HISTORY OF BARBADOS.

PART III.

REMARKS ON THE GEOLOGICAL STRUCTURE OF BARBADOS, AND A SKETCH OF ITS NATURAL PRODUCTIONS.

CHAPTER I.

GEOLOGICAL DESCRIPTION.

GEOLOGY, in a circumscribed meaning, is the science which makes us acquainted with the structure, materials, relative position and arrangement of the solid crust of the globe; but in a higher sense of the word it is that science which, according to the reasoning and investigation of man, gives an account of the "successive changes that have taken place in the organic and inorganic kingdoms of nature[1]." It is the history of our planet. As some important event, the occurrence of which we find chronicled in the pages of the past, conveys to us the cause of the rise and fall of nations and the extinction of languages, so the forms of valleys and mountains, the configuration of coasts, speak in as legible a language, to those initiated in the book of Nature, of former convulsions and of changes which lie as distant, geologically speaking, from our present time as the historical event which was the cause that certain parts of Europe are now inhabited by Celtic, Teutonic or Gallic races.

Time, however, as understood in the every-day occurrences of life, comprises in a geological view a much greater space than, baffled by a limited knowledge and fettered by prejudices, we are able to express[2]. The

[1] Principles of Geology, by Charles Lyell, M.A., F.R.S. Seventh edition, London, 1847, p. 1.

[2] One of the greatest difficulties that geology has had to contend with, is the reproach that this science is opposed to Scripture Revelation. I cannot combat such an assertion in a more persuasive way than by quoting the words of the excellent Chalmers. After reproaching such a supposition, he says, "Let no one, therefore, be checked in his inquiries into the history of the globe by anything but the good

vastness of the science of geology, which combines the higher branches of physics and the history of organic and inorganic nature, assigns to it a place near astronomy, that science which carries us to the regions of infinity and the immensity of space. Thus the sublimity of Geology extends its views and researches into regions and ages more remote than any recorded by man; and the novel and unexpected truths unfolded during the progress of the science have opened to the view myriads of ages, conveying to our mind more distinctly the omnipotence of the Almighty than had hitherto been attempted by human knowledge; and hence it has been emphatically termed the sister science of Astronomy.

These few observations on so great a subject must suffice to introduce those remarks on the island of Barbados which are intended to describe its geological structure.

The smaller islands of the West Indian archipelago, called the Caribbee Islands, geologically considered form two groups; the western group is volcanic, and the other to the east consists for the most part of calcareous rocks. I have already alluded to the curve which these islands form with regard to their situation; and it is a remarkable fact that the outer islands, which are exposed to the direct action of the Atlantic, are calcareous, while the inner islands are volcanic. Hence Anegada, Anguilla, St. Martin[1], Barbuda, Deseada, and the windward part of Guadaloupe, Mariagalante, Barbados and Tobago, are calcareous; while St. Eustatius, St. Christopher, Nevis, Montserrat, Guadaloupe, Dominica, Martinique, St. Lucia, St. Vincent and Grenada form the volcanic series. Leopold von Buch considers this group as standing in immediate connection with the primitive ranges of the Caraccas; and he is inclined to believe that, if we were better acquainted with the region to the east of the Magdalena, and with New Granada and the Caraccas, we might find an uninterrupted connection of the volcanic chain between the Caribbee Islands and the Andes.

Barbados is the most eastern of the calcareous chain; the general outline and aspect of this island has already been described in the third chapter of the First Part of this History: it remains now to give, as far as the limits of this work permit me, a sketch of its geological structure, and of the mineralogical character of its rocks.

rules of philosophical induction, which are essential to the right use of the intellectual strength which God has conferred upon man, to be exercised on the mighty works of nature; and least of all let him be deterred from the pursuit of truth by the vain and impious dread that he may go too far, and penetrate too deeply into those mysteries, which among their other uses have this one, namely, that they continually excite to activity the soul of man; and the more they are studied, lead to deeper delight and more awful contemplation of their glorious and beneficent Author."

[1] I am not quite certain whether the island of St. Martin belongs to the calcareous group.

The first aspect of Barbados leaves no doubt, even to the casual observer, that its origin is to be traced to the labours of the coral animals. It presents one of the most remarkable instances of a coral island, which, by gradual and successive elevatory movements, has been raised to a height of nearly twelve hundred feet above the sea. Mr. Darwin, in his interesting work on Coral Reefs[1], has divided their structure into three classes, namely into the atoll, the encircling and barrier reefs, and the fringing reefs. Instances of the latter kind are very numerous in the West Indian archipelago, and the nature of a coral island composed of dead coral, and fringed by a reef of living polypifers, is perhaps best exemplified in the island of Anegada. The surface of that island is almost flat; only here and there rises a little mound; and some depressions on the western half and south-eastern point are formed in extensive ponds, some above a mile in length, resembling lagoons[2]. The rock consists of dead coral hardened into a compact calcareous mass, and the whole island has the appearance of having been raised above the surface by one great submarine convulsion. Barbados, on the contrary, proves by its structure that the elevatory movement was interrupted by periods of rest, and hence the step-formed terraces, which, as far as I know, have no parallel in other coral islands[3].

It is certainly curious, if not startling, to a person who has not devoted his attention to the structure of our earth, that a considerable portion of its surface is the result of organic secretion, and that the same process still continues in operation in the warmer regions of the globe, rarely extending beyond the tropical zone[4]. The observations of modern voyagers, and chiefly those of Mr. Darwin during the interesting voyage of her Majesty's ship 'Beagle' round the world, have thrown much information on the structure of coral islands; and it is now believed that the coral-forming polypi began to build on submarine ridges and rocks at a moderate depth; and that while they were yet at work, "the bases on which the reefs first became attached slowly and successively sank beneath the level of the sea, whilst the corals continued to grow upwards[5]."

The structure of Barbados offers several features difficult to reconcile with this theory, which prove that it belongs to the fringing reefs. The island appears under two very distinct features, namely,—

[1] The Structure and Distribution of Coral Reefs, by Charles Darwin, M.A., F.R.S. London, 1842.

[2] Remarks on Anegada, Journal of the Royal Geographical Society of London, vol. ii. p. 152.

[3] Mr. Darwin informs me that something similar, though probably not in such a degree, has been observed in the Pacific.

[4] The small group of islands called the Bermudas, in latitude 32° north, form an exception. It is however considered that the waters of the Atlantic, warmed by the Gulf-stream, possess a similar temperature as the seas under the tropics.

[5] Darwin's Coral Reefs, p. 98.

A. Coralline limestone, with beds of calcareous marl, containing recent shells in large numbers and many species.

B. Strata of siliceous sandstone, intermixed with ferruginous matter, calcareous sandstones, siliceous limestones, different kinds of clay, selenite, earthy marls, frequently containing minute fragments of pumice, strata of volcanic ashes, seams of bitumen, and springs of petroleum (Barbados tar). For the sake of definition I will call this formation, which is peculiar to the district called "Scotland" in Barbados and "Below Cliff," the Scotland formation.

A. Coralline Limestone.

The coralline rocks constitute the great bulk of the superficial area of Barbados, and occupy six-sevenths or about ninety-one thousand acres, while the Scotland formation occupies only about sixteen thousand acres. The characteristic feature of the coralline formation, chiefly when viewed from the west, is an elevation rising progressively in the form of terraces to the highest ridge of the island. The following diagrams represent (fig. 1) a section supposed to be drawn from near Payne's Bay through Dunscomb to Mount Hillaby and Chalky Mount; and fig. 2, a section from South Point through the Rising Sun, the Valley and Windsor to near Drax's Hall[1].

Fig. 1.—*Section from near Payne's Bay through Mount Hillaby to Chalky Mount.*

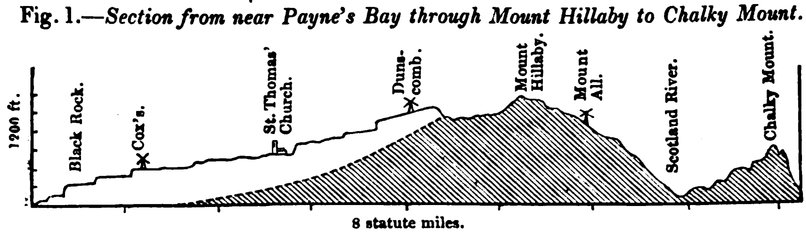
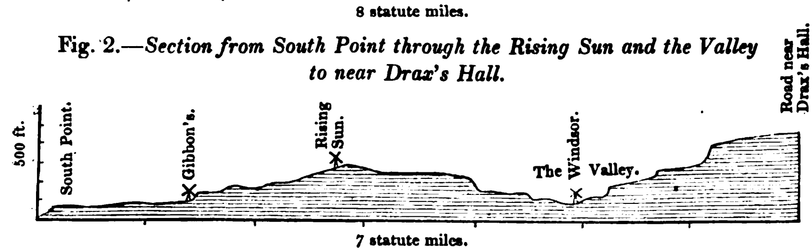


Fig. 2.—*Section from South Point through the Rising Sun and the Valley to near Drax's Hall.*



These terrace-like cliffs are precipitous, frequently wall-like, and in some instances, as for example near Black Bess, Rock Hall and Mangrove Pond, above one hundred feet high. They are so vertical, that when the observer is standing on the edge, their base may be seen straight down below:

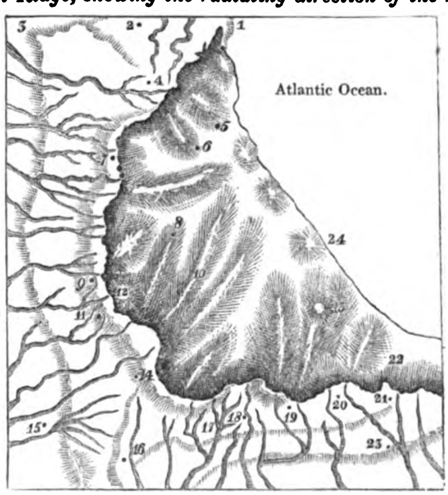
[1] The sections are true to the scale in a horizontal direction, but not in a vertical one, as the form of the terraces on so small a scale would have been lost. The vertical scale is five times increased in comparison to the horizontal one. A section of the island, from the northern to the southern point, on a true scale, is engraved on the topographical map.

they are traversed by deep fissures or ravines, which radiate from the high semicircular ridge of the coralline formation in a very regular manner to the west, north and south, but not to the east, where the coral-rocks end abruptly. The Scotland hills stretch their ridges from this high elevation as it were towards a central point. The gullies open at their head only in a few instances to the east, as at Welchman's Hall Gully and Castle Grant Gully. These numerous ravines, some of which, as at Apes' Gully, present perpendicular walls of about one hundred and fifty feet, serve at present as watercourses. The intersides and protuberances, or their salient and retiring angles, are so regularly shaped, that they would fit in some instances if it were possible to bring them together. It has been asserted by Hughes[1], and more recently by a writer in the 'Barbados Agricultural Reporter,' that the direction of these ravines is undeviatingly east and west. This is erroneous, and the remark holds good only of those ravines which have their origin on the crescent-like ridge between Granade Hall and Apes' Hill. The ravine which has its head to the north of Granade Hall takes a north-west direction, and another between Woodbury and Ellis' Castle stretches northward to Pumpkin Hill, and from Spring Hall north-east to River Bay. The ravines near High-land, Lion-castle, Sturge's, Castle Grant, &c., run to the south; those near Saltram, Malvern, the Guinea and Woodland, to the south-east,—proving my former observation, that they radiate from the crescent-like ridge which commences near Hackleton's Cliff, and sweeps round Chimbarozo[2], Sturge's, Gregg's Farm, the Spring, Red Hill, Granade Hall, Mount Nicholas and Mount Stepney, which line designates the highest ridges in the island, and encircles the Scotland formation.

Fig. 3.—*Map of the Central Ridge, showing the radiating direction of the ravines.*

References.

1. Pico Teneriffe.
2. Lambert's.
3. Mount Gilboa.
4. Nicholas Abbey.
5. Morgan Lewis.
6. Overhill.
7. Prospect.
8. Bawden's.
9. Spring Head.
10. Mount All.
11. Apes' Hill.
12. Mount Hillaby.
13. Bissex Hill.
14. Dunscomb.
15. St. Thomas' Church.
16. Belair.
17. Sturge's.
18. Mount Wilton.
19. Castle Grant.
20. Marshal Hill.
21. Malvern.
22. Hackleton's Cliff.
23. Villa Nova.
24. Chalky Mount.



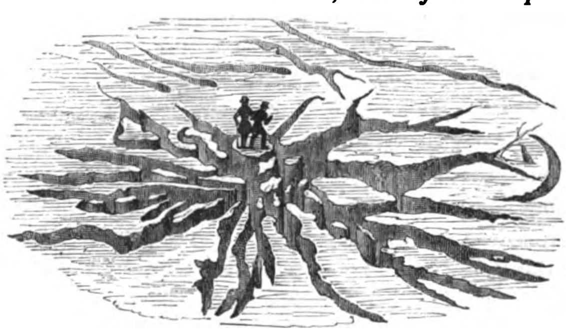
[1] Natural History of Barbados, p. 4.

[2] It is called so in the island, although erroneously if named after Chimborazo in Quito.

We cannot ascribe these ravines entirely to the effect of currents, however numerous the proofs we possess of their powerful effect. If the direction of the ravines were undeviatingly east and west, we could have no doubt that they were caused by currents of the sea, and owed their prolongation to the gradual rise of the land from one level to the other, and to the force of accumulated masses of rain-water which effected forcibly a passage to the sea. But their remarkable and regular radiation prevents such a supposition, as currents do not exert their force from a given point in all directions, however great their violence may be. Nor can we possibly ascribe their origin to the action of running fresh-water. On the small extent of the superficial ground which the central ridge presents, and which does not amount to ten square miles, there could never have collected such a mass of water as to cause these numerous and deep ravines (some of them a hundred feet in depth), the greatest number of which have their origin on the highest table-land.

The rending and fissuring of the ground in countries which have been exposed to earthquakes, is ascribed to a violent movement from below upwards. During the earthquake in Calabria, the ground near Jerocarne "was lacerated in a most extraordinary manner; the fissures ran in every direction, like cracks on a broken pane of glass, and as a great portion of them remained open after the shocks, it is very possible that this country was permanently upraised." I quote this passage from Mr. Lyell's 'Principles of Geology'[1], where it is illustrated by a sketch, of which I give the outlines: the size of the figures will convey some idea of the comparative size of those fissures. If now we compare the small map (fig. 3)

Fig. 4.—*Fissures near Jerocarne in Calabria, raised by the earthquake of* 1783.



on the preceding page with the above sketch, the analogy between the radiation of the fissures caused by the earthquake, and the direction of the ravines or gullies in Barbados, is very remarkable. I would not assert it as my opinion that these gullies, as we find them at present, were caused along their whole extent by a subterranean convulsion. The cracks having been opened, the waves, and at a later period the accumula-

[1] Seventh edition, p. 457.

tion of fresh running waters, prolonged them at successive levels. I was greatly confirmed in my opinion respecting their origin by an interesting report of Mr. W. Hopkins on the Theory of Earthquake Movements, which contained a theoretical investigation into the nature of the mechanical effects that would result from the action of such forces[1], and among which the radiating effect from a focus was particularly dwelt upon.

I consider the heights near Gregg's Farm, Mount Misery, and Marshal Hill, that part of the island which by an elevatory movement was first raised out of the water. The reef-building polypi require to be constantly submerged or washed by the breakers; hence as soon as their structure rose above the level of the sea, it caused their death, but the solid masses of their fabric stood for ages. A period of rest in the movement exposed these cliffs to the action of currents and the devastating effect of breakers, and gave them a precipitous form. The gradual elevation of the submarine mountains enabled the labourers to commence their work anew upon their slopes, which were still submerged, and another reef was formed, which, where it fronted the sea, inclined at a higher angle, and was more compact, from the circumstance (proved by every coral-reef to this day) that the corals grow most vigorously on the outside. The interval between that barrier and the first terrace, now above the water, was partly built up by the polypi, partly filled by the heaping up of fragments washed from the outer barrier inwards, and by accumulations of drift matter brought by the currents. If another period of rest ensued, the denuding power would exercise a similar effect, until the island, thus elevated step by step, obtained its present form. The devastating effect of the sea in our times may plainly be seen on those long lines of cliffs which skirt the Atlantic in the parishes of St. Philip, St. Lucy, and even on the leeward shore, though on a smaller scale, near Bat's Rock, Reed's Bay, &c.

If an elevatory movement similar to those of former periods were now to take place, and the reefs called the Cobblers, which extend at present to a distance of nearly three miles from the land, were to be raised twenty feet above their present level, the escarpments at Cummin's Hole, and near the Animal-flower Cave[2], which are comparatively smooth and almost perpendicular, would then offer a similar appearance to the cliffs near Black Bess, the Rock, &c. The interval between the outer edge of the Cobblers and the present beach would consist of undulating surfaces, basin-like excavations, filled up with sediment and fragments of delicately branched corals, broken-off branches of the larger species, shells, calcareous sand, &c., just as we find now on the plateau of the terraces when digging for any depth into the ground[3]. Such hills as Grand View in

[1] This report was read at the meeting of the British Association for the Advancement of Science, in Oxford, on the 29th of June 1847.

[2] See *ante*, pp. 218, 225.

[3] The sloping ground between the successive terrace-elevations and the table-lands

the parish of St. Thomas, Mount Alleyne, and Mount Standfast, which rise considerably above their respective plateaux, may have been formed by partial upheavings, by slow and little starts.

The coralline structure rests on earthy marls and on clays. This is evident in Skeete's Bay, at the conical hill called Pico Teneriffe, near Granade Hall, &c. I have found no instance where the marls and clays of the Scotland formation have been superposed upon the coralline limestone; and this circumstance authorizes the supposition that the coral-forming polypifers began to build on a submarine formation of the Scotland rocks while still submerged.

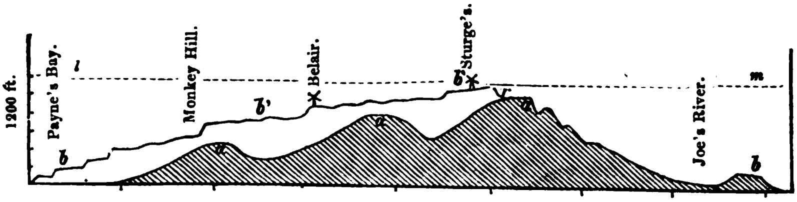
The experiments of Mr. Darwin at Keeling Island, to ascertain the depths at which reef-building polypifers live, have shown him that in ordinary cases a depth of from twenty to thirty fathoms probably indicates the limits of the vigorous growth of corals, and Mr. Dana observes that "twenty or perhaps sixteen fathoms will include very nearly all the species of the Madrepore and Astræa tribes;" Kotzebue found living beds of coral in twenty-five fathoms. MM. Quoy and Gaimard assert that coral animals commence the formation of their structure at a very limited depth, and that they never found any fragment of the genus Astræa, which they consider to be the most efficient in building reefs, at a greater depth than thirty feet. This statement has been quoted so frequently, that, previous to the researches of Captains Beechey and Moresby and of Mr. Darwin, it was usually taken as an incontrovertible fact. It is now proved "that in several places the bottom of the sea is paved with massive corals at more than twice this depth, and by sounding at fifteen fathoms (or thrice the depth) off the reefs of Mauritius, the arming of the lead was marked with the distinct impression of a living Astræa[1]."

The great depth of the masses which are composed of coral rocks in Barbados far surpasses the limits which even Mr. Darwin has given as the greatest depth at which the polypifers construct their fabric; but a close investigation of the mural cliffs of Barbados will prove that they do not consist of a mass alike compact, but of an accumulation of calcareous matter, exuviæ of the coral animals, cemented together by carbonate of lime, and frequently hardened into a compact limestone with conchoidal fracture and translucent edges. The following diagram will explain my opinion respecting the structure of these great masses of coral rock, which have in some instances been perforated to a depth of two hundred and forty feet, without finding any other rock than coralline limestone.

possesses numerous depressions, which have been deepened in many instances by art, and are used as reservoirs for rain-water. One of these cavities near Castle Grant is of great depth; and Sober's Bottom, in St. Philip's, is, according to tradition, bottomless. This is not probable; the depression must be however of great depth to have given rise to the idea.

[1] Darwin's Coral Reefs, p. 84.

Fig. 5.—*Section from Payne's Bay through Sturge's to Joe's River.*



8 Statute miles.
l, m. Supposed ancient level of the sea.
b, b', r, b. Contour of the ground.
a, a, a. Supposed submarine elevations during former ages.
r. A point 120 feet below the surface of the sea.

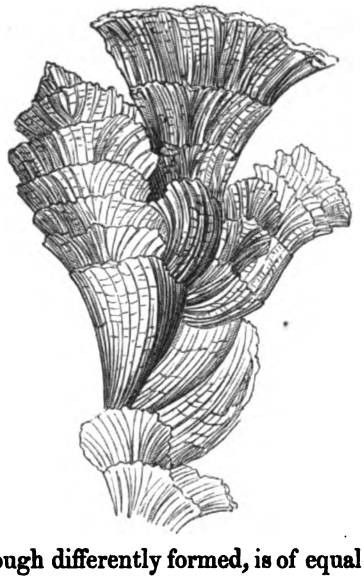
The line *b b' b' r a b,* is a section of the island of Barbados from Payne's Bay to the mouth of Joe's River, on a similar scale as fig. 1 at page 534; *l m,* the ancient level of the sea before any part of the island had emerged; *a a a* (supposed) submarine elevations, of which the point *r* was one hundred and twenty feet below the level of the sea, when the reef-building polypifers commenced their structure on the slope of the submarine elevation, and continued building upwards. While this was going on, dead corals were broken off from the reef and fell to seaward upon the slope of the island (between *a* and *a*). This in the course of ages became masses of great vastness, and by chemical precipitation assumed the appearance of compact limestone; while the sedimentary matter derived from the decay of the corals and the drift-matter of currents added to its thickness, until it reached the point where the coral animals commence building, and those active architects then constructed their fabric likewise upon the debris of former races. Let then a gradual elevatory movement have taken place with intervening periods of rest, during which the land where it bordered the sea was exposed to the destructive powers of the waves; it would then follow that the cliffs were rendered smooth, while the fragments torn off fell upon the slope of the submarine elevations. This process being continued at subsequent periods, the thickness of a thousand feet of coral matter being thus accumulated, cannot be considered any difficulty, for in the carboniferous formation of South Wales strata to the amount of above twenty thousand feet, including much limestone, have been piled up within our geological period. If therefore we could procure a vertical section at the points *b' b'* between *a a,* we should have a thickness of four hundred feet, of which the base would consist of debris formed into limestone, and the upper part of solid reefs. The elevations *a a* are merely imaginary; nor is there any necessity that such should exist, as the point where the coral sediment accumulated might lie beyond the limits of the present skirts of the island. This would explain why hitherto nothing but coralline limestone and calcareous marls with clays have been found, either on the surface or in digging wells over the ninety-one thousand acres which form the coralline portion of the island.

It is certainly wonderful, if we examine the soft and almost gelatinous bodies of these minute creatures, to ascribe to their construction those numerous islands which are scattered for thousands of miles over the space of the ocean[1]. "Let the hurricane tear up its thousand huge fragments, yet what will that tell against the accumulated labour of myriads of architects at work night and day, month after month[2]?"

The beauty and regular structure of some species of Astræa are very remarkable; they are frequently exposed where cuttings have been made for the construction of roads. The variety of the branching stems, expanding fanlike, convey in their present state but an imperfect idea of the picture which they must have presented when the numerous inhabitants were all alive and their fabric clothed in vivid colours.

At Two Miles' Hill the road has been cut through the coral rock, and the cutting on the left-hand side on ascending presents an *Astræa* imbedded in the rock, six feet eight inches high and four feet in breadth, of which the following figure is a sketch; and near Sandy Lane is

Fig. 6.—*Astræa, at Two Miles' Hill.*



another, which although differently formed, is of equal interest and almost similar in size.

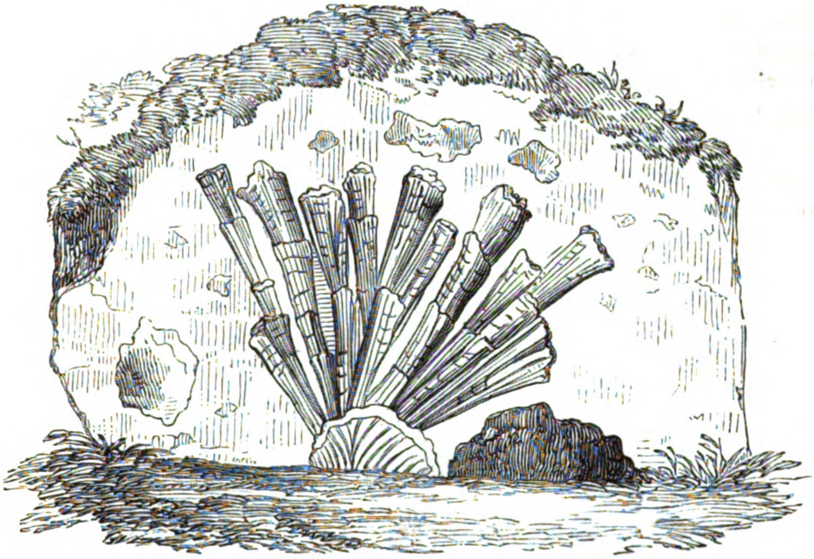
If now I adopt the theory which I have endeavoured to explain, I come to the following conclusions respecting the structure of the coralline formation as it is now presented to our view.

[1] "Look at the space of ocean," says Darwin, "from near the southern end of the Low Archipelago to the northern end of the Marshall Archipelago, a length of 4500 miles, in which, as far as is known, every island, excepting Aurora, which lies just without the Low Archipelago, is atoll-formed."

[2] Darwin's Journal of Researches, p. 460.

These terraces, which we may consider as having formed in times past the outer edges of the reefs, present one of the most interesting instances

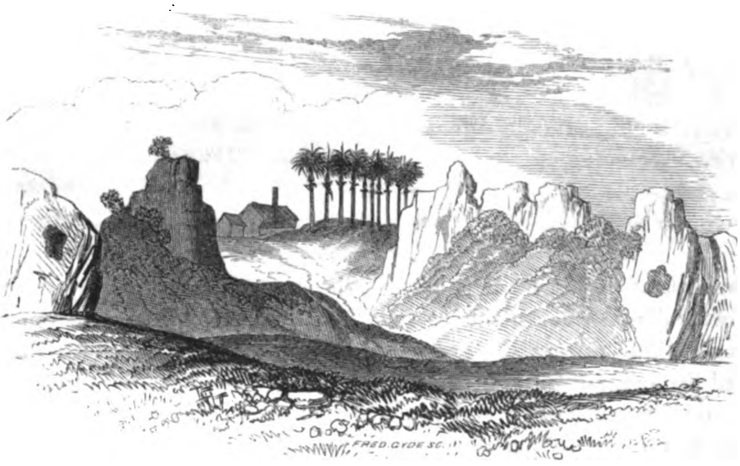
Fig. 7.—*Astræa, in a coral bank near Sandy Lane.*



illustrative of the theory of a gradual elevation, with intervening periods of rest and subsequent denudation. The structure of Barbados renders it obvious that during the gradual and slow elevation which ultimately raised the summit of Mount Misery to a height of nearly eleven hundred feet, six long periods of rest intervened, during which the terraces that are now so distinctly traced were formed. I have already alluded to the highest summits which first raised their heads above the ocean, and the perpendicular cliffs of which denote the first period of rest. The cliffs near Dunscomb, Fortress and Belair, correspond with those to the northward near Ellis Castle and Gay's, and to the eastward with those above Ashford, the Chapel of the Holy Innocents, the Moravian Station, and Blackman's Mansion-house, and give evidence of another period of rest. Near Indian Pond, Belmont and Villa Nova extends a third terrace, between which and the opposite line of cliffs near Golden Ridge and Ashford, the valley called Sweet Bottom intervenes. This valley, at the time these cliffs were raised above the ocean, formed a strait, between the northern portion of the island and the little islet to the south, on which Golden Ridge, Ashford and Lemon Arbour are now situated.

One of the most extensive and characteristic terraces is that which stretches from Reed's Hill for nine miles northward to Mount Gilboa, ten miles eastward along Locust Hall, Gunhill and the Mount to Point Moncreiffe, and from thence sweeps round northward to St. John's church. For the sake of distinction I will call this terrace the cliff-terrace. It is broken more or less by rents, or where the terraces are traversed by ravines. The terrace itself has on its steep side cavities of greater or less extent, formed by the sea when rushing in as it does now in the Animal-flower Cave and numerous other caves of that description near the coast. Huge masses of the cliff were broken off by the battering waves, and when in the progress of elevation these parts had been raised above the reach of the sea and the spray of the waves, soil gathered here and there and vegetation sprung up. Such an instance is exhibited in the terrace-like cliff near the Rock, as the following woodcut will illustrate. The cliffs to the right and left have cavities which in other places (as near Pleasant Hall) are of much greater depth and extent.

Fig. 8.—*The Rock.*



At the period when this large terrace was raised, the island presented on a reduced scale an appearance in its outline similar to what it does at present; Sweet Bottom resembled then the valley of St. George; the heights of Golden Ridge and Ashford, the ridge of Christ Church, and the deep indenture in the cliffs north of Edgehill and Social Hall corresponded to the outline of Carlisle Bay.

There is another circumstance which strikes the observer on comparing the respective elevations of these terraces on their eastern and southern points with the northern, namely their much greater height at the former points. Gun-hill and Reed's Hill are respectively 729 and 629 feet; from thence the heights decrease towards Mount Gilboa, which is only 449 feet high. And this refers likewise to the upper terrace which extends from Cotton Tower to the northward. The Valley formed at the succeeding period a strait between that portion now called the Ridge and the larger part of the island to the north of it. We may here trace two partial terraces, which were washed at that time by the currents rushing through the strait; the line of cliffs on which Walker's, Brighton, Harrow and the Thicket stand, will define the northern shore; while Yorkshire, the Police Station B, and the terrace near Lower Birney formed the southern bank.

It might be said that Mount Gilboa and Reed's Hill belonged to two different terraces. There is however no sudden rise between the two; and on advancing from Mount Gilboa to Reed's Hill, the rise is gradual[1] in the nine miles which extend between the northern and southern extremities of that terrace. This refers likewise to the terrace which extends between Harrison's Head and Rock Pleasant, but it does not hold good with others, where the terraces are sometimes interrupted and indistinct.

The terrace-like cliffs which, commencing from the northward, extend from Harrison's Great Head along Colleton, Dover Castle, Oven's Mouth, Oxnard's, &c., to Rock Pleasant, offer as continuous a line (excepting where it is broken by the Valley) as the great cliff-terrace, to which it may be said to stretch parallel. The great valley, the mouth of which opens through Bridgetown to the sea, intersects this terrace: it is continued on the southern side by the heights of Highgate and Clapham.

The periods of rest became of shorter duration, and were more frequent during succeeding epochs, and the denuding action seems to have had less effect upon the northern part of the island than upon the southern. The lower terraces extend scarcely beyond Holetown: they are however very distinct, and may be traced from thence to the south and to the eastward in the parish of Christ Church. Of those of a later period the cliffs on which Bankhall, Government House, the Pine, Bishop's Court, and Græme Hall are situated are perhaps the most distinct.

I have not alluded in this description to some terraces of minor extent, which are essential in our theory of a gradual elevation, with succeeding periods of rest, but which are not sufficiently distinct to deserve a description.

The mural cliffs on the leeward side of the island are in some instances very high. As they owe their steepness to the abrading power of the waves and currents, it is a proof that the breakers beat furiously against the lee-side of the island at the time of their formation; perhaps south-western gales such as now occur during the hurricane seasons were then more frequent.

The undermining effects of the waves of former ages on the windward side of the island is very evident near Boscobelle and Pico Teneriffe, where large masses of coral rock lie about in great confusion, which have evidently been detached from the high cliffs above. The cliffs at Long Bay and near the Crane have been subjected to a similar action at former periods; they are now protected by an extensive beach which the sea has

[1] For the sake of particularizing, I mention the following ascertained heights on the line of this terrace commencing from the north: namely, Mount Gilboa, 449 feet; Black Bess, the northern point, 501 feet; the southern point, 581 feet; Lancaster Hill, 596 feet; Monkey Hill, 619 feet; Reed's Hill, 629 feet.

thrown up. The land gains here decidedly upon the sea. Vast masses of cliff several hundred feet in length have sunk at the edge of the cliff-terrace near St. John's church, and likewise higher up near Union in the parish of St. Joseph: they sunk directly downward, so that the soil and vegetation remained upon it. In other places these detached portions are of less extent, and assume the forms of towers: this is the case near the churchyard of St. John's, above Codrington College and near Black Bess: the last is upon a gigantic scale.

The occurrence of hillocks between two lines of terrace is very common; they are perhaps analogous to the low islets which are sometimes formed on reefs. There are two such hillocks behind Grand View Villa, in St. Michael's, which consist of hard calcareous rock with large masses of different species of the genus Astræa imbedded in it.

I refrain from expressing an opinion as to the length of time which elapsed between the epochs of denudation[1]. Geologically speaking they have not been remote. We possess proofs that Barbados has been elevated gradually to its present height since the epoch of existing shells. I have found species of the genera Turbo, Lucina, and Petricola near Sugar Hill, Chimbarozo, and Mount Wilton, which situations, with Mount Misery, form the highest elevation of the coral rock[2].

At these places casts only of the shells are found; while the fossil shells, eight hundred to a thousand feet lower, in many instances still retain their lustre, and do not differ from those found in the adjacent sea, except that the fossil shells are generally much larger than the recent. It is remarkable, that others, which at the period when they were imbedded must have been abundant around the island, are now very rare, or are only found further northward among the Virgin Islands. This refers to *Cytherea casta, Tellina lacunosa, Strombus accipitrinus, Turbinella pugillaris*, &c. I have found the impression of a Pecten near Fort George. Impressions of shells are otherwise very rare, and this is the only instance of my meeting with one during my researches.

Certain species of shells are firmly imbedded in the coral rock. One shell of a bivalve is sometimes found in the rock with the convex side

[1] On the leeward coast, along the road which leads from Bridgetown to Speightstown, after having passed Bat's Rock, there are frequently lines of rounded and angular pieces of limestone, pieces of corals, &c., heaped one upon another, showing decidedly that it was formerly a shingle beach. I have been told that Indian hatchets have been found among these fragments, which would fix their date of upheaval within an historical period.

[2] The numerous evidences of elevation within the tertiary period of nearly the whole area which the West Indian archipelago occupies, finds an additional proof in Barbados. The elevatory movement, however slow and gradual, was not accompanied by an intermediate subsidence,—an opinion which is supported by the fact that the few fossil shells found on the central ridge are merely casts, while it is quite different, as above observed, with those found in lower situations.

upwards, while the corresponding shell is met with in the reverse position at a short distance from it. The cuttings of the road above Two-miles' Hill contain *Cypræa exanthema*, and *Venus Pavia*: *Strombus gigas* is found abundantly imbedded in rocks on the road from Constitution Hill to Pilgrim, and likewise near the Pine Estate. *Cassis tuberosa* is met with in the same neighbourhood; *Lucina pennsylvanica* in the rocks near Skeete's Bay, Cones near St. Anne's and near St. Stephen's Chapel.

The shells imbedded in marl are more numerous and in better preservation than those in the coral limestone. Some of the recent shells in these beds near Grand View in St. Michael's, and about 165 feet above the sea, have retained their pearly lustre and colour so surprisingly, that one might be tempted to disbelieve that they had been lying buried for ages in the marl. This refers chiefly to specimens of *Strombus pugilis, Bulla striata* and *Cypræa cineraria*. I found in the beds of marl several Stalactites, some eighteen inches long, surrounded with calcareous concretions and shells consisting of *Lucina edentula, L. divaricata,* Venus, and other bivalves. Since Stalactites can only be formed in aërial caverns, their occurrence in these marl beds is curious. They were perhaps swept by freshets into the sea from caverns situated in the cliffs on the dry land, where they were surrounded with these shells and subsequently raised up with the bottom on which they were lying.

Numerous shells of *Tellina radiata* are found near Hopewell, in the parish of Christ Church. They have lost their striated appearance, and are of a uniform chocolate colour. Two of these shells having remained exposed for some time to the rays of the sun, I saw with astonishment that the heat and light developed again their striated colour, which now appeared of a pale red[1]. *Voluta musica* and *Murex messorius* occur in the same bed of marls as the *Tellina radiata*. Some very remarkable calcareous concretions, nearly spherical and cavernous, lie in large numbers on the sloping cliffs near Cummin's Hole. The inner part is sometimes formed of concentric layers. They are called by the people "rock-seeds," and vary from the size of a pigeon's egg to two inches in diameter. I have seen them imbedded in the cliffs near the Crane.

At the conclusion of this sketch of the geological structure of Barbados will be found a list enumerating the shells which I collected in the fossil state in Barbados; I have already observed that they are much larger than those of the same species now in the adjacent sea. This refers chiefly to a Turbinella, which has all the appearance of *Turbinella pugillaris,* only that its size is so much larger than they are found now, being

[1] These shells of the *Tellina radiata* near Hopewell are quite perfect, and consist of every variety of size, from half an inch to three inches, a sure proof that they must have existed in families. There is another remarkable circumstance connected with them, they are frequently bored like many of the shells in their recent state. These holes are ascribed to some species of the Order Trachelipoda; they have been therefore coexisting with the Tellina. This hole is likewise seen in the fossil *T. lacunosa.*

twelve inches in circumference. A fragment of a gigantic shell one inch-and-a-half in thickness, inclosing a large Petricola, appears to have come from a Tridacna, which genus is at present no longer to be met with near Barbados.

B. The Scotland Formation.

Quite different in appearance and in structure is the "Scotland district," including the hills and hillocks "Below the Cliff." From the semicircular heights which encompass this district, project long ridges of hills as it were towards one point[1], diminishing in height as they approach the sea. Some small groups rise from the plain in the neighbourhood of Long Pond, Walker's, and Morgan Lewis. The sides of the hills are abrupt, naked and barren, and sparingly clothed with timber. Mount Hillaby forms the highest summit in the island, and rises on the south-western end of this group, which from its alpine character in miniature, has received the name of Scotland[2].

This formation, as far as exposed to view, extends from Cove Bay, in the parish of St. Lucy, to Skeete's Bay in the parish of St. Philip. Doctor Davy, Inspector-General of Army Hospitals, discovered traces of the Scotland series near the northern point of the island.

I have already alluded to the various modifications of tertiary rocks which are found in this district; nevertheless their character under all modifications possesses an original uniformity. The direction of the strata is generally south-west and north-east; disturbances however have frequently altered this direction, and the consequent variation of their planes of stratification renders it very difficult to ascertain their dip. The strata are more or less inclined, and change in some instances in closely allied rocks of sandstone from the horizontal to almost the vertical. The stratification is at other times wavy, and at Chalky Mount[3] it is contorted.

The earthy marl, or as it is called in the colony, the chalk, constitutes by far the greater part of the series. It occurs stratified near the northern extremity of the Scotland formation, and vestiges of it are observable even near Cove Bay. Further southward, towards Pico Teneriffe, it appears in vast masses, and the Pico itself rests upon it. The sea, beating with great strength against these marls, has hollowed them out and loosened

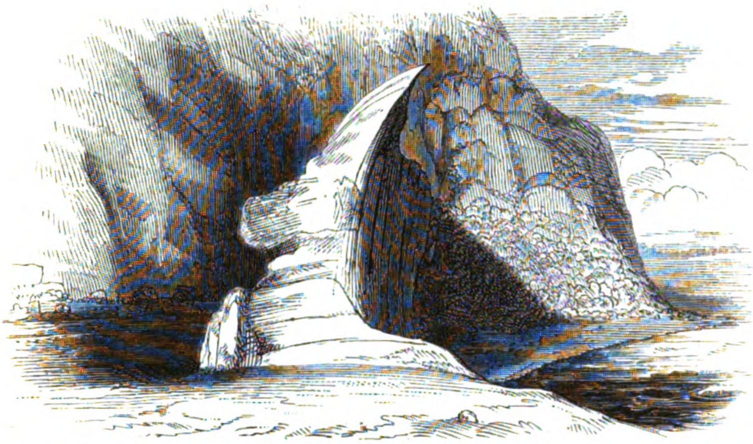
[1] The ridges stretch from below Mount Nicholas south-eastward; from below Red Hill eastward; from Mount Hillaby north-eastward; and from Bissex Hill northward. If these ridges were continued, they would centre about St. Andrew's church into one point.

[2] It will be recollected that Columbus, when requested to give a description of the mountainous aspect of San Domingo, took a sheet of paper, crumpled it up, and throwing it on the table compared it to the appearance which the mountains presented. Such a simile might be used with equal correctness to convey an idea of the aspect which the numerous elevations of Scotland district afford when viewed from Cherry Hill.

[3] This is a misnomer, as the hill consists mostly of siliceous and calcareous sandstones, broken into precipitous and rugged cliffs of an appearance as white as chalk.

large blocks from the cliffs, which are now lying on the beach. One of the cliffs has assumed a fantastic shape, and reminded me of the Needles off the

Fig. 9.—*Cliff below Pico Teneriffe.*



Isle of Wight. Selenite, sometimes in crystals, is found in the marl, frequently lying on the surface. The strata rise to the highest point through the other rocks: the summit of Mount Hillaby consists of earthy marl[1].

It abounds in siliceous shielded animalcules, which Ehrenberg has called Polycystina. The number of species which he found in the marl from the summit of Mount Hillaby, amounted to fifty-four, belonging to twenty-two genera. The marl near Jeeve's[2], or Boscobelle, contained 113 species of Polycystina, five species of Polygastrica, one Geolithia, and two Phytolitharia. Small patches of marl are likewise met with in the flats of Scotland, on the road from Haggat's towards Belle Plain, near a huckster's shop; it contained forty Polycystina, four Geolithia, and three Phytolitharia, but no Polygastrica. Proceeding southward, the marl is succeeded by sandstones, somewhat ferruginous, frequently gritty and coarse-grained. They dip towards the sea at an angle of about 20° to the north-east, rising however near the Round Rock to a more vertical position, and the stratification is sometimes wavy. This is chiefly the case where the sandstone is interstratified with compact clay-iron. The sandstone is subordinate to the marl. At Greenhill it is micaceous, almost slaty, the slabs being placed edgeways, as if they had been uplifted and the soil between them washed away[3].

[1] I cannot conceive why the late Dr. Maycock considered Mount Hillaby as belonging to the coralline formation; the marls and black siliceous sandstones, aluminous clays, &c., extend along the western declivity nearly as far as the Estate Hillaby.

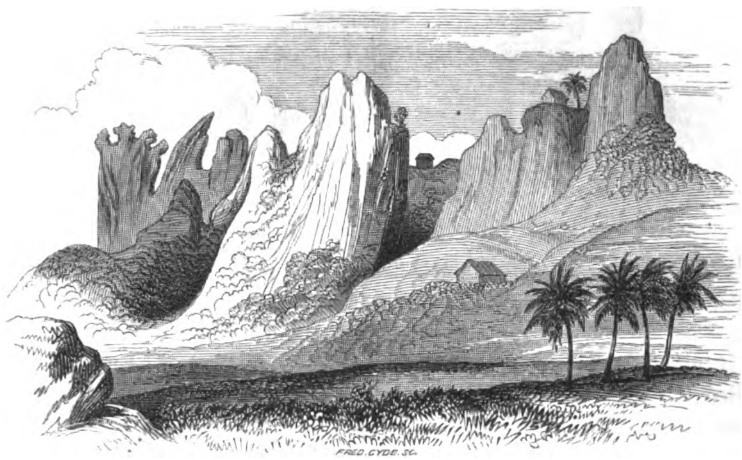
[2] Below Jeeve's, close to the sea, lies a large block, which has a basaltic (?) appearance.

[3] A very marked difference exists in the sand which covers the beaches along the leeward coast, along the shores of Christ Church, St. Philip's, and part of St. John's, and on the other hand those of the Scotland district. The former consists of finely

Several conical hills consisting of masses of accumulated drift-sand intervene between the sea and the Flats, as the level ground is called which extends westward, and is intersected by the mountain streams, called Church- and Scotland-river. I have already alluded to the existence of some salt-springs on the land which extends behind these hills, without expressing a decided opinion as to their origin[1].

On the south-eastern end of the beach which is called Long Bay, rises Chalky Mount to a height of 571 feet, which is highly interesting to the geologist. Its rugged appearance and disturbed strata speak of

Fig. 10.—*Chalky Mount.*



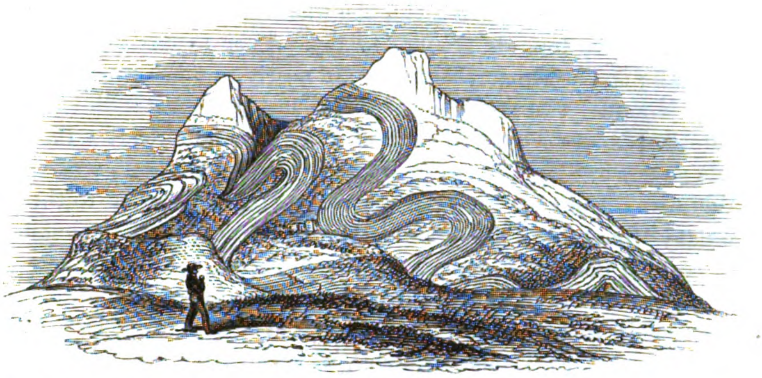
great convulsions. The mountain forms three peaks, and consists mostly of fine-grained sandstone, more or less ferruginous, containing frequently large nodules of ferruginous clay (chiefly between the Hope estate and Mr. Brathwaite's house); at other times the sand is very compact, and has the appearance of passing into jasper. The summit of one of the peaks is capped with coarse conglomerate, and some blocks, which now lie partly in the sea, appear to have rolled down from the summit to their present situation. The fragments are calcareous, sometimes of the size of a pigeon's egg, rounded, seldom angular, and smooth. At Whoop Gully below the sandstone is gritty clay, which is frequently aluminous, and lies in horizontal strata.

On the eastern declivity of Chalky Mount, where that mountain fronts the sea, the strata are apparently much-contorted and twisted; this is chiefly the case where the light-coloured friable sandstone is in contact with a calcareous sandstone containing minute specks of mica; ferruginous sandstone and compact iron ochre rest upon it. The calcareous sandstone is twisted in a most remarkable manner.

comminuted shells and triturated calcareous matter, the latter of siliceous particles, or properly speaking, "sand:" this difference in their nature arises obviously from the relation of the adjacent land from whence the sands were washed down.

[1] See *ante*, p. 224.

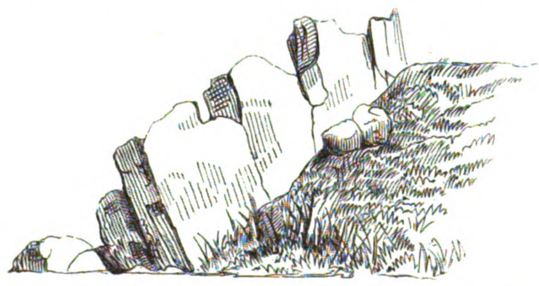
Fig. 11.—*View of the eastern part of Chalky Mount.*



In the neighbourhood of these sandstones, on the north-eastern point of Chalky Mount, is a seam about ten feet in width of fragments of compact gray limestone, coated with calc-spar. Spheroidal concretions, varying from the size of a pigeon's egg to three feet in diameter, and divided into cells and chambers of irregular form, are found among these rocks. They are Septaria, composed of argillo-ferruginous limestone, intersected by veins of calc-spar[1]. The strata of sandstone which this seam traverses, dip at a high angle to the south-south-east, the direction being west-south-west. I found here likewise a nodule coated by mammillar compact lime resembling Aragonite.

The ferruginous fine-grained sandstone (almost red in colour) assumes a slaty structure on the south-eastern part of Chalky Mount. The slabs rise abruptly as if uplifted, and form as it were a wall. The strata under an angle of about 70° dip to the north, the direction being west by north.

Fig. 12.—*End View of Sandstone Strata at Chalky Mount.*



This sandstone is perforated in a most remarkable manner about 250 feet

[1] I brought a specimen almost globular and twenty-four inches in circumference away with me. Mr. Henry Stutchbury tells me that it resembles the Septaria from the Kimmeridge clay at Weymouth.

above the sea. The perforations are only local, and have a smooth and worn appearance. Similar contortions of the ferruginous sandstone as at Chalky Mount, are traced along the whole ridge, which extends from Haggat's Hill up towards Mount Hillaby. They appear denuded near Mount All; and at Monkey Hill they are nearly as much contorted as at Chalky Mount. The last trace of this sandstone is met with above the estate called Mount All, at a height of about nine hundred to a thousand feet.

White and yellowish marls occur near the Hope, somewhat to the west of Chalky Mount; and near Smith's House, where there is an abundance of selenite, I found likewise clays, sometimes of a brown colour and aluminous, with a taste of sulphate of alumina: compact iron ochre is not uncommon in that situation. I have looked in vain for a bed of porphyritic slate or clinkstone porphyry, which Dr. Maycock describes as having discovered at Chalky Mount: he says it was about eighteen inches in thickness, and was lying between beds of very loosely cohering sandstone, dipping to the north-east at an angle of 30°[1].

I have already observed that the summit of Mount Hillaby consists of marls: they are here several hundred feet in thickness, and extend for some distance down the western declivity of the hill towards the estate Hillaby. If a line were drawn following the highest ridge of the hills from south to north, this would be the only instance, as far as I have been able to ascertain, where the rocks of the Scotland formation extend west of that line. Besides earthy marl, clay ironstone and black siliceous sandstone are met with here. Between the estate Hillaby and the two estates Airy Cot and Mount Fruitful, there is a remarkable basin formed by the surrounding mountains. Near the public road leading from Dunscomb to Hillaby, the coralline formation again prevails, and it becomes very evident that this rock rests upon the marls. On the south-eastern declivity near Grove's, bituminous coal (compact asphalt, Erdpech) has been discovered. This substance is found in several parts of the Scotland formation, and will be alluded to wherever it occurs in the description of the structure of the district. The superposition of the rocks near Grove's is here asphalt or bituminous coal, bituminous sandstone, dark brown and gray clay, clayey sandstone, with a ferruginous

[1] Introduction to Maycock's Flora Barbadensis, p. 8. Dr. Davy and Dr. Goding have been equally unsuccessful in discovering this porphyry, which would be an additional evidence of igneous action. I possess among my geological collection which I brought with me from Barbados, a specimen of Diallage rock, and another resembling serpentine: respecting the latter, Professor G. Rose writes to me, "This rock, compact, of grayish-green colour, may be scratched with a knife; fracture splintery, intermixed with numerous small particles of hornblende and dark yellow specks of mica. I never saw previously a similar composition." The specimen was found on the road from Baxter's to Mount All.

cement, and earthy marls. Mr. William Herapath of Bristol has given the following analysis of this coal. It contains in 100 parts,—

Bitumen resolvable by heat into tar and gas . .	61·6
Coke	36·9
Ashes	1·5
Sulphur (none)	0·0
	100·0[1]

The sharp ridge or spur which from below Gregg's Farm runs almost due north-east towards Haggat's, and on which the Boiling Spring and the mineral waters near Vaughan's are situated, ends in a hill of a moderate height between Haggat's and Bell Plain. This hillock is almost entirely covered with compact clay ironstone, in which there are some curious perforations, the cavities being filled with iron ochre: it resembles *Spherosiderit*. On the southern declivity of this hillock, near the road coming from Haggat's, are large blocks of a spherical form of compact limestone, partly imbedded in the bank through which the road has been cut, the cavities on the surface being filled with clay. The valleys of Scotland, chiefly along the rivers, or rather streams, consist of alluvial soils. I regret that I neglected to examine the numerous rounded pieces of rock which are imbedded in the banks of Scotland River. That stream, when swollen by heavy tropical rains, becomes quite formidable, and tearing the banks exposes these rounded fragments which lie buried

[1] Mr. Herapath observes on this coal,—

"The large proportion of bitumen in comparison to the coke or carbon, will prevent this coal from being used as a common fuel unless some means are taken to remedy the inconvenience; it should be mixed with some substance more fixed in the fire, and consequently capable of longer endurance in the heat. Hard charcoal, more refractory coal, and even perhaps earthy substances would be beneficial. If it could thus be made to give a more solid heat, there is nothing to prevent its being made use of generally, as the ashes are in very small proportion, and it contains no sulphur, which is very injurious in several manufactures. I should think it could advantageously be employed in the production of gas, of which it would furnish a large quantity, and of a very rich quality, even exceeding that of cannel coal, the best for that purpose hitherto known. It is useless for me to give the number of thousand cubic feet to be obtained from a ton, as the quantity and quality vary according to the heat administered during the gas-making; but I can say with certainty that a larger quantity can be made from this variety than from any known coal.

"*Composition of other coals for comparison.*

	Bitumen.	Coke.	Ashes.
Scotch cannel............	56·57	39·43	4·00
Derbyshire cannel........	47·00	48·36	4·64
Welsh furnace coal	8·50	88·06	3·43
Welsh stone	8·00	89·70	2·30
Kilkenny	4·25	92·87	2·87
Coal-pit heath	39·10	56·90	4·00

"The latter is used in Bristol for gas, and gives 8000 feet per ton." (Barbados Agricultural Reporter, No. 12, p. 179.)

in zones. For want of a closer examination, I should not like to pronounce them as anything else but alluvium.

To the south of Chalky Mount the rocks are of a more calcareous composition than north of it, where they are more siliceous. Some large blocks near Gill's House make an exception; they consist of a compact sandstone passing into quartz rock[1]; and on the road to Cambridge protrude masses of gray sandstone with seams of calc-spar: there is likewise some brown ironstone intermixed with minute particles of quartz. I found on the south-eastern foot of Chalky Mount some blocks of "Tutenmergel or Tutenkalk," similar to the well-known mineral of that name at Görarp in Schonen; and there are likewise specimens of it, only somewhat differently formed, on a small hillock north by east from the estate Cambridge. Slaty clay-iron, compact clay ironstone, red ochres and bituminous coal, or friable asphalt, are here very common[2]. I observed among the rocks on the small hillock above alluded to a conglomerate consisting of fragments of shells and some corals: their occurrence in this part of the island rather astonished me.

Continuing the road from Cambridge towards Bissex Hill, we come now in the regions of the compact gray limestones. The strata appear to be of great thickness; I have been told that in sinking a well on the new estate on Bissex Hill, no other rock was met with but this limestone. The summit of Bissex Hill is composed of yellow siliceous limestone or calcareous freestone, in which some shells, spines of Echini, and teeth from two species of sharks have been found[3]. Small pieces of yellow ochre occur frequently in this rock. Turning from Bissex Hill eastward, we meet near Springfield a peaked hill or cliff of siliceous marl (the place is called Mastic-field), which contains layers and nests or concretions of semi-opal, replacing the flint of the chalks in England[4]. It resembles in its mineralogical character the semi-opal of Bilin, which is found in Polierschiefer, and is of a dark green colour, almost black, and variegated with white veins, which in other specimens are of a reddish colour. The rock has a conchoidal fracture and is slightly translucent. The cliff of siliceous marl is bounded by fine-grained slaty sandstone, the stratification of which is west-south-west almost at a vertical angle, dipping to the south-south-east. The formation around Springfield is highly interesting:

[1] Professor G. Rose compares this rock in its mineralogical character to the rocks at Humont near Montmorency.

[2] I possess a specimen from that situation which was kindly given to me by J. Bovell, Esq., which is a bean-shaped nodule of clay ironstone eight inches long, formed of concentric layers.

[3] Professor Owen, who obligingly examined these teeth, considers that they belong chiefly to the genus Lamna; but amongst them was the crown of a tooth from a species of the genus Odontaspis. A Scalaria which I found imbedded in this rock is new, and has been described by Professor Forbes as *Scalaria Ehrenbergii*.

[4] I did not find flint in any of the marl beds of Barbados.

here are large masses of calcareous sandstone, traversed by thin seams of bituminous coal (asphalt ?), sometimes containing pieces of bituminous wood resembling Surturbrand: near these seams are found imbedded cylindrical concretions of clay-iron. An isolated block of dark gray limestone enclosing minute quartz pebbles, and two new species of fossil Nucula besides Lucina, &c. is of high interest; it contains a greater number of fossil shells than any rock I have met with. The two species of Nucula, of which figures and descriptions will be found among the list of fossil shells, are very interesting. In a ravine formed by two mountains, is a surprising quantity of Petroleum, and somewhat further southward are some springs impregnated with sulphuretted hydrogen. At the foot of these hills occurs a compact gray slaty calcareous sandstone with specks of mica on its lamination, which apparently belongs to a different and older formation than the rocks in its neighbourhood.

Black siliceous sandstones are more frequent in this part of the island than further northward; on the ridge of hills towards Castle Grant, are strata of volcanic ashes. The unctuous clayey nature of the soil, shelving towards the sea, subjects this part more to slips and sinking than any other in the island[1]; the road from Sugarhill to Joes' River had sunk considerably when I visited Barbados in 1845–46, and a road from Mellow's to Castle Grant was no longer passable. It has been already observed that even the coral cliffs in this part are subject to slips and sinking.

South of the Bath Estate, in the parish of St. John, the hills again resemble in appearance those of the Scotland district on a smaller scale. Near Conset's Bay in a deep ravine occur calcareous and bituminous sandstones, compact yellowish-gray limestone and ferruginous clays. The former are all strongly impregnated with bitumen. In the neighbourhood of Conset's Bay rises a hill which is locally known under the name of Burnt Hill. It is reported by Hughes in his 'Natural History of Barbados,' as having been set accidentally on fire by a slave, and that it continued to burn for the space of five years. Slags which are found on its declivity and on the beach at the foot of the hill, show distinct marks of fire, and confirm the popular tradition. But the rocks near the summit, which have a black appearance, have not been subjected to fire, and consist of bituminous fine-grained sandstone, and are argillaceous, of a dull yellow appearance, dry and rough to the touch, and resemble Tripoli. These rocks, as well as the slags, contain Polycystina in well-preserved forms[2]. A seam of bituminous coal traverses the gray limestone near the summit on the north-eastern point of Burnt Hill. Petroleum oozes

[1] See *ante*, p. 67.

[2] The slaggy masses, which appear to have originally resembled or have been similar to the sandstone near the summit, are of various colours: some have a brownish, some a blueish and some a reddish cast. It is remarkable that the heat to which they were exposed did not destroy the forms of the Polycystina.

in large quantities out of the rocks near the beach. Among the shingle are found large cylindrical bodies consisting of ferruginous clay coated with bitumen. Springs impregnated with sulphuretted hydrogen ooze from under the rocks. I found on the beach a worn or rounded specimen consisting of volcanic ashes, similar in character to the stratum near Skeete's Bay.

Bituminous coal, more compact than any I have anywhere else observed in Barbados, occurs to the south of the new estate at Codrington, under similar circumstances as at Grove's[1]. I received from the Rev. E. P. Smith, tutor of the college, a substance which one of the labourers, employed to dig for the coal, stated to have found lying among or near that substance. It has the appearance of coke, or as it were some other artificial production. It is to be regretted that we have no better evidence than that of the labourer with regard to its having been found among the coal[2]. On advancing further southward, we find again large masses of earthy marls on the little hill on which the chapel of St. Mark is standing; it is capped by coralline limestone, which now prevails, until near Skeete's Bay, where we discover again traces of the clays and marls of the Scotland formation. On the north-eastern bent of this bay is a seam of volcanic ashes lying under the coral rock. In the neighbourhood are large blocks of a conglomerate consisting of minute particles of quartz and comminuted shells; some of these rocks are coarser in texture than others in the same neighbourhood.

There are instances on record, that in different situations of the world portions of rocks have been found differing so much from those in the locality where they were met with, that they must have got there by accident. When examining the peculiar formation at Skeete's Bay, I found on the beach, which consists of shingle of coral, a large elliptical piece of red granite, perfectly smooth, the circumference of its longer side being three feet, and that of the shorter two feet five inches. The occurrence of this rock, which belongs to a series of which not the slightest trace is to be observed in Barbados, astonished me; and I can come to no other conclusion, but that it is part of the ballast of a ship wrecked in the neighbourhood, as no vessel could have entered the bay itself, which is entirely barricaded by coral reefs: the force of the waves, or breakers, may perhaps have thrown it on shore, where I found it imbedded[3]. This is not the only instance of foreign rocks having been

[1] According to Dr. Davy, it consists of 66·7 bitumen, and 33·3 per cent. coke, with an exceedingly minute portion of ashes.

[2] It was pronounced in Barbados to be the true anthracite of mineralogists: this is doubted by Professor Gustave Rose, to whom I sent a specimen for examination, and who cannot be persuaded but that it is an artificial production.

[3] Mr. Darwin has drawn my attention to a circumstance which he mentions in his journal. Captain Ross found on a small "atoll" a few miles north of Keeling, in the conglomerate of coral mud, a well-rounded fragment of greenstone, rather larger

found in Barbados: Dr. Goding possesses a specimen of a primary rock, which, as far as I recollect, he picked up on a beach in Scotland, and the specimen which I found near Mount All is equally curious. In a small collection of rocks from Barbados at the Literary Society in Bridgetown, I observed a piece of porphyry, the parent rock of which appears to be foreign to Barbados.

The observations of Professor Ehrenberg on the relative age of the Scotland series from Barbados, are to the following effect:—

"The comparison of the recent forms of Polycystina with those from the remarkable rocks of Barbados, and furthermore a comparison of the so-called tertiary forms of the halibiolithic Tripoli (formed entirely of marine organic remains) from Oran in Africa, Engia, Zante, as well as from several localities in Virginia and from Bermuda; finally, a comparison with the forms obtained from the marls of Caltanisetta and Castrogiovanni in Sicily; and the results of my examination of numerous samples of mud from the bottom of the sea to a depth of 1620 feet,—have induced me to believe that the forms which compose the rocks of Barbados are comparatively more foreign to the present organization of beings, and to that of the tertiary period, than to the calcareous formation of Sicily."

Professor Ehrenberg considers the calcareous formation of Sicily as belonging to the secondary period, and upon this supposition he bases his opinion respecting the age of the rocks of Barbados. A large proportion of microscopical animals from the latter place bear comparatively a greater resemblance to those from Caltanisetta than to those from any other locality he is acquainted with.

A calcareous compact gray sandstone, with numerous specks of mica (chiefly on the layers) and of fissile structure, which I found on the beach at Springfield, is considered by Ehrenberg to belong to an older formation than the other rocks from Scotland district. It is certainly the lowest in the series, and it appears rather as if it were thrown up against the other rocks.

than a man's head: he and the men with him were so much surprised at this that they brought it away and preserved it as a curiosity. "The occurrence of this one stone," says Mr. Darwin, "where every other particle of matter is calcareous, certainly is very puzzling. The island has scarcely ever been visited, nor is it probable that a ship had been wrecked there." He concluded therefore that it became entangled in the roots of some large tree, in which supposition he was confirmed by a statement of Chamisso's, who observes that the inhabitants of the Radack Archipelago, a group of lagoon islands in the midst of the Pacific, obtained stones for sharpening their instruments by searching the trees which are cast upon the beach. It is therefore probable, that since we have it on record that stones were carried on trees to the Keeling island and the isolated position of Radack, the Barbados granite, greenstones, and porphyry may have been brought in a similar way from the Orinoco. I have already stated at page 180 that the current brings the seeds of Manicaria and Astrocaryum to its shores; it is therefore no impossibility that trees are likewise carried to its coast. The specimen of granite is now in possession of Dr. Cutting, to whom I gave it before I left Barbados.

The Scalaria which I found on the summit of Bissex Hill, and the Nucula from Springfield, induced Professor E. Forbes to consider the Scotland rocks as belonging to the miocene period of tertiary strata. The mineralogical character of rocks is considered at present of little importance when conclusions respecting their age are to be formed. Still my observations on the spot, combined with the mineralogical character of the rocks, lead me to coincide in Professor Forbes's opinion. The chalks of Caltanisetta, on which Professor Ehrenberg rests his opinion that the Scotland formation in Barbados belongs to an older period than the Miocene group, have been considered by different geologists as belonging to different periods; by some they have been regarded as secondary, by others as tertiary rocks. I have no doubt that Ehrenberg's discovery of the new class of animalcules, and an examination of other rocks from the West Indies, the age of which has been better ascertained than those in Barbados, will lead to firmer conclusions than we are at present warranted to form. There can be no doubt that the whole Scotland district is an old sea bottom, of which fact the masses of marine animàlcules, without a single form belonging to the freshwater organization, give the most convincing evidence.

If we now inquire into the circumstances which produced the elevation of the Scotland series of rocks, and transformed the horizontal strata of reddish-coloured and white sandstones into almost vertical and contorted series, we cannot doubt that submarine movements, or volcanic agency acting violently from a given point, gave rise to the local derangements of this formation. The strata of sandstone are more disturbed near Chalky Mount than anywhere else. The siliceous limestones have been here contorted in the most extraordinary manner without the lamination having been obliterated. Close to the contorted strata is ferruginous sandstone; otherwise the general structure of Chalky Mount, as has been mentioned previously, consists of calcareous sandstones, which contain Polythalamia. Ehrenberg makes the following remarks on this sandstone:—

"Where the siliceous rocks contain a combination of calcareous matter, (consequently where they are real marls) and are of a whiter appearance and more friable like chalk, I found they contained calcareous microscopical Polythalamia, which were not in such good preservation as the siliceous-shielded Polycystina. They are surrounded with calcareous morpholites, resembling those which form the finest parts of chalk used for writing. It is by no means rare to find short, slender prisms of microscopical crystals of calcareous spar among this mass."

The presence of pumiceous particles which are disseminated through the marl; and thė existence of strata of volcanic ashes in the parish of St. Joseph and at Skeete's Bay render the volcanic action less doubtful, and I suppose that the line of convulsion followed from Chalky Mount a south-west direction towards Mount Hillaby. It must be observed however that the pumiceous particles might have arisen from a similar fall of "dust" as on the 1st of May 1812.

The isolated rocks of the coral formation, which are found lying on the summit and declivity of hills in the Scotland district, remain to be considered. Their size is considerable, sometimes as much as from twelve to fifteen feet in height, never rounded, but always angular, and of the same character as the cliffs of coral-rocks. They lie generally half-buried in the ground, with their edges upturned, and as if tossed there by force. Although the cliffs of the coralline formation exceed in height (excepting Mount Hillaby) the hills in Scotland, the intervening valleys do not allow us to suppose that these masses of coral rock were detached from these cliffs, and, falling down the mountains, rolled up again to their present situation, traversing valleys and ascending acclivities before they perched upon the top of distant hills. I conjectured that the coralline crust might have once extended over the Scotland district, and that the volcanic force which produced the upheaval of the Scotland strata, might have burst the crust and hurled it partly into the depths of the sea, and partly upon the sides of the hills and their summits. The immense sea-wave which is known to accompany shocks of earthquakes, and commits great havoc along the coasts subjected to it, might in this instance have carried on retiring the greater portion of the coralline crust away, and left only a few as a remnant. It has been considered by others, that a similar agency as that which transported the gigantic boulders of the north of England and Germany has likewise operated here. I think it however probable, upon a reconsideration of my own supposition, that these masses have been detached from the cliffs which now border the Scotland district, previous to the upheaval of the marine bottom, and sunk on the submarine inequalities.

CHAPTER II.

A DESCRIPTION OF FOSSILS FOUND IN BARBADOS.

The geologist is well-acquainted with the great value of the evidence, when judging of the age of rocks, derived from organic remains imbedded in the strata under his consideration. Neither bones of large terrestrial and marine mammalia, of birds or fishes, nor impressions or remains of plants, have been found in the rocks of Barbados; only the fossil remains of the most minute forms of organic life, marine bivalve and univalve shells, most of them (with few exceptions) analogous to those of the present day, have been hitherto discovered in the rocks which compose the island. I shall attempt to give a general account of such fossils as I have become acquainted with during my researches in Barbados. As the animalcules constitute the lowest stage of animal life, they will form the first object of my description of the fossil remains in Barbados.

The *Polycystina*, or cellular animalcules of Barbados, which are quite distinct from true Infusoria, form an independent group of siliceous-shielded animals. Previous to the discovery of the numerous species contained in the rocks of Barbados, Professor Ehrenberg classed the few he had previously described among siliceous *Polygastrica* (Infusoria). The examination of the Barbados rocks has made him acquainted with 361 species of animalcules, of which 282 belong to the group of *Polycystina*, which he divides into seven families, comprising forty-four genera[1]. It would be foreign to my object to give here a detailed description of these remarkable animalcules, or to enumerate them: I must refer the reader who is interested in such inquiries to a memoir which Professor Ehrenberg delivered before the Royal Academy of Sciences of Berlin, and a partial translation of which has been inserted in the 'Annals of Natural History[2].' Still, as far as such a description can be of general interest to the reader, I shall give it here. Infusory animalcules, or Infusoria, a denomination which is merely explanatory of their habitat but not of their structure, are organic beings so extremely minute as with few exceptions to be invisible to the naked eye. Their bodies are for the most part gelatinous, and they were formerly divided into two orders, *Rotifera* and *Homogenea*. Professor Grant, who has written on this subject, observes, that when we place a drop of any decayed infusion of animal or vegetable matter under a powerful microscope, and throw a light through that drop, and through the microscope to the eye, we discover in the drop of water various forms of living beings, some of a rounded, others of a lengthened form, and some exhibiting ramifications shooting in all directions, but all apparently of a soft transparent, gelatinous and almost homogeneous texture[3].

These beings constitute the lowest forms of animals with which we are at present acquainted, and they were at first considered astomatous, that is, destitute of any mouth, and agastric, or possessing no stomach. Upon

[1] Besides the above 282 species of *Polycystina*, he discovered 18 *Polygastrica*, 27 *Phytolitharia*, 27 *Geolithia* and 7 *Polythalamia* in the marls, sandstones and limestones of Barbados.

[2] See Ann. of Nat. Hist. vol. xx. p. 115.

[3] The most remarkable species among infusoria is the *Proteus*, which changes its figure momentarily, sometimes rounded, sometimes divided, so that it is impossible to assign to it any determinate form.

further examination, it was discovered that there existed animalculæ in stagnant pools, in rivers, and likewise in the sea, of a more perfect structure; and Professor Ehrenberg ascertained that Infusoria, which previously were scarcely considered as organized beings, had an internal structure resembling that of higher animals. Some colouring matter, as carmine, was thrown into water which contained infusoria, and it was found that they swallowed it and conveyed it into internal cavities or stomachs. These it has now been found exist in large numbers in almost every known genus, and some single animalcules possess as many as two hundred stomachs, from which circumstance they received the name of *Polygastrica*. Professor Grant asserts that nearly five hundred millions are contained in a single drop of water, that is, as many as there are individuals of our own race on the earth; and it is most surprising, that though so minute, the majority possess eyes, have an acute sense of taste, the power of distinguishing, and that they pursue and seize their prey, and in spite of their great number in a single drop of water, they avoid coming in contact with each other while swimming. These movements are effected by minute hair-like filaments disposed frequently around the mouth. They possess no proper skeleton, but there are parts which give them support. Some of these animals exude on their surface a secretion which agglutinates foreign particles that are floating around them, which serve as a partial covering. The majority of these animalcules possess an alimentary canal with an oral and an anal orifice. Ehrenberg discovered in the greater number of the species nerves, muscles, intestines, teeth, and different kinds of glands resembling in structure those of higher animals. Their power of reproduction is so great, that from one individual a million were produced in ten days; on the eleventh day there were four millions, and on the twelfth sixteen millions. They serve as food to the higher classes, especially of Zoophytes. They themselves are the most voracious of all living beings.

"We are more perplexed," says Professor Buckland, "in attempting to comprehend the organization of the minutest infusoria than that of a whale; and one of the last conclusions at which we arrive is a conviction that the greatest and most important operations of nature are conducted by the agency of atoms too minute to be either perceptible by the human eye, or comprehensible by the human understanding."

A few years since Ehrenberg made the singular and unexpected discovery, that the ashes and pumice in which Pompeii is buried, consists of siliceous cases of microscopic infusoria of freshwater origin, and he found afterwards that several beds of tuff and pumiceous conglomerate near Hochsimmer on the Rhine consisted likewise in a great measure of siliceous cases of infusoria. The Patagonian pumiceous tuffs contain the remains of marine animalcules, which differ in their figure from the elongated forms of freshwater animalcules. The impalpable dust which is known to fall sometimes out of the atmosphere in the midst of the Atlantic, and has been collected from ships upon which it fell, contains infusoria with siliceous shields, and siliceous tissue of plants. This dust is considered to have been raised by the wind or harmattan, which prevails during certain months in Africa and was carried into the air[1].

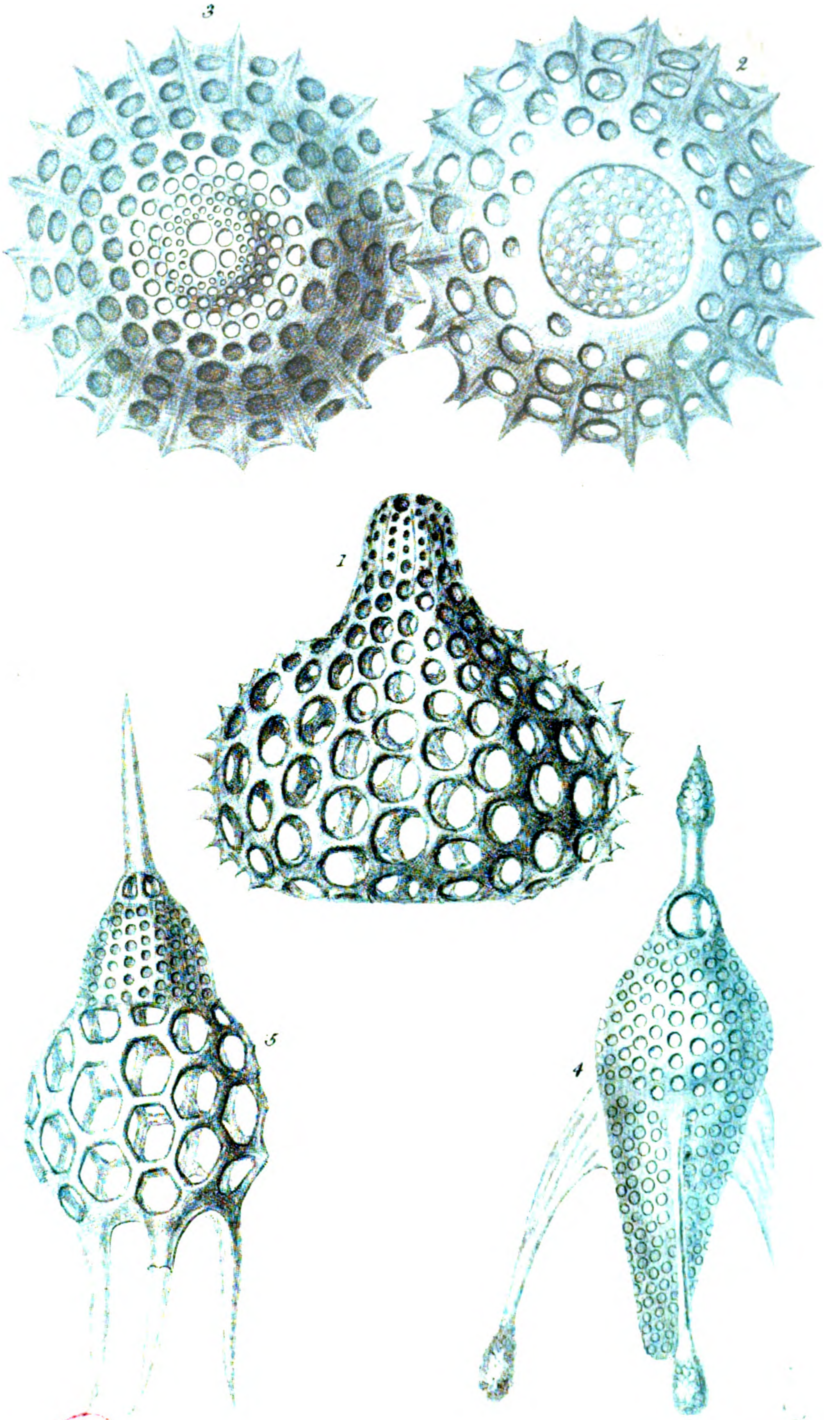
They have been found at the bottom of the sea in a living state and in fossil forms. When I arrived therefore in Barbados, I did not fail to collect samples of mud and marls for the purpose of examination, which I forwarded to Professor Ehrenberg, and in which he found this new class, to the general description of which I shall devote the following remarks[2].

Two parts are to be considered in the structure of the *Polycystina*, namely, the siliceous shield or cuirass, and the soft internal parts which are inclosed by it. This siliceous shield is not peculiar to the new group: it had been previously observed that the animalcules called *Bacillaria* possessed a transparent siliceous covering (*lorica silicea*), which is apparently composed of pure silica. In these organized bodies the shield is divided by longitudinal lines, but in *Polycystina* it consists of several transverse articulations containing two apertures, and covering in the recent species a gelatinous substance of a brown olive colour. Professor Ehrenberg considers that they possess a distinct animal structure consisting of vessels, but without a heart and pulsation, and are provided with a single tubular intestinal canal. The shield possesses an anterior and a posterior aperture; the former is lattice-like or fenestrate, and the latter is open.

The structure of these animalcules is very peculiar; they differ from the *Bacillaria* not only in their external appearance, but also in their internal anatomy. The siliceous shell connects them with the *Polygastrica*, in which the intestinal structure is radiated; but the transverse articulation and the cellular arrangement of their structure point to a connexion with that section which has not a radiated, but a tubular formation of their internal organs, which possess however calcareous and no siliceous shields. Professor Ehrenberg infers from the physiological organization of the whole numerous group a close analogy to the moss-animalcules (*Bryozoa*) and chiefly to *Polythalamia*. Nevertheless the character of

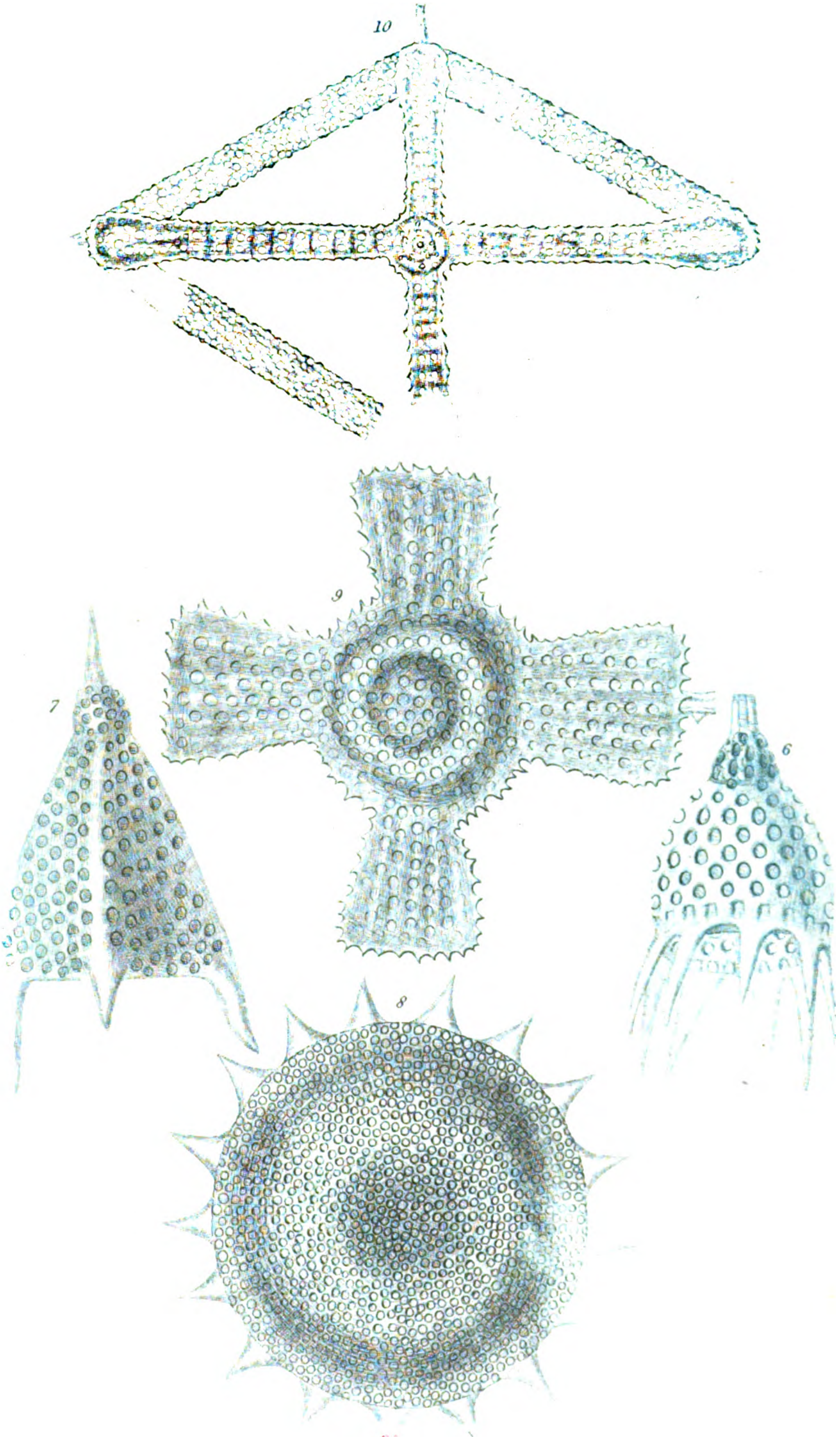
[1] It is now considered that this dust comes in a great measure from South America. Samples of soil which my brother and myself forwarded to Professor Ehrenberg from Guiana, contained two species of infusoria which he had observed in the atmospherical dust, while he did not find any species in the different kinds of dust which he examined, that he knew to belong to Africa.

[2] Dr. Davy, Inspector-General of Army Hospitals, observed already in a discourse delivered before the Agricultural Society of Barbados in July 1846, that some of the rocks abound in siliceous skeletons of infusoria.



Ehrenberg del.

J De C Sowerby sc.



Ehrenberg del. J. De C. Sowerby sc.

the minute shells of the *Polycystina* and the absence of real cavities, independent of their being siliceous, separate them from *Polythalamia*. In the greater number of instances the articulation of the body increases with age in the latter, but this is not the case in *Polycystina*, in which they are individually definite; otherwise the more easily closed transverse articulation of the *Polycystina* is a character entirely wanting in the *Bacillaria*, which possess a longitudinal structure in their skeleton and development. Professor Ehrenberg comes to the conclusion that they form, like *Bryozoa*, a subdivision of *Tubulata*, but in this instance with siliceous shields and individual organized structure. The forms developed in the highest degree in that division would be *Holothuriæ* and *Echinoidea*. The individuals of the group of *Polycystina* are either solitary, or a number are aggregated or associated, as in Polypi. This circumstance has afforded a character for their division into two groups, *Polycystina solitaria* and *Polycystina composita*, and the form of the shield has furnished the important and necessary differences for their subdivision.

The illustrations on the accompanying two plates will convey to the reader who is unacquainted with the study of these minute structures of animal organization, a better idea of the very distinct and beautiful forms of the *Polycystina* than the best description. They represent a few of the numerous elegant forms of the cellular animalcules of Barbados, magnified from two hundred to one hundred times in diameter. Of other siliceous forms which constitute the rocky masses of Barbados, Ehrenberg mentions, besides the *Polycystina*, three groups, namely, *Polygastric Infusoria, Phytolitharia* consisting of fragments of *Spongilla* and *Tethya*; and the third group contains siliceous fragments of perfectly new and very peculiar forms, which are called by Ehrenberg *Geolithia*. These fragments are regularly formed, and consequently easily recognizable: according to their appearance they are divided into stelliform, netlike, annular, tabular, stafflike, nuciform and cephalotic fragments, and the genera have been named accordingly. In some instances the whole mass of rock is composed of such fragments.

I have alluded in general terms to the occurrence of these animalcules in describing the geological structure of the Scotland district. For the information of those who would hereafter devote some attention to the investigation of these remarkable animalcules, I give the following localities in the rocks of which they have been discovered in the largest number; namely in the marls from the summit of Mount Hillaby, from the river near Haggat's, below Jeeve's or Boscobelle, below the Pico Teneriffe, from the Mastic-field Cliff near Springfield in St. Joseph's parish; and in the rocks from the summit of Burnt Hill, Bissex Hill, Mastic-field Cliff, Chalky Mount; and in the volcanic ashes from Skeete's Bay.

It has been asserted by M. Deshayes, "that in proportion to the greater number of fossil species of shells in a strata analogous to living species, such strata may be determined to be more recent; that a great change in the organization of fossil species, and in the proportion of the number analogous to living species, ought to be considered sufficient to constitute different formations." The list of fossil corals and shells will be found to contain such as are still to be met with in the adjacent sea, with the exception of three species of shells, no longer extant among existing species, and which are from the Scotland formation, giving thus an additional proof of the older age of these rocks.

The fossil corals of Barbados which I have found in the coralline formation, consist mostly of *Astræa radiata*, Lam., *A. galaxea ?*, *A. argus*, Lam., *A. rotulosa ?*, *A. stellulata ?*, *A. pleiades*, *A. ananas*, Lam., *A. foveolata ?*, *A. annularis*, *A. denticulata*, *Meandrina gyrosa*, *Caryophyllia fastigiata*, Lam. (*Lobophyllia* of Blainville), *Columnaria* ——?. This enumeration is a proof that *Astræacea* in former ages, as at the present time, were the most prevailing tribe in these seas.

I found also near Fort George a slender, curved, conical spongeous body, converted into limestone: it appears to be a true Spongia, and its nearest ally is, according to Mr. Bowerbank, a recent species from Australia.

LIST OF FOSSIL SHELLS FOUND IN BARBADOS, ARRANGED ACCORDING TO LAMARCK'S SYSTEM.

Class ANNELIDES.

Order Sedentaria.

Fam. *Maldania.*

Dentalium ——?[1]

Fam. *Serpulacea.*

Serpula ——?[2]

Class CONCHIFERA.

Order Conchif. Dimyaria.

Fam. *Solenacea.*

Solen Caribæus, *Lam.*[3]

Fam. *Nymphacea.*

Tellina radiata, *Linn.*[4]

—— maculosa, *Lam.*[5]

[1] A rare shell in the fossil state. Found at Two Miles' Hill.

[2] They are frequently found attached to corallines.

[3] A rare shell in the fossil state.

[4] Found very generally amongst the debris of corals and in deposits of calcareous sands, chiefly in Christ Church parish near the Hope. They are abundant in Barbados, both fossil and recent; but the recent specimens are much smaller than the fossil shells. I possess a specimen in my collection which measures four and a half inches in length and two and a half inches in height.

[5] Very abundant as well in the fossil as in the recent state. It is remarkable that the shell in the fossil state is found equally frequent perforated by a small circular hole, as this is the case in the recent state. I believe it is ascribed to the predaceous Trachelipodes.

Tellina Remies, *Linn.*
—— lacunosa, *Chemn.*[1]
(T. papyracea, *Linn.*)
Lucina pennsylvanica, *Lam.*[2]
(Venus pennsylvanica, *Linn.*)
—— edentula, *Lam.*[3]
(Venus edentula, *Linn.*)
—— divaricata, *Lam.*[4]
(Tellina divaricata, *Linn.*)
—— tigrina, *Desh.*
(Venus tigrina, *Linn.*, Cytherea tigrina, *Lam.*)

Conchacea.

Cytherea casta, *Lam.*[5]
Venus reticulata, *Lam.*
—— Paphia, *Linn.*[6]

Fam. *Cardiacea.*

Cardium lævigatum, *Lam.*[6]
(C. citrinum, *Gm.*)

Fam. *Arcacea.*

Arca scapha, *Lam.*
—— ——?

Pectunculus ——?
Nucula Packeri, *E. Forbes.*[7]
—— Schomburgkii, *E. Forbes.*[7]

Fam. *Chamacea.*

Chama ——?

Order Monomyaria.

Fam. *Tridacnacea.*

Tridacna gigas?[8]

Fam. *Mytilacea.*

Lithodomus cinamomea, *Cuv.*[9]
(Modiola cinamomea, *Lam.*)

Fam. *Malleacea.*

Avicula radiata, *Leach.*[10]
(Meleagrina margaritifera, *var.* radiata, *Lam.*)

Fam. *Pectenides.*

Pecten radula?, *Lam.*[11]
—— ——?

[1] It is abundant in the fossil state, but very rare now in the sea around Barbados. Dr. Cutting, who possesses the finest collection of shells perhaps in the West Indies, and to whom I am indebted for much information, told me that he obtained only one specimen in the recent state, which he received from St. Thomas.

[2] It is abundant as well in the fossil state as in the adjacent sea. The fossil shell is much larger than the recent, and like the latter is almost denuded of the epidermis.

[3] It is at present scarce about Barbados, but very frequent among the Virgin Islands. The large numbers which are found in the fossil state, prove that it was in former ages abundant.

[4] The fossil specimens are much larger than the recent.

[5] Very rare in the fossil state, and no longer extant in the sea around Barbados, though not uncommon among the Virgin Islands.

[6] Both species are abundant in the recent and in the fossil state.

[7] A detailed description of these new fossil shells will be found at the conclusion of this list.

[8] I found merely a fragment of this gigantic shell, which is one and a half inch thick, and encloses a large Petricola. I know not to what shell else to refer this fragment, although this species belongs more properly to Amboyna, and Captain Beechey found several imbedded in coral rock in the South Pacific.

[9] A large fragment of *Astræa ananas*, which I found near Airy Hill, contained upwards of twenty specimens of this shell. I possess likewise several casts of a *Lithodomus* which were found near Chimbarozo in the parish of St. Joseph, and at a height of about 1000 feet above the sea.

[10] One valve is only generally found. It is now scarce in the adjacent seas.

[11] This is an impression upon a piece of coral rock which I found near Fort George. Impressions of shells are very scarce, nor did I find a second during my researches.

Spondylus Americanus ?, *Lam.*[1]
—— —— ?

Fam. *Ostracea.*

Ostrea folium, *Linn.*[2]

CLASS MOLLUSCA.

Order GASTEROPODA.

Fam. *Phyllidiana.*

Lottia —— ?

Fam. *Bullæana.*

Bulla striata, *Brug.*

Order TRACHELIPODA.

Fam. *Neritacea.*

Natica mammilla, *Lam.*
—— canrena, *Lam.*
(Nerita canrena, *Linn.*)
—— vitellus, *Lam.*

Fam. *Plicacea.*

Pyramidella dolobrata, *Lam.*
(Trochus dolobratus, *Linn.*)

Fam. *Scalariana.*

Scalaria Ehrenbergii, *E. Forbes.*[3]

Fam. *Turbinacea.*

Trochus imbricatus, *Lam.*
Monodonta modulus, *Lam.*
Turbo pica, *Linn.*[4]
—— cælatus ?

Fam. *Canalifera.*

Cerithium nodulosum, *Brug.*
—— —— ?
Pleurotoma —— ?[5]
Turbinella pugillaris, *Lam.*[6]
—— cingulifera, *Lam.*
(Murex nassa, *Gm.*)
Pyrula melongena, *Lam.*
—— abbreviata, *Lam.*
Ranella rhodostoma ?, *Beck.*
Murex Messorius, *Sow.*[7]
—— similis, *Sow.*
Triton pileare, *Lam.*
(Murex pileare, *Linn.*)
—— tuberosum, *Lam.*

Fam. *Alatæ.*

Strombus gigas, *Linn.*[8]

[1] As in the case of *Avicula*, only odd valves are to be met with of the genus *Spondylus*. They resemble *S. Americanus*, and are generally found in elevated situations, but I have met them likewise nearer to the sea-shore. They are sometimes firmly imbedded in the coralline rock. I possess the lower valve of a *Spondylus* which I excavated from a coral block (*Meandrina*) near St. Stephen's chapel in the parish of St. Michael, which is of a large size and very ponderous.

[2] It is a rare fossil in Barbados, and, as in the former case, an odd valve is only found. In the recent state it is found frequently adhering to *Gorgonia.*

[3] I refer for a description of this unique shell to the conclusion of this list.

[4] Abundant in both states, but seldom found so large at present in the adjacent sea as it is to be met with in the fossil state.

[5] This shell comes from the rock near Springfield. I regret that I received through Mr. Packer merely a fragment of this shell, which, like the two species of *Nucula*, appears to exist no longer in a recent state.

[6] The large size of this shell in the fossil state in comparison to those which are now obtained is remarkable. Its length from the apex to its greatest distance from it is six inches, the breadth four and a half inches, the width across the aperture two and a quarter inches. It is rare in the fossil state, and likewise at present scarce about Barbados, but common amongst the Virgin Islands.

[7] Dr. Cutting informed me that he was not certain whether this shell is found at present near Barbados. It is common among the Virgin Islands. The fossil specimens are generally well-preserved, and chiefly abundant in Christ Church in a marl-pit near the Hope Estate.

[8] Abundant in the recent and in the fossil state. Fossil specimens are very numerous about the Pine Estate in St. Michael's.

Strombus accipitrinus, *Lam.*[1]
—— pugilis, *Linn.*[2]

Fam. *Purpurifera.*

Cassis flammea, *Lam.*[3]
(Buccinum flammeum, *Linn.*)
—— Saburon, *Lam.*[4]
Purpura patula, *Lam.*
(Buccinum patulum, *Linn.*)
—— ——?
Dolium perdix, *Lam.*
(Buccinum perdix, *Linn.*)
Buccinum ——?

Fam. *Columellata.*

Columbella mercatoria, *Lam.*
Mitra granulosa, *Lam.*
Mitra striatula, *Lam.*
(Voluta Barbadensis, *Gmel.*)
Voluta musica, *Linn.*[5]

Fam. *Convolutæ.*

Ovula gibbosa, *Lam.*
(Bulla gibbosa, *Linn.*)
Cypræa exanthema, *Linn.*
—— cinerea, *Gmel.*
—— bicallosa, *Gray*[6].
—— Spurca, *Linn.*
—— pediculus, *Linn.*
—— ——?[7]
—— ——?[7]
—— ——?[7]
Oliva conoidalis, *Lam.*
Conus verulosus, *Brug.*
—— ranunculus, *Brug.*[8]

DESCRIPTION OF SOME NEW FOSSIL SHELLS FROM BISSEXHILL AND SPRINGFIELD IN BARBADOS.

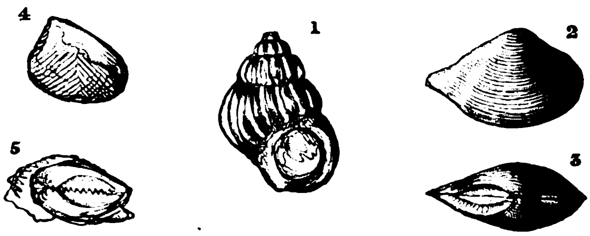


Fig. 1. Scalaria Ehrenbergi.
Fig. 2. Nucula Packeri.
Fig. 3. The same, showing the dorsal margin.
Fig. 4. Nucula Schomburgkii.
Fig. 5. The same, showing the dorsal margin.

Fam. SCALARIANA, *Lam.*

Scalaria Ehrenbergi, *E. Forbes.* (Fig. 1.)

S. testâ brevi, obesâ, ventricosâ, anfractibus 5, longitudinaliter costulatâ, costis

[1] A rare shell in the recent state about Barbados, but common among the Virgin Islands. Fossil specimens are frequently met with in marl-pits.

[2] Rare around Barbados, but common amongst the Virgin Islands. They are found abundantly in marl-pits, with the colour of their aperture as well-preserved as if they had only recently come out of the sea.

[3] Found frequently imbedded in the coral rock in the neighbourhood of Bridgetown, and near Black Rock.

[4] Rare in the fossil state.

[5] Rather rare in the fossil state, but abundant in the sea around Barbados. My fossil specimens are from the Hope in Christ Church parish.

[6] Rare in the fossil state.

[7] I have not been able to determine these three species of *Cypræa.*

[8] Rare in the fossil state.

regularibus æqualibus, lamelliformibus, in ultimo anfractu 16; aperturâ rotundatâ marginatâ.

Shell ventricose and shortly conical, whorls about 5, rounded, longitudinally ribbed; the ribs equal, elevated and not thick, numerous, 16 on the body whorls: no spiral ridge on the base: marginal rib of the round aperture strong and high; columella broad and rather angulated at the base. Length $\frac{8}{10}$ of an inch: breadth $\frac{6}{10}$ of an inch.

This remarkable species is allied to some tertiary forms, probably miocene. Among recent species its nearest ally is the *Scalaria crassilabrum* of Sowerby, jun., a species from the Philippines and Central America.

I found this unique shell near the summit of Bissex Hill, imbedded in siliceous limestone. I am glad that my discovery of this new shell has afforded Professor Forbes an opportunity to name it after the learned Professor Ehrenberg, who, by his discovery of a new class of animalcules in the rocks of Barbados, has added another claim to our thanks for his indefatigable researches into the history of the most minute forms of organic life.

Mr. Edward Packer of Springfield forwarded to me during my stay in Barbados, a specimen of rock consisting of dark gray limestone enclosing small quartz pebbles, in which numerous shells of the genera *Nucula, Lucina, Pleurotoma* and *Venus* were so firmly imbedded as to form one mass. According to his description, this block lies isolated in the neighbourhood of Springfield, and I do not recollect having met with a similar rock *in situ* during my rambles in the island. I have to regret that the specimens of shells which I received from Mr. Packer were mostly very imperfect; this refers chiefly to the *Lucina* and *Pleurotoma*. One of the species of *Nucula* was very perfect, which, at my request, my friend Professor Forbes has named after Mr. Edward Packer, a gentleman who has taken great interest in my researches while in Barbados, and offered me many facilities in prosecuting them.

I have consented, not without some hesitation, to the specific name of the second species, upon which my kind friend Professor Forbes has insisted.

FAM. ARCACEA, *Blainv. and Lam.*

NUCULA (LEDA) PACKERI, *E. Forbes.* (Figs. 2 and 3.)

N. testâ oblongâ subtumidâ, transversè striatâ longitudinaliter obliquè unisulcatâ; latere postico productiore, attenuato, angulato, subacuto; antero rotundato; margine ventrali simplici, subsinuato; lunulâ oblongo-lanceolatâ, carinis elevatis cinctâ.

Shell ovate or oblong, rather tumid, produced slightly retrally into a subcompressed acutely-angled beak, which is separated from the rest of the shell by a shallow furrow; the other extremity is rounded. The surface is crossed by very numerous transverse striæ with sharp intermediate ridges. The beaks are prominent. The lunule is well-defined and smooth, and bounded by two ridges, one of which is the margin of the upper part of the valves. The margins of the shell are smooth. Transverse dimension $\frac{8}{10}$ of an inch; beak to frontal margin $\frac{5}{10}$ of an inch.

This form is allied to several existing tropical and sub-tropical *Nuculæ*, and to some crag forms.

NUCULA SCHOMBURGKII, *E. Forbes*. (Figs. 4 and 5.)

N. testâ ovato-ellipticâ, valdè inæquilaterali, tumidâ, posticè rotundatâ, anticè abruptè truncatâ, lineis sæpè divaricatis sculptâ; umbonibus subterminalibus; lunulâ lanceolatâ, marginibus denticulatis.

Shell rather tumid, ovate, elliptic, very inequilateral, with the beaks nearly terminal at the truncated anteal extremity. The posteal extremity rounded. An arched furrow runs from the beak to the margin at the anteal extremity. This furrow is smooth; the space in front of it is terminated by about a dozen nearly perpendicular curved grooves, bounding a somewhat impressed, nearly smooth indistinct area. Between the arched groove and in front of the border of the lunule, all over the shell are fine curving divaricating furrows, forming a series of elegant angular markings. Towards the cardinal margin these furrows curve inwards, widen, and have thicker interspaces, so as to denticulate the borders of the lanceolate and nearly smooth lunule. The ventral margin appears to have had smooth lips. The cast is smooth. Dimensions of the most perfect specimen, from beak to posterior angle, $\frac{5}{10}$: central breadth $\frac{4}{10}$: thickness $\frac{3}{10}$.

This remarkable shell belongs to a group of *Nuculæ*, of which there are few known species, either living or fossil. The oldest known members of the section occur in cretaceous strata: *Nucula bivirgata*, Sowerby, and *Nucula ornatissima*, D'Orbigny, both gault species, are examples. Still nearer the West Indian species is the *Nucula Cobboldiæ* of the crag, a species which lived on in the Celtic region of Europe till the elevation of the sea-bed of the glacial epoch caused its extinction. Two living *Nuculæ* represent this group, viz. *Nucula divaricata* and *Nucula castrensis*, both described by Mr. Hinds in the 'Zoology of the Voyage of the Sulphur'; the former was taken in twenty-four fathoms in the Chinese seas, and the latter dredged in seven fathoms, sand, at Sitka in North-West America.

CHAPTER III.

THE APPLICATION OF THE MINERAL PRODUCTS OF THE ISLAND OF BARBADOS, AND THE COMPOSITION OF ITS SOILS.

THE existence of several mineral products in the Scotland formation becomes evident from the preceding remarks. They have in a great measure been hitherto unheeded, and the gift of nature has lain there profitless. The author of the numerous valuable contributions in the 'Agricultural Reporter,' signed with the initials J. D., and which are known to be the productions of Dr. Davy, the brother of Sir Humphry Davy, has repeatedly drawn the attention of the inhabitants to the great advantages which might be derived from some of the marls in the improvement of such soils in Barbados as are deficient in carbonate of lime, and also as a valuable article of export, especially to British Guiana, a country remarkably deficient in limestone. Dr. Davy asserts that he knows of no limestone procurable in any part of England so fitted for agricultural purposes as the chalk and soft calcareous marl of Barbados.

It is not likely that Barbados possesses precious metals. Hughes relates that on the surface of the earth on Colonel Abel Alleyne's estate (in St. James's parish), a piece of ore had been found which upon analysis in England proved to contain a large proportion of gold; but though diligent search was made by digging and otherwise no more was discovered. That author mentions another instance of some ore reported to have been found by Dr. Bruce, without the locality where he found it being known. The north-eastern point of St. Peter's parish is another locality where gold is said to have been discovered, but we possess no proofs of the truth of such assertions. The ore found on Colonel Alleyne's estate might have been dropped there by accident after having been brought from South America. It is mentioned by Sloane, that the Duke of Albemarle, who possessed a patent authorizing him to search for mineral treasures in all the West India plantations belonging to England, made great inquiries after minerals in Barbados without success, except that they found some substance at a hill which was very shining and was lodged in the earth; some of it was afterwards sent to Jamaica, but proved to be only white or silver-coloured Marcasite (pyrites), which on trial held no metal, or so little as not to be worth while to look after[1]. Smoky gray clay ironstone (compact clayey oxide of iron combined with carbonic acid) is abundant about Chalky Mount, Mount Hillaby, Jeeve's, &c.

[1] Sloane's Natural History of Jamaica, vol. i. p. 33.

The occurrence of bituminous coal in various situations in the Scotland formation called Manjack[1], has been alluded to in the geological sketch. There are several varieties of combustible matter intermediate between the liquid mineral tar and the bituminous coal, which, according to Dr. Davy's examination, pass in a series from mineral tar through soft bitumen and hard asphaltum into "glance coal," by which name he calls "a mineral substance which possesses the essential character of this coal, viz. not melting when heated, but swelling up from partial fusion and caking, to use an expression commonly applied to bituminous coal of this quality; burning for some time with flame and leaving a portion of cinder or coke, which of course consumes without flame[2]." The consideration of the geological structure of the Scotland formation led Dr. Davy to make some remarks on the probability of finding serviceable beds of coal in certain parts of this island. Such a supposition is borne out by various circumstantial proofs, derived not only from the mineral character of the rocks which compose the district, but from the presence of the tar springs which owe their origin to "woody and vegetable substances which may have undergone by the agency of subterranean fires, those transformations and chemical changes which produce petroleum, and this may, by the same causes, be forced up to the surface, where, by the exposure to the air, it becomes inspissated, and forms the different varieties of pure and earthy pitch or asphaltum[3]." This mineral oil occurs in most countries where coal is found[4]. Mr. Crawford, on a voyage up the Irawaddi to Ava, collected numerous geological specimens which are described by Dr. Buckland in the Geological Transactions; and alluding to the resemblance which some green and yellow sandstone from Prome bore in their mineralogical character to the plastic clay formation, he observes that near Pugan and Wetmasut they were associated with brown coal and petroleum, precisely as they are found containing brown coal all over Europe, and connected with wells of petroleum near Palma, and also in Sicily. Near the petroleum wells of Wetmasut, Mr. Crawford also found large selenites, resembling those which occur at Newhaven in the plastic clay. In Ava, as in Europe, they seem to be co-extensive with the clay-beds of the tertiary formation[5].

The carburetted hydrogen or fire-damp which escapes through the soil at Turner's Hall Wood, although it does not necessarily indicate the

[1] "In several places of America these sorts of bitumen are found and have several names; the most common name is Mountjack, by which it is known very well amongst the privateers."—Sloane's Natural History of Jamaica.

[2] Barbados Agricultural Reporter for January, 1846.

[3] Lyell's Principles of Geology (5th edition), vol. i. p. 335.

[4] The most powerful springs producing petroleum hitherto known, are those on the Irawaddi in the Burman empire. In one locality there are said to be 520 wells yielding annually 400,000 hogsheads.

[5] Geological Transactions, 2nd series, vol. ii. p. 388.

presence of coal-beds[1], affords another probability. Fire-damp, or carburetted hydrogen gas, appears to be generated by the decomposition of iron pyrites in coal, and may often be heard issuing from the fissures in coal-beds with a bubbling noise, as it forces the water out along with it; but it is also a product of the decay of any organic matter when air is present in deficient quantity, or more properly speaking of putrefaction with limited access of air. Iron pyrites are very common in the clays and other rocks of the Scotland district.

The bituminous coal has been hitherto used as fuel in the taich-furnaces of several estates, where it has been combined with megass, and likewise with bituminous clay to prevent its rapid melting and running into a tar, by which a great portion of it is lost, as it runs through the bars of the furnace-grate without igniting. In Wales the labouring class resort to a compound of the small coal which is quite unmanageable for firing, and mixing it with turf and clay into balls, it is dried and used as firing, and is said to give a steady glowing heat without much flame[2]. Asphalt has been extensively used by engravers in the preparation of their varnishes.

The existence of springs saturated with sulphuretted hydrogenous gas has been already alluded to. Such a spring near Mount All, called "the Pottery," attracted some attention in 1830, and it was examined by Dr. Doyle, Surgeon to the Forces, Drs. I. J. Ferguson, and R. C. Thomas. The first gentleman came to the conclusion, after a hasty examination, that the water in this spring, on the surface of which floated naphtha or green Barbados tar, resembled the water of the "Bain de l'Empereur" at Aix-la-Chapelle. Its odour was that of rotten eggs, and its savour not very disagreeable. Dr. Doyle was so forcibly struck with the great resemblance between them, that it appeared to him in tasting the water at the source, nothing was wanting but the caloric and air-bubbles of the waters of Aix to enable him to pronounce upon their identity. He considered that the waters of the Pottery spring possessed qualities of a rare and precious kind, and might be beneficially employed for the cure of cutaneous maladies, as well as for those complaints termed obstructions

[1] Dr. H. W. Hofmann, Professor at the Royal College of Chemistry in London, has been kind enough to analyse this gas. I subjoin his description:—"The gas is perfectly inodorous and colourless; it burns with a light bluish flame and without explosion. The absence of olefiant gas could be immediately seen from the appearance of the flame. The gas was tested for oxygen and for carbonic acid; for the former by small phosphorous balls, for the latter by potassa balls. Both these gases were found to be absent. The gas was analysed by the common eudiometrical process: oxygen was introduced into the gas deflagrated, and the carbonic acid formed, and absorbed by potassa; after which the respective volumes were observed. From these observations the gas was found to be pure light carburetted hydrogen (marsh-gas, fire-damp) CH_2 containing one equivalent of carbon and two equivalents of hydrogen, or in 100 parts, there were 75 parts of carbon, and 25 parts of hydrogen."

[2] Barbados Agricultural Reporter, vol. i. p. 179.

of the liver, spleen, bowels, &c[1]. The two medical gentlemen who accompanied Dr. Doyle were of a similar opinion. It appears from a letter addressed by Dr. Thomas to Mr. Abel Stuart, that there were five springs in the neighbourhood of Mount All and Vaughan's; namely, "a strong chalybeate (to the taste sulphate of iron), and an impregnation of Barbados naphtha; second (the Pottery), a sulphuretted hydrogenous water with a plentiful percolation of naphtha on its surface; third, a strong and simple chalybeate; fourth, a weaker ditto; fifth (looking over Vaughan's), a spring with the evident taste of sulphate of magnesia, and no doubt an aperient[2]. It is much to be regretted that these waters have not been analysed long ere this by some skilful and accurate chemist, as we must remain much in the dark about them until that is done."

The Barbados green tar, or petroleum, has been used with success in cases of leprosy. Mr. Abel Stuart petitioned the House of Assembly to erect upon Bird Island an hospital for the more convenient prosecution of his labours in the cure of leprosy by means of the green tar, and chiefly by the use of the waters from the spring called the Pottery, to which he ascribed similar qualities as the Harrowgate waters. He asserted that he had made his experiments chiefly upon cases of confirmed leprosy, and that in no instance had he failed to arrest the progress of the disease, even in its last stages. The object of the petition was not carried out, and I am not aware whether the virtue of the tar and the waters of the spring are really so efficacious as Mr. Stuart has stated. The beneficial effect of the naphtha in cutaneous affections is undoubted, and a kind of naphtha soap, under the name of Hendrie's Petroline Cosmetic Soap, is much in use in cutaneous diseases, and in cases of fine and tender skins. According to Dr. Andrew Ure, it contains from ten to twelve per cent. of petroleum, which, not being susceptible of saponification with alkali, retains its detergent and sanitary virtues upon the skin quite unimpaired. A patent medicine, under the name of Dr. Berkeley's Aromatic Tar Pills, was much in vogue some twenty years ago. It was asserted that Dr. Berkeley, Bishop of Cloyne, had introduced the tar in 1744, and recommended its qualities in numerous diseases. As usual with universal medicines, the aromatic tar pills were to cure every disease.

The clays, mixed more or less with siliceous matter, were formerly extensively used for the preparation of earthenware. The potteries were very numerous during the last century, when it was customary to manufacture forms for making clayed sugars. Goglets, pitchers, and some other coarse articles of pottery and ware, are still manufactured in the Scotland district.

The numerous Septaria might be used for the preparation of cement. Parker's cement is prepared out of a similar mineral, which is found in the London Clay.

[1] Dr. Doyle's letter to Mr. Caldecott.

[2] It is used as such by the labourers in the neighbourhood.

The yellow and brown ochres, which are found in St. Andrew's and at Bissex Hill, are sometimes used as paints by the labourers.

The calcareous sandstones are extensively used for building materials, and the micaceous sandstone is well-adapted for the erection of chimneys and furnaces. It is usually called firestone in consequence of it. The calcareous conglomerates, composed of triturated minute fragments of shells, are used for dripstones, and those rocks which consist of more minutely comminuted shells, for building materials. This rock is quite soft when quarried, and may be cut into any shape. By exposure to the air, or by being washed by the sea, it assumes great hardness. The Mole Head is built of similar rock, which is quarried extensively near Highgate.

The productive soil which rests on the coralline formation is of a varied nature. On the higher table-land, as near Mount Wilton, Lyon Castle, and Castle Grant, is a soil of reddish-brown hue, which, according to Dr. Davy, contains a large proportion of a siliceous matter in a very finely divided state, with a certain portion of clay, and an admixture in small quantities of lime and magnesia[1]. Another quality of soil is that which prevails between the terrace elevations, as in the higher valley called Sweet Bottom, chiefly near the estates Sweet Vale and Redland. It contains more clay than the first-mentioned soil, and a large proportion of silica, but little lime and magnesia. Its colour varies between red and brown[2]. A third variety of soil differs little from calcareous marl. It is incumbent on a substratum of marl, and consists of carbonate of lime, containing fragments of sea shells. It is generally of a light colour, and occurs especially on the north-eastern part of St. Philip's, in parts of St. Michael's, and also of St. Lucy's. A fourth variety is in some situations almost black, consisting of vegetable matter in a peculiar state of decomposition, approaching (as Dr. Davy believes) the state of peat[3]. It contains commonly a good deal of clay with a sufficiency of calcareous matter, and of silica and magnesia. It occurs in low situations towards the sea-coast. Dr. Davy mentions another variety of soil from Codrington Estate below the college. It is a calcareous argillaceous marl of a gray colour, consisting of alumina, carbonate of lime, and of silica in well-adjusted proportions, with some carbonate of magnesia. The steep hills and ridges below the college, and their valleys and ravines, consist of such soil, which though barren in aspect possesses real fertility and abundance of water.

[1] The greater part of these observations on soils are quoted from 'A Discourse delivered before the General Agricultural Society of Barbados on the 22nd of December 1846, by John Davy, M.D., Inspector-General of Army Hospitals.' Printed in the Barbados Agricultural Reporter, February 6th, 1847.

[2] Some bluish clay is found near Sweet Vale on the road to Redland.—R.H.S.

[3] I have received from Mr. Pile some dark black soil from the neighbourhood of Spring Garden, which has all the appearance of peat.—R.H.S.

Dr. Davy considers that the soils on the table-land and Sweet Bottom arose from the subsidence of drift-matter, brought by the currents when these parts were lying at a considerable depth in the ocean. He observes, that the red soil of the higher grounds presents itself at heights where it could not be brought after the ground on which it rests, namely, coral and shell limestone, was raised from the depths of the sea, because there is no higher ground near from which it could have been conveyed by the action of water. Dr. Davy describes a hill, the summit of which consists entirely of red clay, near Horse Hill, and there is another near Sugar Hill. Barbados does not offer a singular instance of red soil resting on coral limestone, which some geologists suspect to be the residue of the limestone exposed for ages to the dissolving action of rain-water.

I regret exceedingly that I carried no sample of this red soil with me, in order to send it to Ehrenberg for examination, whether it contains siliceous Polycystina. So much is certain however, that the red soils from Sweet Bottom and from the road near Mount Wilton differ geologically in their age from those near the summit of Mount Hillaby; the former does not contain a single species of Polycystina, while the red soils from the northern declivity, near the summit of Mount Hillaby, contain several. These fossil animals are entirely peculiar to the rocks of the Scotland formation, which is of great importance in the relative judgement of their ages, if compared with the coralline formation. The numerous specimens of soil and mud, which I forwarded to Professor Ehrenberg, from several parts of the high table-land and the flats of St. Lucy's and St. Philip's, do not contain a single species of the cellular animalcules.

CHAPTER IV.

A SKETCH OF ORGANIC NATURE AS DEVELOPED IN BARBADOS.

Heat and light are the two great agents of nature which call organic life into existence; without it, those forms which now astonish us by their multiplicity would have remained inorganic substances. It is true we see in the rock a regular arrangement; we observe a gradual and laminated structure, and the crystal demands our admiration by its symmetry; nevertheless, these forms extend only in one direction, resolvable in straight lines, while organic nature abounds in forms of endless varieties.

Where organic life has once been called into activity, be it represented by the smallest vesicle invisible to the naked eye or the majestic oak, there it will increase and augment under circumstances favourable to its further development. Nature never rests; vesicle is added to vesicle, cell to cell, and in organs of a higher degree follows fibrous tissue, the formation of which proclaims the first stage of vegetation. After the production of these fibres, other organs are successively produced; and, forced onward by the inert power of organic life, the plant ascends to its perfect form.

The rock, an inorganic substance, increases by the adhesion of new parts from without—it enters into several chemical and mechanical combinations, and may be divided into several parts alike in nature; but deprived of the power of reproduction, it remains a dead mass. And nevertheless, in that very power of reproduction which constitutes the great privilege of organic life, lies the germen of death.

Animals and plants form organic nature; they possess instruments of action: on the action of each and their co-operation together depend their growth and perfection. They breathe by pores and absorb foreign substances. A derangement of their organs causes an interruption in their activity and produces ultimately death. Their reproduction is stipulated by natural laws. Only in the lowest stage of the vital activity, namely, in those organs which by their crystalline and fragmentary structure, by their straight lines or extension in one direction, remind us of inorganic substances, occurs a multiplying by spontaneous separation (*Diatomaceæ*). These microscopical bodies appear like the first dawn of organic nature—a stray ray of the all-animating sun called them into existence, ready to assume the form of vegetable or animal bodies. But even in the most imperfect state of organic bodies we find a combination of cells, a division in small organisms, and a reciprocal activity in the substances which compose their organization.

It was formerly asserted that the difference between inorganic substances and organic bodies, and between plants and animals, consisted in the following character:—"Inorganic bodies or rocks are without vitality, and of a similar structure throughout their extent; they increase by *juxta-positio*, and do not multiply by reproduction. Organic bodies are of dissimilar structure, increase by *intus-susceptio*, and multiply by reproduction. Without voluntary motion and stomachs they are called plants; with a will and motion and a stomach, animals[1]."

Our advanced knowledge proves that these limits are not so sharply drawn by nature as to permit the assertion, here ends animal life, and

[1] Linnæus expressed the difference between inorganic substances and organic bodies, and plants and animals in the following short sentence: *Lapides crescunt—Vegetabilia crescunt et vivunt—Animalia crescunt, vivunt et sentiunt.*

there begins the animal kingdom. It is asserted by M. Bory de St. Vincent and Professor Kützing, that there exist organic bodies which are animals at one period and vegetables at another. Kützing boldly asserts that the *Diatomaceæ*, which are considered to stand at the extreme limit of organic life, are as much of animal as of vegetable origin. It appears therefore that animals and plants cannot be distinguished at the extreme limits of the great divisions of organic bodies, and that nature is connected by indivisible links. Voluntary motion and stomachs can no longer be assumed as the barrier between plant and animal[1].

Professor Lindley, in his 'Vegetable Kingdom,' a work of which it is difficult to speak in terms of sufficient praise, observes, when alluding to *Diatomaceæ*, that "from this point the naturalist who would learn to classify the kingdom of plants must take his departure. He perceives that those species which consist of cells, either independent of each other (*Protococcus*, *Uredo*) or united into simple threads (*Conferva*, *Monilia*), are succeeded by others in which the threads collect into nets (*Hydrodictyon*) or plates (*Ulva*), or the cells into masses (*Laminaria*, *Agaricus*); peculiar organs make their appearance, and at last, as the complication of structure increases, a leaf and stem unfold as distinctly limited organic parts."

The extent of this work, according to the plan which I sketched myself previous to the commencement, has already so far surpassed the limits then prescribed that I am obliged to satisfy myself with very general terms on systematic arrangements in introducing the Catalogue of such plants as are growing spontaneously in Barbados, or as have been introduced since its settlement as a European colony.

The contemplation of nature when our race was still in the cradle of its existence, suggested already the division of what man saw around him into grass and herbs yielding seed, and fruit-trees yielding fruit, of moving creatures that have life in the water, of fowl that fly above the earth, and cattle and creeping things. A close observation and intimate acquaintance with nature no doubt rendered such a classification self-evident; it is therefore remarkable that after ages had elapsed, and the other sciences connected with the history of our earth kept pace with the advance in knowledge, botany should have erred from the straight path and invented an arrangement of the vegetable kingdom which was totally at variance with the simple laws so obvious in nature. It scarcely requires the observation that all our systems are mere conventional contrivances to place the numerous objects of nature into a classified arrangement, with the view of facilitating our search after an individual object.

As long as systems were invented which did not rest upon the principle that those plants which are most alike should be arranged in groups,

[1] It has been recently advanced that the existence of starch in plants is the best mark of distinction, as this compound is entirely unknown in animal life.

it happened that the systematical combination contained vegetable forms differing as much in appearance as the humble grass from the majestic palm. Gesner, Cæsalpinus, the brothers Bauhin, Ray and Magnolius, were the first who attempted in the sixteenth and seventeenth centuries to arrange the few plants then known according to conventional rules. Tournefort proposed a system which was founded on the form of the corolla; and to him belongs the merit of having classed the plants then known, and which amounted at that period to about ten thousand, into genera, species and varieties, and distinguished the genera by proper names. Linnæus published in 1734 his sexual arrangement, which for its simplicity and facility received the general approbation of all botanists of that period. He followed the path which Tournefort before him had already adopted, and introduced a scientific nomenclature, and bestowed likewise short characteristic names for the species.

Linnæus employed the stamens and pistils for the formation of his system. Such an arrangement may have been adequate to the advance of the botanical science at that period, but no person was more persuaded of its incompleteness than the ingenious author himself. Plants which bore to each other the greatest resemblance were unnaturally separated by this arrangement; and he acknowledged that the present system was merely a substitute for a more natural arrangement, for which he considered the science at that time unprepared. A natural distribution of plants occupied the great philosopher during the latter days of his life, when he threw together such genera as he knew into sixty-seven groups, which he called Fragments, and some of which are adopted to this day.

Linnæus compared very appropriately the objects of animated nature to the places marked on a map, many of which border closely on each other[1]. The genera in a systematical arrangement correspond with provinces, the orders with empires, the classes with the four grand divisions of the world.

DeCandolle has used a similar picture with regard to the vegetable kingdom. He observes, "that certain genera which stand still isolated resembled islands which, separated from the land, are dispersed far asunder in the ocean. If it were possible to place before the eye such a chartographical arrangement of the genera and families, the remark would force itself upon the observer that in some empires the places are crowded and approach each other quite close, but in others they lie far asunder. This difference must be ascribed, as in geography, to two causes—the intermediate places are unknown, or that nature in reality possesses here and there, in the order of things, empty places (perhaps originally, perhaps arisen with the lapse of time) similar to the deserts and morasses on our globe."

Ray announced already in 1703 he conceived a natural system to be that "which neither brings together dissimilar species nor separates

[1] "Plantæ omnes utrinque affinitatem monstrant, uti Territorium in mappa geographica."