tain a family. Further, it is surely the cause or the result of second-rate qualifications as a college teacher to attempt to carry on another business with no bearing upon his professional pursuits for the sake of the increased income. Scarcely less valuable is the semi-professional routine of tutoring, commercial analysis, and even the preparation of uninspired text-books, for the same reason. These things do not give the best preparation for and naturally do not lead to the highest university positions, though they do bring immediate financial reward; better far devote the time to some research if there is any in the teacher, and qualify for advancement in the college or university world. In education as in business, both the teacher and the institution may expect to get what has been paid for; if the teacher gives less than his best efforts he may look for less than a full reward, and the institution that seeks bargains in teachers will probably get something cheap—and nasty; if first-rate results are to be achieved the price of first-rate ability must be paid, allowing for a long and expensive preparation.

The bearing of this upon the question of research is evident; to cultivate the vitality of the intellect it must be free—free from anxieties as to the necessities of life, free to proceed in broad and deep channels, with all the incentives of intercourse with things intellectual and esthetic.

The story is told of a college teacher, who was conspicuous at prayer meetings, that it was his custom in closing a lengthy petition covering a large amount of detail to say, "And now, O Lord, to recapitulate," and so on.

Permit me, then, in conclusion to summarize the points I have tried to present. In undergraduate schools research has a very important place as a stimulator and vitalizer of the teaching; it is, however, a secondary calling and should not be allowed to interfere with the main function of the undergraduate teacher, namely, instruction. The selection of men for such positions should be based primarily on their qualifications as teachers, and research should not be undertaken until a broad and deep foundation has been laid. The value of research, however, makes it most important that men capable of doing it should be helped in their efforts by the most favorable environment possible.

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A PLEA FOR ORGANIZED RESEARCH IN THE TROPICS

As science progresses we begin to look for new fields of research, for an increased sphere of investigation, for a greater and more varied amount of facts upon which to base our generalizations and our conclusions. As modern development generally becomes more pronounced we begin to reach out for opportunities in new regions, in those parts of the world where civilization has not yet gained a final foothold. To-day the tropical countries are still comparatively unknown, forming a terra incognita which contains many secrets for the explorer, many problems to be solved by the scientist, many riches to be gathered by the pioneers, always ready to exploit the resources of new regions.

With the striking diversity in their natural productions, their variety of geological structure, and their extreme conditions of climate, the tropics offer, in most branches of natural science, exceptional opportunities and wide fields for investigation and research.

Scientific research in the tropics has been carried on in a more or less perfunctory manner. Tropical research generally has not been conducted in a really scientific way. There is no organized and systematic investigation of tropical conditions, with the exception of a few years' work in this direction in Java and the Philippines.

I hasten to explain the above statements which at first sight may appear too sweeping and too severe. It is true that by individual and public effort, in the eastern tropics, in India, Ceylon, Malaya, Java and the Philippines a large amount of scientific research on tropical subjects has been accomplished from time to time. Vast quantities of valuable observation have been accumulated, but we still lack scientific data from many other parts, without which we can not arrive at definite conclusions. It is equally true that many individual scientists and scientific explorations have penetrated the swampy forests of the Amazon and the Orinoco, have marched over the pampas of Brazil and the llanos of Peru, have paddled up the affluents of Magdalena and Marañon rivers, climbed the snowy peaks of the Andes under a tropical sun, dwelt on the fever-infested sands of the Mosquito coast or sweltered in the dampness on the slopes of the Central American volcanoes, but all this work has been accomplished without a comprehensive plan or a definite purpose in view as to a final understanding of the conditions of the tropics. This pioneer work is most valuable, it has shown us what a marvelously rich field for research is to be found in the tropics.

The old European nations with tropical dependencies realized long ago that the successful opening up of their colonies depended on a proper knowledge of their resources. From the time of Linnæus, who sent many of his pupils to tropical countries, to that of the Honorable East India Company, from the time of Captain Cook's first voyage, when Banks and Solander gathered such valuable data, up to the present day the collections from the tropics have been mainly of an economic nature. These collections have been stored and studied in European and American scientific institutions, generally by scientific men who have not themselves had the opportunity of travelling in the tropics. Where such studies have been made on living specimens the latter have been kept under artificial conditions, which seldom if ever give a true imitation of the real natural surroundings such as they exist in the tropics.

The most important among such institutions in Europe is Kew, with its gardens, hothouses, museums and herbarium. By being the central place of tropical botanical research for the British colonies, as well as a school of tropical horticulture, which has produced a great number of scientific men for Great Britain's tropical dependencies, Kew has rendered tropical science invaluable service.

The Imperial Institute in London, in later years, has commenced to investigate colonial products more closely than was possible at Kew, and the brief but useful work of the Liverpool Institute for commercial research in the tropics indicated the lines upon which tropical investigation ought to be conducted. The Liverpool School of Tropical Medicine through the investigations of Ross and others deserves the highest praise.

We find in India numerous scientific institutions for tropical research, and in the British colonies generally the botanical and acclimatization gardens have become features of the greatest importance. Of British tropical gardens in the East, those in Singapore, Peradeniya, Calcutta and Kamerunga are especially noteworthy for their services to botanical science in general and to tropical agriculture in particular. The German, Brandis, organized Indian forestry on a scientific basis, which is not surpassed even by the work of Pinchot in this country, and the investigations in recent years at the Dehra Dun Forest Research Institute are unique in their thoroughness and value. It took an American to establish Indian agricultural research on a modern footing, and the Agricultural Research Institute at Pusa is now recognized as one of the leading institutions in the east.

The small acclimatization gardens in Brisbane, Port Darwin, Perak and Bangalore have been very useful in their way.

Holland found that the material progress of its colonies depended on the scientific development of agriculture, forestry, mining and other industries. With characteristic

thoroughness the Dutch set about the study of their colonial resources. The botanic garden at Buitenzorg with its many accessory institutions remains easily the leading one in the world, and the monumental work of Treub, whose recent death is a great loss, as an organizer and scientist can not be overestimated. His agricultural department of the Dutch East Indies was probably more efficient than any similar institution in the entire world.

The new development of the black continent has led to increased activity in the investigation of its scientific problems. Many new institutions of research have been founded, both in British, German, French, Belgian and Portuguese colonies in tropical Africa.

While the eastern tropics and their resources are comparatively well known, we have a very scant knowledge of the tropics of the western hemisphere.

Besides the few scientific institutions in the British and Dutch West Indies, and in Brazil, there are no botanical gardens, no agricultural experiment stations, no meteorological observatories, no medical research institutes, no zoological laboratories in the American tropics. In all the large territory of Central America, in Colombia, Venezuela, Ecuador and Peru there is absolutely nothing being done in scientific research of the tropics.

The United States of America have in recent years acquired valuable tropical dependencies, and in Porto Rico, Hawaii and the Philippines, notably in the last, scientific investigation is receiving due attention, in accordance with the requirements for scientific knowledge characteristic of present-day America.

The people of this country are, however, interested also in other parts of the American tropics, even if these are not political dependencies of the United States. It is sufficient to recall the fact that over a billion dollars of American money are invested in the tropics, in order to realize this. The American people investing in the tropical industries of the equatorial regions of this hemisphere have not had the assistance of science in making their investments secure and profitable. How different are conditions in Great Britain!

America has been so preoccupied with the development of its own enormous resources that the tropical parts of this hemisphere have been left to work out their own destiny unaided.

The Monroe Doctrine as an expression of the homogeneity of all interests affecting America should cease to be a political theory only, and should be brought down to commercial, industrial, literary and scientific reciprocity between the American countries. Trade relations are becoming more intimate. It is time that scientific relations become more frequent.

Tropical America is to-day more European than American. For centuries maritime Europe has been trading with the American tropics, supplying immense amounts of capital for the development of their vast resources, and converting these countries into commercial, if not political, dependencies.

To this day Europe has done more for the scientific exploration of tropical America than American scientists. There is, fortunately, no Monroe Doctrine as regards American science. But thoughtful Americans can not but lament their country's neglect of the great opportunities for contributing to the progress of civilization in tropical America.

Every country in the world needs the products of the tropics. Those that have not tropical dependencies of their own must acquire such products from other countries. The requirements of a prosperous nation of 90,000,000 of consumers have created a great market for tropical products in the United States. Humanity in general derives to-day many products from tropical countries, which have become articles of daily need where a century ago they were luxuries.

Tropical America, with its vast areas of fertile land, its abundant rainfall and perfect climate, and its proximity to the world's largest market, is capable of supplying all the products of the tropics in enormous quantities.

To be able to take advantage of these conditions, it is of the greatest practical importance that we arrive at a better and proper understanding of tropical countries.

The aid of science is necessary to make the tropics habitable and productive. Academic as well as applied science has in the tropics an open field. But we need organization and systematic work, instead of haphazard skimming of the surface of the scientific treasures of the tropics.

Where the problems are legion, and where the material is as abundant, and the opportunities as frequent as they are in the tropics, it is a general failing of the scientific worker that he becomes interested in too many features to be able to do his best. This must be avoided.

With the exception of the botanic gardens at Buitenzorg there are no scientific institutions in the tropics adequately equipped or properly manned. The usual small institution with a staff of two or three scientific men, often hampered by demands on their time for work in applied science, can accomplish but little. The need of a large institution for the investigation of tropical America becomes apparent when we take into consideration a few of the scientific and practical problems, which in thousands are waiting to be solved in the tropics.

The riches of tropical countries were the incentive which led to the great discoveries of unknown lands. They furnished the principal motive for the travels and discoveries of Columbus, of Balboa, of Vasco di Gama, of Dampier and Captain Cook, of Bougainville. Humboldt made his most acute observations while following the Cordillera through the American tropics. Darwin and Wallace collected their most important evidence in tropical countries for the theory of natural selection. Huxley, and Agassiz, father and son, acknowledged the value of their tropical journeys for their work.

The educational value to the young naturalist of tropical travel is now well recognized. It is to be hoped that an American institution for tropical research will make it possible for every young scientist of this great country to study for some time at least the peculiar conditions of the tropics and to contribute to the knowledge of tropical phenomena, by travel and investigation.

The conditions of life in the tropics as far as prevailing external conditions are concerned, are favorable to the development of a multitude of individuals, and consequently there is such a severe struggle for existence as is entirely unknown in more temperate climates. The many problems arising from this fact can not be studied to better advantage elsewhere.

There is no better place for a study of plant geographical problems than in the undisturbed regions of the tropics.

Systematic observations of the phenological stages and similar features of tropical plants in their natural surroundings have yet to be undertaken.

Very little work on the ecology of tropical plants has so far been done. This should be undertaken in the tropics. The hothouse method of studying plant phenomena is not reliable. Instead of showing the development of the tropical plant in its natural surroundings, it rather indicates the adaptability of the plant to unusual conditions and the possibility of acclimatization. The plants can not be placed under natural conditions in artificial temperatures.

The plant pathologists will find the tropics teeming with lower forms of life preying upon vegetation, and work on these lines is in great demand and of immense practical value.

The relation of plant life to geological conditions, the work of plants in changing the topography of the earth's surface, are equally interesting to the botanist and the geologist, and very little is so far known upon these questions from the tropics.

While in cold regions there is a retardation of development of plant life caused by low temperatures, in the tropics the same effect is caused by variation in moisture. The latter factor controls plant life in tropical regions, while in temperate portions of the earth heat is the principal factor influencing vegetable phenomena. Thus the dry season in the tropics corresponds to the winter in other parts; it is the time of rest and death. These relations are as yet but little understood in the tropics.

While light and the incident sunshine fur-

nish the mechanical or molecular energy at the disposition of the plant, they are the least understood of the climatic elements. In the tropics the light conditions are very intense and for this reason actinometric studies are especially necessary in tropical countries.

As for the chemical intensity of light, such comparative work as that of Roscoe and Thorpe in England, Portugal and Brazil opens up most interesting vistas of research.

While we have valuable results from temperate climates in regard to the relation of plants to soil moisture, evaporation and associated phenomena, we know practically nothing about these conditions in the tropics.

We know that in the tropics the average annual temperature differs but little, while the quantity of precipitation differs largely. The latter feature is of greater importance and needs therefore special study. We have a large amount of scattered data and much generalization, but practically nothing of definite scientific or practical value.

Tropical soils are as yet very little studied, except in a few localities, as in the West Indies, British Guiana and Java. The rapid decomposition of rock caused by the combination of abundant moisture and heat furnishes new layers of soil as well as a fascinating subject of study for the geologist and the chemist.

The numerous vegetable products of the American tropics are as yet very little known from a scientific point of view. There are scores of tan barks, dozens of oil-producing plants. New rubber plants are found frequently in the neotropical regions. New and old tropical fruits invite study, and economic plants generally occur in abundance.

When we consider that tropical America has given mankind more economic plants than any other part of the world, it seems strange that, after all, tropical America is less known to-day than any other region of the earth. We may only mention corn, potatoes, cacao, tobacco, rubber, sisal hemp, vanilla and probably bananas among the important vegetable products of the western hemisphere.

There is an open and very profitable field for the plant breeder in improving tropical products.

The tropics are inhabited by peculiar and interesting races of mankind, and traces of ancient civilizations are now obliterated by a luxuriant forest vegetation, which clothes the tropical lands from the level of the sea to the summits of the loftiest mountains. The anthropologist and the ethnologist find in tropical America some of the most complicated and interesting problems of research.

It is in the tropics where the principal volcanic belts encircle the globe, and with their variety of geological structure, their frequent earthquakes, their coral formations bathed by the tepid waters of the great tropical oceans, the tropics of America offer unequaled opportunities for geological studies.

The violent electric discharges in the tropics produce atmospheric nitrogen, which probably is carried by the rain water into the soil, and thus contributes to and probably explains some of the fertility of the tropical soils. Our knowledge in this regard is very limited.

Where the tropics teem with vegetable products of the most striking diversity, animal life also is most abundant and of great variety. Tropical zoology is so far only touched on the surface, and especially are the lower forms of animal life in the equatorial zone known only slightly.

The pathogenic bacteria have only in a few instances been investigated and a large field is here open. There has been much progress in tropical medicine during late years, but while we know the elements of this science there is still much to learn, many tropical diseases to study and many remedies to discover.

Modern science has demonstrated that life in the tropics is possible for white man, and if ordinary precautions are taken he is as safe there as in any other place. Tropical exploration has craved its dues in form of many martyrs to science, but with modern appliances and present-day knowledge there is no need of privations and exposure during tropical travels.

In this regard it is of special importance that systematic research in the tropics be

inaugurated, so that scientific workers may receive proper instructions and advice as to methods and conditions of life and travel. Instead of gathering his own experience in this regard he should be able to rely on that of others, and without waste of time devote himself to his scientific work. Every scientific investigator in the tropics knows that the information he received when he prepared for his journey of exploration into the primeval forest was practically valueless, and he had to learn for himself, often at considerable expense, loss of time and not infrequently of health.

An international, a Pan-American institution for the scientific study of the conditions of tropical America is needed. American scientists should take the lead and invite their colleagues of the Latin-American republics to join them in a systematic endeavor to study the tropics of this hemisphere, its natural riches and its diversified conditions. Such a course will be as important for the preservation of peace, for the mutual understanding between the peoples of the Americas, and for the progress of these countries as commercial treaties or diplomatic conventions.

I do not propose here to enter into details in regard to the organization of a Pan-American scientific institution for the systematic study of the American tropics. I do believe that the time is ripe for such an undertaking, and I have reason to think that if a suitable plan is defined and proposed it will meet with the ready response and approval of the public and the governments of all the American republics.

Pehr Olsson-Seffer
Tezonapa Botanical Station,
Mexico, D. F.,
December 20, 1910

Octave Chanute[1]

Octave Chanute was born in Paris, France, February 18, 1832. He was brought to this country in childhood, was educated chiefly in New York City and began the practise of his profession as civil engineer at an early age.

After having done efficient work in railway construction in New York, Indiana and Illinois, he became in 1863 chief engineer of maintenance of way and construction of the reorganized Chicago and Alton Railroad, remaining upon that line until 1867.

During this connection, having been invited to submit a design for the proposed Union Stock Yards of Chicago, his plan was selected in competition with a number of others and he built these yards as chief engineer. He was also awarded a premium for a competitive design for a bridge across the Missouri River at St. Charles, Mo. In 1867 Mr. Chanute went to Kansas City, Mo., as chief engineer of the bridge across the Missouri River at that point. This was the pioneer bridge across the Missouri River, and as the river pilots and riparian dwellers had given this stream a bad reputation, the successful completion of this bridge across it in 1868 attracted great attention and interest.

Later Mr. Chanute successively became chief engineer of the Kansas City, Fort Scott and Gulf, the Kansas City and Santa Fe, the Atchison and Nebraska, and the Leavenworth, Lawrence and Galveston railroads.

From 1873 to 1883 he was in the service of the Erie Railway as chief engineer. During this connection he readjusted the motive power of the road and lessened the grades so that the through freight trains, which averaged eighteen cars when he first became connected with the line, had grown to thirty-five cars when he closed his connection with the road in 1883, when he removed from New York to Kansas City, in order to look after his personal interests, and to open an office as consulting engineer.

In this latter capacity he took charge of the construction of the iron bridges during the building of the Chicago, Burlington & Northern Railroad between Chicago and St. Paul in 1885, and of those of the extension of the Atchison, Topeka & Santa Fe Railroad, from Kansas City to Chicago, in 1887 and 1888; the latter involving, besides a number of minor streams, the Missouri River bridge at Sibley

[1] Presented to Section D, American Association for the Advancement of Science, Minneapolis, December 30, 1910.