
GENERAL REPORT

ON THE

INVESTIGATIONS IN PORTO RICO OF THE UNITED STATES FISH
COMMISSION STEAMER FISH HAWK IN 1899.

BY

BARTON WARREN EVERMANN,

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INTRODUCTION.

Soon after Porto Rico became a part of the United States the Commissioner of Fish and Fisheries decided to make an investigation of the aquatic life of that island. An examination of the literature pertaining to the natural history of the West Indies showed that comparatively little was known concerning the fishes, and scarcely anything of the other aquatic animals or of its aquatic flora. The land animals and plants were better known, but even these had received but scant attention.

Dr. Juan Gundlach seems to have been the only zoologist who had made any considerable collections of the animals of the island. He appears to have made two visits to Porto Rico, the first in 1873 and the other in 1875-76. In June, 1873, he landed at Mayaguez and remained in that vicinity until October 4, when he went by boat to Aguadilla. On November 4 he went to Arecibo, whence he returned to Mayaguez via Quebradillas and Aguadilla. After visiting Guanica about a week he returned to Mayaguez and sailed for Habana December 4. Some of the results of his observations were published by him in the *Journal für Ornithologie* for 1874 and 1878.¹

In 1875 Dr. Gundlach made his second visit to Porto Rico, reaching Mayaguez on September 14, but the rains kept him from collecting. Early in January, 1876, he went by boat to Aguadilla, intending to go on to Arecibo, but an epidemic of smallpox prevented him doing so for a time, during which he collected to advantage about Quebradillas. He finally reached Arecibo, however, and also visited Vega Baja and Dorado. On May 19 he reached Utuado and returned to Arecibo July 3. About July 10 he went to Bayamon, where he met Dr. Stahl, with whom he visited San Juan, returning to Mayaguez about a week later. There he remained until August 25, when he sailed for Habana. While at Mayaguez he visited Dr. Domingo Bello y Espinosa, a practicing physician of that city, who was much interested in the botany of Porto Rico. He probably also visited the German vice-consul at Mayaguez, Leopold Krug, who had sent to Berlin some collections of the reptiles and batrachians of the island, which were reported on by W. Peters in 1876.²

¹ Beitrag zur Ornithologie der Insel Portorico. <Journal für Ornithologie 1874, 304-315.

Neue Beiträge zur Ornithologie der Insel Portorico. <Journal für Ornithologie 1878, 157-194.

² Peters, W.—Ueber eine von Hrn. Viceconsul L. Krug und Dr. J. Gundlach auf der Insel Puerto Rico gemachte Sammlung von Säugethieren und Amphibien, so wie über die Entwicklung eines Batrachiers, *Hylodes martinicensis*, Dum. Bibr. ohne Metamorphose. <Mon. Berlin Akad. Wiss. 1876, 703-714, and pl. 1; Reptiles, 705-708; Batrachia, 709-714 and pl. 1.

The various results of Dr. Gundlach's work in Porto Rico were published by him under the general title "Apuntes para la fauna Puerto Riqueña," in the *Anales de la Sociedad Española de Historia Natural*.¹

The fishes collected by Dr. Gundlach were studied and listed by Professor Poey. He gives, with brief annotations, a list of 106 nominal species, only 94 of which he identifies. The entire list seems to represent 99 good species. In this paper Poey proposes the new generic name *Monosira* (= *Larimus*) and two new species, *Monosira stahli* (= *Larimus breviceps*) and *Antennarius inops*. The paper is scarcely more than a list and gives nothing as to the habits, abundance, or distribution of the species.

In 1869 Prof. Carl Sundevall published, in the *Annals of the Royal Academy of Sciences of Stockholm*, a report on a collection of birds obtained in Porto Rico by J. A. Hjalmarson.

Dr. August Stahl, of Bayamon, seems to be the only resident of Porto Rico who has given much attention to the natural history of the island. Though engaged actively in the practice of medicine, Dr. Stahl found time to make not only extensive collections in most groups of animals and plants, but also valuable studies of the archæology of the island. His studies were pursued under many difficulties and discouragements, and most of his collections finally deteriorated and perished. In 1883 he published at San Juan a catalogue of the zoological specimens in his collection which, though a mere list, is possessed of considerable interest.² Dr. Stahl's collection contained about 90 species, agreeing approximately with the list given by Professor Poey.

Apparently somewhat more attention has been paid to the botany of Porto Rico than to its zoology. Various publications pertaining to the botany of the West Indies have contained references to Porto Rican plants, besides which have appeared a few papers based chiefly or wholly upon Porto Rican material. Perhaps one of the most important is that³ by Dr. Domingo Bello y Espinosa, published in 1881.

Dr. Ignatius Urban's work⁴ on the flora of the West Indies, recently published, contains a great deal of information concerning the botany of Porto Rico.

In 1884-88 Dr. Stahl published a volume⁵ on the botany of Porto Rico, which has considerable value.

In January, 1899, Dr. Charles Frederick Millspaugh, curator of botany in the Field Columbian Museum, spent several days (January 5-23) making botanical col-

¹Vol. vii, 1878, 135-234, Mammals and Birds, and 343-422, Birds, by Dr. Juan Gundlach. Vol. x, 1881, 305-317, Amphibians, by Dr. Juan Gundlach, and 317-350, Fishes, by Prof. Felipe Poey. Vol. xii, 1883, 5-58 and 441-484, Mollusks, by Dr. Juan Gundlach. Vol. xvi, 1887, 115-133, Crustaceans, by Dr. Juan Gundlach.

²Fauna de Puerto Rico. Clasificación Sistemática de los Animales que corresponden á esta Fauna, y Catálogo del Gabinete Zoológica del Dr. A. Stahl en Bayamon, pp. 1-249. San Juan, 1883.

In this book Dr. Stahl devotes chapters to mammals (43-46 and 133-135), birds (47-66 and 136-157), reptiles (67-71 and 158-161), fishes (72-81, 162-167, and 246), insects (82-102 and 169-213), arachnids (103-105 and 214-215), crustaceans (106-110 and 216-220), worms (111 and 112, and 243 and 244), and polyps (123 and 124, and 245).

³Apuntes para la Flora de Puerto Rico. <Anales de la Sociedad Española de Historia Natural 1881, 231-304; 1883, 103-130.

⁴Symbolæ Antillanæ seu fundamenta floræ indiæ occidentalis. Vol. i, fasciculus i, 1898; ii, 1899; iii, 1900; vol. ii, fasciculus i, 1900. Berlin, Paris, and London. [Vol. i, fasciculus i, is a bibliography.]

⁵Estudios para la Flora de Puerto-Rico, Folletos i-vi. i, Las Talamifloras, pp. 191, 1884; iii, Las Leguminosas. iv, Las Calcifloras, 1896; v, Las Rubiaceas y Sinantereas, 1887; vi, Las Gamopétalas, pp. 284, 1885; 1888.

lections in Porto Rico and the outlying islands. The results have been published and add materially to our knowledge of Porto Rican botany.¹

But little has been published concerning the mammals of Porto Rico. Besides the papers by Gundlach and Stahl already mentioned, two short papers² have recently been published by Mr. Gerrit S. Miller, jr., of the U. S. National Museum, giving descriptions of two new species of Porto Rican bats.

Concerning the food-fishes of the island absolutely nothing was known except by inference, and nothing was on record regarding the existence, character, extent, or methods of the commercial fisheries. It was known that of the food articles imported by Porto Rico dried cod-fish held an important rank, and that only an inconsiderable part of it came from the United States.

It was believed that an investigation of the aquatic animals and plants of Porto Rico would not only yield important scientific results, but that a study of the fishes and fisheries of the island would prove of mutual commercial value to the island and to the United States; and for the purposes of comparison in the future it was of vital importance that the work be initiated before the modifying influences from the United States began to be felt. The Commissioner of Fish and Fisheries therefore decided to undertake such an investigation at once, and to make it as comprehensive and thorough as possible with the funds and the time which were available.

The principal subjects of investigation were, of course, the fishes and fisheries of the island. This would include a determination of the species of the fishes on and about the island, the distribution, abundance, and habits of each, the value of each as food for man or for other fishes, the location and character of the different fishing-grounds, the species taken on each, the relative rank of the food species, the methods of the fisheries, and the character and extent of the import and export trade in fishery products. Similar investigations concerning the reptiles, mollusks, crustaceans, and all other groups of aquatic animals and plants were also desired, particularly with reference to the native oyster, turtles, and other food species. The opportunity to add to our knowledge of the land animals, especially mammals, birds, reptiles, and batrachians was not to be neglected.

The U. S. Fish Commission steamer *Fish Hawk*, Lieutenant-Commander Richard G. Davenport, U. S. N., commanding, was assigned to the work, and the following persons were selected to carry on the investigations: Dr. Barton W. Evermann (naturalist in charge), Dr. H. F. Moore, Mr. M. C. Marsh, Mr. W. A. Wilcox, and Mr. J. B. Wilson. Mr. A. H. Baldwin accompanied the party as artist to the expedition more especially that the life coloration of the fishes might be accurately depicted. Mr. August Busck, of the U. S. Department of Agriculture, joined the expedition for the purpose of studying the insect fauna of the island. Mr. A. B. Baker, of the National Zoological Park, was also a member of the expedition on behalf of the Smithsonian Institution, chiefly for the purpose of making collections of the land vertebrates.

¹ Plantæ Utowanæ; Plants collected in Bermuda, Porto Rico, St. Thomas, Culebra, Santo Domingo, Jamaica, Cuba, the Caymans, Cozumel, Yucatan, and the Alacran Shoals, December, 1898, to March, 1899; The Antillean cruise of the yacht Utowana, Mr. Allison V. Armour, owner and master. Field Columbian Museum Publication 43, Botanical Series, vol. II, No. 1, pp. 1-110. Chicago, March, 1900.

² Two new Glossophagine Bats from the West Indies. <Proc. Biol. Soc. Wash., XIII, May 29, 1899, 33-37. [Of these two species, one (*Phyllonycteris bombifrons*) is from a limestone cave near Bayamon.] The bats of the genus *Monophyllus*. <Proc. Wash. Ac. Sci., II, March 30, 1900, pp. 31-38. [This paper contains a description of *M. portoricensis*, the type of which came from a cave near Bayamon.]

The investigations extended over 45 days, but included only about 38 days of actual work. Though this period was brief, the results are very satisfactory, and the collections obtained show how rich the Porto Rican aquatic fauna is. Naturally, more attention was given to the fishes than to any other group; nevertheless, the collections along other lines, particularly with the mollusks and crustaceans, have proved exceedingly rich and valuable. At this writing the reports upon the collections in all the groups are not sufficiently advanced to enable a definite statement to be made as to the actual number of species obtained in each group, or the number of new genera and species in each, but it is known that the percentage of new forms in most of the groups is quite high. It must be remembered, however, that the brief time devoted to making the collections and the extent of territory covered precluded the possibility of their being exhaustive.

Further investigations about Porto Rico will be sure to yield additional interesting results. The places which will furnish the largest number of new and interesting forms are the coral reefs about the island, particularly those at Mayaguez, Guanica, Ponce, Arroyo, and Culebra. Dredging will also prove very rich, although destructive to dredging apparatus.

ACKNOWLEDGMENTS.

It is with pleasure that this opportunity is taken to acknowledge the many favors and courtesies shown us by the Government officials and citizens of Porto Rico during our stay on and about that island. Mention must first be made of Maj. Gen. Guy V. Henry, commanding the Department of Porto Rico, and Brig. Gen. Fred. D. Grant, military governor of the district of San Juan, through whose thoughtful consideration we were brought in touch with other United States officials and with various prominent citizens of the island. Capt. James A. Buchanan, collector of customs, gave invaluable assistance to Mr. Wilcox in securing the statistics of the import trade in fishery products. Many kindnesses were received from postmasters at the various places visited, particularly from Mr. Walter Landis, of San Juan. The officers of the United States Army in Porto Rico extended to us every courtesy in their power, and we must make especial mention of Capts. S. Keynolds White and Charles G. Stevenson, of the Forty-seventh Regiment New York Volunteer Infantry, and Lieuts. Matthew G. Addison and Charles M. Leach, of the same regiment, who during our stay at Caguas kindly shared their quarters with us and did everything in their power to make our visit at that place pleasant and profitable. Similar courtesies were shown us by Capt. R. A. Marshall, of the same regiment, stationed at Carolina, where we were also under obligations for most hospitable entertainment at the home of Señor José V. Berrios.

To Lieutenant Foster, of the Nineteenth Infantry, stationed at Ponce, we are under very great obligations for placing an ambulance at our disposal for a trip over the military road from Ponce to Cayey and Arroyo. A similar kindness was shown us by Lieutenant Wright, of the Nineteenth Infantry, stationed at Guanica, in furnishing us conveyance from that place to Yauco.

To Capt. Arthur C. Hansard, of Hacienda La Perla; Señor Don Luis Gonzalez, of Luquillo; Señor Augustini, of Hacienda Catalina; Señor Don Antonio Bianchi, of Añasco; Señor Pablo McAllister, of Hacienda Romana, near Guaniquilla; Dr. A. Stahl, of Bayamon, and Señor Don Ignacio G. Vidal, of Puerto Real, we are indebted for

many favors. Captain Hansard and Señors Gonzalez and Augustini gave valuable assistance during our trip to El Yunque Mountain. Señors Bianchi and McAllister placed us under many obligations while at Mayaguez and Ensenada del Boqueron. At Puerto Real, Señor Vidal gave us valuable information regarding the fishes and fisheries of that place; and to Dr. Stahl we are indebted for much interesting information concerning the natural history of the island. Captain Mansfield and Señor Susano Bocanegra, the official interpreter at Aguadilla, did us good service, and we received various kindnesses from Señor Nicholas Molinari, of Isabel Segunda; Señors Miguel Ramirez, Ricardo Amado Fariña, and Guillermo R. Scamaroni, of Culebra, and Señors Francisco Trinidad and Emile Just, of Rio Grande.

Mr. Oscar Riddle, teacher of zoology in the Model and Training School of San Juan, furnished valuable information concerning the fishes of the San Juan market, and Dr. W. C. Kendall, of the U. S. Fish Commission, rendered important service during the study of the collections. Dr. J. D. Milligan, the ship's pharmacist, assisted Mr. Baker in collecting the birds of the island, and through his untiring efforts specimens of the Porto Rican parrot and other rare species were added to the collection.

For the Puertorriqueños as a people we have only words of praise. Wherever we went we received from them the most kind and cordial treatment.

GEOGRAPHICAL FEATURES OF PORTO RICO.

POSITION AND SIZE.

Porto Rico is the most easterly and the smallest of the Greater Antilles. It lies between $65^{\circ} 16'$ and $67^{\circ} 16'$ west longitude and $17^{\circ} 54'$ and $18^{\circ} 31'$ north latitude; that is, about 1,500 miles south of Maine and 600 miles east of Washington. It is in the same latitude as Haiti, Jamaica, Guatemala, Bombay, and the northern end of the Philippines. It is 1,500 miles from New York, 1,300 from Norfolk, or 1,000 from Key West. It is about 95 miles long and 35 miles wide, and its area is in round numbers 3,600 square miles, or about three times the size of Rhode Island, or one-tenth that of Indiana. The coast line is about 360 miles, which is 1 mile for every 10 square miles of area. It is quite regular in form, the long diameter being east and west, and the north and south shore lines are approximately parallel. The shore lines at the east and west ends are less regular. The northern coast extends east and west in a comparatively straight line.

HARBORS.

The only harbor on the north side of the island is that of San Juan, which is partly surrounded by mangrove swamps and is protected at its mouth by Cabras and Cabritas islets and some dangerous banks. There is an anchorage off Arecibo, which is safe, however, only in favorable weather. On the northwest and west are anchorages or coves at Aguadilla, Rincon, Añasco, Mayaguez, Puerto Real de Cabo Rojo, and Ensenada del Boqueron. The broad bay at Aguadilla is formed by Capes Borinquen and San Francisco. The cove at Rincon is shallow, and protected only by Cape San Francisco on the north. That at Añasco is a somewhat deeper indentation, protected, however, only at the north by Punta de la Cadena. The harbor at

Mayaguez, lying between Punta de Algarrobo and Punta de Guanajibo, is scarcely more than an open roadstead and affords safe anchorage only during the favorable season. Puerto Real de Cabo Rojo and Ensenada del Boqueron also have safe anchorage only when the winds are favorable. The south coast has a larger number of bays or other indentations, but the only harbors which vessels of regular draft can enter are Guanica, Ponce, and Jobos. Guanica Bay is a spacious basin, completely landlocked, and with adequate depth of water. The entrance to this beautiful harbor is only about 100 yards wide, with high hills on either side. The large bay at Ponce is simply a broad, open roadstead. Jobos Harbor, some 35 miles east of Ponce, has recently been found by the U. S. Coast and Geodetic Survey to possess a good depth of water and to be exceptionally well protected. Arroyo, the port of Guayama, has a fairly safe roadstead. At the east end of the island is a pretty safe harbor inside of Punta Lima and Cayo Santiago, near Hucareš and Punta de Santiago, the ports, respectively, of Naguabo and Humacao. A similar harbor is found at Puerto de Fajardo, between Punta de Mata Redonda and Cabeza de San Juan.

COASTS.

The northern shore of Porto Rico rises nearly everywhere abruptly from the sea, with very little beach anywhere. There is but a narrow strip of shallow water, and less than 100 miles offshore is the Brownson Deep, one of the deepest holes in the world, where soundings of 4,561 fathoms have been taken. This coast is also remarkably free from fringing islets. The east and west ends of the island are lower and have considerable stretches of sandy or gravelly beach, with an occasional mangrove swamp and a few small islets fringing the shore. The south coast is nearly everywhere low, with long reaches of sandy beach and mangrove swamp. This shore, as well as portions of the east and west shores, is fringed throughout much of its length by beautiful coral reefs composed chiefly of fan, stag-horn, and brain corals. The small keys along the coast are also often surrounded on one or more sides by coral reefs.

TOPOGRAPHY.

Viewed from the sea, as one approaches Porto Rico from the north, the scene is one of very great beauty. The island appears as a great mass of remarkably rough, irregular mountains, rising abruptly from a narrow coastal plain, and in many places astonishingly steep. Seen from the north these mountains are steep, but beautifully rounded and covered to their summits with rich green vegetation. As seen from the south the slopes are longer, the individual peaks less numerous, and the vegetation not so luxuriant. As has been well said by Mr. Robert T. Hill—

There is little regularity in the arrangement of these mountains; there is no definite crest line, but the peaks rise from a general mass, whose sloping sides are deeply corrugated by drainage ways. Their surface has been etched by erosion into innumerable gabled lateral ridges (or cuchillas), separated by deep V-shaped gorges. * * * The main range of mountains extends from Mayaguez through Adjuntas and Aibonito to Humacao on the east. This is the Cordillera Central west of Aibonito and the Sierra de Cayey east of that place. Near the center of the island a range¹ bifurcates from the main line and runs to the northeast as the Sierra Luquillo.

¹This range contains El Yunque, the highest peak on the island. Its height probably does not exceed 3,300 feet, and the summits elsewhere seldom exceed 2,000 or 2,800 feet.

GEOLOGY.

Mr. Robert T. Hill gives the following account of the island:

Porto Rico consists of three geologic elements: (1) A central system of deeply ribbed and corrugated mountains, with V-shaped gorges and ridges; (2) lower hills, forming irregular bands along the north and south coast; (3) playa plains, consisting of alluvial soil, occupying old reclaimed estuaries, which extend from the foot of the central mountains across the line of foothills to the seashore. It is roughly estimated that nine-tenths of the island is of the mountainous character, and that the remaining tenth is of the foothill and playa character. The central mountains are composed of water-sorted volcanic ejecta—tufas and conglomerates—with occasional dikes and masses of interbedded subcrystalline bluish limestone of rare or exceptional occurrence, all of which is entirely decayed at the surface, breaking down into red clay resembling that of the southern Appalachians. The dikes are of hard, black, igneous rock, with small white porphyritic crystals. In the east the substructure is said to be granites, especially syenites. In Naguabo and in Mayaguez some serpentine rocks have been observed. The foothills are composed exclusively of rocks of sea origin, consisting of the peculiar type of tropical white limestones, of a loose-textured, chalky, marly, and shelly nature, of various degrees of induration. The rocks of the central mountain region are of Cretaceous and possibly early Eocene age; at least, no evidence tending to establish other dates for their formation has been as yet discovered. The white limestones of the coastal hills are all of later Tertiary and Pleistocene age. The playa deposits are alluvial formations, consisting usually of a rich, chocolate-colored, sandy loam.

CLIMATE.

Porto Rico is well within the torrid zone, but, lying toward the eastern limits of the Greater Antilles, its climate is favorably modified by the prevailing winds and rendered far more agreeable than in any other island of the West Indies. The trade winds, modified by the high mountains of the interior of the island, give it not only a moderate temperature, but they cause the peculiar distribution of precipitation which characterizes it. Though the area of the island is small, nevertheless the extremes of climate, particularly the rainfall, are very great. The annual precipitation on the southern coast seems to be only about 20 inches, while on the northern side it ranges from 55 to 123 inches. It is even said that there is an authentic record for 13 months, chiefly in 1893, when not an inch of rain fell at Guayama, and the records at Cabo Rojo show one period of three years when no rain fell. This difference in precipitation between the north and south sides of the island is shown by the character of the beds of the streams, those of the south being more dry and full of rocks and bowlders.

In the following tables are given certain meteorological data for seven places in Porto Rico, compiled from the reports of the United States Weather Bureau.

Climatological data for year ending April 30, 1900.

Locality and month.	Temperature.					Precipitation.			Sky.			Prevailing direction of wind.
	Mean.	High-est.	Date of high-est.	Low-est.	Date of low-est.	Total.	Greatest in 24 hours.	No. of rainy days.	No. of clear days.	No. of partly clear days.	No. of cloudy days.	
<i>San Juan:</i>	°F.	°F.		°F.		<i>Inches.</i>	<i>Inches.</i>					
May	78.7	89	3	68	1	2.59	0.85	12	11	18	2	SE.
June	79.4	91	22	71	6	7.23	1.42	28	7	17	6	E.
July	79.7	87	2	70	8	7.53	3.60	22	11	16	4	E.
August	80	88	29	71	20	10.38	5.63	19	14	12	5	E.
September	80.6	91	11	71	30	13.66	3.76	20	13	11	6	SE.
October	79.5	90	10	68	1	10.21	2.73	20	6	12	13	SE.
November	78.8	88	29	70	19	11.81	2.57	16	11	14	5	SE.
December	76	88	2	65	26	2.10	.49	10	18	11	2	NE.
January	75.6	86	1	68	15	3.93	.75	21	13	18	0	E.
February	75.7	86	25	66	19	2.13	.70	13	12	15	1	E.
March	75.8	89	31	67	7	1.57	.71	11	11	14	16	E.
April	77.5	93	25	68	8	5.92?	1.91	19	11	17	2	E.

Climatological data for year ending April 30, 1900—Continued.

Locality and month.	Temperature.					Precipitation.			Sky.			Prevailing direction of wind.
	Mean.	High-est.	Date of high-est.	Low-est.	Date of low-est.	Total.	Greatest in 24 hours.	No. of rainy days.	No. of clear days.	No. of partly clear days.	No. of cloudy days.	
<i>Caguas:</i>	°F.	°F.		°F.		Inches.	Inches.					
May	79	93	20	62	1	1.70	0.80	16	19	6	6	E.
June	79	95	2	65	1-4	6.93	1.30	25	19	6	5	E.
July	79.8	93	*23	63	8	8.47	1.60	23	6	8	16	E.
August												E.
September	80.7	89	*2	70	*1	3.21	.97	21	16	6	8	E.
October	77.8	90	*21	64	*3	9.36	2	21	0	16	15	NE.
November	77.4	89	*18	64	1	4.85	.95	20				E.
December	72.5	89	1	55	30	1.50	.33	13	21	4	6	E.
January	72.4	89	6	59	1	1.59	.30	13				
February	73.3	89	9	59	13	1.62	.40	13	17	0	11	NE.
March	72.3	86	31	58	21	1.01	.28	9	21	10	0	NE.
April	75.6	89	*6	61	8	7.42	7	5	24	2	4	NE.
<i>Aguadilla:</i>												
May	79.8	87	25	72	28	6.48	2	13	12	15	4	
June	80.8	87	*6	75	*1	7.40	1.80	12	4	22	4	W.
July	82	89	23	74	27	4.68	1.30	7	5	23	3	N.
August	80.8	87	6	74	8	†5.35		4	2	5	1	
September												
October	78	86	1	73	13	†8.75	1.70	17	3	8	18	N.
November	77.7	84	*11	73	*2	9.38	2.70	14	15	10	5	NE.
December	75.8	83	1	65	20	2.64	.52	8	15	11	4	NW.
January	†78.6	†91	5	†71	*5	†2.96	†.75	8	17	10	4	NE.
February	78.6	88	27	71	*12	1.32	1	4	21	7	0	NE.
March	78.6	92	28	69	16	.18	.18	1	24	6	1	NE.
April	79.8	88	*27	72	9	5.31	1.52	8	14	13	3	E.
<i>Mayaguez:</i>												
May												
June	†79.6	89	26	66	27	†10.97	2.19	22	1	4	22	NE. SE.
July	78.7	92	*9	68	*8	14.41	2.10	19	5	0	29	SW.
August	78.2	90	*6	67	*3	19.02	8.40	11	5	0	26	NE.
September												
October	82.4	89	*8	73	*1	8.73	1.15	21				SW.
November						3.52	1.20	10	10	10	10	SE.
December	77.6	91	1	62	25	1.04	.50	3	22	5	4	NE.
January	76.6	91	5	63	14	1.49	.48	12	11	12	8	SE.
February	76.4	91	18	63	*2	1.06	.85	5	15	7	6	SE.
March	77.1	93	31	64	*16	1.21	1.12	3	9	19	3	NE.
April	77.9	92	25	62	3	5.44	1.23	15	11	4	15	NE.
<i>Rajardo:</i>												
May	80.4	89	*20	69	31	1.25	0.35	9				
June	80	88	*12	71	*3	5.88	1.55	27	17	8	5	NE.
July	81.6	89	*3	69	28	5.58	1.30	19	21	4	6	NE.
August	82	91	28	72	31	6.21	5	11				
September	81	90	*5	70	30	6.13	1	15				
October	79.1	89	*3	68	10	17.07	4.40	19	17	8	6	
November	78.8	88	27	70	*2	†17.80	5	20	12	12	4	
December	74.9	86	10	60	*25	4.79	.30	5	22	0	0	NE.
January	76.2	85	*4	63	1	4.44	1	18	20	8	3	NE.
February	76.4	86	*26	67	*19	.65	.10	9	23	5	0	NE.
March	76.3	86	2	65	12	2.15	1.40	8	27	3	1	
April	78.6	89	25	65	6	13.77	8.45	16	19	7	4	NE.
<i>Hacienda Perla:</i>												
May	78	89	5	68	7	6.79	1.87	20				
June	78.2	87	21	69	3	11.17	2	30				
July	80.1	95	31	72	*5	10.60	1.74	30				
August	80.8	90	2	73	*1	18.65		21	21	0	10	E.
September	80	88	*13	72	*1	14.98	1.98	27	8	0	22	E.
October	78.9	87	8	72	*3	17.74	4.48	27	15	0	16	E.
November	78.6	88	13	69	*2	29.52	9.30	26	15	0	15	E.
December	74.2	86	*1	63	*24	4.86	1.09	19	20	0	11	E.
January	73.8	85	1	63	9	9.69	1.37	29	5	0	26	E.
February	73.8	84	*7	65	*8	3.17	.63	23	20	0	8	E.
March	74	88	31	63	22	5.36	2.84	20	24	0	7	NE.
April	76.6	89	5	63	*8	23.08	10.70	29	17	4	9	NE.
<i>Vieques:</i>												
May	78.6	91	19-22	68	*3	3.26	1.45	4	27	2	2	SE.
June	79.4	90	16-30	68	15	5.68	1.12	17	18	9	3	SE.
July	78.6	90	5	69	10	6.45	2.30	13	21	7	3	SE.
August	78.4	90	25	59	8	7.03	5.30	11	19	10	2	SE.
September	81.3	93	13	73	22	8.25	1.10	13	13	13	4	SE.
October	81	91	*2	68	*29	10.43	2	10	20	6	5	S.
November	76.8	86	*17	68	*4	16.99	6.26	12	14	8	8	E.
December	75.1	86	*1	62	24	.30	.20	2	28	3	0	E.
January	76.9	89	29	68	*23	6.15	1	15	16	9	6	E.
February	76.2	89	*24	67	*4	3.85	1.70	15	16	8	4	NE.
March	76.4	86	*12	67	*2	2.65	1.45	6	27	2	2	SE.
April	78.4	88	15	69	8	9.78	8	8	8	18	4	SE.

* And other dates.

† Incomplete.

a, b, c, m, r, etc., = 1, 2, 3, 13, 18, etc., days missing from record.

HYDROGRAPHY.

The rivers of Porto Rico are remarkable for their great number, their shortness, the restricted areas of their catchment basins, and the rapid descent which they make from their headwaters in the central mountains to the sea. The precipitation is in most parts of the island very great and, with the multitude of streams, the island is unusually well watered. Moreover,¹ because of the steepness of the slopes, especially on the northern coast, and the impervious character of the clay soil which covers them, the proportion of precipitation which runs off makes these rivers of even larger volume than would otherwise be expected under corresponding conditions. Into the northern ocean flow 12 streams of considerable magnitude; toward the west coast flow 4 of relatively equal size; into the eastern sea flow 5 of less magnitude, and into the southern sea flow 17 of considerable size but comparatively small perennial volume. There are between 1,200 and 1,300 streams and branches of less volume, but yet of sufficient size to have received separate names.

Since the average width of the island is but 35 miles and its extreme length but 95 miles, while its commanding summits range in altitude from 2,800 to 3,300 feet, it is evident that the slopes are steep, the fall of the rivers great, and the velocity of their waters high. Moreover, as the main summits of the dividing mountain ranges have been shown to be one-third nearer the southern and eastern coasts than the northern and western, it is also evident that such streams as flow north and west are three or four times as long and drain ten to fifteen times as great areas as those flowing to the south and east. The former have average lengths of 25 to 40 miles, measured along their stream beds; the latter have lengths of but 5 to 15 miles. For these and reasons already given the streams flowing north and west necessarily have less abrupt slopes than do those which drain eastward and southward, which plunge from an altitude of 3,000 feet to sea-level within a comparatively few miles.

It is thus seen that, as the island is divided climatologically into two distinct portions, it is similarly divided hydrographically, largely as a result of the same causes—the trade winds and the topographic configuration of the surface.

The twenty-eight larger rivers have their sources high among the summits of the Cordillera Central. Those flowing to the north and west are characterized by precipitate descents of 1,000 to 2,000 feet in the first 5 miles of their headwaters. Thereafter they flow more leisurely and with consequent increased size to within 5 miles of the coast. There they emerge practically at sea-level in long meandering curves through the alluvial playas about their mouths. Because of the lowness of their grades near the coast and their resulting low velocity all are of considerable width and moderate depth in the playa levels. A few miles inland, where they flow over steep, rocky beds, their channels are narrow and often confined by precipitous rocky walls, their width is of but comparatively few feet, their depth often less than a foot, and their velocities so high as to render them veritable mountain torrents.

On the southern coast the larger rivers have bed-widths as great as those which enter the northern and western coasts. Their lengths, however, are so short for the

¹ Mr. H. M. Wilson, of the U. S. Geological Survey, made a study of the water resources of Porto Rico in January, 1899, the results of which have been published as "Water-Supply and Irrigation Paper of the U. S. Geological Survey No. 32." We have made free use of this excellent report in our account of the hydrography of the island, sometimes copying literally, without quotation marks.

same fall that they are not characterized by the long stretches of low, meandering grade found near the coast in the playas to the north. They emerge, on the contrary, from the mountains at but 4 to 5 miles from shore line at altitudes of 200 to 400 feet, and as a result this elevation is passed with comparatively steep slopes over rocky or boulder-strewn channels. Above these coastal stretches and within the mountains the lengths of the rivers are so short for the relatively great heights which they fall that their dimensions are little greater than those of the smallest brooks which flow from the hill summits in the Rocky Mountains.

The rivers of the north and of the west are more like the streams of humid regions in the United States, as their perennial discharge is always fairly well maintained. The larger of these rivers have at low-water stage bed-widths of 150 to 200 feet, average depths of 2 to 4 feet, and minimum discharges of 250 to 1,500 second-feet. In time of flood, although these rivers attain maximum discharges of 10,000 to 20,000 second-feet, these volumes are not greatly in excess of the flood discharges of the rivers of the southern slopes.

The width of stream-beds of the southern rivers is often as great as that of those entering the northern coast, but owing to the infrequency and small amount of the precipitation and the relatively porous character of the soil, reducing the percentage of run-off, as well as to the smallness of their catchment basins, they discharge minimum volumes of but 50 to 100 second-feet. These streams resemble the rivers of our Western plains in that their beds are nearly dry the larger part of the year, but they are yet of sufficient capacity to discharge great volumes during the sudden floods to which they are subject. The beds of these rivers, even near the coast, are boulder-strewn and from 100 to 300 feet in width. The depth of their banks is 10 to 20 feet, yet the minimum surface-width of such streams is but 50 to 100 feet and their average depth 0.5 to 1.5 feet during their minimum discharge. In maximum flood such streams reach discharges aggregating 5,000 to 10,000 second-feet, in some cases even more, as shown by their wide, rocky, dry beds.

Though the number of streams and branches which have received names is said to be over 1,200, the number named on the best maps does not exceed 100. On one map 81 streams have received separate names; of these, 43 flow directly into the ocean, while the remaining 38 are tributary to them. Probably not over 50 of the entire number would be called rivers in the United States.

In the mountains the water in most of the streams is usually exceedingly clear, but in the lower portions it is often muddy, although the streams examined by us in January and February were, as a rule, quite clear.

Our opportunities enabled us to examine only a few of the streams and only in the most general way. The following brief descriptions of some of the principal ones examined are based partly upon our own observations and partly upon those of Mr. H. M. Wilson.

Rio Loiza.—This is perhaps the longest river on the island. It has its source well toward the south where the divide is near the southern coast, northeast of Guayama, flows near the towns of San Lorenzo, Caguas, and Carolina, and enters the ocean about 15 miles east of San Juan. At Carolina it is a broad, shallow stream, with sand and gravel bottom and moderately clear water, and when seen by us (February 20) the ford near there was perfectly safe for carriages, the water probably not exceeding 2.5 feet in depth. Mr. Wilson gaged this river near Carolina in January and reports

it as averaging 220 feet wide, 3 feet deep, and having a minimum discharge of 16,000 second-feet. The Rio Loiza was also examined at the hacienda of Señor Nicolas Quinones, about 2 miles to the east of Caguas, where it is a considerable stream, from 40 to 100 feet wide, with a rather swift current. The depth is in most places less than 3 or 4 feet, though there are places of greater depth. There is a good ford at the hacienda. The bed of the stream is in most places of sand or gravel, though some muddy reaches were observed, and rock bottom occurs where the stream cuts against a hill. Usually one of the shores is low, sloping up gradually 2 to 5 feet to a level bottom covered with meadows and fields of tobacco and cane. On the other side the shore rises abruptly into wooded mountains of moderate height. At the hacienda there is low bottom land on each side.

The *Rio Caguitas*, a tributary of the Rio Loiza, is crossed twice by the Caguas-Aguas Buenas road just west of Caguas; it then flows northward and eastward around the town and joins the Rio Loiza near the hacienda of Señor Quinones, the road to which crosses it several times. It was examined throughout most of its length from the Aguas Buenas road to its mouth. It is a rather pretty stream, 30 or 40 feet wide and from a few inches to 3.5 feet deep, with much deeper pools at intervals. The shores are usually of clay, sometimes of gravel, one shore generally high, the other low and spreading away into low level river bottom. The bed of the stream is of sand or mud in the more quiet and deeper reaches and of fine gravel where there is some current. The water appears clear and pure and there is usually a fairly strong current. The flow is estimated at 50 second-feet.

On the gravel bars and along the edges was considerable aquatic vegetation, among which were obtained specimens of 4 fresh-water crustaceans, including a sword-shrimp (*Xiphocaris elongata*), 2 prawns (*Bithynis jamaicensis* and *B. olfersii*, the latter numerous), and a crab (*Epilobocera sinuatifrons*).

The temperature of the water at the Aguas Buenas ford at 11 a. m., January 9, was 71°, when that of the air was 77°.

The *Rio Turabo*, another tributary of the Rio Loiza, was examined by Mr. Wilson where it is crossed by the military road near Caguas, and found to be similar to the Caguitas in character and volume.

Rio Bayamon.—This river was examined in the vicinity of the city of Bayamon, and also at its mouth at Palo Seco. It is a stream of some size, having its headwaters near Cidra, on the north side of the divide between Cayey and Aguas Buenas. It flows nearly north, passing just west of Aguas Buenas and by Bayamon, entering the sea near Palo Seco, about 2 miles from San Juan. At Bayamon it is perhaps 35 to 50 feet in average width, with a depth varying from a few inches to 3 or 4 feet. The current is strong, the low banks are of red clay, and the water is usually more or less muddy. The bottom of the stream is chiefly of tough clay or gravel and clay. At the town of Bayamon is a dam which interferes with the free movement of fish.

Rio Arecibo.—This stream rises in the Cordillera Central about Adjuntas and flows northward to the sea at Arecibo. Near Adjuntas, at an elevation of 1,440 feet, it has a minimum discharge of 40 second-feet. A few miles below, at Utuado, its discharge is 100 second-feet. Lower down it receives as tributaries Rio Don Alonzo, Rio Tanama, and other smaller streams, which greatly increase its size.

Rio Culebrinas.—This is a stream of moderate size, rising between Lares and San Sebastian and flowing westward into the sea just below Aguadilla. Near San Sebas-

tion, at an elevation of 140 feet, it has a bed 125 feet wide, a current of 4 feet per second, and a volume of 100 second-feet. At its mouth it is only about 60 feet wide and has a slow current. The bottom is soft mud and sand.

Rio Añasco.—This is of somewhat larger size, with its headwaters on the divide west of Adjuntas, and enters the sea north of Mayaguez. One of its tributaries, the Rio Yahueca, was examined by Mr. Wilson at an elevation of 1,440 feet, 5 miles west of Adjuntas, where the minimum discharge was 20 second-feet. The Rio Blanco, into which the Yahueca flows, at an elevation of 1,350 feet, about 8 miles west from Adjuntas, has a minimum flow of about 50 second-feet. The Añasco River, at a point about 8 miles above the town of Añasco, at an elevation of 80 feet, has a bed-width of 150 feet, a surface-width of 75 feet, a depth of 1.5 feet, and a volume of about 600 second-feet. Below Añasco this river flows through a level playa and has an easy meandering course, its grade being low and the current slow. Its surface-width here is about 200 feet, the depth 4 to 8 feet, and the flow about 1,000 second-feet.

Rio Yauco.—This small stream rises among the hills north of Yauco and enters the sea near Guayanilla. It was seen near Yauco, where it is only a few yards wide and has a small volume. It is used to some extent for irrigation purposes. ●

Rio Portugues.—This stream at Ponce has a bed-width of 175 feet and a discharge of 60 second-feet. Its total available discharge is much greater, but the major part of it is diverted a few miles above the city for irrigation purposes and for the water-supply of Ponce.

The *Rio Jacaguas*, which is crossed by the military road at Juana Diaz at an elevation of 160 feet, has a width of 180 feet, a minimum surface-width of 50 feet, and a discharge of 50 second-feet. The discharge would be greater, but a portion is used for irrigation purposes above the military road.

Rio Descalabrado.—This is a small stream crossing the military road between Juana Diaz and Coamo, where it has an elevation of 260 feet, a comparatively dry bed 120 feet wide, a 2-foot current, and a discharge of 40 second-feet.

Rio Coamo.—This river has its sources in the Sierra de Cayey and the Cordillera Central south of Aibonito and Barranquitas, and flowing southward, enters the sea east of Ponce. At Coamo the bed of the stream is 360 feet above sea level, and has a bed-width of 100 feet, though its surface-width is somewhat less. Its average depth was about 4 inches and the flow about 100 second-feet.

Rio Guamani.—A small stream rising in the Sierra de Cayey north of Guayama and flowing southward by that town into the sea just east of Jobos Harbor. It is crossed by the military road just west of Guayama, where it is a small creek, a few feet wide and a few inches deep.

Rio Naguabo.—This small river rises on the south slopes of El Yunque and has its mouth near Hucares. Below Naguabo it is sluggish, with mud bottom.

Rio Fajardo.—The Fajardo River rises in the Sierra Luquillo and flows northeast into the sea at Playa de Fajardo. Just south of Fajardo, where it was examined, it flows through a low, level plain, with cané fields on either side. The bed is several yards wide and made up of coarse gravel or larger rocks. Just above the ford the bed was considerably wider than the water surface. The current was about 5 feet per second, and the average depth 2 feet. The water was clear and apparently pure. At its mouth it is deeper and much wider and rather muddy. Its banks are low and

largely of mud, in places overgrown with grass. It is navigable for rowboats for a mile or more above its mouth.

Rio Luquillo.—This stream has its sources on the slopes of El Yunque Mountain and flows northward, entering the sea near the village of Luquillo. Different branches of this river were examined at various places on and about El Yunque, where they are all swift, turbulent mountain streams, full of falls, cascades, rapids, and small but relatively deep pools. The bed is usually of rock and is well covered with bowlders of various sizes. The water was always clear and pure and the maximum temperature February 19 was 69°. There was but little aquatic vegetation visible, but small crustaceans (*Atya scabra* and *Xiphocaris elongata*) were quite common. These streams are doubtless not materially different from other mountain streams of this island, particularly those having their sources in dense shade, such as prevails upon the slopes of El Yunque. Although the amount of water is not great, and there are no long, quiet reaches, there is ordinarily a continuous stream of sufficient volume to permit fishes to pass easily throughout the entire length, barring the impassable falls. The deep pools are often of good size. The relatively low temperature and the character of the water, together with the presence of crustaceans, which would afford a food supply to a limited number of fish, render it probable that the small-mouthed black bass might be introduced into these streams with a fair prospect of becoming established. Indeed, a maximum temperature of 69° would not be unfavorable to the rainbow trout, which we have seen in southern California in small streams very similar to those examined on El Yunque, and whose summer temperature is probably no lower. The experiment of planting the rainbow trout in some of these Porto Rican streams and the small-mouthed black bass in others is well worth trying.

Lagoons of Porto Rico.—There are no real lakes on this island, but near the shore are several lagoons. These are usually narrow and relatively long, separated from the sea by a low, narrow strip of sand and surrounded by a dense fringe of mangrove bushes, which makes it difficult to reach them. Some of them have permanent connection with the sea, while others are connected only during times of heavy rain. The water in most of them is strongly brackish or salt, while in a few it is relatively fresh. The fishes frequenting these lagoons are chiefly mullets and snooks ("liza" and "robalo"). The principal lagoons are Tortuguero and Caña Tiburones near Barceloneta, and Guanica and Flamencos near Guanica.

LOCAL INVESTIGATIONS.

When the *Fish Hawk* was assigned to the Porto Rican investigations, it was understood that she would have to return to the United States early in the spring to engage in shad-hatching operations on the North Carolina coast. In order, therefore, to accomplish as much as possible, it was arranged to carry on synchronously four lines of work whenever possible.

1. A party usually consisting of Professor Evermann and Mr. Wilson, assisted by four to six men of the ship's crew, with the steam launch, a flatboat, seines, and other apparatus, would do collecting along the shore, particularly in those places where seining could be done.

2. Another party under Mr. Marsh (sometimes assisted by Mr. Wilson) and four to six sailors using the oil launch would do collecting on the reefs, paying particular attention to the invertebrates.

3. Mr. Wilcox devoted his time to the statistical inquiry, visiting the customs officials, the dealers, and the fishermen. The records in the custom-houses were critically examined as to the extent and character of the trade in fishery products with other countries; the dealers were interviewed, the fishermen were visited, and the methods of the fisheries investigated.

4. Whenever the weather permitted, the *Fish Hawk* was engaged in using the beam trawl or dredge, and in making soundings. This work was under the immediate direction of Dr. Moore, assisted by Dr. J. D. Milligan, the ship's pharmacist.

By adhering as strictly as possible to this general plan a greater amount of work was accomplished than would otherwise have been possible. It frequently happened that one or more of these lines of work was interrupted from one cause or another; and the dredging operations especially, on account of unfavorable weather, the breaking of apparatus, and other causes, were not altogether satisfactory.

The *Fish Hawk* reached San Juan Harbor on the morning of January 2, and preparations were at once begun for field work. During the afternoon of the 2d and the morning of the next day observations were made along the shore of the harbor and on the seaside of the little island upon which San Juan is built, and in the afternoon of the 3d the first collecting was done. With the cutter, Messrs. Evermann, Moore, Marsh, and Wilson went to the head of the harbor, then up Martin Peña Inlet some 4 miles to beyond the railroad bridge and the military road. This inlet is from 30 to 150 feet wide, 2 to 10 feet deep, and extends through low-tide flats covered with a dense growth of low mangrove bushes. The water was more or less stained with vegetable juices and the bottom was usually of black mud or mixed mud and broken shells. The only fishes seen were a few young mullets. Beginning a few rods above the mouth of the inlet and continuing well toward the railroad bridge we found the mangrove stems thickly covered with the shells of the small native oyster (a form of *Ostrea virginica*). The majority of these shells were alive, though many, particularly those highest on the stems, were dead. On these stems we also found many small barnacles, an occasional *Mytilus caustus*, and groups of bryozoans, and among the stems were a good many small crabs and an occasional individual of a larger species with red back and white claws (*Goniopsis cruentata*).

At one place on this inlet the low ground or mangrove swamp is quite narrow on the south side and a considerable hill of cherty limestone rises from near the water's edge. In this hill are three or four small caves in which a few bats were found, apparently all of one species, probably *Artibeus perspicillatus*.

During the subsequent days spent at San Juan other trips were made up this inlet and the boat dredge was used at several places. The bottom, however, proved quite barren, and very little life of any kind was found. Fishes were extremely rare and mollusks and crustaceans were scarcely less so. Among the mangroves several specimens of water birds were seen, the kingfisher (*Ceryle alcyon*), brown pelican (*Pelecanus fuscus*), great blue heron (*Ardea herodias*), little blue heron (*Ardea cœrulea*), little green heron (*Ardea virescens*), a species of rail and a sandpiper. On the shore a number of land birds were seen, among them the American redstart (*Setophaga ruticilla*), a fly-catcher called *pitirre* by the natives (*Tyrannus dominicensis*), summer yellow-bird (*Dendroica petechia ruficapilla*), a vireo (*Vireo calidris*), and several others which we did not know and of which no specimens were obtained.

San Antonio Bridge.—At its east end the little island upon which San Juan is built is connected with the mainland by the bridge of San Antonio, which crosses the San Antonio Channel. Several trips were made to the vicinity of this bridge and the shores of the channel just east of it proved to be excellent collecting-ground. At the north end the bottom is of clean, compact sand, with patches of algæ, and the depth soon increases to a fathom or more, while the south shore has a bottom of sand and mud and the depth increases less rapidly. The seine could be operated very well except on the south side, where it would occasionally fill up with mud.

Palo Seco.—Across the bay from San Juan, at the mouth of the Bayamon River, is the little fishing village of Palo Seco. The fishing-grounds are in the river near its mouth, where the water is almost fresh, though dirty from the muddy bottom and débris. The commercial fishing here is principally with gill nets set across the mouth of the river. These are used chiefly for "liza" (mullet). Seines and cast nets are also used to some extent, the principal species taken in the former being "sardina" (*Opisthonema oglinum*), *Carana hippos*, *Hyporhamphus unifasciatus*, *Oligoplites saurus*, *Polydactylus virginicus*, *Selene vomer*, *Trachinotus*, *Spheroides Gobiesox*, and *Lobotes surinamensis*. The species taken in cast nets were "mojarra" (*Gerres lineatus*) and mullet.

Cataño.—Across the bay, southwest from San Juan, is Cataño, a small village, the shore terminus of the railroad leading to Bayamon, where some fishing is carried on. The shore between this place and Palo Seco is sandy and the depth of water increases moderately. This shore was not particularly good as a collecting-ground, though some species were secured which had not been taken before.

Seashore near San Juan.—The seashore or wall of the little island upon which San Juan is built was examined throughout its entire length, from Morro Castle to Escambron Point and on around to Fort San Geronimo. This coast is chiefly a high, rocky wall, upon which the waves and breakers are constantly thundering. In a few places, chiefly toward the east end, are tide-pools in which, at the proper stage, some small fishes can be found—principally mariposas (*Eupomacentrus* and *Abudefduf*) and gobies. In the little cove between Escambron Point and Fort San Geronimo is a short stretch of sandy beach, the depth increasing moderately and the bottom with a liberal supply of algæ, where fair collecting can be had.

San Geronimo.—The shore between Fort San Geronimo and San Antonio Bridge is also good collecting-ground. This locality was visited frequently by Mr. George M. Gray, of Woods Hole, Mass., during the winter of 1899–1900, and a collection of about 37 species of fishes obtained. Mr. Gray has kindly permitted us to examine his collection and to include the species in the present report. All specimens credited in this paper to San Geronimo belong in the collection made by Mr. Gray.

San Juan market.—During our stay at San Juan (January 2 to 17) it was our custom to visit the San Juan market every morning to learn what species of fishes were handled there, the relative abundance of each, the methods of handling the fish, and the price at which each was sold. Market here, as well as elsewhere in Porto Rico, begins very early in the morning and is practically over by 7 or 8 o'clock. It was therefore necessary to reach the market as early as possible to see the fish stalls at their best. A large number of food-fishes were seen and many valuable specimens were obtained. During the winter of 1899–1900 Mr. Oscar Riddle, in charge of the biological work in the Model and Training School at San Juan, made frequent visits

to this market. His excellent training as a naturalist and knowledge of ichthyology enabled him to study critically the fishes found and to gather a large amount of interesting and important information concerning them. He has very kindly furnished us a report embracing the results of his observations and inquiries, and we desire in this place to express to him our deep appreciation of his intelligent interest in this matter and our thanks for the valuable information we have thus obtained. This information will be found in the chapter dealing with the commercial fishes.

Caguas.—While at San Juan a trip was made to Caguas, on the military road, 25 miles (36 kilometers) south from San Juan and near the center of the island from north to south. This place has an elevation of 246 feet above sea-level, and lies in a beautiful valley surrounded by hills of moderate height. The Rio Caguitas flows northward just west of the town, then turns eastward and, after a tortuous course of about 2 miles, flows into the Rio Loiza, near the hacienda of Señor Nicolas Quinones. The seining of this stream was quite satisfactory. Though fishes of considerable size were rare, young fishes were fairly abundant, the following species being represented: *Awaous taiasica*, *Agonostomus monticola*, and *Sicydium caguita*. A small shrimp (*Bithynis olfersii*) was very abundant, especially among weeds growing in the water's edge, where the bottom was somewhat muddy. A much larger shrimp, possibly the same species, and a sword shrimp were found in some numbers. Only a single species of water plant, probably *Myriophyllum*, was found in a few places.

The Rio Loiza was examined just above the mouth of the Rio Caguitas, 2 miles northeast of Caguas, where it is 75 to 100 feet wide and 1 to 7 feet deep. One shore is usually low, while the other may be high, rising abruptly into wooded hills. At the hacienda is a ford, and both shores are low. Seining was not very satisfactory. A great many young of the "dajao" (*Agonostomus monticola*) were caught, and a few small gobies were seen. We were told that good-sized examples of "dajao" and "guavina" occur here, and eels are caught in the "nasa," as explained elsewhere. The same crustaceans and mollusks were found here as in the Rio Caguitas.

Bayamon River.—One visit was made to the town of Bayamon, about 6 miles south of San Juan; and the Bayamon River examined near the town, where it is a stream of some size, flowing through a level plain and with red clay banks 2 to 10 feet high. The water was roily from recent rains and somewhat above low-water stage. The river contained considerable aquatic vegetation. At first the seine was hauled downstream in the usual way over the riffles, through the deep holes and through various inviting places, but scarcely anything was caught. Then it occurred to us to see if the fish might not be hiding in the holes under the banks. The seine was stretched lengthwise of the stream parallel with the bank and a few feet from it, and then pulled through the water and up against the bank. Then with sticks we prodded in the holes under the bank to scare out any fishes that might be hiding there, and on lifting the seine we found it usually well filled with moron, guavina, ciaga, dajao, anguilla, camaron, etc. Similar experience was had at Caguas in the Rio Caguitas and the Rio Loiza. Evidently the fresh-water fishes and crustaceans of these rivers have been able to protect themselves from being carried out to sea during high water by occupying protected places in the banks, and this has now become a habit with them. This habit is discussed at length in another portion of this report.

Arecibo.—The *Fish Hawk* did not make any stop at Arecibo, but Professor Evermann and Mr. Wilcox visited it by rail from San Juan. Considerable commercial

fishing seems to be carried on here, chiefly in the mouth of the Rio Grande de Arecibo and along the beach in front of the city. No collecting was done here by us, but a few species were obtained from the local fishermen, among them *Elops saurus*, *Awaia thazard*, *Vomer gabonensis*, *Conodon nobilis*, and *Micropogon furnieri*.

Aguadilla.—The *Fish Hawk* spent but one day (January 18) at this place, dredging in the harbor (stations 6055 and 6056), while two shore parties did seining and other collecting at various places near the town, between Punta Borinquen and the mouth of Rio Culebrinas. Just above the town the shore is very rocky and abrupt. There is no beach, and it is possible to get along only by crawling among or over the large and wave-worn rock masses rising abruptly from water several feet deep and upon which the waves are constantly dashing. These rocks were thickly covered with several species of small gasteropods (chiefly *Nerita peleronta* and related species) and a large species of Chiton.

In the bay in front of the town the water increases in depth quite rapidly, so that the use of small collecting seines (50 to 150 feet long) was not very satisfactory. The beach, however, is sandy, and the seines were hauled with fair success. Farther down the beach the depth increased more gradually and the seine collecting was somewhat more satisfactory. Opposite the Columbus monument (marking the spot where Columbus is supposed to have landed November 17, 1493) the surf was too strong and successful collecting could not be done; but nearer the town were found some shoals covered with algæ and other vegetation, where fishes and crustaceans were fairly abundant and good collecting was had, though considerable annoyance was caused by the seine persistently catching on the rocks. A number of food-fishes were obtained from the native fishermen, and on a visit which Mr. Marsh made to Aguadilla by rail from Mayaguez, on January 22, several additional species were obtained.

Mayaguez.—Mayaguez Harbor proved to be an excellent collecting-ground, and all four lines of investigation were carried on successfully each day during the stay at this place (January 19 to 23). The vessel made dredging stations 6057 to 6071, and two shore parties were usually at work. Various good collecting-grounds were found. Perhaps the best was about the mouth of a little creek just above the playa and on and about the coral reefs in the same neighborhood. Here the bottom was of sand, well covered with algæ in many places, and the depth increased only moderately. Some of the most interesting fishes were seined here, among them being species of *Antennarius*, *Eupomacentrus*, *Chaetodon*, etc.

The coral reefs here proved exceedingly interesting. They were made up chiefly of fan coral (*Isopora muricata palmata*) and the stag-horn coral (*Isopora muricata*), with which were mixed a good many heads of one of the brain corals (*Platygyra viridis*) and patches of *Pterogorgia acerosa* and *Rhipidogorgia flabellum*, whose long, brightly colored branches, swaying back and forth by the waves, presented a very beautiful scene. In a few places small masses of coral were exposed as the waves receded at low tide, and upon these the brown pelicans would rest; but usually the broad sheets of the fan coral spread out from a few inches to 4 or 5 feet beneath the surface of the water and were never exposed. These sheets were often very broad and very beautiful when observed through 1 to 3 feet of clear, quiet water. Walking about over these reefs was a somewhat hazardous undertaking; the edges of the thin sheets would always break when stepped upon and not infrequently the entire blade would break away, precipitating the investigator among a mass of coral.

blades with sharp or jagged edges, which would cut or lacerate one's legs and hands in the most painful manner. Then most of these species, at least *Millepora alcornis*, *Pterogorgia acerosa* and *Rhipidogorgia flabellum*, have the sting-cells well developed and render one's condition still more uncomfortable. Swimming about in the open places among the corals, hiding under the spreading blades, and resting quietly in the nooks and corners everywhere, gaily colored fishes could be seen. The most abundant was perhaps *Abudefduf saxatilis*, called "mariposa" by the natives; tangs, cockeye pilots, blennies, the young of several snappers (*Neomænis synagris*, *N. analis*) yellow-tails, parrot-fishes, and scorpænas were also noticed.

Among those coral masses, covered more or less with algæ, were found a good many crustaceans, and down in the interstices were star-fishes and sea-urchins. The most abundant urchin was an exceedingly long-spined species (*Diadema*), the wound from whose spines is very painful. Very few mollusks were found among these corals, but in the shallow water nearer the shore, in the sand, or among the masses of *Porites*, shells were fairly abundant, though the species represented were few. Decidedly the most abundant was a little *Donax*, which was common just at the water's edge, and, as the waves receded, numbers could be seen hurriedly burrowing themselves in the sand. So quickly would they disappear that it would require prompt action to dig them out before the coming of another wave.

Another good seining-ground was on the sandy beach up the coast for a mile or more above the reef and toward Punta del Algarrobo, in front of a large cocoanut grove which extends along near the shore for considerable distance. The water increased in depth moderately, the bottom was of sand covered with a liberal growth of algæ, and fishes, crustaceans, mollusks, sea-urchins, sea-cucumbers, etc., were reasonably abundant. The most common fishes were the smaller scaroids, such as *Sparisoma vyzrodon*, *S. niphobles*, *S. hoplomystax*, *S. flavescens*, and *Scarus croicensis*. The short-spined white sea-urchin (*Toxopneustes variegatus*) was abundant, as was also the large sea-cucumber (*Holothuria surinamensis*).

Considerable work was done with the boat dredge in Mayaguez Bay. The larger part of the bay was covered, but the only dredging-grounds of value were between the coral reefs already described and Punta del Algarrobo. The southern part of the harbor was dead bottom and almost completely barren. The principal objects obtained with the boat dredge were many small crustaceans, including several species of crabs not obtained before, five or six species of sea-urchins, and a few mollusks.

The dredging in this vicinity was somewhat more satisfactory, and some of the stations were particularly rich, especially in bivalves. One station which proved exceedingly rich is No. 6062. The dredge was hauled here in 25 to 30 fathoms over bottom composed of mud, sand, and shells and in about 3 pints of material saved more than 100 species of mollusks were represented.

Puerto Real de Cabo Rojo.—This small bay and vicinity proved very good collecting-ground. The best, perhaps, was along the south side of the small bay, near the cocoanut grove of Señor Don Ignacio G. Vidal. The bay here was well supplied with algæ, the bottom was usually suitable, and fishes were abundant. Much of the shore in this vicinity is covered with mangrove bushes, and it is here that the largest and best oysters are obtained. It was learned that some oysters are occasionally gathered here for the market at Mayaguez and perhaps other towns of the island.

At this place we found fishing boats with live-wells, after the manner of those in common use at Key West. By eliciting the interest of these fishermen we were able to obtain excellent specimens of many important food-fishes, among them several species not previously secured. These fish had been caught chiefly in the basket traps; a few were taken with hand line.

The spade-fish (*Chatodipterus faber*) was seined here in large numbers.

Ensenada del Boqueron.—This open bay is only a few miles south of Puerto Real. Our work on this coast covered practically the entire shore from Puerto Real to Los Morillos de Cabo Rojo at the extreme southwest corner of the island. Just below Puerto Real is a rocky and abrupt section of the shore terminating in Punta de Guanaquilla, a rocky point several feet high, at the north side of Ensenada del Boqueron. The entrance to this bay is quite wide, and as but little protection is afforded, the surf is usually heavy. Much of this shore, however, is good collecting-ground. The best place is perhaps on the north side near the Hacienda Romana of Señor Don Pablo McAllister. Dredging stations 6072–6078 were made off this coast.

Guanica.—Parts of two days (January 28 and 29) were spent at this place. Guanica Bay is one of the best protected harbors in Porto Rico. Inside the harbor the shores are in most places of compact sand over which seines can be drawn without difficulty. At the upper end the water is shallow and vegetation is abundant. In places the bottom is somewhat muddy, but not sufficiently to make shore collecting impossible. Animal life, however, was unexpectedly rare in this part of the bay. On the northeast side of the harbor more fishes were found, but the bottom was rocky in places, which made it difficult to make successful hauls. Specimens of *Chilomycterus* and *Monacanthus* that had not been seen elsewhere were obtained here. Just outside the harbor, on the west side, is a coral reef which was particularly rich in crustaceans, annelids, and other invertebrates. No dredging was done at this place.

Ponce.—The harbor at Ponce is merely an open roadstead, and during our stay there (January 30 to February 2) the water was too rough for satisfactory collecting, except during the early part of the day or in particularly well-protected situations. The places visited were the shore and three small islands westward from the playa and the reef about the Cardona Island light-house, all of which proved exceptionally rich in fishes, mollusks, and crustaceans. A number of new and interesting species of each group were obtained. The shore westward from the playa is of compact sand, and seining can be carried on fairly well as far out as the little islands about Punta de las Cucharas. These islands are low, but dry. About some of them are a few clumps of mangrove. About a very small, naked sand island excellent collecting-ground was found, and here the type of *Doratonotus decoris*, a new and interesting species of labroid fish, was found among the algæ. An old coral reef here also afforded many interesting species. The reef at Cardona Island was visited frequently and proved unusually rich in new and interesting forms, among them three new species and two new genera of fishes (*Gillias jordani*, *Coralliozetus cardonæ*, and *Auchenopterus cingulatus*). No dredging was done by the ship at this place.

Arroyo.—The surf here was too heavy for seining, but the reef at Punta de las Figuras yielded considerable interesting material, and was particularly rich in crustaceans. Other parts of the reef were examined, but proved not so productive as the region near the light-house. Considerable commercial fishing is done at Arroyo, chiefly with basket traps, though haul seines, hand lines, and cast nets are also used; and from

fishermen several valuable specimens were obtained, among them being some species of fishes new to the collection. The ship did not do any dredging about Arroyo.

Vieques Island.—The entire north coast of this island is without bays or harbors, and is so exposed that a heavy surf is constantly beating from one end of the island to the other, rendering collecting practically impossible. The south side has four or five well-protected bays and would doubtless prove a rich and interesting collecting-ground. Along the north shore, near Isabel Segunda, the principal town on the island, a few hauls with the seine secured several species of fishes; and in a little creek west of the town some brackish-water species were taken, including young mullet (*Mugil curema*), *Guavina guavina*, robalo (*Centropomus undecimalis*), and hog-choker (*Achirus lineatus*). Specimens of several food-fishes were obtained from the fishermen, and a few other species were collected on the reef near the town.

Dr. Moore visited El Caballo Blanco, a small shoal about 1.5 miles northwest from the town, where he made valuable collections of invertebrates.

Culebra Island.—The shore collecting about this little island was chiefly inside Ensenada Honda and along the neighboring shores outside. This harbor is one of the best as well as one of the prettiest found in Porto Rico, or any of the outlying islands. It is commodious, the depth is sufficient for large vessels, the entrance is very narrow, and it is surrounded by high, picturesque hills. The shores of this bay are usually high and there is little or no mangrove. In most places the depth increases slowly, the bottom is usually well covered with algæ, and there are no rocks which interfere with seining. The place is therefore quite suitable for this kind of collecting, and a good number of desirable specimens was obtained.

Just across the neck of land forming the southwest side of the harbor is an indentation in the coast called "Seine Bay" by the Tortola fishermen. Here the coast sweeps around in a broad, gentle curve with a long beach of clean, compact white sand, which was found to be an excellent seining-ground. In one part of the bay the water is quite shallow, and a considerable area is covered with small masses of dead coral, under and about which many small but interesting fishes were found. By first surrounding one of these masses with a light seine and then lifting the coral mass out of the way, the fishes, crabs, etc., hiding under it could usually be captured. Seining was also successful in several naked open areas or deeper pools, free from vegetation, and with clean, white, sand bottom, in which various species of fishes were seen. The most conspicuous fishes in the pools and about the coral masses were cockeye pilots (*Eupomacentrus* and *Abudefduf*), young snappers, and young mojarras, while under the rocks various species of blennies would be found. Certain species of starfishes and sea-urchins were also common.

Brown pelicans were quite abundant here, as also on the reefs at Mayaguez and Guanica, feeding upon "sardinas" and such other fishes as they could catch.

At the lower or southeast end of this cove a high, rocky point comes down to the water. The shore is very rocky and a rich, live reef comes close in. Attempts were made to collect on this reef, but the surf was too high and little could be done.

The region off this side of Culebra Island is one of the principal fishing-grounds visited by the fishermen from Tortola, St. Thomas, and Santa Cruz. These fishermen make the bulk of their catch in the pots or basket traps. These are usually baited with white chunks of cactus pulp, which probably serve simply as a decoy, and set in 5 to 8 fathoms of water. Each pot has usually three buoys, fastened to it by long,

plaited bark or wooden ropes. The principal fishes seen in these pots at the time of our visit (February 7 to 12) were tangs, hog-fish, black grouper, and white grunt.

On the neck of land separating this cove from the harbor is a small lagoon of nearly fresh water, entirely surrounded by such a dense border of mangroves that it was impossible to do any seining in it. Such an examination as could be made did not show that the lagoon contained any fish. About it were seen a few coots, ducks, fishhawks, and kingfishers, as well as various species of land birds.

The reef on each side of the entrance to the harbor was found to be the richest in species of any we visited. Not only were mollusks, crustaceans, annelids, and many other groups well represented, but many species of fishes were found, including several undescribed forms. That portion of the reef east of the entrance was particularly interesting, and the corals there were unusually fine. Our best specimens of the stag-horn coral were obtained at this place.

Dredging stations 6079 to 6095 were made between the islands of Vieques and Culebra, and eastward toward St. Thomas, in depths varying from 6 to 25 fathoms. The bottom at all these stations was of coral rock or coral and sand, and was exceedingly destructive to dredging apparatus. The attempts to use the dredge or the beam trawl were very discouraging. The net was sure to catch upon or under, ragged, projecting rock, and the whole thing would be carried away or the bottom torn out of the net. The most satisfactory work done here was with the tangle, which, though most exasperating to work with, nevertheless always brought up a considerable amount of valuable material, most of which could be saved by exercising unlimited care and patience. Many of our most interesting species of mollusks, crustaceans, and fishes were obtained at these stations, and this region, in spite of the very rough character of the bottom, was our most satisfactory dredging ground.

Hucares.—Some time (February 13 to 16) was devoted to investigations in the vicinity of Hucares. This small place is the port of Naguabo, and is only a few miles up the coast from Playa de Humacao. This coast is afforded some slight protection by Punta Lima and Cayo Santiago, but very little collecting could be done along the shore near Hucares, and still less at the playa, on account of the roughness of the surf. On the lee side of Cayo Santiago fairly good ground was found; but by far the richest collecting in this region was in the little cove just above Point Lima. The surf here was comparatively smooth, the bottom was free from rocks, and fishes and other animals were fairly abundant, both as to individuals and species. A small brackish pool on the shore at this place afforded some additional species, the most interesting of which was the tarpon, of which a number of young individuals were obtained. Three dredging stations (Nos. 6097 to 6099) were made off Hucares, which yielded a good deal of valuable material.

Fajardo.—The last work done by this expedition was off Fajardo, February 16 and 17. This coast is apparently but poorly protected against the northeast trade winds, and during our stay a heavy surf was constantly rolling, precluding the possibility of drawing a seine. It was even difficult to make landings with rowboats.

A short distance off the playa are two little islands, Cayo Obispo and Cayo Sanquedo, about which was excellent collecting-ground. On the lee side many parrot-fishes, chaetodonts, and cockeye pilots or mariposas, and one fine specimen of the interesting pipe-fish, *Corythoichthys cayorum*, were obtained. The water here is shallow for a considerable distance from shore, and the bottom is usually smooth and well

covered with algæ. On the windward side is a very interesting reef, made up chiefly of masses of dead coral on the shore side; these masses were always well covered on the outside with small crustaceans and univalve mollusks, and by breaking the masses and pulling them apart, which could usually be done quite easily with the hands, many other species were found hidden or lurking in the interstices or in burrows of their own making. Several species of fishes were thus obtained, including some that are new.

This part of the Porto Rican coast was particularly rich in mollusks, a number of species being obtained here that were not seen elsewhere. One interesting bivalve, *Cytherea dione*, seems to be not uncommon here, though it is said not to occur at any other place about Porto Rico.

CHARACTERISTICS OF THE AQUATIC FAUNA OF PORTO RICO.

Certain interesting peculiarities of the aquatic fauna of Porto Rico are directly traceable to the physical characteristics of the shores and environing waters. The shallow, submerged bank from which the island rises borders it very narrowly, and all sides soon drop off into great depths. The 100-fathom line is close to the shore, particularly on the north and south sides. On the north a depth of 3,000 fathoms is soon found, and a little farther out is the "Brownson Deep," with its great depth of 4,561 fathoms. On the Caribbean side also the platform is narrow, a depth of 2,500 fathoms being soon reached. On the east and west ends the platform is continuous in each direction and the depths are frequently less, though by no means inconsiderable, as 700 fathoms has been found at the east and 660 fathoms in Mona Passage. Not only is the border of shallow water about the island very narrow but there are scarcely any banks or shoals. Probably the only ones are in Mona Passage and these are of uncertain depth and location. With the exception of San Juan, Guanica, and Jobos harbors on Porto Rico, and Ensenada Honda on Culebra Island, the entire coast is exposed, not only to frequent storms but to the strength of the trade winds, and for a part at least of every year, or even of every day, there is a heavy surf which beats against the rocky shores or swashes back and forth incessantly on the sandy beaches, holding detached objects, rocks, sticks, or animals at its mercy.

That this rigorous environment has produced certain modifications of form and habit which enable the animals to resist or circumvent the force of the sea is perfectly evident from an examination of the species of any group. The crustaceans, perhaps, have been most interestingly modified, the adaptation taking the direction of an unusual development of hooks and spines upon the legs which enable them to hold on to corals, algæ, or other objects; and the fauna on the exposed coast is remarkable for the great number of species possessing such characters and the almost entire absence of species not so modified. Some species also simulate bits of alga, or actually have algæ growing on their backs, so that when clinging to a mass of coral they are practically indistinguishable. Often have we examined small masses of dead coral and, deciding that it contained nothing, would be on the point of throwing it away, when a small portion of the mass would begin to move and we would discover it to be a small algæ-covered crustacean. Other species of crustaceans maintain themselves by living in the interstices among the rocks or coral, or burrowing into them.

The most characteristic feature of the molluscous fauna was the great preponderance of those species which, such as gasteropods, can cling to rocks, or which either

burrow into rocks or live among their interstices. Bivalve shells are rare, excepting those which either live in or burrow into the coral rocks or sand. The species of *Donax*, so common at Mayaguez, is an excellent illustration of this, and *Cytherea dione*, found only at Fajardo, is another. Starfishes and sea-urchins, except those species which live in or under rocks or among the branching corals, are very rare, and such other animals as lie exposed upon the bottom, or which have no special means of maintaining themselves, were poorly represented or entirely absent. The facies of the fish-fauna has been determined in the same way. Brackish-water, free-swimming, shallow-water, and surface-swimming fishes are notably absent, while there are many blennies and gobies living in, under, or among the rocks and in the reefs; gobies, chaetodonts, and the like, in the tide-pools or in holes in the rocks along the shore, and scaroids and blennies among the algæ. Among free-swimming fishes as a rule only those species are well represented which live at sufficient depths to prevent their being seriously disturbed by the constant swashing along the shore. In short, all the shore species, not only of fishes but of all other groups, are those which have been able to maintain themselves either by holding to something, by burrowing or crawling into the rocks, by living in protected nooks and corners along the shore, by living in patches of algæ, by burrowing in the sand, or by darting into protected places when the surf becomes too strong.

The peculiar physical conditions described above also account for the scarcity of marine mammals and reptiles, and for the apparent absence of commercial sponges about the island. The only marine mammal known from Porto Rico is the manatee (probably *Trichechus latirostris*), and it is of very rare occurrence, owing no doubt, to the absence of broad sluggish rivers in which it finds its favorite environment. Turtles are also uncommon. The species represented are said to be the hawksbill (*Eretmochelys imbricata*) and green turtle (*Chelonia mydas*), which are rare, except at the east end. The scarcity of turtles is doubtless due to the absence of large areas of shallow water with sandy bottom. So far as known, there is no species of alligator, crocodile, or seal about this island.

What has been said of the marine fauna of Porto Rico applies equally well to the inhabitants of the streams of the islands. In the rivers are found more than a dozen species of fishes, most of which are strictly fresh-water species or fishes which run well up fresh-water streams, and with these occur several species of shrimps and prawns. All the rivers of Porto Rico, as already stated, are swift, turbulent streams at all times, and during heavy rains they become veritable torrents, carrying everything caught in the current far out to sea. Fresh-water inhabitants of these streams, in order to escape being swept into an adverse environment in the sea, have acquired the habit of burrowing or going into holes in the banks where they are comparatively safe, even during the greatest of floods. During the evolution of this habit the individuals which tended to seek the holes in the banks most promptly, and to remain in them most persistently, would stand the best chance of surviving, and the result in time has been species that habitually stay in the protected shelters or which do not wander far away.

List of dredging stations of the U. S. Fish Commission steamer Fish Hawk about the island of Porto Rico.

Station No.	Date.	Locality and exact position. ^a	Depth.	Bottom.	Dredging instruments.
	1899.		<i>Fathoms.</i>		
6050	Jan. 13	Off entrance to San Juan Harbor, Old Fort S. $\frac{1}{2}$ W. $1\frac{1}{2}$ miles.	91	Sand, mud.....	7-foot beam trawl.
6051	Jan. 13	Off entrance to San Juan Harbor, Old Fort SW. $\frac{1}{2}$ W. $1\frac{1}{2}$ miles.	45	.....do.....	Tangle.
6052	Jan. 13	Off entrance to San Juan Harbor, Old Fort SW. $\frac{3}{4}$ W. $5\frac{1}{2}$ miles.	310	.....do.....	Dredge.
6053	Jan. 16	San Juan Harbor, NW. angle of Morro Castle $\frac{1}{2}$ mile....	4 to 7 $\frac{1}{2}$	Fine sand.....	Do.
6054	Jan. 16	San Juan Harbor, NW. angle of Morro Castle $\frac{3}{4}$ mile....	4 $\frac{1}{2}$ to 5 $\frac{1}{2}$	Sand, mud.....	Dredge and tangle.
6055	Jan. 18	Off Aguadilla, Point de Borinquen light-house NE. by N. $\frac{1}{2}$ N. $3\frac{1}{4}$ miles.	137	Sand, mud, and shells.	Dredge.
6056	Jan. 18	Off Aguadilla, Point de Borinquen light-house NE. $\frac{1}{2}$ E. $3\frac{1}{4}$ miles.	48	.....do.....	Do.
6057	Jan. 19	Mayaguez Harbor, custom-house E. $\frac{1}{2}$ N. $\frac{3}{4}$ mile.....	4 $\frac{1}{2}$	Sticky mud....	Do.
6058	Jan. 19	Mayaguez Harbor, custom-house E. by S. $1\frac{1}{2}$ miles.....	7 $\frac{1}{2}$	.....do.....	7-foot beam trawl.
6059	Jan. 19	Mayaguez Harbor, custom-house E. by S. 2 miles.....	7	.....do.....	Do.
6060	Jan. 19	Mayaguez Harbor, custom-house E. by S. $\frac{1}{2}$ S. $2\frac{1}{4}$ miles....	12	.....do.....	Dredge.
6061	Jan. 20	Mayaguez Harbor, black buoy entrance harbor N. by W. $\frac{1}{2}$ W. $\frac{1}{2}$ mile.	12 to 18	Sand, mud.....	11-foot beam trawl.
6062	Jan. 20	Mayaguez Harbor, red buoy entrance harbor NE. $\frac{1}{2}$ E. $\frac{1}{2}$ mile.	25 to 30	Sand, mud, and shells.	Dredge.
6063	Jan. 20	Mayaguez Harbor, Punta del Algarrobo E. $2\frac{1}{2}$ miles.....	75 to 76	Rocky, sand and coral.	11-foot beam trawl.
6064	Jan. 20	Mayaguez Harbor, custom-house E. $\frac{1}{2}$ N. $4\frac{1}{2}$ miles.....	22 to 33	Sand, mud.....	Dredge.
6065	Jan. 20	Mayaguez Harbor, custom-house NE. $\frac{3}{4}$ E. $4\frac{1}{2}$ miles....	4 to 6	Coral.....	Do.
6066	Jan. 20	Mayaguez Harbor, Punta del Algarrobo E. $4\frac{1}{2}$ miles....	161 to 172	Sand, mud.....	11-foot beam trawl.
6067	Jan. 20	Mayaguez Harbor, Punta del Algarrobo E. by N. $\frac{1}{2}$ N. $5\frac{1}{2}$ miles.	97 to 120	Coral.....	Dredge.
6068	Jan. 21	Mayaguez Harbor, custom-house ESE. $\frac{1}{2}$ E. $7\frac{1}{4}$ miles....	224 to 237	(?)	9-foot beam trawl.
6069	Jan. 21	Mayaguez Harbor, custom-house ESE. $\frac{1}{2}$ E. $7\frac{1}{4}$ miles....	223 to 231	Sand, mud.....	Dredge.
6070	Jan. 21	Mayaguez Harbor E. $\frac{3}{4}$ S. 9 miles.....	220 to 225	Rocky.....	9-foot beam trawl.
6071	Jan. 24	Outside of Mayaguez Harbor, custom-house E. $\frac{3}{4}$ N. $9\frac{1}{2}$ miles.	192 to 163	.....do.....	Do.
6072	Jan. 25	Off Punta de Melones, Cabo Rojo light-house SSE. $5\frac{1}{2}$ miles.	7 $\frac{1}{2}$	Coral, sand, shells.	Tangle.
6073	Jan. 25	Off Punta de Melones, Punta Guaniquilla S. by E. $1\frac{1}{2}$ miles.	8	(?)	Dredge.
6074	Jan. 25	Off Puerto Real, Punta Guaniquilla S. $\frac{1}{2}$ E. 2 miles.....	8 $\frac{1}{2}$	Coral, sand.....	Tangle.
6075	Jan. 25	Off Boca Prieta, Punta Guaniquilla SSE. $3\frac{1}{2}$ miles.....	8 $\frac{1}{2}$	.....do.....	Do.
6076	Jan. 26	Off Gallardo Bank, tangent of Morillos de Cabo Rojo ESE. $\frac{3}{4}$ E. $9\frac{1}{2}$ miles.	10	.....do.....	Do.
6077	Jan. 26	Off Gallardo Bank, tangent of Morillos de Cabo Rojo 12 miles.	10 $\frac{1}{2}$	.....do.....	Do.
6078	Jan. 26	Off Gallardo Bank, tangent of Morillos de Cabo Rojo $13\frac{1}{2}$ miles.	11 $\frac{1}{2}$	.....do.....	Do.
6079	Feb. 6	Off St. Thomas, Sail Rock W. by N. $\frac{1}{2}$ N. 6 miles.....	20 to 23	Coral.....	Do.
6080	Feb. 6	Off St. Thomas, Sail Rock NW. $\frac{1}{2}$ W. 4 miles.....	20	.....do.....	Dredge.
6081	Feb. 6	Between Culebra and St. Thomas, Sail Rock N. by W. $\frac{1}{2}$ W. 3 miles.	17	.....do.....	Do.
6082	Feb. 6	Between Culebra and St. Thomas, Sail Rock N. $2\frac{1}{2}$ miles.	18	Rocky and coral.	Tangle.
6083	Feb. 6	Between Vieques and St. Thomas, Sail Rock NE. $\frac{3}{4}$ N. $7\frac{1}{2}$ miles.	25	(?)	Dredge.
6084	Feb. 8	Off Vieques Island, San Juan light-house NW. $\frac{1}{2}$ N. $14\frac{1}{2}$ miles.	11	Coral, sand, shells.	Tangle.
6085	Feb. 8	Off Vieques Island, Point Mula light-house SSW. $\frac{3}{4}$ W. $5\frac{1}{2}$ miles.	14	Coral, sand.....	7-foot beam trawl.
6086	Feb. 8	Off Culebra Island, Point Mula light-house SW. $\frac{1}{2}$ S. $8\frac{1}{2}$ miles.	14 $\frac{1}{2}$	.....do.....	Dredge.
6087	Feb. 8	Off Culebra Island, Point Mula light-house SW. $\frac{1}{2}$ S. $10\frac{1}{2}$ miles.	15 $\frac{1}{2}$	.....do.....	Tangle.
6088	Feb. 8	Off Vieques Island, Sail Rock NE. $\frac{1}{2}$ N. $10\frac{1}{2}$ miles.....	23	Coral.....	Do.
6089	Feb. 8	Off Vieques Island, Culebritas light-house N. $\frac{1}{2}$ E. $7\frac{1}{2}$ miles.	21	.....do.....	Do.
6090	Feb. 8	Off Culebra Island, Culebritas light-house NNE. $5\frac{1}{2}$ miles	16	.....do.....	Do.
6091	Feb. 8	Off Vieques Island, Culebritas light-house NE. $\frac{1}{2}$ N. 10 miles.	15	.....do.....	Do.
6092	Feb. 8	Off Vieques Island, Culebritas light-house NE. $\frac{3}{4}$ E. $7\frac{1}{2}$ miles.	16	.....do.....	Do.
6093	Feb. 8	Off Culebra Island, Culebritas light-house NE. $5\frac{1}{2}$ miles.	15	.....do.....	Do.
6094	Feb. 8	Off Vieques Island, tangent of Cabras Island NEE. $\frac{1}{2}$ E. $10\frac{1}{2}$ miles.	12	.....do.....	Do.
6095	Feb. 8	Off Vieques Island, Point Mula light-house E. by N. $10\frac{1}{2}$ miles.	12 $\frac{1}{2}$	.....do.....	Do.
6096	Feb. 8	Off Vieques Island, Point Mula light-house E. $\frac{1}{2}$ N. $11\frac{1}{2}$ miles.	6	.....do.....	Do.
6097	Feb. 8	Off Humacao, village of Hucareos N. $\frac{1}{2}$ W. $5\frac{1}{2}$ miles.....	10	.....do.....	Do.
6098	Feb. 8	Off Humacao, village of Hucareos N. $\frac{1}{2}$ W. 3 miles.....	12 $\frac{1}{2}$	.....do.....	Do.
6099	Feb. 8	Off Humacao, village of Hucareos NW. $\frac{3}{4}$ W. $2\frac{1}{2}$ miles....	9 $\frac{1}{2}$	.....do.....	Do.

^a All compass bearings magnetic.