

## THE ALBATROSS SOUTH SEA EXPEDITION.

By H. F. MOORE, *Naturalist of the Albatross.*

In advance of the complete reports of the scientific expedition to the South Seas of the U. S. Fish Commission steamer *Albatross*, which will be published in the Bulletin of this Commission, the following outline of the cruise is submitted:

The vessel, under the command of Commander Jefferson F. Moser, U. S. N., sailed from San Francisco on August 23, 1899. The scientific work was under the direction of Mr. Alexander Agassiz, assisted by a civilian staff composed of Messrs. A. G. Mayer and W. McM. Woodworth, of the Museum of Comparative Zoology; Mr. Maximilian Agassiz, of Newport, and Messrs. C. H. Townsend, H. F. Moore, A. B. Alexander, and H. C. Fassett, of the Fish Commission. The naval officers attached to the ship at all times showed great interest in the work of the expedition and furthered it by all means in their power. They were Lieuts. Hugh Rodman and B. K. McMorris, Ensigns A. J. Hepburn, C. R. Miller, and C. S. Kempff, Surgeon J. C. Pryor, and Paymaster Grey Skipwith.

Between San Francisco and Nukahiva, in the Marquesas Archipelago, the first objective point, 26 soundings were made, resulting in the development of a basin from 2,500 to 3,100 fathoms deep, lying between latitudes 24° 30' N. and 6° 25' N., and probably extending at least between longitudes 120° W. and 140° W. For this great oceanic depression Mr. Agassiz has proposed the name of Moser Basin. The floor of the Pacific over this depression, as, indeed, in a larger part of the deep waters explored by the *Albatross*, appears to be pretty completely covered with a deposit of red clay and manganese. The character of the deposit varies at different stations, being sometimes in the form of slabs, but more often composed of rounded nodules of various sizes up to 6 inches in diameter, sometimes smooth and sometimes mammilated, and often inclosing or partially inclosing the teeth of sharks and the hard ear-bones of cetaceans. In the deep waters where the manganese is not found the bottom consists usually of globigerina ooze, gradually changing to pteropod ooze as the depths decrease, then to fine and finally to coarse coral sand as the coral islands are approached, or to volcanic mud and volcanic sand in the vicinity of volcanic groups like the Marquesas and Society islands.

On the morning of September 14, 22 days out of San Francisco, the high island of Ua-Huka, in the Marquesas Group, was sighted, and

the afternoon of that day and the early hours of the following morning were spent in sounding and using the beam trawl and tow nets in the channel between that island and Nukahiva. Between the islands a depth of 830 fathoms was found and the trawl hauls developed an apparently rich bottom, but the nets were so badly damaged by the rocks that comparatively few specimens were obtained.

At 9.30 a. m. on September 15 the anchor was let go in the harbor of Tai-o-hae, Nukahiva Island. This harbor, with a comparatively narrow entrance, is surrounded by high hills sloping almost from the water's edge, and has the appearance of an ancient crater, the seaward walls of which have broken down and admitted the waters of the Pacific. Tai-o-hae is the seat of the French government in the Marquesas Islands, and the members of the expedition were received with great kindness by the government officials and residents. Two days were spent in coaling and the members of the scientific staff utilized the time in making collections on shore. The natives in the vicinity of Tai-o-hae have adopted many of the outward forms of civilization, and many of them live in houses of European architecture of a simple type. In the interior, however, more of the ancient life is to be seen and houses of pure native construction, invariably built on stone platforms, are common, in fact, almost universal. In the forests are found the sites of many old villages, now overgrown with large trees and in some cases almost hidden by vegetation.

The population of the island is decreasing, probably as a result of changes in their mode of life and the introduction of diseases unknown before the advent of the whites, and as a rule the people are subdued in demeanor and apparently convinced that their race is doomed to extinction. The Marquesas Islanders are among the few South Sea Islanders (of whom the ancient dwellers on Easter Island are the most notable) possessing the art of stone carving. Several specimens of rude idols were seen, and the members of the party who had the best opportunity for observing are of the opinion that they are still objects of some veneration, if not of worship.

About noon on September 17 anchor was weighed and the *Albatross* stood out of the harbor for the northwestern end of the Paumotu Archipelago, en route to Tahiti. Soundings were made on this line which, when considered in connection with those obtained before reaching Nukahiva, appear to indicate that the submarine plateau from which the Marquesas Islands arise has a depth of about 2,000 fathoms and a width of 50 miles.

On September 20 Ahii, the first of the low islands, was sighted and before noon of the following day the ship, under the pilotage of a native, entered the lagoon of Rairoa, through Avatoru Pass, and came to anchor. Three days were spent in examining the atoll and making collections. A line of soundings was run across the lagoon, which is the largest in the Paumotus, developing the fact that it has a practically level floor with a depth not exceeding 20 fathoms. This line

was subsequently extended seaward at each end for a distance of several miles, in order to develop the submarine insular slope.

After leaving Rairoa the atolls of Mataiwa and Tikehau were examined from the ship and a landing for a few hours was made at Makatea, an elevated coral island of considerable interest. The cruise was then continued to Tahiti, in the Society Islands, where coal and supplies were to be obtained for the cruise through the Paumotus.

Tahiti was sighted at daylight on September 27 and the anchor dropped in Papeete Harbor on the afternoon of the same day. A week was spent at this port in coaling, laying in supplies, and making minor repairs and overhauling the engine. The naturalists of the party utilized the time in collecting on shore and on the reefs. The harbor is protected from the sea by a barrier reef, part of a long stretch which practically encircles the island, changing from fringing reef to barrier reef, and conversely, as it establishes or loses its connection with the main island. Opposite Papeete the reef is interrupted by a pass, one of many which occur at intervals, through which shipping gains access to the harbor. Papeete is the seat of the French colonial government in the South Sea Islands. It has a garrison of about 200 men, and a cruiser is usually lying in the harbor. The United States and several European governments are represented here by consuls, who are accredited to the French South Sea possessions as a whole. The population is said to be about 5,000, of whom a large number are whites engaged in trade or connected with the government of the island.

On October 5 the *Albatross* sailed from Papeete for a cruise through the Paumotu Archipelago, during the course of which Makatea was revisited and about twenty-five other islands, of which Pinaki was the easternmost, were examined. During this cruise much information was gathered concerning the formation of the islands of the Paumotus, which furnish a fairly complete series, from the typical atolls like Rairoa to the elevated coral plateau of Makatea.

A landing was made at Makatea and a party crossed the island to a village on the east side. The top of the coral table-land exhibited a slight depression in the interior, and the rocks are eroded by subaerial agencies into a picturesque diversity of caverns, small canyons, and pinnacles, unlike anything seen elsewhere on the cruise. The precipitous walls, which in places rise sheer from the sea, and elsewhere are fringed with narrow beaches and reef flats, by their terraces and lines of caverns eroded by the waves, indicate that the island has passed through four periods of elevation. The cliffs are most precipitous on the weather side, and the terraces best developed on the more sheltered shores. The vegetation is richer and more varied than on the low islands of the Paumotus subsequently visited.

Stops varying in length from six days to an hour or two were made at a number of the islands, and wherever opportunities occurred collections were made by the naturalists of the expedition. The trawl and dredge hauls, which were in depths of from 725 to 2,440

fathoms, yielded but meager results, and the surface and intermediate tow nets also took but little. The collecting on the reefs and in the shallow water was unproductive, as compared with similar collections in the West Indies, although some interesting forms occurred in considerable abundance. About 100 soundings were made in this part of the cruise, and the contour of the bottom and the extent of the main Paumotu plateau west of Pinaki were fairly delineated.

In that part of the Paumotu Archipelago visited by the *Albatross* the natives showed, in their habitations, boats, utensils, and mode of life, the influence of somewhat intimate contact with the whites. On some of the larger islands are stationed gens d'armes, the local representatives of the French colonial government, and traders and missionaries are found almost everywhere. Nukatavake was the only island where the expedition noted any approach to primitive conditions, and the stop there was too short to enable the members of the party to make more than the most casual observations. It is probable that in the eastern islands more of the old life obtains than in those parts of the archipelago in more immediate communication with Tahiti. The people are much under the influence of missionaries, mostly Tahitians, although some are whites, and while their morality is perhaps not all that could be desired, they exhibit considerable zeal in their religious observances and some rivalry between the various sects. At Pakaka, on Apataki, with a population of perhaps 200, the members of the expedition observed four churches, and were informed that there was one more, a representation which it would be difficult to duplicate in a village of the same size in the United States.

Three days were spent at anchor in the lagoon off Rotoava on Fakarava, where is located the French residency for the Paumotu Archipelago. Like most of the larger villages of the eastern Paumotu, Rotoava is well kept, with a broad main road shaded by cocoanut trees stretching along the lagoon front, the coral soil compacted to a smoothness resembling concrete. The usual collections and observations were made and the ship sailed on October 14. A stop of very short duration was made at Anaa, an island rich in cocoanut trees and supporting the densest population in the archipelago. A curious fish trap or weir, constructed of coral rocks, was observed on the reefs at this place, the fish being removed from it at low water with dip nets. The lagoon of Anaa is one of great beauty, and its brilliant colors reflected on the clouds were visible many miles away, long before the island itself was sighted.

After leaving Anaa the islands of Tahanea, Tuanaka, Raroia, Takume, and Taenga were visited, but the first stop, six days, was made at Makemo, where bad weather delayed the arrival of a coal supply ordered from Papeete. The naval officers utilized the enforced stay in making a survey of Northeast Pass and its anchorage, which have been inadequately charted, and in carrying on magnetic and astronomical observations of value to mariners. The reef flat in the

sea face of Makemo is narrower than at Rairoa, and its outer edge is extremely rugged, with gnarled tongues of nullipore-covered rock thrust seaward, leaving between them gullies in which the water wells with the surf. In places where the end walls of the gullies are abrupt the heavy swells, which roll almost unceasingly in this region of the trades, dash vertically aloft in spouts sometimes 20 feet or more in height. The nullipores grow most luxuriantly in those parts of the reef which are reached by the spray, and consequently the sea verge of the reef is raised above the level of the flats behind, and around the blowholes there is usually a partial rim, which slopes away like the flanks of a crater. At Makemo and nearly all islands where the outer edge of the reef has a nullipore ridge with a comparatively narrow reef flat behind there is a channel about a foot in depth, through which the water dashed over the rim flows in rather swift currents parallel with the shore, until it finds a lateral channel permitting it to flow back to the sea. In some places at Makemo, Fakarava, and elsewhere this canal is incompletely eroded, and consists of a network of small channels from 6 to 18 inches in depth, where the sand and fragments of coral rock washed back and forth by the currents show clearly the mechanical agents by which the scouring out of the ledge rock has been effected. At Makemo there is also a narrow cut, as yet but 2 to 4 feet deep, through which the tide rushes into the lagoon at high water and which is doubtless a pass in embryo. A contemplation of this and various other cuts in different stages of formation was convincing that passages through the rims of atolls are, at least sometimes, formed by erosion rather than by discontinuity in the growth of corals. After the cut has once reached a depth where the sea has access to it at or near low water the cutting away of the rocks must proceed more rapidly, as swift currents are continually discharging through the gaps on the lee side of the atolls the vast quantities of water which the waves wash over the low rims of reef on the weather side. In some of the passes of the Paumotu there is a current of 7 or 8 knots flowing from the lagoon seaward which is sometimes merely checked and not reversed, even at high water.

Hikueru was visited principally for the purpose of examining the pearl fishery in the lagoon, which has no entrance sufficiently deep to float even a large boat, the small sloops and catboats used in the fishery being dragged and carried over low places in the reefs. The lagoon is opened to fishing one year out of three, when the small resident population is augmented by a heavy influx from most of the Paumotu Islands and some of the Society group—at the time of the visit of the *Albatross* it being estimated that over 3,000 persons were on the island. The fishery is carried on entirely by naked native divers—men, women, and the larger children. The men frequently go to a depth of 15 fathoms, staying under water from two to three minutes, and the best divers are said to sometimes reach a depth of 20 fathoms. The members of the party saw a man bring up several

shells from water 14 fathoms deep, after an immersion of two minutes and forty seconds. The yield of mother-of-pearl is large, but apparently decreasing. Pearls are not so frequently found here as in other islands of the archipelago where the shells are less abundant.

After leaving Hikueru a stop was made at Nukatavake, as before mentioned, and a landing was also made at Pinaki, where the lagoon was found almost inclosed, shoal, with over 100 small islets of *Tridacna* shells, and apparently in process of filling up.

From Pinaki the *Albatross* went to the Gloucester Islands, where valuable observations were made, and then via Mehetia to Tahiti.

On November 6 the expedition again arrived at Papeete, where it remained until November 15, coaling and refitting. During both this and the first visit the expedition was received with much courtesy by the people of Papeete, who, in addition to the extension of hospitality, in a number of cases provided facilities and rendered assistance to the members of the party in carrying on their work. In addition to the shore and reef collection, several members of the party examined most of the valleys in the vicinity of Papeete, and made soundings and observations in Lake Vaihiria. The population of the island is restricted to a narrow fringe around the coast, the interior, with its high peaks and narrow spurs, separating equally narrow valleys, being ill adapted to the temperament and necessities of an ease-loving people like the Polynesians. A road, mostly in good condition, encircles the island, and, with the sea, affords the sole means of communication. The reef skirting Tahiti is principally of the barrier type, sheltering a channel from the sea and affording a smooth passage for small craft navigating the coast. In some places the channel is of sufficient depth to afford passage and harbor to vessels drawing 15 feet, and the steamers, which come several times a year to load fruits for the Australasian colonies, are able to take berths near the plantations from which they draw their supplies.

The soil of Tahiti, as is usual in volcanic islands, is fertile and the vegetation luxuriant. Cotton and sugar are produced, but appear to be less important than formerly. Coffee grows almost within reach of the sea. There is an increasing production of vanilla, which is said to be of excellent quality; and the oranges grown on the island are unsurpassed. The plantations are all on the strip of lowland along the coast and in the lower and broader portions of the numerous valleys which furrow the island radially from the high interior. Papeete, the capital, has a trade of some importance, being the distributing point for the entire French South Sea Establishments and the port of transshipment of their products of copra and pearl shell.

The beauty of the island is unsurpassed by anything seen on the cruise. Its high, rugged mountains, one exceeding and several others almost equaling 7,000 feet in height, the many cascades and waterfalls plunging over precipitous valley walls or leaping from ledge to ledge on the flanks of the ridges, its dales and valleys, with rapid

coursing streams and wealth of tropical verdure, form the elements of a picture as rich in detail as it is bold in ensemble.

The shore line is fringed with cocoanut palms, and the small sandy islands on the reef are given up to the culture of the same tree. Much of the uncultivated land along the coast and in the lower parts of the valleys is given up to dense thickets of guavas, which, since their introduction some years ago, have, together with the lantanas, spread with such amazing rapidity that they have become a nuisance. In the upper parts of the valleys the wild plantain, or "fei," with its great upright bunches of fruit, as distinguished from the drooping bunches of the banana, grows in abundance and is an important item in the dietary of the natives, who carry it to their homes along the coast. Wild oranges, limes, and shaddockes are common and excellent in quality; calladiums grow in the marshy spots; tradescantias in places almost choke the streams; and along their damp margins, where level tracts free of rocks occur, a species of wild ginger, the rhizomes of which are used in making a native curry, grows in dense thickets, and in November exhales a delicious aromatic odor from its flowers, just peeping a few inches above the ground. Higher up the valleys dracænas and tree ferns occur, tillandsias and the bird's-nest fern depend from the larger trees; clambering vines, creeping pandanus, and the giant fern abound among the rocks; a variety of trees, including an occasional sandalwood, clothe the hillsides, and a host of small and delicate plants cling to the precipitous rock faces, where dripping waters keep them perennially moist.

In the streams the gamy little perch-like *Dula* lies in the pools, shrimps of the genus *Atya* court the shelter of stones and aquatic vegetation, and a crab of the family *Thelphusidæ* scales the vertical faces of the overhanging rocks with astonishing celerity and always out of reach. A little kingfisher is always found along the streams and their dry beds, apparently depending more upon insects, which it catches on the wing, than upon the usual food of its kind, and in the woods are at least two species of pigeons and other smaller species. A large hawk was also several times observed attempting to catch the ducks which make Lake Vaihiria their home, but it is said to be an imported species. High up the valleys the frigate bird is always to be seen sailing about the almost inaccessible crags where it makes its nest; and a little white tern is commonly seen in Tahiti, as at Nukahiva, far inland, and occasionally resting upon the trees.

On the reefs the fauna is hardly more rich than in the Paumotus. The living corals are in most places neither abundant nor varied. The solitary fungia is scattered over the reef flats, in shoal water, and there are patches of reef-forming corals about the edges of the dead rock, and more or less impoverished-looking clusters on its submerged top, but nowhere apparently are there flourishing masses such as were seen in the pass at Rairoa. Gorgonians and Alcyonaria generally are poorly represented in both the Society and Paumotu archipelagoes;

several species of starfish are common, but not abundant, and there are 4 or 5 species of sea-urchins and several holothurians. A species of *Grapsidae* is common about the rocks along the shore and exposed on the reefs, and by raising the coral fragments and breaking them in pieces several small crabs were found, together with stomatopods and shrimps and prawns and other species of crustacea, and a number of worms were collected in the same manner, although less extensively than in the Paumotus.

Tahiti proved interesting and attractive, especially on the second visit, after the monotony of the atolls of the Paumotus, and it was left with some regret on the morning of November 15.

Some of the Leeward Islands of the Society group were visited, with anchorages overnight at Tahaa and Bora Bora, and a short stop was made at Aitutake, in the Cook group. The Leeward Islands, like the rest of the Society group, consist of bold and picturesque volcanic peaks skirted by coral reefs and reef islets on a broad shore platform, and Aitutaki resembles them, but its peaks are low and its structural features in general on a smaller scale.

The next place visited was Niue, an isolated, elevated, coral island, with bold precipitous terraced walls, rising to a height of from 150 to 200 feet above the sea. The surface of the island is comparatively level and less elaborately sculptured by erosion than is Makatea, which it resembles in a general way. The vegetation is far inferior in luxuriance and variety to that of the Society Islands, but excels that of the atolls of the Paumotus. Some attempt has been made to raise sugar, but the fields did not look promising.

From Niue the *Albatross* steamed to latitude  $21^{\circ} 18' S.$ , longitude  $173^{\circ} 31' W.$ , where a sounding and Blake trawl haul were made in 4,173 fathoms, the greatest depth at which a trawl has ever been used. A species of sponge, allied to a form before known only from comparatively shallow water, was taken. In latitude  $21^{\circ} 18' S.$ , longitude  $173^{\circ} 51' W.$ , a sounding of 4,540 fathoms was obtained.

Early in the morning of November 28 the magnificent cliffs of Eua were sighted, and just before noon, after coasting the east, south, and part of the west shores of the island, anchor was dropped in English Roads, off Ohonua village. The east side of Eua presents the highest and finest coralliferous limestone cliffs seen during the cruise, and they excited the admiration of all on board. Eua was left on the following morning after an examination of its general features, and a short run was made to Nukalofa, the capital of the Tonga Islands, where the members of the expedition were kindly received by King George, the officers of his government, and the people. The government of the Tonga group is a limited monarchy under the control of the natives, and the islands appear to be well conducted and orderly. Tongatabu, on which the capital is situated, is somewhat elevated in its southern part, but slopes gradually away to the northward, where it is continued over the plateau as a number of small islets and reefs.



The interior of the island is level and the soil apparently fertile and cultivated more or less by the natives, who ship their fruits to the English colonies in Australasia. A large proportion of the people are owners of a horse or two, which they use in their agricultural operations and for the transportation of their products to the coast.

The collections here were not extensive, as the reef and waters in the neighborhood of the anchorage exhibited an unusual paucity of life. A trip was made to the village of Hihifa, where there is a remarkable rookery of fruit bats, occupying about fifteen adjoining trees and estimated to contain upward of 6,000 individuals. Although these animals destroy considerable quantities of fruit, they are "tapu" and under the immediate protection of the chief of Hihifa. They are not permitted to be shot or molested in any manner, and it was only after considerable negotiation that the members of the expedition were allowed to catch three specimens, which were taken back to the ship alive. Nowhere else on the cruise were fruit bats of this or any other species found in colonies of more than a score.

After leaving Nukalofa, the Namuka and Vavau groups of the Tonga Archipelago were visited and examined with relation to their exposed and submarine structure. At Namuka Iki there is a small area of stratified volcanic rock, soft and friable, and said to resemble somewhat the so-called soapstone of the Fiji Islands. Namuka Iki is the convict settlement of the Tonga Islands. A number of rude huts were seen on the island, some of them showing indications of quite recent habitation, and several recently cultivated yam plantations were observed, but the inhabitants, who are few in number, kept out of sight. Namuka Island, from Namuka Iki but a few miles distant, is composed of uplifted coralliferous limestone, the weather shore being extremely rugged and much eroded by the seas. In the interior are several rounded eminences of moderate height, but upon examination these were also found to be composed of limestone.

Residents of Namuka stated that some of the islands of the group are volcanic, and those seen from the ship appeared to be. The Namuka Group is, therefore, of mixed formation, partially volcanic and partially of elevated coral limestone.

From Namuka the course lay between the western chain of volcanic islands and the plateaus of the Namuka, Hapai, and Vavau groups. Lette, of the volcanic chain, is still active and some of the others have been the scene of recent activity. Falcon Island, which appeared above the sea in 1885 as a low volcano, with a cone of loosely compacted ash and scorixæ, had been entirely washed away by 1898 and reduced to the condition of a breaking reef, much as it appeared when first discovered in 1865.

No landings were made on the islands of the Hapai plateau, but some of the westernmost were seen to be limestone islands of considerable height. The Vavau Group, comprising the most northern islands of the Tonga Archipelago, is one of picturesque beauty. The northern

part of the principal island, Vavau, is high and bold, with precipitous shores, but it slopes away to the southward where it breaks up into an intricate maze of headlands and islands, gradually decreasing in size and height until they are lost beneath the sea as breaking reefs on the southern edge of the plateau. This archipelago of islets is evidently the eroded remnant of a single high coral island, of which Vavau is the largest fragment, which formerly covered the entire plateau and was, perhaps, connected with the Hapai Group.

The *Albatross* anchored at Neiafu, Vavau, on the morning of December 4 and left in the afternoon of the following day. The harbor is well protected, but the water is rather deep. It is approached through a fine fiord with precipitous coralliferous limestone walls, from which a number of flat-topped rocks and islets have been cut off by the erosive action of the sea. At Neiafu the rocky walls of the fiord are interrupted and a broad slope extending into the interior gives room for the village and an ample cultivated acreage behind it. Several trading stations are situated along the cove, one on the starboard side in entering being in a situation of almost idyllic beauty.

The island is generally well wooded and produces a variety of fruits and vegetables. The natives are of the Maori race, like those of Hawaii, Samoa, and the islands which the *Albatross* visited to the eastward. Here, as in the other islands of the group, tapa, the bark cloth of the South Seas, is produced in considerable quantities, and the rap rap of the tapa club is heard everywhere and all day long. A few corals were collected at Neiafu, but the other collections were poor.

From Vavau the vessel ran to the Fiji Islands, making a short stop at Kambara in the Lau Group, and then proceeding to Suva, where nine days were spent in refitting and coaling. A number of cases of specimens were packed up and shipped from this port, previous shipments having been made from Papeete.

Suva is the seat of the British Government in the Fiji islands, and the expedition was kindly received by the colonial officials, who, among other courtesies, provided an excellent guide and carriers for a party which visited the interior. The town has a population of less than 2,000, of whom a large proportion are whites. The harbor is good, protected from the prevailing easterly winds by a high point and from the swell of the open sea by a coral reef traversed by a deep pass which forms the entrance. The anchorage is good, and vessels of considerable draft can lie alongside the wharf. Extensive collections having been made by Mr. Agassiz on a former expedition to the Fijis, but little collecting was done along the coast, and three members of the party made an excursion into the interior of Viti Levu, the principal island of the archipelago.

This island is the largest and most populous visited by the *Albatross*. Its interior is mountainous, but the peaks are neither so high nor steep as those of Tahiti, about 4,000 feet being the greatest altitude, and the valleys are broader. The principal river, the Rewa, entering the

sea a few miles east of Suva through an extensive delta, is a broad stream navigable for light-draft steamers for a distance of 30 miles or more from its mouth. Launches make daily trips from plantations up the river to Suva, and it is important as an avenue for the transportation of cane to the mills, substantial steel barges towed by launches being used for the purpose. The natives also carry their fruit and produce on bamboo rafts, which are floated downstream to the delta and thence to Suva. The valley of the Rewa is populous and fertile, and a number of plantations are located on its banks. Oranges and related fruits, which in a feral state abound in the Society Islands, were rarely seen growing wild in Viti Levu, and the fei, although it probably occurs, does not hold an important place in the diet of the natives, who subsist largely on fish, yams, taro, and bread-fruit. As in all the volcanic islands visited, as contrasted with the atolls, the meat of the cocoanut is not much eaten, though its oil is used in preparing certain dishes and its water is used as a beverage. A sort of glutinous pudding, prepared by pounding up cooked taro with cocoanut oil, is highly regarded as a delicacy, and the stone pestles used in its preparation are found in every household. The Fijians, like the Samoans, Tongans, and other Polynesians, drink kava, which is an infusion of the comminuted roots of a species of pepper (*Micropiper*). Formerly the green roots were reduced to a pulp by mastication, but for hygienic reasons this has been prohibited, and the dried roots are now pounded in a mortar or grated. The beverage is not fermented, and intoxicating properties are denied to it by recent investigators.

The weather side of the island is well wooded and fertile, the vegetation is luxuriant and in general more massive in character than in Tahiti, and the filmy growths of tropical forests are less conspicuous.

The Fijians are a sturdy, independent race with dark skins and fine physiques. The women have less beauty than those of the Maori race, but many of the men are fine specimens of vigorous, athletic manhood. As a rule they are not given to toil, and to supply labor for the plantations there have been large importations of Indian coolies, whose physical inferiority to the natives is striking.

In the coastal regions of Viti Levu there is more or less admixture of Tongan blood, and the color, especially of the chiefs, is lighter than among the mountain people of purer Papuan descent. For the most part the natives live in houses of pure Fijian architecture, those of the chiefs, especially, being well constructed and often neatly kept. Some of them have the beams and pillars neatly and ingeniously ornamented with wrappings of cocoanut fiber sennit in various designs and colors, and in the house of the chief at Rewa the wood-work is hardly to be seen for the closeness of its ornamentation.

As chiefs of districts and villages the old native ruling classes have been given a certain amount of authority under the British colonial government, and the natives are well satisfied and contented without having lost their natural independence of character. As a race they

are intelligent, and some of the chiefs have been well educated in the schools of the Australasian colonies, speaking English with fluency and being well informed of the events of the world.

The common people and some of the chiefs live much as they did before the advent of the whites, excepting that they have, of course, long given up their tribal wars and some of the practices arising therefrom. Most of them are professed Christians and in form, at least, are more devout than some of their white neighbors. In the vicinity of Suva white influence is seen in the dress of the women, a cotton gown reaching to the ankles, and the men wear cotton loin cloths, or sulus, and shirts, the chiefs dressing in white. In the interior of Viti Levu, however, and at Kambara, the dress of many of the women is a skirt of fiber reaching to about the knees, and the men wear the sulu without covering to the upper part of body. Except in a few places, practically all of their household utensils are of home manufacture after their ancient models, and their villages are innocent of corrugated iron. A few large, double-sailing canoes are still to be seen, but there are none approaching in size the great war crafts of former times, and in the neighborhood of Suva, at least, they are fast giving place to sloops and cutters, whose general superiority the native appreciates.

Before reaching Suva four soundings, ranging between 324 and 600 fathoms, were made among the southern islands of the Lau Group, and another of 990 fathoms was made about 13 miles west of Kambara. After leaving Suva no soundings were made until in latitude 12° 43' S., longitude 179° 50' W., a depth of 1,445 fathoms was found about midway between Fiji and the Ellice Islands. The trawl and tow nets were used at this station with rather meager results and this constitutes practically the only work of the kind between Suva and Yokohama, although the surface net was used on several occasions. The following day a sounding of 245 fathoms was found at a point about half a mile south of Nurakita Island. This island, usually known as Sophia Island, is owned by a white man who has erected an apparently substantial building, and is inhabited by Samoans in his service.

From Nurakita the *Albatross* proceeded to Funafuti, when anchor was dropped in the lagoon off the village of Fongafale on the afternoon of December 23. Funafuti is one of the few atolls which have been well surveyed. It is almost 15 miles long and about 10 miles wide, its greatest length being nearly due north and south, and its width east and west, magnetic. The depth of the lagoon will average 24 fathoms, but it is considerably shoaler on the west side, and there are many reefs and coral patches scattered everywhere over the lagoon, these being readily recognized in the sunlight by the light-green color in contrast with the blue of the deeper water. Outside of the atoll the water is deep, soundings of 1,000 fathoms being obtainable within 2 or 3 miles of the shores and still deeper water being found beyond. Funafuti is, in fact, the summit of a steep submarine peak. The land lies on the eastern and southeastern rim of the

atoll and consists of a number of long and extremely narrow islands on the reef flats. It is widest, about 600 yards, at the easternmost point, where the village is situated, but elsewhere it is rarely a third as wide. A large part of the land consists of coarse coral shingle and rubble overgrown by an almost impenetrable scrub, but near the village it has a more sandy soil, supporting a growth of cocoanut trees. There is also in the vicinity of the village a slightly brackish sink or shallow pool where taro is grown and whose verge supports a few banana and breadfruit trees, the first that the expedition found growing on an atoll. In 1897 a boring 1,100 feet deep was made at Fongafale to determine the depth of the coral formation and the character of the underlying structure of the atoll.

The population of Fongafale, which is the only inhabited island on the atoll, is stated to be about 250, with a native government under the protection of the British flag. The natives are all Christian and extremely devout, Sunday being entirely devoted to religious observances and services at other times being frequent. On Sundays the men dress in shirts and trousers and some wear coats, and the women appear in loose flowing wrappers of cotton stuff and hats of a style never seen elsewhere, but which are the pride of their owners and the glory of Fongafale. On ordinary occasions the women wear nothing but a short skirt of pandanus-leaf strips sewed to a waistband.

The chief and one or two others have houses built of coral rock and plaster upon European models, but the majority of the dwellings are of native design, but of several types, as if extraneous influences had been at work. The most common type, and the one probably indigenous to the island, has a floor or platform over the whole or a large part of the space occupied by the house, raised about 2 feet above the ground, a sort of picket fence preventing the encroachment of pigs and dogs beneath. Another type is without a platform, but the ground is covered with a neat layer of white coral shingle and pebbles, over which mats are spread when one wishes to sit or lie down. Houses of this character, probably of Samoan origin, usually have no permanent walls, but a sort of native "venetian blind," made of broad mats of cocoanut leaves, is arranged so that it may be raised or lowered as occasion requires.

The natives of Funafuti are quite different in appearance from those of the Fiji Islands, belonging to the Maori race, which inhabits the islands to the eastward. During recent years, at least, they have had considerable intercourse with the Samoans, whom they resemble in appearance, and it is not improbable that the Ellice Islands were populated by emigration from the Samoan Archipelago, which is distant between 500 and 600 miles. A Samoan teacher was present on the island at the time of the visit of the *Albatross*, and so far as could be judged his influence was paramount to that of the chief. The natives were hospitable and kindly disposed, and exerted themselves for the pleasure and entertainment of the members of the expedition. With the exception of two Roman Catholic missionaries, who contem-

plated leaving on account of the coldness of their reception by the already Christianized natives, there were no white men resident on the island. The white trader had died several months before and no one had taken his place. The supply of tobacco, soap, and some other necessaries was exhausted, and the members of the party availed themselves of an active demand for these articles in making collections of ethnological specimens, a fairly complete collection of fishing appliances being secured.

During the two days spent at Fongafale the naturalists of the party made collections of corals and other specimens on the reefs. Great difficulty was encountered in getting specimens of fish, not only at this island, but everywhere in the South Seas. It was rarely that fish could be taken on a line, and the few captured generally belonged to species of which specimens were easily obtainable. Places presenting opportunities for hauling the seines were comparatively few, owing to the coral growths on the bottoms of the lagoons, and on the outside of the atolls there were usually no places whatever where a net could be set. Gill nets were tried in a number of places and in several ways, and traps of various types were set where strange and gorgeously beautiful fish were swarming, but only the most meager results were obtained. Fishes in considerable numbers and variety could always be seen about the corals, but on the slightest alarm they would withdraw into the numerous holes and crannies, where they were secure against all attempts to catch them.

Attempts to secure specimens and fish for the officers' mess from the natives were no less abortive. The South Sea Islanders everywhere pay more or less attention to fishing, but in a desultory way and upon a small scale and, except when they go out to sea after flying-fish and bonito, rarely make catches of considerable size. In lagoon fishing they usually catch barely enough for a meal for themselves. They use a large variety of apparatus—traps differing in type in every group, but all made upon the principle of our own lobster pots, seines, dip nets, scoop nets, hooks and lines, and spears. The nets are nearly all made by the natives of twine composed of fibers indigenous to the islands, and many of the lines are also of home manufacture, although the cotton line of the whites is used more or less in many places. The natives generally exhibit considerable skill in making twine and cordage, and examples were seen which in strength and workmanship were not inferior to the products of machinery. Iron hooks obtained from traders are now extensively used in most of the islands, but in some cases barbless ones are preferred to the ordinary type, and for some kinds of fishing the native hooks of pearl shell and bone are found more effective. For catching the bonito and kindred species the natives and white residents of the islands claim that nothing equals a sort of native "fly," which, with slight modifications, was found everywhere from the Paumotus to the Marshalls. It consists of a pearl-shell shank to which a slightly curved and retrorse point

of bone or shell is firmly lashed and furnished with a tuft of stiff fiber to serve as a lure. For lagoon fishing a hook made of a single piece of lamellibranch or gasteropod shell is sometimes used, and for shark fishing recourse is still occasionally had to the ancient hard-wood hook; but both of these types have been largely displaced by iron and steel, in some cases the natives adapting the new materials to the old familiar models.

Iron wire has also almost displaced hard wood for the armament of the fish spears, although the old model, with its crown of six or eight points, is still adhered to from the Paumotus to the Carolines. Spear-  
ing fish is practiced on the reefs at night when the flaring lights of cocoanut-leaf torches are used to lure the fishes from their hiding-places among the corals.

The *Albatross* left Funafuti on December 26, and sailed for the Gilbert Islands, coasting the island of Nukufetau en route. Between the Ellice and Gilbert islands she encountered much bad weather, with wind and rain, and it was found impossible to make soundings. In the Gilberts the islands of Arorai, Onoatua, Taputeuea, Apamama, Maiana, Tarawa, Apaiang, Maraki, and Taritari were coasted and examined. Landings for a few hours were made at most of them, excepting Taritari, where the ship entered the lagoon and lay at anchor for a day and a half off the village of Butaritari.

Eleven soundings were made in the Gilberts, and the indications are that these islands, like the Ellices, are the summits of rather steep submarine peaks rising from a depth of about 2,200 fathoms. No landing was made at Arorai, but natives who came off in a boat stated that there was a small sink or pond, but no lagoon. Maraki has a lagoon of considerable relative size, but, with the exception of two small, shallow passes, practicable for boats only, it is entirely inclosed. With the exception of Arorai and Maraki, all of the Gilbert Islands visited by the *Albatross* have lagoons, which are only imperfectly inclosed by land, the western part of the atolls, as a rule, consisting of reefs, without the sandy linear islets which characterize the weather side. Some of the atolls have a double fringe of islets, a peculiarity which was nowhere seen in the Paumotus, but which was afterwards noticed in certain of the atolls of the Marshall Archipelago.

On the morning of January 5 the ship entered the southern passage of Taritari atoll, under the guidance of a white pilot, and early in the afternoon came to anchor off the village of Butaritari, where she remained until the morning of January 7. The lagoon is full of coral patches of all sizes, from a few feet in diameter up to reefs of considerable size, and a collection of the characteristic species was obtained. The shore and reef collecting proved poor in those portions of the atoll within reach of the ship, and circumstances did not permit this branch of the work at any considerable distance from the anchorage. In company with some of the white residents and natives a trip was made to the reefs near the entrance for the purpose of making a collec-

tion of the reef-dwelling fishes by means of explosives, but the attempt was attended with but poor success, owing, the natives stated, to the fish having been scared away by previous operations. Explosives for catching the fishes on the reefs and poisons for taking them in the small tidewater pools, where, from their shy and secretive habits, it is difficult to secure them with nets, are perhaps the only feasible means of making extensive ichthyological collections under the conditions prevailing in the South Seas, and the expedition was handicapped by not possessing the means for working along these lines. On the whole, the biological collections on the coral islands were disappointing, and far less than similar effort would have yielded in the waters of the West Indies or on the coast of Japan.

At the various islands where stops were made a few ethnological specimens, principally fishing and canoe implements and articles of adornment, were gathered, but as a rule the time was too short for collecting of any sort. The houses differ somewhat in different islands, but typically consist of rather high cocoanut-thatch roofs supported on blocks of coral rock or posts about 3 feet high. Many of them, but not all, have floors on a level with the eaves, a scuttle or hatch giving access to the compartment above, which is used for sleeping purposes and as a storehouse. On some of the islands where no landing was made, e. g., Taputeuea, the corner stones, which are usually about 10 or 12 inches square in cross sections, were seen in places along the beach, sometimes quite in the open, on bare sand flats, the rest of the house having disappeared.

On all of the islands visited more or less attention is given to the cultivation of a large rank-growing species of taro, which has probably been introduced from some of the volcanic islands of other groups where it is indigenous. The taro patches are artificially constructed trenches dug in the sandy soil and usually for some distance into the underlying coral rock and filled with an accumulation of vegetable mold, which lying, as it were, in a more or less impervious basin, is kept constantly moist by the rains. These beds are carefully cultivated and fertilized by household refuse and other materials, the soil from time to time being loosened up and added to by materials sifted through a sieve of cocoanut fiber. At Apamama a spade made of a pearl shell lashed in a cleft stick is used in agricultural operations. Bread fruit grows sparingly, and in general the fauna is more varied than in the Paumotus.

The natives are smaller and of slighter build than those of the Ellice Islands, and their color is somewhat darker and the hair generally straighter and coarser. The men wear a pandanus-leaf mat reaching to below the knees, and the women are clothed in skirts of stripped leaves, which form a very scant covering. As a rule, they are a wild-eyed people, especially the women, and formerly they were fierce and warlike, completely clothing themselves for battle in armor made of closely woven cocoanut-fiber sennet. They are still under the



government of native chiefs, but under the protection of Great Britain. There are white and Chinese traders on a number of the islands, and at Butaritari there is a little colony of whites, mostly Germans.

Between Taritari and Jaluit soundings were made at intervals of about 50 miles, which indicated a remarkable uniformity of depth of between 2,411 and 2,505 fathoms, and at a point 5 miles off the south point of Jaluit atoll 1,937 fathoms was found. Jaluit was reached on January 9, and after a stay of five days, spent in coaling, the expedition left for a cruise through the Marshall Archipelago, the course being through the Ralick chain as far as Rongelab and thence back to Jaluit via the Ratack chain. The following atolls were visited in order: Jaluit, Elmore, Namu, Kwajalong, Rongelab, Likieb, Wotje, and Arhno, stops being made at the last four and at Jaluit.

Twenty-six soundings were made during the exploration of the Marshalls, which indicate that the islands rise rather abruptly from a depth of 2,000 to 2,600 fathoms. A depth somewhat less is found between some of the atolls, but in general the soundings do not indicate the existence of the two extended ridges from which the Ratack and Ralick chains have been supposed to arise. The Marshall Islands are nearly all atolls of considerable size, Kwajalong having a length of about 65 miles, and all of the others visited except Arhno being 30 miles or more on their longest diameter. With hardly an exception their rims are composed principally of reefs awash or but slightly submerged, making them dangerous objects to approach at night or in heavy rains. The islets on the reefs are almost invariably small and in some cases are ranged in a double series, one near the outer and the other near the inner edges of the reef. The studies of the Marshalls, Gilberts, and Ellice islands on the one hand and of the Paumotus on the other supplemented one another in a very satisfactory manner, the former furnishing data concerning the action of the formative agencies producing the several varieties of land masses and the latter exhibiting the characters of the substructure upon which the islets rest. The dynamic studies in the Marshalls and Gilberts are doubtless of general application, but the character of the underlying formations in these groups can not be predicated from the knowledge gained in the Paumotus. The Carolines may in a measure serve as a guide, but the differences between the Society and Paumotus islands, which are even more intimately associated geographically than are the Carolines and Marshalls, induce caution in drawing conclusions based on relations of propinquity.

There are ship passes and anchorages in most of the lagoons, but as they are more or less studded with coral patches it is dangerous to enter them except in bright weather. The *Albatross* was detained over three days at Arhno Atoll on account of heavy rains and overcast skies, which made crossing the lagoon hazardous. Considerable rain was met with in the Marshalls, which appear to have a moister climate than most of the low islands.

The vessel returned to Jaluit on January 29, and a week was spent in coaling and overhauling the machinery. During this and the previous visit the naval officers of the expedition were engaged in making magnetic and astronomical observations and in a survey of that part of the atoll in the vicinity of the anchorage and Southeast Pass. Opportunities for doing such work were few during the cruise, but whenever a chance presented itself it was embraced with enthusiasm. A collection of corals and other biological materials was made at Jaluit and Arhno, but as usual the reef collecting was not prolific, and neither trawl hauls nor tow-net collections were made in this part of the cruise nor afterwards. From the time the ship entered the Paumotus until she left the Carolines specimens were taken by means of the submerged electric light and scoop net whenever she came to anchor in the lagoons or lay to off the islands at night. In the aggregate a good many specimens were taken in this way, and they represent practically the entire pelagic catch after leaving Suva, but being almost invariably taken in the lagoons or close to shore, the proportion of larvæ and immature individuals of reef-dwelling animals is very large. Judging from the appearance of the water and the specimens taken in the scoop net, the pelagic life of the waters west of the Marshalls is richer than among the eastern islands of the Pacific, where more pelagic work was done.

The flora of the Marshall Islands, like that of all atolls, is limited, about equal in richness to that of the Gilberts, but excelling the Paumotus. At Jaluit the white residents have imported several species from the Carolines, but most of them can be made to grow only with difficulty. There are a few bananas, pineapples, limes, and other plants, some of them set out in soil imported for the purpose from the volcanic islands to the westward, and one or two small gardens of European vegetables have been painfully established in the same way. It is almost pathetic to see the struggles of some of the Europeans to surround themselves with the familiar things of their far-away homes and to supply a few vegetables to break the monotony of the diet to which they are necessarily restricted by residence on an atoll.

The breadfruit flourishes better in the Marshalls than in the low islands of the southern groups, and the jack fruit is also common. The natives subsist principally on the cocoanut, the fruit of the pandanus, and fish, although the breadfruit and jack fruit are used to some extent where they have been introduced and taro is grown on some of the islands. Arrowroot starch in cocoanut shells was seen at one or two of the islands, but the pia plant, from which it is obtained, was not observed, and the product may have been imported. During the season when the pandanus is ripe it appears to be almost the sole vegetable food, and piles of the woody portion of the fruit are seen in the refuse heaps of every domicile. It is eaten raw, when it has a sweet taste something like sugar cane, and is also scraped and made into large sheets or cakes, which are smoked and dried for

preservation. As in all of the low islands, the kernel of the cocoanut is eaten, and the oil expressed from the grated meat is used in the compounding of the few "made dishes" affected by the natives.

The Marshall islanders exhibit much skill in canoe building and navigation. The canoes were formerly made of driftwood, as most of the islands did not furnish trees of sufficient size or suitable structure, but material derived from the whites is now used to some extent. The sailing canoes are often of considerable size, and are made of a number of pieces sewed together with cocoanut fiber sennit and calked with pandanus leaves, cocoanut fiber, and the gum of the breadfruit or jack trees. The hull is skillfully designed, and with the large triangular mat sails trimmed close they point up well and are quite speedy. Like all South Sea canoes, they are provided with outriggers, always kept to windward. These islanders also used a chart made of sticks and small shells, indicating the positions of the islands and the currents. They are said to be quite expert in navigating their canoes from island to island by means of these charts, but are sometimes not as successful with the white man's sloop, which is coming more and more into use by the natives, especially the chiefs.

The women are adepts at mat making and often show considerable taste in the border designs, which are worked in black, brown, and yellow, in contrast to the white body color. The material used is prepared pandanus leaves, with another fiber for some of the stitching, and the dyestuffs are of native production. These mats are worn as clothing, the women using two, held at the waist by a girdle to form a sort of skirt, and the men wearing one as a breechcloth. The men also, with ludicrous effect, occasionally wear a pair of garments made of strips of pandanus leaves, one being thrust beneath the girdle in front and the other behind, so that they hang over like a pair of horsetails, reaching to about the knees.

At Jaluit and some other islands the natives, especially the chiefs and their families, dress in clothing fashioned after that of the whites, and at one island the men wear calico petticoats in lieu of trousers.

The Marshall islanders appear to be slightly larger in stature than the Gilbert islanders and with somewhat heavier frames. Their color is also darker, although in this respect our observations do not agree with some of the published statements concerning them. They are less hospitable than the Fijians and Maoris, but everywhere exhibited a friendly disposition. There is much sickness among the islands, usually of a type introduced by the whites, and the German Government has established a hospital at Jaluit, where the natives receive excellent treatment.

During both visits of the *Albatross* to Jaluit, which is the seat of the German government of the Marshall Islands and the headquarters of the several trading companies, the members of the expedition met with the kindest and most hospitable treatment from the Herr Landeshauptmann, his officers, and the white residents.

Jaluit was left on February 5 by way of the Southwest Pass, which has deep water, but is skirted on the lagoon side by a long fringe of reefs. Namorik was passed in the night, and on the afternoon of February 7 the *Albatross* reached Kusaie, the first of the Caroline Islands. A boisterous sea was encountered in this part of the cruise which not only prevented sounding, but made it inexpedient to enter Chabral Harbor, as contemplated, its mouth being open to the full force of the trade winds, and it was nightfall when the ship came to anchor in Port Lottin, the approaches to which were in smoother water. The room in this harbor is circumscribed and the published plan is inaccurate, and a hurried survey was made by the officers of the vessel during the day and a half spent there.

Kusaie, which is 10 or 12 miles in diameter, is a high volcanic island, with its central peak, Mount Crozer, rising to a height of 2,155 feet, and several others almost equaling it in altitude. The shores are largely formed of mangrove swamps traversed by a network of confluent channels and bayous, in which respect it resembles the delta regions of Viti Levu and some of the other large islands of the Fijis, and differs from the Society Islands, where the mangrove was not seen anywhere. Many of the streams of Kusaie have no definite mouths, but in their lower courses become lost in the mangrove swamps. The entire coast of the island is fringed by reefs lying outside of the mangrove swamps and interrupted in but three places by harbor mouths, and, by using the bayous and the shallow channels back of the reefs, canoes can travel around considerable parts of the coast in smooth water, even when a heavy sea is running outside.

The vegetation of Kusaie is dense and varied. Here the vegetable ivory tree, the most majestic of the South Sea palms, was first met with by the expedition. Its fruit is an article of commerce, being utilized in the production of articles for which ivory was formerly used. Fruits and vegetables and some excellent beef were obtained here for the use of the ship.

On February 10, the day following her departure from Kusaie, the *Albatross* reached Pingelap, where she lay to without sending a party ashore. Pingelap is an atoll of irregular shape and hardly 3 miles in diameter. There are three islands on the reef, between which fierce war was formerly waged until one gained the ascendancy and brought all under its rule, since which the population has increased so rapidly that the people can barely support themselves upon the scanty yield of the soil and the fisheries, their only resources. A party of natives, including the chief, who came off to the ship, stated that although the people are all professed Christians, the missionary vessel never calls there, and they are left to the religious ministrations of a native.

Ponape, the capital island of the former Spanish administration of the Carolines, was reached on February 11, and a stop of less than a day was made at Kiti Harbor, on the south side, Jakoits, the northern port and seat of government, not being visited. The inner harbor has

good water and bottom, but the approach through the narrows is much restricted by coral reefs on each side, and as the stay of the *Albatross* was to be brief she anchored in the outer harbor, the entrance to which is easy. Ponape closely resembles Kusaie in its general characters, but is somewhat larger, having a diameter of about 15 miles, with a central peak rising to an altitude approaching 2,900 feet. The reef platform surrounding the island is, however, much broader than at Kusaie, being upward of 2 miles across at Kiti Harbor and much wider on the north shore. There are a number of islands on the reef, some of them of volcanic origin, probably detached portions of the main island, while others, for example those near Kiti Harbor, are, like the islets of typical atolls, composed of reworked coral sand and fragments from the reefs. Behind the sandy islets, which are mostly on the edge of the reef and near the harbor mouths, there is, at least to the eastward of Kiti Harbor, a channel with some depth.

A small river, about 100 feet wide at its mouth and several feet deep, flows into the head of Kiti Harbor, but the entrance to it is so obstructed by a bar that the boats could only enter it with ease near high water. It contains many small fish, though apparently of but few species, and its banks support a rich vegetation. There are several white men at Kiti Harbor and some small plantations of bananas and other fruit trees. The breadfruit, jacktree, and vegetable ivory palm all attain a large size, and the royal poinciana, with its scarlet blossoms on otherwise almost naked branches, was found in abundance.

The last stop made by the *Albatross* in the Caroline Archipelago was at Moen or Uala Island, in the Truk group, which was reached on February 14 and left on February 17. The Truk group consists of about a score of volcanic islands and islets surrounded by a barrier reef, with a diameter of about 70 miles, and supporting numerous low, sandy islets having the appearance, as viewed from the ship, of the islands usually found on atoll rims. The northern part of the reef is said to be much broader than the southern, where it varies from about one-third to one-half mile in width, with many interruptions. The high islands, which are volcanic in formation, vary from 12 miles in length to inconsiderable islets, several of them possessing peaks 1,200 or 1,300 feet high. Each of these islands is surrounded by a narrow fringe of reef, and in fact the group as a whole looks like an exaggeration of the conditions observed at Kusaie and Ponape, the lagoon being merely the reef channel of those islands enormously widened and considerably deepened and surrounding a group of smaller islands instead of one large one.

In addition to the islands at which stops were made, the islands of Andema, Namu, Losap, the Royalist group, and Namonuito were coasted, and their general characters observed from the ship.

The land fauna of the Carolines is much richer in proportion to the land area than in any of the other islands visited by the *Albatross*. In the Ellice, Gilbert, and Marshall islands land birds are extremely

uncommon and of but few species, the avi-fauna being poorer than in the Paumotus. The Society and Fiji islands are progressively richer, but it was not until the Carolines were reached that the woods and thickets seemed full of birds and resounded with their songs and cries. Parrots and pigeons of several species, white-eyes, flycatchers, kingfishers, and many other species were observed at Kusaie, Ponape, and Truk, and the collections, which, in spite of effort, had languished for lack of material after leaving Suva, began to offer some returns to the shooters notwithstanding the brevity of the opportunities, which made it impossible to secure a really representative collection. Two species of herons, seen nowhere else, resembling one another more or less in color, but differing greatly in size, were taken at Ponape.

Four species of bats, three of which are represented in the collections, were observed in the Carolines. Three of them belong to the Frugivora, while the fourth is insectivorous, the only species of its kind observed except at Viti Levu. The fruit bats appear to subsist mainly on the flowers of the poinciana, and especially on the island of Ponape must exist in large numbers, as from one to twenty were seen in almost every tree of that species. Several species of lizards were collected, and it is probable that careful collecting in all parts of the islands would show a much more extensive reptilian fauna than that observed in the eastern islands of the Pacific.

The natives of the several Caroline islands visited differ more or less in appearance and present customs and social conditions. In Kusaie and Ponape they have been brought into more intimate contact with the whites, from whom they have copied their clothing and in a measure their houses. The women wear long loose gowns or "mother hubbards," and the men usually dress in the shirts and trousers—the former, in regulation tropical style, worn outside—and most of them have hats. In Truk, however, this dress, although occasionally seen, is rare, the men wearing a breechcloth reduced to the utmost limit and the women a cincture or loin cloth of cocoanut fiber reaching to the knees. The upper part of the body is usually naked, but is covered on occasion by a sort of poncho, a straight strip of cloth about 6 feet long, with a slit in the middle through which the head is thrust.

The people of Truk, especially the men, are much given to personal adornment. The face is heavily powdered with turmeric, the hair is worn in a high knot on the crown of the head and bound with strips of bright cloth, necklaces of various materials are worn in profusion, and from the pierced and extravagantly stretched lobes of the ears depend looped chains of cocoanut-shell rings, which are often 4 or 5 feet long and form a bunch 6 inches long and 2 inches in diameter.

The natives of Truk are taller and more slender than the people of Kusaie and Ponape. The men are well formed and athletic looking, but with somewhat effeminate faces, owing in a measure to their lavish adornment and the manner of wearing the hair. The younger women are often comely and both sexes are more yellow than the Kusaie

and Ponape people, an effect which is heightened by the profuse application of turmeric to their complexions.

At Kusaie the houses which appear to represent most nearly the native type are built of half-round sticks lashed horizontally to a framework and are thatched with cocoanut leaves. Some of them are elevated on platforms, provided with porches, and divided into rooms, but there is reason to believe that all of these features, excepting perhaps the first, are copied from the whites. At Moen Island in the Truk group the houses are larger, with the ends open or closed by a sort of shed leaning against the main structure. Several families, or the married members of the same family, reside under the one roof, a row of small compartments for their occupancy stretching along each side of the house, leaving a broad central aisle, or hall, which is used as a general living room, workshop, and storehouse. Canoes are housed and sometimes built in the main hall, and the various household utensils and fishing appliances are stored there.

The women of some of the Carolines—e. g., Kusaie and Truk—weave a coarse cloth from the fibers of the banana, which is spun into a thread by rolling several fibers together upon the naked thigh and knotting the lengths into a continuous piece. In Kusaie the warp is laid up on small ornamented benches with pins, and at Truk the same purpose is attained by laying the thread around pins driven into the ground in proper relationships of distance and position. The hand looms are of simple type, alike at the two islands mentioned, but much larger at Truk. The cloth is still extensively used for clothing at Truk, but not so much at Kusaie.

The people of Kusaie and Ponape are mild, peaceable, and friendly, but those at Truk still engage in tribal wars and are said to be warlike and treacherous, a reputation which the members of the expedition believe to be justified. They still fight with spears, but many of them are provided with good firearms.

Six soundings were made, one near Namu Island, where 525 fathoms was found; another about three-quarters of a mile south of Port Lotton, Kusaie, where the depth was 371 fathoms, and four others at places removed from insular influence, which show apparently that the islands of the archipelago rise rather abruptly from a depth of upward of 2,000 fathoms, the extremes being 2,162 and 2,533 fathoms. After leaving the Carolines the soundings gradually deepened until, in latitude  $12^{\circ} 51' N.$ , longitude  $145^{\circ} 46' E.$ , about 100 miles southeast of Guam, 4,813 fathoms was found, but in latitude  $13^{\circ} 08' N.$ , longitude  $145^{\circ} 25' E.$ , approaching the Ladrões, the depth had decreased to 2,337. A few months before, as was learned at Guam, the U. S. S. *Nero*, while sounding out a cable route, had found over 5,000 fathoms somewhere near the same place, and the *Challenger*, during her famous cruise around the world, made a sounding of 4,475 fathoms farther to the westward, but evidently in the same basin, which is established as one of the deepest holes in the world, almost equaling in depth the great Tonga Deep.

Guam was sighted the morning of the 21st of February, and after coasting the eastern, northern, and part of the western shores the ship came to anchor in the harbor of San Luis d'Apra. The coast of the northern part of the island resembles that of Makatea and Niue, with limestone cliffs in places several hundred feet in height, but the southern part is volcanic, and near Agaña contacts were found which indicated that the igneous rocks had burst through the preexisting limestone, though there is reason to believe that some of the elevated calcareous rocks farther south are more recent than the igneous rocks with which they are in contact. The northern part of the island is flat-topped, although considerably eroded, while the southern half is rolling and hilly.

The harbor of San Luis d'Apra is well sheltered, in part by high land and in part by a long stretch of reef with a narrow opening, and since the occupation of the island by the United States it has been thoroughly surveyed by the naval officers stationed there. There is only a small village at the harbor, but a good road leads to the populous town of Agaña, the capital, several miles distant, and a telephone line now connects the two places. Agaña lies on the seacoast, but a reef with but very shallow passes makes it useless as a harbor, except for very small craft. It is built partly in the Spanish style, partly native, and partly a mixture of the two, and under the energetic administration of Governor Leary many of its unsanitary features have been corrected and it presents a clean and orderly appearance. Its principal buildings are the palace and the offices of administration, the barracks, and the hospital, all built by the Spaniards, and which either face or immediately adjoin the parade or plaza in the center of the town. The population is said to number over 6,000.

The island is about 27 miles long and 7 or 8 miles wide, and its general topography has already been indicated. It has a moist climate, not excessively hot, and is fairly well watered; the streams, however, are small and are said to be shrinking as a result of cultivation and the clearing of the forests. Oranges, shaddockes, limes, bananas, bread-fruit, and all the tropical fruits are found, and corn, rice, sugar, tobacco, sweet-potatoes, and other imported plants are cultivated.

The population is a mixed one, consisting of the natives or Chamorros, with a few Filipinos and Caroline Islanders, and a mixture of the first two with Spanish blood. The Americans complain of the extreme indolence of the native population, a characteristic which their Spanish predecessors appear to have recognized, as they imported natives of the Carolines for labor on some of the public works. A small village of Caroline Islanders near Agaña, left stranded by a contractor who had imported them, still maintains in a measure the Caroline manner of living. Most of the people speak Spanish, but some are endeavoring to learn English since the cession of the island to the United States.

The *Albatross* left Guam on February 25, and after coasting Rota,



a high limestone island, laid a course for Yokohama, Japan. The only other island of the long Ladrone chain sighted was the northernmost, Farallon de Pajaros, an active volcano, with an elevation of over 1,000 feet, which, from a distance of 25 miles to the westward, appeared to have steam and smoke issuing from several vents. At its southern end there is a smaller, less lofty portion, either detached or with a low connection with the main island.

On March 4 the *Albatross* came to anchor outside of the breakwater at Yokohama, but she afterwards moved into the inner harbor. Until May she was refitting, repairing engines, and in dry dock at Uruga, but early in that month she proceeded on a dredging expedition in the direction of the Inland Sea. About 70 dredge, trawl, and tangle hauls were made in Sagami and Suruga bays, and the Sea of Ise and adjoining parts of the coast. The work was practically all inside of the 100-fathom line and on the edge of the Kurosiwa or Black Current, the great warm stream which flows from the south along the east coast of Japan and sweeps northward along the Kurils and the Aleutian Chain, where it becomes the great North Pacific Drift. This great stream bears much the same relation to the shores of Asia that the Gulf Stream bears to the east coast of North America, and in the same manner its warm waters bear a rich pelagic fauna, furnishing food and a congenial environment to the host of animals which live on the bottom. The trawling was very good, and rich collections of fish, crustaceans, worms, echinoderms, and mollusca were obtained. Two large tanks were filled with specimens of *Metacrinus*, a "stone lily," formerly rare, and stalkless crinoids of several species were obtained in large numbers. The Alcyonarian fauna is rich and varied and a considerable collection of these beautiful organisms was obtained, and a number of siliceous sponges, including half a score of the beautiful glass-like Venus' flower basket (*Euplectella*), were taken in the trawls. For taking these delicate organisms in an uninjured condition the apparatus used by the *Albatross* is not so good as the long lines used by the Japanese fishermen, which have adventitiously yielded to science the fine collection of sponges in the Imperial University of Tokyo.

The crustacean fauna of the edge of the Black Current and the coastal slopes of Japan is especially rich in the suborders Macrura and Brachyura, to which the shrimps and the hermit crabs, spider crabs, etc., respectively, belong.

After finishing the dredging operations the *Albatross* returned to Yokohama, where she coaled and sailed for Hakodate on June 1. Several trawl hauls were made en route to the latter port and a short and unsuccessful search was made for a reported dangerous rock off Kinkwazan. The ship was much delayed by fogs and reached Hakodate on June 8. After coaling she sailed June 12 for Alaska, where she was at the end of the fiscal year.