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and Thomas G. Clemson,
Esq.

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gested to me the probability of detecting structure in the ashes of coal; and, upon examination, I find that the white ashes of "slaty coal" furnish most beautiful examples of vegetable remains. We have thus additional evidence that the *basis* of vegetable structure is independent of carbon.

Explanation of the Figures. (Plate I.)

Figs. 1, 2, 3. Skeletons of portions of recent plants.

1. Part of husk of Oat, with separate drawings of the cups, which are attached at nearly uniform intervals along the siliceous columns.

2. Part of leaf of the Iris.

3. Hair of leaf of *Cornus alba* (Common Dogwood).

Figs. 4, 5, 6, 7, 8. Siliceous skeletons of portions of plants occurring abundantly in the white ashes of coal.

4, 5. Cellular structure.

6. Annular ducts with transverse bars.

7. Spiral fibre.

8. Fibre *in situ*.

Magnifying power about three hundred linear. The parallel siliceous lines of the Oat, occurring in some cases at intervals of 1-4000th of an inch, form a very delicate *natural micrometer*.

P.S. Since writing this paper, I have been indebted to Mr. Brown's kindness for the perusal of Struve's Inaugural Dissertation, "*De Silicia in Plantis nonnullis*." It is the author's object to show that pure silica forms the skeleton of three species of *Equisetum*, and also of the *Spongia lacustris* and *Calamus Rhodan*. I am gratified by finding the following remark: "*Sub æris libero aditu ustis, restat sceleton, totam plantæ formam accurate servans, partibus animalium osseis quam maxime comparandum*." p. 12.

My attention has also been directed to Mr. Lyell's observations on Göppert's Memoir on the Process of Lapidification, *Phil. Mag.*, May 1837, p. 408, and Ehrenberg's Memoirs on Fossil Infusoria, *Scientific Memoirs*, vol. i. part iii.

IV. *Notes relative to the Geology of a Portion of the District of Holguin in the Island of Cuba, and the Mineral Region on the North-east Coast, from the Observations of himself and THOMAS G. CLEMONS, Esq. By RICHARD COWLING TAYLOR, Esq., F.G.S., &c.**

WE have prepared a detailed description of the mineral region in the vicinity of Gibara, and particularly as to its copper lodes; but as some delay will unavoidably take place in its publication, I have arranged a portion of our notes as a preliminary communication to the *Philosophical Magazine*.

A considerable portion of the year 1836 was devoted to an examination of the north-east part of this island, a mineral region which, so far as I can learn, has never been visited for scientific purposes, and till recently has never been investigated for the practical objects of mining.

* Communicated by the Author.

The area of which I propose now to give a sketch is situated between the city of Holguin and the sea, and forms a mountainous belt or zone parallel with the northern coast of Cuba. That part of it, at least that part which is within the limits of this investigation, in which copper lodes of value have been proved, appears to be only two or three miles in breadth. The centre of this mineral range is about eight miles, in a straight line from the *Embarcadero* or landing-place of the Gibara river; from hence that stream is navigable for lighters four or five miles to the bay and port of Gibara. The known copper lodes are almost entirely limited to the Savanas, which it may probably be not uninteresting first to describe.

Natural Features of the Savanas.—This term, in the island of Cuba, implies an elevated hilly range, for the most part clear of wood, excepting the *Corojo* palms, the Palmettos of two or three species, and some occasional patches of low thorny bushes, aloes, and beautifully flowering shrubs, peculiar to these sites. The surface is everywhere thickly strewn with detritus of the prevailing serpentine rocks of the district, and is covered with a coarse description of grass, rejected by cattle, and which is commonly fired in every spring, either for the improvement of the scanty pasturage, or from time to time, to facilitate the search after copper veins.

Innumerable small streams and ravines, whose beds are dry during the greater part of the year, wind amidst the Savanas in the most intricate manner; descending to larger streams on their way to the main outlet at the bay of Gibara, or to that of Barriay and others which indent the north-eastern coast of Cuba. Their courses in the elevated country are distinguishable by the superior luxuriance of the vegetation along their banks. These streams, with their borders of rich and woodland soil, form the boundaries of the numerous distinct Savanas, each of which bears its separate name.

Smaller detached areas of open and unimproved land, resembling the Savanas, appear on the hills which rise from the midst of the surrounding woods. They are known by the denomination of *Saos*, and are kept open by occasionally firing the coarse herbage. The rocks which appear on their surfaces are of the same character as those on the Savanas, and sometimes indicate mineral traces.

Still smaller open and elevated areas are called *Saoitos*, and partake of the common character, having a few straggling palmettos and mahogany trees dispersed over their rocky surfaces.

The Savana region, whose extreme limits are imperfectly defined, and of which but a comparatively small portion has

at present been ascertained to contain veins of copper, is remarkable for the undulations of its surface, and consists of a countless series of rounded hills, which rise from one hundred to four or five hundred feet above the bed of the principal streams. Some of these hills are prolonged in the form of ridges, stretching several miles in a direction varying between north-east and east; their sides penetrated deeply, at inconsiderable intervals, by innumerable lateral ravines. Other eminences are so surrounded by watercourses and ravines as to appear in regular oval or circular forms, as if constructed by the hand of man, like the ancient mounds and earth-works of Europe, on a gigantic scale. Some of them are a few hundred yards only in diameter, and rise from two to four hundred feet in elevation, and slope on all sides with a remarkable uniformity. To speak of these conformations of the surface, chiefly derived from the slow operation of drainage, as mere undulations will scarcely convey an adequate impression of the superficial character of this region. It is seldom that so extensive an expanse of country is seen, which, without presenting any precipitous faces of naked rock, maintains over its entire area a surface so uneven. Standing upon one of these eminences in the midst of the savanas, and looking over those countless barren and rounded hills, the only scene to which they may be compared, yet on a very inferior scale as to magnitude, will be the billows of an agitated ocean.

These circumstances of external configuration are not unimportant to the miner, who will perceive the facilities they offer to his operations, and how readily these ridges and hills, containing the mineral veins, can be reached, and worked, and drained, to a great depth, from the adjacent ravines.

White Limestone Mountains.—Whilst describing the peculiar features which characterize this part of the island, and which are mainly attributable to geological phenomena, we may not pass unnoticed those remarkable mountains of limestone or marble, which not only approach the borders of the savanas, but even rise in the midst of them.

As we approach the bay of Gibara from the sea, the aspect of the coast and country inland is bold and striking. Mountains of strange forms, pinnacles and isolated bluffs, and elevated saddle-shaped masses, steep and bare of vegetation on their faces, range along the coast at the distance of a few miles in the interior.

We cross them, and amidst them, and pass to the savanas in their rear, towards the south. From hence, as they stretch, at intervals, to the east and to the west, a scene unusually striking and geologically interesting presents itself.

From the midst of the barren savanas and the lower wooded plains arise those lofty detached mountains of compact marble, whose singular forms, and whose white, precipitous, waterworn sides, contrast so remarkably with the rounded, sunburnt hills of the savanas, and give such a peculiarity to the contour of this coast, and furnish to the mariner such conspicuous landmarks. At a little distance, and even at several miles from the base of these mountains, their precipitous faces appear vertically and distinctly striated, like clusters of enormous columns, hundreds of feet in height. We at first attributed this appearance to the possibility of a section of vertical strata being thus presented. But on closer examination we found no such traces of stratification: all sides appeared to possess the same singular, strongly marked vertical lines; and we saw that this remarkable columnar appearance was derived from the erosion of the perpendicular face of the hard rock, wherever exposed to the atmosphere, into deep vertical grooves or flutings, on a large scale.

On the mountain of *La Silla* this phenomenon is beautifully exhibited; and when from its summit we looked down upon the numerous spurs of this mountain, and upon its surrounding masses, we had the singular prospect of apparently an immense assemblage of groups of enormous crystals of white rock, distributed over a space more than a mile broad and two or three miles long, shooting perpendicularly upwards from the woods below, and contrasting strongly with the dark green foliage of a tropical forest.

From the bases of the *Toro loco*, the *Llavason*, and the *Siera alte* mountains, particularly the former, an equally grand and singular view is presented, resembling snow-white basaltic pillars, clear of all vegetation on their sides, except here and there an aloe rooted in some crevice. At this distance the illusion was equally beautiful; when looking to the irregular outline of their crests, it seemed as if the entire mountains, a thousand feet in height, formed one enormous group of vast crystals.

Intermediate Valleys and Plains of rich Alluvial Soil. — In close contiguity to, and intermixed with many of the savanas, are extensive tracts of low and comparatively level alluvial land, the richest, the most luxuriant, and the most prolific, perhaps, in the world. A very small portion of this land is otherwise than in its primitive state of nature, and is covered with timber of the most valuable properties. When cleared, its fertility is apparently inexhaustible, requiring no manure, and it is capable of yielding two or three crops in one year.

This singular intermixture, this close approximation of ab-

solute barrenness and redundant fertility, is not the least striking among the peculiarities of the region under consideration. We have chosen here to advert to it, because it cannot fail to be seen from this circumstance, that in an œconomical point of view it bears materially upon the convenience, and consequently upon the local value, of sites hereafter designed to be scenes of a busy population connected with the mines, which though seated within an area of positive sterility will derive incalculable benefits from their proximity to one of the utmost fecundity.

Rocks of the Savanas.—Our notice of the rocks and nature of the ores of this region will be brief, and will be reserved in detail for another place. The rocks of the mineral district may be divided into two classes: those which contain much diallage and are more or less crystalline in their structure; and those in which that mineral is wanting or is less prevalent; and they all may be arranged under the head of serpentine rocks.

They are sometimes distinct, and, again, are mixed in all proportions. The surface rock, as well as that which has been extracted from the shafts and levels but which has been exposed for a while, is more or less in a disintegrated form; of a soft unctuous touch, and easily reduced to powder. As the constituents of this rock happen to vary, it changes into one of a petrosiliceous nature, is hard, and resists the disintegrating nature of the atmospheric agents. We have previously made mention of this class of rocks in our account of the bituminous veins within them, in the vicinity of the Havana*.

Copper Ores.—The surface ore, or the mineral substance containing copper, that is found at the outcrops, or upon the back of the veins within a few feet of the surface of the ground, differs materially in its physical characters and in its chemical composition from that ore which is found to predominate in the same lode at greater depths. The term surface ore is here applied to amorphous or informal masses of mineral, of different colours, containing more or less metallic matter.

Frequently at the outcrop of veins containing cupriferous ores, the term surface ore is applied to a heterogeneous mixture of several distinct mineral species, of which copper forms one of the constituents, associated with other minerals of little or no value. These ores are generally red, brown, black, green, and the different hues that grow out of an indiscriminate mixture of those colours; the most prominent of these species being the oxides, sulphurets, silicates, and carbonates of copper, with iron, &c. As we descend upon the vein the

* See Lond. and Edinb. Phil. Mag., vol. x. p. 161.—EDIT.

ore assumes a different character. The copper is then found in combination with sulphur and more or less iron; the mineral having a foliated structure, which it owes to an intimate mixture with the foliated magnesian rock, its gangue. At the depth of ninety feet, as we observed in the Buena Isabela mine, that structure is lost, and a more compact and permanent form is assumed. Occasionally the foliated character is maintained, but it is not so marked as nearer the surface*. This ore is raised from the depth quoted in masses of from fifty to three hundred pounds weight each, and free from gangue; but masses have been detached, by blasting, of the estimated weight of one thousand pounds.

Native copper is met with, particularly at the mine of *San Fernando*, on the upper portion of the lodes, and descending to the depth of thirty yards. This occurs in masses of from ten to two hundred or more pounds weight.

Chromate of Iron of great purity occurs in beds and irregular veins in the serpentine rocks at several places in this district. At one point masses containing many cubical yards project several feet above the general surface of the savana.

Discovery and Progress of the Mines in the Savana Region.—It does not appear that any knowledge of the actual existence of lodes of copper on the north-east side of the island of Cuba prevailed before the year 1830. Soon after this time, however, a couple of Mexican working miners were employed to explore for gold amongst the hills and open savanas within the district of Holguin. It was during their ineffectual researches for the more precious metal in this quarter that the first copper veins were discovered; and subsequently the denouncement of *San Fernando*, containing three veins, was commenced, and entrusted to the management of a Mexican manager, by John Bedopia, Esq., an English resident on the island. We have taken the liberty of mentioning this gentleman personally, because to his individual enterprise we are in a great measure indebted for determining the existence of mineral veins within this district.

The mine of *San Fernando* has continued to be worked by negro labour, although but slowly, and under all the disadvantages of the old Mexican system and incompetent management. The ore is a sulphuret, of a bronze green colour, rich in copper, and intermixed with rich gray ore, and, to the depth of the first 30 yards, with native copper.

In the same vicinity have been subsequently made by the same proprietors the denouncements of *Socorro*, *San Antonio*, *San Juan*, *Mina Inocentes* and *San Olivo*.

* T. G. C.

In the mean while, during the active search for gold by numerous individuals, discovery was made of the vein denounced under the appellation of *San Augustin*, and which now comprises the four veins of *Prosperidad*, *Santa Isabel*, *San Augustin*, and *San Nicolas*. The ore of *San Augustin* is as rich as any in the district, so far as has been examined, varying from 23.30 to 51.60 per cent.

The denouncements of *La Buena Isabela* and *Perseverancia* commenced being mined in 1834. A few English miners were employed in the former in the year 1835, and after proving the vein, the works were suspended on account of some temporary difficulties on the part of the owners.

Stimulated by the success which attended the mining of the *Cobre* veins in the vicinity of *St. Iago de Cuba*, the researches on the north side of the island were continued on a limited scale by a few individuals. During the last two or three years, notwithstanding no mining undertaking had been conducted so far as to bring in a single dollar, great activity was exhibited in searching all the savanas through a great range of country. These explorations, however eagerly prosecuted, have up to the present moment led to no other new denouncement than that of *Savana Veija*. Indications and traces have been observed at detached positions, but among these no works, except of the most trivial and superficial nature, have been proceeded with.

All the denouncements made up to the time we are now writing are comprised within an area of only five miles in length by two in breadth. That of *Savana Veija* is among the most promising. The principal vein was discovered in 1835, but copper had been traced at one or two points on this savana three or four years earlier. There appear to be seven or eight good veins here, which are imperfectly proved. No capital has hitherto been employed in this undertaking; and in fact this may be said of the entire region, with the exception of the *San Fernando* and the *Good Isabella* mines, and even in them it has been expended to a limited extent only.

Assays of the ores from the various denouncements within this region have been made in abundance, with a view to the ascertainment of their quality. These results, however satisfactory, it is scarcely necessary to communicate in detail here.

White Limestone of Holguin District.—I add a few additional notes relative to this rock.

Having examined numerous mountains, hills, and belts of this beautiful rock, and traced their connection with the adjacent formations, we were led to the opinion that it is of the same geological age as the serpentines, the greenstones, the

diofites, and the euphotides which occupy so large an area in the island of Cuba.

In the vicinity of *Savana Veija* are limestone hills, composed of very thin layers or laminæ, dipping to the south from 50° to 75° . This rock is white, occasionally tinged with green, and contains numerous interposed beds, varying from half an inch to 4 inches thickness, of red and flesh-coloured crystalline limestone. In other situations we observed that this limestone is either cream-coloured, or with various delicate tints of yellow, green, or pink.

The Gibara river is crossed repeatedly by bands of this limestone, which are traversed by a network of quartz veins. In these positions the rock exhibits evidence of having been shattered and broken, the fragments being reunited in a siliceous cement, and so distorted that the original arrangement of the laminæ or seams of the limestone is obscure and almost obliterated. In general all these traces of original stratification are absent, which inclines us to the opinion that we see the mass only in a modified form, and that it has been subjected to the same influence which has changed the adjacent rocks, and modified the quartz into a substance resembling porcelain, and converted the serpentine almost into a vitreous slag.

We examined two small conical hills of unstratified white limestone near the *Sao Gibara*, which seem to be surrounded by greenstone. We may mention here that we have observed greenstone at the base of most of these limestone mountains; among others in that of *La Silla*, where the greenstone seemed confounded or intermixed with the limestone. We shall advert to this further on, as a fair illustration of a class of mountains which characterizes so strongly the eastern parts of Cuba. The summits of these and other hills of similar character are broken into large masses, and exhibit extensive fissures, affording hiding-places to the numerous wild dogs which infest the country.

The structure of this beautiful marble is extremely fine and compact, too much so, I am informed, to admit of its adaptation to external building purposes, as I had anticipated; but for finished and more delicate work in the interior, and for the ornamental departments of architecture and sculpture, it appears well adapted. Its fracture is conchoidal; its colour commonly white or cream-colour, or slightly tinted, and its texture inclined to waxy. The specific gravity is great. Blocks of almost any magnitude may be obtained without a flaw. When struck with a hammer the loose fragments emit a sonorous ringing sound. Upon the mountains all the ex-

posed surfaces are honeycombed and have sharp projecting points as in the coral rock of the coast.

Upon the skirts of most of these mountains are tufaceous deposits, covering the surface; which calcareous tufa has been derived from the decomposition of the rock, and is brought down by the numerous springs which descend the hills. This soft tufa incloses various extraneous substances, and contains beautiful impressions of leaves and vegetables.

Organic Remains.—In this rock traces of organic remains are so extremely rare, that during months of examination but two or three specimens came under our observation. They were madrepores, the structure of which had been partly obscured by crystallization, or by the change which the mass of limestone had undergone. We have not observed the slightest trace of a shell in this formation. It is possible that it may have originally contained organized fossils which have been obliterated by the modification to which the rock has evidently been exposed. No mineral veins or substances were detected in it.

From the foregoing description it would appear that this rock or marble is neither the white limestone with tertiary shells, described by Mr. De la Beche as abounding in Jamaica; nor the compact lithographic limestone, sometimes containing *Pectens*, *Cardites*, *Terebratulæ*, and madrepores, described by M. de Humboldt at the west end of the island of Cuba, under the name of *Calcaire* [Jurassique?] *de Guines*, which we ourselves have had some opportunity of examining in the vicinity of Havana. We conceive that it is more ancient than those rocks; and that it is contemporary with the *Euphotides* and metalliferous serpentines of this region.

It is a prevailing character of the Holguin and Gibara limestone that it contains large masses of carbonate of lime of a much later origin. These are accounted for, on the supposition that they were open fissures, cavities, and even large caverns, which in process of time have been wholly filled by stalagmitical infiltration. All these later deposits are of a brick-red colour, remarkably fetid, and embrace vast quantities of casts of land shells, occasionally intermixed with marine univalves, and with a few small bones, apparently of the great Indian rat, one of the very few indigenous quadrupeds of the island, and now inhabiting the same mountains.

La Silla.—This singularly-shaped mountain of white limestone is about two miles long and one in breadth. Its sides, towards the summit, are bare and perpendicular, so that only at one or two points is it practicable to attain the top, by the

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assistance of the luxuriant foliage of certain creeping shrubs, or an occasional tree growing amongst the recesses and crevices.

The barometer being injured in the ascent, no correct calculation was made of the height of *La Silla*, which we estimated at from one thousand to twelve hundred feet above the sea, here distant about eight miles.

Contrary to our expectation, we found that the summit was limited to a narrow ridge; a mere vertical wall of honey-combed limestone, on which it was practicable only in a few places to obtain sufficient space for standing, assisted by the shrubs that were rooted in the crevices.

We have adverted to the singularly beautiful appearance of these rocks when viewed either from the crest or from below; which effect was produced by the vertical wearing or erosion of the white marble in grooves, giving them the aspect of enormous columns and of gigantic groups of crystals.

The upper surfaces of this rock are deeply honeycombed; that is to say, they have numerous sharp projecting points, on which it is dangerous to walk, and have also innumerable circular holes two or three inches in depth and one inch or more in diameter, perfectly smooth and regular in their interior, as if bored with an auger.

No stratification can be perceived in this enormous mass of limestone. Certain lines of separation there are, which may be traced at various angles, as well as vertical fissures, but none of these were the result of stratification. Large blocks are commonly seen piled on the sides near the summits of these mountains. They are remarkably sonorous when struck, ringing under the blow of the hammer like a bell.

Land-shell Limestone of La Silla.—We have adverted to the barrenness of the white marble in organic remains, and we obtained from hence only a single specimen, a madrepora, which was somewhat modified in form.

We have now to describe a deposit, rich in fossil shells, of a novel and remarkable character.

On the surface and on the sides of *La Silla* is a great abundance of subsided masses of stalagmitical rock, derived from the limestone, and filled with hollow casts of an immense assemblage of univalve shells, which at the first glance I thought were tertiary. On examination these shells were observed to be peculiar to a separate rock of a brick-red colour, but the position of that rock was not immediately discovered. This red earthy stone was also crowded with small spherical bodies; black, smooth, polished, with minute rounded and kidney-shaped pebbles, from the size of mustard-seed to that of a

small pea. They were unequally distributed, and in some specimens but few can be observed. The shells were in almost every instance enveloped in crystallized carbonate of lime.

During subsequent researches we ascertained that the red rock was not interstratified with the white limestone, but occupied the spaces formed by ancient open fissures, sometimes a few inches only in thickness; but in one instance, within fifteen feet only of the summit, it was exhibited of the breadth of fifty feet, and of a thickness varying from ten to thirty. This mass was evidently composed of a numerous series of deposits, having different tints, and being more or less earthy or crystallized, emitting an offensive odour when broken.

It was not until after two or three visits to this mountain that we traced satisfactorily the extent of these insulated shelly deposits, acquired a knowledge of their origin, and perceived the process by which they were consolidated. It became evident, on comparison, that these univalves, which were as abundant as in any deposit we have seen, were referrible to *land genera*, such as exist in profusion among the rocks of the same mountain, amounting to eight or nine species at least. The inhabitants of these shells retire into the open fissures and caves, and in some instances are probably carried into them; and the dead and unoccupied shells lie in vast numbers in such places, in every instance mixed with the red earth, similar in colour to the more earthy portion of the consolidated rock. These caves are resorted to by multitudes of bats, and beneath the holes in the roof where they most congregated I observed heaps of the dung of these animals, of a bright red colour, as if derived from some seeds or berries upon which they had fed. It is possible that a portion of this red colour of the earth and of the consolidated rock was derived from this source, and probably the globular bodies to which I have referred originated in the same way.

By the stalagmitical process the shells, together with other extraneous substances within its influence, become enveloped in crystallized carbonate of lime, and the operation of infiltration may be seen slowly but uniformly proceeding, until caves and fissures of considerable size are wholly filled up with the new mass, and are consolidated with the older limestone. Sometimes the mass contains brecciated fragments of this white limestone. It approaches in colour to the osseous breccia of Gibraltar. We had little hope of discovering bones of large animals in the caves of an island which contained on its discovery no quadruped larger than the Indian rat. But we met with fragments of bones which we referred to the *Hutia*, or large Indian rat of the island, which is nearly the size of

the raccoon. The *Hutia* is the largest if not the only native quadruped of Cuba, and we observed it on the very spot where we conceived we had recognised its fossil remains. Its flesh is sought by the negroes as a favourite food.

On first consideration it appeared almost incredible that land shells should accumulate in such multitudes as we find them, packed together in layers irregularly within the red stalagmitical limestone. But having witnessed in the caves of *La Silla* the myriads of dead shells there assembled and lying in heaps upon the floor of red earth, we perceived that the process was then going on before our eyes, and that by the infiltration and crystallization of carbonate of lime, these shells were entombed, consolidated, and the whole mass converted to a beautiful marble. This process continues until some of the caves are completely filled up, and the recent mass becomes an integral part of the original rock.

In the interior chambers of the caves, which were the furthest removed from light, the only living shell I observed was a *Clausillia*, which adhered to the walls in great numbers.

I may observe that no traces of the original shells were noticed in the newly-formed rock; the matter of the shell seems to be absorbed during the change it undergoes, and its conversion to solid rock.

There yet remains an interesting fact to be pointed out. Amongst the numerous land-shells which the red shelly modern rock exhibits may be detected, occasionally a univalve which is decidedly marine, and the same circumstance is observable among the dead land-shells in the caves. It was this occurrence of marine shells that occasioned our hesitation, and prevented us from earlier deciding on the real origin and character of the new red shelly limestone. We perceived that perfectly fresh or recent marine univalves were by no means uncommon even upon the highest crest of the mountain of *La Silla*. This mystery was solved when we found that the active agents in the transportation, and in the admixture of sea and land exuviae, were the soldier crabs, which abound here, and which inhabit the littoral shells almost wholly, wherever they are found, borrowing those habitations for their temporary purposes, and discarding them when too small for their convenience.

The soldier crabs (genus *Pagurus*) at certain seasons resort to the sea-shore, where we have seen them in great quantities. They return from their pilgrimage, carrying or rather dragging the shell of some marine univalve for many a weary mile; and thus, like the pilgrims of the olden time, each

bearing his shell to denote the character and extent of his wanderings, they proceed for miles into the interior. Thus, at the distance of eight or ten miles from the nearest shore, we trace them to the very summit of a precipitous mountain, almost twelve hundred feet high. When these borrowed habitations become too confined for the accommodation of their tenants, the crabs desert them, and seek for larger shells, leaving the others mingled with the terrestrial shells, as we observed. The marine shells which had been thus conveyed from the sea to the top of *La Silla* were

Trochus, two or three species.

Turbo, two or three species, particularly *T. muricatus*, Lam.

Littorina, one.

Monodonta, one.

No doubt other genera and species were also transported thither by the same agents, but those above mentioned we can testify to.

Of the land shells, which exist equally in a fossil state on the mountain of *La Silla*, and were seen abundantly in their living state in the same locality, we have collected the following, of which Mr. Isaac Lea has kindly furnished us with the specific names.

<i>Cyclostoma sulcata</i> , var.....	Lamarck.
<i>Rupa mumia</i>	Lam.
<i>Carocolla marginata</i>	Lam.
<i>Carocolla</i> ——— ?	
<i>Helix microstoma</i>	Lam.
<i>Helicogena auricoma</i>	
<i>Helix muscarum</i>	Lea.
<i>Helix purpuragula</i> ?	Lea.
<i>Clausilia</i> ——— ?	

Caves of La Silla.—At about a hundred and fifty feet below the summit of the mountain of this name is an extensive suite of caves. Those we passed through, six in number, extended above three hundred feet to the south, and others stretch off to the north, in the compact white limestone to which we have referred. These caves swarmed with bats, snails, spiders, tarantulas, scorpions, and other vermin, and the large snake called the *Majus*. They are also the resort of hogs, which run wild in the woods, and bring hither a well-known pest in the insect termed the Jigger.

The entrance to the cave is at the bottom of a perpendicular cliff of limestone. The interior is not unlike to an Anglo-Norman crypt, having a heavy groined roof and pillars of continually increasing stalactite. This tendency to encrust the walls or sides contracts the areas of the chambers, to some

of which the apertures are nearly closed up. All these chambers have nearly level floors, covered to an unknown thickness with red earth or mould, on which is thickly strewed the dung of the thousands of bats which congregate here, and myriads of snail-shells. I think the dung of the bats alone would be in sufficient quantity to account for the red earth, and that the colouring matter of this earth and of the rock into which it passes is vegetable and not mineral, as the examinations to which it has been submitted appear to determine. We would have ascertained the depth of this soil on the floor of the cave, but the annoyances from the causes alluded to rendered our stay there almost impracticable. We ascertained quite enough, however, to feel assured that in this soil, to which the bats have largely contributed and have coloured by some vegetable exuviae,—in the multitude of dead and decomposing shells, for which this cave seemed the charnel-house, the tomb of millions,—in the gradual conversion of this mass to the state of solid rock, we saw the origin of those beds of shelly carbonate of lime which at first sight seemed almost inexplicable.

Admixture of Terrestrial, Marine, and Freshwater Shells.—The shores of the bay of Gibara supply to the geologist an instructive instance of this association of shells of different habits. There are several streams which empty themselves into this bay, and which in times of floods, during the rainy season, bring down an immense number of dead land-shells from the high lands of the interior. We here noticed extensive banks or deposits of terrestrial and marine shells, as on the mountain of *La Silla*; but the agency is reversed. In the one case we saw that the marine shells were conveyed by those active agents the soldier crabs even to the highest crest of *La Silla*. In the other the land shells have been brought down from the rocky recesses of *La Silla*, and are deposited in multitudes with those of the sea, on the margin of the estuary. Were any great geological catastrophe to occur, by which these accumulations would be buried, and be subjected to the examination in future times of some inquiring naturalist, he would see repeated here the phenomena which have been observed in more than one position in remote parts of the globe: with these he would find also a full proportion of freshwater shells, but of one genus and species only, the inhabitants of the Cuba streams, the *Neritina virginea* of Lamarck; of which great quantities are brought down by the freshes and deposited on the beach with the terrestrial and sea shells, and with the small oysters which cluster so thickly on the pendent branches of the mangroves of the creeks.

Coral Rock of different Ages on the Shores of the Island of Cuba.—In our examination of the rocks which approach the north coast of Cuba, we have seen nothing to countenance the hypothesis of a gradual transition from the crystalline white limestone we have described in this article, to the fragmentary coral rocks which appear on some parts of the coast, and thence to the modern reef of living corals which encompasses the Indian islands. Some such passage we have observed on the borders of the sea near Matanzas, the Havana, and the Moro Castle; but the compact limestone of the first class is not in those positions, and a newer lithographic rock interposes.

On the west side of the Bay of Gibara the white limestone is observed, declining at first at an angle of 45° , and then decreasing to 20° towards the sea. Upon and near the base of this slope rest ancient beds of aggregate coral rock, reaching to about twenty feet above the present high-water line. This rock is indurated and externally honeycombed like the white compact limestone of the mountains.

Three or four miles to the west of the bay the shore is bordered with a reef of living corals, having an intermediate space of shoal water called the *Bazo*, nearly half a mile broad, between it and the beach. This shoal has been described in detail by Mr. R. C. Taylor in Loudon's *Mag. of Nat. Hist.*, vol. ix. p. 449, &c.

High up on the beach may be seen a more ancient reef, forming a solid ledge of aggregate rock, for the most part composed of corals, shells, and coral sand or mud, now consolidated into a hard rock or cliff, some twenty or thirty feet high, against which the surf beats violently at high water. This is another proof of a change of level on this coast. The old reef, of which we spoke, after continuing for a mile or two as a cliff whose base is washed by the waves, passes obliquely inland, and now has a hill covered with a thick wood of wild fig, sea-grape, and a few aloes and palmettos between it and the sea. This rock is also honeycombed, its surface being full of holes and sharp points. In the mass, which consists of various madrepores and cabbage-formed corals of great size, we observed spines of *Echini*, and numerous univalve and bivalve shells, having their cavities wholly filled with indurated coral, sand, or mud; the whole forming a perfect illustration of the consolidation of an old rock containing organic remains, some of the oolites, for instance, the coral rag, or the Farrington coral beds.

From this old reef we collected a series of characteristic specimens, all of which are common in the West Indian seas. One

of the distinguishing characters of this old coral rock is that it is for the most part made up of a branching species, which appears to have existed at that time in great profusion, but which we have failed to discover living in the vicinity on the present reef. This ramose coral of the beach, when worn by the action of the waves, reminded me of forms which were nearly similar, which I remember to have seen at the base of the chalk at Hunstanton Cliff in Norfolk, and to which I made reference more than fourteen years ago in an article in the Philosophical Magazine, First Series, vol. lxi. p. 82.

Our notice of these different aged reefs would be incomplete did we stop here. We have remarked that there is a difference of level, amounting to full twenty feet, perhaps thirty, between the outer and the inner reef. Now as the coral insects do not live above high-water mark, and indeed are seldom seen living above the extreme low-water level, and commonly are several feet below it, it would appear that this ancient inner reef, which passes inland, was produced under different circumstances of relative elevation of the sea and land; and that either the sea has been depressed to a depth corresponding with the existing reefs of the coast, or, what is more probable, that the land has been elevated since the construction of the old reefs, not only here but at more distant points.

We have also to note that the Zoophytes differ decidedly in the two reefs, and therefore the circumstances which promoted the growth of genera and species in one case, were changed or were absent in the other.

Among the *Mollusca* also of the old reef the greater part, (although common to the seas of these latitudes, like the corals,) consist of different species to those now living in the vicinity of the recent reef, or that are thrown up on the present beach; and we looked in vain for some which exist in great profusion, and may be seen living at low water, at the base of the old coral reef.

We conceived that a further confirmation of the supposed change of level suggested itself in the prevalence of extensive fissures in the old coral bed, where it slopes towards the sea at low water. These cracks, which seem to imply displacement and disturbance, may be traced separately many hundred feet, commonly running parallel with the coast in an east and west direction.

Putting these facts together, one is led to conclude that other agents have been in action besides the mere erosion of the ocean waves, or an occasional and temporary elevation of its waters; and although we look to a much less remote date for these

On the Fossil Jaw of a gigantic Quadrumanous Animal. 33

operations, we are perhaps not widely wrong in ascribing them to some such causes as have produced such remarkable changes of position in, and modified the composition of, every rock on this side of the island of Cuba. This influence, towards the west, has manifested itself by the injection of petroleum and bituminous matter, not only in large quantities into the fissures of the stratified rocks, but into the solid rocks themselves, and even filling cells in the veins of chalcedony by which they are traversed. In the quarter of which we have attempted to draw the foregoing sketch, this influence is seen in the partial vitrification of the serpentine and allied rocks; in the admixture or proximity of igneous rocks; in the conversion of masses of quartz into a species of porcelain; in the kneading into the most contorted and fantastic forms the old stratified beds; in the obliteration, to a great extent, of the planes of stratification of the limestone; in the destruction of the traces of organic remains which there is reason to conceive existed in that formation; and in the conversion of the whole series into a compact, unstratified, and apparently homogeneous mass.

Philadelphia, March 1837.

R. C. T.

*V. On the Fossil Jaw of a gigantic Quadrumanous Animal allied to the genera Semnopithecus and Cynocephalus. By Lieuts. W. E. BAKER and H. M. DURAND, Engineers.**

LYELL, when combating the inconclusive evidence advanced in support of the theory of the progressive development of organic life, notices the absence of remains of quadrumanous species in a fossil state, and the hypothesis which this circumstance has by some geologists been considered to countenance. He, however, draws attention to the fact, that the animals which are found in subaqueous deposits are in general such as frequent marshes, rivers, or the borders of lakes, and that such as live in trees are very rarely discovered; he adds, moreover, that considerable progress must be made in ascertaining the contemporary Pachydermata before it can be anticipated that skeletons of the quadrumanous tribes should occur. Considering the great number of relics assignable to the *Pachydermata*, *Ruminantia*, and *Feræ*, which the Sub-Himálayan field has produced, it is not therefore sur-

* From the Journal of the Asiatic Society of Bengal, vol. v. p. 739 *et seq*. This paper forms one of a series, by the same authors, on the Sub-Himálayan Fossil Remains of the Dádúpur collection. Dr. Falconer and Capt. Cautley's Memoir on the *Sivatherium giganteum*, another Sub-Himálayan Fossil, will be found in Lond. and Edinb. Phil. Mag. vol. ix. p. 193 *et seq*.