VII.—*On the Relations of the Flora and Fauna of Santa Cruz,
West Indies.*

BY THOMAS BLAND.

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Professor A. Agassiz (Bull. Mus. Comp. Zool., Cambridge, V, Nos. 14, 289, June, 1879) remarks, "One of the most interesting results reached by this year's cruise, is the light thrown upon the former extension of the South American Continent, by the soundings taken while dredging, and those subsequently made in the passages between the islands by Commander Bartlett. These, together with the soundings already known, enable us to trace the outline of the old continent with tolerable accuracy, and thus obtain some intelligible, and at the same time trustworthy, explanation of the peculiar geographical distribution of the fauna and flora of the West India Islands."

Professor Agassiz writes (l. c.): "In attempting to reconstruct, from the soundings, the state of things existing in a former period, we are at once struck by the fact, that the Virgin Islands are the outcroppings of an extensive bank. The greatest depth between these islands is less than forty fathoms, this same depth being found on the bank to the east of Porto Rico, the 100-fathom line forming, in fact, the outline of a large island, which would include the whole of the Virgin Islands, the whole of Porto Rico, and extend some way into the Mona Passage." • • "On examining the 500-fathom line, we thus find that Jamaica is only the northern spit of a gigantic promontory, which once extended toward Hayti from the mainland, reaching from Costa Rica to the northern part of the Mosquito coast, and leaving but a comparatively narrow passage between it and the 500-fathom line encircling Hayti, Porto Rico, and the Virgin Islands, in one gigantic island. The passage between Cuba and Jamaica has a depth of 3,000 fathoms, and that between Hayti and Cuba is not less than 873 fathoms, the latter being probably an arm of the Atlantic. The 500-fathom line

connects, as a gigantic island, the banks uniting Anguilla to St. Bartholomew, Saba Bank, the one connecting St. Eustatius to Nevis, Barbuda to Antigua, and from thence extends south so as to include Guadeloupe, Marie-Galante, and Dominica. This 500-fathom line thus forms one gigantic island of the northern islands, extending from Saba Bank to Santa Cruz, and leaving but a narrow channel between it and the eastern end of the 500-fathom line running round Santa Cruz. As Santa Cruz is separated from St. Thomas by a channel of forty miles, with a maximum depth of over 2,400 fathoms, this plainly shows its connection with the northern islands of the Caribbean group, rather than with St. Thomas, as is also well shown by the geographical relations of its mollusca."

Professor Agassiz gives (l. c.) an extract of a letter addressed to him by Commander Bartlett, from which I quote the following:—"I finished up the line connecting Saba Bank with St. Croix. I found the connection perfect, but the ridge has 700 fathoms water on it near St. Croix. There is 1,000 fathoms three miles north, and 1,800 fathoms five miles south of the ridge."

Professor Agassiz refers to the connection of Santa Cruz "with the northern islands of the Caribbean group, rather than with St. Thomas." As he bases his argument on the deep channel which separates Santa Cruz from St. Thomas, I judge that he excludes the Virgin Islands, of which St. Thomas is one, from the Caribbean group. In that case, in his view, Sombbrero, Anguilla, St. Martin and St. Bartholomew (the three latter on the Anguilla Bank) and Saba (the Saba Bank connected by a ridge with Santa Cruz), are the "northern islands," to which the Professor alludes.

In my paper "On the Physical Geography of, and the Distribution of Terrestrial Mollusca in the Bahama Islands" (Ann. N. Y. Lyc., X, 1873, 320), after quoting some of the views of Professor Dana, expressed in his work, "Corals and Coral Islands," 1872, I wrote as follows:—

"The facts regarding the diminution in size of the islands of the West Indies to the eastward, are of peculiar interest, not only as affording conclusive evidence of the greater subsidence in that direction, but in connection with geographical distribution."

"The banks and islands forming the long Bahama chain diminish in size to the southeast, where are situated at its termination the submerged Mouchoir Carré, Silver and Navidad Banks. In a similar manner, the submerged Virgin Island Bank (with Aneгада on its northeastern extremity, geologically, in the opinion of Dr. Cleve, resembling the Bahamas), Sombrero and the Anguilla Bank, terminate the chain of the West Indies (parallel with the Bahamas) eastward from Cuba."

In a previous paper (Proc. Amer. Phil. Soc., 1871, 57) I endeavored to show, that the land-shell fauna of Porto Rico, with Viéque, the Virgin Islands, Sombrero, Anguilla, St. Martin, St. Bartholomew and Santa Cruz, is unquestionably the same.

My present object is to show that Santa Cruz is connected with St. Thomas, the fauna of both derived from Porto Rico, in common with that of Sombrero and the islands on the Anguilla bank, but by no means with Saba.

Before discussing the statement of Prof. Agassiz as to the connection of Santa Cruz with the northern islands of the Caribbean group rather than with St. Thomas (of the Virgin group), I would first shortly describe the general features of the geology of Santa Cruz, and the character of its flora.

Dr. P. T. Cleve (Proc. Royal Swedish Acad. of Sciences, Stockholm, 1871) remarks:—"The geological formations of the island belong to different ages. The northern mountain ridge is the oldest, and to judge from its great petrographical resemblance with the rocks of the Virgin Islands, it would seem to belong to the same geological age as the latter, or the cretaceous. Upon those highly disturbed strata, very little disturbed beds of coralline limestone and white marls rest; they are probably of the miocene age. The youngest formation consists of detritus swept down from the mountains by rains and mixed with the white marls, and in a recent formation of calcareous sand around the shores." * * *

"The recent formations of the island are partly terrestrial, partly marine. The former covers a great deal of the surface of the island in the plains below the mountains. It consists of detritus and clay, sometimes mixed with white marl. In this detrital mass are found shells of terrestrial mollusca, some of which are of extinct species and some no more extant in St.

Croix, but found living in the islands of Viçque, and Puerto Rico."

To Baron H. F. A. Eggers, scientists are indebted for an extremely valuable paper on "The Flora of St. Croix and the Virgin Islands" (Bulletin U. S. Nat. Mus., No. 13; Washington, 1879), from which I offer extracts. The distribution of the plants has an important bearing on that of the terrestrial mollusca, and the evidence to be derived therefrom as to the former faunal connections of Santa Cruz.

Baron Eggers remarks:—"Looking at the vegetation of St. Croix and the Virgin Islands in its generality, and without entering into details, we may consider it to be identical, showing the same main features." * * * "Yet, in looking more closely into details, we are soon struck by finding a great many species in the one which are not found in the other."

Referring to the list of plants given in his paper, it will be seen, the author says, that "out of a number of 881 indigenous phanerogamous species no less than 215, or c. $\frac{1}{4}$, are found in the Virgin Islands only, whilst 98, or about $\frac{1}{8}$, occur only in St. Croix, thus leaving only 568, or less than $\frac{3}{4}$, common to both." He adds, that it is "in the forest vegetation, which best represents the original flora of the islands, that the greatest and most varied differences are observed, showing especially the great variety of species in the Virgin Islands which are not at all found in St. Croix, and among which are many of the commonest and most generally distributed forms." * * *

"However great are the differences in the flora on the two groups of islands, yet this interesting fact is not due to their possessing endemic species, as all the plants known as growing on them are also found in other West India Islands, especially Porto Rico, whence the vegetation of both the Virgin Islands and St. Croix seems to be derived."

With respect to the question, "Why is it that St. Croix, although the largest of all, has received a comparatively and absolutely much less number of species than, for instance, the far smaller St. Thomas?" Baron Eggers offers the following solution:—"I am thus led to think that, at a former period, all the West India islands have been connected mutually, and perhaps with a part of the American continent also, during which time

the plants in common to all the islands, as well as to the West Indies and the continent, have expanded themselves over their present geographical areas, at least as far as they are not possessed of particular faculties for emigration over the sea. By a subsequent volcanic revolution, St. Croix, as well as many of the other islands, has thereafter been separated from Porto Rico and the Virgin Islands, and put into its present isolated position, which it seems to have retained ever since, whilst the latter group of islands has either still, for a long period, remained in connection with Porto Rico, or, if separated at the same time from it as St. Croix, has, by another revolution, been again connected with the former."

As to the plants now living in Santa Cruz, which have not been found in the Virgin Islands, Baron Eggers desires it to be understood, that whilst his investigations of Santa Cruz have been thorough, his explorations have been less complete, and he feels confident that not a few of such plants may, by closer research, still be discovered in the latter.

I propose, now, to examine the character of the terrestrial mollusca of Santa Cruz, and the evidence which they offer us to the connection of that island with others in its vicinity.

The most important feature is the number of species found semi-fossil only,—several extinct, others still living elsewhere: of the whole, I add the following list.

SEMI-FOSSIL SPECIES, EXTINCT.

? *Chondropoma basicarinatum*, Pfr.

" *chordiferum*, "

The latter, perhaps, a variety of the former.

C. Santacruzense, Pfr., now living in Santa Cruz and St. Thomas, is of much the same type, and may be considered the living representative of *C. basicarinatum*.

In Malac. Blatt., xxi, p. 173, D. F. Weinland described a fossil, from Menke's collection, attributed to Hayti, as *Cyclostoma* (*Tudora*?) *Kuzika*. He sent to me a specimen of it, and I forwarded to him the Santa Cruz-fossil (*C. basicarinatum*), which he considers the same, the habitat Hayti of Menke being erroneous (Jahrb., vii, 1880).

Thelidomus incerta, Fér. This occurs, also semi-fossil, in St. Thomas;—its nearest ally is *T. notabilis*, Shuttl. of St. Jan and Tortola.

Plagioptycha Santacruzensis, Pfr. Allied closely to *P. nemoralina*, Pet., of St. Thomas, St. Jan and Tortola.

Bulimulus extinctus, Pfr. Near to *B. elongatus*, Bolt., which inhabits Porto Rico, the Virgin Islands, islands on the Anguilla Bank, several of the northern Caribbees, Curaçao and Buen Ayre.

Bulimulus Riisei, Pfr. This can scarcely be compared with any known West Indian form.

Strophia rudis, Pfr. var. *latilabris*, Pfr. Allied to species now living in Porto Rico and in several of the eastern Virgin Islands.

SEMI-FOSSIL SPECIES, EXTINCT IN SANTA CRUZ, BUT LIVING ELSEWHERE.

Chondropoma Tortolense, Pfr. A specimen from Santa Cruz, in my cabinet, I referred to this species, which now inhabits Tortola and several of the more eastern Virgin Islands.

Caracollus caracolla, L. This species is found living in Porto Rico and Viéque; it is nearly allied to *C. sarcocheila*, Morch, *C. insititia*, Shuttl., and *C. excellens*, Pl., of Hayti.

In my Catalogue, Ann. N. Y. Lyc., vii, 1861, I included *C. marginella*, Gmel., as occurring semi-fossil in Santa Cruz, but erroneously, as I was assured by the late Mr. Robert Swift.

Surcinea approximans Shuttl.—I referred a specimen in my cabinet to this species, which occurs in Porto Rico, the Virgin Islands, and several of the Caribbees.

SPECIES NOW LIVING IN, AND PECULIAR TO, SANTA CRUZ.

Cistula rufilabris, Beck.—Allied in many respects to *Chondropoma Julioni*, Pfr. of Sombrero.

Cylindrella chordata, Pfr. (*Trachelia*.)

SPECIES NOW LIVING IN SANTA CRUZ AND ELSEWHERE.

Chondropoma Santa-cruzens, Pfr.

- *Microphysa vortex*, Pfr. Also, St. Thomas.
- *Bulinulus fraterculus*, Fér.
- *B. elongatus*, Bolt.
- *B. marginatus*, Say.
- *Pupa pellucida*, Pfr.
- * *Succinea Riisei*, Pfr.

With regard to the genera of the semi-fossil species, I may remark, *Thelidomus* is characteristic of Cuba and Jamaica, is represented in Porto Rico and the Virgin Islands, but has one species only in the Caribbees, *T. discolor*, Fér.

Plagioptycha belongs to Hayti, and *Caracolus* to Cuba and Hayti, with a representative in Porto Rico, but neither in the Caribbees.

Strophia, with numerous species in Cuba and the Bahamas, several in Hayti, Porto Rico and the Virgin Islands, does not occur in the Caribbees. One species, however, lives in Curaçao and Buen Ayre. The impression only of a species, is found in the phosphatic lime-rocks of Sombrero.

* These species, more or less widely distributed, cannot be said to be characteristic of the faunas of any of the islands.

The discovery of a submarine ridge, connecting Santa Cruz with Saba is interesting; but its geological age is as uncertain as is that of the deep chasm now separating Santa Cruz from St. Thomas.

I have shown, conclusively, I think, that the land-shells supply abundant evidence of the former connection of Santa Cruz with St. Thomas, and the other islands of the Virgin group, but none of its connection with Saba.

A variety of *B. fraterculus* occurs in Saba, and a *Succinea*, which I believe to be *Riisei*, with several of the widely distributed *Stenogyra*, and *Helicina picta*, Fér., belonging to the Caribbean fauna, is also found there. Very recently I have received from thence, through the kindness of my friend, Mr. F. A. Ober, many specimens of *Amphibulima patula*, Brug., hitherto known only from St. Christopher, Dominica and Marie-Galante.

The five-hundred-fathom line mentioned, embraces Anguilla, St. Martin, and St. Bartholomew, but their land-shells are far more allied to those of Porto Rico and the Virgin Islands than to Caribbean species. *Macroceramus signatus*, Guild., occurs in Anguilla and St. Bartholomew, in several of the Virgin Islands, and in Hayti,—the genus is not represented in the Caribbees.

Pineria Schrammi, Fisch., of Guadeloupe, which I believe to be identical with *P. Viequensis*, Pfr., of Viéque and Barbados, inhabits each of the three islands on the Anguilla bank.

With regard to changes of the flora and fauna of Santa Cruz, two causes have been suggested, but entirely under misapprehension, and I deem it desirable to place the facts on record.

The Rev. John P. Knox, in his "Historical Account of St. Thomas, W. I." (New York, 1852), relates circumstances connected with the establishment of a French colony in Santa Cruz, in 1650. The settlement, he says, proved at once very unhealthy. He adds:—"In order to arrest the mortality which was so rapidly thinning their numbers,—a mortality which arose from the dense and aged forests that covered the island, scarcely affording an opportunity for the winds to carry off the poisonous vapors with which its morasses clogged the atmosphere,—

the colonists who remained, set fire to the woods, and, going on board their ships, became spectators of the conflagration. They returned on shore after the flames were extinguished."

Mr. Alfred Newton, in "Observations on the Birds of St. Croix" (*Ibis*, I, 59, 1859), quotes Knox's account of the conflagration, and in his remarks rather amplifies it.

"That the simultaneous and sudden destruction by fire of all the woods on an island like this, would have a marked and lasting effect upon its fauna, no one can doubt; and one of its results may probably be traced in a fact ascertained by Herr Apothek Riise, of St. Thomas, that in St. Croix there occur the dead shells of about a dozen species of terrestrial molluscs, of which he has never found a single example inhabited by the living animal, though they are undoubtedly recent and not fossil forms. It is difficult to account for the extinction of so many species, unless it may be presumed that the changes brought about in the island by so great a fire, rendered it unsuitable for their longer habitation."

I called the attention of Baron Eggers to this subject, and he entirely discredits any such general conflagration. He informed me, that old Père Labat, when in 1700 he visited the island, after its having been given up and abandoned by the French in 1676, found it entirely covered with wood, as did also the first Danish settlers who, in 1739, went over there to found their plantations.

The destruction of the species of mollusca referred to, must rather be attributed to geological changes.

In the Bulletin of the Torrey Botanical Club (N. Y., IV, No. 2, July, 1873), a communication appeared from Mr. F. Hubbard, on the subject of the desiccation of Santa Cruz. He wrote:—"At my former visit, twenty-seven years ago, the dessication (of Santa Cruz) had undoubtedly made some progress, but it had not been sufficient to make itself manifest in a very marked degree. The change from fertility to barrenness, which at first must have been almost imperceptible, is no doubt taking place in an accelerating ratio." He adds:—"The final depopulation of this beautiful island seems now to be written indelibly among the decrees of fate."

Baron Eggers informs me, that the year 1873 was an uncommonly dry one, as had been, also, 1872, and as was 1874. The effect of the drought was, he says, very plainly to be seen, but since, there have been not less than three or four very wet years, and the island at present (March, 1880) is as green as ever.

Baron Eggers remarks :—"There can be no doubt that, compared with St. Thomas, Santa Cruz is more favored with moisture than the reverse; its forests are still of some extent, and trees are not removed in the latter as in former times, when the land was continually cleared more and more to satisfy the increasing demand for sugar."

At the end of last century, he says, there were 27,000 acres in cane cultivation, now there are only 17,000. The difference of 10,000 acres is again overgrown with trees, shrubs, grass, etc.

The so-called desiccation of the island of Santa Cruz can, in fact, be no more accepted than the conflagration caused by the French colonists, as sufficient sensibly to affect its flora or fauna.