands supports a so-called Bureau of Science, but nearly all governments carry on the kinds of work that the Bureau of Science does and recognize the efficiency and economy of centralization, and they refer to the Philippine Government as one where there has been no political interference and where the scientific work has been done efficiently, as it should be. The Imperial Institute erected at South Kensington, London, as the National Memorial of the jubilee of Queen Victoria, by whom it was opened in May, 1893, is very similar to the Bureau of Science. "The principal object of the Institution is to promote the utilization of the commercial and industrial resources of the Empire * * * and for the collection and the dissemination of scientific, technical, and commercial information relating to them." Its staff "includes officers with special qualifications in the sciences of chemistry, botany, geology, mineralogy, and in certain branches of technology in their relation to agriculture and to the commercial utilization of economic products." The Federal Government of the United States does much of the same kind of work as does the Bureau of Science, the main difference being that the Federal Government does a so much greater volume of scientific work that it is handled in several institutions. The Bureau of Plant Industry in 1915 had more than 1,400 employees and 273 scientists for the investigation of technical and economic phases of botany alone, while the Bureau of Science has 30 scientists for all lines of investigation, including botany, bacteriology, serology, ornithology, marine biology, entomology, geology, chemistry, standardization, physical and mechanical testing, etc. A branch of work that is a division

[1] Printed in the *Philip. Rev.* (1918), 3, 239. This press bulletin is also printed in Spanish. Issued in May, 1918.

with from two to five men in the Bureau of Science is found in the United States to be a bureau with hundreds of employees. The Bureau of Standards, the Bureau of Biological Survey, the Bureau of Plant Industry, the Bureau of Chemistry, the Bureau of Soils, the Bureau of Mines, the Bureau of Entomology, and others correspond exactly in character to the work of parts of the Bureau of Science. The Public Health Service hygienic laboratory in Washington, D. C., does a great deal of work analogous to that carried on in the Bureau of Science. The volume of work in each of these institutions is so large that complete aggregation is impossible.

The governments of most countries have recognized the services of scientists with decorations and in the endowment of scientific institutions similar to the Imperial Institute described above. In many countries there are private institutions similar to the Rockefeller, Carnegie, and Smithsonian Institutions in the United States and the Pasteur Institute in France that do some of the work that the Bureau of Science is called upon to do. The Philippine Islands has a greater need of scientific work for its sanitary, economic, and industrial development than those countries that have been carrying on such work for a longer period. There are still many tropical diseases concerning which far too little is known and for which we have yet no remedy. There are many industries carried on in a primitive fashion in the Philippine Islands that could be vastly developed. Sources of wealth are being discovered that previously have remained untouched. There is reason to believe that the resources of the Islands can be developed along many lines.

The Bureau of Science was established as the Bureau of Government Laboratories on July 1, 1901, by Act No. 156 of the Philippine Commission. Entomological investigations began on December 9, 1902. On January 1, 1903, the serum laboratory and the grounds at San Lazaro were transferred to the Bureau from the Board of Health. The section of botany, which had been organized in the Bureau of Agriculture, and the nucleus of the herbarium were added on July 1, 1903. The collector of natural history specimens of the Ethnological Survey was transferred directly to the Bureau on November 16, 1904. On November 1, 1905, the Bureau of Mines became the division of mines of the Bureau of Science; and on November 1, 1906, the Ethnological Survey, formerly the Bureau of Non-Christian Tribes, which before that time had been incorporated with the Bureau of Education, was transferred to the Bureau of Science. The name "Bureau of Science" has been used since 1905.

The present laboratory building of the Bureau of Science, which was added to in 1911, was first occupied early in 1905, and at that time the work was enlarged by the appointment of an engineering force and by the operation of steam and electric machinery. In 1910 the power plant was enlarged so as in addition to supply the Philippine General Hospital and the College of Medicine and Surgery, University of the Philippines, with steam and electric energy for operating lights and all their other elaborate equipment. The aquarium of the Bureau of Science, situated in Manila on Calle Gral. Luna (Palacio) within the bastion of Real Gate of the old Walled City, in which there are on display nearly a thousand specimens of curious and brightly colored tropical fishes and other interesting forms of marine life representing more than 150 species, was opened in February, 1914. During 1917 the Iloilo Customhouse was occupied, in which the third floor is devoted to the Bureau of Science Iloilo sugar laboratory, and a bleeding house was completed on the main grounds of the Bureau of Science for use in connection with the manufacture of serums and vaccines.

The purchase of books for the library began soon after the organization of the Bureau, and this adjunct of the scientific work grew rapidly, necessitating the gradual enlargement of the force and the organization of the library staff. The original plan contemplated an expenditure of 90,000 pesos, spread over a period of six years for sets of general periodicals and other books on chemistry, geology, zoölogy, bacteriology, pathology, physiology, and general sciences. Books purchased with this fund, together with the thousands of pesos' worth of publications that were received gratis, formed the nucleus of the scientific library of the entire Government. The valuable material received by gift and the continuations of sets purchased from current appropriations have been bound. These, together with the books and serial literature of the clinical principles such as surgery, skin diseases, and ophthalmology, which have been provided by the University of the Philippines, have been placed in the library. The Bureau of Science library (division of science of the Philippine Library) is the central scientific library of the Philippine Government and serves the University of the Philippines, other offices of the Government, and the public.

Although there were several bureaus established when the scientific work in the Philippine Islands was begun, all of them that needed laboratory facilities were subsequently brought together in the Bureau of Science with a saving of expense and equipment. The economy and efficiency of doing one kind of work in one place and by the same trained men are universally

recognized in commercial and industrial organizations, and the Philippine Government recognized similar advantages in doing in the same way the routine work required by the Government. The Philippine Government, with its limited funds, has always maintained the policy to concentrate and centralize all similar and closely related work. It was realized that, instead of having each analysis done by a different man, each with a separate set of apparatus and occupying a separate laboratory, a number of analyses of a similar kind for different offices could be often done at the same time by one expert with one set of apparatus, thus effecting economy in time, apparatus, building, and personnel, and affording the possibility of having a better man to do the work. The Philippine Government has intentionally avoided organizing various scientific bureaus, and all scientific work has been brought together in one efficient institution, thereby effecting economy and reducing the cost of administration and expense of operation to a minimum. Furthermore it is possible to get more service from individual books and apparatus and also to reduce to a minimum the overlapping and the duplication of effort. A government can afford to equip one laboratory institution well, when it cannot afford the duplication of a great deal of expensive apparatus or maintenance for others. With an increase in the size of an institution and the number of men coöperating, the yield of the original and constructive work increases much more than proportionally. A large portion of the research work of the Philippine Government carried on in the Bureau of Science would remain undone, except for the stimulus to activity by association when the scientific work is correlated and coördinated in one institution. Having scientific work together in one place insures most thorough and competent planning of the work, better supervision, an incentive and stimulus to direct accomplishment along original lines, and an intelligent balance with regard to the needs and relative importance of different classes of scientific work. There is no other scheme of organization that will accomplish the work with the expenditure of so little money. The separation of the work into divisions and sections is merely a matter of internal administrative convenience.

The Bureau of Science is somewhat similar to the Bureau of Printing in that it serves nearly all other bureaus in the Government, and like the Bureau of Printing, it requires trained men to make the service of the highest quality. It would be quite as feasible for each bureau to do its own printing and binding as to do for itself the work now done for it by the Bureau of Science.

BACTERIOLOGY AND MEDICINE

The Bureau of Science does a large amount of routine laboratory work for the Philippine Health Service and others, including the examination of rats for plague, stool examinations for cholera and other organisms, bacteriological examinations of waters and foods, routine microscopical examinations of blood, urine, fæces, etc. The microscopical work is performed for the purpose of the early identification of infectious diseases such as cholera, bubonic plague, typhoid fever, leprosy, tuberculosis, malaria, worms, genito-urinary diseases, etc. There is a large amount of serum and vaccine work carried on by the Bureau of Science. Serums and vaccines in large variety are continually kept in stock. The entire Islands are dependent upon the serum laboratory of the Bureau of Science for the supply of serums and of vaccine virus. The Bureau of Science produces annually enough vaccine virus to vaccinate 2,000,000 people against smallpox. Wassermann tests to determine the presence or absence of syphilitic infection are performed. A large amount of other work on dysenteries, the activity of drugs and chemicals as a basis for the treatment of various diseases, sanitary surveys, investigation for pathogenic organisms and insects concerned in the transmission of diseases, and many special problems, as shown by the published results in the Philippine Journal of Science, have been completed. The scientists have solved the problems of a large number of tropical diseases with regard to the causes, prevention, and treatment that have baffled specialists all over the world for many years. All this work is ultimately to assist health conditions in the Philippine Islands, and the biological work of the Bureau of Science has been a large factor in successfully combating epidemic and other diseases in the Philippine Islands.

BOTANICAL AND ZOÖLOGICAL SCIENCES

The botanical and zoölogical sciences are much alike in that they involve a large amount of routine work in the identification of species of plants and animals. The naming of species must be done so that the information concerning them can be recorded and correlated with work that may have been done on the same or related species in other countries.

The work of the botanists involves general work on all phases of Philippine botany. Medicinal and agricultural plants must be studied. Philippine forests contain many species of plants that produce fibers, timbers, gums, resins, dyes, tans, etc., of

economic value. The botanical names of these and detailed information as to their soil and moisture requirements, rates of growth, distribution, etc., are needed in order that the greatest use can be made of them. Probably no region in the world presents a richer flora than that of the Philippine Islands, and the task of assembling material to represent practically a complete flora of the Archipelago is an enormous one. The total number of species will certainly exceed 10,000, of which about 7,500 are already definitely known. The need of continued exploration is urgent. The Bureau of Science has one of the largest herbaria in the Far East and by its help is continually assisting other branches of the Government and individuals in the identification of specimens.

Some of the most troublesome diseases of plants and animals are due to fungi, each disease being caused by a different species of fungus. Fungi affect not only man himself, but many of his important industries, including forestry, agriculture, and stock raising. These fungi are specially troublesome in tropical countries, so that the study of them is a very important branch of Philippine botany.

Economic work in entomology involves the control of flies, mosquitoes, and other insects that are known to be carriers of disease and of the many species of insects injurious to forests, fruit trees, agricultural crops, etc. The Bureau of Science has introduced the silkworm and supplies eggs and instructions to those who wish to produce silk. The silk industry is well adapted to Philippine conditions, and it should be rapidly developed.

In many tropical countries sea products, especially fish, form a much higher percentage of human food than in temperate regions. This is true also in the Philippine Islands, yet not nearly so much of these products are used as could be. Philippine waters contain fish equal in quality to those found elsewhere, and their great quantity and variety are demonstrated in all of the local markets. The Bureau of Science has done all that the limited personnel would permit to stimulate the economic fisheries industries. Considerable work has been done in the development of deep-sea fishing, in improving the methods of capture and marketing, and in means for drying, salting, and canning surplus stock. Only one species of fish, the bangos, is raised in artificial ponds, and this is a profitable industry. It is probable that other and better fishes can be raised by somewhat similar methods. The black bass has been successfully introduced, and there are many lakes where it could be planted with

much profit to the people. Mosquito fish are bred and distributed for the extermination of insect pests. Besides food fishes there are many sea products that are sources of revenue. These include oysters, clams, shrimps, crabs, pearl and button shells, window shells, trepang, sponges, etc. Each of these products can be improved and increased through Government help and regulation. In most countries the fishery survey precedes the development of this industry, and here we can scarcely expect more development along these lines until this work has been done. On the other hand, there is a very active interest from a number of sources in the establishment of sardine canneries and in other Philippine fisheries resources, and I have every reason to anticipate a rapid growth of this industry if the Government can afford to do the pioneer work. Besides the actual exploitation on the marine products, these will afford the raw materials for several household industries.

The study of the food of birds has established the fact that birds are very important in protecting forests and agricultural products and that they hold in check some of the most injurious insects. The Philippine Legislature has wisely passed laws based upon the information of the Bureau of Science, protecting Philippine birds and mammals. Careful and extended study of the food of birds is needed to learn which kinds are of especial benefit to man and which are useless or injurious.

CHEMISTRY

In our inorganic laboratories tests of nearly 10,000 samples of cement have been made annually as well as physical tests of reënforcing iron, steel, rope, wire, ties, road material, cement pipes, concrete, mortar, building blocks, bricks, tiles, stones, cloth, and other similar materials. Analyses are made of clays, rocks, minerals, soils, fertilizers, iron and steel, paints, pigments, metals and alloys, articles such as spoons, mixed paints, electric batteries, water-proofing compounds, crude chemicals, etc., for the various branches of the Government, provinces, municipalities, and the United States Army, for private parties, and for general purposes. Many analyses are performed to assist in the valuation of customs' imports, to decide the cause of damage to imported goods, and to settle controversies between importers, shipping houses, and insurance firms. Considerable work has been done to find substitutes for chemicals and other substances unavailable in the Philippines because of the war and to devise methods suitable for their use. The assaying of ores is also carried on. Investigations in the field of corrosion of, and

protective coatings for, structural iron and boilers, lime and sandlime products, cement, vitrified brick, and other structural materials show the calcareous and siliceous resources of the Philippine Islands and give hope for a substantial decrease in the cost of permanent construction. Studies have been made of light fireproof construction material that may be substituted for nipa. The standardization of weights and measures is a regular duty of the Bureau of Science. The re-standardization of provincial and municipal standards and the standardization of instruments of precision are also carried on. A large number of analyses of waters from various sources and a study of the best treatment for eradicating harmful bacteria and for purifying water supplies are carried on. A study of anticorrosive paints is in progress and should lead to practical results. The Government spends thousands of pesos each year in applying poor paint. Paints that are satisfactory in a temperate climate may be entirely unserviceable under the different conditions of service in a tropical climate.

An organic chemist represents the Bureau of Science on the Food and Drugs Inspection Board, and samples of foods and drugs in accordance with the demands of the Food and Drugs Act are analyzed. The organic chemists have carried on a large amount of research work on beriberi and its prevention and cure, on the composition and characteristics of Philippine fruits, copra production, papaya gum, perfumes and essential oils from native plants, etc. A preparation for the extermination of anay in an infested building is regularly prepared. The chemical analyses of paper textiles, oils, soaps, etc., are performed. The people have been safeguarded by passing judgment on various devices offered for sale ("oxypathor," "electrolytic water sterilizer," worthless compounds, etc.) Medico-legal work of various kinds is performed.

The Bureau of Science Iloilo sugar laboratory established in accordance with Act No. 1896 of the Philippine Legislature is engaged in umpire polarizations of sugar and in the instruction of planters as to the best methods and time of cutting cane, sugar boiling, operating mills, etc. This work should be greatly extended, for in modern mills a slight error in judgment frequently means a large loss. Some modern mills are producing only a little better sugar and securing only slightly greater extract than the crude, old-fashioned plants, because they have no trained personnel. The yield and quality of sugar produced in the Philippines is much below what it should be. The best way to improve and increase the sugar production of the Philippine

Islands is a careful application of scientific knowledge. We should collect full information as to what variety of cane is most desirable to plant. One variety is noted for its sweetness, another for the size of the stalk, and so on. The results obtained from different varieties in their home countries are often different from those in other lands. It frequently happens that a given variety does well only in one kind of soil and in a given climate. The various problems in cane culture can be solved only by careful experimentation with chemical analyses of the soil and of the cane, etc. The Government sugar laboratory is appealed to in cases of dispute between sugar growers and merchants as well as for ordinary polarizations.

GEOLOGY AND MINES

The larger part of the time of the geologists of the Bureau of Science has been devoted to engineering geology, economic geology of metallic and nonmetallic minerals, geologic reconnoissance and topography, and geologic mapping. The geology, field relations, and economic aspects of coal, asbestos, gold, sulphur, petroleum, artesian water, road metal, iron ore, building stone, soils, raw minerals for clay products, Portland and natural cement, and lime have been studied. Our geologic examinations have assisted in the selections of sites for engineering structures. Geologic examinations and the correlation of artesian well core samples have aided in the location of drill sites. Statistics of metallic and nonmetallic minerals are regularly collected. The work of the geologists is extremely practical and the work in delimiting the economic resources could be greatly extended advantageously.

The information that the Bureau of Science now possesses with regard to the industrial, economic, and sanitary development of the Philippine Islands is not sufficiently used. The facilities of the Bureau could be made more inclusive if individuals would submit to it more of their problems, and it has been the aim of the Bureau in its communications to the press to show that the greatest assistance can be rendered to manufacturers and others who bring their problems. In general, the Bureau endeavors to be of the greatest possible assistance to manufacturers, producers, miners, planters, and public-health workers by making reports and giving expert advice on crops, soils, fertilizers, plant diseases, insect pests, mining, etc., and in performing analyses and examinations of sugar, soils, fertilizers, waters, coal, metals and alloys, gums, resins, minerals, cement, food products, biological and pathological specimens for practi-

tioners and for the various branches of tne Government, and of other materials of agricultural, industrial, and medical use and interest. There is extensive information along many lines in the Bureau of Science that should effect a large annual saving to the inhabitants of these Islands, if it were utilized. Each year shows more clearly that thousands of pesos could be saved annually to the sugar growers alone, if they had the scientific informatien necessary with regard to planting, harvesting, and recovering sugar most efficiently and economically. More perfect extraction and more careful handling of the juice will increase the production and improve the quality of the sugar, even if there is no increase in the yield or in the planted area. The best way to improve and increase the sugar production of the Philppine Islands is by the careful application of scientific knowledge. The Bureau of Science has carried on an investigation of tanning methods in the Philippine Islands, working under conditions as they prevail in Philippine tanneries, and has produced leather free from the disagreeable odor characteristic of Philippine leather and equal in quality to the imported product. The local tanners are being instructed in methods that will avoid waste and greatly increase the production of leather. The introduction of these methods will also assist in conserving the supply of camanchile bark, which is rapidly becoming exhausted and even now is difficult to secure. Under the provisions of Act No. 2376 the Bureau of Science has continued its work of preparing extract of tikitiki for the treatment of infantile beriberi. The properties and some of the uses of oils produced from lumbang, kapok, cashew, castor bean, tree-cotton seed, physic nut, pili, calumpang, and cato have been determined. The drying qualities of the lumbang oils have been examined. Chaulmoogra oil and its administration in the treatment of leprosy have been studied. The Bureau of Science has shown conclusively that papaya gum made in the Philippines is equal, if not superior, both regarding color and activity, to any now in the world's market. Practical and efficient methods of sterilizing containers used in marketing natural or carbonated waters have been devised. The Bureau of Science has investigated the suitability of the waste from abacá, or Manila hemp, cogon grass, and various other substances for paper pulp. It has published an article on the destructive distillation of waste woods of various kinds and the products obtained as a result of this distillation and also one on the methods that will insure maximum yields of alcohol from molasses. It has introduced the silkworm industry, the desirability of extending which in the Archipelago becomes

more apparent each year. In order to bring information of this character to the attention of the reading public, a series of press bulletins was inaugurated in 1912. Up to the present time 86 independent numbers of this popular publication have been issued. The industrial articles that indicate the scope of the commercial utilization of Philippine economic products have been on the following subjects:

The financial loss occasioned by harvesting unripe sugar cane, the methods of clarifying sugar cane juice, and various other leaflets on the melting, reboiling, and manufacture of, and the prevention of economic waste in, both nipa and cane sugar; Philippine alcohol and beverages, and the value of the former as a motor fuel; Philippine dyes and tanning and paper-pulp materials; copra and other coconut products; resins, terpenes, perfumes, edible nuts, and vegetable oils other than coconut oil; medicinal plants; the castor oil plant (tañgan-tañgan) in the Philippine Islands; tikitiki extract; papaya gum; starch; rubber; kapok; rattan, bast fibers, and other Philippine tie materials; how to prepare coconut butter; Philippine flour substitutes; the methods of preservation, drying, or otherwise utilizing Philippine food products; the nutritive value of Philippine vegetables; the milk supply in the Philippine Islands; Philippine substitute for cork; improvement of the tanning and leather industry in the Philippine Islands; shark-liver oil; cigar molds and their prevention; birds in their economic relation to man, agriculture, and forestry; bat guano; silk; honey; coconut insects, the cigarette beetle, and other insects injurious to agricultural products; sponges, pearls, commercial marine shells, and other fishery resources and products of the various parts of the Philippine Islands; rabies; "carriers" and cholera control; diseases of man and other animals; water surveys; soil surveys; lime; the manufacture of roofing tiles and of vitrified and other clay products; gold, silver, lead, copper, and iron ore deposits in various parts of the Philippine Islands and other metallic mineral resources; petroleum, coal, gas, and asphalt resources of various parts of the Philippine Islands; and Philippine fuels.

A great deal of the assistance that we are able to-day to give to industries of various sorts depends on scientific work of a specialized character that was accomplished in preceding years. Certain problems require years for completion, and economic investigations must anticipate commercial and industrial development. For this reason much of the work of the Bureau of Science becomes most useful at a later date. For example, the work of the Bureau of Science on paper pulp completed ten

years ago is now attracting general attention. Pasteur's experiments to disprove the theory of spontaneous generation were not looked upon as of any practical value at the time they were undertaken, yet they are the basis of the modern practice of sterilization, and the noun "Pasteurization" perpetuates the author's name. Geology, the study of rocks, may seem dry and useless, yet this study is necessary for the discovery and recovery of such useful substances as iron, gold, coal, and petroleum.

Many people confuse the investigation and demonstration of mining, industrial, agricultural, and commercial possibilities with the subsequent development of these. The Bureau of Science has no function in operating such enterprises as the latter; its regular function ceases when the respective possibilities have been demonstrated, and it then becomes the responsibility of individuals and corporations to show sufficient enterprising spirit to carry on the commercial aspects. However, the Bureau of Science always has been and is most willing to coöperate with these in the establishment and development of new industries. The Bureau of Science is continually studying the possible resources, the health, and other problems of the Islands, to be prepared in so far as possible for questions as they come up and to have information on hand when it is needed. It has prepared, published, and circulated throughout the Philipine Islands reports and statistical information concerning its work that has aided and will continue to aid industrial and commercial development; but it has no authority to enforce the use of improved industrial methods, the elimination and the utilization of waste products, and other similar betterments. The Bureau of Science is doing all that it can toward the introduction of new and better industries of immediate and vital interest to the inhabitants of these Islands; but this cannot be effected if the people prefer to continue in the use of the old methods, as has happened. El Ideal of July 14, 1917, says: "To remedy this state of affairs it is necessary to organize a persistent campaign of education as the only practical method by which to cause to be forgotten all those antiquated and worthless methods which are difficult to disregard because of their long-established use. Therefore the first thing needed is to supply the Bureau of Science with sufficient funds with which to organize a corps of public demonstrators."

In order to show the amount of routine work performed, attention may be called to a few statistics with regard to the Bureau of Science.

	Fiscal year.			
	1906–7	1909–10	1912–13	1916
Chemical and physical analyses and tests of metals, minerals, clays, cements, fertilizers, soils, fuels, waters, paper, gums and resins, foods, drugs, etc	3,064	9,353	15,602	19,823
Examinations of fæces, urines, blood, sputum, gonococci, rabies, rats for plague, and miscellaneous bacteriological examinations	26,449	34,913	152,471	365,645
Total analyses, tests, and examinations	29,513	44,266	168,073	385,468
Available appropriation ---- pesos	381,838.28	404,159.16	409,884.30	371,976.00

The manufacture and sale of vaccine virus, serums, bacterial vaccines, prophylactics, etc., have grown even more rapidly than the analyses, tests, and examinations listed above. The preparation and administration of the Pasteur treatment to persons bitten by mad dogs has also increased. With such a large increase in the amount of routine work during the last few years and with no increase, in fact with a decrease, in available appropriation, there has been time for little other than routine duties, and many of our employees are much overworked.

Although the routine work of the Bureau of Science has greatly increased year by year, the number of authorized scientific positions has been reduced by the Legislature, until at the present time there are no positions devoted exclusively to research and no time has been available since 1914 for any work that has not had an immediate technical application, and much has had to be left entirely undone. It is impossible for the present personnel to do the work that should be done. The Bureau of Science does not have a great number of specialists in any one activity, and in many cases there is one specialist who does eight or ten different classes of work. There are continual resignations on account of inadequate salaries, and it is impossible to retain the employees or to fill certain positions at the salaries offered. The technical research work that is done is carried on as a side issue, taking little or no time from the necessary routine, but resulting in contributions to the scientific phase of the subject. The research men have had largely to give up their time to routine work or clerical duties that should have been performed by additional personnel. In the final analysis the completed research problems are the pegs that fasten the shield of industrial development to these Islands. As already pointed out, sources of wealth in the Philippine Islands are being

discovered that previously had remained untouched. There is reason to believe that the resources of the Islands can be developed along many lines if technical personnel is available. Local industries should be improved by every means within our power, and the Bureau of Science should have sufficient personnel of highly technically trained men, so that industrial development by the study of original problems may become the main issue.

ILLUSTRATIONS

PLATE I

Main building, Bureau of Science.

PLATE II

East wing, Bureau of Science.

PLATE III

FIG. 1. Rear view of Bureau of Science main building, showing power plant.
2. Serum-animal bleeding building, Bureau of Science.

PLATE IV

FIG. 1. Bureau of Science Aquarium.
2. Aquarium, showing main corridor.

PLATE V

Library, showing a corner of the reading room and a portion of the stacks.

PLATE VI

Room in the biological laboratory, showing type of central desk.

PLATE VII

FIG. 1. Interior of the room for filtering serum.
2. Interior of the stable for serum animals.

PLATE VIII

Interior of herbarium, showing type of cases.

PLATE IX

FIG. 1. Interior of the silk house, showing ant-proof racks for silkworms.
2. Corner of the room for marine biology, showing some of the aquaria and museum shelves.

PLATE X

Type of room in the chemical laboratory.

PLATE XI

FIG. 1. One of the large hoods in the chemical laboratory.
2. Main room devoted to physical chemistry.

PLATE XII

Vacuum drying and distilling apparatus.

PLATE XIII

FIG. 1. Bureau of Science cement-testing laboratory.
2. Testing machine equipped for timber testing.

PLATE XIV

Testing machine breaking concrete pipes.

PLATE XV

FIG. 1. Machines for testing the cementation value and toughness of road materials.
2. Hydraulic briquetting machine for testing road materials.

PLATE XVI

FIG. 1. New lime kiln.
2. Assay house.

PLATE XVII

Geology and mining exhibit room.

PLATE XVIII

FIG. 1. The Babcock and Wilcox boiler units of the power plant.
2. A corner of the engine room.

PLATE XIX

Machine shop, showing shaper, universal milling machine, press drill lathe, etc.

PLATE XX

FIG. 1. Producer-gas plant.
2. Producer-gas engine and dynamo direct coupled.

PLATE XXI

FIG. 1. Small-animal house, showing breeding cages.
2. Publications of the Bureau of Science.

PLATE I. THE MAIN BUILDING OF THE PHILIPPINE BUREAU OF SCIENCE.

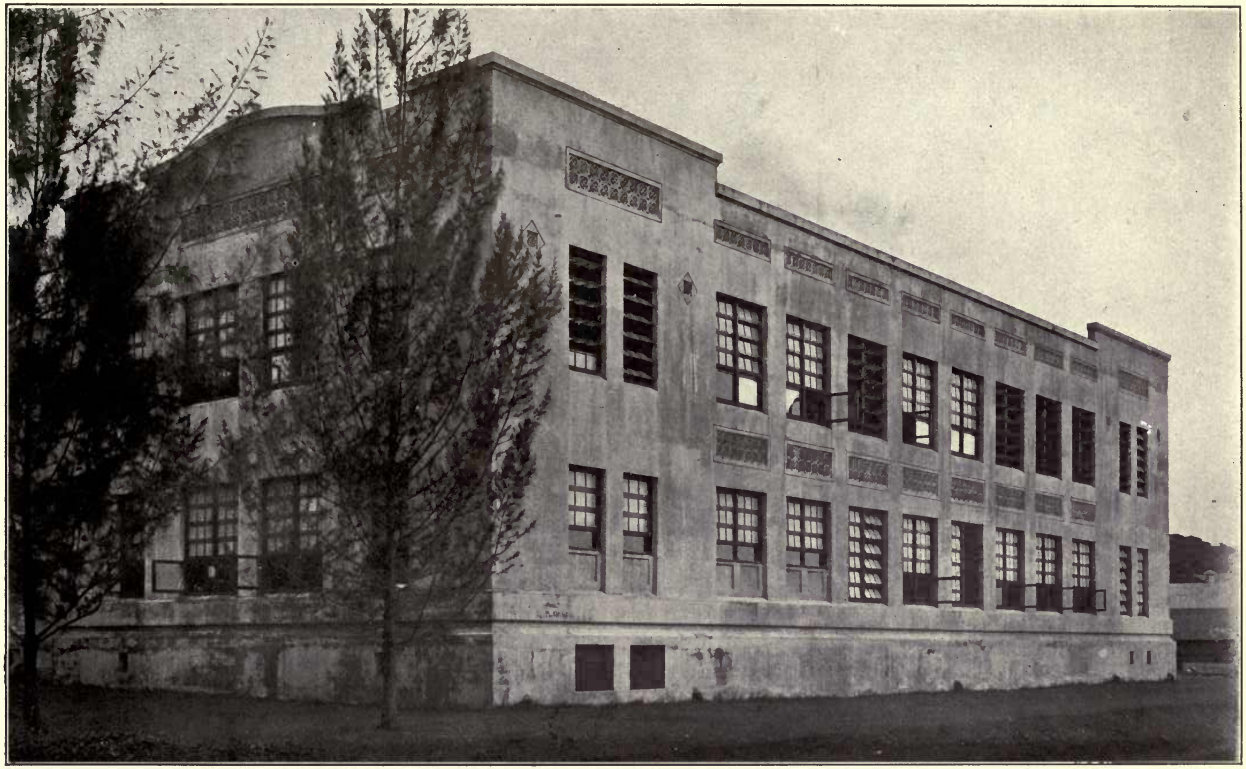

PLATE II. EAST WING, BUREAU OF SCIENCE.

Fig. 1. Rear view of Bureau of Science main building, showing power plant.

Fig. 2. Serum-animal bleeding building, Bureau of Science.

PLATE III.

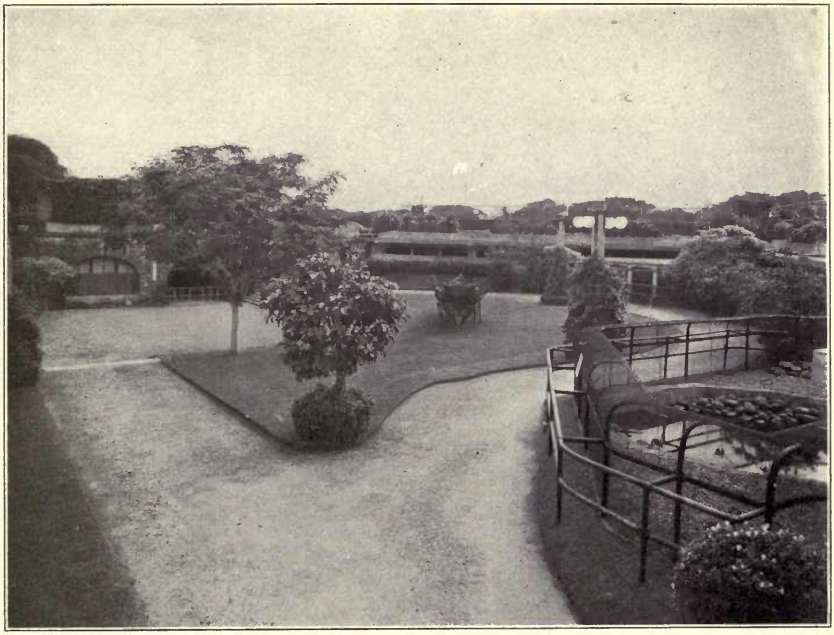

Fig. 1. Bureau of Science Aquarium.

Fig. 2. Aquarium, showing main corridor.

PLATE IV.

PLATE V. LIBRARY, SHOWING A CORNER OF THE READING ROOM AND A PORTION OF THE STACKS.

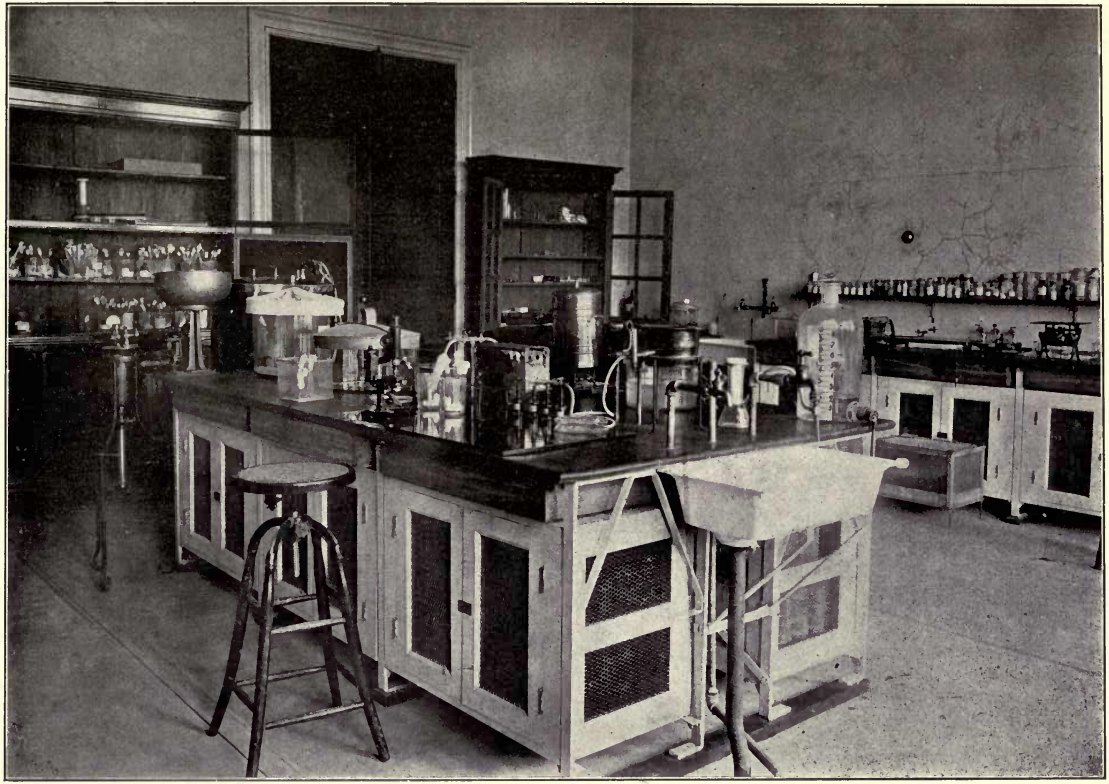

PLATE VI. ROOM IN THE BIOLOGICAL LABORATORY, SHOWING TYPE OF CENTRAL DESK.

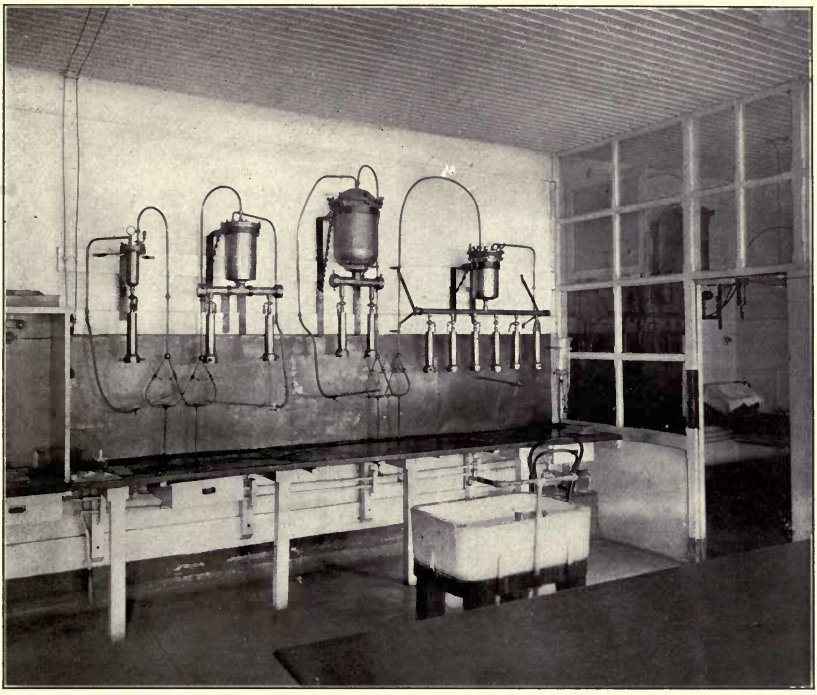

Fig. 1. Interior of the room for filtering serum.

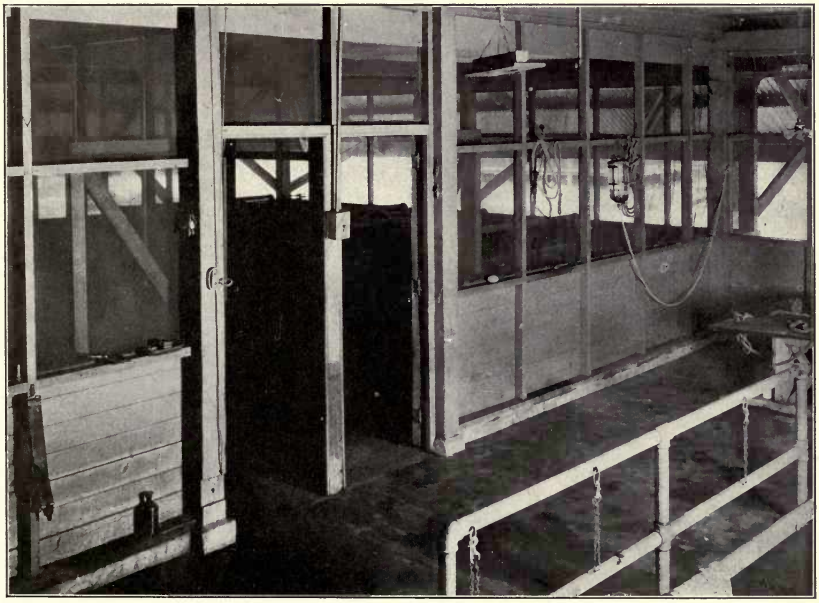

Fig. 2. Interior of the stable for serum animals.

PLATE VII.

PLATE VIII. INTERIOR OF HERBARIUM, SHOWING TYPE OF CASE.

Fig. 1. Interior of the silk house, showing ant-proof racks for silkworms.

Fig. 2. Corner of the room for marine biology, showing some of the aquaria and museum shelves.

PLATE IX.

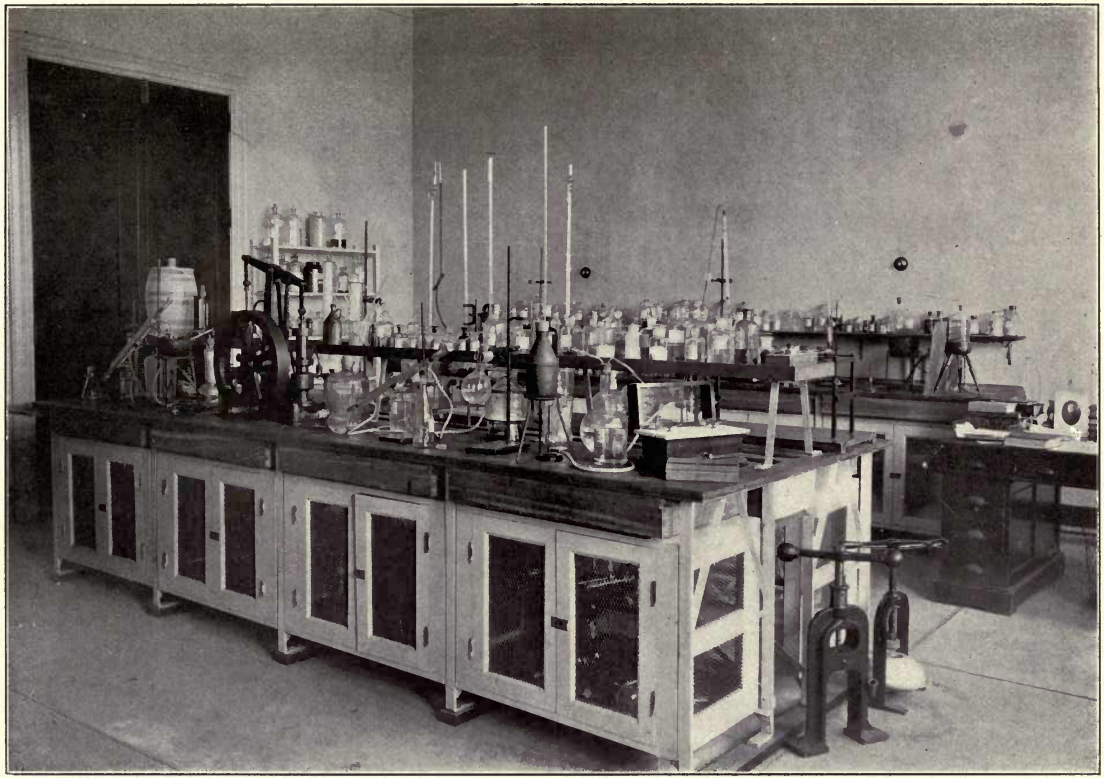

PLATE X. TYPE OF ROOM IN THE CHEMICAL LABORATORY.

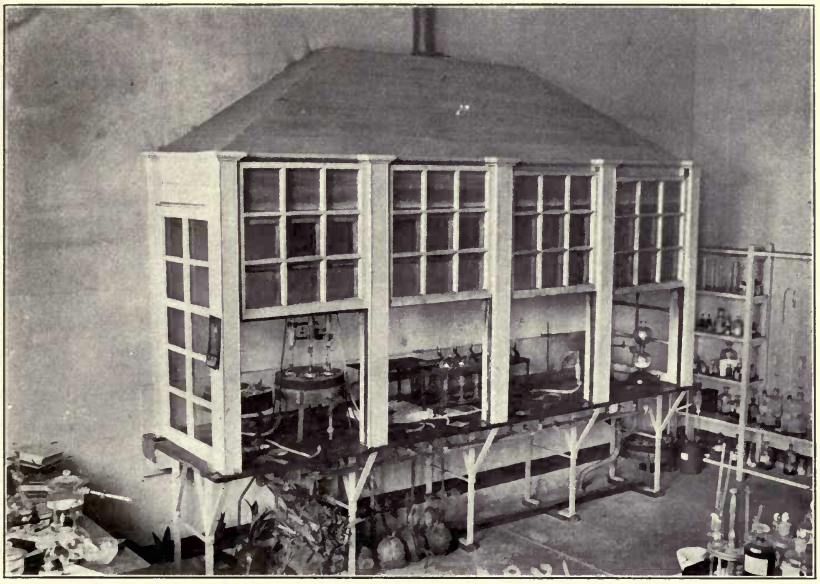

Fig. 1. One of the large hoods in the chemical laboratory.

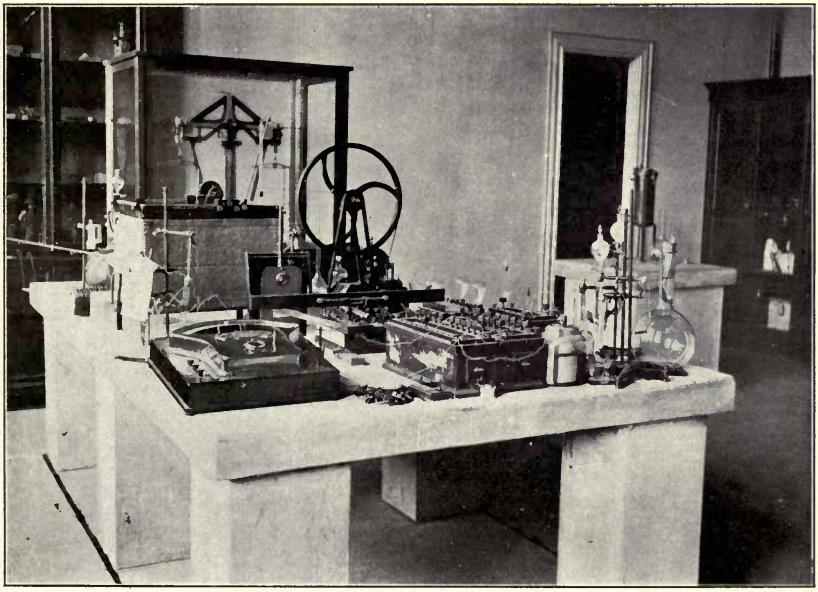

Fig. 2. Main room devoted to physical chemistry.

PLATE XI.

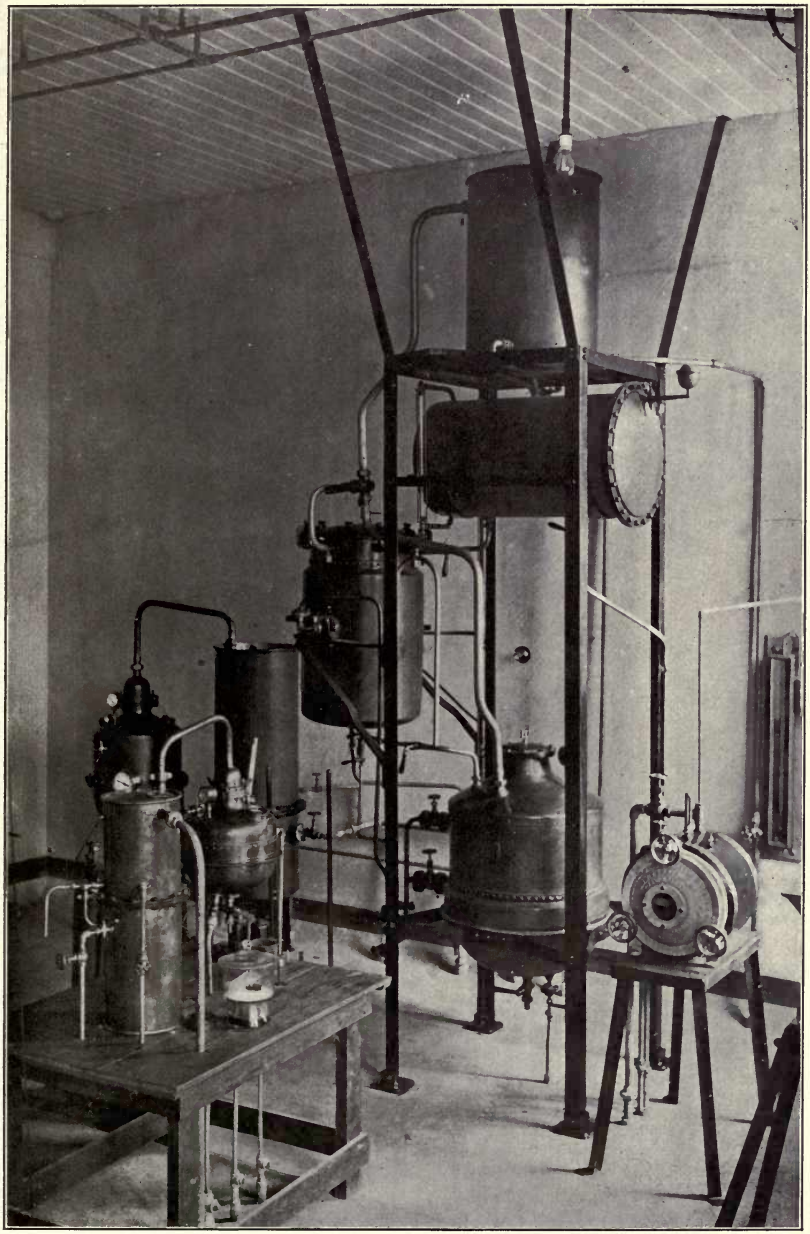

PLATE XII. VACUUM DRYING AND DISTILLING APPARATUS.

Fig. 1. Bureau of Science cement-testing laboratory.

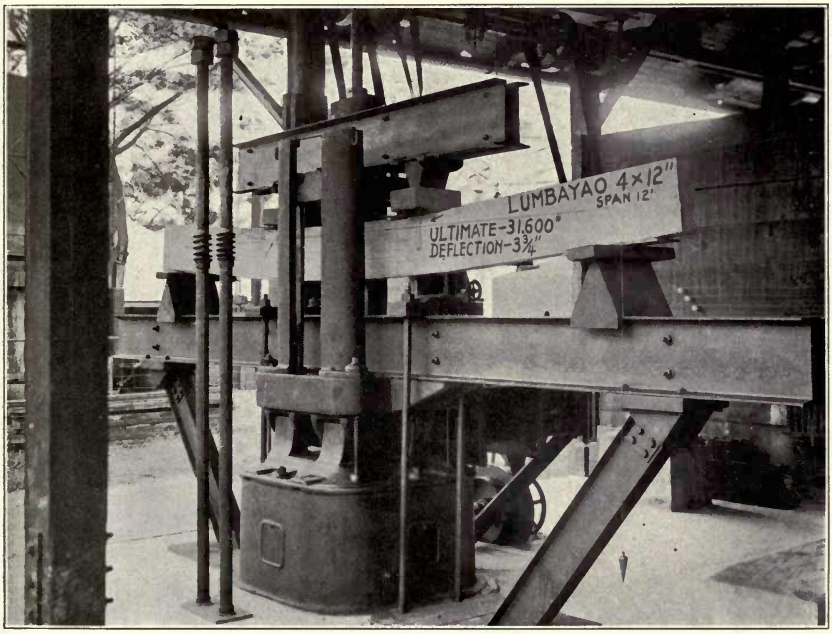

Fig. 2. Testing machine equipped for timber testing.

PLATE XIII.

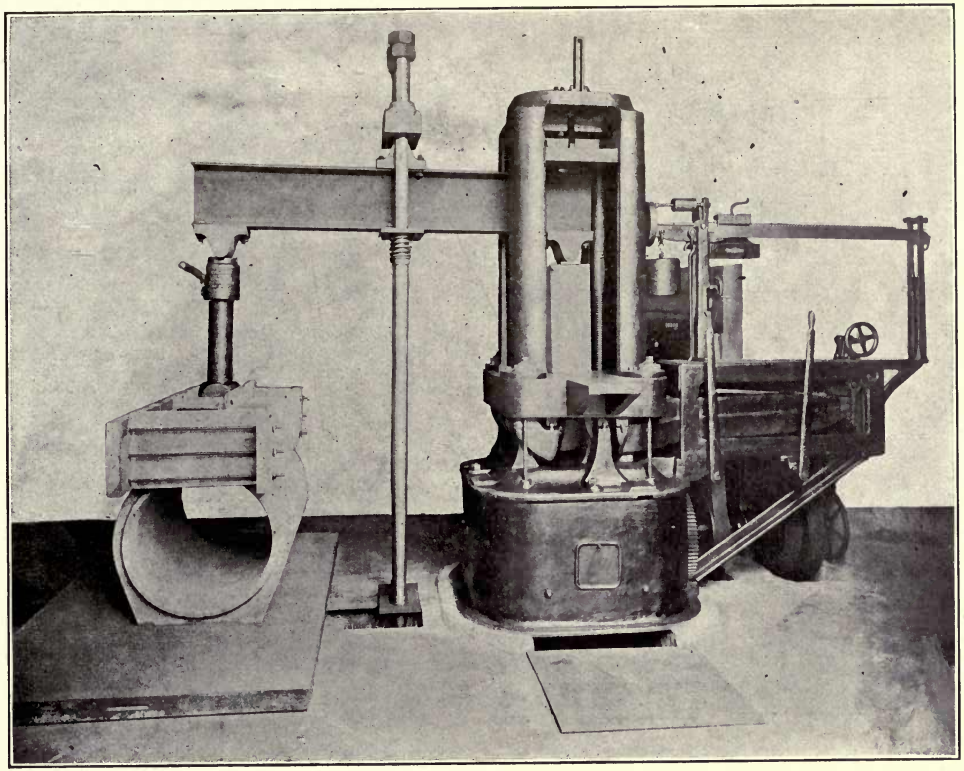

PLATE XIV. TESTING MACHINE BREAKING CONCRETE PIPE.

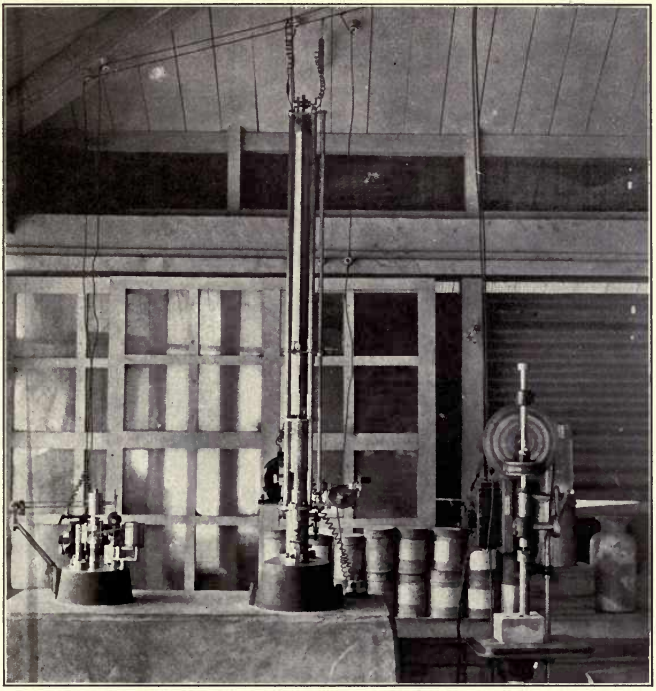

Fig. 1. Machines for testing the cementation value and toughness of road materials.

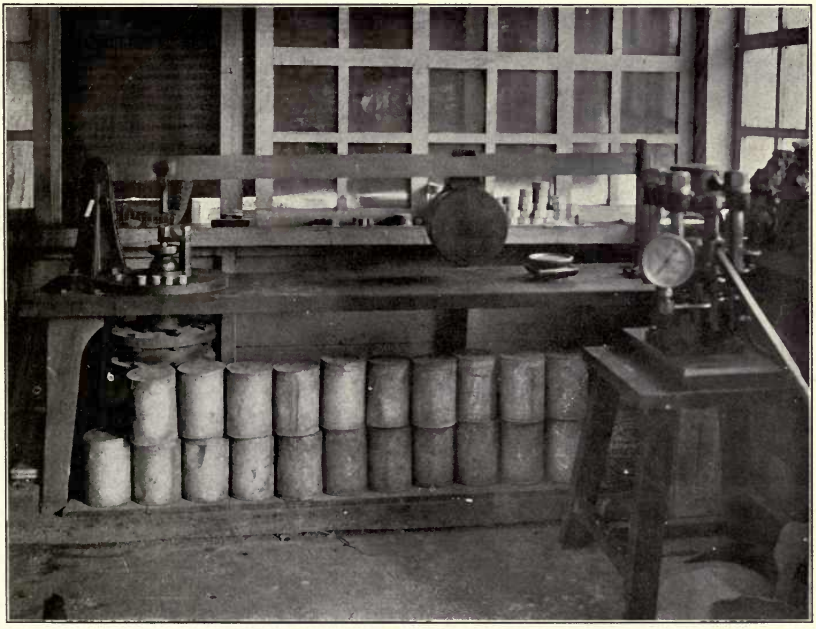

Fig. 2. Hydraulic briquetting machine for testing road materials.

PLATE XV.

Fig. 1. New lime kiln.

Fig. 2. Assay house.

PLATE XVI.

PLATE XVII. GEOLOGY AND MINING EXHIBIT ROOM.

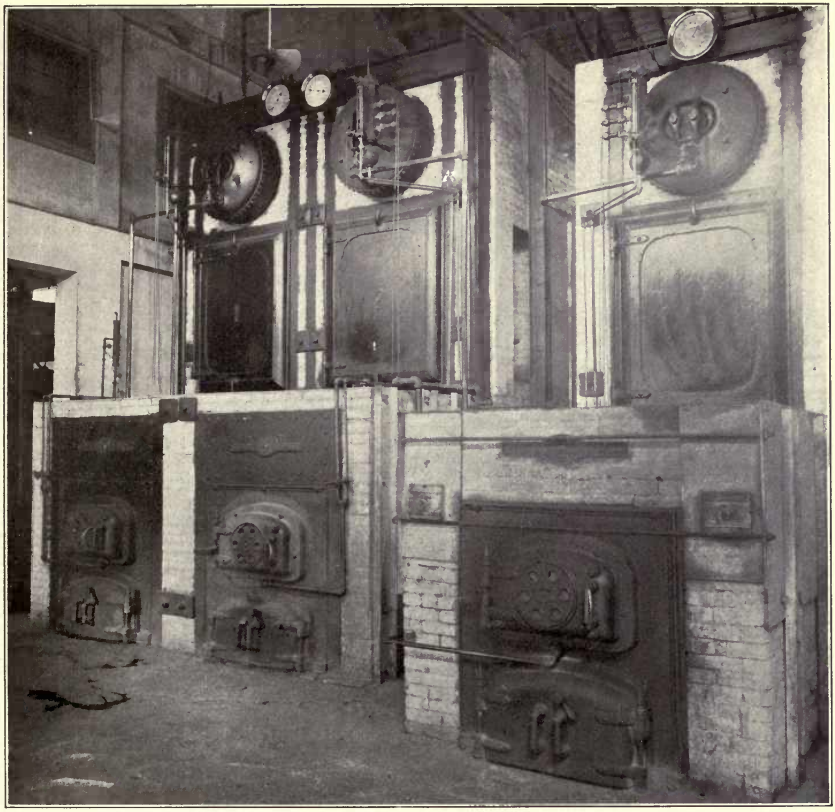

Fig. 1. The Babcock and Wilcox boiler units of the power plant.

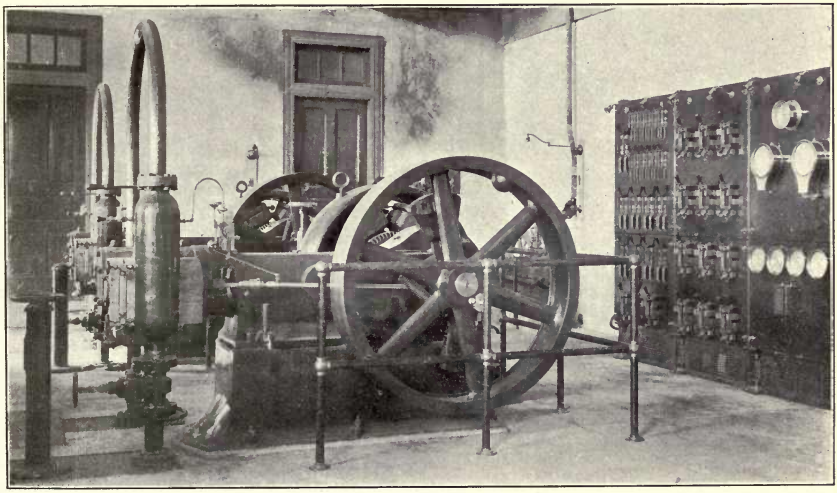

Fig. 2. A corner of the engine room.

PLATE XVIII.

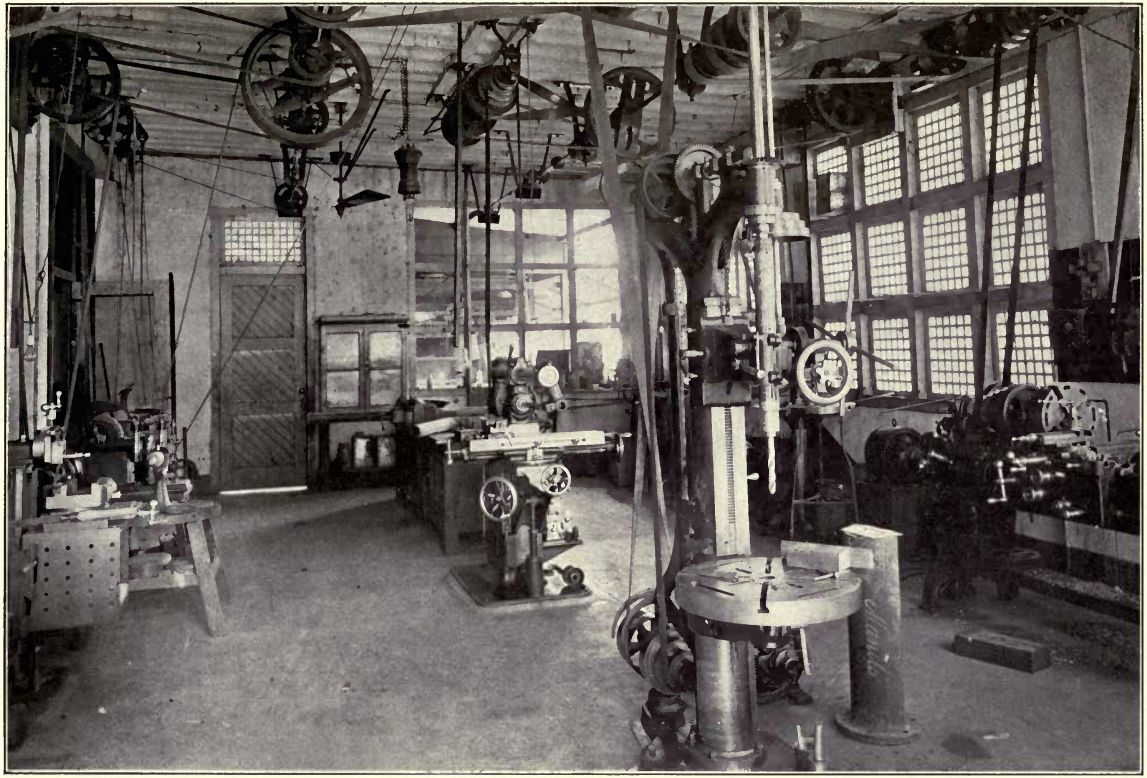

PLATE XIX. MACHINE SHOP, SHOWING SHAPER, UNIVERSAL MILLING MACHINE, PRESS DRILL, LATHE, ETC.

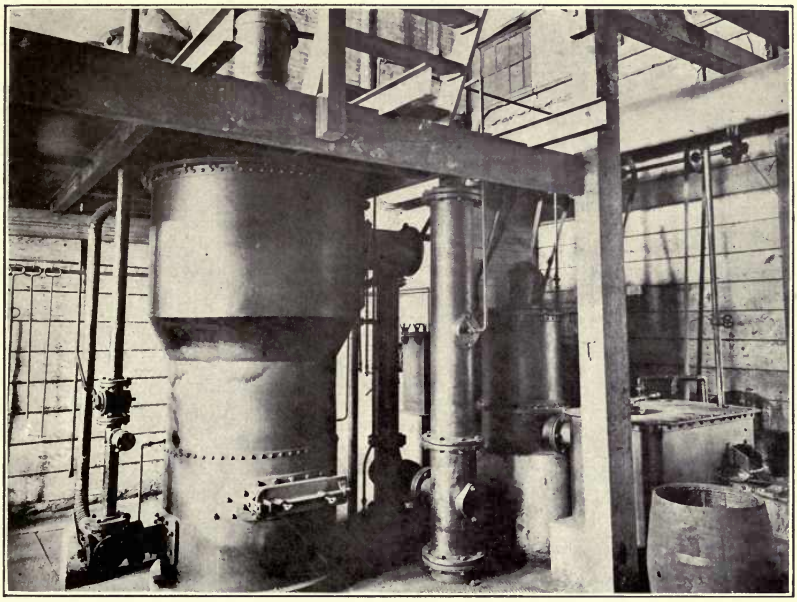

Fig. 1. Producer-gas plant.

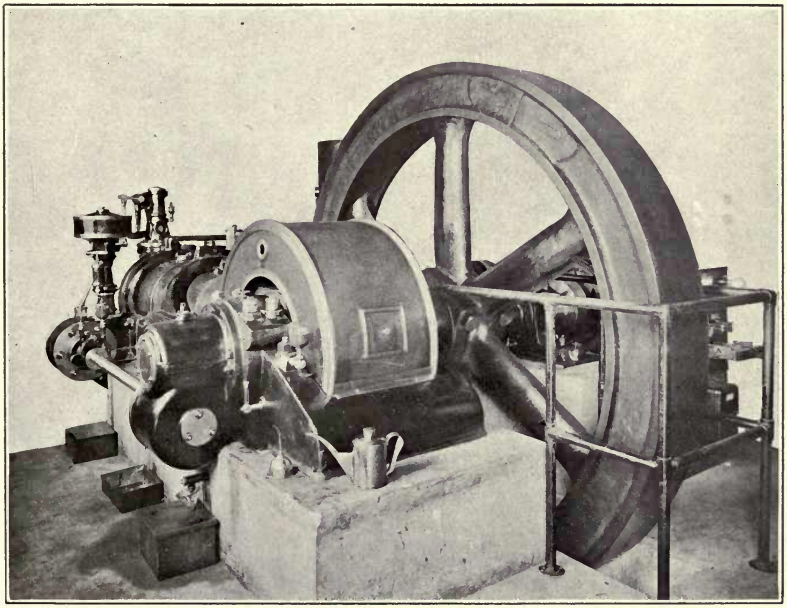

Fig. 2. Producer-gas engine and dynamo direct coupled.

PLATE XX.

Fig. 1. Small-animal house, showing breeding cages.

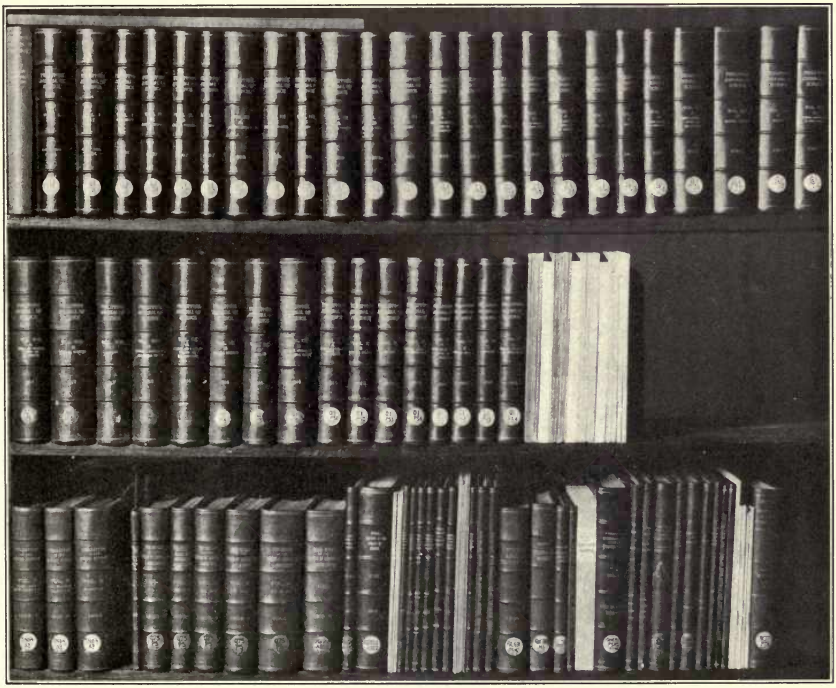

Fig. 2. Publications of the Bureau of Science.

PLATE XXI.

BUREAU OF SCIENCE PRESS BULLETINS

The numbers of the Bureau of Science press-bulletin series are issued at irregular intervals in typewritten form to distribute information of immediate local interest and are printed in some of the Manila newspapers. The following numbers only are available as printed pamphlets for free distribution:

No. 32, revised. Birds in their economic relation to man. By Richard C. McGregor. (Issued December 29, 1915.)

No. 50. The manufacture of 96-degree sugar by the use of open kettles (cauas) and the vacuum pan. By L. W. Thurlow and J. F. Armstrong. (Issued in August, 1916.)

No. 67. La savia de la palmera (nipa) como materia prima para la fabricación del azúcar en cantidades comerciales. Por D. S. Pratt, L. W. Thurlow, R. R. Williams y H. D. Gibbs. (Issued in Spanish only in August, 1917.)

No. 71. Philippine Bureau of Science charts. (Issued in English on November 14, 1917; in Spanish in December, 1917.)

No. 74. A comparison of the manufacturing units in some of the centrals of the Philippine Islands. By L. W. Thurlow. (Issued in English and in Spanish in December, 1917.)

No. 75. Methods of clarifying cane juice. By L. W. Thurlow. (Issued in English and in Spanish in December, 1917.)

No. 85. Copra and coconut products. By Alvin J. Cox. (Issued in English and in Spanish in February, 1918.)

No. 86. Philippine fuels. By Alvin J. Cox. (Issued in English and in Spanish in February, 1918.)

No. 87. The Philippine Bureau of Science. By Alvin J. Cox. (Issued in English and in Spanish in May, 1918.)