determined to 1 part in 5000, or 1 part in 10,000, the result would inspire confidence, or, if it must be, distrust, in our present value for the ratio between oxygen and hydrogen.

These suggestions, necessarily tentative in their nature, are submitted to the American Chemical Society, in the hope of obtaining from those who do me the honor to listen to them or to read them, expressions as to the desirability of making experiment in the lines described, and discussions of the new methods indicated as possible.

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CRUISE OF THE ALBATROSS.
III.

Mr. Agassiz's third letter written from the *Albatross* to Hon. George M. Bowers, U. S. Commissioner of Fish and Fisheries, is dated Suva Harbor, Fiji Islands, December 11, 1899, and is as follows:

We left Papeete, November 15th, after coaling and refitting on our return from the Paumotus. During our trip to Suva we made a few soundings from Tahiti to Tonga, striking the northern extension of the deep basin lying to the eastward of Niue; the depths ranged from 2472 to 2882, the bottom being red clay. This would indicate a greater extension westward of the zone over which the manganese-nodule bottom extends.

After leaving Niue we steamed for the deep hole of the Tonga-Kermadec Deep, about 75 miles to the eastward of Tonga-Tabu, and in 4173 fathoms made a haul with the Blake beam-trawl, by far the deepest trawl haul yet made. The gear was carefully inspected and strengthened as far as practicable by Captain Moser, and it was with considerable anxiety that we laid out 5000 fathoms of wire rope for our haul. Fortunately, everything went off successfully and we landed the trawl safely back on deck. To my great surprise we found in the bag a number of large fragments of a silicious sponge belonging probably to the genus *Crateromorpha* which had been obtained by the *Challenger* in the Western Pacific, but in depths less than 500 fathoms. We also brought up quite a large sample of the bottom; it consisted of light brown volcanic mud mixed with radiolarians.

We decided to trawl at 4173 fathoms rather than wait for a possibly deeper sounding, as the conditions for work were admirable and we did not care to run any risk from a change of weather. After our haul we made a still deeper sounding in the proximity of the 4762-fathom sounding marked on the chart, and found 4540 fathoms with the bottom of the same character as at the place where we trawled. We also took a couple of soundings in the line from Vavau to the southern extremity of the Lau Group in Fiji, but found, as we expected from the soundings given further south, comparatively shoal water, viz., 1381 fathoms. In the channel north of Yangasá, where we crossed the Lau Plateau between Yangasá and Mothe, we found 453 fathoms, with bottom composed of coral sand, pteropod ooze and a few globigerinæ. Between Namuka and Yangasá we obtained 324 fathoms, between Namuka and Marambo 600 fathoms, and between it and Kambara 450 fathoms, and finally about 15 miles west of Kambara we sounded in 990 fathoms. These soundings would indicate a continuous plateau of moderate depths from Wailangolala south upon which the islands of the Lau Group rise.

On our way back to Papeete from the Paumotus we examined the eastern coast of Tahiti, and from Papeete examined the western coast as far as Port Phaeton at Tararao Isthmus. We examined in a general way the Leeward Society Islands: Murea, Huaheine, Raiatea, Tahaa, Bora-Bora, Motu Iti and Maupiti. There are excellent charts of the Society Islands, so that it was comparatively simple to examine the typical points of the group and to gain an idea of their structure as far as it relates to coral reefs. The Society Islands are all volcanic islands edged with shore platforms, some of great width, upon which the barrier or fringing reefs of the islands have grown. The structure of the reefs of the Society Islands is very similar to that of the Fiji reefs round volcanic islands. A comparison, for instance, of the charts of Kandavu, Viti Levu, Mbengha, Nairai, and and of other volcanic islands in the Fijis, with those of the Society group, will at once show their identity. Huge platforms of submarine denudation and erosion characterize both, with fringing and barrier reefs determined by local conditions. Perhaps it is easier to follow the changes which have taken place in the Society Islands; and such islands as Tahaa and Bora-Bora, where we anchored, as well as Maupiti, are admirable examples and epitomes of the structure and mode of formation of the coral reefs of that group.

In Motu Iti and Tetuora the volcanic peaks have disappeared, leaving nothing but a shallow platform upon the outer edges of which sandy coral islets have been thrown up. There is, however, one point in which the barrier reefs of the Society Islands differ from those of Fiji. The barrier reefs in Fiji are generally indicated merely by reef flats, upon which the sea breaks, and an occasional rocky islet or negro-head; only rarely do we find sand keys upon the fringing reefs of the islands of Fiji. In the Society Islands, on the contrary, we find the line of the barrier reef usually well indicated by long lines of narrow islets thrown upon the reef platforms, exactly as they are in the Paumotus. These islands and islets are usually well wooded, and thus give a very peculiar aspect to the barrier reef. In the case of Bora-Bora, Maupiti and Aitutaki, for instance, we have a central volcanic peak of considerable height surrounded by a wide lagoon, the sea edge of which is formed by a fringe of wooded islets and islands forming a more than half-closed ring around the central island which, in Bora-Bora and Maupiti, rise in slopes and nearly vertical walls, the former to a height of nearly 2400 feet, the other about 1100 feet.

The only island of the Cook group which we examined was Aitutaki, as Atiu is composed of elevated limestone, and Rarotonga is volcanic. I hoped we might find that atoll to be in part volcanic and in part composed of elevated coralliferous limestone; we found it to be volcanic, an island with the structure of Bora-Bora on a smaller scale.

We anchored at Niue, an island composed of elevated coralliferous limestone showing three well-marked terraces, the lowest of not more than 5 to 10 feet and in many places disappearing completely, the limestone cliffs rising vertically from the sea well into the second or even the third terraces. The vertical faces of the cliffs are dotted with caverns and deeply indented by small cañons extended at right angles to the face of the shore or forming blunt headlands separating short reaches of coral sand beaches. The second terrace varies in height from 50 to 60 feet, the third from 90 to 100 feet. The second terrace is deeply undercut; and in the higher vertical cliffs extending into the third terrace from the sea, the former positions of the terraces are usually indicated by lines of caverns. There are corals on the sea slopes of the first terrace extending to 10 or 12 fathoms growing much as they are found at Makatea.

From Niue we went to the Tongas, which we found a most interesting group. The elevated tertiary coralliferous limestones take here their greatest development, and are on a scale far beyond that of their development in the Lau Group of the Fijis or the Paumotus. The first island of the Tongas we visited, Eua, is perhaps the most interesting of the islands composed of tertiary elevated coralliferous limestone I have visited. From Dana's account of it, evidently given at second hand, I expected to find an island somewhat like Viti Levu on a very much smaller scale. But as we steamed up to it from the east there could be no mistaking the magnificent face of nearly vertical limestone cliffs forming the whole eastern face of the island, and at points rising to over a thousand feet in height. At all projecting points lines of terraces were plainly marked; at the northern point three could be followed, and at the southern extremity five, with perhaps traces of a sixth.

Upon rounding the southern extremity of the island we could see that the island was composed of two ridges, running north, separated by a deep valley, the western ridge being much lower than the eastern, not rising to a greater height than a little over 500 feet. The western ridge is also composed of limestone, and at the headlands we could trace three terraces. There is a narrow shore-platform along the western face, at many points of which there are blow-holes where the sea throws up spray to a considerable height, but these blow-holes are best seen off Cook Point, the southern extremity of Tonga-Tabu.

As we steamed along the western face of Eua Island, we could see the ridges of the eastern side rising above the crests of the lower ridge, its slopes indicating a valley of considerable size. We anchored at English Roads, opposite the outlet of the drainage of the interior basin where a small river has cut its way through a depression in the shore terrace. On landing we followed the crest of the western ridge for a few miles and could see the whole valley forming the basin of the island lying between the two ridges, at our feet; the slopes leading to the bottom are quite gentle, and the valley dips very gradually northward back of the outlet, on the western shore. Nothing could show more clearly that such an island was not an elevated atoll, but a plateau which has been eroded and denuded for a long period of time by atmospheric and other agencies, and in which a deep basin-shaped valley with gentle slopes has been gouged out—a plateau similar to that of Tonga-Tabu Island and of Vavau, but of greater height and less extent.

To the westward of the Tonga Islands is a line of volcanic islands extending nearly 200 miles from Honga Hapai to Fanualai, some of which have been active very recently. Falcon Island disappeared in 1898 and Lette is still active. This line of volcanoes runs at a distance of from 15 to 20 miles parallel with the trend of the four irregularly shaped plateaus upon which rise the Tonga Islands. They are the summits of a great ridge over 200 miles in length, sloping very gradually to the westward and being somewhat more steep to the eastward, into deeper water, towards the smaller platforms from which rise the volcanic peaks of the group. The plateaus of Tonga-Tabu, Namuka, Hapai, and Vavau, being separated by deep valleys connecting the eastern and western flanks of the ridge. These four plateaus rise abruptly from the 100 fathom line. The extremity of the southern one is occupied by Tonga-Tabu Island. The land behind the cliffs of its southern coast rises to a height of over 250 feet and slopes northward very gradually to form the low land which occupies the north coast of the island, and is, except, at Mount Zion and Cook Hill, not more than from 10 to 20 feet above the level of the sea. At Cook Point (and along the southern coast) three terraces are indicated. The northern coast is deeply indented by shallow bays, full of islands, reef flats, and reef patches, on which corals grow in great profusion. In a distance of nearly 10 miles northward of Nuku-Alofa the plateau is nowhere more than 15 fathoms deep; and a long tongue runs northward, gradually deepening into 20 to 50 fathoms to the 100-fathom line.

The Tonga-Tabu plateau is separated from the Namuka Group Plateau by a funnel-shaped channel with a depth passing rapidly into 300 fathoms from the 100-fathom line. The Namuka Plateau is rectangular. The principal island is Namuka, where we anchored. We found the island to be composed of tertiary elevated coralliferous limestone with a shallow sink, filled with brackish water, occupying the south-eastern part of the island. The sink is separated by a high sand beach, about 200 yards wide, from the sea.

Namuka Iki, the island next to Namuka, we found to consist, at its southern extremity, of stratified volcanic material resembling somewhat the so-called soapstone of Fiji. I was told that other islands in this group, near Tonumeia, in the center of the Namuka Plateau, were volcanic. Mango, as we could see it from our anchorage, appeared to be volcanic. So that this part of the Tongas is, like the Lau Group in Fiji, made up of islands in part volcanic and in part composed of elevated coralliferous limestone. The eastern edge of the Namuka Plateau (which we did not visit) is edged with small low islands. We merely steamed past the western islands of the Hapai Group, but close enough to see that Tongua, Kotu, and Fotuhaa, which are respectively 120, 120 and 200 feet high, are composed of elevated limestone. The eastern flank of the Hapai Plateau is edged with long low islands with extensive coral reefs along the reef flats of these islands.

The Hapai Plateau is triangular, with isolated islands rising on the northwestern side from the deep water separating it from the Vavau Plateau. It is separated from the Namuka Plateau by a narrow channel with over 300 fathoms of water.

The northernmost plateau of the broad ridge of the Tonga Islands is the Vavau Plateau. This is elliptical, with a long tongue extending on the eastern face of the ridge toward the northern point of the Hapai Plateau, ending in isolated banks (the Disney and Falcon banks), lying to the northward of the broad channel, with over 400 fathoms separating it from the Hapai Group. The Vavau Group is by far the most picturesque of the Tonga Islands. It consists of the principal island of Vavau, extending across the northern part of the Vavau Plateau. Several parts of the island of Vavau are finely terraced; four terraces are indicated there, and other flat-topped smaller islands show traces of two or three terraces. The northern edge rises to a height of more than 500 feet, and slopes in a general way southward and inland. The southern shore is deeply indented by bays and sounds and flanked by innumerable islands and islets, some of considerable height (150 to 250 feet), which gradually become smaller and smaller as they rise toward the southward and eastward, these islands having been formed from the denudation and erosion of the greater Vavau. They form tongues of land and sea and sounds of all shapes and sizes, showing the traces of the former land connections of the islands and islets and their disintegration on the eastward and southward by the action of the sea. The islands and islets to the southward of the main islands rise from more or less extensive reef flats which stud the whole plateau, and on which corals grow in great profusion (mainly Millepora, Porites, Pavonia, Pocillopora, Fungia, and Astrea), to a depth of 5 to 6 fathoms in the sound. In the Namuka Group they extended in the more open waters to 14 and 16 fathoms.

It is evident that in the Tonga Group, which is a very extensive area of elevation, the recent corals have played no part in the formation of the masses of land and of the plateaus of the Tonga Ridge, and that here again, as in the Society Islands and Cook Islands, both also in areas of elevation, they are a mere thin living shell or crust growing at their characteristic depths upon platforms which in the one case are volcanic, in the other calcareous, the formation of which has been independent of their growth.

We expect to leave for the Ellice, Gilbert, and Marshall islands as soon as we can coal and refit.

A. AGASSIZ.

THE OCCURRENCE OF APTOSOCHROMATISM IN PASSERINA CYANEA.*

THE following remarks upon the Aptosochromatism of *Passerina cyanea*, although of insufficient importance to establish the phenomenon of color change without moult as a constant occurrence in the species, are conclusive enough, I am convinced, to prove the possibility of such a change, and are merely offered as such for what they may be worth.

Individual error and dogmatism have greatly retarded honest effort in this most important branch of ornithological science. It is a singular fact that certain individuals have conceived the idea that a feather once having passed its premature condition is utterly disconnected with the vital system of the bird, and such individuals cling to this belief with a tenacity wonderful to behold. They do not tell us, by the way, how it is that certain species of birds lacking external sebaceous glands manage to present as bright plumage as their allies so provided. Doubtless they may attribute the presence of oily matters upon the surface of the feathers of those species in which these glands are wanting to osmotic action; but admitting this, why not admit Aptosochromatism?

In his article on alleged changes of color in feathers (Bull. Am. Museum Nat. Hist. 1896), Dr. Allen compares a feather to a green leaf, which when once formed, cannot extend its growth to repair any injuries which may arise from insects, etc. This simile might well be carried yet farther and to better advantage. When the later summer or early fall approaches, certain leaves undergo a complete change in color, resulting in the beautiful colors of our September and October woods. The history of the underlying phenomena of autumnal coloration in leaves is very obscure, yet no one doubts the occurrence of the change for an instant. So it is with Aptosochromatism—the individual feathers undergo in many cases complete color changes, and although the underlying processes of these changes may be obscure, the fact of their presence is to my mind undeniable.

At the present time Aptosochromatism has not progressed far enough to encourage one to take up in detail the systematic occurrence of the color change in our species of native birds. It seems evident that for the present, attention should rather be devoted to endeavoring to demonstrate its fundamental principles, without which no science is firm, plainly evident as may be its happening.

Passerina cyanea, apart from its seasonal fall moult by which the plumage acquired in the spring is changed for the duller garb of the fall, doubtless exhibts two forms of Dichromatism, a term whose proper place, I hope, is now recognized as the fundamental term for the complex phenomena of double coloration. As I shall direct my attention toward proving that Aptosochromatism is concurrent in the species, and Ptosochromatism in the present paper will play an inconspicuous part. Both are compre-

* Read before the Nuttall Ornithological Club of Cambridge, Mass., June 5, 1899, with exhibition of the bird worked upon.