estimated at two million nuts monthly (including those fed to animals), whereas it was formerly estimated at three million monthly. The decrease is due to bud-rot.

Much work has been done on this trouble in the British West Indies, where the destruction of sick trees and the use of Bordeaux mixture as a preventive have given good results.

Considerable attention has also been given to the bud-rot by the United States Department of Agriculture, which, at the request of the planters, sent Mr. Wm. Busck to Baracoa to investigate the disease in 1901. The measures which he recommended are substantially the same as those which are now to be carried out. The results of his work are given in Bulletin No. 38, Division of Entomology, U. S. Department of Agriculture. In the spring of 1904, Dr. Erwin F. Smith, of the U. S. Department of Agriculture, spent some time in Cuba studying the disease. Mr. Busck had regarded it as caused by a fungus, *Pestalozzia palmarum,* but Dr. Smith regarded it as a bacterial rot. The results of Dr. Smith's work are given in Science, N. S., Vol. XXI., No. 535, p. 500, March 31, 1905. During the past year his investigations have been continued at Baracoa and other West Indian coconut-producing points.

The subject has been written on largely by Cuban authorities, notable among whom is Dr. Carlos de la Torre, of the University of Havana; and the Department of Vegetable Pathology of the Estación Central Agronómica de Cuba has given it as much attention as possible among many other problems during nearly four years, but without being able thus far to reproduce the disease at will.

The work for which the appropriation has just been made by the Cuban government is in continuation of investigations undertaken by the Cuban Department of Agriculture through the Estación Central Agronómica in March, 1907. At this time Mr. Wm. T. Horne, chief of the Department of Vegetable Pathology of the Estación Central Agronómica, was sent to Baracoa to study means of eradicating the disease and during the summer he made three other visits. The trouble was found widely distributed and progressing at an alarming rate. The principal work done was the treatment of several small groves with the most thorough sanitation possible—*i. e.,* dead and hopelessly sick trees were felled and burned, while new cases and suspected trees were flamed out. In two of the groves which were treated the disease was passing across, killing every tree in its path. The work showed that all trees with fairly well developed cases die. It was thought that some very early cases were saved by the flaming; at least the disease was checked. It was not stamped out in the groves, but the results were as satisfactory as could have been expected in decreasing the infection.

The work now to be undertaken is probably the most extensive measure ever adopted to control the bud-rot of coconuts and it is most sincerely to be hoped that this aid from the general government will sufficiently suppress the disease so that by a vigorous system of inspections it may be thoroughly and permanently held in check.

SPECIAL ARTICLES

REGARDING THE FUTURE OF THE GUANO INDUSTRY AND THE GUANO-PRODUCING BIRDS OF PERU[1]

To the people of Peru the importance of the guano industry needs no emphasis, but it is well, first, to make clear just what is the alarming condition with which the country is confronted, and what is the object to be striven for.

Every one knows that the great ancient deposits of guano are now almost non-existent. As these deposits have been successively exhausted of various high grades, there is now left only the lowest grades that it is profitable to extract, and also some supplies of such very low grade that under present conditions they are not marketable. However, the birds are

[1] The present paper, very slightly modified from a report recently submitted to the Peruvian government and published officially in Spanish, is presented in English with the kind permission of Sr. Larrabure y Correa, Director de Fomento in Lima.

each year making new deposits, especially on their nesting-grounds, and this new fresh guano usually has a very high per cent. of nitrogen and a comparatively low per cent. of sand. Now, as the remaining deposits of old guano are rapidly being exhausted, the annual gross output of guano is bound to decrease very considerably, and the industry will be dependent entirely upon the yearly deposit of the birds.

Probably the general impression held in other countries regarding the accumulations of guano in Peru has been that they were comparable to coal formations, in that they represented the very gradual accumulations of untold years, and were, practically speaking, a finished formation. By the very nature of such deposits they would surely be exhausted sooner or later. Unfortunately this partly erroneous impression seems to have been the controlling one both in Peru and outside. For, while many of the intelligent men of intimate acquaintance with the islands have recognized the producing value of the modern birds, the whole policy of extractors and the government has been, until rather recently, that of making the most of the old deposits, with general disregard of the productive birds.

When one sees one thousand tons of new guano of the highest grade taken from an area of twelve thousand square meters, where the birds have been nesting for much less than one year, when one observes on a neighboring island an area, five times greater, completely covered with birds at their nests, when one, later, finds this latter flock increased by nearly fifty per cent., as the birds have been driven from other islands—with such convincing appeals to the eye and the mind, one will not fail to recognize the present producing value of the birds.

For this new guano of annual production, there is, on the one hand, the insatiable demand of the export trade, and, on the other, a steadily growing requirement for the needs of national agriculture. Since it is generally estimated that the agriculture of Peru requires about forty thousand tons per year, and since this quantity is surely more than the present yearly production, it follows that the impression regarding the exhaustibility of the guano deposits may, doubtless will, prove true, as far as the North American or European consumer is concerned. More than this, it is inevitable that, with the continuance of the present conditions, national agriculture will soon be forced against an actual and disastrous shortage of this fertilizer. The hope of the future lies, then, in the effort to make the annual deposits of guano greater in future years than it now is. National agriculture may have an additional hope, also, that arrangements may be made with the exporting company whereby a greater proportion, if not all, of the fresh guano of high grade may be available for domestic use.

I. THE AIM IN VIEW

To realize the hope that the annual deposit will be greater in future years, it is necessary to cease treating the birds as wild animals whose homes men may invade almost like beasts of prey to seize the useful product, regardless of the producing birds. Under a wiser policy the birds will be looked upon as domestic animals, engaged in a useful labor, and from which a greater benefit will be derived the more an intelligent consideration is shown for their welfare. By the protective measures there are three ends to gain.

1. The present number of birds may be permitted to spend a greater proportion of their time upon their chosen nesting-grounds so that a greater proportion of the guano may be available. The most useful birds, the "guanay" (*Phalacrocorax bougainvillei* Less, a cormorant) and the "alcatras" (*Pelecanus Molinae* Gr., a pelican) spend a great part of their time during the entire year upon the nesting-field or neighboring grounds unless frightened away by the presence of men. In this case they are likely to spend much more time upon the water, or upon the small islets and cliffs, where the deposits are less available, if not largely lost.

2. The present tendency to decrease in numbers may be checked. There is a wealth of reliable testimony from the older men of

long experience in the industry, that the useful birds, especially the alcatras, were formerly vastly more abundant than now. Considering the well-known facts regarding the robbery of eggs on a large scale in past years, the destruction of young and old birds, and the disturbance of the birds in their nesting-grounds by the extraction of guano, it is inconceivable indeed that the birds have not decreased greatly in numbers. If they have endured the treatment they have received without decrease in numbers, then protection can hardly be worth while. On the other hand, if it is true, as represented by every one who should know, that there has been a great diminution in number of birds, then—

3. *We may hope that the protection of the birds will result in a great increase in their numbers.* Before the working for guano on a large scale began and before the nesting-grounds began to be plundered for eggs and fowls, the birds must have existed in a condition of abundance dependent upon their food supply, their enemies and their natural prolificness. New factors have entered in recent years which have caused the birds to decrease materially below this *normal condition of abundance.* If these unfavorable factors are removed by well-considered and well-executed protective measures, why may we not see an increase in number toward the former normal abundance?

I think it conservative to say that the proper protection of the birds means the saving to Peru of hundreds of thousands of dollars' worth of guano each year. The wise action of the government in keeping closed during last season the south island of the Chinchas probably saved one thousand tons or more of guano of high grade during this year. Besides, it has been a benefit to the birds, which, if properly followed up, will yield results in all successive years. The keeping closed of the north island of the Chinchas would not have saved much guano during that season, but, as the beginning of a plan for the fostering of the alcatras, it might have yielded results in future years. For it seems sure that the alcatras was once an abundant and important bird in this region. Now it has practically abandoned the region, but as I showed in a report published in the *Boletin del Ministerio de Fomento* of June, 1907, the few alcatrases which remain had chosen this one island, of all in the Chincha and Ballestas groups, for their nesting-ground. The islands of Lobos de Afuera were abandoned for two years, and the alcatrases settled themselves chiefly in the northern part of the eastward island, and on an islet near by. Here, now, was an ideal arrangement: while the extraction of guano on a large scale was in operation in the Lobos de Tierra Islands, these timid birds were in undisturbed possession of the Lobos de Afuera. Unfortunately, this condition was not permitted to continue, for last season the extraction of guano was resumed on these islands, and the birds were entirely routed. They have now taken new positions, more or less scattered, but with an especial aggregation on the northern part of the westward island. Now guano is again to be extracted from these islands and the pelicans will be routed again from their newly established homes. Is it not time to awaken to the fact that the alcatras is gradually disappearing?

The three instances cited above are adduced to illustrate this point; we need not merely look out for the next two years, but may well plan for protective measures that are intended to work progressively to the advantage of the industry for the next twenty years or more. We want to see many more birds in 1915 than are present in 1908, and more birds in 1920 than in 1915; and this will not be accomplished by routing the birds from their nesting-grounds as soon as they are fairly established.

II. ONE CONTRACTOR TO AN ISLAND

As illustrating the effect of admitting more than one concessionist to an island, let us take the Ballestas Islands, as worked in 1907, for example. As directed by the government, I visited these islands in May and June, and again at the end of July. In the last part of May the work of extraction had been in operation but a few weeks and practically no guano had been shipped, yet every inch of

nesting-ground on all three islands had been dug up and thrown into piles, while every bird had been routed. It was perfectly evident that the work of extraction had been carried on entirely without regard to the preservation of the useful birds. I do not mean by this that there was much wanton destruction of the birds, but that practically no consideration was given to the necessities of these fowls for the completing of the rearing of their young or for the mating and other preparations for the next season of reproduction. No inducement was offered to the birds to continue nesting upon the same islands. A little more forethought and system in the manner of working might have saved many tons of guano for the season which is now beginning.

Now, this reckless mode of treating the birds will be continued as long as more than one contractor is licensed to work on the same ground. It is easy to picture the beginning of the work. Two or more contractors have concessions for certain quantities of guano on the north island of the Ballestas. There is on the southwest corner of the island a deposit of several hundred tons of fresh guano. Naturally, this place is the goal of each concessionist. The first to arrive, or the strongest, as the case may be, devotes every effort to the digging up of this area of high-grade guano, since by the act of heaping it in piles his claim is established, and no other contractor has the right subsequently to touch these piles. *Of course, this area of new fresh guano is the chosen breeding-ground of the birds, and so the entire flock of birds, young and old, is routed unceremoniously from the land of their recent nests.* As just the same policy is pursued simultaneously on each of the other two islands of the group, it results that *within the first few weeks of the open season every producing bird on the Ballestas Islands is driven from its nest.*

From the testimony of eye-witnesses it appears that a large number of young fowls were unprepared to abandon their nests, and that the enforced removal of the birds did not occur without the loss of an important number of helpless creatures. From personal observation I know that, even as late as the middle of June, there were large numbers of young birds on the south island of the Chinchas that were still being fed from mouth to mouth by the parents, and I must, therefore, believe that the complete routing of the birds from the Ballestas two months earlier, in April, must have been very harmful. We need not be too quick to blame the contractors in this case. Driven by the force of a very severe competition, they try to establish their claims immediately to as much as possible of the best guano, and, in the heat and bitterness of the competition, they grasp for guano while they are blinded to the welfare of the birds.

If but a single concessionist is admitted to an island, then a more systematic method of extraction may be followed, and more consideration be given to the needs of the birds. It would be better still if only a single concessionist were admitted to the group. Furthermore, the government can require of the concessionist that an intelligent and competent man be put in charge of the work of extraction, who shall be held responsible for the fullest protection of the birds.

I may also refer to the fact that such a measure would eliminate those many and unfortunate disputes between contractors which, as is notorious, have been occurring in recent years on these islands and which reach to the point of threatened and even actual personal violence.

III. CLOSING ISLANDS FOR PERIODS OF YEARS

The plan of working all islands simultaneously condemns itself, and a system of proceeding from one island to the next as soon as the guano from the first is exhausted is little better than the plan of working all islands simultaneously. An improvement on this is the plan which has been suggested several times recently, of dividing the islands into two groups, the islands of one group to be worked one year while those of the other remain closed. This, however, on consideration, is seen to be inadequate, since the birds would thus be disturbed each year as they are

driven back and forth from the islands of one group to those of the other.

The merit of a system of rotation depends on leaving the birds unmolested for periods of years, the longer the period the better. For example, it would be an incalculable gain if the alcatrases, which are now using the westward island of the Lobos de Afuera, could be left undisturbed on their grounds for the next four or five years, say until the extraction of old guano from Lobos de Tierra is concluded. Then, in turn, the latter island would be left to the birds for another period of five years, whether the Lobos de Afuera was exhausted in one year or in four years. In other parts of the coast, according to the conditions, certain islands would be opened each year, but in accordance with a plan which would permit the birds to remain undisturbed for periods of years.

In stating that the main hope of the guano industry consists in leaving the fowls unmolested for periods of years, I speak from my own observations on the habits of the birds and on the disturbing effect caused by the presence of even a single visitor. At the same time, it is not a new idea, and the intelligent men of long experience in the industry will insist upon the same principle. I wish to add this: the idea of a systematic closure of islands, if adopted, must be followed resolutely. It may sometimes mean the suffering of national agriculture or of the export trade for want of necessary fertilizer, but the suffering should be accepted rather than break the protective measures. It is fair to choose between two courses, either to plan for the future of the guano industry, adhering to reasonable protective measures, even if present sacrifice is necessary in order to reap the future benefit, or else, continually to cater to present wants and caprices and let the future look out for itself.

IV. CLOSED SEASON

It was a most wise action of the government in establishing a closed season of five months (November to March), when all of the islands were worked each year. Too much dependence, however, can be placed upon this measure. With a proper system of rotation and closure of islands for years, the closed season for the summer months becomes a matter of secondary importance. There is no season of the year when the birds may be disturbed without harm. In the middle of June last year there were numbers of birds in the Chinchas Islands which were still being fed from mouth to mouth by their parents. At the same time the process of pairing for the next season had begun and by July 29 hundreds of eggs had been laid, as the beginning of the next season's brood of young. During what months, then, could work have been conducted on this island without injurious molestation of the birds? The fostering of the birds will be accomplished only by leaving them unmolested for the entire year and for several years in succession. If an island is to be opened it is not of vital importance whether it be opened in April or in June.

I believe it to be more harmful to open too late than too early. To illustrate this, let us make an imaginary case of the south island of the Chinchas. If it be possible to do without this island, it will be most beneficial if the island may remain closed until April or May, 1909. Suppose that it is now decided to keep this island closed, and that later, about August, it is found that the supply of guano from other sources is inadequate and the demands of national agriculture are such that it is deemed necessary to extract guano from this island. The island is opened early in August—with what result? Just at the stage when the majority of the birds have mated for the season, when a large number of eggs are newly laid, and when the females are laden with eggs ready to be deposited in the prepared nests—just at this critical time, the birds are frightened from the island. The new-laid eggs are abandoned, and other eggs laid during this time of change may be lost as the birds chance to stop upon the neighboring rocks or islands. For the change of home is not accomplished in a day; it requires many days or weeks for the birds to realize that the old home must be abandoned, to settle themselves in a new place, and to recover from the demoralization attending the forced change.

More harm is wrought than if the birds had been routed in April; then, by the beginning of the new season of laying, they might have found themselves established in the new homes. The case is imaginary, but it leads to the following important conclusion: Before deciding whether to open or close the south island of the Chinchas, the Lobos de Afuera, the Zarate, the Isla Blanca, or any one of many large and small which have birds in reproduction, it should be carefully considered how much guano is required and from what places it may be obtained. The determination of which islands should remain closed and which open can then be made intelligently, and the islands opened at once or else kept finally and absolutely closed.

It is hardly necessary to refer to the fact that the condition of the sea in the winter months is much more unfavorable for the extraction of guano than in April or May.

The closed season serves a most useful purpose, but for the future the dependence must be placed on closure for periods of years, and less emphasis may be laid on the matter of a month or two.

V. TO PLACE THE EXTRACTION OF GUANO FOR NATIONAL AGRICULTURE IN THE HANDS OF A SINGLE COMPANY

Such a measure as this I believe to be a part of the ultimate solution of the problem. Saying this, I have no reference to any special arrangements which may be pending and with the terms of which I am unfamiliar. In making arrangements with a company, many subsidiary problems arise, such as, the effective protection of the birds, the proper system of rotation of the islands, the manner of conducting the work, the proper distribution of the guano in case the supply does not equal the demand, the analysis of the guano, and the selling by units of nitrogen and of phosphoric acid, the guarantee of an equitable price, etc. Undoubtedly these problems will be carefully studied out before any permanent contract with a company is entered into.

The merit of placing the guano extraction in the hands of a company depends upon making the contract last for a period of years, say for ten years or more. By this means the company is induced to *plan for the future,* which is the desideratum.

It is likewise very desirable that some adjustment may be made with The Peruvian Corporation Limited, with entire regard to all natural obligations, but with a view to securing a harmonious plan of working for the protection of the birds, and also to enabling the national agriculture to get the best of the guano, at a reasonable cost, and with prices proportional to the value of the guano. It is difficult to believe that two companies working in rivalry for the same guano will not work to the injury of the birds, unless each be strictly limited as to territory, or some way be found of harmonizing the rival interests for the benefit of the industry.

There are other important questions which need not be discussed here, but which should be suggested for consideration. A government bureau for the analysis of guano might be established in order to give to the small agriculturist the same advantage which the larger haciendas now enjoy, namely, of buying the guano by analysis. I have known cases of the adulteration of guano by sand, for the simple reason that the guano so reduced in quality could be sold by the contractor at the same price as a guano of higher grade. The price to all farmers, large or small, should be directly proportional to the value of the guano in the fertilizing elements as shown by analysis. The matter of having deposits of guano on shore has sometimes been suggested. This might serve to expedite the extraction of guano on the islands, so that they could earlier be abandoned to the birds, even if the fertilizer could not be sold and delivered at once. The shore deposits might be utilized to equalize the annual supply, and they might serve as the basis for mixing stations, should this prove practicable, where guanos of any desired strength of phosphoric acid and nitrogen could be prepared and supplied according to order.

CONCLUSION

It is seen, then, that there are many questions which require to be carefully studied

out. If the best solution is not attainable, then the second best may be adopted, but it may be the earnest hope of all that, after the fullest consideration of the matter, all parties interested may be led to cooperate in the attainment of a plan by which the interests of national agriculture may be safeguarded without the sacrifice of any legitimate interest.

The problem before the government, the national agriculture, and the exporting company, is this: How can the guano industry be saved to the future? Certainly no legitimate interest can be furthered by a continuance of the present unsatisfactory system, with its sacrifice of the birds.

I think the solution of the problem will be furthered if we put the question in this way: What system of regulation will result in the greatest annual deposit of guano twenty years hence?

NOTE

Without attempting at this time precise figures, the following considerations are suggestive and not misleading.

If we take a cubic meter of guano as a ton, then, with an average thickness of 10 cm. (4 inches), an area 10 meters by 10 meters, or 100 square meters, would yield ten tons of guano, and on 60,000 square meters there would be 6,000 tons. A point of significance, economically speaking, is the commercial value of permitting the birds to make the deposit even one centimeter thicker during the year. The flock of cormorants, *Phalacrocorax bougainvillei,* which covered very closely an area of 60,000 square meters (15 acres) and was the largest single aggregation of birds on the coast of Peru, was seen on the south Chincha island last year. It is easy to find that the nests average about three to the square meter, giving a total of about 180,000 nests. Allowing four birds to the nest, that is, a pair of adults and a pair of young, we have 720,000 birds. Two months later I estimated the flock as fifty per cent. larger, the island being at that time, in fact, practically entirely and densely covered with birds. It is not extravagant, then, to say that there were at least one million birds. Of course, very much smaller flocks are commonly estimated at "millions." Nor, again, does it seem out of reason to say that, had this island been opened by the government for extraction of guano, each month that the work endured would have caused the loss from this island of nearly 1,000 tons of guano, a part of which quantity, it is true, would have been deposited on other islands, but a large part of which would doubtless have been irrevocably lost. However, the main point to bear in mind, both from the point of view of the economist and from that of the naturalist, is this—that the continual disturbance of the birds means inevitably their gradual extermination.

Robert E. Coker

Lima, Peru,
April 8, 1908

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 651st meeting was held on May 23, 1908, President Bauer presiding. By invitation, Professor Bailey Willis, of the U. S. Geological Survey, presented and explained the proposal of the Washington Academy of Sciences to establish a weekly *Journal of Science.* The character and scope of the proposed publication were described at some length. The academy is to bear the entire cost of maintaining the *Journal* for the first three years and during this time the members of the affiliated societies are to receive the publication free of cost. In return for this service during the three years' experimental stage of the *Journal* the academy asks that the affiliated societies shall give the *Journal* their programs to print and for which they shall pay. Short abstracts of the papers read before the societies are to be submitted to the society for publication. At the close of the three years' experimental period it is proposed that the *Journal* shall thereafter be paid for by the affiliated societies at the rate of two dollars per member per annum.

Mr. R. L. Faris read a paper on "Tides in the Solid Earth observed by Dr. Hecker," being a review of the results of the horizontal pendulum observations recently published by Dr. Hecker at Potsdam. This paper will be published in full in the May, 1908, number of the *Monthly Weather Review.*

R. L. Faris,
Secretary