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THE FISHERIES AND THE GUANO INDUSTRY OF PERU



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# THE FISHERIES AND THE GUANO INDUSTRY OF PERU.

By ROBERT E. COKER,  
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## I. THE FISHERIES.

Doubtless the fishes and the fishery resources of no country represented at this congress are less known to the world than are those of Peru. That the resources are unstudied is not attributable to their inadequacy or to the failure of the people of Peru properly to value them, for Peru possesses a wealth of certain valuable forms, and no people could be more highly or more generally appreciative of fish food; nor is it because they have any recent origin that the industries are little known. In fact, there is reason to believe that centuries before the Columbian period the occupation of fishing was pursued in Peru, not simply as an unorganized food hunt, but as an important industry. Therefore neither the natural conditions nor the nature of the people can account for the scant knowledge of the fishery resources or the inadequate state of the industry. The explanation is found rather in the unfortunate history which has burdened the country since the overthrow of an earlier social and industrial life. It is only recently that a stable government has been able to give serious and effective attention to the many phases of industrial life of the nation, and to include in its many endeavors the effort to conserve and develop the valuable resources of the sea.

### CONDITIONS AND RESOURCES OF THE REGION.<sup>a</sup>

The traveler from the north has his first glimpse of the coast of Peru as the steamer, after passing down the Guaya River from the chief port of Ecuador, enters the Gulf of Guayaquil. The steamer may, as sometimes happens, touch at

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<sup>a</sup>For the scientific names employed in this report I am indebted to those who have kindly identified the specimens collected in Peru: Dr. Barton W. Evermann and Mr. Lewis Radcliffe (fishes), Dr. W. H. Dall (mollusks), Miss Mary J. Rathbun (crustaceans), and others.

A forthcoming series of systematic papers by various writers will give a comprehensive view of the chief aquatic resources of Peru as far as known at present. For detailed information regarding the methods of fishery, as well as the conditions and resources, reference is made to various reports by the present writer in the "Boletín del Ministerio de Fomento," Lima, vol. v., no. 12, Dec. 1907; vol. vi., no. 2, 3, 4, and 5, Feb. to May, 1908, and others in press.

the port of Tumbes, well known as the landing place of Pizarro. If so, the first impression of Peru is that which may have been anticipated of a tropical latitude—a region of thick vegetation, chiefly mangrove trees in swamps intersected by narrow winding estuaries, and traversed by a permanent river of considerable volume. The local conditions are similar to those that prevail in the neighboring territory of Ecuador. Naturally in such a region there is an abundance of shellfish, including oysters and many species of clams and crabs.

Typical, however, as this Tumbes region may seem for the latitude ( $3\frac{1}{2}^{\circ}$  S.), and fitting perfectly to the region lying northward, the locality is entirely unique for the coast of Peru. About 20 miles beyond the territorial line the aspect of the shore presents the sharpest change. As the southern limit of the delta of the Guaya is passed, the green luxuriance disappears abruptly to give place to shores of barren and desolate appearance, and this new aspect continues practically unchanged for the remaining 1,400 miles of the Peruvian coast, and onward, in fact, into the domain of Chile. (Fig. 1, pl. XII.)

The type of coast characteristic of the country is, then, the reverse of what one might expect of a tropical region. With shores rainless and barren, a most significant feature is the practical absence of large rivers emptying into the sea or mingling with the ocean waters in coastal sounds or bays. The portion of the country west of the lofty western cordillera, the watershed of the continent, is a steeply sloping desert interrupted by the narrow valleys of numerous little rivers formed from the melting snows of the Andes. In the cooler season (May to September) the scant waters of these precipitous streams are soon exhausted by natural evaporation or seepage, or spent in the irrigation ditches of the fertile valleys. On the other hand, although in the warm period of November to March the melting snows swell the rivers into torrents, the coast at this time is enduring its driest season, and the soils and irrigated farms are making their greatest demands upon the rivers' flow. Such portion, then, as may eventually reach the coast in any season can form but a small lagoon, and this may be quite separated from the ocean by a narrow levee of shingle, which the surf builds up against the river. The mouth of the Rimac offers a good illustration of this interesting type of river mouth, across which one may walk dry-shod. (Fig. 2, pl. XII.) Beneath one's feet the lagoon empties gradually into the ocean through the loose formation of water-worn stones. Only in times of excessive flood is the levee actually broken through to form a visible mouth.

It is unnecessary to point out the significance to the fisheries, or to the natural history of the coast, of this general absence of estuaries, sounds, or brackish bays, such as would offer a quiet breeding ground for some kinds of ocean fishes, or afford a favorable environment for oysters, clams, and other valued shellfish.

No fishes ascend the upper courses of the rivers and the very few species found in the lower parts are very small and of negligible economic value. These little rivers are of great importance to the fisheries, however, as the habitat of the most important shellfish of the country, the excellent "cameron de rio."<sup>a</sup> This fresh-water shrimp is a most highly and deservedly prized product, the equal in quality of any crustacean form. The rivers are also significant, since in the time of flood the most important of the food fishes, the large "corbina," is found in greatest numbers in the neighborhood of the mouths, probably feeding upon the small crustacea which find their way out of the river. The season of "agua nueva" (new water) is a propitious one for the fishermen.

Consequent upon the absence of large rivers and the steepness of the coast, there are few good bays or harbors. Most of the ports are upon a more or less exposed shore, where embarkation must be effected through the surf, unless a long pier has been built out beyond the ordinary breakers. Even in comparatively calm weather, the great swells rolling into the open bays often assume such proportions as to make landings impracticable even with the use of long steel piers. Fortunately, the coast is entirely free from storms; but the fisheries as well as commerce are seriously handicapped at such ports as Eten, Salaverry, Cerro Azul, and Mollendo, where for days at a time communication between sea and land is rendered impossible by the prevalence of "la mar brava" (the wild sea).

Untropical as is the coast of Peru in its aspect as described above, it is equally so as regards the temperature of the ocean water. There is no more significant feature of the coast than the Humboldt or Peruvian current which flows northward and northwestward along the west coast of South America, bringing the cold antarctic waters down to the equatorial region. To find upon the coast of the United States a summer temperature of the ocean water corresponding to that of Callao at 12° S. one would go to about the latitude of New York on the Atlantic side (41° N.) or Monterey on the Pacific (36° N.). The Peruvian current, in conjunction with other factors, particularly the constancy of the winds on the coast, produces a relative uniformity of temperature conditions. There is little variation in the water temperature from hour to hour during the day, little difference from month to month during the year, and a relatively small change from latitude to latitude. It is probable that such variations as are found are due more to very local conditions, or to the swinging of the current, than to seasonal changes or differences of latitude. At Callao (12° S.) the water in early summer was at 15–19° C. (59–66° F.) and in early winter from 16.5 to 19° C. (61–66° F.); at Paita (5° S.), in April, records from 15.5° to 20.5° C. were taken, with an average of 17.5° C. (63.5° F.);

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<sup>a</sup> *Bithynis caementarius gaudichaudi* (Milne-Edwards).

while at Mollendo ( $17^{\circ}$  S.), more than a thousand miles to the south—or as far away from Paita as New York from Miami, Fla.—the midwinter temperature was  $16^{\circ}$  C. ( $61^{\circ}$  F.). This current leads the fishermen to go southward from the port instead of northward, if a prompt return journey is desired, and its supposed swinging movements are of further significance, as it causes certain pelagic fishes to approach or recede from the coast.

With such low-water temperatures a tropical fauna is, of course, absent. Corals are wanting, sponges nearly so, and the general character of the fauna and flora of the region is such as would ordinarily be found in much higher latitudes.

In contrast to the barrenness of the coast there is a peculiar wealth of certain forms in the open ocean. The great red seas, formed sometimes, at least, of myriads of microscopic dinoflagellates, are of common occurrence. They are of uncertain value and sometimes seem to work much injury. Sometimes, too, great areas of the surface of the sea are reddened by the vast numbers of small crustacea (*Munida*), which then play a part of great importance as food for the fishes and for the guano-producing birds. More striking still are the immense schools of small fishes, the "anchobetas" (*Engraulis ringens* Jenyns), which are followed by numbers of bonitos and other fishes and by sea lions, while at the same time they are preyed upon by the flocks of cormorants, pelicans, gannets, and other abundant sea birds. It is these birds, however, that offer the most impressive sight. The long files of pelicans, the low-moving black clouds of cormorants, or the rainstorms of plunging gannets probably can not be equaled in any other part of the world. These birds feed chiefly, almost exclusively, upon the anchobetas. The anchobeta, then, is not only an article of diet to a large number of Peruvians, and the food of the larger fishes, but, as the food of the birds, it is the source from which is derived each year probably a score of thousands of tons of high-grade bird guano. It is therefore to be regarded as the most valuable resource of the waters of Peru. No more forcible testimony to its abundance could be offered than the estimate, made roughly, but with not wide inaccuracy, that a single flock of cormorants observed at the Chincha Islands would consume each year a weight of these fish equal to one-fourth of the entire catch of the fisheries of the United States.

The fishing grounds and opportunities, especially with the methods of fishery now in use, are restricted by the scarcity of good bays and by the rapid deepening of the water off the shore. Yet there are compensatory features. In proximity to almost every port are groups of islands, often with numerous coves and abundant outlying rocks, which offer a varied home for many species of rock and shore fishes. Along the coast proper some of the same species are found, with a good representation of the drums, the lizas, the flounders, and silversides.

To mention the most esteemed and important fishes:<sup>a</sup> The "peje-rey" or silverside (an atherinid), the most delicate of all fishes, is most easily taken in early or mid winter when it is depositing its eggs upon the algæ near the shores; the "corbina" attains a size of 30 or 40 pounds, and from its abundance and fine quality is the fish of first rank in importance; the "liza," or mullet, and the "lenguados," or flounders, are also of the first class. Yet perhaps none of these is superior to the congrio (representative of the Ophidiidæ), which is not commonly taken except in the southern part of Peru. Nearly a hundred food species could be mentioned, but only two or three more of these deserve mention for special reasons.

The bonito, though poor in quality, is, from its abundance and cheapness, the fish most available to the poorer people. The anchobetas (*Engraulis*) are favored by the indigenous Peruvians. Large quantities are preserved in the crudest way by mixing with salt and spreading on the ground to dry in the sun. They are then sacked to be sold at a small price (\$1 the sack, more or less). This little fish of manifold uses is all the more significant because of the rare opportunity it offers for the preparation of an excellent preserved product—an opportunity that is not now utilized.

The selachians (sharks, rays, guitar-fishes, and angel-fishes) are not in most countries accounted important food fishes. But they occur in remarkable abundance in the northern region of Peru, where they are freely used and esteemed by the indigenous population. Just northward of the Peruvian waters our steamer passed for hours through an enormous aggregation of various kinds of selachians, the great giant rays, and sharks of all sizes, hammer-head and sharp-nose. On one occasion, in December, 1907, the beaches of the island of Lobos de Tierra seemed literally fringed by the protruding fins of sharks basking in the shallow waters.

The preparation of such fishes by drying them in the sun constitutes an important industry for the fishermen who frequent the island of Lobos de Tierra during the season when it is not closed for the protection of the guano birds. This island, unlike the others of the coast, is surrounded by sand bottoms favorable for net fishing. It is only 10 miles from the coast, but about 70 miles from the nearest fishing ports (Eten, Sechura). The fishermen form a camp here, coming out with their families in balsas (Sechura) or balandras (Eten, Paita). All kinds of fishing are pursued, but the most characteristic is the use of large-meshed nets of strong material for the capture of selachians and large flounders. The skillful manipulation of these fishes for preservation with or without the use of salt merits special description in a later connection.

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<sup>a</sup> Peje-rey, *Basilichthys jordani*, etc.; corbina, *Sciaena gilberti* Abbott; liza, *Mugil cephalus*; congrio, *Genypterus blacodes*; bonito, *Sarda chilensis*.

Naturally a coast like that of Peru does not offer a favorable environment for many kinds of the better shellfishes. The scallop<sup>a</sup>, "concha abanico," "senorita" or "conchita," as it is variously called, is, however, very abundant in many places and often attains a large size. It ranks next to the freshwater shrimp, the "cameron de rio." Mussels, beach clams, the spiny lobster,<sup>a</sup> and various crabs are found in the market, but quite irregularly. The small region about the port of Tumbes in the extreme north is as unique for the coast of Peru in its fishery resources as in its physical features. From the mouth of the Tumbes River to Capon, near the Ecuador line, there is a network of salt and brackish estuaries in which thrive a variety of crabs, clams, and mussels. But the chief resource of the region is the abundant oyster,<sup>a</sup> which grows attached to the roots and branches of the mangrove trees margining the salt creeks (fig. 3, pl. XIII). The fishery for oysters is very restricted at present, but there is undoubtedly a fair opportunity for its development.

An allusion should be made to the pearl fishery which, in 1900, was exploited in the region from the Bay of Sechura to Paita. It appears that at the start the fishery was a success, but after a very brief period ceased to yield, and subsequent efforts failed entirely to locate any banks of pearl oysters. It is possible that the discovery of these beds awaits only the prosecution of a systematic investigation with deep drags or by diving. The "pearl oyster", or "concha perla" of the region is *Pteria peruviana* Reeve, the shells of which may not infrequently be found upon the beaches.

Perhaps in no other country is fish food more generally esteemed and used when available. So we find that not only the usual edible fishes and larger crustacea and mollusks, such as have been mentioned, but a wide variety of smaller and less generally esteemed forms are sought and prepared for the trade. In some parts of Peru there is hardly an available shore form that is not taken to be used as food. As articles of diet, we should include some species of sea weeds, the *Hippa*, hermit crabs and barnacles; the conchs, large and small; the crepidulas, patellids, fissurellids and chitons; the excellent sea-urchin and the sea-cucumber; the sea-anemone and ascidians—or almost everything of suitable size except annelids and jellyfishes.

Along the entire coast a considerable element of the population finds its support in taking fish for personal use and for the trade. In the larger ports the greater part of the product is eaten in fresh condition, but at other places where the fish must be conveyed a greater distance to port, or distributed over a wider territory on land, the fishermen salt or dry their catch by methods adapted to their means and knowledge.

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<sup>a</sup>Scallop, *Pecten purpuratus* Lamarck; spiny lobster, *Panulirus ornatus* (Fabricius); oyster, *Ostrea chilensis* Philippi and *O. columbiensis* Hanley.



Many of the present methods employed in the capture or preservation of fishes probably date back to a very remote time; for it is interesting to note that Peru not only claims an ancient fishery but offers some evidence to indicate that centuries ago the fishery and related industries had a relatively high degree of organization. The interesting story is often told of the system of transportation of fresh fish from the coast to the royal home in Cuzco, a region where fresh sea fish is never available now.

Through the earliest writers we know of the appreciation and use by the earlier Peruvians of the guano deposits of the coast for their great agricultural industries. The rigorous edicts for the protection of the guano-producing birds were evidence of admirable foresight and antedated by centuries any further effort to preserve the birds. Relics of pottery and gold are found buried in the sand or in the guano, and it is an interesting fact that modern explorations upon the coast and islands indicate that the villages necessarily supported by the fishery or guano-working industries possessed a degree of wealth that could have resulted only from an industry of relatively high development.

The great shell heaps and the islands and causeways of shells in the estuary region of the Gulf of Guayaquil testify to an early fishery of oysters and clams pursued in no rude or half-measure way. A thousand years of the present oyster fishery would not leave a trace comparable to these.

In short, it is probable that the ancient Peruvians were as competent in the fishery as in agricultural, textile, and other industries. Nevertheless, whatever may have been the condition in this earlier period, this industry, like all others, certainly fell to a very low stage after the conquest. During the past few years new fishermen have come in, new methods have been introduced, and better facilities have appeared; and yet the industry is but poorly developed, and its condition is distinctly unsatisfactory.

In attempting to give a brief account of the fishing industry as it is now carried on, it is not necessary that modernly introduced methods should receive more than the mention. It may be of value, however, to speak more fully of those forms of fisheries which may be presumed to have continued in use since the pre-Columbian period—those which are not borrowed but are actually and historically "home industries."

#### FISHING CRAFT.

It would seem natural that a people who could construct magnificent buildings and walls of stone that endure to our present admiration, would have fashioned good wooden boats, if the forests of timber had been available; but with the coast region desert and barren except for the scrubby growth of algaroba, with its dense and heavy wood, the ordinary materials of boat construction

were absent. A resourceful people found a substitute for wood in the reeds growing thickly near the rivers; bound together in sufficient numbers, these were made into remarkably strong craft which continue even now to serve a useful purpose. The "caballito" (fig. 5, pl. xiv) in its simplest form, as now used at Pacasmayo, for example, is made of two long bundles of "totora." The reeds are individually weak and flimsy, but the bundle, which is well wrapped with twine, is strong and comparatively stiff. Each bundle is about a foot in diameter at the aft end; forward it enlarges a little, and then tapers to a point at the other end. The two bundles are securely bound with rope, and the long tapering ends curve upward in graceful form. At a short distance from the stern (about one-fifth of the entire length) the inner and upper reeds of each bundle terminate squarely to form the forward end of a small pit, where the fish may be kept. The pit, which is about a foot deep at its forward end, rises gradually to the top of the caballito near the stern.<sup>a</sup> The craft derives its Spanish name of "caballito" (pony) from the method of its use. The fisherman sits astride, just forward of the pit, with his legs hanging in the water or resting on the side of the boat. For a paddle he uses a plain split of bamboo cane, paddling with each end alternately. With its shapely taper and upturned pointed end, the caballito, mounted by an Indian fisherman, not only presents a picturesque appearance, but is most serviceable for use in the short swell near the beach where an ordinary boat would be unwieldy. With his caballito anchored just beyond the surf, the fisherman sits just in front of the pit and facing astern. Of the three lines in use, two are attached to his belt while the third, which is stout and carries a large hook, is secured to the caballito. If both hands are busy with one line, the other is held with the toes. The fish must be killed with a small stick before being thrown into the pit, from which they might easily escape if alive.

The caballito is also used in net fishing. The net is in the form of a very large small-meshed bag which when in the water is kept open by gourd buoys attached to the top of the mouth on each side and by stone sinkers on each side below. The mesh may be  $1\frac{1}{2}$  to 2 centimeter bar. Extending outward from each side of the mouth is a "brazo" (arm) of some 8 fathoms length and of very large mesh. To the ends of the arms are attached the hauling lines. The fishermen astride of their caballitos haul this net through the water to take a school of "sardinas" or other fishes, all the time making as much noise in the water as they can with feet and paddles. The same type of net may be worked from canoes or flat-bottomed boats. (Pacasmayo, Chimbote).

The totora reeds may be bound together to form a much heavier and larger craft than the caballito. The "balsa" of Cerro Azul is made, like a raft, of

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<sup>a</sup> Dimensions of a caballito: Length, 4.50 meters; width at stern, 0.56 meter, stern to forward end of pit, 0.94 meter; depth of pit, forward, 0.30 meter.

three logs well lashed together, but each log is only a bundle of totora, which tapers slightly toward the forward end, where it is gently curved upward. The diameter at the stern is about 25 centimeters. The bundle consists of an inner core or heart ("corazon") and a thin outer shell, so that as the exposed reeds decay under the action of the water and the sun they may be removed and replaced without disturbing the entire balsa.

The most elaborate boat of reeds<sup>a</sup> is the balsa used in Lake Titicaca, where it is fashioned in a more boat-like form. (Fig. 6, pl. xrv.) The squarish sail is woven of the same reeds and somewhat in the fashion of a Venetian blind. These balsas are broad, and excavated so that they may accommodate an entire family bringing their various products to market. Though we are not at this point immediately concerned with the fisheries of the lake, an allusion should be made to the use of these totora reeds in the construction of fishing weirs. At the small end of the funnel-like weir there is set a net fixed on a conical framework of poles which can be raised or lowered from the balsas.

These boats of reeds could not have sufficed for the longer fishing voyages and the commerce from port to port, but this need was supplied by the introduction of the balsa wood growing in Ecuador. This exceedingly light wood possesses the merit of not absorbing water, so that it will float indefinitely. From these logs, rafts or balsas are constructed in all sizes, from the small ones of about 6 feet length to the large 30 or 40 foot balsas, which have an upper deck and are fitted with a large squarish sail. On these the Indians with their families will live for weeks. The fishermen of Paíta and Sechura find their most profitable fishing grounds about the islands of Lobos de Tierra or Lobos de Afuera, at distances of 70 to 100 miles from port. Living on the commodious balsas, the fishermen navigate along the coast, fishing where it is desirable, or moving to their camps on the islands, to remain until a cargo is salted away.<sup>b</sup>

Some type of canoe is found at every port. Most of these are made from wood brought from the region of Guayaquil. "Canoas" of the commoner woods are said to last only a few years; "figaroa" is a much better wood; "huachapelí," however, is most highly esteemed, and it is said that canoes of this wood have a life of a hundred years or more. One of these canoes was nearly 15 yards in length, but the ordinary length is from 6 to 9 meters. The canoe is usually strengthened with timbers and given greater freeboard by the addition of a pine plank on each side. They may be fitted with a large squarish sail called a "vela cuadrada" or a "banda."

Boats of good modern types are to be found at almost every port. When the first foreign fishermen (Italian and Spanish) came over, Mediterranean

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<sup>a</sup> *Malacochæle totora* is used for boats, sails, pontoons, weirs, thatching, etc.

<sup>b</sup> On the brief trip to Mollendo the writer did not have opportunity to examine a balsa made of the hides of sea lions, the description of which must, therefore, be omitted.

types of boats were introduced, and it is said that for some time the ready-built boats were imported by ships coming around the Cape. However that may have been, the boats are all built in Peru now and chiefly of American white pine strengthened with oak. A variety of types are in use, of which the neatest is the felucca ("faluca" or "falucho") as it is employed at Callao. This has a round bottom and smooth sides, is pointed at both ends, and may be entirely decked. There is a long, narrow hatch, the "escotilla," and in the extreme aft end a small "escotilla de popa" opening into a compartment in the stern dignified by the name of "salon" and used for the storage of nets or fish. With the covers of the escotillas in place, the little boat is snugly decked in. The space under the forward deck serves for bedding, clothing, and other things, while under the side decks are spaces ("escafetas") for the keeping of cooking utensils, provisions, and miscellaneous equipment. Though the boats are small, yet for the period of a fishing trip the fisherman regards his boat as his home and equips it accordingly. A typical Callao felucca is  $5\frac{1}{2}$  meters in length, 2 meters in width, and 0.65 meter in depth.

As typical of the felucca, the mast stands about midway and supports a triangular lateen sail; that is, a triangular sail which is attached by its fore margin to a lateen yard or "entena." The entena hoists obliquely to the mast. For use in the scallop dredging, greater power and convenience are secured by modifying the sailing rig. The mast is then placed well forward and a boom and gaff sail (schooner-like) is used.

These closely decked feluccas are found only at Callao. In other ports the boats are usually square of stern and uncovered. At all ports the boats seem to have no other name than "bote de pescadores" (fishermen's boat), the designation by which they are distinguished from the bote chalanos, canoas, balsas, and caballitos.

One of the common inferior boats of the coast is the bote chalano, with square stern, steep sides, and flat bottom, or, as at Callao, with a wedged but fore-and-aft planked bottom. At Callao it is used with a large square sail.

All of the boats are without centerboards and are comparatively poor sailers into the wind. Therefore if a fishing trip is made to northward of the port, the return journey against both wind and current is always tedious. The use of the centerboard is unknown.

The best sailing craft are the "balandritas" or small sloops of Pacasmayo. The balandras used there for trips to the Lobos Islands are 25 to 30 feet in length, with a 7 to 10 foot beam and a depth of  $3\frac{1}{2}$  to 6 feet. Square of stern, well decked in, and with a small cabin, they have fair seagoing qualities and may carry from 10 to 14 tons. The balandritas are of the same form, but smaller.

They are good sailers and are well adapted for trolling in the bay for the 40-pound robalos.<sup>a</sup>

Reference to boats would not be complete without mention of the American whaleboats which from time to time have been left by the whalers in the region of Tumbes. They are used in the local whale fishery and for other purposes. Valuing economy of nervous energy more than saving of time, the fishermen of Tumbes avoid any trouble from the centerboard, and cripple their boats, by securely sealing the centerboard well from below.

#### METHODS OF FISHING.

Besides a few small and unimportant hand nets, such as the "chaya" and the "bajia," there are only four or five types of nets in use. These are the "ataraya," or casting net; the "red derecha," or gill net; the "chainchorro," or beach hauling seine; the "anchobetera," and the "trasmalla."

The "trasmalla" (trammel-net) or "red de tres paños" (net of three cloths) is clearly an innovation, and is now found only where it has been directly introduced by the European fishermen, as at Callao and Mollendo. The others are doubtless indigenous to the country, although in some cases apparently modified by modern influences.

Where there are good beaches the fishermen wade into the surf to throw the ataraya, but, except when the valued lizas are abundant, the method is slow and profitless. (Fig. 4, pl. XIII.) The gill net, "red," or "red derecha," is essentially the same wherever found, though appearing under a variety of names, according to the size of the mesh and the kind of fish for which it is intended. Used at the surface or at the bottom, set straight or traplike, in the form of the letter S or of a figure 6, employed in the far off shore fishery for bonitos or in the treacherous surf on a steep shingle beach, it may have a mesh of any size from 1½ to 10 centimeters. Thus we find it as a "pejereyera" (1½ to 2 cm., bar measure), "cabinsera" (3 cm.), "lizera" (4 to 5 cm.), "bonitera" (5 to 7 cm.), "corbinera" (6½ to 9 cm.), "robalera" or "cazonera" (9 to 10 cm.), according as the net is designed for the capture of fishes of the sizes of peje-reys, cabinsas, lizas, robalos, cazones (large sharks), etc. The measures are always stated in "dedos" (fingers), one dedo being equivalent to about 2 centimeters, diagonal measure, and therefore the measure in dedos corresponds approximately to the bar measure in centimeters. The greatest part of the catch of the entire coast is taken by these nets.

The chinchorro is used where there are suitable beaches. It is a hauling seine, with a bag or bolsa about 7 fathoms deep by 2½ high. In the back or

<sup>a</sup> Chalanos, feluccas, and balandritas may be valued, approximately, at 200 soles, 400 soles, and 600 soles, or at \$100, \$200, and \$300, respectively.

bottom portion for 2 fathoms it is of small mesh and strongly reenforced, while the outer portion is of larger mesh (about 8 centimeters). The long "brazos" (arms), or "bandas," extending out from each side of the mouth are 13 fathoms in length and 50 meshes (10 cm. each) in height. In making a haul, two canoas or balsas are used in putting the net, while it is drawn onto the beach by several men, often with two or three mules.

Perhaps the most characteristic net is the anchobetera, a modification of the chinchorro, used in taking the little anchobetas, which occur in such vast schools. The bolsa, or copa, is 4 or 5 meters in depth, and, when flattened, 9 or 10 meters wide (that is, 18 to 20 meters in circumference). The opening or mouth of the bolsa is surrounded by a sort of funnel, of four portions; the upper and lower "pechos" (breasts) with a mesh of 9-centimeter bar, and the right and left "sobacos" (armpits) with a mesh of 20-centimeter bar. From the sobacos the brazos, or arms, lead out on each side with a length of 5 or 6 fathoms, and a mesh of 40-centimeter bar (16 inches). In surrounding small schools of anchobetas, the net is worked from canoas or balsas. A larger net of the same type may be used for "sardinas," as referred to on page 342. It would be called a "sardinera" or a "red clara."<sup>a</sup>

In the way of line fishing, we find the simple still-fishing line, or "cordel," the trolling line, or "cordel bonitero," and the trawl-line or bait-line—the "espinel."

The espinel is of particular interest, as one of the most effective methods of fishing and as being the only method by which one of the very best fishes of the coast is taken in any abundance. As used at Callao, Chimbote, etc., the espinel carries 50 to 100 hooks on short lines attached at intervals of 1 to 2 meters, and it is worked in 20 to 30 fathoms of water. The espinel fishery, however, is best seen at Mollendo. Fishing in 46 fathoms at a trial on the usual fishing grounds, and using a line of 1,500 hooks, our fishermen took 256 congrios at one haul. As the hooks were attached (by 30-centimeter side lines) at intervals of 1 meter, the length of line fished was nearly 1 mile, but such a line is readily worked by one man with an assistant to control the boat. The line was set after 7 o'clock in the evening and taken up after midnight. The catch of about 400 pounds of the best fish, made at one haul of the line, was considered good, but not unusual, and the fishermen describe hauls of 700 pounds on 1,200 hooks kept in the water for four or five hours.

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<sup>a</sup>The name "clara," it may be remarked here, is at first confusing, being applied to nets of very different types. The "clara" is the clear net—that is, the net which the smaller fish can pass through. Therefore, fishermen who speak of the anchobetera as "la red" (the net) would call the same form of net with larger mesh the "clara;" in another community, where the gill net for cabinsas was the net in most common use, and therefore spoken of as "la red," the "clara" would be a net of somewhat larger mesh, such as the "lizera" or the "bonitero." Thus in one community the "red clara" is a gill net, while in another community it is an entirely different type of net.

In this case only four fishes other than the congrios were taken (two sea basses and two rays), and it is significant that the congrio appears not to be taken in any numbers except by the use of the espinel. The congrio, eaten fresh, is considered an unsurpassed food fish, and, as will appear on a later page, it gives the best salt product prepared in Peru. It seems surprising, therefore, that the espinel is not more extensively used. The method is relatively laborious, but the yield is in proportion to the labor. Undoubtedly, the reluctance of the fishermen to use it is due, not so much to the amount of work involved, as to its relative intricacy, the necessity of much preparatory work in the securing of bait, the baiting of the many hooks, the arrangement of the lines in the tubs, and, finally, the constant care required in the manipulation of the line in order to avoid mischievous tangles.

At Callao the espinel is not often used, and then only in a small way, the fishermen preferring those methods which, however much actual labor they may involve, require the least forethought. The congrio is practically unknown to the market there. Even at Mollendo, where the effectiveness of the method is not infrequently demonstrated, it is not regularly used, the fishermen choosing rather to throw a shot of dynamite near the rocks and scoop the fish from the surface. Undoubtedly there are extensive fishing grounds which will become available only with the extension of the espinel fishery or by the introduction of the bottom trawl-net ("red barradera").

Dynamite must be mentioned as one of the common methods of fishing. This abuse is certainly working an incalculable damage, especially in certain regions. It is prohibited by the government, but the efforts to prevent its use have so far been ineffectual, and the practice is at present the most serious defect of the fishery.<sup>a</sup>

#### PRESERVATION OF FISHERY PRODUCTS.

Some of the methods of preservation employed are of especial interest, but before particular mention is made of these, a word may be said as to the significance of the fish-preservation industry to the country.

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<sup>a</sup> A list of apparatus used for taking sea fish in Peru would be made nearly complete by adding the following to those that have been mentioned above: The dredge, or "rastra," employed in the scallop fishery, especially at Callao, and a rather better rastra formerly used in the abortive pearl fishery at Sechura and Paita; the net for turtles, or "tortugera;" the gig, or "figa," for taking the flounders at Callao, a little oil being sometimes poured on the water to make the surface smooth; the "bolador," made of wood in the form of the dasher of an old-fashioned churn, which is thrust sharply into the water, making a loud sound to drive the fish into the gill net or the trammel net; the pole and hook ("gancho"), for taking gobies and devilfishes from the rocks; the lance ("harpón"), thrown at the larger fish from the shore, from a pier, or from the boat; the harpoons, as rarely used in the fishery of swordfishes ("peje-espada") at Mollendo; and the ordinary harpoon and hand-lance outfit employed in the shore fishery of whales at Tumbes. We are not here concerned with the various baskets and hand nets with which the fresh-water shrimps are taken, or with the methods employed in the lake and river fisheries of the interior.

For want of convenient methods of transportation, it is only the people of the ports who can have the luxury of fresh fish, and even these may know it only as an occasional delicacy if the fishermen are accustomed to work at a considerable distance from the port. To the people of the interior only salt fish is ever available, and they prize it highly. Even this is a rare luxury in most parts of the country, however, on account of the rather unsatisfactory preservation of fish and the entire want of system in the marketing and distribution of the product. At some ports, in fact, neither fresh nor salt fish are regularly obtainable.<sup>a</sup>

At the island groups of Guañape, Lobos de Afuera, and Lobos de Tierra practically all the fish taken are preserved by salting or drying for the supply of the region of coast between Salaverry and Paita. Paita even boasts a small exportation of salt fish, since two balandritas convey annually about 50,000 fish ("sierras," "bonitos," "caballas," "peje-blancos," and "meros") to Manta, in Ecuador, and other ports of the north.<sup>b</sup>

That preserved fish is not more available to the people of Peru is rather remarkable in view of the general occurrence of deposits of salt. In almost every part of the coast are found salt beds of greater or less purity. In some places, as near Pisco, cakes of almost pure salt can be picked up from the ground. The extraction, refining, and sale of salt are restricted, however, to the National Salt Company, and the common market price is exceedingly high. So far as I am aware, only the fishermen of one village, San Andres, near Pisco, have the privilege, especially granted them, of taking for themselves the comparatively good salt from the hillsides near the shores of Paracas, where they commonly fish for peje-reyes and other fishes. On the other hand, the Government, realizing the absolute necessity of cheap salt to the fishermen, has made special arrangements for their benefit. Each fisherman is entitled to receive monthly from the salt company 2 quintals (200 pounds) of salt at a nominal price, while for such further quantities as he may need the price is fixed very much below the regular market price. These arrangements would seem to be most satisfactory to the fishermen, at least; but the indigenous fisherman has an almost unconquerable prejudice against the purchase of salt, and will rarely go beyond the allowance, although often complaining of its inadequacy. In times of especial abundance, quantities of fish are therefore sold at small prices or allowed to spoil.

One of the expedients of the fishermen, resulting only in part from the inadequacy of the salt supply, is the use of what they call "salitre." The

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<sup>a</sup> The importation of salt and canned fish in 1905 amounted to about £38,361 (\$186,800), but the imported product does not reach a large proportion of the natives, who are without fish food of any kind.

<sup>b</sup> Sierra, *Scomberomorus sierra*; bonito, *Sarda chilensis*; caballa (mackerel), *Scomber japonicus*; peje-blanco, *Caulolatilus* sp.; mero, not identified.



word means saltpeter, but it is applied by them to what is merely a natural mixture of salt and sand and other impurities, which may be found near some of the villages. It is claimed by many of the Indian fishermen that the fish preserved with the so-called salitre will keep in better condition for eating than those preserved with pure salt.

The crude native methods of drying anchobetas have already been noted. Occasionally these little fishes are prepared in small quantities, by pickling, so as to make a very palatable food.

Generally speaking, no choice is exercised in the selection of fish for preservation; any fish that comes to hand and is regarded as edible will be packed away. There are certain forms of preservation, however, which seem to be worthy of further description.

*Preservation methods at Mollendo.*—The fisheries of Mollendo, though not extensive, would form a chapter in themselves. The markets of the port and of Arequipa, the second city of the country, display a variety of fish products not seen in the more northern markets.

On some accounts the most interesting fishery product of this region is the peculiar dry and tangled egg-mass which is found on the local markets as "cau-cau." This is the egg-mass of the "volador" or flying fish, which is collected in season and dried that it may be kept on the markets throughout the year. These eggs have an especial interest from the fact that, although flying-fish eggs have been known to science for nearly fifty years, they were, until quite recently, attributed erroneously to the little sargasso fish (*Pterophryne*) of supposed nest-building habits. A few years ago, after the discovery of the true eggs of *Pterophryne*, the identity of the eggs of the so-called "nests" with those of the flying fishes was soon established. The cau-cau appears to have been a product long familiar to the natives of this part of Peru, by whom the eggs have been attributed, and correctly as it seems, to the flying fishes.

Each egg is 2 millimeters in diameter, and its membrane is produced into a number of filaments, which, though rather scattered over the surface of the egg, have a tendency to a bipolar distribution. The filaments, though very fine, are quite long and the fibers of different eggs are thoroughly intertangled, to unite the many eggs into a closely woven mat. Sometimes the filaments are so twisted together as to give the appearance of a well-defined thread.

The cau-cau of the market, then, is a large number of the shrunken berries, entangled to form a shapeless mat. A mat may be a good double handful or more, and the filaments are so completely interwoven as to make it difficult to tear the mass into portions. When soaked in water the eggs will expand and take an appearance as if freshly laid. They are found in early summer, beginning with October, and are said often to be entangled with weed. My visit was in July (midwinter) and the cau-cau then on the market was quite free from

seaweed. Floating seaweed is, indeed, not common in the region, and the mat form of the large and otherwise shapeless masses suggests that they were formed while floating at the surface.

The most important preserved product of the region is the "charquecito," made from the congrio, a reference to the capture of which fish has already been made. The preparation was not observed, but as it was described the congrios are opened, cleaned, washed in salt water, and hung up to dry. Six or eight days later they are thrown into piles ready for the market. The drying and subsequent preservation must be watched with care to prevent heating or curling. The tail bends up in drying and must be pressed or bent out to preserve the desired appearance. The charquecito is the most highly esteemed preserved fish, but, like all fish products of the coast, it is rarely shipped to other ports. It brings a good price, 5 or 6 reals per pound (25 to 30 cents American).

Besides the charquecito and the cau-cau, a number of minor products are preserved. Dried seaweed is prepared by the simple process of putting the fresh weed into molds and pressing it into flat plates, which, after being dried in the sun, are folded and are then ready for sale. The seaweed used is called "uyos" or "cocho-uyos," but the species so dried is not the ordinary "cocho-uyos" that is eaten at other ports.

"Lapas" (fissurellids) and "barquillos" (chitons),<sup>a</sup> after being boiled and stripped of the shell, are dried and strung, and a "sarta" of two dozen of these "atados" (strings) is sold for the very small sum of 30 centavos, or about one-third the price of the fresh shellfish.

The "pincho de mar," a holothurian, is skinned and dried to make a crude trepang. "Ocoti," or "pota," is the sea anemone<sup>b</sup> stewed and stripped of the skin. It is sometimes dried. It is a custom for the Serranos, or inhabitants of the interior, coming down to the coast at Ilo, to take back with them the trepang, ocoti, etc., along with the cau-cau and charquecito.

In this connection it may be mentioned that, besides the characteristic methods of preservation practiced in this region, other fisheries are followed here that are rarely found in other ports. The capture of the swordfish ("peje-espada") is sometimes attempted, and at least one fisherman is well equipped with the necessary harpoons. The swordfishes are said to weigh 200 to 400 pounds and to bring 26 to 50 soles each (\$13 to \$25).

The prized "erizos" (porcupines), or sea urchins, are more commonly taken here than elsewhere. Ascidians, which bear the surprising name of "ciruelas" (cherries), are stripped of the test, so that the inner portion is taken out "como

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<sup>a</sup> Lapas, *Fissurella costata* Lesson, *F. crassa* Lamarck; barquillos, *Chiton granosus* Trembly; *Enoplochiton niger* Barnes.

<sup>b</sup> *Phymacter clematis* (Dana) Milne-Edwards, as identified for the U. S. National Museum by Prof. J. Playfair McMurrich.

un huevo" (like an egg) and is eaten raw or in soups under the name of "cochizo" or "piuri."

Finally an allusion should be made to the taking of the abundant bogas, suchis, and peje-reyes (species of fresh-water fish) in Lake Titicaca. These fishes are considered delicacies and are brought down to Arequipa, the chief city of the region. Dried lake peje-reyes were observed on the market.

*At Lobos de Tierra.*—Reference has been made to the capture of selachians and flounders in the region of Lobos de Tierra. Many of these are preserved by sun drying and without the use of salt or other preservative. The process is of some interest, as the fishermen are peculiarly expert in preparing the fish.

On the return from the fishing trip, after the fish are thrown into piles on the beach, the first matter is the apportionment of the catch, since two or more fishermen have worked together. The division accomplished, they set to work individually to prepare the fishes for drying. Each man has beside him, when at work on the beach, an oar or a board sprinkled with sand and used for sharpening the knife. A short sharp sheath-knife is used and it is whetted by a stroke or two on the oar after almost every cut that is made. The "guitarra" (guitar-fish) is laid on the sand with the back up. Five cuts practically prepare the fish. The first splits the right and left sides incompletely apart, leaving the backbone in the left half; the second lays open the right side of the head; the third lays open the right side of the body; the fourth lays open the left side of the body; the fifth lays open the left side of the head. A few quick slashes to better expose the meat for salting, the removal of the entrails, and the making of a slit in the tail by which to hang the fish complete the process, and the fish is thrown aside for washing.

The "angelota" (angel-fish) must be cut a little differently, but the process is accomplished with hardly less dispatch. The outer parts of the outer fins are first removed. The first cut splits the fish; the second lays open the right side with the aid of a few additional slashes in the meat; the third and fourth lay open the left side. The head, gills, and entrails are then cut entirely away and the body of the fish is thrown aside to be washed.

The small boys assist by taking the opened fish, two at a time, into the water and washing them free of the sand, blood, and other dirt. The fish are then hung from poles by the slit in the tail. Two or three slender pieces of cane put crosswise keep the skin stretched, and the fish are thus left to dry in the sun. Four days is said to be sufficient for the curing if the weather is bright. Hanging in this way, they look like merely a series of skins, but the meat is all present as a thin layer on the skin. No salt or salitre whatever is used on them. They are strictly sun cured, as flat thin sheets of skin and meat.

"Tollos" (small sharks) and "cazones" (large sharks) are prepared in very much the same way as the angelotas.

The "rayas" (rays) are handled in an interesting way. The fish is laid on the back and two circular cuts are made. The first cuts away the lower wall of the mouth and gill cavity, leaving this wall hanging as a flap on the left side anteriorly; the second cuts away the lower wall of the abdominal cavity, leaving this as a flap on the left side posteriorly; the entrails are then removed; a vertical cut from above is made through the backbone from the head to the base of the tail and one or two short cuts may be made on each side of the thick base of the tail; a series of cuts are then made across the disk of the raya, which now looks like a circular gridiron. These crosscuts extend to the skin below.

When all the rayas are prepared, sand is rubbed well into the cuts of each, and the fish is laid in a hole in the ground. The hole is covered with boards or mats or by filling with sand, and the fish are thus left in the sand on the beach for a day to let the moist sand absorb the blood. They are then taken out, washed and salted, after which they are laid across poles or logs to dry in the sun. Three or four days are required for the drying.

With regard to the use of salt, the fishermen state that salt is never used on guitarras, but is always used on rayas; angelotas and tollos are prepared with or without the use of salt, according to preference or to the quantity of salt available. Salitre is used to some extent, but salt is considered much better.

The waste products in the preparation of the fishes are simply thrown on the beach and the "gaviotas," or gulls, gather in great numbers to eat them. The eggs of the guitarra are supposed to have a certain medicinal value, and are sometimes saved for this purpose.

On the mainland the dried fish bring from 10 to 60 centavos apiece, according to the demand. Practically all of the ordinary fish taken here are salted, but at the time of my visit few fish, other than the selachians mentioned and flounders and mackerel, were being taken.

*Oils.*—In the illustration (fig. 7, pl. xv), there is seen, below the drying fish, a turtle shell, into which has been thrown a quantity of turtle fat. Placed, as it is, in the sun, the shell is tilted so that the oil flows out into a can placed below the point of the shell, which serves as a spout. The oil is used medicinally, especially for dressing wounds of man or domestic animals, and also to take internally for troubles of the liver. Turtles were seen abundantly in this region. On one occasion I saw 10 heads of turtles thrust out of the water to breathe at one moment and within the space of a few yards. They were feeding on the abundant seaweed of these shores. In this part of Peru, however, the turtles are rarely used, as the meat is not valued. The only place where a turtle fishery was observed was in the south, at Pisco. The meat is there sold locally at 25

to 30 cents the quarter or less, but the real object of the fishery is the oil, which is valued for miners' lamps.

A net for turtles, or "tortugera," at Pisco may be about 80 fathoms long by 2 fathoms or a little more in depth. A net observed had a mesh of 30 centimeters (1 foot) bar. In the use of this net the fishermen, working near the shores, watch carefully, and when a turtle is seen, put the net out as quickly as possible. One to 5 or 6 may be taken at a time, or, when they are especially abundant, as many as 10 may be taken at one haul. Two fishermen, working together, may take as many as 80 turtles per week. January, February, and March are regarded as the best months in which to take them, because they are fattest in those months.<sup>a</sup> The fat is thrown into a big pot of 8 to 10 gallons capacity and slowly cooked, while the shells are used for fuel. The fishermen state that 80 or 90 turtles yield 16 to 20 tins of oil, selling at 3 soles (about \$1.50). Computing from these figures, the oil yielded by an individual turtle would be worth from 27 to 38 cents, while the total catch of two fishermen in one week might be worth \$24 to \$30 for oil, besides the value of the meat.

The fishery for whales off the coast of Peru has been pursued by foreign vessels for more than a hundred years. After an English vessel, manned by American whalers, made a most successful voyage around Cape Horn in 1788-1790, the coasts of Chile and Peru soon became favored whaling grounds for both English and American vessels. The agreeableness of the climate off the coast of Peru, the freedom from dangerous storms, the convenience of certain ports, the abundance of whales, all conspired to make it a favored cruising ground, and Callao, Paita, and Tumbes became places of common resort for refitting and provisioning. Peru derived a direct commercial benefit from this fishery. Tumbes gained more than this; for sometimes the crews were recruited with local sailors, and occasionally these native recruits, acquiring experience and skill, rose to the rank of officials of the boat crews. In this way the "Tumbeseños" learned the methods of the whale fishery, and the way was opened for a national fishery. For at least twenty years persons or companies of Tumbes have followed this fishery, employing the well-equipped whaleboats left behind by the foreign whalers. It is, however, a small fishery, 10 to 14 whales in a season being accounted a good catch. The season of 1907 was a very poor one, only 4 whales being captured, with a yield of about 6,500 gallons of oil, valued in Tumbes at about \$1,300.

The coast has long been abandoned by all foreign whalers except a few Chilean boats, which are supposed to take about 150,000 gallons of oil each year. At the local valuation this would amount to approximately \$30,000. The

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<sup>a</sup> Turtles are not known to come on the beaches to lay in this region, nor so far as I know, south of the region of Tumbes, where it is said that the nests are made about September. The only common turtle of the coast is the Pacific green turtle. The tortoise-shell turtle is said to be found very rarely.

Chilean boats, which are said to use the whaling gun and explosive harpoon, probably take chiefly the sperm whales; while the native whalers confine their attention to the humpback whales found nearer the shore in the Gulf of Guayaquil, and employ only the harpoon and lance thrown by hand. The Gulf of Guayaquil is reputed to be a favored breeding ground of the humpback whale, and it is about at the bearing season (May, June, etc.) that the local fishery is pursued.

Except the preparation of oil from turtles at Pisco and the capture of whales at Tumbes, there is no fishery for oils in Peru.

For a time the sea lions ("lobos de mar") were taken for the oil and hides, but the government prohibited the continuance of the fishery, partly because of the use of dynamite and partly that an inquiry might first be made as to the relation of the sea lions to the guano-producing birds. It was a question whether the lobos were injurious to the birds, in the competition for food, or were of real assistance to them in so herding and demoralizing the surface fishes as to make them more available to the birds. It is probable now that the fishery will be resumed under proper regulations and restrictions.

The porpoises and dolphins seem never to have been sought; in fact, many of the fishermen have a peculiarly friendly feeling for these animals, believing that in some way they aid the Christians ("ayuda los Cristianos").

Fur seals, "lobos finos" or "lobos de dos pelos" (lobos of two coats), while undoubtedly occurring on the coast as far north as Paracas, are not abundant enough, nor perhaps of sufficient value, to support a fishery. The "gato de mar" (sea-cat), a species of river otter (*Lutra*) that lives in the sea, is not uncommon in some regions, but is never abundant. Its pelt when taken is regarded as of some value.<sup>a</sup>

#### FUTURE OF THE FISHERY INDUSTRY.

In spite of the antiquity of the fisheries of Peru, and notwithstanding the introduction of European fishermen with their improved boats and nets, the industry is now so inadequate and unsatisfactory that the larger part of the people of Peru are not supplied with a class of food which they peculiarly appreciate.

Some of the difficulties are inherent in the situation in a country whose industrial life in all its phases is relatively undeveloped, and many of these difficulties will disappear naturally as the country generally advances further in the path of industrial progress which it has so propitiously entered. Rapid and frequent transportation between ports is wanting, railroad rates are neces-

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<sup>a</sup> We are not concerned with the preservation of the large fresh-water fishes by smoking and other methods which are practiced on the headwaters of the Amazon. I have been informed that this is such an extensive industry that smoked fish in that part of Peru is a more common food than beef.

sarily high, and ice is at present at almost prohibitive prices. The fishery industry everywhere is without that organization and specialization which marks the higher stage of development attained in many other countries. Each fisherman makes his own nets, conveys his catch to port, sells the fish fresh or preserves them by salting or drying for sale at a future time—everything in an individual way. Experience in other countries shows that economy is the result of systematization, and that the middleman, even if characterized as the “necessary evil,” may not only keep the market more regularly supplied but also give the fisherman a better average profit and the consumer a lower average price. So in Peru we find the fish when unusually abundant thrown away or sold at a very low price, because the fisherman has not the means or lacks the energy to preserve a large catch, while the public complain of an irregular market and of an excessively high price in ordinary times. I have referred to the unusual appreciation of fish-food by Peruvians. Rarely is a meal served without fish where it is obtainable, yet to a large part of the people beyond the ports this much-prized luxury is seldom to be had.

Modernizing the fishery is not sought for itself, for many of the original Peruvian methods of capture are suited to the natural conditions and best adapted to the social nature, the abilities, and the wants of the people. Except in Callao and Mollendo, the fishermen are all native Peruvians but slightly touched by the wave of modern progress. In attempting to introduce new and larger methods, it would be unnecessary and unjust to hamper or antagonize a kindly people, poor in wealth but rich in contentment, who are working out a peaceful and honorable life after the bent of their nature. The *caballito* and the *balsa*, the *chinchorro* and the *anchobetera*, the *camerone* traps and other native nets may long continue to give satisfactory food to many Peruvians. Yet if the native fishermen may be taught to capture their fish more abundantly, and to salt and dry them more efficiently, their labors may be the more profitable and the more useful to them and to others. Furthermore, without prejudice to them, their fisheries may be supplemented by those who can pursue the industry in a larger way and with better organization; and this is clearly necessary if the larger part of the population of Peru is to obtain fish and to have it regularly and cheaply.

The abundant catches of the excellent *congrios* made with the *espinel* (trawl line or bait line) in the region of Mollendo and the success of this method when used in other parts show well that, although relatively laborious, it could be more extensively employed to great advantage. The deep bottom trawlnets, while not actually tested in Peruvian waters, would in strong probability prove successful, and it is much to be desired that experiments be made with them. The use of power boats will be necessary, and the introduction of these for quick conveyance of fish to market will enable the fishermen to

spend a greater proportion of their time upon the fishing places, increase the territory conveniently accessible for the markets of Callao and Lima, and open new fishing grounds. Finally, the opportunities are excellent for the proper preservation of several kinds of fish by various methods.

## II. THE GUANO INDUSTRY.

The guano problem, which is perhaps the most important economic question confronting the nation of Peru to-day, has been included in the fishery studies partly because it is impossible entirely to dissociate the guano industry and the fisheries in protective and regulative measures. Strictly, indeed, we may consider guano a fishery product, for it is formed by the birds from the small fishes, which swim in such enormous schools along this coast. Chiefly for this reason, in fact, I have on a previous page referred to the anchobeta as the most important resource of the waters of Peru. It is, however, an inadequate statement of the relation of the guano and fishery industries to say that the existence of the guano-producing birds in Peru is dependent upon the presence of large schools of fish. One of the most important products of the fishery industry of the United States is the fish guano made by direct manufacture from the menhaden. In Peru a nearly equal value of guano is produced annually from the anchobetas through the agency of the birds. This guano is obtained far more cheaply than if the process of manufacture were depended upon, since it can be brought from the islands at little more than the cost of transportation. (Fig. 8, pl. xv.) It is a very significant practical question to what extent Peru should continue to depend upon the birds for the production of nitrogenous guano, or whether the direct manufacture of fertilizer from the fishes should be undertaken in order to supplement the present available supply. This question will not be specifically discussed at this time, but the matter here presented has a very direct relation to its solution.

Peru owes the importance of its guano deposits, not only to the abundance of the sea birds and the fishes upon which they feed, but in equal part to those natural conditions which have permitted the conservation of the nitrogenous parts of the guano. Had the coast been subject to rains, or were the climate more moist, the nitrogenous portion of the guano would have been converted into ammonia and lost by evaporation or drainage. There would have resulted then, at the best, a phosphatic guano of relatively low value. The guano consists, as is well known, of the excrement of birds and sea lions, with the other offal matter of the rookeries, consisting of bodies of birds and sea lions, birds' eggs, and fish. For our purposes the sea lions may be excluded from consideration. Undoubtedly they have lent considerable bulk to certain deposits of guano, but, from such information as can be gained, it seems practically sure



that apparent deposits of seal guano which have given a high analysis owe their chemical value in large measure to bird guano which has been formed with it.

#### THE PROBLEM.

It is difficult to overestimate the significance of the guano problem to Peru. It is not merely that the country is threatened with the loss of an exportation industry which has yielded important revenues; the sugar and cotton planters of the country have been coming more and more to recognize the value of the fertilizer for the production of their crops. In fact, with the relatively crude methods and the inefficient labor, combined with the necessary expense of irrigation, the profit from these crops is, to a considerable extent, dependent upon the availability of a cheap fertilizer. Even at this time the nation's agriculturists are estimated to require 40,000 tons annually, while, under existing conditions, they have been able to secure only about two-thirds of this amount. The guano deposits have been so mortgaged for the payment of the bonded debt that, under the present arrangements, the largest part of the guano must be exported. Thus, in 1907, of approximately 124,000 tons of guano extracted, only 26,000 tons were taken for the agriculture of Peru. Under a continuance of the present conditions, it is certain that even this proportion of the nation's requirement can not be obtained for more than a few years longer.

The exhaustion of the old deposits will soon be realized. It is true that there have been "false alarms" in the past in this regard. Islands which have been proclaimed exhausted have been revisited and have afforded new supplies of the fertilizer. This has been due only in a relatively small degree to the continued deposition of the birds; in part it is explained by the occasional discovery of new deposits of buried guano; but that the same island has been successively exhausted two or more times is chiefly accounted for by the fact that the term "exhaustion" has been used in a relative sense. At one time it was not profitable to extract guano lower than a certain grade, while at a later time the market would be content with a fertilizer of much lower nitrogen value. It would become profitable, then, to return to "exhausted" islands where the lower grades had remained.

At present the old guano supplies are reduced to the very lowest grades that it would be profitable to extract and transport to foreign markets, and the approximate amount of such guano being known, it is estimated that at the present rate of exportation all the available guano of old formation will be removed within four or five years. It is not probable that new deposits will be found of sufficient quantity to change the present outlook materially.

It is clear, therefore, that within a few years the guano industry will be dependent upon the yearly production of the birds. The amount of this new production can not be stated accurately, but it is fairly estimated to be between 20,000 and 30,000 tons. This amount, if divided as now between the export and the home trade, would be of comparatively little value to either. The estimated annual production is, indeed, less in number of tons than is actually required by Peru's agricultural industries alone; but since the new guano has a much higher average nitrogen value than the guano that is now used, and on which the estimated annual demand is based, it is probable that the yearly formation would meet the present demands of home agriculture. Furthermore, it is believed that with the adoption of the correct method of working the islands, and with the most thorough protection of the birds, there would result a material increase in the production of guano, sufficient to keep pace for a considerable time with the growing demand. It is even possible that there would be a surplus for exportation.

#### THE GUANO-PRODUCING BIRDS.

At least twenty-four species of birds frequent the islands, not including seven species observed at sea in proximity to the islands and coast. Twelve of these were observed nesting on the islands. From the commercial standpoint the chief birds are the cormorant, the pelican, and the gannet, the first and last mentioned being the most abundant birds on the coast.

#### THE CORMORANT.

The white-breast cormorant (*Phalacrocorax bougainvillei* Lesson), the paramount guano-producing bird, occurs along practically the entire coast, nesting on the level ground or the more gentle slopes, and always in closely crowded rookeries (fig. 9 and 10, pl. xvi). This cormorant, the "guanay," occurs most abundantly in the south, at the Ballestas and Chincha islands. The nests are closely crowded over great areas, where it may readily be ascertained that they average about three to the square meter. At the close of the season there may be allowed at least four birds to a nest, counting the parents and one pair of young. The population of a flock, after the young are raised, may therefore be estimated by multiplying by twelve the number of square meters covered by the rookery. On the Ballestas and Chincha islands in June, 1907, rookeries of 4,600, 10,000 to 12,000, and 60,000 square meters, respectively, were measured, and other smaller rookeries were observed. These flocks, then, must have contained 55,000, 120,000, and 720,000 birds, respectively. At a later time the last-mentioned flock, on the South Chincha Island, was so much increased, chiefly through recruits from the other flocks; that a million birds could have been only an underestimate of its population. The photograph (fig. 9, pl. xvi) shows but a very small portion of this immense aggregation of birds.

It may be of interest here to consider for a moment the potential commercial value of such flocks of birds. Let us assume that each of these birds leaves upon the island daily a single ounce of guano. This is actually an underestimate, as such a rate of deposition would not account for the quantity of guano actually extracted after a year's accumulation on a rookery; but on this assumption of 1 ounce a day for each bird, the deposit would grow daily by 1,000,000 ounces, 62,500 pounds, or 28 long tons. A million birds would then produce over 10,000 long tons of guano per year. Such an amount is probably not actually formed at this ground, for the reason that a million birds is a decided overestimate of the average number of birds on the rookery throughout the year. However, on the assumption of 1 ounce of guano per day per bird, it follows that 100 birds would produce 1 long ton of guano per year.

We may come more nearly to the actual conditions. From the various calculations I have made it appears that a rookery will yield about 1 long ton of guano per year for 28 nests. This guano of the "guanayes" is very high in nitrogen, giving an analysis of 12 to 14 per cent and higher, and we may value it at \$40 per ton.<sup>a</sup> Twenty-eight nests, or 28 pairs of birds, have an annual producing value of \$40. We give a fair idea of the commercial significance of these birds to Peru when we say that each brace of birds contributes annually \$1.43 worth of guano, besides leaving a pair of offspring to continue its service. Is it not, then, of the greatest importance that the fullest protection should be extended the birds, and every possible precaution taken to insure that there may be the maximum number of birds at every rookery, and that these birds may remain upon the rookery the maximum amount of time?

Previous to making the above computation, from observations at other rookeries, I had estimated the number of nests on the south island of the Chin-chas at 180,000, and, by an independent series of measurements of the deposits of guano at various places in the rookery after two years of accumulation, had estimated the amount of guano at between 12,000 and 15,000 tons. Making a new calculation on the basis of the figures just worked out—that is, 1 ton to 28 nests—the 180,000 nests would give 6,400 tons per year, which is in close agreement with the original computation from measures and weights taken on the rookery.

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<sup>a</sup> The cost of guano to a Peruvian farmer can not be taken as a basis of valuation, since the government practically gives the guano to him, exacting a tax of only 1 sol (about 49 cents) the ton. The expense to the farmer is merely the cost of extraction and transportation. The cost of a ton of 9 per cent guano on the farm is, therefore, only \$12 or \$13 in American gold. This cost, however, does not at all represent the value of the guano, if the cost were based on the ordinary laws of supply and demand. The real value to the farmer can not be computed.

The guano for export was consigned to the exporting company many years ago by a process of adjustment, in return for the acceptance of certain obligations; so that it is not practicable, either, to calculate the value of the export guano on the ground.

However, considering the high selling value of guano of such excellent quality in foreign markets, and since the cost of extraction is less than \$5, and the freight relatively low, it can not be considered unreasonable to assume that guano of this high analysis has a value to the world of \$40 per ton.

## THE PELICAN.

The second bird in importance is the "alcatraz," or pelican (*Pelecanus thagus* Molina), although it has not now nearly the rank of the cormorant. The pelican is not only far less abundant, but it appears that its guano is distinctly less in quantity and inferior in value to that of the cormorant. It can not be said in what degree this is due to an inherent difference in the birds, or to the fact that the cormorant breeds chiefly on the islands of the south, where the conditions are better for the preservation of the guano, while the pelican now breeds chiefly in the north where the atmosphere is more humid, and therefore deleterious in its effects on the deposits of guano.

There is one thing of especial importance for consideration in regard to this bird. The pelican, of all the useful birds, is the one which seems to be most affected by the disturbances incident to the extraction of guano, and therefore, of the three chief commercial birds, it is the one which has been most reduced in numbers. This may offer a reasonable basis of hope for the future. It does not appear that the breeding territory of the pelican was always confined as now to the northern regions. The islands of the south are smaller, so that the working of the islands is more directly disturbing to the birds. It is natural, therefore, that the rookeries of pelicans in this region should now be small and confined to the outlying and less accessible rocks. In the north, on the other hand, the islands of Lobos de Tierra and Lobos de Afuera are comparatively large, giving more opportunity to the birds to separate themselves from the guano workers. During recent years, too, the extraction in the north has usually been restricted to one group of islands, while the other was left to the undisturbed possession of the breeding birds. It is unfortunate that during the past two years both islands have been worked, with results which can not but be seriously injurious to the welfare of the pelicans.

In March, 1907, large pelican rookeries, with eggs and all stages of young, were observed to the eastward of the Lobos de Afuera islands and an islet just off the north end of this island. During the following winter, about August probably, the birds were entirely routed from these islands, and the rookeries were swept clean of guano. A new home was established on the westward island, where the photograph (fig. 11, pl. xvii) was taken in December, in the early part of the laying season. Not a single bird remained to make its nest on the islet, and only a few very small and scattered rookeries were found on the entire eastward island.

In March, 1907, there were probably about 80,000 flying birds (mature and immature pelicans, not counting the nestlings of every stage) using the Lobos de Afuera islands at night. In December, 1907, there were between 20,000 and 40,000 nesting birds on the same islands. The irregular nature of the rookeries

made it impossible to arrive at a more definite estimate. Probably by the following March, after the rearing of a brood of young, this number was nearly doubled, but it can hardly be supposed there were so many as in the preceding March.

It is believed that a proper consideration of the welfare of the pelican would promise much benefit to the country. It may be expected that with the most careful protection, the bird would increase materially in numbers in the north, and even more so in the south, so that in time the pelican would have a much higher value and would take a rank nearer to that of the cormorant.

#### THE GANNET.

The common "piquero," a species of gannet (*Sula variegata* Tschudi), which von Tschudi considered the most important bird (and this view seems to have been generally accepted), is still important, though of far less value than the other two species mentioned. However, on account of its habit of nesting on the cliffs and other comparatively inaccessible places, the great proportion of the guano is now lost in the sea, and it is doubtful whether the bird has ever had a commercial value comparable to the cormorant or the pelican. (Fig. 10, pl. xvi.) With the better systematization of the guano industry in future years, much of this guano now lost might be saved by the construction of shelves or other collectors at the bases of the cliffs.

Von Tschudi found that a single piquero in captivity would produce  $3\frac{1}{2}$  to 5 ounces of guano per day. If each bird leaves about its nest 2 ounces of guano daily, 1,000,000 piqueros would leave 20,000 tons per year. The piquero is so abundant and so generally distributed along the coast that 1,000,000 would seem a low estimate of the number of birds on even a portion of the coast. The piquero breeds throughout the year and the nests therefore are always in use.

#### THE PENGUIN AND THE PETREL.

Only two other species require particular mention. The penguin, or "pajaroniño" (*Spheniscus humboldti* Meyen), is now of almost negligible value, but was formerly so abundant as to be highly ranked by Raimondi. The rookeries are confined to the caverns, and the guano is considered very good, although there is little of it.

The "potoyunco," a species of petrel (*Halodroma garnoti* Lesson) of oceanic habit except for its nesting in subterranean homes, is still significant, but in relatively low degree. The nesting places are found on many islands, however, especially on the lofty San Gallan. Great areas of the surface of the ground, from the lower hillsides to the tops of the peaks that are usually capped with clouds, are undermined by nesting chambers of these birds. They will burrow indifferently through the hard crust of sand on the hillsides or beneath the

cloud-fed vegetation of the hilltops. The guano produced here must be of significant quantity, and it is reputed to be of high quality. It is remarkable to note that this little bird was given first rank by Raimondi.

The penguin and the potoyunco from their habits are the most helpless against ruthless destruction, and they seem undoubtedly to have been reduced from a condition when they possessed a much greater economic value than now. The exterminating process still continues, as both birds are frequently killed by the fishermen and the guano laborers. The potoyuncos especially are regularly sought by the fishermen. They can easily be captured at night in their underground nests, and quantities of them are taken to be salted and sold on the mainland. If adequate protection is extended to these two birds it seems reasonable to hope that they would increase in numbers toward the former condition of abundance and again take rank as important economic assets.

It is not within our province at present to speak of the other cormorants, another gannet, the gulls and terns, and the shore birds which are found on the island and coast. None of these species, individually, has a commercial importance, yet it must be remarked that, collectively, they may add materially to the total quantity of guano which may be swept from the ground.

#### EXTRACTION OF GUANO AND PROTECTION OF THE BIRDS.

Under the existing arrangement, all of the guano that is exported from the country is taken by a single corporation, which has offices in Lima, as well as in London, New York, and other cities. The corporation does not usually work the islands, but has the guano extracted by contract, paying to the contractor so much per ton delivered to the vessel. Often these contracts, involving only a few thousand tons, are given to native contractors. A large part of the export guano, however, is extracted by a single commercial company, which works now upon the northern islands. From this guano the government derives no present revenue, but the amount extracted is reported to the government and credited against the amount of guano which has been mortgaged to the corporation for obligations of the government previously taken over by the corporation.

The guano for the Peruvian agriculturists is extracted by a similar contract system, with the following method of procedure: The farmer who desires guano applies to one of the many individual contractors. A typical contract may be instanced. The contractor agrees to sell and the farmer to buy 600 metric tons of guano at 14 soles (about \$7) the ton, the guano to give an analysis of 9 per cent of nitrogen. The contract further provides that if the average analysis is higher or lower the farmer will pay an additional price of 1 sol per ton for each unit of nitrogen above 9, while 2 soles the ton will be deducted from the

price for each unit below 9. Another type of contract might cover a larger quantity of guano, say 5,000 tons, to be delivered during four years, certain stated amounts to be made available each year. The contractor, having calculated the amount of guano necessary to fulfill his contracts for a given year, applies to the Ministerio de Hacienda (corresponding to our Department of the Treasury) for a concession to take such and such amounts of guano from stated islands, and, if the concession be awarded, the contractor pays to the government 1 sol for each ton conceded. In case of failure to obtain the amount asked for, and on which payment has been made, the government adjusts the matter equitably by continuing the balance of the concession to the following season or refunding the proportionate part of the payment.

This introduces one of the weakest points in the present method of extraction. It frequently happens that two or three or more concessionists are authorized to take guano from the same island. Only one who has lived on the islands while the working was in progress can appreciate the bitterness of competition that ensues. The disputes, the threats, and the personal violence which may arise are aside from the question. It is the effect upon the birds that is of vital moment.

Since it is understood that a concessionist establishes finally his claim to any deposit of guano by throwing this into piles, and since the best of the guano is found at the rookeries, disaster to the birds is inevitable. The first party to arrive, or the strongest, as the case may be, obtains possession of the rookery, and within a few days the entire breeding ground is torn up and the birds completely routed, without regard to the presence of immature birds or unhatched eggs. Under a better system a responsible contractor would at least allow the birds to use a portion of the ground, while, with as much consideration of them as possible, the guano was being extracted from the remainder. I should not omit to add that I have seen some concessionists working in this intelligent way where there was due opportunity. (Fig. 8, pl. xv.)

The government has not failed to recognize the necessity for protection of the birds. The destruction of birds or of eggs has been made a penal offense, and it is now practically stopped. It is a difficult matter to keep a thorough surveillance of a long coast, where the towns are widely removed, and of many islands, some of which are miles from the mainland. Hence there is still some violation of these laws, and the potoyunco, as has been mentioned, suffers especially from such depredation. At times, too, the eggs of more important birds may be taken, but the wholesale robbery of nests has been practically eliminated. Formerly the eggs were valued for food and for use of the albumen in clarifying wines, and it is said that enormous quantities were taken regularly.

That which most concerns the present government is how to regulate the working of the islands so that the necessary amount of guano may be taken

with as little detriment as possible to the birds. Two years ago a "closed" season of five months was established, to include the months of November to March, which constitute the height of the breeding season, and the writer was instructed to make a study of the habits of the birds, with reference to determining whether such a period was proper or adequate, or whether other methods of regulation were required. As a result of the studies made on various visits to the chief rookeries, it became apparent that the closed season adopted was inadequate, although it was a most significant step in the right direction and has undoubtedly already yielded results of value.

The pelican rookeries on the 1st of April were covered with eggs containing live embryos, and with all stages of young birds, immature and incompletely feathered. Young pelicans only partially feathered were to be found as late as June. Cormorants were feeding their young from mouth to mouth in June, while already the preliminary love plays and preparation of nests for the following season were in progress. By the end of July a large number of eggs were laid for the following season and a few even had hatched.

It follows, therefore, incontrovertibly, that there can be no season when the islands may be worked without disturbance of the birds. I believe the rookeries of pelicans and cormorants are never deserted voluntarily except for so long a period in the day as may be necessary to secure food. The breeding season of the gannet, as has been mentioned, is continuous throughout the year.

It becomes very clear, then, that only a very carefully and consistently followed plan of rotation in the working of the islands would insure the birds the best conditions for undisturbed breeding. For a period of at least five years certain islands in each region might be left as the unmolested abode of the birds, while the extraction of guano was being prosecuted on other islands. At the expiration of that period, certain other islands would be closed while the accumulations of guano on the previously closed islands would be available for extraction. The system might be worked out in such a way that each year certain islands would be opened, and a steady supply of guano be available each year.<sup>a</sup>

In partial adoption of a plan of rotation, the government has kept the south island of the Chinchas entirely closed during the past two open seasons, and it is estimated that by the expiration of the third year of closure there will have accumulated on this one island about 20,000 tons of guano of the highest grade. It is only fair to state that the government has enforced the closed season and kept this island closed in the midst of very serious difficul-

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<sup>a</sup> The plan which the writer drafted in 1907 for the Chincha and Ballestas Islands and other points of the region (Boletín del Ministerio de Fomento, Junio, 1907) may be cited as an illustration. After further observation of the birds on the rookeries, I would modify this plan by using five-year instead of three-year periods, as was then suggested.



ties. We have seen that it has proved impossible to grant to the farmers of the country the full amount of the guano which they desire. However warmly and sincerely the principle of regulation may be indorsed, there must be faced a strong and not unreasonable cry from the many farmers for more fertilizer. Only by the opening of the middle, and later of the north, island of the Chinchas, which it had been intended to keep closed, and by the opening of the Lobos de Afuera Island, was it possible to give to the farmers the two-thirds portion of the guano which they required.

A large and important industry with exacting relations to creditors and to national agriculture can not be thrown upon a new basis in a moment; but the interests of all concerned are linked with the welfare of the industry, and it is believed that those on all sides who have power or influence are giving serious attention to the matter. It is probable that the proper solution of the question will not long be delayed, and we may confidently anticipate a brighter and far more satisfactory future for the guano industry, at least so far as the people of Peru are concerned.

#### CONCLUSION.

As a concluding word, it may be stated that the investigation of the fishery and guano industries was taken up a little less than two years ago. The first step has been the collation of data regarding the industries, the methods in use, and especially the conditions and the opportunities for development. The studies of the present writer conclude at this point. It is intended by the government to continue these studies and to adopt practical measures that will facilitate the development of the industries. It is evident that important economic results may be gained which will benefit both the fishing population and the country at large.

It is hoped also that arrangements may be made to investigate the fresh waters of the interior with reference to determining whether it is possible and profitable to introduce new species of fish into some of the lakes and rivers.

It is to be added that the government appreciates the ultimate necessity for an accurate knowledge of the marine fauna and flora, and desires to promote a knowledge of the natural history of the country. With this in view, the writer was instructed to collect the chief economic forms and others associated with these. The collections thus made will probably not include many new forms, except of the fishes, but it is intended that they shall serve as a basis for systematic reports illustrating the economic forms and epitomizing the present systematic information regarding the more important economic groups. To this end the collections will be intrusted to specialists in the various groups. It is believed that the reports will be of value to science and that they will be of especial service to those who may in future have the opportunity to enlarge our knowledge of the natural history of a comparatively neglected region.

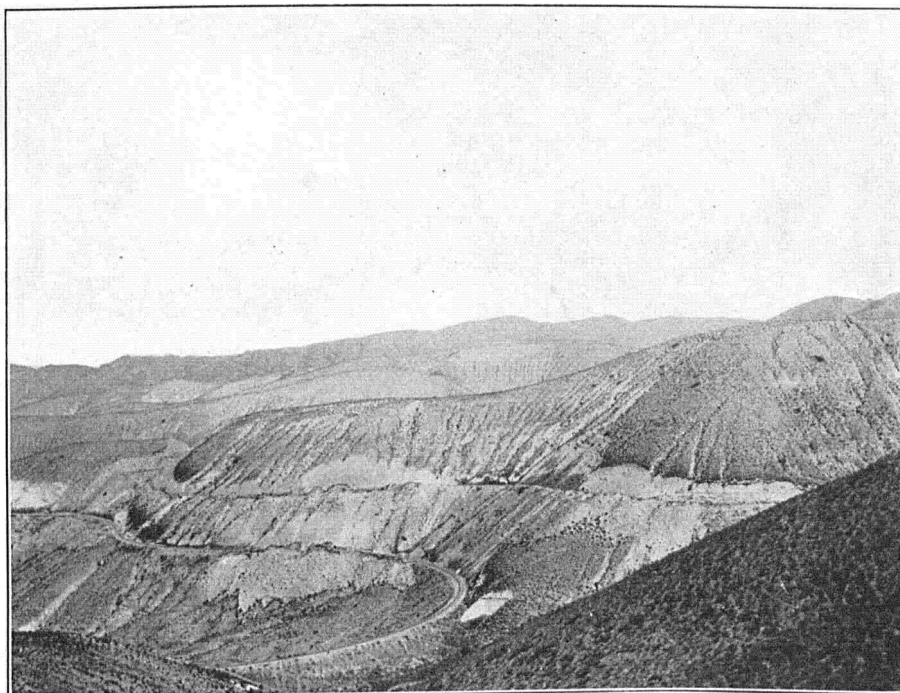


FIG. 1.—A characteristic scene on the coast desert, taken from the Southern Railroad between Arequipa and Juliaca.

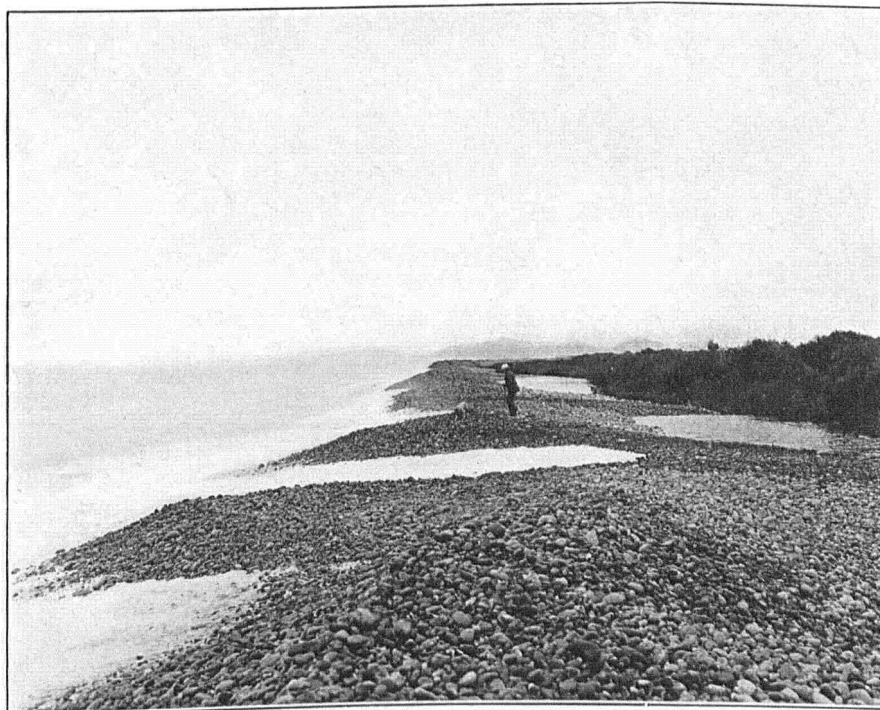


FIG. 2.—Mouth of the River Rimac near Callao. On the left the ocean, on the right the lagoon formed by the river. The water of the lagoon escapes into the ocean by seeping through the natural dike of shingle.



FIG. 3.—Gathering oysters from the mangrove trees, Tumbes.

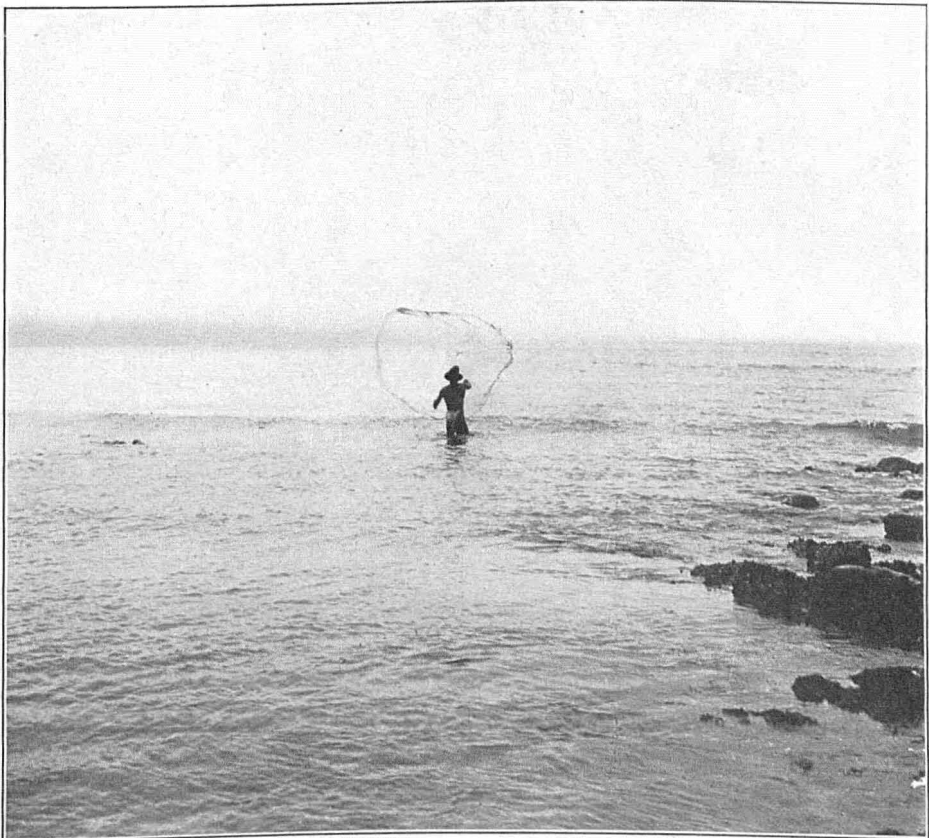


FIG. 4.—Native fisherman in the surf, throwing the ataraya (cast net).

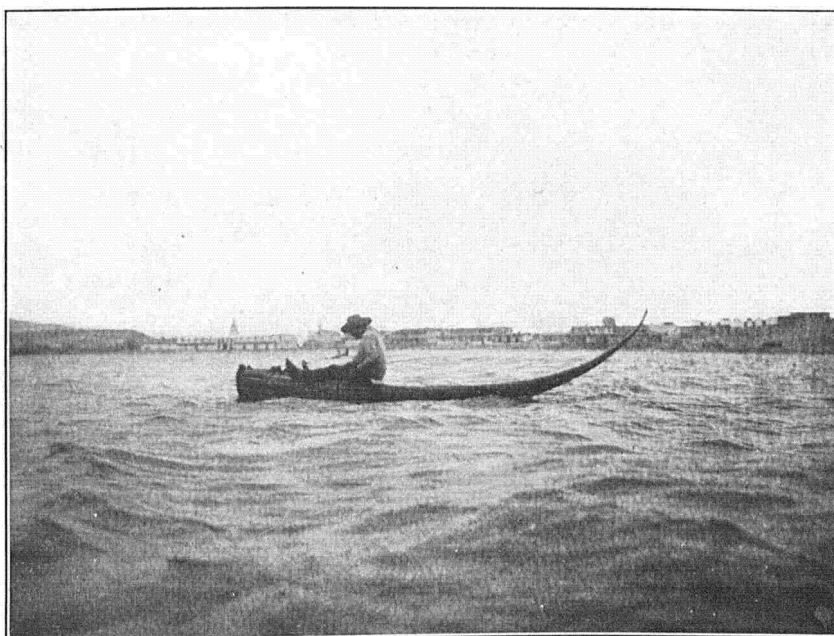


FIG. 5.—A Peruvian fishing with hook and line from a caballito, Pacasmayo.

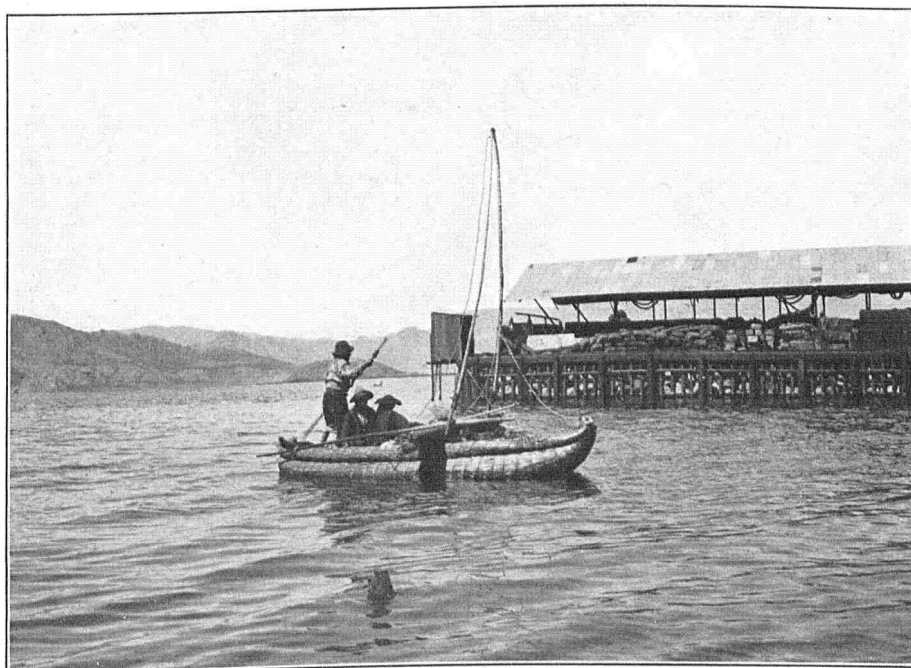


FIG. 6.—Balsa on Lake Titicaca. Made of reeds.



FIG. 7.—Drying sharks, guitar-fishes, etc., without the use of salt. Lobos de Tierra.



FIG. 8.—Sacking guano to be shipped by anda-rivel (automatic trolley), Ballestas Islands.

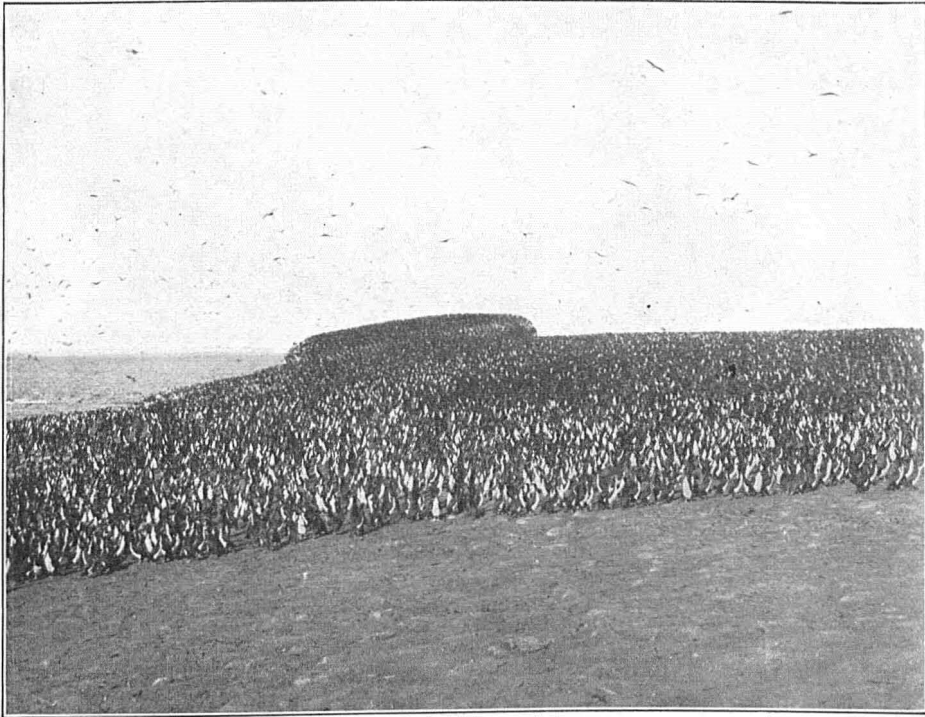


FIG. 9.—A very small portion of a flock of cormorants on the south island of the Chinchas.

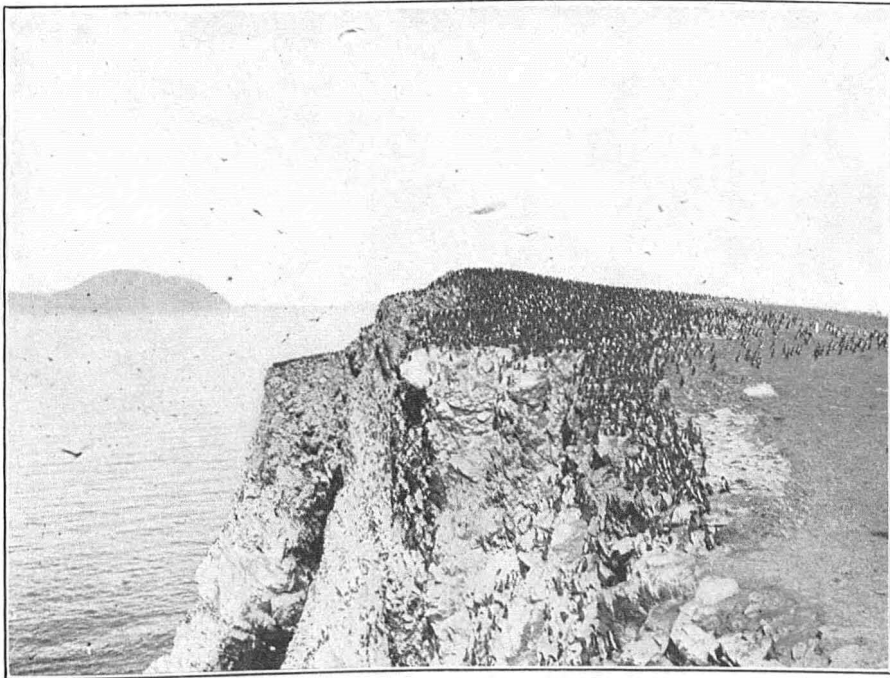


FIG. 10.—A small flock of cormorants on the top of the south island of the Ballestas. Gannets are barely distinguishable on the ledges.

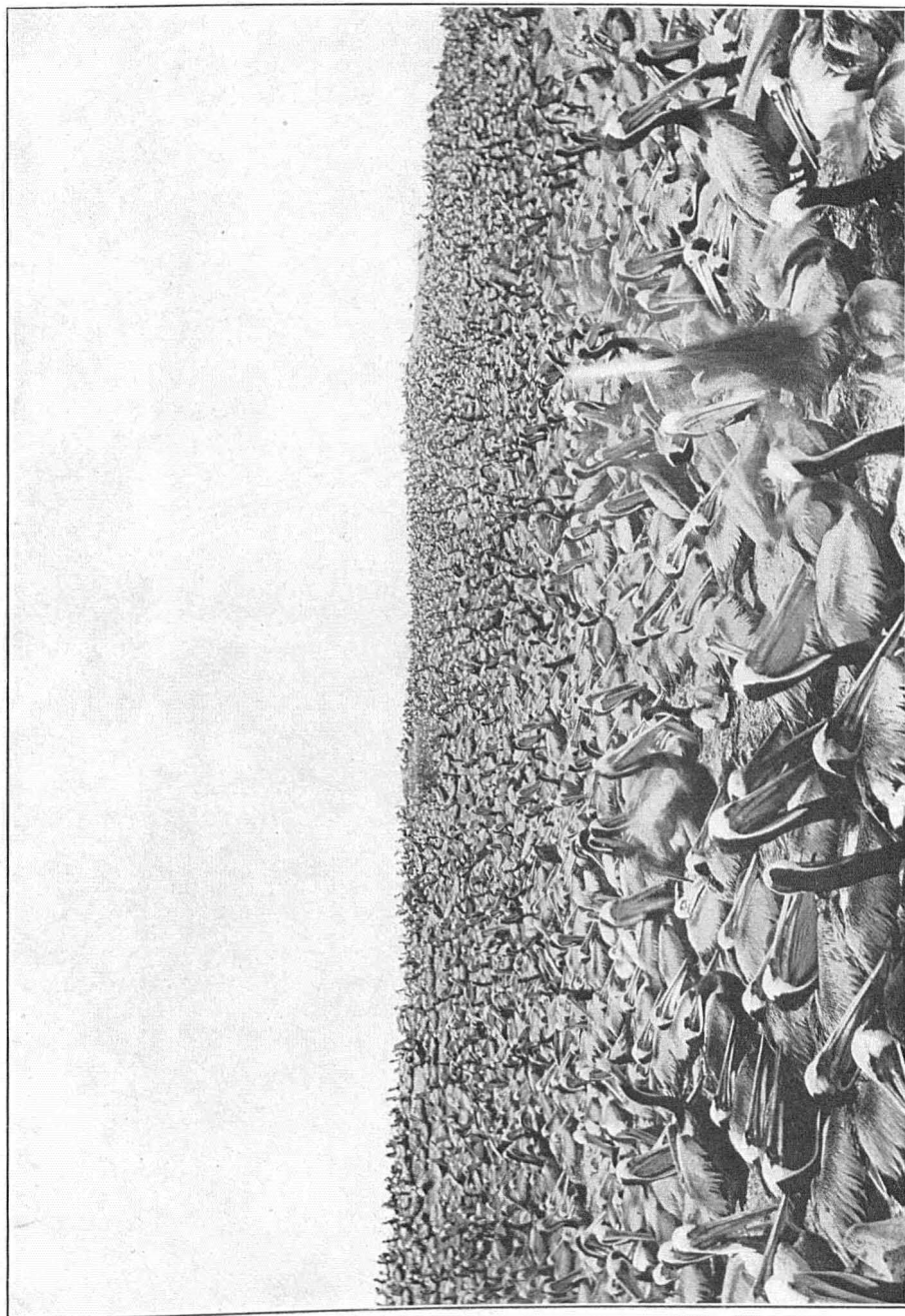


FIG. 11.—Pelicans on their nests, Lobos de Afuera.