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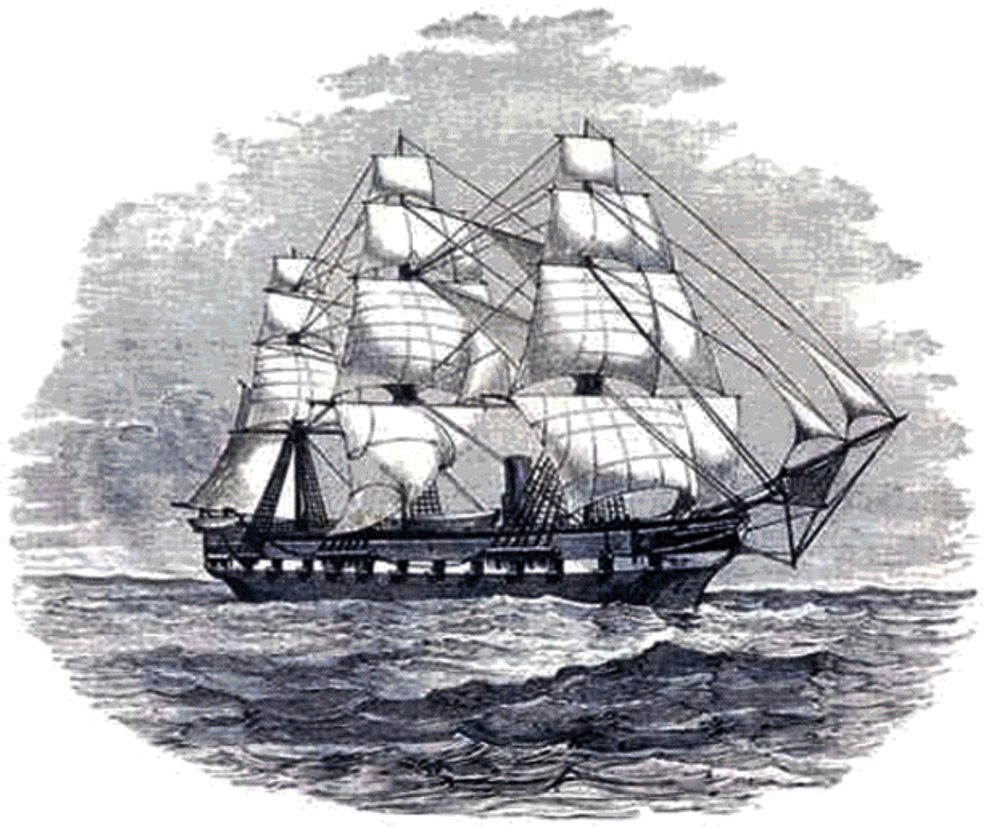

THE

PRINCIPLES

OF

GEOLOGY EXPLAINED,

and viewed in their relations to

REVEALED AND NATURAL RELIGION.

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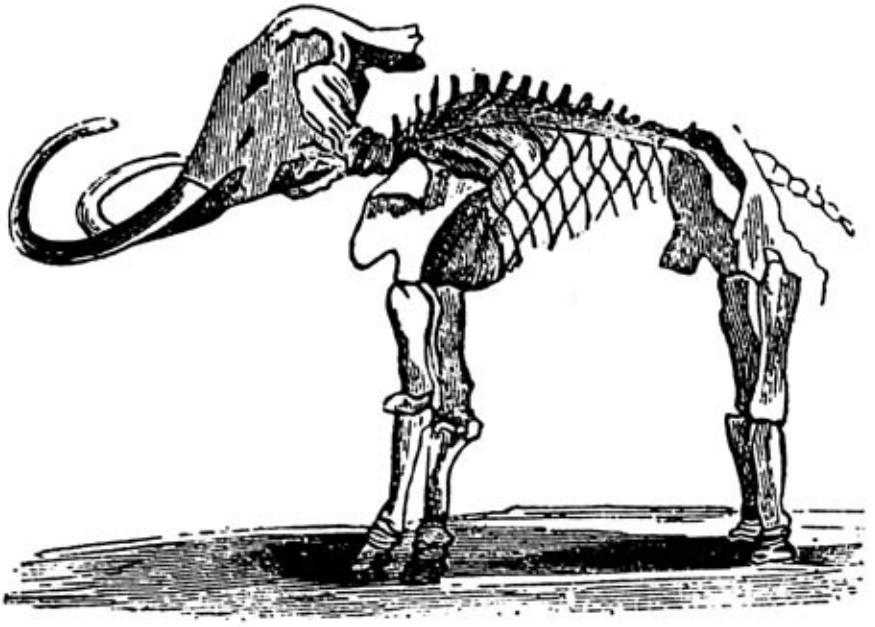
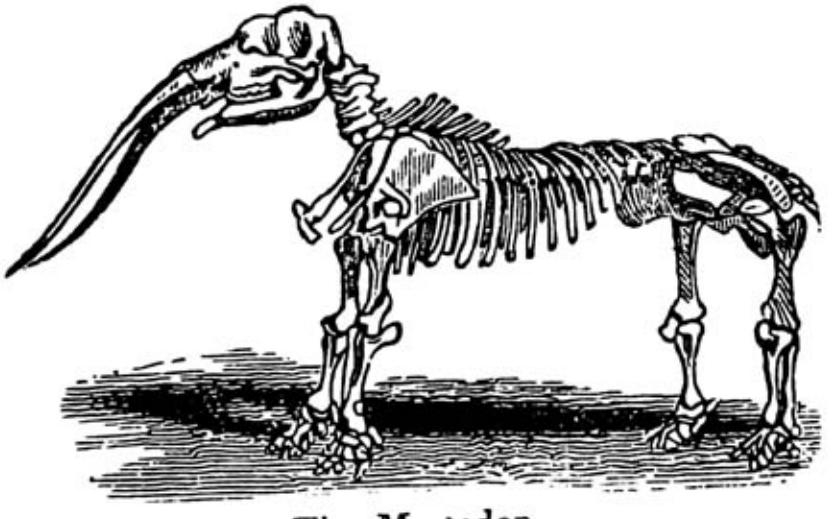


The Mammoth.



The Mastodon.

CONTENTS.

	Page
PREFACE,	vii
INTRODUCTORY OBSERVATIONS,	1
PART I.	
PRINCIPLES OF MODERN GEOLOGY,	5
Aqueous Rocks,	6
Igneous Rocks,	11
Tabular View of Fossiliferous Strata,	16
PART II.	
ACCORDANCE OF GEOLOGY WITH REVEALED RELIGION,	24
Proofs of the Antiquity of the World,	26
Such facts as are stated above cannot be accounted for by the Deluge of Noah, or by any causes of which the operation has been subsequent to the creation of man,	32

Page

That the world was created in its present state is an incredible supposition, - - - - 33
Difficulties may excite undue alarm, - - 36
Modes of Conciliation, - - - - - 39
Opinions regarding the six days, - - - 40
On such a subject we should not be dogmatical or hasty in our decisions, - - - - 43
Important agreements between Scripture and Geology, - - - - - - - 45
Why was not the ancient world more exempt from physical evil than Geology supposes it to have been? - - - - - - - 50
The Deluge, - - - - - - - 53
Extent of the Deluge, - - - - - 56
The testimony of tradition, - - - - 62
A Deluge not impossible, - - - - 64
Observation does not warrant scepticism, - 66
Concluding remarks on this department of the subject, - - - - - - - 70

PART III.

PROOFS FURNISHED BY GEOLOGY OF THE BEING AND PERFECTIONS OF GOD, - - - - 75
I. Geology in its Relation to the Organic World, 76
The Megatherium, - - - - - 77
Extinction and Introduction of Species, - - 85
Hume's argument against Miracles, - - 99
The Development Hypothesis, - - - 101

Page

II. Geology in Relation to the Inorganic World, - 116

Balancing Agencies and Processes, - - 116

1. { Water, - - - - - - - 117
   { Fire, - - - - - - - 120

2. Consolidation and Disintegration, - 124

Substances of High Economical Value—

1. Coal, - - - - - - - - 128

2. Lime, - - - - - - - - 132

3. Metals, - - - - - - - 134

The proof is infinite, - - - - - 138

No good is to be expected from Atheism, - 142

CONCLUSION, - - - - - - - - - 149

APPENDIX.

I. Objects of Geological Science, - - - 156

II. Provision has been made in creation for unity, variety, and beauty, as well as utility, - 161

III. Doctrine of the Transmutation of Species, - 170

IV. Recent appearance of man, - - - - 188

GLOSSARY AND INDEX, - - - - - - 193

PREFACE.

THE writings of geologists are now in general circulation. They are read with much interest, and, at the same time, with not a little perplexity by the most enlightened section of Christian society. In my intercourse with young men of good education, I have found more of them disquieted in their minds, if not unsettled in their religious principles, by the results of geological investigation, than by any other difficulties attending revealed truth. In these circumstances, I have been compelled to give some attention to the subject, that I might 'be ready always to give an answer to every one that asked me a reason of the hope that is in me, with meekness and fear.'

If I mistake not, the time has come when we

must all meet the problems here presented for solution, with a perfect frankness. The honour of anticipating the exigency and exposing the causelessness of alarm, before it was wide spread, regarding the march of science in this new region bordering on sacred ground, has been already won by great and good men, several of whom have gone to their rest.* But others, at what-

* A writer in the *Edinburgh Review* (No. clxxxii., Oct., 1849, Art. 1,) says: 'The recent interpretation of the commencement of Genesis—by which the first verse is simply supposed to affirm the original creation of all things, while the second immediately refers to the commencement of the human economy; passing by those prodigious cycles which geology demands, with a silence worthy of a *true* revelation, which does not pretend to gratify our curiosity as to the previous condition of our globe, any more than our curiosity as to the history of other worlds—was first suggested by geology, though suspected and indeed anticipated by some of the early Fathers.' The reviewer has not, in these sentences, expressed himself with his usual precision and accuracy. How could any interpretation be 'recent,' and '*first* suggested by geology,' when it had been 'anticipated by some of the early Fathers?' My friend, Dr. Eadie, says, 'The length of time that may have elapsed between the events recorded in the first verse (of the first chapter of Genesis) and the condition of the globe, as described in the second verse, is absolutely indefinite. How long it was, we know not; and ample space is therefore given to all the requisitions of geology. The second verse describes the condition of our globe, when God began to fit it up for the abode of man. The first day's work does not begin till the

ever distance, must follow in the same course, and the various points in debate must be freely and generally canvassed, till good information shall have set public solicitude at rest.

It will not be denied, I think, that Geology has been hitherto regarded with coldness and

third verse. . . . This is no new theory. It was held by Justin Martyr, Basil, Origen, Theodoret, and Augustine —men who came to such a conclusion without any bias, and who certainly were not driven to it by any geological difficulties.' (*Biblical Cyclopædia, Art. Creation.*) Professor Hitchcock, who has given great attention to the history of this subject, declares that he is not aware of any new theories of exegesis having been originated by geologists.—(*See Student's Cab. Lib., Vol. IV., p.* 24.) Certain it is, however, that the views indicated above were not current in this country till of late years; and that Dr. Chalmers had great merit in giving them distinctness, and even originality of exhibition, and in gaining attention and favour for them by his eloquent writings. In the highly interesting memoirs of him, by his son-in-law, the Rev. Dr. Hanna, it is said: 'The merit, I believe, belongs to Mr. Chalmers, of having been the first clergyman in this country who, yielding to the evidence in favour of a much higher antiquity being assigned to the earth than had previously been conceived, suggested the manner in which such a scientific faith could be harmonised with the Mosaic narrative, and who, even in the dreaded investigations of the geologist, discerned and indicated fresh "footprints of the Creator." So early as 1804 he had arrived at the conviction that "the writings of Moses do not fix the antiquity of the globe. If they fix anything at all, it is only the antiquity of the species."'—*Memoirs*, vol. i., p. 386.

suspicion by the greater portion of the religious community, and that most theological writers, who have found it in their way, have rather availed themselves of the best excuses for dismissing its pretensions, than shown any disposition to entertain them very courteously. Times without number have these lines of Cowper been quoted.

> 'Some drill and bore
> The solid earth, and from the strata there
> Extract a register by which we learn
> That He who made it, and revealed its date
> To Moses, was mistaken in its age.'
>
> TASK, B. iii.

In Cowper's day Geology was only in its infancy, and had no matured claim to respect and confidence. At all stages of its history it has had reckless advocates, who have opposed their own crude suggestions about terrestrial phenomena to the clearest statements and strongest proofs of an accredited revelation. Perhaps it is well to scorn these scorners, and answer such fools according to their folly. But no one who is conversant with the facts will allege that our more celebrated geologists are speculators of

this description, or that the results of their able, diversified, and interesting investigations can be fairly set aside by pleasantry or ridicule.

Nor will it do to plead the quarrels of geologists as sufficient reason for refusing them an audience, and for requiring them to agree among themselves, before a Christian shall look at the nature and tendencies of their principles. It is true that geologists differ among each other on points of importance. And this is a good reason why we should not be impatient for a perfect apparent accordance between Geology and Scripture. The seeming accordance which we would hail in the present state of the science, might become a source of perplexity in its future stages. But while geologists have their differences, they have also their agreements, as any one will perceive who reads the first part of this small Treatise, and remembers that the principles there explained are now generally admitted. How could a tabular representation of the fossiliferous strata of the earth obtain common consent, unless the science were in an advanced state? It must especially be considered that geologists are now agreed on certain points,

such as the great age of the earth, having the most intimate connexion with scriptural interpretation.

Nor, finally, will it suffice for a removal of difficulties to allege merely that the Bible was not designed to teach Geology. That is true: and the truth is one which, in all discussions upon the subject, we should ever keep in mind. It rebukes the construction of a formal system out of a few notices designed for other and nobler applications, and also forbids a rigid explanation of popular terms on philosophical principles. Still, the Bible does give us accounts both of the Creation and the Deluge; and if we attach to its narration any distinct meaning at all, we are called on to inquire how far that meaning is reconcileable with the conclusions of elaborate observation.

The spirit which starts these objections to the labours and doctrines of geologists is one, it may be, of jealous concern for the truth and safety of the word of God. But anxiety may be sincere and friendly where it is not wise. Uzzah feared for the ark of God when shaken by the oxen, although it was perfectly secure; and he

put forth his hand to prop it up, when he had better confided in its proper support. I acknowledge that Geology has occasioned some difficulties to Christians. But these difficulties, I am persuaded, are often exaggerated; and I entirely agree with the able writer in the 'Edinburgh Review,' already alluded to in a note, who says:—'Geology has, however, in our judgment, done at least as much already to remove difficulties as to occasion them; and it is not illogical, or perhaps unfair, to surmise that, if we will only have *patience*, its own difficulties, as those of so many other branches of science, will be eventually solved.'

The reviewer gives, as a striking example of the confirmation which Geology may afford to scripture history, that the vast changes and multiplication of languages, within a period so brief as what Geology assigns to the past duration of man, may prove to be inexplicable on any other principle than a miraculous intervention. 'We think,' he observes, 'that the philologist may engage to make out, on the *strictest principles of induction*, from the tenacity with which all communities cling to their language, and the slow *ob-*

served rate of change by which they alter; by which Anglo-Saxon, for example, has become English, Latin Italian, and ancient Greek modern (though these languages have been affected by every conceivable cause of variation and depravation); that it would require hundreds of thousands, nay, millions of years to account for the production, by known natural causes, of the vast multitude of totally distinct languages, and tens of thousands of dialects, which man now utters. On the other hand, the geologist is more and more persuaded of the comparatively recent origin of the human race. What, then, is to harmonise these conflicting statements? Will it not be curious if it should turn out that nothing *can* possibly harmonise them but the statement of Genesis, that in order to prevent the natural tendency of the race to accumulate on one spot, and facilitate their dispersion and destined occupancy of the globe, a preternatural intervention expedited the operation of the causes which would gradually have given birth to distinct languages?'*

Other examples, of the service rendered to Revealed Religion by Geology, will be found in

* For Oct., 1849, p. 353.

the following pages. Here I will allude only to the conclusions deducible from the proved introduction of new races of plants and animals into our earth, at different periods of its history. These special interpositions of divine power remove all antecedent unlikelihood to the working of miracles for sufficient ends. Between the acts in question there is no essential difference of nature. I know that new creations have been called 'a law;' but miracles are a law in the same sense; for the meaning of such language can only be, that the effect is produced in conformity with plan, and with due regard to harmony of operation in the universe of God. Whether a race be created, or a miracle be performed, each has its proper use, place, and connexion; and, in either case, God is not the God of confusion, but of order. This argument obviates *a priori* objection not only to miracles, but to the scheme of salvation which they were designed to establish; and I desire to engage the earnest consideration of reflective minds for these words of Dr. Scouler,—'Special acts of providence, as well as general laws, that is, the steady purposes of wisdom, are part of the plan

on which the universe is governed. If we are thus assured, that in thousands of instances, during the vast period which has elapsed since the first creation of living beings on this earth, interpositions of divine power, out of the ordinary course of nature, have taken place, surely every *a priori* objection is removed to the probability of interpositions of the same power for moral ends, and for revealing to man what it was infinitely more important he should know, than merely biological results, his own real nature, his relation to the Creator of all things, and the means of securing the divine favour.'*

A Christian should seek to know more of Geology than its harmlessness. It treats of the works of God: and 'the works of the Lord are great; sought out of all them that have pleasure therein.' We are directed by Scripture itself to 'look upon the earth beneath,' and learn what it teaches us respecting its Maker. 'In his hand are the deep places of the earth; the strength of the hills is his also. The sea is his, and he made it; and his hands formed the dry land.' If we conduct such a survey as these words indicate,

* Page 92, etc., of this Treatise.

with dutiful diligence and a becoming spirit, we shall be prompted to subjoin with the inspired writer: 'O come, let us worship and bow down; let us kneel before the Lord our Maker.' I have endeavoured, in the third and last part of this Treatise, to exhibit such pleasing proofs of the Being and Perfections of God, furnished by Geology, as may induce the reader to prosecute the subject for himself, and to study those larger and more scientific publications, which, perhaps, he might not have encountered without an introduction.

With all the high sense I entertain of the importance of the general subject, I have an humbling and painful consciousness of my incompetency to do it justice. And I would not easily have been induced to undertake such a volume, simple and initiatory as it is, unless the idea had occurred to me that I might possibly obtain the co-operation of my much-esteemed friend, Professor Scouler of Dublin, whose general eminence as a man of science is well known both within and without the scientific world, and whose superintendence of the Geological Department at the meeting

of the British Association in Glasgow elicited universal admiration. He most kindly assented to the joint authorship, so soon as it was proposed to him; and he has supplied almost all the Foot-notes, and the whole of the Appendix for this Manual.

It is due to Dr. Scouler to state, that although he suggested amendments on the text, he is in no sense responsible for any of its faults; and that as the Treatise was submitted to his inspection, in detached portions, and as, in many instances, he had only a vague idea of what topics I was to treat, his contributions to these pages have been written under every disadvantage.

The use of technical language has been avoided as much as possible, both by Dr. Scouler and by myself. Still, it could not be altogether excluded. The copious glossary incorporated with the index will remove, it is hoped, any difficulty arising to the common reader from this cause.

It is time to close this Preface, already too extended. The estimate of a work is seldom, I believe, much influenced by prefatory explanations. In the consciousness of having attempted

to do a service to sound views and good morals, I commend this small volume to the candid perusal of intelligent readers, and, above all, to the blessing of Him who has put the best of treasures 'in earthen vessels, that the excellency of the power may be of God, and not of us.'

D. K.

Glasgow, March, 1850.

INTRODUCTORY OBSERVATIONS.

If we were introduced into a stately edifice, we could not refrain from examining its structure and contents. We might not be qualified to pronounce a well-instructed judgment on any of all its constituent parts—to compare with the best models of art, or test by an ideal standard of excellence, the form of its pillars, or the texture of its tapestry. But we would not be deterred, on that account, from looking around us, and endeavouring to ascertain the age, the plan, the size, and uses of the building. If we saw much that we admired, our admiration would not rest in the material objects by which it was immediately occasioned, but would pass to that master-mind, in whose creative conception the structure arose, and completed its fair proportions and symmetry, before a stone of it was laid, or the perception of sense could discover its existence.

Now, this world is a majestic dwelling. What palace of royalty is comparable to it in excellence? What lustre can rival its great lights? What cisterns can come into competition with its mighty ocean? What carpeting can vie in beauty and richness with its luxuriant vegetation? It is not the part of rational beings to occupy such a home and pay no attention to its materials and configuration. We take some position in the landscape. Around us are numerous objects, all of which have a history, if it can only be found and deciphered. Whence flow these streams? How were those mountains elevated? Why have we soft earth here, and hard stone there? How happens it that one mass of rock is homogeneous in its aspect, while another has a laminated structure, and abounds in varied and distinguishable ingredients?

Without profound or varied scientific knowledge, we can perceive the uses of individual parts; we can mark the relations between some of them and others; we find them associated in constituting a magnificent whole; and, if a puny building brings before us the builder, and secures him the homage paid cheerfully to genius,

how shall we survey this fair creation—so capacious, and well-ordered, and munificently stored—and not rise from the work to the Agent, from the gift to the Benefactor, till even these stupendous wonders around us are forgotten in the admiration of perfections, by which they are infinitely transcended!

'These are thy glorious works, Parent of good—
Almighty! thine this universal frame,
Thus wondrous fair! thyself how wondrous, then!
Unspeakable! who sit'st above these heavens,
To us invisible, or dimly seen
In these thy lowest works; yet these declare
Thy goodness beyond thought, and power divine.'

PARAD. LOST, b. v.

In these preliminary observations, I have shortly developed the nature of the argument, derived from final causes, for the Being and Perfections of God. It may be thus expressed more formally: Whatever proves design, proves the existence of a designing agent. If the design manifested were small in its character, there would be no need to suppose the agent great. But if the design shown be so vast, so grand, so stupendous, so overwhelming, that we cannot

reasonably ascribe it to a finite intelligence, then we should recognise in it a divine authorship, and acknowledge the existence of an infinite Creator. I trust that the globe which we inhabit will be seen to furnish such a proof of the divine existence and attributes, while, in a manner brief and imperfect, I treat Geology* as a branch of Natural Theology. It is first of all necessary, however, to understand the facts disclosed by a science, before we can found reasoning upon them. And as science and Scripture have been supposed, in this case, to militate against one another, some remarks on their accordance may be farther useful, in composing our minds for a calm consideration of the proof of design in this department of creation. I propose, therefore,—

I. To explain shortly the Principles of Modern Geology; then

II. To remark on their accordance with Scripture; and

III. To consider their moral application, regarded as a sub-division of Natural Theology.

* From γεα, *gea*, earth, and λογος, *logos*, a discourse. A science treating of the constituents and history of the earth.

I.

PRINCIPLES OF MODERN GEOLOGY.

I propose to explain the Principles of Modern Geology.—Some acquaintance with it, as I have already said, is a requisite preparation for the disquisitions which are to follow. At the same time, as the main design of this Treatise is not to expound Geology, strictly and simply considered, I will make my explanations of it as few and as brief as possible. If, in my extreme solicitude to make myself intelligible to the non-geological section of society, I may sometimes deviate from a technical accuracy, I hope that the more informed reader will excuse this occasional looseness of expression.

A proper understanding of the nature of Rocks, may be regarded as a key to the comprehension of the whole subject. When we speak of rocks, we must not think merely of isolated blocks, strewing a sea-shore, or heaped upon one

another to form a few natural promontories. We must think of extended mineral masses, constituting whole mountain-chains, and lying under plains and valleys themselves. Nor is the term Rock restricted to hard stony substances. It is used comprehensively of the softest soils, because the same materials may be either incoherent or indurated, and their transition from the one state to the other is often undefined and insensible.

Rocks may be divided generally into the Aqueous and the Igneous. 'Continents and mountain-chains, colossal as are their dimensions, are nothing more than an assemblage of many such igneous and aqueous groups, formed in succession during an indefinite lapse of ages, and superimposed upon each other.'*

AQUEOUS ROCKS.

The AQUEOUS ROCKS are sometimes called *Sedimentary*, because they form a *sediment* deposited in water. If we take a pitcher of turbid water, and allow it to become quiescent, there will, by and by, be a muddy deposit found in

* Lyell's Princip. of Geol., vol. iv., b. iv., ch. 17.

the bottom. And this familiar instance, with allowance for the modifying action of currents, illustrates, on a small scale, the manner in which all our sandstone quarries have resulted from substances, suspended in lakes and seas, gradually sinking by their weight, and becoming accumulated in the channel. Aqueous Rocks are also said to be *stratified*, because they are *strewed* with considerable regularity, and form successive strata, or layers, imposed on one another. They are also said to be *fossiliferous*, when they contain fossils or remains of vegetables and animals embedded in their substance.

The older fossils are generally in a petrified state. In such cases, bone and wood have not been converted into stone, but have become saturated with mineral matter, or wholly replaced by it; and the manner in which such combinations and exchanges of substance take place, while the most perfect delicacy of filaments and tissue is preserved, and the most microscopic details of internal structure are shown, is a subject of great interest, and one as yet imperfectly understood.

In these few words I have described cursorily

the nature of sedimentary rocks, which constitute so considerable a portion of the crust of the earth. They are nothing else than accumulations of transported and deposited matters, which often enclose relics of life, especially such as have belonged to the inhabitants of the ocean.

But if the subject be new to my reader, the account given will seem to be strange and inadequate. Whence, he will be disposed to ask, can there have been obtained a supply of sedimentary detritus sufficient to constitute the material of islands and continents? The objection is natural, but not insurmountable. Our most fertile lands bear evident marks of being transported matter. Such are the carses of the Forth and Tay, and such, on a scale more gigantic, are the plains of Assyria and Bengal, and the deltas of great rivers, as of the Niger and the Mississippi. Demerara has this character, and may be considered a carse of the Orinoco. The river Nile, alone, is estimated to carry down to the sea every year above three thousand millions of cubic feet of detritus, or as much as would build forty pyramids of the largest dimensions. In

fact, the whole of Egypt seems to be an accumulation of fine clay, transported by its goodly river from remoter and loftier regions. Independently of the action of rivers, the ocean is constantly wearing down the rocks which it washes, and daily reducing into sedimentary substance vast quantities of their material, which comes to be diffused by tides and currents over the bed of the sea, and sifted by the joint action of gravity and water in motion. But sediment, it may be said, is soft and loose, and never, at all events, attains the consistency of rock. This is a mistake. Certain substances, such as limestone, become hard immediately on being precipitated from water. And there are various ways in which the hardening of watery deposits can be rationally enough accounted for.* The mud

* Stratified rocks, that is, deposits from water, may be solidified in many ways. Solid matter may exist in water either in a state of chemical solution or mechanical suspension. Deposits from a solution are aggregations of crystals, and usually coherent: such is the nature of some calcareous and silicious rocks, which are formed in the same manner as refined sugar or salt, from the evaporation of sea-water. By far the greater number of rocks have been derived from matters held in suspension in water, and such were, of course, originally merely loose and incoherent masses of sand or clay: thus solidification has been a sub-

above presses the mud beneath, and mere pressure, if heavy and prolonged, may fasten the component particles together. There is oftener, however, an admixture of cementing substances, as of lime or iron, and this carried among the particles, by permeating water, indurates the whole mass.

As to the fossils, we may easily conceive how fish and sea-weed, dying in their proper domains, may be entombed in the strata; and the same may happen with any vegetable or animal productions, drifted by currents from their original sites to the spots where they are found.

The facts which I have thus cursorily mentioned, furnish some of the data on which

sequent process. Both the manner in which stratified deposits have been solidified, and the period of time which the process may have occupied, are exceedingly various. Mechanical deposits may be rendered coherent by the infiltration of some cementing substance, and loose sand may be changed into solid quartz rock from being percolated by water holding silica in solution. As sedimentary matters are of a very heterogeneous composition, the chemical reactions of their contents will produce solid rocks, just as a mixture of fine sand and iron filings will, if exposed to the weather, become a hard mass. The long-continued action of heat will also cause the cohesion of sediments, and this influence has operated very extensively in nature. S.

modern geologists found their speculations. They account for the varied composition of strata, by the diversity of the rocks from which they have been derived, and note the order in which the distinctive layers have been superimposed on each other, as affording an infallible criterion of relative age. And so they make out a classification and history, of which the trustworthiness depends on the certainty of the facts, and the soundness of the deductions. A principal importance attaches to the fossils: because some found in certain layers are not found in others, and their presence or absence in particular localities, furnishes large and varied subject of consideration, and widens the range of the teaching of nature to 'the utmost bounds of the everlasting hills.'

IGNEOUS ROCKS.

Thus far I have spoken of Aqueous Rocks, or rocks formed in water. Let me add a few remarks on IGNEOUS ROCKS, or those rocks which give evidence of the action of fire.

There is certainly known to be a vast amount of heat in the globe. Some consider it one ocean of fiery liquid, with a crust over it, which

we inhabit. Some think that the heat is migratory; and is now developed more in one direction and now in another. Be that as it may, the heat is intense, and widely diffused, and cannot fail to produce important effects in the regions where it operates. It may *half melt* rocks, before aqueous in their character; so that we may still discern the strata, but in a very different condition. And this is supposed to be the case with our *slates* retaining marks of stratification, but having a structure very different from any which could have been derived simply from the process of deposition from water, and in many places quite crystallised. 'Whether electricity or any other causes have co-operated with heat to produce this influence, may be matter of speculation.'*

Again, the subterranean fire may entirely melt the rocks with which it comes in contact, and these may afterwards be cooled and solidified far down in the earth. The rocks which are termed *granites* are understood to have been thus formed. They are highly crystal-

* Lyell's Elem. of Geol., part i., ch. i.

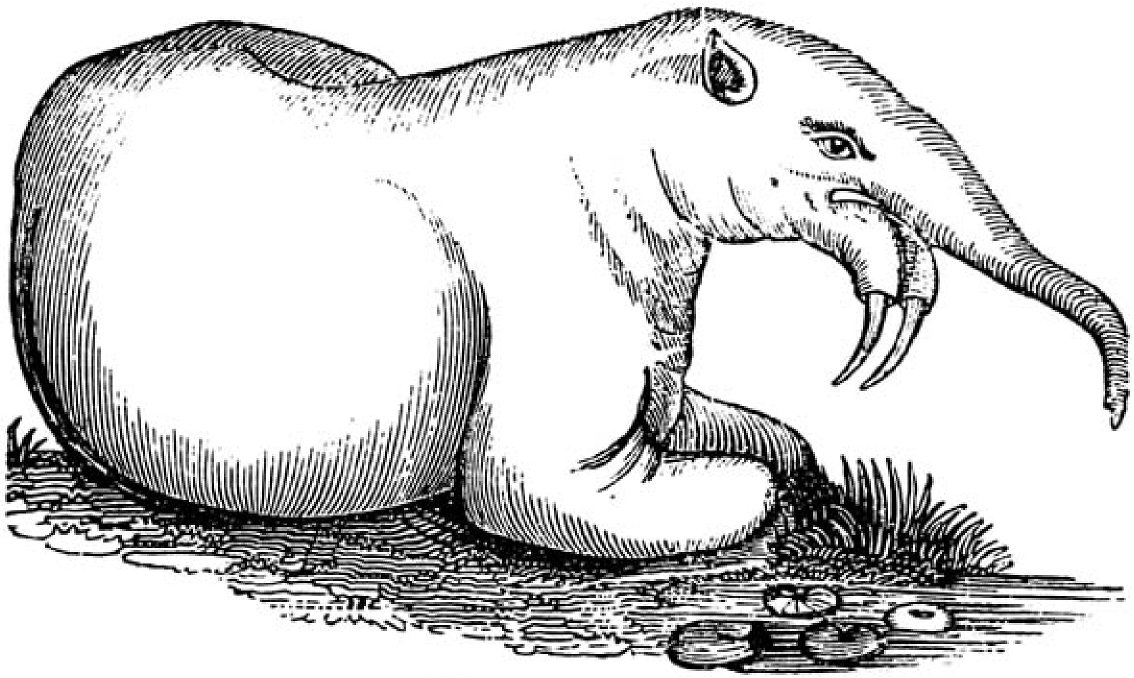
line in their structure, and the mode of formation supposed would be favourable to the process of crystallisation. They are not mixed with the porous and cellular substances which are found in alliance with erupted rock, and which derive their state from the expansion of contained gases and from exposure to the atmosphere. They are seldom, if ever, found to have spread themselves over other formations. They send veins occasionally into adjacent rocks, but do not seem to have overflowed them. From such facts geologists are led to infer, that granite passed from a state of fusion into a state of solidity at great subterranean depths, and that it afterwards became exposed, as now consolidated, by denudation, or from having been forced up in a hard state through overlying deposits. It is a striking circumstance, that no pebble of granite is found in the red sandstone conglomerates of Arran, though the mountains which now give it its character of boldness and sublimity consist of granite, and though morsels and blocks of this stone are strewed plentifully over the island, and over the adjoining mainland. The inference is, that the granitic masses were not

elevated and exposed when the pudding stones were formed; and the probability is, that their present prominence is due both to upheaval, which raised them aloft in a solid condition, and to aqueous denudation, which washed away the superincumbent strata.

Or, finally, the heat may melt rocks, and the melted matter may rise to, or near to, the surface through volcanic openings, and in some instances, may spread itself as lava over the adjoining territories. Of this nature, in the opinion of modern geologists, are our *whinstones*, or generally the trap rocks, with their various sub-divisions. All such facts are instructive to the geologist; but on the whole, the igneous rocks, from wanting fossils, do not afford equal materials for comment and inference as the watery formations.

I shall have occasion to state many more facts related to geology; but they will be best introduced in connection with the principles which they will be employed to elucidate or establish.

It may be proper, before I conclude this Part, to give the reader a tabular view of the fossiliferous strata, as they have been arranged in the systems and nomenclature of Geologists. He



The Dinotherium.

must remember, that they have been deposited in succession, and that each of them was at one time the uppermost, receiving the deposits which fell on it from superincumbent waters, till these new deposits formed a new stratum, and added another to the ascending series. It must also be kept in mind, that though all the groups of strata, so far as they have been observed in Western Europe, are exhibited in the table, the series is not understood to be actually complete in any one part of the globe. Where land was in a state of elevation above the sea, it could not receive the sediment thrown down by its waters, and it must be consequently devoid of the formations of that period. Even where strata have been formed, what is called denudation has often taken place, and the newer strata have been swept away, leaving others which are older uncovered. Geologists hold themselves justified in their classification, if so often as a stratum appears it is always found in the place assigned to it relatively to the others. The strata have been distributed into three great divisions. The lowermost, which are of course the oldest, have been called the Primary; the next of depth and age

have been called the Secondary; and the more recent have got the appellation of Tertiary. I have introduced these divisions and their subdivisions as they are presented to us in Sir C. Lyell's Elements of Geology, only prefixing the Post-Tertiary Series and appending to the several sections some brief explanations derived from various sources. It is awkward, perhaps, to blend the compendious and the precise; but my object will be gained if the particulars mentioned shall render the general classifications more intelligible and memorable:—

GROUPS OF FOSSILIFEROUS STRATA OBSERVED IN WESTERN EUROPE,

Arranged in what is termed a Descending Series, or beginning with the Newest.

Post-Tertiary Series.

This group is now in the course of formation. It includes all geological phenomena which have had their origin since the close of the Tertiary period. Here we have the bones of man in a fossil state, and articles fabricated by man. Comprehends beds of shelly gravel, the shells in which are of existing species.

Tertiary, or Supra Cretaceous, *i. e.*, above the Chalk with which the uppermost of the Secondary series commences.

1. Newer pliocene,—*i.e.* Newer of the 'more recent' Tertiary strata, [from πλειων, *pleion*, more, and καινος, *cainos*, recent.] The period of this group has been called 'the epoch of gigantic mammalia.'—In this 'period, immediately preceding the existence of man, the earth teemed with large herbiverous animals, which roamed through the primeval forests unmolested save by beasts of prey.'—*Mantell.* 'Its remains are principally those of animals related to the elephant, as the mammoth, mastodon, etc., and to various species of hippopotamus, rhinoceros, horse, ox, deer, and many of extinct genera; while, in caverns and fissures of rocks, the skeletons of tigers, boars, hyenas, and other carniverous animals, are embedded.'—*Ibid.* The teeth of elephants, collected on the coasts of Norfolk and Suffolk alone, according to Mr. Woodward, have belonged to 500 individuals.

2. Older pliocene,—*i. e.* Older of the 'more recent' Tertiary strata. To this group belongs a deposit called the 'crag.' In the eastern part of the county of Suffolk, it is seen in its most characteristic form. In part of Suffolk, it consists of two masses,—the upper of which has been called *red crag*, and the lower *coral crag*. The two are exceedingly distinguishable in mineral composition and fossils, and geologists have felt some difficulty in accounting for the difference.

3. Miocene,—*i. e.* 'Less recent' than Nos. 1 and 2, [from μειων, *meion*, less, and καινος, *cainos*, recent.] The Tertiary deposits of England are limited to the Eocene, and the older and newer Pliocenes,—the Miocene being wanting.'—*Lyell.*

4. Eocene,—*i. e.* New dawn, [ηως, *eos*, dawn, and καινος, *cainos*, recent.] So called because among the remains

of extinct species some remains, though in a small proportion, of living species, begin here to be discovered, so that the new or present state of the world dawns upon us. To this group belongs the London clay, so called because it is found in the neighbourhood of the metropolis, in a basin of the underlying chalk. The fossils differ widely from the overlying crag. The shells resemble those of the tropics, but few of them are identical with living species. 'Some fish, also, such as, a sword-fish, about eight feet long, and a saw-fish, about ten feet in length, indicate a warm climate.'—*Lyell.*

SECONDARY.

5. Chalk,—so called because it consists in part of that white earthy limestone to which the name chalk is applied. Abounds in marine remains, as corals, sponges, shell-fish. Contains some reptiles. With the termination of the secondary period the ammonite ceased to exist. It is found here and in the under strata, but not in any overlying deposit. The ammonites derive their name from their supposed resemblance to the horns of the statues of Jupiter Ammon. 'All the appearances concur in leading us to believe that this deposit was formed in a deep sea, far from land, and at a time when the European fauna [race of animals] was perfectly distinct from the Tertiary period.'—*Lyell.*

6. Green sand,—so called because some of the sands of this formation have a bright green colour. The green grains consist mostly of silicate of iron. Fossils similar to those of the chalk, but generally of different species. 'Unlike the white chalk [remarkable for its purity] this deposit consists of a succession of ordinary beds

of sand, clay, marl, and impure limestone, the materials of which would result from the wearing down of pre-existing rocks.'—*Lyell.*

7. Wealden.—The sub-divisions of this group may be best studied in that part of Kent, Surrey, and Sussex which is called the Weald—hence the name. It also appears in the opposite coast of France. The shells of this group are almost exclusively those of lakes and rivers, and though it is not very extensive, it is deemed of great interest as being a fresh-water formation interposed between marine formations. Contains numerous and various remains of terrestrial plants and animals. Tortoises, like the genera now found in tropical regions. At least five genera of Saurian Lizards; one of which, the Iguanodon, was of vast length. 'Length from the mouth to the tip of the tail 70 feet.'—*Mantell.* 'Thigh bones 8 inches in diameter. Such bones, if covered with muscles and integuments, would form limbs upwards of 7 feet in circumference.'—*Ib.* 'Some individuals must have far exceeded this estimate.'—*Ib.* Other writers consider these dimensions exaggerated. 'While the bones of the extremities were perhaps six or eight times larger than those of the most gigantic alligator, the whole length of the iguanodon is not likely to have exceeded thirty feet.'—*Ansted.*

8. Upper Oolite, or egg-stone, [ωον, *oon*, λιθος, *lithos*,] a variety of limestone composed of rounded particles, like the roe or eggs of a fish. The name has been given to a whole group in which this limestone occurs. Here, we have a great series of marine strata under the Wealden, a fresh-water deposit.

9. Middle Oolite.—'One of the limestones of the Middle Oolite has been called the "Coral Rag," because it

consists in part of continuous beds of petrified coral, for the most part retaining the position in which they grew at the bottom of the sea.'—*Lyell.* Another subdivision is the Oxford clay.

10. Lower Oolite.—'The slate of Stonesfield, only six feet thick, but abounding in fossils, has been shown to be at the base of the inferior Oolite. Besides fragments of wood which occur in all parts of the Oolitic group, there are many impressions of ferns, cycadeæ, and other terrestrial plants. Several insects, also, and among the rest the wing covers of beetles are perfectly preserved.' — *Lyell.* In these strata are the earliest remains of terrestrial mammalia as yet found.

11. Lias.—This is a provincial name for a particular kind of limestone,—here employed to denote a group of strata in which it is found. Classed by some geologists with the Oolitic strata. The fossil fish resemble generically those of the Oolite, are all of extinct genera, and differ widely from those of the Chalk. 'It is not, however, the fossil fish which form the most striking feature in the organic remains of the Lias; but the reptiles which are extraordinary for their number, size, and structure. Among the most singular of these are several species of Ichthyosaurus and Plesiosaurus. . . It is evident from their fish-like vertebræ, their paddles, resembling those of a porpoise or whale, the length of their tail, and other parts of their structure, that the habits of the Ichthyosaurus [fish-lizard] were aquatic. Their jaws and teeth show that they were carnivorous; and the half-digested remains of fishes and reptiles found within their skeletons, indicate the precise nature of their food.'— *Lyell.* The genus Ichthyosaurus is not confined to this formation.'—*Ib.*

12. Upper New Red Sandstone, and Muschelkalk. Called also Triassic System.—The sandstone of this group is called red, because much of it is stained by oxide of iron. There is found associated with it in Germany a great chalky formation, called the Muschelkalk or Shelly-limestone. 'It is in this system that rock-salt and salt springs occur in Cheshire and other parts of England.'—*Lyell.* 'A few traces only of fossil shells, fish, and plants, have been detected in this formation in England.'—*Ib.*

13. Magnesian Limestone System,—*i. e.*, stone composed of carbonate of lime and carbonate of magnesia, sometimes in nearly equal proportions: and Lower New Red Sandstone. Called also Permian System.—It was first pointed out by M. Agassiz, that all the bony fish of the Magnesian Limestone, and of all the more ancient formations, have the vertebral column continued into the upper lobe of the tail, which is much longer than the lower lobe, whereas, in strata newer than the Magnesian Limestone, the tail-fin is divided into two equal lobes, as in most living fishes, the vertebræ not being prolonged into either lobe.

14. Coal.—The bulk of this formation consists of sandstone, shale, and limestone; but many beds of coal are interstratified with them—hence the whole are called carboniferous or coal-bearing. 'The coal is entirely compressed land vegetation, chiefly from trees of great size, whose stems, branches, leaves, etc., are abundant in or on the interposed shales and sands.'—*Dr. P. Smith.* 'One of the most remarkable peculiarities of the coal fossils is the singular preponderance of the tribe of ferns, and the great variety of form in which plants of this kind are developed.'—*Ansted.*

15. Old Red Sandstone. Called also Devonian System.—In the Lower Old Red Sandstone the ganoids first appear.—*H. Miller.* So far as is yet known, all the fish of the earliest fossiliferous system (Primary, exhibited below) belonged to the placoid, or broad-plated order—a great division of fishes represented in the existing seas by the sharks and rays.—*Ib.* In accommodation to the mutilated state in which fossil fishes are frequently found, Agassiz classified them according to the structure of the scales. He divided them into four orders. (1.) Placoidians (from πλαξ, *plax*, a broad plate.) (2.) Ganoidians (from γανος, *ganos*, splendour, because of the brilliant surface of their enamel.) (3.) Ctenoïdians, from κτεις, *cleis*, a comb.) (4.) Cycloïdians (from κυκλος, *cuclos*, a circle.) 'It is not too much to affirm, that in the comparatively small portion which this cluster of islands (the Orkneys) contains of the third part of a system (the Lower Old Red Sandstone), regarded only a few years ago as the least fossiliferous in the geologic scale, there are more fossil fish enclosed than in every other geologic system in England, Scotland and Wales, from the coal measures to the chalk, inclusive. Orkney could supply with ichthyoltes (fossil fishes) by the ton and the ship load, the museums of the world.'—*H. Miller.*

PRIMARY FOSSILIFEROUS OR TRANSITION.

16. Upper Silurian,—so called by Sir R. Murchison from that part of England and Wales which constituted the ancient British kingdom of the Silures, where this group can be best studied. 'The most remarkable fossils are the scales, ichthyodorulites [bony spines forming the anterior part of the dorsal fin,] jaws, teeth, and coprolites [excrements] of fish of the Upper Lud-

low rock. As they are the oldest remains of vertebrated animals yet known to geologists, it is worthy of notice that they belong to fish of a high or very perfect organisation.'—*Lyell.*

17. Lower Silurian. 'It is an interesting fact, that with many extinct forms of testacea [animals devoid of bones, with soft bodies, and having a shelly covering] peculiar to the Lower Silurian, others are associated belonging to genera still existing, as nautilus, turbo, buccinum, turritella, terebratula, and orbicula.'—*Lyell* on the authority of *Murchison.* 'No land plants seem yet to have been discovered in strata which can be unequivocally demonstrated to belong to the Silurian period.'—*Ib.*

18. Cambrian and older fossiliferous strata. Professor Sedgwick has given to this group of rocks the name Cambrian, because it is largely developed in North Wales. There succeeds a group called the Cumbrian (studied with advantage in Cumberland), in the upper portion of which some fossils are found, and these are the oldest monuments of life as yet discovered.

I may add, that under these fossiliferous strata we have very extensive deposits, which the older geologists called primitive. They are now called non-fossiliferous, or metamorphic. They contain marks of stratification, but instead of being mechanical aggregates, they are highly crystalline, in consequence, as is thought, of having been subjected to igneous agency. Such are micaceous schist, hornblende schist, and gneiss.

II.

ACCORDANCE OF GEOLOGY WITH REVEALED TRUTH.

I proceed to offer some remarks on the accordance of this modern science with revealed truth. The superiority of the Bible to the productions of mere human wisdom, is at once evident even in this debated field, when we bring Scripture into comparison, or rather into contrast with uninspired speculations. The cosmogonies or world-makings of the ancients would have doomed any pretended revelation, giving them its sanction, to certain rejection. Some of the heathen philosophers pronounced water to be the origin of all things. Some of them explained conflicting appearances, by supposing two creative principles, or agencies, the one good, and the other evil. Some of them accounted for the production of worlds, and all their wonderful provisions, by a fortuitous concourse of atoms. These follies, even when dressed out in all the fascinations of learn-

ing and eloquence, make, after all, a poor figure beside the first chapter of Genesis,—simple, grave, majestic, as we could desire any narrative to be, having God for its author, and providence for its subject.

An apparent discordance between Scripture and science, in this province, mainly arises from the fact that a sedimentary deposit of rocks, to the thickness, as is computed, of eight or nine miles, and the appearance and disappearance not only of individual plants and animals, but of very many races, one after another, of which the fossils are considered a sufficient proof, seem to demand an immense duration of time to account for the phenomena. Whereas, Scripture has been understood to pronounce the world of no greater age than five or six thousand years. Some dismiss the difficulty by denying the extreme antiquity of the world, and unqualifiedly defending the supposed chronology of Moses. And there are yet some respected authors who write and publish in favour of these views. We ought not to be rash in such a question, and pronounce these writers unscientific for aiming to be scriptural. Let their writings be exa-

mined, and all that is urged in them, with pious intention, and often able execution, be deliberately weighed.

PROOFS OF THE ANTIQUITY OF THE WORLD.

It must, in candour, be admitted that the more eminent geologists are now united in maintaining the greater age of the earth, and that the proofs of it which they advance are not easily withstood. The arguments for the antiquity of the globe are thus summed up by Professor Hitchcock :—

'1. More than two-thirds of existing continents are covered with these rocks; which contain numerous remains of marine animals, so preserved as to prove incontestably that they died on the spot where they are now found, and became gradually enveloped in the sand, or other stony matter, which accumulated around them, their most delicate spines, and processes being preserved. In fine these rocks present every appearance of having been formed, just as sand, clay, gravel, and limestone are now accumulating in the bottom of the ocean, by a very slow process. Except in extraordinary cases, indeed,

it requires a century to produce accumulations of this kind even a few inches in thickness.

'2. But geologists think they have ascertained that the fossiliferous strata in Europe are not less than eight or ten miles in thickness: How immense the period requisite for the production of such vast masses!

'3. This mass is divided into hundreds of distinct strata, or groups of strata; each group containing peculiar organic remains, and arranged in as much order, one above another, as the drawers of a well-regulated cabinet. Such changes, of not only mineral composition, but of organic remains, show that there must have been more or less of change of circumstances in the waters from which the successive strata and groups were deposited. And such changes must have demanded periods of time of long duration, for they appear to have been, for the most part, extremely slow. We hence derive confirmatory evidence of the views that have been presented concerning the vast periods that have been employed in the production of the fossiliferous strata.

'4. Another circumstance still further con-

firms these views. In very many instances, each successive group of the strata above referred to, contains rounded pebbles derived from some of the preceding groups. Those strata, then, from which such pebbles were derived, must not only have been deposited, but consolidated and eroded by water, so as to produce these pebbles, before the rocks now containing them could have been formed. It is impossible that such changes, numerous as they must have been, could have taken place in such short periods of time. There must certainly have been long intervals between the formation of the successive groups.

'5. The history of the repeated elevations which the strata have undergone, conducts us to the same conclusion. Different unstratified rocks have been intruded among the stratified ones of various epochs, and the strata have been elevated at each epoch. But the oldest strata were partially elevated before the newer ones were deposited: for the latter rest in an unconformable position upon the former. Indeed, we often find numerous groups of strata resting unconformably upon one another, the lowest being most tilted up, the next higher less so, and

the third still less, until the latest is frequently horizontal; having never been disturbed by any internal protruding agency. It is obvious, then, that after the first elevation of the lowest group, there must have been an interval of repose sufficiently long to permit the deposition of the second group, before the second elevation; then a second period of repose, succeeded by a third elevation; and so on to the top of the series. Here, then, we have the same evidence of the slow formation of the stratified rocks, as is taught us by their lithological characters, and their organic remains.

'It is impossible to exhibit the preceding arguments in a light as striking as they present themselves to the practical observer. Such a person, indeed, needs no laboured argument to satisfy him, that if the stratified rocks were deposited in the manner the work is now going on, immense periods of time were requisite. Even if he admit, what we are not disposed with some geologists to deny, that the causes now in operation did formerly act with greater energy than at present, yet he will still see the necessity of allowing periods of time vastly extended to

form the fossiliferous rocks, unless he admit, without any proof, that the laws of nature have been changed. God could, indeed, have performed the work miraculously, in a moment of time: But the supposition is wholly gratuitous, and even worse than this, as we shall show in the proper place. It is one thing to admit what God *can* do, and quite a different thing to show what he *has* done.

'6. Finally, there appear to have been several almost entire changes of organic life upon the globe since the deposition of the fossiliferous rocks began. And comparative anatomy teaches us, that so different from one another were the successive groups which we find in the different strata, that they could not have been contemporaries. But each group appears to have been adapted to the condition of the globe at the time; and it was continued apparently, until by the extremely slow process of refrigeration, the temperature was rendered unfit for their residence, when they became extinct, and a new creation arose. But they lived long enough for rocks thousands of feet in thickness to be deposited, which now contain their remains. Who

can doubt that vast periods of time were requisite for such changes of organic life? and who can believe that they have taken place since the creation of man?

'We have dwelt thus long upon this point because of its importance. For if there is not the most conclusive evidence in geology of the existence of the globe longer than the common interpretation of the Mosaic history admits, we need not surely spend time in reconciling the two records. We cannot, however, but believe, that every impartial mind, which fairly examines this subject, will be forced to the conclusion, that the facts of geology do teach as conclusively, as any science not founded on mathematics can teach, that the globe must have existed during a period indefinitely long, anterior to the creation of man. We are not aware that any practical and thorough geologist doubts this, whatever are his views in respect to revelation. Some writers on geology, indeed, who have studied the subject only in books, and are little else than compilers, have taken different ground: But of how little weight must the opinion of such men be regarded, when set in opposition to the

unanimous voice of such men as Cuvier, Humboldt, Brongniart, Jameson, Buckland, Sedgwick, Murchison, Conybeare, Greenough, Bakewell, Lyell, Mantell, De la Beche, and many more; who not only stand among the most distinguished philosophers of the present day, but—many of them at least—are equally well known as decided friends of revelation? Unless the evidence were very strong, there would be found among so many of different education and professions at least one dissenting voice: but there is none.'*

SUCH FACTS AS ARE STATED ABOVE CANNOT BE ACCOUNTED FOR BY THE DELUGE OF NOAH, OR BY ANY CAUSES OF WHICH THE OPERATION HAS BEEN SUBSEQUENT TO THE CREATION OF MAN.

It was supposed at one time, that the deluge of Noah might have carried the fossil shells to the inland and elevated situations where they are now met with in such abundance. When the insufficiency of this explanation became apparent, it was contended that the strata were

* Student's Cabinet Library, No. xix., pp. 18–22.

probably deposited during the centuries which intervened between the creation and the flood, and that the sea and the land then changed places, thus leaving exposed the stratified regions which the waters had covered. It will be seen from the epitomised argument of Professor Hitchcock, that this latter hypothesis, though preferable to the former, is far from being adequate or unobjectionable. It does not allow a sufficiency of time for the heaping up of strata of such number and dimensions, or for the appearance and disappearance of so many successive races of plants and animals; and it leaves wholly unaccounted for the alternations of salt water and fresh water formations, which prove the same region to have been at one time the bed of the ocean, and at another an island or continent, interspersed with lakes and traversed by rivers.

THAT THE WORLD WAS CREATED IN ITS PRESENT STATE IS AN INCREDIBLE SUPPOSITION.

To get rid of these formidable difficulties, some have suggested that God may have created the world just as it is—bearing all the marks of

processes through which it has never passed. It is not easy, however, to look on pebbles rounded and smoothed, as if they had been rolled in water, and believe this to be their original condition. And far more difficult is it to look on organic remains, and believe that scattered branches and bones never existed save in this fossil state. Let the following instance suffice for illustration :— A fossil echinus, or sea urchin, is found in a block of limestone. This shell has the same marks of having been inhabited by a living creature, as any shell of analogous form cast upon our shores. Why should we admit the evidence of former vitality to be decisive in the one case, and wholly reject this testimony in the other? On examining the fossil echinus, we see attached to it the lower valve of a shell-fish, called the crania. Is this second appearance of former life also delusory? and has the play of semblances been thus complicated, as if to insure misapprehension? Nor does the concatenation of illusions, if they are to be so regarded, end here. The upper valve of the crania is sought for, and it is found at a little distance in the calcareous mass. It is seen that valve answers to valve, when they are

brought together and compared. They have every indication of having been a pair. And is it so that they were always apart till the hand of man conjoined them? Was the lower valve created in connection with a shell of a totally different genus from itself, and the upper valve created a short way off, in a state of brokenness and detachment? The precise facts, here represented, have come under the observation of geologists; and there is surely a difficulty in ascribing to the God of truth this multifarious and bewildering mimicry of realities. On such principles, indeed, there could be no certainty or satisfaction in the interpretation of nature.*

* To maintain that rocks were created just as they are, is a doctrine of very dangerous tendency. If fossil shells were never inhabited by shell-fish, or if fossil teeth were never intended for mastication, what becomes of final causes? In Epicurus and La Marck such things excite no surprise; but writers of no ill intention have sometimes fallen into this strange mistake. For the sake of the non-geological reader, it is desirable to analyse this well-chosen example. The sea urchin (Echinus), while alive, was covered by numerous spines attached to the shell. On the death of the animal, a period must have elapsed during which decomposition took place, and the animal matter disappeared, and the spines fell from the shell. After this, the young crania attached itself to the denuded shell, and in its turn died, and one of its valves fell off, in consequence of the decay of the soft parts, while the other remained agglutinated to the sea urchin on which it grew. S.

DIFFICULTIES MAY EXCITE UNDUE ALARM.

Let it be supposed that geologists are correct as to the antiquity of our planet, and also, for the sake of argument, that no mode could be discovered of reconciling their conclusions with revelation, it would not follow that a satisfactory solution might not hereafter be suggested. A difficulty is not always a confutation. Geology has its own difficulties. It tells us, for example, that nodules of flint are scattered at pretty equal intervals through beds of chalk; but it does not account for this mode of distribution. 'The separation of the flint into layers, so distinct from the chalk, is a singular phenomenon, and not yet accounted for.'* Apart from the laminæ of stratification, we are pointed by the geologist to joints and cleavage in many rocks, but he is incompetent to inform us how they came there. 'Whatever nomenclature we adopt,' says Sir C. Lyell, 'it is clear that three distinct forms of structure are exhibited in certain rocks throughout large districts: viz.—first, stratifica-

* Lyell's Elem. of Geol., part ii., chap. 15.

tion; secondly, joints; and thirdly, slaty cleavage; the two last having no connexion with true bedding, and having been superinduced by causes absolutely independent of gravitation. . . Before treating of joints, it may be well to speak of the probable origin of slaty cleavage in those cases where it is decidedly unconnected with sedimentary deposition. It must be referred to crystalline or polar forces acting simultaneously and somewhat uniformly, in given directions, on large masses having a homogeneous composition. . . The cause of this tendency to a jointed structure is by no means understood.'* Here we have pure conjecture as to the origin of cleavage, and a confession of ignorance as to the cause of joints. We are assured by geological writers that influences now operative in the globe would produce (plenty of time being allowed) all the appearances presented by its contents. This is the grand principle of modern geology in the estimation, at least, of some of its advocates; and yet the important exception occurs of new races taking the place of extinct races—a revolution many a time repeated in the earth's geological history,

* Lyell's Principles of Geology, book iv., chap. 27.

but not an example of which has fallen within the period of human observation or annals. But though plenty of time may wear out an old race, it does nothing to account for the production of new races. To this day geologists are divided among themselves on the question whether the strata of the earth prove, or do not prove, a progress *towards higher and higher perfection* in organic structure. 'The popular theory of the successive development of the animal and vegetable world, from the simplest to the most perfect forms, rests on a very insecure foundation.'*

Those difficulties which lie within geology may be cleared away by future discoveries. But we have like reason to hope, that the partial obscurity now resting on the relations of geology to the Bible will be dissipated by the progress of science, or by juster exposition of Scripture itself.

There is this of some moment to be considered, that the difficulty respects the oldest class of *facts mentioned in Scripture*, and those which are farthest removed from all aids to exposition. In the case of other religions, the most ancient pretensions are the most plausible, from being

* Lyell's Princip. of Geol., book i., chap. 9.

the least accessible to searching investigation. It is otherwise with the religion of the Bible. Just in proportion as the facts of Scripture, becoming recent, admit of scrutiny, they bear the test of it; and we find the preternatural works of Christ more lucidly and abundantly substantiated than the miracles of Moses. Is not this circumstance confirmatory of its claims? It may be said that the account of creation is history, and should therefore be unambiguous; but it is a history of God's doings, and we need not look in such a case for the common-place obviousness of every day details.

MODES OF CONCILIATION.

The foregoing considerations might be urged, were no possible solution apparent. But various ways have been proposed of harmonising geology and Scripture; and if none of these be entirely satisfactory, they have enough of promise to rebuke the temerity of a scoffer's exultation. They show us in what direction we may seek, with a reasonable prospect of finding, an exit from embarrassments.

Our best expositors of Scripture seem to be

now pretty generally agreed that the opening verse in Genesis has no necessary connexion with the verses which follow. They think it may be understood as making a separate and independent statement regarding creation proper, and that the phrase, 'in the beginning,' may be expressive of an indefinitely remote antiquity. On this principle of interpretation, the Bible recognises, in the first instance, the great age of the earth, and then tells us of the changes it underwent at a period long subsequent, in order to render it a fit abode for the family of man. The work of the six days was, according to this view, not a creation in the strict sense of the term, but a renovation—a remodelling of pre-existent materials. Some difficulty, however, remains in explaining the transactions of these days, so as to establish their accordance with geological discoveries.

OPINIONS REGARDING THE SIX DAYS.

In former times, Whiston, Des Cartes, De Luc, and other distinguished men, advocated the opinion that the days spoken of in Genesis were

not periods of twenty-four hours, but of a vast duration. More recently, Professors Jameson and Silliman have espoused this solution of the difficulty, and have, with great talent and plausibility, engaged the resources at once of criticism and science in its defence.

Dr. Buckland believes that there is no sound critical or theological objection to the interpretation of the word 'day,' as meaning a long period, but he thinks that there is no necessity for such extension in order to reconcile the text of Genesis with physical appearances. He supposes creation to have been succeeded by cycles of ages, during which all the physical operations disclosed by geology were going on. Then terrestrial convulsions supervened and produced chaos, or literally a state of confusion and emptiness. The earth was covered with dense vapours, and darkened by them. This confusion, and its attendant obscuration, God so far removed on the first day as to make the light appear and distinguish it from the darkness; in this acceptation of the words, 'He said, Let there be light, and there was light.' On the fourth day the gloom which had overspread the

earth was not only modified, but dissipated, so that the heavenly bodies came into view with all that conspicuousness which renders them so valuable to man, and constitutes them especially the signs of seasons. Thus his mandate was fulfilled: 'Let there be lights in the firmament of the heaven,' etc. In like manner, Dr. Buckland explains all the transactions of the days mentioned in Genesis as being improvements which followed temporary disorder; and he understands the inspired penman to describe changes which our own globe, and the celestial bodies, underwent, not in their own general condition, or in their connexion with the universe at large, but in their relation to man and his specific well-being.*

Dr. Pye Smith has started the opinion that the recital which follows the announcement of creation may have respect to a sub-division of the globe. He thinks that the term 'earth' may have a local and restricted sense, and may be designed to express that particular part of our world which God was adapting for the dwelling of man, and the animals connected with him.

* See Bridgewater Treatise, vol. i., chap. 2.

The history of the work of the six days is, he thinks, 'a description in expressions adapted to the ideas and capacities of mankind in the earliest ages, of a series of operations, by which the Being of omnipotent wisdom and goodness adjusted and finished not the earth generally, but as the particular subject under consideration here, a PORTION of its surface for most glorious purposes. . . This portion of the earth I conceive to have been a large part of Asia lying between the Caucasian ridge, the Caspian Sea, and Tartary on the north, the Persian and Indian Seas on the south, and the high mountain ridges which run, at considerable distances, on the eastern and western flank.'*

ON SUCH A SUBJECT WE SHOULD NOT BE DOGMATICAL OR HASTY IN OUR DECISIONS.

In these schemes of conciliation I shall not enter particularly. Each of them has been plausibly defended, and we should examine, without prejudice, all that can be said in their behalf. I do not think, however, that we have

* Holy Scrip. and Geol. Science, p. 198, 4th edit.

reached the time when any one of them, or any other of like nature, should be very positively maintained. As regards the bearing of physical facts on the elucidation of Scripture, we are, if I mistake not, doing little more as yet than examining witnesses; and we must exercise a little patience before we find ourselves in a condition to sum up the evidence or to pronounce judgment. Geology is but feeling its way to the formation of a complete and coherent system. If in its present state it exhibited an apparent accordance with our interpretation of Scripture, new difficulties might arise from subsequent geological discoveries. It is enough for the present that apparent contradictions are becoming less prominent, while possible means of reconciliation are enlarging on the view. We are thus emboldened to say, with Dr. Buckland, 'I trust it may be shown, not only that there is no inconsistency between our interpretation of the phenomena of nature and of the Mosaic narrative, but that the results of geological inquiry throw important light on parts of this history, which are otherwise involved in much obscurity.'

IMPORTANT AGREEMENTS BETWEEN SCRIPTURE AND GEOLOGY.

But there are marked features of accordance between the volumes of nature and of revelation which I am unwilling to overlook. Both teach us the being of a God; both ascribe to him the same perfections of knowledge, wisdom, power, and goodness; both tell us that he created the world, and prepared it for becoming the abode of man. Both date the creation of man about 6000 years back; and if a change so great as his introduction to the earth then took place, it is most reasonable to believe that great accompanying changes, such as are described in the first chapter of Genesis, were made on his account.

'I need not dwell on the proofs of the low antiquity of our species,' observes Sir C. Lyell, 'for it is not controverted by any experienced geologist; indeed, the real difficulty consists in tracing back the signs of man's existence on the earth to that comparatively modern period when species now his contemporaries began to predominate. If there be a difference of opinion respecting the

occurrence in certain deposits of the remains of man and his works, it is always in reference to strata confessedly of the most modern order; and it is never pretended that our race co-existed with assemblages of animals and plants, of which *all or even a great part of the species* are extinct.

'No inhabitant of the land exposes himself to so many dangers on the waters as man, whether in a savage or civilized state; and there is no animal, therefore, whose skeleton is so liable to become embedded in lacustrine or submarine deposits: nor can it be said that his remains are more perishable than those of other animals; for in ancient fields of battle, as Cuvier has observed, the bones of men have suffered as little decomposition as those of horses which were buried in the same grave. But even if the more solid parts of our species had disappeared, the impression of their form would have remained engraven on the rocks, as have the traces of the tenderest leaves of plants, and the soft integuments of many animals. Works of art, moreover, composed of the most indestructible materials, would have outlasted almost all organic contents of sedimentary rocks. Edifices, and

even entire cities, have, within the times of history, been buried under volcanic ejections, submerged beneath the sea, or engulphed by earthquakes; and had these catastrophes been repeated throughout an indefinite lapse of ages, the high antiquity of man would have been inscribed in far more legible characters on the framework of the globe than are the forms of the ancient vegetation which once covered the islands of the northern ocean, or of those gigantic reptiles, which, at still later periods, peopled the seas and rivers of the northern hemisphere.'*

The recent creation of man is a fact of vast importance and interest, in whatever aspect or relation it may be viewed. I shall have occasion to speak of it again. At present I only adduce it as proving that, by the testimony of geology itself, the Scriptures give a just view of the age of the earth, in so far as it is the world of man, and in no other aspect did it concern us as moral agents to be made acquainted with its chronicles.

Fossil remains bear testimony not only to the appearance of new tribes, but to the disappearance of former tribes. And as geology shows

* Prin. of Geol., b. i., ch. ix.

us that other races have become extinct, it confirms the intimation of Scripture, that the human race also may pass from the earth, and verify the announcement in its relation to man, that time shall be no more.

Even in regard to scriptural chronology, where the grand difficulty is supposed to lie, I may remark that while the Bible declares of the human race that we are of yesterday, yet, in characterising the age of the earth, revelation never speaks of it as if it were modern. God 'hath chosen us in Christ before the foundation of the world.' Would the apostle have so expressed himself, unless he had considered the world to be exceedingly ancient? 'Of old hast thou laid the foundation of the earth.' Would not a modern geologist, who believes in a Creator, adopt as his own this declaration of the psalmist? 'Or ever the mountains were brought forth, or ever thou hadst formed the earth and the sea, even from everlasting to everlasting thou art God.' It is plain that in this passage the globe is spoken of as only less ancient than eternity itself.

If by the testimony both of geology and of

Scripture the world be so very ancient, it is a pity that any misconception or prejudice should blind us to the interest of the fact. It has been said that geology is only less extensive than astronomy in the range of its discoveries. The compliment is just, but inadequate. While astronomy tells us of the extent of creation, geology informs us also of its antiquity; and the impression induced by surveying unnumbered worlds is scarcely more solemn or grand than that which we derive from reviewing unnumbered ages. We are awed in beholding nebular matter resolved into shining points, and in recognising each of these myriads of myriads of bright particles as a gorgeous sun and probable centre of attraction and illumination to encompassing planets. But if we lift a pebble from the sea-shore, and begin to decipher its characters, written by the finger of God himself, we have no relief from this awfulness. We pass from the abysses of space only to be lost in the abysses of duration, and we are transported by the retrospect into depths of the past, where all reckoning fails us, and the lapse of centuries is reduced to undiscernible insignificance. Where were we when these grains of

sand were assorted? Compared with the date of their assortment, the fall of Babylon has just happened, and even the creation of man is an event of yesterday.

WHY WAS NOT THE ANCIENT WORLD MORE EXEMPT FROM PHYSICAL EVIL THAN GEOLOGY SUPPOSES IT TO HAVE BEEN?

I have found some persons startled at the idea that the world, as it existed before the creation and transgression of man, presents, in the delineations of geologists, so little that is paradisiacal. But where does the Bible say that the whole earth was ever a paradise? If it had been so, what need would there have been for any paradise at all? Eden was brought into existence, if we are to believe the Scriptures, in immediate connexion with the creation of man; and its peculiar delights were found only within its own enclosures. A wide difference, therefore, between the general condition of the earth and the felicities of paradise is altogether conformable to the scriptural narrative.

Not a few, however, are particularly shocked to think that fossil remains should indicate the ravages of death among the brute creation, at

periods anterior to the fall of man. They have been accustomed to regard death as in all cases the effect of sin, and they are confounded to hear of creatures having died in the earth before it was tainted or blighted by transgression. But let the following considerations be duly weighed: —(1.) If birds and beasts and creeping things had not died, they must have been immortal; and we at once perceive that there is an unsuitableness in the nature and extent of their powers to the inheritance of immortality. (2.) The supposition of irresponsible and sinless creatures dying in consequence of the sin of man is a mysterious explanation of the facts; and instead of removing the difficulty, only replaces it by another. (3.) The circumstance of man alone having been created immortal, is not at all more wonderful or unlikely than that man alone should have been created rational. There is in truth a natural fitness that these wonders should go together—Reason and Immortality. As eternal life appears inappropriate to an insect, so, on the other hand, a duration equally brief with that of the brutes appears inappropriate to the faculties and affections, the retrospects and anti-

cipations of the soul of man. The immortality of the human body, and the happy immortality of the human spirit, were, however, made conditional on obedience. The apostacy of our race brought sad derangement over this seemly order; but surely the consequences have not been more disastrous than might have been anticipated from the acknowledged entrance of moral evil. (4.) The Scriptures advance nothing at variance with these statements. They tell us of no tree of life of which the lower animals might eat and live for ever; nor do they give us the slightest hint that such creatures expire because our first parents partook of the tree of the knowledge of good and evil. That brutes die because man has sinned, has been asserted innumerable times by divines of eminence; but I consider it unnecessary to enter into any critical examination of the few texts which have been supposed to favor this idea, as they have scarcely even a semblance of giving it any countenance. We are told, indeed, that 'sin entered into the world, and death by sin;' but it is evident that the apostle, in so expressing himself, used the language in relation to man, for he adds,

'and so death passed upon all men, for that all have sinned.'* The death of animals is a fact in the course of nature, the truth of which all parties must admit. It creates, however, no special difficulty to the reception of our holy faith, for it contradicts in no way whatever either the scriptural narrative or Christian doctrine. This objection, when justly viewed, only shows then how much safer we are with the Scriptures themselves, as our rule of faith and manners, than with the most ably-executed and generally-received systems of theology.

The foregoing paragraphs exhibit grand features of accordance between what the Bible says and what the earth shows; and we shall search in vain for equally striking symptoms of a common divine origin in any human productions.

THE DELUGE.

A view of Geology, in its relations to Revealed Religion, would be incomplete without some observations on the Deluge of Noah. The scriptural account of that catastrophe may be

* Rom. v. 12.

summed up in a few sentences.* It happened about sixteen hundred and fifty years after the creation of man, and about two thousand three hundred and fifty years before the Christian era. Noah, forewarned of God, had prepared an ark for the saving of himself and his house. He was also commanded to bring into the ark of every living thing of all flesh, two of every sort, to keep them alive with him. Of beasts which were clean, according to the Jewish law, Noah was to take to him by sevens—that is, seven males and seven females. He was also to take of all food that was eaten, to keep alive the tenants of the ark, both rational and irrational. A week after Noah entered the ark, taking with him his three sons and his wife, and his sons' wives; a rain, which lasted forty days, began to fall, and the fountains of the great deep were broken up; so that the land was overflowed by the waters, till all the hills that were under the whole heaven were covered. The waters had so far abated, one hundred and fifty days after the deluge commenced, that the ark rested on the mountains of Ararat. At intervals of a week each

* Gen. ch. vi., vii., viii.

Noah sent out a raven, which came not back—a dove, which returned—the same dove, a second time, which returned with an olive leaf in her mouth—the same dove, a third time, which was not again seen. On the two hundred and twenty-fourth day, the tops of the mountains were visible. The whole period included between the day of Noah's entrance into the ark, and that of his leaving it, was a year and eighteen days.

The marine remains of animals and vegetables, with which many of the fossiliferous strata abound, were long referred to this deluge as the cause of their transportation, and were appealed to as evidence, that the diluvial waters had overflowed the whole earth. The friends of revelation were naturally disappointed when this position was disputed, and the fossils were alleged to have belonged in general to periods much more ancient, and to have been entombed where they are now found under other circumstances. The question arises, How far does the scriptural account of the Flood appear now to accord with geological phenomena? To discuss all the points of controversy connected with this subject, would require a large separate

treatise. In volume 14th of the 'Edinburgh Philosophical Journal,' there is an ably-conducted argument between Drs. Fleming and Buckland, on the principal points in dispute. Divines have been blamed for obstructing the progress of science. But Dr. Fleming had the moral courage to advance, in this discussion, opinions not generally received, and which were at that time in advance of most scientific men themselves. The conflicting views and reasonings are very fairly and ably exhibited by Professor Hitchcock, in volume 4th of the 'Student's Cabinet Library.' Ample justice is done to the same subject by Dr. P. Smith, in his excellent work on Scripture and Geological Science. I will restrict myself to a few general statements, which may indicate the results of much elaborate disquisition.

EXTENT OF THE DELUGE.

1. Our best expositors of Scripture are now generally of opinion that the flood, though extensive, was local. The language of Scripture certainly seems, at first sight, most unqualified: 'All the high hills that were under the whole heaven

were covered.'* It is certain, however, that Scripture often uses general language with a restricted signification. We are told† that 'Adam gave names to all cattle, and to the fowl of the air, and to every beast of the field.' If we reflect for a moment, we perceive that this statement, when interpreted according to its letter, involves something like an impossibility; and what need was there to name any animals beyond those which were to serve man, and form the subject of his discourse? We are informed that in consequence of the murrain 'all the cattle of Egypt died;' and yet some escaped, for it is afterwards mentioned that, by a subsequent plague, the Lord 'smote all that was in the field, both man and beast.'‡ When it is averred that 'all countries,' we can only understand that some countries 'came into Egypt to Joseph to buy corn;'§ and a limited portion of the habitable world must be intended by that 'all the earth'‖ which sought to hear the wisdom of Solomon. Within a certain vessel Peter could only see some samples, when he is represented to have seen 'all manner of four-footed beasts of the

* Gen. vii. 19. † Gen. ii. 20. ‡ Exod. ix. 6, 25.
§ Gen. xli. 57. ‖ 1 Kings iv. 34.

earth, and wild beasts, and creeping things, and fowls of the air.'* At the time the Epistle to the Colossians was written, most of the world was in heathen darkness, and in utter ignorance of the true religion; yet in that epistle Paul speaks of 'the gospel which was preached to every creature under heaven.'† He could not mean to expose himself to the charge of palpable untruth. In all these, and many like cases, we readily and necessarily assign a modified sense to absolute terms. There is no reason why this principle of interpretation should be held inapplicable to the history of the deluge.

The difficulties which beset the idea of a universal deluge, irrespectively of geological discoveries, have induced many expositors, both ancient and modern, to believe that it was limited.

Even when we take the largest estimate of the size of the ark, its dimensions exclude the supposition that it contained all land animals, and the food necessary for their preservation. The number of species of terrestrial mammiferæ alone is, on a moderate calculation, about seven hundred;

* Acts x. 11, 12. † Col. i. 23.

and, as they entered the ark by pairs, this gives us fourteen hundred individuals. Some of the animals were of great bulk. There are two species of living elephants, probably seven kinds of rhinoceros, besides many gigantic species of the ox tribe, of deers, antelopes, etc. In addition, we have about four thousand species of birds, after deducting aquatic fowls. As to insects, there must be, according to the estimate of able naturalists, above two hundred thousand of them. Then we have to find place for a sufficiency of food. The carnivoræ would require an ample supply of prey. In some instances the sustenance needed to be of a kind which could scarcely be stored up, for how could the ant-eaters be provided with their ant-hills?

All the difficulties are not involved in the question of adequate accommodation. America has its peculiar animals, so has New Holland, and the same observation applies to Africa and Asia, and even to their associated islands, Madagascar, Java, Borneo, etc. How were the animals to be transported from these regions and back again, and how were they to find their

proper food and temperature by the way?* Difficulties multiply upon us the longer we consider the subject. Many plants would be destroyed by a marine deluge, as certainly as animals, and would equally require to be sheltered from the salt water.

It is true that all these obstructions could have been removed by miracles. A miracle could have brought the animals together, and afterwards restored them to their respective domains. A miracle could have reduced their dimensions, and made them small enough to be

* If anything more were required to show the partial location of birds, the galapagos archipelago might be mentioned: of 26 specimens shot by Mr. Darwin, 25 were peculiar, though bearing a strong resemblance to American types; some birds were even confined to particular islands; and the gulls, one of the most widely-dispersed families, are peculiar. But on this comparatively recent volcanic group, only 500 miles distant from the coast of America, everything is peculiar, birds, plants, reptiles, and fish, and though under the equator, all have sober covering. . . . The distribution of animals is guided by laws analogous to those which regulate the distribution of plants, insects, fishes, and birds. Each continent, and even different parts of the same continent, are centres of zoological families, which have always existed there, and nowhere else; each group being almost always specifically different from all others.—*Physical Geography, by Mary Somerville*, vol. ii., pp. 210, 218. These are most instructive volumes, and they are admirably adapted to the general reader.

contained in the ark; as in Milton's description the fallen angels were made sufficiently dwarfish to be accommodated in the hall of pandæmonium:

'Behold a wonder! they but now who seemed
In bigness to surpass earth's giant sons,
Now less than smallest dwarfs in narrow room
Throng numberless.'

Another miracle could have supplied the animals with their proper food, or changed their mode of life altogether. But the supposition of such miracles is highly improbable, not to say irreverent. When we are confuting the prodigies of the heathen, we are accustomed to point out their want of adequate object—their apparent uselessness; and we ought not rashly to expose the miracles of Scripture to a similar reproach.

If we adopt the principle which Scripture itself so unequivocally sanctions—that general terms may be used with a limited sense—the whole account is simple and consistent. A deluge of great extent inundated the dry land. In respect to men, whom it was designed to punish for their wickedness, it was universal, excepting only Noah and his family, whom it pleased God to spare alive. Along with them were preserved

such animals as were most useful to them, and such as were fitted to fulfil the purposes of Providence after the waters should have retired.

THE TESTIMONY OF TRADITION.

2. The deluge of Noah has general tradition in its favour. We find it in the mythologies of the Egyptians, Hindoos, Chinese, South Sea Islanders, etc. etc. Some have maintained that these traditions relate to different deluges, and that each country has magnified the reminiscences of its own floods. But there are adequate grounds for rejecting this explanation. It is not easy to suppose that there have been in all countries inundations of such magnitude, within the human period, as to originate in all of them such wonderful legends. Besides, these traditions have so much in common with the scriptural narrative, as to prove the identity of their source. We find in them not the flood only, but the ark, the raven, the dove, the olive leaf, and other particulars. It has been also shown that the traditionary accounts correspond more closely with the scriptural narrative as we approach

that region of Asia where the ark rested. At one period the chronicles of the Chinese were triumphantly adduced as evidence that the human race has been visited by no such judgment as the flood for cycles of ages. But the extreme antiquity of these chronicles is now abandoned by sceptics themselves; and this shows how cautious we should be in attaching importance to specious objections, which may do incalculable mischief, and then be entirely exploded.*

* The various and discordant speculations respecting the antiquity of ancient monuments, afford an instructive lesson as to the danger of drawing conclusions from negative or uncertain premises. In no instance is this more apparent than in the history of discussions respecting some points of Hindoo antiquity, and concerning the date of the Zodiacs found in the temples of Upper Egypt. The astronomers and scholars of Europe were long perplexed in fixing the date of the construction of the Zodiacs of Esné and Dendera. It was imagined that these Zodiacs represented the state of the heavenly bodies at a very remote epoch. By some they were supposed to indicate the extravagant antiquity of fifteen thousand years; others were more cautious, and inferred the comparatively limited age of four thousand years before the Christian era; while another believed they were no older than the battle of Actium. As Cuvier has justly remarked, all these conjectures became useless, when people ended where they should have begun, by studying the Greek inscriptions sculptured on the monuments, and when Champollion deciphered their hieroglyphics. It is now ascertained that these supposed ancient temples were erected dur-

A DELUGE NOT IMPOSSIBLE.

3. Geology proves that the supposition of a deluge involves no natural impossibility. Infidels were wont to prove that the waters of the earth were not of sufficient quantity to reach the summit of the highest mountains, and that ocean must be heaped above ocean before this effect could be produced. Now it is known that any region, however elevated above the level of the sea, may be brought, by subsidence, under its

ing the domination of the Romans. The portico of the temple of Dendera bears a Greek inscription stating that it was consecrated to the prosperity of Tiberius. The temple of Esné, whose construction was placed as far back as about three thousand years before the Christian era, has a column whose inscription gives it the date of the tenth year of the Emperor Antoninus. There is still more decisive proof that these Zodiacs have no reference either to the precession of the equinoxes, or a change of the solstices. A mummy cloth brought from Egypt has a very legible Greek inscription respecting a young man who died in the nineteenth year of the reign of Trajan. The cloth has also a Zodiac painted on it, marked in a similar manner to that of Dendera, and therefore was, in all probability, a mere astrological composition respecting the individual whose body was wrapped up in it. The Zodiacs in the temple, are, probably, astrological formulæ respecting the dedication of the building, or the nativity of the emperor in whose reign it was constructed. —*See Cuvier's Ossemens Fossiles.* S.

waters, and that, as a matter of fact, the loftiest peaks have been actually submerged. Sir C. Lyell says, that if the deluge be understood to have covered only 'that portion of the earth which was then inhabited by man, there are two classes of phenomena in the configuration of the earth's surface which might enable us to account for such an event: First, extensive lakes elevated above the level of the ocean; secondly, large tracts of land depressed below that level.'* Here, then, is another instance in which a bold and seemingly decisive objection to scriptural narrative has perished before the progress of science. It is now proved and conceded that vast regions have been laid under water: and if we believe that the deluge was universal only in respect to man, beyond whose domains the judgment would have been unmeaning, then, in such events as have incontrovertibly happened, we have an appropriate power of destruction quite equal to the results. It is of great consequence to observe that deluges are thus shown to be a part of the course of nature. When this is admitted, and no one now denies it, all that we

* Vol. iv., b. iv., ch. xix.

are required to believe in regard to the Noahian deluge is, that God, in a particular instance, employed, in a very signal manner, his natural and usual administration to fulfil his moral purposes. Surely this proposition should create, to a well-ordered mind, neither offence nor alarm

OBSERVATION DOES NOT WARRANT SCEPTICISM.

4. The earth presents no geological appearances at variance with a belief in the Noahian deluge. There has been little examination of Armenia to ascertain the distinctive features of its diluvial deposits. But the friend of revelation has nothing to fear from scrutiny, whatever may be its results. Although no traces of devastating currents should remain, the fact, by the showing of geologists themselves, would prove nothing against the Bible. In arguing that the fossiliferous strata could not have been formed by the flood, they have proved, at great length, that a temporary submergence of land could not produce so great effects, and would leave very few monuments. Why, then, should we be startled if the monuments on

further examination shall not be discovered? While some have ascribed an utter demolition of the earth's crust to the flood, and have thus caricatured its probable consequences, perhaps some have gone to the opposite extreme, by saying that it would make no impression at all on the constituents of a landscape. But though masses of detritus were accumulated in particular localities, and the distribution of hills and valleys were somewhat changed, who, after the lapse of very many centuries, could certainly discriminate these effects from those of preceding or subsequent agencies? If a river overflow its banks, or a lake burst its barriers, we see sad ravages committed over the adjacent region. But next year they are less visible. In a few years the action of the elements has farther modified their obviousness; and when centuries shall have elapsed, how shall they be certainly recognised?

In making these remarks, I am taking the lowest ground as being the surest ground. Some eminent geologists do not yet consider a deluge, which may be called general, at all disproved. Professor Hitchcock, for example, who

has so fully espoused and so ably defended the principles of modern geology, maintains that a deluge appears to have overflowed a great portion of our globe at a date comparatively recent; and that for anything science, in its present state, shows to the contrary, this may have been the deluge of Noah.* The position I have taken,

* 'If we mistake not, then, the deluges of Scripture and of geology, may, or may not, have been universal, in consistency with the language of the sacred history, and with the facts of science as they are at present understood. They agree, therefore, in having been very extensive, if not universal. And in view of such proofs of their identity, it should require decisive evidence to the contrary to disjoin them.' . . Professor Hitchcock then mentions the principal objections to this identity, and adds:—'Upon the whole, the arguments against the identity of the two deluges appear to us rather to preponderate. "This important point, however," to use the language of Dr. Buckland, "cannot be considered as completely settled, till more detailed investigations of the newest members of the Pliocene, and of the diluvial and alluvial formations shall have taken place." We feel no great anxiety how this question is settled, as to its bearing upon revelation. But examined in the true spirit of the Baconian philosophy, it seems to us there is quite too much evidence of the identity of the two deluges, and quite too much ignorance of the whole subject of diluvium yet remaining, to permit an impartial geologist to decide preremptorily, as some have done, that they could not have been contemporaneous. We rather prefer that state of mind in which the judgment remains undecided, waiting for further light. Meanwhile, it is sufficient, so far

however—that the deluge was probably local, though extensive, and that such deluges have certainly happened—removes all objection to the Bible, and it is such as infidels themselves can scarcely call in question. In fact, some enemies to the Gospel have seen the historical proof of the deluge to be so strong, that they have confessed it to be irresistible. M. Boué, for example, an eminent writer and scoffer of the French school, has said, 'I shall be vexed to be thought stupid enough to deny that an inundation or catastrophe has taken place in the world, or rather in the region inhabited by the antediluvians. To me this seems to be as really a fact in history as the reign of Cæsar at Rome.'*

So safe are we with the simple narrative of Scripture. But where would we have been had the Bible contained some of the defences of it put forth by its misguided friends? What way of escape should we have had if any writer held

as revelation is concerned, to have shown that no presumption is derived from geology against the truth of Moses' history of the deluge; but rather a presumption in its favour, even on the most unfavourable supposition.'—*Cabinet Library*, vol. iv., pp. 372–374.

* Quoted by Professor Hitchcock, Cab. Lib., vol. iv., p. 299.

by us to be inspired, had assured us that the deluge was caused by the approach or stroke of a comet? It is now ascertained that a comet has no solidity, and that even its densest portion consists of attenuated vapour. A hundred other explanations, equally untenable, have been offered, which, if they had been a part of the Bible itself, as they were designed to be a vindication of it, would have brought into utter discredit its claims to authenticity. So true is it that the folly of God is better than the wisdom of man; and that while systems of philosophy change continually their phases, the word of the Lord endureth for ever.

Allow me to add, that if geology has its proper evidence, so has Scripture—evidence clear, and broad, and varied, which no difficulties affect—and that the same searching after truth which has led men of scientific mind to acquiesce in modern geology, has induced many of the more eminent of their number to own the proof of Scripture to be decisive and irresistible. The great Cuvier, the father of philosophic geology, was president of the Bible Society in Paris, and was meditating a speech for one of

its meetings, eulogistic of the Bible, when he was removed by death. Need I speak of Silliman, professor of chemistry in Yale College, America; of M'Culloch, like the others I have mentioned, no divine, but a profound geologist, and strong advocate of the Christian religion? It would be tedious to enumerate such men as Sedgwick, Conybeare, Buckland, Bakewell, Miller, all enlightened geologists, and friends of biblical truth.

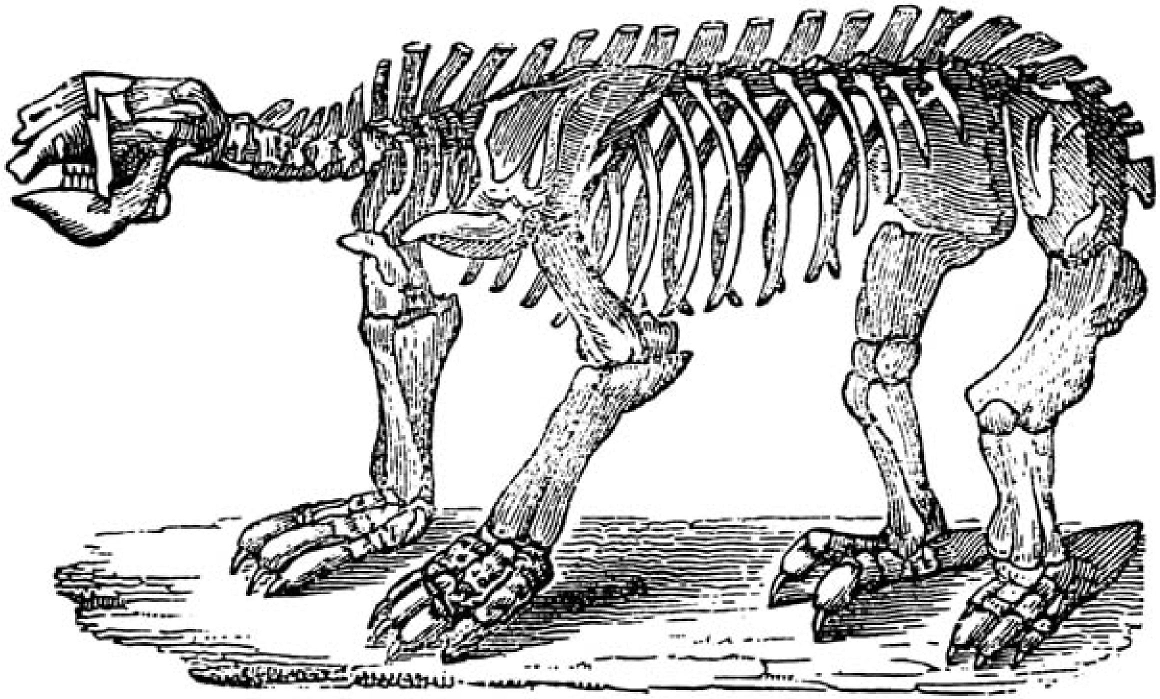
We have had, I confess, Biblico-Geological Treatises, written with all the fervour of zeal, and all the rashness of indiscretion. 'Let us for a moment suppose,' says Professor Sedgwick, 'that there are some religious difficulties in the conclusions of geology. How then are we to solve them? Not by making a world after a pattern of our own—not by shifting and shuffling the solid strata of the earth, and then dealing them out in such a way as to play the game of an ignorant or dishonest hypothesis—not by shutting our eyes to facts, or denying the evidence of our senses: but by patient investigation, carried on in the sincere love of truth, and by learning to reject every consequence not warranted by di-

rect physical evidence. Pursued in this spirit, geology can neither lead to any false conclusions, nor offend against any religious truth. And this is the spirit with which many men have of late years followed this delightful science. But there is another class of men who pursue geology by a nearer road, and are guided by a different light. Well intentioned they may be, but they have betrayed no small self-sufficiency, along with a shameful want of knowledge of the fundamental facts they presume to write about: hence they have dishonoured the literature of this country by *Mosaic Geology*, *Scripture Geology*, and other works of cosmogony with kindred titles, wherein they have overlooked the aim and end of revelation, tortured the book of life out of its proper meaning, and wantonly contrived to bring about a collision between natural phenomena and the word of God.'* We cannot stand by these defences of Scripture, but we can stand by Scripture itself. Why is it so? Why is the alleged folly of revelation more tenable than the wisdom of its advocates? The

* On the Studies of the University; quoted Stud. Cab. Lib., No. xix., p. 22.

most easy and natural explanation is, that 'all Scripture is given by inspiration of God.' In its simple and unsophisticated statements, we have an impregnable munition of rocks; and strong in this confidence, we defy, we court investigation. A contracted policy of cowardice on the one hand, or of intolerance on the other, may have gloomed on fair inquiry, and forbidden its prosecution, and deprecated its results; and all may have been presented as an acceptable offering on the altar of Christian faith. But Christianity ejects the gift from its sanctuary—disclaims the necessity and denounces the expedient. It proclaims the whole universe to be God's temple, and invites all to inquire in it, who will inquire reverently. 'Lift up your eyes to the heavens, and look upon the earth beneath.' 'Stand still, and consider the wondrous works of God.' 'The works of the Lord are great; sought out of all them that take pleasure therein.' 'Walk about Zion, and go round about her; tell the towers thereof; mark ye well her bulwarks; consider her palaces, that ye may tell it to the generations following, for this God is our God for ever and ever.' 'Prove

all things, hold fast that which is good.' In obeying these commands, the friends of revealed truth will find nothing to subvert it; they will find enlarged and multiplied motives to credit its doctrines and obey its statutes. And even its adversaries, in attempting its overthrow, will contribute to its strength: the camp of the Assyrians will become the spoil of the Israelites, and the glory arrogated by man will redound to God.



The Megatherium.

III.

PROOFS FURNISHED BY GEOLOGY OF THE BEING AND PERFECTIONS OF GOD.

I proceed now to consider the moral application of geological facts and principles, regarded as a branch of natural theology.

In this aspect, the subject is full of practical interest, and is well adapted to invigorate devotion.

It has been already stated that natural theology treats of the evidence for the being and perfections of God, derived from the manifestation of design in the works of creation. Geology has supplied most valuable additions to this argument from final causes. In drawing attention very briefly to the nature of its testimony, I shall speak of the organic, and then of the inorganic world.

Mylodon Robustus.

GEOLOGY IN ITS RELATION TO THE ORGANIC WORLD.

The anatomy of living species has furnished writers on natural theology with ample and interesting proofs. But geology accomplishes a more remarkable feat. It supplies the history of innumerable races of animals and vegetables which have been long extinct, and points out the most diversified proofs of wise and benevolent design in the structure of organic remains with which ancient strata are interspersed. It demonstrates that plants which grow no more, and animals which live no more, exhibited the most perfect adaptation to their respective localities and means of subsistence.

To select some of the best of countless examples, and present them in lucid order and expression, would be a service by no means unimportant to my aim, and which, with the aids now had in abundance, might be performed without great originality or research. But I do not feel myself competent to the task; and though I were, I could ill spare the time which the exe-

cution of it would require of me. I will restrict myself to a short account of the Megatherium; and in the brief notice of it I am about to give, I will take aid freely from the fuller description of Professor Ansted, for which he confesses himself largely indebted to Professor Owen.

THE MEGATHERIUM.

The name Megatherium means Great Beast. The remains of the huge animal so called are found in the continent of South America, in beds of the later tertiary period. It belongs to the order of Edentata, [*i. e.*, toothless, from the absence of cutting teeth,] and is most nearly allied to the sloth among existing species. The sloth is still common in the forests of South America. When it is on the ground, it moves slowly and with much difficulty. Seeing it in such a position, one would pronounce it a very unseemly creature, and most awkwardly constructed. But it never descends to the earth voluntarily. Its home is among the branches of trees, on the foliage and tender twigs of which it feeds; and for that place of residence and mode of life, its

limbs and all its organs display the most perfect adaptation.* It can suspend itself from a bough, which it clasps with all its four legs, and while thus hung in mid air, under the branch, can most composedly enjoy its leafy repast. When change of place is needed, it can pass from tree to tree, and pursue its branched-way through the forest with the greatest nimbleness and agility. Every one who has visited tropical regions, has been struck with the singular and beautiful appearance of parasitical plants grow-

* The mechanism of the claws of two tribes of animals presents very interesting matter for reflection. In the carnivorous feline, the claws are only occasionally used, and not to impede motion, they are retracted and drawn up, and of this every one has a familiar and domestic example in the claws of the cat. In the cat, the claws are held retracted by elastic ligaments, that is, by a mere physical not a vital force, consequently without fatigue or any effort of will on the part of the animal. On the other hand, the erection of the claws, and their employment in seizing and tearing, is a voluntary process, performed by muscular force, which is liable to fatigue. If from the cat tribe we turn to the sloths; we find the arrangement inverted. In the sloth the claws are usually employed in grasping, and hence they are retained in that state by an elastic ligament, that is, a physical power, not vital. On the contrary, they are retracted by a muscular force, because this is rarely required in an animal whose whole life is spent in embracing the branches of trees. S.

ing in the woods. The cotton trees which I saw in Jamaica had their vast horizontal branches covered with them, and presented the remarkable aspect of a rich and variegated nursery in the skies But the sloth turns these plants to practical advantage, and avails itself of their natural cordage and network, which unite the branches, to prosecute its sylvan course with the greater facility.

Some remarkable peculiarities of the skeleton of the sloth are found in the Megatherium, but with such modifications in the shortening and lengthening of the legs, and the addition of a powerful tail, as to show very considerable difference of habits, along with essential and important resemblance. Its length was about nineteen feet, its breadth across the loins nearly six feet, its height not exceeding nine feet. The trunk of its enormous body was terminated by a pelvis, and hind extremities nearly three times as large as those of the most gigantic elephant. Its food consisted of the roots or of the softer portions of trees ; and it was so formed that it might rest its hideous weight securely on the hinder legs and tail, while its fore legs were freely and power-

fully exerted in uprooting trees, or in wrenching off their branches and stripping them of their edible parts. The posterior portion of the skeleton, comprising the lumbar vertebræ, the bones of the pelvis, the tail, and the hinder extremities, exhibit a succession of contrivances suited to bear up against extraordinary bulk and ponderousness.*

* 'The first thing,' says Professor Ansted, 'to be noticed with reference to this part, is the wide expanse of bone stretching out from each side of the vertebral column to a distance of five feet, and scarcely leaving any interval in the hollow of the back. Powerful bones are seen placed at right angles to the spine and vertically over the hind legs, and these form a solid mass well fitted to withstand any amount of pressure, and enabling the hind legs to support without injury almost any effort that could be made by the animal when resting, as if on a tripod, upon its hind legs and tail. This great width also indicates a large size of the abdominal cavity, adapted to the habits of the animal as a vegetable feeder, but at the same time rendering it ponderous and unwieldy.

'Articulated to each of the broad plates of bone stretching out thus from the back, we find legs of corresponding magnitude and strength. The thigh-bone is not more than *twenty-eight inches long, but its circumference at the* smallest part is equal to its length, while the circumference of the thigh-bone of an elephant is not more than twelve inches. Although, however, the thigh-bone is short, it is set vertically, and not obliquely as in most animals, and its *full length is thus taken advantage of, but the rate of pro-*

Professor Ansted shows that the anterior portions of the animal are not less in keeping with

gression would thus be in a corresponding degree slow. The size of the leg when clothed with flesh must have been large even in reference to the circumference of this bone, for it is much flattened and expanded outwards.

'The character of strength indicated so clearly both by the proportion, the position, and the peculiar shape of the thigh-bone, is fully preserved in the other bones of the leg; for we find the two bones, the tibia and fibula, united together both at the top and bottom, forming an almost solid column, nearly as large as the femur, and set vertically beneath it. This is a contrivance only characterising the armadilloes among living animals, and in them it corresponds with an apparatus of the fore extremity, enabling the possessor to burrow beneath the surface of the earth. Its object is to offer a powerful resistance to the great pressure exerted when the hind extremities are employed as the purchase, while the fore-legs are being made use of for digging. In the megathere it is likely that the similar contrivance was useful in very nearly the same way.

'The base of the column we have just been considering was no less remarkable for massiveness and extent than was the vast and massive shaft itself. The bone of the instep is a cube of nearly nine inches a side; it rests on a heel-bone extending eighteen inches backwards, and the other bones are of similar proportions. The foot was terminated by three toes, one of which appears to have been armed with a tremendous claw. The claw, or rather its sheath, for of the actual claw itself we have no remains, measures upwards of ten inches in length and thirteen inches in circumference at the root; and in this respect, therefore, the analogy with the sloth is still preserved.

The tail of the Megatherium is a part in which the

its nature, and that its organs collectively form a perfect system.*

extinct genus differed essentially from the sloth. Its length was very considerable, certainly not less than five feet. The vertebræ of which it is composed are so large, that the circumference of this organ near the root must have been between five and six feet. Large processes are attached to the caudal vertebræ, which would strengthen it greatly: and there are indications on the back of extremely powerful muscles to work it. It assisted, no doubt, in occasionally supporting part of the weight of the body.'—*The Ancient World*, ch. xv., p. 342.

* I cannot resist the temptation to give an example:—'The shoulder-bone of the megathere is remarkable for the enormous size of one extremity. It is small in the middle and upper part, and is connected with the blade-bone by a round head fitting into a socket and admitting of free motion. At the lower end, however, where it is attached to the arm-bones, it attains an immense breadth, and served for the attachment of muscles of extreme and unusual magnitude, working the fore-foot. The use of this expansion will be obvious, if we compare the shoulder-bone of a ruminating animal, where the crests are scarcely observable, with the corresponding bone in the elephant and rhinoceros. In the ant-eater, this contrivance is carried yet further, and by its means the animal is greatly aided in digging up the large solid nests of the white ant. The bones articulated to the large termination of the shoulder-bone correspond well in magnitude and strength. The one is broad, powerful at its upper end, and short, and the other revolves freely upon it, giving that motion of the fore extremity by which man is able to move his hand on either side by a simple motion of the wrist.

'The entire fore-foot must have been a yard long and

Here, then, is a fossil animal, which at first view appears clumsy as well as colossal. If we mistake its calling, and judge of its configuration by uses which it was not intended to fulfil, then we shall be tempted to pronounce its proportions ungraceful and cumbrous. It has no provisions for speed. But what need could it have for rapid locomotion? It required not to pursue after prey, for it was graminivorous. And wanting the feebleness, it required not the swiftness of the roe to escape from predatory enemies; for a stamp of its foot or a stroke of its tail would have pounded into jelly the carcase of a lion, had such a foe then lived, and would have extinguished in a moment the vitality and sovereignty of the king of beasts. But understand that this quadruped of mountain-like dimensions, subsisted on the roots and other parts of trees, and needed a support which its weight would not crush when its fore-legs should be engaged in procuring its subsistence, and

twelve inches wide. It was provided with five toes, three of which were conspicuous for their large size, and were armed with long and powerful claws. The other toes did not appear outside the foot, being only rudimentary.'—*The Ancient World*, ch. xv., p. 345.

then we have conditions in its frame harmonising with its destination; and legs, and feet, and ribs, and tail, and claws, and teeth, and all the constituents of its anatomical structure accord with the place assigned it in the range of being.

It was devoid of means which some animals depending on the same kind of sustenance have for bringing it within their reach. It could not burrow in the ground as the tuco-tuco, a rodent animal described by Darwin, does to exhume roots, and it wanted the long neck of the giraffe to reach elevated foliage. But it had ample compensation for the absence of these facilities in its simple strength. It might eye with the desire of hope the sturdiest constituent of the forest. When it had poised itself on its hinder legs and columnar tail, thus giving to its enormous weight a pyramidal base, and having clasped with its fore-legs the stately trunk, securely swung itself from side to side—the firmest racine attachments would be loosened by such oscillations—the strongest stem would bend hither and thither under this immense and shifting pressure; till the agitated tree, though

it were a monarch of the forest, would be laid prostrate, and its deepest roots and most aspiring branches would become equally the spoil of the monster assailant.

EXTINCTION AND INTRODUCTION OF SPECIES.

Allied to the Megatherium were various gigantic species which may be grouped together as 'megatheroid animals.' But they have all disappeared from the scene of life, and though they are of comparatively modern date, centuries have elapsed since the last of them looked vainly for its companions, and lay down to expire in sickness and in solitude. Many species of animals have shared the same fate. The nautilus and the ammonite are two shells which are found together, in all the ancient strata, till we rise to the chalk, and there the entire genus of the ammonites bids farewell to animated nature. Mr. Richardson becomes poetical at this thought, and gives some pretty verses, from which I select the following:—

THE NAUTILUS AND THE AMMONITE.

The Nautilus and the Ammonite
  Were launched in friendly strife;
Each sent to float, in its tiny boat,
  On the wide wild sea of life!

For each could swim on the ocean's brim,
  And when wearied its sail could furl;
And sink to sleep in the great sea deep,
  In its palace all of pearl!

. . . . . .

They swam 'mid isles, whose summer-smiles
  Were dimmed by no alloy;
Whose groves were palm, whose air was balm,
  And life—one only joy!

They sailed all day, through creek and bay,
  And traversed the ocean deep;
And at night they sank on a coral bank,
  In its fairy bowers to sleep!

And the monsters vast, of ages past,
  They beheld in their ocean-caves;
They saw them ride in their power and pride,
  And sink in their deep sea-graves.

. . . . . .

And they came, at last, to a sea long past,
  But as they reached its shore,
The Almighty's breath spoke out in death,
  And the Ammonite lived no more?

So the Nautilus now, in its shelly prow,
  As over the deep it strays;
Still seems to seek, in bay and creek,
  Its companion of other days.

And alike do we, on life's stormy sea,
As we roam from shore to shore,
Thus tempest-tost seek the lov'd, the lost,
But find them on earth no more! *

It is interesting to think of species perishing, so that tribes which once peopled and crowded whole lands and seas cease to have a living representative. But Geology establishes, by the most abundant proof, the yet more important fact, that new species have been ushered into the world at different periods of its history. When countries have undergone a change of temperature, and races adapted to the former state of the climate have died out, they have been suc-

* Geology for Beginners, Appendix C.

Although it may appear hypercriticism to measure a piece of pleasing poetry by a zoological standard, yet we may remark that from a change in the use of a term the history of two very different animals has been confounded. The nautilus of the ancients, and of the poets of all ages, is not the nautilus of zoologists. The ancient nautilus, which we might perhaps call nautilus poetarum, is the argonauta argo of naturalists. The shell is not chambered, and the broad expansion of two of the arms of the animal has given rise to the fable of the sailing nautilus, while the shell has no small resemblance to a gondola. The nautilus of geologists and zoologists was unknown to the ancients. Two species still survive in the eastern seas, but they have no apparatus comparable to a sail, and the shells are chambered. S.

ceeded by new orders, most of which could not have lived under the prior condition of things, but are every way adapted to the altered circumstances. Our own country presents numerous examples. Its fossil flora and fauna, plants and animals, evince congeniality with tropical warmth. If restored to life now, they would, with few exceptions, speedily relapse into extinction, amid the chill blasts of this degenerate epoch. But tribes to which the caloric of past days would have been enfeebling and deadly, are at home and healthful in our frigid atmosphere.*

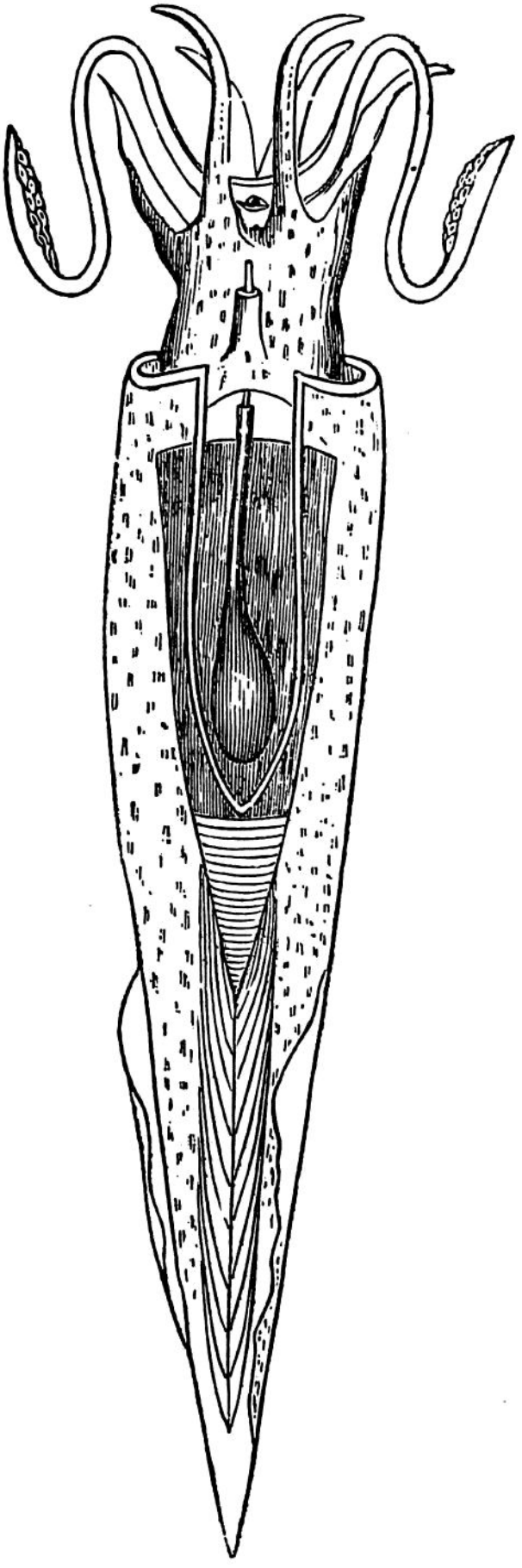
These facts confute the notion so long in

* The relation of animals to external conditions of temperature is obvious, and there are extremes of heat and cold which limit the existence of species. These limits vary with the species. It is, however, to be remembered that very different animals may live under nearly similar physical conditions. Thus, the crocodiles of the Nile and Ganges, although of distinct species, might, beyond doubt, change rivers, and still subsist; and the saguor of America might live in the delta of the Niger as well as on the banks of the Amazon. The capability of animals for enduring changes of temperature is often far greater than we would suspect. The tiger is often killed in the coldest regions of Siberia; and it is not twenty centuries since the lion lived in Thrace, the modern Roumelia, and on the banks of the waters of the Danube. Still it is true that, from a survey of the extensive groups of plants and animals, we may infer the nature of the climate, as above stated. S.

favour with atheists, that events have been going on just as we see them, through a past eternity; and that animals have produced animals, and plants have produced plants, each after its kind, in all prior ages. Metaphysicians urged many powerful objections to this assumption, and exerted their energies in proving that an eternal succession of generations is a tenet involving contradiction and absurdity. But we have no longer need of these abstract arguments. By the aid of geology we can now bring the controversy to the test of facts; and in the strata of the earth, we have tables of stone, on which are written, in decisive and indelible characters, an utter disproval of the atheistical hypothesis. The supposed sameness of the world vanishes before scrutiny, and without and within it is inscribed with *change*. We stand in the woods of South America, and while we gaze on their vegetation, and mark the structure and habits of their birds and beasts, and debate with ourselves the question, whether what is be only a repetition of what has been, and the history of life be a sheer exemplification of a perpetual motion, the curtain drops, the

scene changes, the past returns; and now we have a world so old that to us it is new. The megatheres are traversing the recesses of these strange woods; and the goodliest trees bend under their paws and quiver under their gnawings, as if seized with the terrors of irresistible destruction. And the Toxodon is there—a pachydermata-rodent animal of gigantic proportions—having so much in its complicated structure, both of the terrestrial and the aquatic, that it is difficult to say whether it moved on the land, or remained in the water. And the Macrauchenia, with a body about as large as that of a rhinoceros, and a neck nearly as long as that of the giraffe, is slowly crossing the level country—secure from human assault, for as yet there is no man. And the Glyptodon, almost as colossal as the megatheres, but resembling in form the tortoise, or rather armadillo, and clad in a coat of mail which would have crushed an animal less powerful, clears away the vegetation which leaf-eating tribes of smaller capacity have spared.

When we have begun to be familiar with the life and times of these creatures, geology once more deranges our notions of settled order.



It transfers us to other regions, and throws us back on older eras. We are carried in the spirit of palæontology to the compartment of the globe where England now is, but then was not; and strange seas are spread out before us, and frightful saurians of the early ages of the secondary period tenant these waters. The Ichthyosaurus, or fish-lizard, of which not the genus only, but the entire natural order, is lost, rules and ravages the ocean. With a length of thirty to forty feet,* with enormous eyes, combining microscopic and telescopic power—which neither minuteness nor distance can elude—with jaws full of conical teeth, and plated and cross braced to render their grasp as powerful as it is prompt, this monstrous marine reptile is plying its paddles, and dashing through billows, and filling its capacious stomach with indiscriminate prey.† More near to the land, the

* Geologists give very different measurements of fossil animals. It does not follow that their accounts are contradictory, since different specimens may have been adopted as standards. In these paragraphs my principal authority for numbers is Professor Ansted.

† There is evidence that the ichthyosaurus, when urged by its appetite, did not abstain from feeding on its own species. S.

plesiosaurus, a creature of about thirty feet long, and also a voracious lizard, only less dreadful than the last mentioned, is scouring the shallower water, and following the movements of its meditated victim with the curlings and twistings of a long serpentine neck. And these waters are rich in encrinites, animals of so peculiar and complicated a structure, that in some species the number of separate calcareous pieces of which their singular skeleton is made up, has been calculated to amount to not less than one hundred and fifty thousand. And ammonites and belemnites here abound, and countless fishes of many kinds, all differing more or less from our living aquatic population. Leave this region, and after cycles have elapsed, visit it again, and once more it defies recognition, and we seem to have entered a different planet.*

* To have a proper conception of the vastness of such revolutions, we must not restrict ourselves to the consideration of their completeness, but also extend our views to the number of created beings which they comprise. Not only must every class of the animal kingdom be comprehended, but we have to remember that parallel changes have affected successive creations of the vegetable kingdom also. But, further, it is only fragments of past creations which have come down to us. The soft fleshy animals, destitute of

Such exchanges of species exclude all notions of unvarying succession; and altogether the proved mutability of the world is an admirable antidote to atheistical tendencies. Atheism,

solid parts, would decay with rapidity; the vast tribes of insects, and the delicate or shrubby plants, would rarely leave any memorial of their existence; the class of birds would seldom be preserved, although, by a strange peculiarity, we find the impressions of their footmarks in strata in which we have not hitherto detected their bones. If we may reason from the known to the unknown, we may find at least approximations which will give us some idea of the extent of these revolutions. Already the number of species of fossil shells, recorded by naturalists, exceeds that of existing species; in respect to the great terrestrial quadrupeds, the number of genera and species found in the tertiary strata is greater than that of living kinds, described in systematic works. As the deposition of strata, that is, the transportation of detritus to the sea and lakes, there to find a resting-place, involves the existence of islands, continents, and rivers, we have every reason to believe that forests and land animals also existed. In our present world, every well-defined region has its peculiar plants and animals, in fact, a little creation by itself. That a similar disposition existed in former times has not been disproved, and several facts lead to such an inference. The great quadrupeds of the Paris tertiary basin are distinct from those of the tertiary beds of India, and even in the secondary strata, and among the more widely-diffused sea mollusca, the chalk of Sussex and Kent yields a different set of fossils from what we find in the same formation on the banks of the Tagus. The number of plants at present living on the earth's surface may be estimated at about one hundred thousand, and that of

where it is not merely assumed to serve an end, is more a thing of impression than of argument, and results from the power which things seen wield over our feeble nature. What we

animals at double the amount. Assuming that the ancient epochs of the history of our globe were analogous, in as far as general laws are concerned, to our present world, we may now form some idea of the extent and richness of creative power which this retrospective history displays. Such inductions give us a magnificent idea of the successions of organised bodies during the immense series of ages which are included in our geological chronology, but they are by no means necessary to establish the fact of repeated creations. The simple inspection of any sufficiently complete and accurate list of the organic fossils found in the different formations, affords ample evidence for all purposes of inference and argument, always bearing in mind that the evidence is above all doubt, and that no future progress in our knowledge can assail it, any more than improvements in botany and zoology can ever change the great facts we know respecting the geographical distribution of our present species.

We are here presented with two orders of facts, both of them well ascertained, and both, in our present knowledge, difficult of solution. We have, in the first place, the extinction of multitudes of plants and animals, and that not once but repeatedly; and, in the second place, we have repeated creations of new races. With respect to the extinction of species, the case admits of partial explanation, although it is doubtful if we can fully solve all difficulties. We know that among other geological phenomena the interchange of land and water has repeatedly taken place;—if mountains are elevated in one place, islands and continents are sub-

habitually behold, and never find altered, becomes so stable in our apprehensions, that we begin to ascribe to it a necessary and self-explained existence. We feel as if there were an

merged in others; and such revolutions must necessarily be attended by the destruction of many species. As all such changes must be accompanied by corresponding changes in local climates, this effect may reach animals inhabiting regions remote from the site of actual change. Any shallowing of the sea between Carolina and the Bahamas, by deflecting the current of tepid water, called the gulf-stream, would render the west coast of Greenland an uninhabitable region of perpetual ice. Although such considerations will do much in accounting for the extinction of animals and plants, more especially of terrestrial ones, there is another order of facts which at present appear inexplicable. The climates of great part of Europe and Northern Asia, when inhabited by elephants, hippopotami, and the rhinoceros, were much colder than at present, and the extinction of these races appears to have been synchronous with an amelioration of temperature. But a far greater difficulty remains. These extinct animals had for their companions species which still subsist:—the remains of the musk-ox, the urus, and the red-deer are found in the same position as those of the elephant and rhinoceros; and we cannot tell how one kind of animals was extirpated, while another was permitted to survive. The same difficulty occurs in the tertiary shell-fish. Descending from the older to the newer periods, we find that the proportion of extinct species diminishes, while the per centage of existing species increases, till we arrive at deposits containing only the remains of living species.

When we examine the other fact, as to the appearance of

absurdity in supposing it not to be, or to be otherwise. What should the ocean do but lash its wonted shore, and stun the ear by its eternal roarings? Why should the river forsake its banks by

a new species, suggestions of a far different complexion arise. Do we know of any secondary causes or powers of nature whose co-operation could produce a single species—not to say an elephant or a tiger, but even an infusorial animalcule? We have elsewhere commented on the doctrine of the transmutation of species, and on the present occasion have only to speak of their origin. Here we have but two alternatives before us, either to admit the hypothesis of spontaneous generation, or a direct interference of creative power. With respect to equivocal generation in its full sense, and as held by Lucretius and Epicurus, we believe it is entertained by no naturalist of the present day; even La Marck, while maintaining that the simpler plants and animals originated in this way, repudiates its possibility in the case of higher organisations. The usual doctrine is to maintain the spontaneous production of the simpler organised bodies, and then deduce the higher, by a process of development and transmutation of species. As regards the evidences of spontaneous production, its advocates have not produced a single direct fact—nothing but negative and indirect reasoning has been brought forward. From the publications of Redi, in the seventeenth century, down to those of Ehrenberg, the domain of spontaneous generation has been gradually narrowed, so that the hypothesis, if by no means abandoned, has been rendered untenable. The chief arguments in favour of the idea were derived from the history of infusorial microscopic animalcules, and from the difficulty of explaining the dissemination of entozoa in the cavities and

which it has been sheltered and kept in its course from time immemorial? Where should the mountain stand but where parent, and child, and children's children, have beheld it through un-

solid organs of animals. Infusorial animalcules were held by La Marck to be animals of extreme simplicity; in short, mere globules of animated mucus formed from decaying matters. In confutation of this notion, we may quote the beautiful researches of Ehrenberg, who has shown that this supposed raw material of animals constitutes beings of a highly complicated structure, possessing a stomach, muscles, and, in some cases, even eyes, and hence far from being the simplest of animal structures. With respect to the parasitic worms occupying the bodies of animals, we have the decisive fact that they possess organs of reproduction and give rise to abundance of ova; so that whatever difficulty we may have in tracing their history, there is none in accounting for their origin, on the same principle as that of other animals.

Vital power is different from every other force which we perceive in nature, and has nothing in common with gravitation or chemical action. It is manifested in a certain class of beings, and is only transmitted by generation. We know of no power or combination of powers in nature which can produce a new kind of plant or animal. Mere vitality can no more give origin to a new species, than gravitation can create a planet. We must ascend beyond secondary causes, and must admit a direct interposition of divine power, wherever a new species has appeared upon our globe. The result is surprising, and is one to which no other research has conducted us; and thus geology opens a new chapter in the book of creation more wonderful than any we had previously studied. Special acts of providence, as

numbered generations? 'Since our fathers fell asleep, all things continue as they were,' and we are beguiled into the notion that so great constancy is tantamount to necessity.

But geology dissipates this illusion. It teaches us that though the face of the earth may seem to us unvarying, it is neither unchangeable nor unchanged. That which is necessarily is immutably. But the world has been the subject of vast mutations, and unless we ascribe creative energy to the elements, and so constitute them divinities, and in denying the existence of one God, fabricate to ourselves a whole system of Polytheism, we must acknowledge that these changes have had a producing and presiding

well as general laws, that is, the steady purposes of wisdom, are part of the plan on which the universe is governed. If we are thus assured, that in thousands of instances, during the vast period which has elapsed since the first creation of living beings on this earth, interpositions of divine power, out of the ordinary course of nature, have taken place, surely every *a priori* objection is removed to the probability of interpositions of the same power for moral ends, and for revealing to man what it was infinitely more important he should know, than merely biological results, his own real nature, his relation to the Creator of all things, and the means of securing the divine favour. S.

cause, and that races have been suppressed and replaced, and each order of being adapted to its proper situation and temperature by one who was before all things, and by whom all things consist—who killeth and maketh alive, and is so mighty in his acts, that none may stay his hand, or say unto him, What doest thou?

HUME'S ARGUMENT AGAINST MIRACLES.

The successive creations to which geology bears witness completely explode Hume's objection against miracles, that they are incredible, because opposed to experience. A new creation is not provided for by the laws of nature, in so far as we have observed their operation. If a negation is to be accounted opposition, the fact is opposed to all our personal experience, and even to all human experience. We have not here the experience of a single witness to plead as an exception. Yet the proof that new races have been created is ample and irrefragable; and we have thus a striking example how little *a priori* arguments against miracles avail when

opposed to substantial facts and reasonable inferences.*

* Hume maintained that in all the successions of phenomena which we observe, either in the world without us, or in our own minds, we are merely cognisant of antecedents and consequents, and have not, nor can obtain, any proper notion or belief of an active and efficient cause. He admitted no other idea of order in the course of nature than what experience suggests to us, and what, when often repeated, produces that notion of causality which consists of habit and expectation. In accordance with this hypothesis, he adroitly observes, that as the universe is a single effect, and thus the result of a single antecedent, we cannot from this solitary instance infer that it had a creator. A single pair of events, consisting of an antecedent and a consequent, can produce no belief, form no habit, and induce no expectation; thus a single creation will afford no idea of a creator.

Without entering upon the region of metaphysics, a geologist may be permitted to make some observations on the correctness of Hume's argument, that the world is a single effect, a solitary and unique phenomenon. If by the world we understand the universe, the aggregate of all created things, it is not necessary to quit our earth to ascertain that the world is not a singular effect. Though the universe, in all its vastness, be the work of a single creator, it also exhibits many limited creations, subordinate and distinct in themselves, but still under the same general conditions. If we look to our existing creations of plants and animals, we shall find that our earth is far from being a singular effect. On the contrary, we find a multiplicity of effects, displaying creative power and wisdom. The animal and vegetable productions of Australia and America are very peculiar, being confined to their respective regions, and found nowhere else. Let us suppose a Guarani Indian of Brazil,

THE DEVELOPMENT HYPOTHESIS.

Much speculation has been created of late by what is called the development hypothesis. As put forth by the author of the 'Vestiges of Creation,' it finds the original of all things in fire mist.

and a native of New Holland, to have elaborated, in the solitudes of their respective forests, the Humean doctrine of causation, and inferred, from their respective fields of observation, that the creation was a solitary and singular effect. If our two sceptics were to change countries, they would be introduced to scenes where not a plant or an animal would be known to them. The idea of the world being a singular effect would give place to a very different conclusion. Such is the effect which the contemplation of the various provinces of the vegetable and animal kingdoms would produce. We see in Australia animals organised in a peculiar manner, different from those of all other countries—we find not singularity, but diversity—we find distinct realms of creation.

The case becomes infinitely more striking when, from the living provinces of creation, we turn to the periods of the extinct races. Here, in as far as the vegetable and animal kingdoms are concerned, we cannot with any propriety of language call the organic world a singular effect. When contemplating the fossil species, we can look back to a period when they were not—a long cycle of ages, during which they lived and multiplied—and ultimately an epoch when, having fulfilled their allotted part, they ceased to exist. It is also to be remembered, that from the first ascertained appearance of living beings on our earth, down to the present creation, this wonderful revolution has happened repeatedly. S.

The igneous particles were diffused with extreme rarity throughout space, but they had in them the principles and powers of matured and replenished worlds. First of all, they rolled together to make suns; the masses of these suns, in the course of contraction and condensation, threw off zones, which turned into globular bodies and became planets. As improvement proceeded, inorganic matter, imbued with electrical and other properties, produced organisation; then simple structures developed more complex and refined structures, and so progress went on to perfection, till eventually the brute developed the man. The constituents of this theory, which ascribe a nebular origin to the stellar universe, were the conjectures of great men, though they have lost all their plausibility in consequence of the discoveries made by Lord Rosse's telescope. But the dream of development which has been allied with them has been honoured with far more refutation and notoriety than it deserves. At present I will offer a few observations on the doctrine of development as applied to species. It maintains that in the course of ages new species may have been produced, according to a natural law, as well as

new individuals ; the transmutations, it is alleged, may have been nicely graduated, and each new species may have differed little from the prior species by which it was developed. It is not permitted us to charge the hypothesis with atheism, because it allows that there may be a God, and contends that he may originally have impressed life with plasticity and adaptability, so that it may take to itself new forms and characters in suitableness to varying conditions and circumstances.

At the same time, there is nothing to be gained by supposing these metamorphoses of species to have happened, unless to invalidate the scriptural history of our race, confound the origin of rational and irrational beings, shed uncertainty and perplexity over their destination, and throw back divine intervention so far into the past, that, to our weak conceptions, it is virtually annulled in becoming so antiquated.

The hypothesis is besides liable to positive and insuperable objections, of which the following may be stated :—

1. The fossils contained in the different strata do not show a graduated progress from more

rudimentary to more perfect structures. That there has been no such progression is very decisively shown by Mr. Hugh Miller in his 'Footprints of the Creator.' Others have incontrovertibly established the same position. Professor Phillips, as quoted in the 8th number of the North British Review, says:—'The bivalve mollusca of the oldest Snowdonian rocks* were certainly as complicated, nay, more highly organised, than the greater number of conchifera of the present ocean, since they belong to the brachiopoda. The crustacea of the Silurian system were at least as curiously organised as the limuli of the North American coasts. The goniatites of the mountain limestone, are far more curiously constructed than the nautili, which lie with them, and also inhabit western oceans. The belemnites and ammonites, turrilites, and other extinct genera of the oolite and chalk, reveal to us an extinct order of cephalopoda larger, more powerful, and more curiously organised, than existing loligines and sepiæ. It is evident, therefore, that *the whole notion of a gradual amelioration or enrichment of the animal organisation may be dismissed as a mere*

* The lowest fossiliferous rocks.

illusion of the fancy of a finite being, who vainly transfers to the work of the Almighty the pattern of his own limited labours.'

2. There are constituents in the structure of animals which exclude the possibility of transition upwards or downwards—which do not allow of the supposition that they produced other forms, or were produced from them. The great Cuvier, in a passage quoted by the able North British Reviewer, says :—'No deviation in the ordinary form of this animal (the cuttle-fish) has ever produced or can constitute a being placed beneath it; nor can, or ever will, its better development give rise to a series of animals of a more perfect species to be classed immediately above it.' The letter of a friend (Dr. Scouler) supplies me with the following illustration :—'In some cases it is difficult to imagine the possibility of transitions, even when the species are so closely allied that their distinctions can with difficulty be expressed either by words or the pencil. In such instances, where structures are closely allied, the dispositions and instincts may diverge widely, and oppose a barrier to all transmutations. This is observed in thousands of

cases in the insect tribes; but I shall quote a more familiar example. The hare lives above ground, sheltering among brakes and bushes. The young of this timid animal are enabled to run after the dam immediately after birth. On the other hand, the rabbit excavates a subterranean abode, where it brings forth its young, which are at first blind and helpless, and there nurses them until they have strength. The young rabbit becomes an individual of a social establishment, while the solitary hare seeks protection for itself alone; and between these alternatives there is no medium.'

3. The nature of the changes supposed does not admit that they should in general be diminutive. An example will best illustrate and establish this observation. A hand or foot must be one or other of these organs distinctively; in other words, it must be adapted for clasping or walking. To change the one of these into the other would necessarily be a great metamorphosis, and there is no conceivable way of subdividing it into degrees. Besides, a single alteration of corporeal structure may change the general conditions of life, and render the re-

casting of a whole animal indispensable to its preservation. This is the well-known law of the correlation of organs. Remove the proboscis of an elephant, and how many other alterations become necessary before the creature can satisfy its hunger and thirst?*

4. The objectionableness of the hypothesis is not of a kind to be diminished in being graduated. Laws of nature do not thin out like a stratum of limited extension; and the laws of life are just as truly natural laws as any others which are so called. The invariability of species is ascertained by evidence equally distinct and decisive as the property of gravitation. Show us that two stones do not gravitate towards

* Let us investigate the structure of the elephant. We find in most birds and quadrupeds that the length of the head and neck together is equal to that of the fore legs, and the reason for this is so obvious as scarcely to require being specified. In the elephant this is not the case; the fore limbs are much longer than the head and neck, and consequently the animal could not reach the ground to take up its food. There is still another difficulty in this instance: the long tusks of the elephant, even if the neck were of the requisite length, would effectually hinder him from laying hold of anything by his tongue or lips. Until, therefore, the proboscis grew and became developed the elephant must in the meanwhile have starved. S.

each other, and we shall believe that there may be mountains or planets which have no mutual attraction. Show us that one new species has been developed from other species, and we shall then believe that any animal may pass into any other animal; or that inanimate things may become vital, and the rocks of a sea-coast may produce, as the conditions shall require, whales or elephants. But while each law is attested by innumerable proofs, and all the evidence is confirmatory, without exception, we must believe both in the property of gravitation, and in the permanency of species, and instead of vainly trying to explain the phenomena of either, by the agency of the other, allow to each its proper and independent operation. To no purpose is it answered that some races confessedly undergo modifications in new positions; for these modifications have narrow limits which they never exceed, and cannot be made to exceed; and circumstantial variations so bounded, disprove instead of establishing the indefinite ductility and transmutability of species. 'The question still is unresolved, what the origin, or whence the existence of our present races? Not

by spontaneous generation, we are taught by natural science, in one of its most authoritative lessons. Not as we know from another of its lessons, by the transmutation of old species into new ones. Not by any combination that we have ever observed of all the known powers and principles in creation—and thus are we enabled to refer those things in nature which of all others have most exquisite and manifold collocations—the most certainly to a definite origin, the most nearly to the finger of a Creator.'*

5. The hypothesis, under all its aspects, is rendered incredible and absurd by the recent creation of man. Here the notion of gradation utterly fails. Between other races and the human race we see no approximation, but the widest and most unrelieved interval presented to us in nature. It is impossible to make out any sliding scale by which the interval might have been filled up with intermediate beings; and the monuments of former life unite with the present inhabitants of the earth in demonstrating that there neither are nor have been any such connecting orders. The ape has some external

* Chalmers' Nat. Theol., b. ii., ch. 3.

similitude to man, but a little scrutiny elicits numerous and impassable contrasts.*

* Most people are so struck with the general resemblance of the external features between man and the Ourang-outang, that they become prepossessed with the notion, that the differences are few and unimportant, compared with the numerous characters they possess in common. Nothing, however, can be more mistaken than such an opinion, which at once vanishes before a detailed comparison of the corresponding organs of man and the ape. An examination of the structure of the foot alone will afford an illustration of discrepancies, such as we find pervading almost every other organ. In man the foot, framed for sustaining the whole weight of the body, is placed at right angles to the leg, and forms an arch, supported by the heel-bone, and the broad expansion formed by the scarcely flexible toes. The motion of the foot at the ankle is limited, being merely a hinge motion, and not at all rotary. On the contrary, the foot of the ourang-outang has the fingers long and flexible, and the great toe changed into a thumb; or, in other words, the foot is, in structure and function, a hand for grasping, and not a foot for biped progression. In accordance with this, the ankle-joint admits of great liberty of motion, admirably fitted for a prehensile organ, but forming a most imperfect foot. Hence the hinder extremity of man and the ape are the contradictories of each other. So much is this the case, and so incapable are the ape tribe of anything like easy walking when erect upon their hind feet, or rather hands, that the position is very painful to them. If we look at an ape making the attempt, we see that his long flexible fingers are an inconvenience; his thumb, or great toe, is of no service, and is laid across the foot; and the animal, instead of resting, as man does, on the sole of the foot, only rests on the outer edge of a half-closed hand; and, further, the great

There is this consideration, too, which should not be overlooked, that the question is not

freedom of motion of this foot-hand gives the animal an unsteady and tottering gait, and renders walking on two feet most insecure. In short, the hinder limb of the ape is not made for walking, but for climbing trees; and it is, therefore, as opposite in function and arrangement of parts as can well be imagined. It is also to be remembered that a foot-hand is eminently a brutal conformation. It is possessed not merely by the monkeys, but by many climbing animals very low in the scale, such as some of the squirrel tribe and opossums. If the foot of the ape is, so to speak, the contradictory of the human, the anterior extremity is equally so. No animal has a hand comparable to that of man, which, useless for progression, is such a perfect instrument for prehension that we use the term manipulation as equivalent to the highest degree of dexterity. On the contrary, the anterior extremity of the ape has a very mutilated thumb; and the American monkeys of the genus Ateles, are so called from the circumstance that the thumb is altogether absent; so in man and in apes the anterior extremity stands in the relation not of resemblance, but of contrast. To follow out this view would be to institute almost as many comparisons as there are organs in the ape and in man, and we shall only quote another. In all other animals, the skull is joined to the first of the vertebræ of the neck in such a manner as fits the animal for quadruped motion; and the ourang-outang is no exception to this law. On the other hand, in man the skull is poised upon the top of the erect vertebral column, so that the additional weight in front, caused by the jaws and organs of sense, is compensated for by a slight effort of the muscles of the back of the neck—and hence the head is erect, and the face directed to the sky; and in this respect, also, there is no resemblance between man and the ape. We must remember

simply one of new *forms*, as the hypothesis is usually expressed, but of new powers; and not simply of physical qualities, but of mental endowments. Suppose that the body of a lion took to itself the human figure. For legs we have now arms—for claws we have now fingers—in all respects, we may have a perfect human body; but man is not body alone. When we have got the material tenement, we have still to account for the spirit which is in man, and we still need the inspiration of the Almighty to give him understanding. Legs have passed into arms, claws into fingers, but what has passed into a sense of the humorous? What into a perception of beauty and sublimity? What into that power of reflection, by which thought, after nobly scal-

that, strong as the contrast appears between the different organs of man and the ape, taken individually, the contrast appears still stronger when we remember that these differences are correlated, and that the one involves the other. In man, the articulation of the head to the spine, the breadth of the chest, the strong muscles of the loins, the calf of the leg, and the arched foot, are all so many conditions of erect attitude and walking. These truths are so obvious, that they have been adopted by modern zoologists, when in their systems they consider man not only a distinct species from the ourang, but place him also in a distinct genus; and what is more, this genus is placed alone, and by itself, in the bimanous order. S.

ing the heavens, turns yet more nobly inwards on itself? Above all, what has been metamorphosed into conscience—into that faculty which tells us of right and wrong—of a law and a judge—and which fills us with hopes and fears of rewards and punishments? The hypothesis in question becomes more and more inconceivable the farther we pursue it into its details. It has been already shown that the transformation imagined has not been and could not be gradually accomplished; and the idea of its sudden accomplishment is not less evidently preposterous. Suppose an ape to produce a child, the child would die in the charge of such parentage. Dr. Thomas Reid, the metaphysician, has observed:—'He must, in my apprehension, have a very strange complexion of understanding, who can survey the various ways in which the young of the various species are reared, without wonder, without the pious admiration of that manifold Wisdom, which hath so skilfully fitted means to ends in such an infinite variety of ways. . . . How common is it to see a young woman, in the gayest period of life, who has spent her days in mirth, and her nights in profound sleep, without

solicitude or care, all at once transformed into the careful, the solicitous, the watchful nurse of her dear infant: doing nothing by day but gazing upon it, and serving it in the meanest offices; by night, depriving herself of sound sleep for months, that it may lie safe in her arms! Forgetful of herself, her whole care is centred in this little object.'*

Would an ape make an equally safe or tender guardian for the babe? We are told that Oliver Cromwell, in his infancy, had a trial of this nursing. A huge monkey got hold of him, it is said, and carried him to the roof of the house, and to the horror of the spectators who looked for his speedy fall and destruction, there fondled and dandled him very composedly. This remarkable adventure has been generally classed with the perils of Cromwell's early days, and the common understanding is, that if the experiment had been carried a little farther, he would have occupied less space in the history of England. The ape, then, instead of producing an infant, must have sprung into a full-grown man. But a man alone would have no progeny; so another

* 'On the Mind,' essay iii., chap. iv.

ape or it may be a goat, according to the 'conditions,' must have very opportunely 'developed' into a full-grown woman! And on these conclusions we are thrown by pretenders to philosophy, who reject revelation; and who ill conceal their contempt for the credulity which assents to its evidence!

The foregoing observations show how little the author of the 'Vestiges of Creation' would gain, even if he could prove, as he certainly cannot, that there has been a regular progress towards perfection of organic structure, and that the more perfect organism is always the more recent. The question of progress is evidently distinguishable from that of production. As man is the last, he is confessedly the greatest work of God. But we have seen that man cannot have been produced either gradually or suddenly by other species which preceded him. He at least must have had a different, and, as regards prior tribes, independent origin. This is a demonstrable fact; and by this one fact the necessity of divine intervention is fully established, and the adequacy of the development hypothesis to account for the phenomena is utterly exploded.

II. GEOLOGY IN RELATION TO THE INORGANIC WORLD.

The remarks which I am now about to offer will have respect mainly to the inorganic world, and any reference I make to plants and animals will be of an incidental and cursory description.

The earth is not a wild, abandoned to neglect, or controlled by casualties, but is governed on a system, in which the several agents fulfil each some important function, and co-operate in sustaining a collective harmony. In other words, we occupy an abode which can be the work only of a mighty—of a divine Architect; and which teaches us, emphatically, his attributes and our obligations. Let us first notice certain balancing agencies, and then remark on particular substances of much practical interest.

I.—IGNEOUS AND AQUEOUS AGENCIES.

In viewing the globe comprehensively, we are specially struck by the vast effects of Water and of Fire. These seem to be rival or conflicting powers, and yet, with all their apparent

antagonism, they are, in reality, accordant and co-operative, affording a remarkable exemplification of Dr. Chalmers' general statement, that 'forces of a right intensity and direction have been made to meet together, so as to be productive of a desirable result.'* They invite our attention to their individual and reciprocal action.

WATER.

To begin with the first-named: One of the mightiest agents in nature is WATER. It was required in great abundance, and most amply has it been provided. Never is human littleness more evinced, than when we contrast the goodliest canals and reservoirs of enterprising man, with the waters of the great deep—simultaneously lashing so many shores, and encompassing so many kingdoms, and, we may say, the globe itself, in its awful universality. More than two-thirds of the surface of the earth are covered by the ocean, and the extent of dry land is farther limited by rivers, lakes, ponds, and marshes.

The objection may be started, that there is

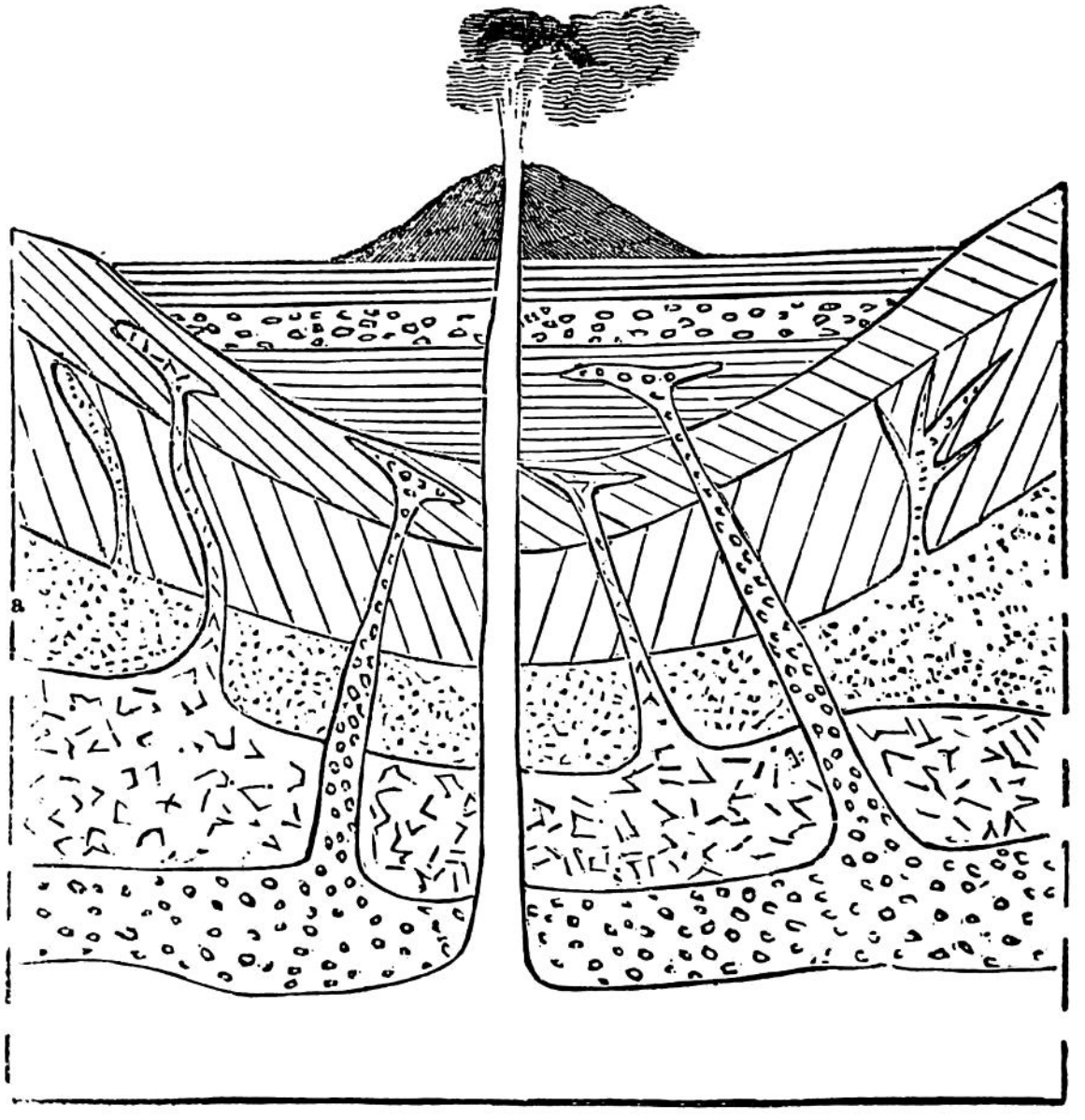
* Nat. Theol., b. i., ch. 3.

too much sea. But an acquaintance with facts, and a just consideration of their bearings, teaches us the reverse. We need not complain that the sea circumscribes our domains, as if we wanted room, when vast regions, quite open to us, are thinly peopled, and there remains so very much land to be possessed. The sea yields those exhalations which pass into dew and rain, and irrigate the earth ; and if the effect be not excessive, we should not ascribe superabundance to the cause. That moisture is not to be considered superfluous which, flowing off from the fields, and descending into fissures, ravines, and valleys, becomes springs and rivers, impels machinery and introduces shipping, and after adorning many a landscape, and serving countless valuable purposes, mingles anew with the waters of the ocean. It is a wonderful system on which we are thus remarking. The blood of animals flows in containing vessels ; so does the water, made artificially to supply towns ; but elevated by no forcing pump, the vapour rises from the sea, and, conducted by no tubes, it performs its vast and beneficent circuit with infallible regularity. The sanguineous circulation

lasts only for a few years; this aqueous circulation is maintained without decay through innumerable ages.

Nor is the sea a blank to vitality—it is not all dead sea. It is not the Typhon of the Egyptians—a name which denoted with them the personation of evil, and which they applied censoriously to the sea, as being in their apprehension ποντος ατρυγετος, a barren sea, unproductive of vitality.* Even the salt of the sea was an abomination to the Egyptians; and hence, perhaps, to 'sow with salt' became a symbol of devastation in the imagery of Eastern writers. The sea is full of life, active life, varied life. Who may enumerate all its plants and animals and animalcules, and tell how its sands and rocks, and shallows and profounds, are adapted respectively to their different populations? So largely are the vegetable and animal kingdoms represented in the sea, as to give confirmation to a saying of the ancients, that 'whatever exists elsewhere is found in the sea, and that the sea contains things found nowhere else.' Nor is it a negation to human comfort. It

* See Analysis of Egyptian Mythology, by J. C. Prichard, M. D., p. 79. London, 1819.



The Source of the Volcano.

The extinct Volcano of Auvergne in France.

supplies man with food. The finny tribes he has neither fed nor tended. He has provided for them no sustenance, no shelter, no guardian care. And yet, in the absence of all his attentions and culture, they are supplied to him in such abundance as to raise the question, whether, by all his fisheries, they are sensibly diminished. In sustaining his ships, the sea becomes a medium of communication for him between the ends of the earth. And let it be remembered, that these vessels are human abodes, and that thousands of our race, or hundreds of thousands, dwell mostly on the main. In every way, then, the ocean is included in the habitable globe.

FIRE.

Let us now advert to the other agent, FIRE. The ocean, in lashing shores, tends to wash them away; and if this power alone operated, islands and continents would gradually disappear. The sea, wearing down everything into its channel, would become less deep, and more extended, till all would be surrounded by its ascendant billows. To counteract this destruc-

tion there must be a compensating reproduction: and the reproducing agent is Fire. To a certain extent, the sea itself compensates for its destructiveness, by covering its bed with new strata, which may afterwards be elevated. But although this agency would diminish the depth of the ocean, it would never cause 'the waters under the heaven to be gathered together into one place, and let the dry land appear.' The power of upheaval lies in heat. The bulk of substances is greatly affected by their temperature. In general they expand when they are warmed, and contract when they are cooled. In this way the elevation and subsidence of land may be accounted for by the increase or reduction of igneous agency. Subterranean heat coming into contact with solid rocks, may not only enlarge their volume, but may turn them into a liquid or gaseous state. The liquids or gases thus formed have prodigious elastic energy, and may lift up strata of whatever strength and thickness. The upward pressure may be of wide extent; and throughout that range of action the conditions may be so nearly equal, that large tracts of land may be simultaneously and almost

uniformly elevated. It has been abundantly proved that parts of Sweden and other countries are exemplifying such elevation at the present time. Or the pressure from beneath may act on a limited portion of the overlying strata; but even in that case the sides of the mountain rise with its uplifted summit, and the whole of a country may be only the lower and gentler declivity of the mountain ridge. Thus the internal heat of the globe, though residing in profound and inscrutable mansions, is palpable in its effects. When straitened for space, it forces the crust of the earth to yield to its expansiveness, and the result is seen in all that rises above the level of the sea. Nor is this all. The equipoise established at first is constantly preserved, so far at least as is conducive to benevolent designs. The sea is ever demolishing what it assails, and mass after mass yields to its denudations. This constant waste a volcanic agency as constantly repairs—ever deepening the channel of the ocean, and thus restricting its prevalence, or elevating the ocean's bed, and thus raising up what it strives to wash down. In either of which ways a divine Governor still breaks up for the deep

his decreed place, and sets bars and doors, and says, ' Hitherto shalt thou come, but no further, and here shall thy proud waves be stayed.'

What a magnificent equilibrium is presented in these conceptions! the tide of the ocean is uncontrollable by us; nor is the insignificance of man ever more apparent than when he loses sight of land for weeks and months together, in crossing the aqueous expanse, especially when a tempest overtakes him, and his frail bark drifts and leaks, and seems to be perishing in its diminutiveness and helplessness.

'Now shivering o'er the topmost wave she rides,
While deep beneath the enormous gulph divides;
Now launching headlong down the horrid vale,
She hears no more the roaring of the gale,
Till up the dreadful height again she flies,
Trembling beneath the current of the skies.

FALCON. SHIPW., Cant. 3.

The agitation of the sea is equalled in its majesty and terrors only by the rockings of the earth, when hidden fires dissolve restraining barriers, and burst from their imprisonment. Who can be composed when the earth is moved, and its foundations are out of course? Who may stand by the crater, or think to close its

lips when it vents its fury—when it breathes flame and mutters thunder? Each of these awful powers, the aqueous and the igneous, seems to be in itself illimitable. But there is a God who can make even such agencies become bounds to one another; who can poise them in salutary proportion and counteraction, and reduce all their frightful mastery to a mutual helpfulness, by that power which weighs the mountains in scales, and the hills in a balance; which stretches out the north over the empty place, and hangeth the earth upon nothing.

II.—CONSOLIDATION AND DISINTEGRATION.

We present another example of compensating processes: The dry land is partly in a soft, earthy state, yielding easily to pressure, and partly hard and stony, resisting the separation of its particles. Both these conditions of it are manifestly required and serviceable. If the matter of the globe were all reduced to powder, there could be no arts—no architecture. A stately edifice could not be built of mud. If, on the other hand, the entire mass of the globe were solidified

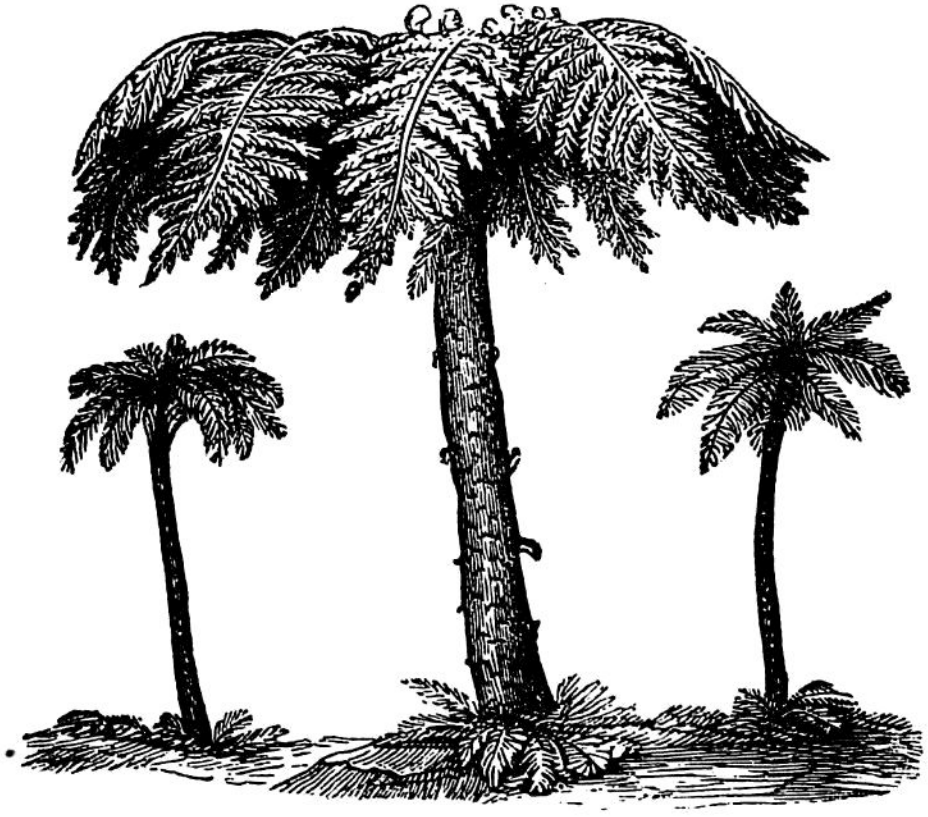
and obdurately cohesive, there could be no vegetation. A tender plant could not strike its roots into marble or flint. Here, then, are changes which need to be effected, each in its peculiar manner, and which require, at the same time, to be duly proportioned and preserved from excess. Let us look at the processes separately, and in their mutual relation. On the one hand, loose sand or mud is converted into firm and steady rock; and whether this be effected by heat, or compression, or cement, the process is one of law; and if other laws that work well and gain their end bring honour to the lawgiver, why should God only be denied this honouring acknowledgment? But, on the other hand, there must, we have seen, be a neutralising process. That the material of this globe may not be unduly consolidated, there must be a disintegrating agency engaged. Where there is no hammer and no human hands to wield it, there must be other influences at work to break the rock in pieces. Not only must it be pulverised; it must be coated over with soil, and colonised, if I may so express myself, by vegetable and animal races, corresponding with its position, seasons, and

temperature. See how all this is effected. The bed of the ocean rises. The hidden cavern becomes an elevated promontory. Where waves pursued their objectless course undisturbed, their progress is now arrested by an upheaved mass, it may be of mica-schist, or trap-rock, or limestone. The billows throw themselves on the obstruction, dash themselves into breakers, and strew the beach with foam, as if furious at the interruption to their long-established ascendancy; while the emerged rock is dark and gloomy, as if it still frowned on the ocean which had so long *obscured its greatness and contemned its dignity.* Now that this mineral mass has escaped from the waters, and exposed itself to the day, what purpose does it serve—can it serve, in the material creation? On all its rugged surface there is no mould; perhaps not so much sand that the finger might write in it the word Hope. But let that rude and naked crag be revisited after centuries have elapsed, and what appears now? An Elysian field—an island for the blessed. The pastures are clothed with flocks. The valleys also are covered over with corn, they shout for joy, they also sing.

Cyclas Revoluta.

Who has done this? Man? No. The abode has been prepared for him, but not by him. From the moment that the rock emerged from the ocean, a varied instrumentality was applied to bring it into culture. The oxygen of the air, in allying itself with certain mineral ingredients, detached them from others, and broke up the wall of adamant. The fowls of the air were efficient husbandmen in carrying seed and manuring the soil; and even the earth-worm, which we seldom mention but in scorn, performed its unacknowledged service in detaching loose particles from underlying stones, and bringing them to the surface, where their presence was available. Was each of these agencies accidental? Above all, was their harmonious co-operation a thing of chance? A glorious divinity must this chance be, and strong must be the faith of him who credits its marvels! Such a believer has little pretext for ridiculing credulity. They may seek consolation, who think they can find it in such marvellous peradventures; among the trees of that garden I will rather recognise the voice of God, I will hear it in the rustling of the leaves, and the warbling of the birds; and knowing that

FOSSIL REMAINS.



The Ancient Tree Ferns.

the sin of the first Adam has been expiated by the sacrifice of the second Adam, I will not shun but welcome the divine presence, and reckon the charms of nature infinitely more charming, when I can say in the language of the pious Cowper, 'My Father made them all.'*

After these examples of balancing agencies, I invite attention to particular substances of great importance; of these I will instance Coal, Lime, and Metals.

I. COAL.

The history of Coal is a subject of great interest. We all know its value for economical purposes,

* Another very beautiful example of compensation is derived from the relations of the animal and vegetable kingdoms to the atmosphere. The result of all changes of composition in animal bodies, is to deteriorate the atmosphere, and to render it unfit for supporting the life of sentient beings. Animals, by respiration, are continually throwing carbonic acid into the atmosphere, and indeed the final decomposition of the body after death, tends still further to load the air with unhealthy azotised matters. The purity of air, however, is maintained by the counteracting influence of the vegetable kingdom. Plants eagerly absorb the azotised matters, as ammoniæ, which afford them nourishment, and, above all, they decompose the carbonic acid, assimulating the carbon to their organs, and restoring the pure oxygen to the atmosphere again, fitted for the respiration of animals.—S.

and we can scarcely fail to recognise intention in its utility. But consider at what periods, and in what manner fuel was thus prepared for us. The vegetable origin of coal is now universally admitted; but vegetables might have been so constituted, that after living their day, they should have been resolved into their elements and utterly dissipated. Generally speaking, they do pass into a state of decomposition, serviceable to manure and soil, but not to ignition. We needed however to have combustible material for our fires and furnaces, and marvellous indeed is the manner in which it has been prepared and preserved for us. Amid the strata of the earth we find seams of coal of such number and dimensions, that with all the immense waste of it now daily in progress, there is no fear of its being exhausted for centuries to come. And how came it there? It forms the remains of plants of which no species are now living. We can easily suppose that the steps have been very different by which it has passed from its verdant to its present mineral condition. In some instances, descending streams which flow no more carried down the drift wood which was gradually

accumulated in lakes or estuaries. In other cases large forests must have been submerged where they grew. Accumulating vegetable matter for many a year and many an age, they enjoyed profound and secure solitude; animals, of which we may have no traces, lodged among their branches and foliage, and exemplified the habits characteristic of their different natures, through many successive generations. The sea slumbered afar off; its broad expanse was probably far out of sight, and the noise of its breakers still farther out of hearing. At length terrestrial revolutions supervened, and disturbed the quiet; agitated by volcanic heavings, the earth rose and sunk; the ocean displaced by the elevation of its channel, invaded the dry land, till the goodly trees were covered like sea-weed by its overflowing waters, and were ultimately bent, and crushed, and buried, by accumulating sediment. Or a powerful and violent torrent swept the forest from its place, uplifted it root and branch, and hurried it along with its own tumultuous swellings, till on the far off sea it became heavy with imbibed water, and sunk to be embedded in the fathomless abysses. On any

of these suppositions, how utterly lost would have appeared to us the deluged arborescence! But a hand not seen fashioned its repository —stored it up there in impregnable keeping— subjected it to influences all operative for good. And now in these last days the deep and the earth deliver up their trust; and we enjoy the numberless benefits of well-fed fires, often little considering whence their aliment has been derived.*

* Although no fact in geology is better established than the vegetable origin of coal, a complete theory, including an explanation of all the phenomena, is still a desideratum. This arises in part from the circumstance that coal-fields exhibit considerable diversity in the nature of their contents, and the mode in which they are arranged. Some may be accumulations of plants transported by rivers, and ultimately deposited under water, either fresh or marine; or the perfect preservation of the delicate parts of ferns may exclude the idea of transportation, and lead to the belief that the beds of mineral fuel were slowly accumulated on the spot, from the long-continued influence of vegetation. But we must remember that the accumulation of vegetable matter on dry land, or in shallow water, is scarcely possible but in cold or temperate climates: in the tropics, the process of putrefaction, and the voracity of myriads of insects, will cause the trunk of the stateliest tree to disappear almost as rapidly as the carcase of an elephant.

It does not appear necessary to account for the materials of the coal-beds, by imagining that the atmosphere formerly contained a greater proportion of carbonic acid than it does

II. LIME.

The next substance I have mentioned as being of like importance with coal, is LIME. Besides many lesser utilities, it is of high importance for the improvement of land, and may be pronounced indispensable to the beauty and stability of our houses. Though found in mountain masses it has been ascertained to result principally, if not exclusively, from comminuted shells and other parts of animal structure. The shell-fish is empowered by its constitution to secrete calcareous matter from the waters, lacustrine or marine, in which it lives, and therewith to fashion for itself its protecting envelope. After serving its purposes to its aquatic occupant, this covering might have returned to its for-

at present. On the contrary, besides the many difficulties attending the supposition, Liebig has shown that it is unnecessary, inasmuch as there is at present more carbon in our atmosphere, in combination with oxygen, than exists in all the coal-fields of the world. We thus see that our fuel once existed in a gaseous state, and that it had its origin in the atmosphere, whence it was separated by the influence of vegetation, and ultimately submerged and preserved under depositions of stratified matter. S.

mer condition; and in many cases it does come to be dissolved and held in solution by the floods from which it had been abstracted.* There are enough, however, of these exuviæ preserved for economical necessities. The cast-off shells accumulate; by the action of the elements they are kneaded into limestone, and in the

* Much of our limestone was once dissolved in the waters, and subsequently separated by numerous aquatic animals, and converted into the solid supporting or protecting parts of their frame. In this respect there is a close analogy between the formation of carbonaceous and calcareous substances. They exist in solution in the air or water, and their accumulation in stratified masses is not, as is the case with other strata, merely an inorganic process, but vital action is as essential to the result as gravitation, chemistry, or the transporting power of water. It is, in this point of view, interesting to trace the history of a piece of crystalline limestone. In the vicinity, it may be, of some trap or granite vein, we find a bit of marble, containing, it may be, crystals of granite, and we find that this marble is a continuous portion of a stratum which, in other places, abounds in shells and corals. With these data, we may look back to a period when the calcareous matter which existed in the ocean was afterwards separated by shell-fish and zoophytes, and converted into shells and corals. After this accumulation of calcareous matter was formed, it was acted on by heat from some igneous rocks; the mechanical aggregation of the calcareous particles disappeared, the organic forms became obliterated, and now we find a mass of crystalline limestone, containing simple minerals instead of extinct shells. S.

course of ages, by a changed distribution of sea and land, the quarry supplies what the watery cavern received. Between the means and the end, what intervention of time! what complexity of operation! what revolutions of the globe! Who, looking on the mollusc as it extracted its testaceous secretion from the waters of the deep, could have recognised there the preparatory stages of human architecture? But why should we marvel at the connexion when all is of God, and known unto him are all his works, from the creation of the world? I notice finally,

III. METALS.

Analogous observations are applicable to them. It needs not be to be told that the metals are the foundation of the arts, and that the arts are identified with civilised life. And where do we find commodities so precious? They are found in mineral veins filling up fissures of rocks. These rocks are of all sorts—igneous and aqueous—more ancient and less ancient. The metals themselves are met with in great varieties of condition, now one only in a chink, now

several, now each by itself, now mingled together; here diffused through stone, there constituting an ore, and in a third instance, forming detached lumps. Great difficulty has been experienced in accounting for the phenomena of these veins, as neither fire nor water, the two great agents in nature, possesses powers equal to the results.* 'That many veins (says Dr. Macculloch) have a double origin is only one of the numerous difficulties that beset this subject.'† Of late it has been shown in a very decisive manner

* The origin of metalliferous veins is perhaps the obscurest subject of geological investigation. We do not know in what manner, nor by what agency, fissures and cavities in rocks have been filled up by mineral substances. Besides admiring the great variety of chemical compounds, and rich display of geometrical forms and groups of simple minerals, we have to acknowledge that a still more difficult inquiry remains behind. The proportions of gold, tellurium, and many other metals, is infinitely minute when compared with the earth's crust; and the tendency of the geological changes, since the deposition of the primary strata, must have been to disseminate such metallic substances so completely as to render them imperceptible even to the tests of the chemist. So far, however, is this from being the case, that by some not understood means, these rare metals, so sparingly supplied, are found aggregated in certain localities where they may be detected by commercial enterprise or scientific curiosity. S.

† Geology, vol. i., ch. xix.

by Becquerel, that electrical action can produce such effects. The experiments of Fox indicate the same truth. Without entering into the controversies which have been agitated on the subject, or attempting to clear up its remaining mysteries, these facts, I may state on the authority of eminent geologists, as now well established: *First*, the rocks had originally no such veins. *Second*, the cavities in which the metals collect were caused by disturbance and dislocation; and here we have another of the many benefits attending on those convulsions of nature, which appear so formidable. *Third*, the metals were separated from the general mass of the rocks, and deposited in the chinks provided for them, by very slow and imperfectly understood processes. What a laboratory then was here! what multiplicity and immensity of chemical operations! To outward view, the mountain would have seemed a slumbering and inert heap of matter, when all of it was passing from its pinnacles to its foundations, from its surface to its centre, through busy transformations. The infiltrated water was permeating every pore; so were the gases which that water absorbed,

while the electric stream, flowing with ceaseless constancy and resistless power, impressed its influence upon all; and thus were the metallic particles disengaged from their earthy alliances, and conducted through their narrow and secret passages, to their appointed store-chamber. And now, when enlightened industry lays that chamber open to the light, the miner has little to do but gather up the metallic treasures prepared to his hand!

If benevolent design appears in the formation of coal, and lime, and the metals individually, the illustration becomes cumulative when we view them in conjunction. Coal was prepared in one way: limestone in another: metals in a mode different from both. But after pursuing paths most unconnected and dissimilar, they meet in serving man. They are often found in the same neighbourhood, and there the furnace of coal is to be seen smelting the ferruginous shale that lined it, while the lime acts as a flux in reducing the iron ore to a metallic condition.

THE PROOF IS INFINITE.

I am greatly tempted to multiply examples and illustrations, for every department of creation would furnish them. 'Ask now the beasts, and they shall teach thee; and the fowls of the air, and they shall tell thee. Or speak to the earth, and it shall teach thee; and the fishes of the sea shall declare unto thee. Who knoweth not in all these that the hand of the Lord hath wrought this? With him is wisdom and strength, he hath counsel and understanding.'

Dr. Chalmers has said, with his usual eloquence, 'For doing aught like adequate justice to the theme, we should go piece-meal over the face of this vast and voluminous creation; and show how in the exquisite textures of every leaf and every hair, and every membrane, Nature throughout all her recesses was instinct with contrivance, and in the minute as well as the magnificent announced herself the workmanship of a master's hand; and this sets forth the significancy of that scriptural expression, "the manifold wisdom of God." It is to us interminable. When told that we might expatiate for

weeks together on the habitudes and economy of a single insect, we may guess how arduous the enterprise would be, to traverse the whole length and breadth of a land, so profusely overspread and so densely peopled with the tokens of a planning and presiding Deity. It would be to trace the footsteps of a Being, who, while he wields with giant strength the orbs of immensity, pencils every flower upon earth and hangs a thousand dew-drops around it—at one time walking in greatness among the wonders of the firmament, and at another, or rather at the same time, scattering beauty of all sorts in countless hues and inimitable touches around our lowly dwelling-places. He hath indeed lighted up most gloriously the canopy that is over our heads—he hath shed unbounded grace and decoration on the terrestrial platform beneath us. Yet these are only parts of his ways—for the whole of his productiveness and power who can comprehend? This will be the occupation of eternity—amid that diversity of operations at present so baffling, to scan the counsels of the God who worketh all in all.'*

* Nat. Theol., B. II., c. 3.

On other subjects we may fall in with proof, here we cannot escape from it. Embark in the swift ship, and mark retiring headlands till the last peak disappear, and sea on all sides begirts the horizon, we still behold the wonders of God in the great deep. Or retire to the wilderness—an ocean of sand relieved by no gallant ships: pass into depths of its solitude where no caravan travels, where no savage roams, where no beast of prey even disturbs the silence by its howlings, or the level by its footmark, still the desert heath, which knoweth not when good cometh, will invite attention to its structure—will attest by its humours and vessels, its root and stalk, and leaves, and flowers, that God hath so clothed it; and will put it to the verdict of intelligence and candour, whether any Solomon, in all his glory, was ever arrayed like one of these. Or if vegetation fail, if no blade of grass surmount the arid waste, take up a grain of sand and note its revelations. It is composed of different elements chemically combined. It partakes with the earth in its rotations and revolutions. It contributes its due proportion to that gravitating power which gives figure to the globe,

and weight and stability to all things on its surface. And when we ponder these and such like properties, we shall find that particle of matter becoming eloquent on morals, and all explicit and profound on the perfections of God, vindicating its own place in the averment, 'the whole earth is full of his riches.'*

God has witnesses in all epochs as well as in all objects. If the present were silent, the past would speak. The ichthyosaur would start from its lias, and the asterolepis from its bed of sand-

* Although nothing may appear less likely to excite curiosity, or to convey information, than a particle of sand scarcely perceptible to the eye, to the cultivated mind it suggests a long train of relations and harmonies. The mode in which its facettes reflect light enables us to ascertain the crystalline form of the mineral to which it belonged. But the train of thoughts does not end here: each crystalline form refracts the luminous ray in its own peculiar manner, hence the crystalline form gives the refractive characters, and this again gives the formula of its chemical composition. To select an example: if the grain of matter be calcareous spar, we discover its crystalline form to be a rhomboid, and this form of crystal possesses the power of double refraction, and again these two conditions involve a certain chemical character as belonging to carbonates of certain earths and metals. They seem to be correlative characters, and the one gives the other somewhat, as the teeth, claws, and stomach of a carnivorous animal are linked in mutual dependence. S.

stone, to rebuke atheistical presumption and claim dutiful homage for the Ancient of Days.

NO GOOD IS TO BE EXPECTED FROM ATHEISM.

And why should unbelief be so strenuously advocated? What means this striving, as zealous as fruitless, to expel God from his dominions? Whence springs this eagerness of puny creatures to annihilate the Creator, and undo the beneficence that made and sustains them, as if by denuding the universe of an architect and occupant men could serve themselves heirs to the inappropriated inheritance? Suppose atheism established, what is it to do for us?

Promote morality? If so, it would perform a goodly service. Every careful observer must have remarked what an ascendant influence the moral element wields in the lot of humanity. Visit the most wretched of a city population, and you may find them groaning under many hardships, and each of these inflicting its own sufferings; but the master evil, and that which transcends, and either originates or aggravates all the rest, is delinquency. They might arise from

their degradation, or would not sink so far in its depths, but for this millstone of vice which they have hung with their own hands around their own necks. We may do much for them, and all of us are bound to do all that can be done in their behalf. We may give them civil privilege, we may give them personal attire and bodily sustenance, we may even instate them in honest and gainful occupations ; but if we succeed not in severing the manacles of immoral habits, we fail to rescue the object of our compassion. We leave the prisoner where we found him, in his cell and in his chains, and what is worse, we see the ransom we have tendered for his rescue perverted to the aggravation and perpetuity of his bondage. I am uttering no opinion on any proposed measures of amelioration. If they are submitted to us, let them be examined by us, and, if they are enlightened, let them be adopted. But what I say is, that well-doing is essential to well-being, and that while a moral transformation is not effected, all other amendments will be as the drop in the bucket, and the small dust in the balance, against the crushing preponderance of a degenerate con-

duct. Were it so, then, that atheism favoured morality, the effect would say much for the cause. But how can it possess any such tendency? Doctrine is the tree of which morality is the fruit, and if the tree be cut down, the fruit perishes. When the being of God is denied, all that we owe to God is simultaneously annulled. To love him for his excellences, to thank him for his bounties, to study conformity to his will, to rest on his sympathy amid sorrows, and on his succour amid perils, all this class of duties evanish with the God to whom they relate. If the word Morality retain any meaning at all, it can, then, be referable only to fellow-creatures. But even as respects them, the most of duty is unreal if there is no God. It is no part of duty in that case to teach men godliness, to set them a pious example, to dissuade them from profanity, to further their progress in a heavenward journey, and elevate their meetness for an inheritance of light. The whole of virtue must then consist in ministering to man's temporal advantage. But when the weightier matters of the law are discarded, the lesser will not be more respected. In being left alone, they will be, on the contrary,

brought into jeopardy. Love to God secures love to man, for if we own him as a father, we must own one another as brethren. Our obligations to fellow-men, in addition to their own force, are then included in our obligations to God; and, what is of very great importance to be observed, the most subordinate actions are hence invested with all the efficacy of the highest motives. If we displace these elevated sanctions, if we consign every sublunary transaction to its own slender buttresses, if we tell the haughty oppressor that no voice more authoritative than his own rebukes his cruelties, or the lurking assassin that no discernment more wakeful than that of his wretched victim watches his movements, is there not a danger, is there not a fearful certainty that even the residue of morals, so feebly protected, must yield to the pressure of temptation, and perish in the same gulf with the more solemn responsibilities of a disrelished piety? We have a corroboration of all these statements in the Socialist schemes of our modern Atheists. They have laid the axe not more at the root of religious doctrine than of all moral order. The same fell blow is to pros-

trate all principles of godliness, all rights of property, all conjugal relationship. And all that has been hitherto recognised as distinguishing citizens from savages, or a good man from a knave, is to be replaced by the Utopianism of the fool, who hath said in his heart, There is no God.

What, then, is atheism to do for us? Secure us liberty? that is its principal pretence. Religion is identified with priestcraft, and priestcraft with intolerance, and all are enjoined to give up with their faith as they would regain their freedom. I am not to disparage liberty—the birthright of man—the glory of a nation—the end of government itself: distrusted and denounced, yet always innocent and kind; blessing to the last when suffered to remain, and even when banished from the earth, rising into the heavens as a star of hope, and shedding its rays of promise on the island of the exile, the dungeon of the prisoner, and the fetters of the slave. I admire Liberty: and I pity the mind which, from dread of its abuses or hatred of its equity, can behold with jaundiced eye its incorruptible attractions. But I deny the affinity of liberty to atheism. If men do not serve God, they will

not be without a superior, for sin will reign in their mortal bodies, and they will obey it in the lusts thereof. Nor will any get rid of all worship by banishing a pure worship. The conscience will have a creed; if denuded of religion, it will put up with superstition, and the chance is, that in extirpating piety you restore paganism. Nor will atheism guarantee a civil liberty. It promised to do so in France: the promise, indorsed by philosophy and adorned by eloquence, was believed, and the wished-for sceptre was put into its hand. But its reign was a reign of terror, its history was a chronicle of butcheries, and it perished by its own suicidal violence, amid the loathing and horror of all civilised nations. Or, if any object to foreign examples, go back to the history of our own country. Revert to the struggles which secured that measure of freedom in the exercise of which we complain of restrictions, and claim to be relieved. Was it atheism that won for us these rights? The chivalry of free-thinking? No; the atheist cannot afford to die. He has nothing to serve but time; and what, then, should he be but time-serving? The victory was gained by those who entered into

the conflict provisioned for all its alternatives—to whom life was Christ, and death was gain. The power of a Christian conscience wielded the sword of the Spirit against the swords of tyrants; and that ethereal weapon it was which prospered the patriots, and got them the victory.

What, then, is atheism to do for men? Make them happy? Some miseries it may mitigate for the moment—benumbing the sense of guilt, and the fear of wrath. It may serve a like purpose as the stupefaction of inebriety to the despairing mariner, who drinks the intoxicating draught and then laughs wildly at the tempest, and falls into deep sleep amid the howlings of the wind and the lashings of the waves, to awake only when 'the proud waters have gone over his soul.' Atheism may for the present qualify wretchedness; it cannot impart felicity. There is nothing in its negations to communicate positive bliss, and all who would find joy and peace must seek them in believing. The favour of God—the God and Father of our Lord Jesus Christ—will make any man happy, truly, perfectly, permanently happy; and no darkness is so profound as not to be dissipated by the light of God's countenance.

CONCLUSION.

In conclusion, I draw two practical lessons from Modern Geology, on the supposition of its conclusions being established:—

(1.) One lesson taught us by Modern Geology is the mutability of this world. I do not speak of its laws, which are strikingly uniform, but of its constituent matter as moulded by their operation. We have seen that the sea and the dry land have repeatedly exchanged places. The scenes we now traverse were once the channel of the ocean. We stand where the coral built its reef, or the sea monster sported. Beside us are the cliffs which the tides or breakers lashed, recording, in their wasted steeps, the severity and protractedness of the watery siege; while under us are the accumulated remains of an extinct aquatic population. The fathomless cavern has become the sheltered garden, or productive valley, and the plough turns up the wonders of the deep. Should the world be preserved till like

changes again occur, the bed of the present sea will be rich, when upheaved and exposed, in still more interesting revelations. The cleft of a rock belonging to some mountain ridge, or the falling bank of some inland river, will lay bare the wreck of our gallant ships. It would be foolish indeed to think of navies lying entire and well-ordered in the depths of the sea, as when they were elevated on the stocks, or congregated in the harbour. Scarcely has a bark struck and sunk till the shore is strewed with its tackling, timber, and cargo; and of the fated crew one lifeless corpse is cast upon the beach, a second is enwrapt in sea-weed, to decay amid its foldings, and a third is promptly devoured by predatory fishes. But many a damaged vessel has gone down in still water, and has been gradually embedded in its sedimentary deposit. Even where the hulk has broken up, relics of its freight may be preserved,—perhaps attire, perhaps documents fenced by affectionate or official care from aqueous invasion. And what shall we think of languages being examined which subsist only in a fossil condition, and which, if they can be deciphered, will tell of sailing from one country

and proceeding to another, both of which will have ceased to be countries, and long since presented continuous ocean on the map of the globe! These are, no doubt, fancies, and they may be deemed very extravagant; but they are such fancies as must be realised, if what has occurred already and repeatedly occur again. They suppose such changes as have already happened, such as are even now in progress, and will insure these catastrophes, if changes still greater do not, in the meantime, befall our planet, and cast anew its destinies. It is true that though the world were permanent, its permanency would little avail us when we must shortly—very shortly—forsake its scenes for ever But the vanity of the creature is more perceptible to our dull apprehension when exhibited on a scale so vast; when the solid globe is seen to be inscribed with characters of change; when the mightiest continents appear as temporary elevations of the ocean's channel, and the boasted kingdoms of the earth present no boundary which the shifting billows have not fashioned, and may not again obliterate.

(2.) Modern Geology smiles contempt on the

pride of antiquity. If the world be understood to have existed for only 6,000 years, the annals of a family may seem a considerable proportion of the entire period; and the noble heir, looking on the ruins of his ancestorial castle, may plume himself on a family consequence filling so large a space in the earth's history. But admit the conclusions of modern investigation, and the whole time of man is utterly lost in its measureless eras. Our vaunted race are all the entrants of yesterday, compared with many of the irrational tribes which we regard with contempt. And the oldest palace has no chronicles, and seems as though it had been created by one breath, to be demolished by the next, when we contrast its revered duration with that of the stones of which it is composed, and the subjacent strata by which it is supported. A poor ground for elatedness are these fractional measurements of the past, the whole sum of which has only to be estimated by the age of material formations or fossil reptiles, in order to assume infinitesimal insignificance. The dignity of long duration does belong to man. We must seek it, however, not in the past, but in the future, in

cultivating meetness for a glorious immortality, of which the treasures shall still be possessed, and the laurels still worn, and the strains still celebrated, when these heavens and this earth shall have passed away, and no place is found for them.

I have thus performed, as I could, a service for which I freely acknowledge myself imperfectly qualified. Perhaps I should have let it alone; but I have been often requested to state publicly my views regarding the religious tendencies of geology; and I have an impression that the members of our churches should hear the sentiments of their ministers on all subjects which affect the interests of truth and godliness. I feel that I would do violence to my convictions of duty, and the yearnings of an affectionate solicitude, if I did not add a few words of weightier consequence. They are designed more especially for that most interesting section of society who are in the spring-time of life, and whose opening powers, with all their vitality and promise, are liable to be suddenly and fatally blasted. I may be excused if, in these parting sentences to them, I exchange indirect statement for direct ad-

dress. The subject I have been discussing is important, but is not the most important. A knowledge of it would make you wise, but not unto salvation. The writing of these paragraphs has been interrupted by calls to visit chambers of sickness and beds of death: and you will suffer me so far to associate these occupations in this appeal, as to remind you that the hour is coming to you also, in which you will require truths more cheering than either science or literature affords, to sustain your courage, and warm your hearts, and elevate your hopes, and replace the fading lights of this retiring world by the promissory beams of an immortal glory. I do not wish to intimidate you. You have great means of improvement—great means of usefulness. If you only dedicate yourselves to God, in the gospel of his Son, I dare not set limits to the good which you may be enabled to acquire and to accomplish. But dangers surround you—dangers of opinion—dangers of practice—dangers of which the power is annually attested in the many and melancholy wrecks of youthful promise. And nothing but the truth of God, received in faith and steadfastly maintained, will make

you superior to all perils, and bring you to a promised and glorious destination. 'And may the very God of peace sanctify you wholly; and I pray God your whole spirit, and soul, and body, be preserved blameless until the coming of our Lord Jesus Christ. Faithful is he that calleth you, who also will do it.'

APPENDIX.

I.

OBJECTS OF GEOLOGICAL SCIENCE.

No one has given a clearer and more philosophic exposition of the nature and objects of geological science than Hutton has done in the first chapter of his Theory of the Earth. 'We perceive,' he says, 'a fabric erected in wisdom, to obtain a purpose worthy of the power that is apparent in the production of it. The globe of the earth is a habitable world, and on its fitness for this purpose our sense of the wisdom of its formation must depend. To judge of this point, we must keep in view, not only the end, but the means also by which that end is obtained. These are, the form of the whole, the materials of which it is composed, and the several powers which counteract or balance one another in procuring the general result.' These observations contain a very sound exposition of the true character of

geological pursuits, and only require some expansion and illustration. The complex science of geology, which considers the adaptation of the earth to the support and welfare of living beings, consists of two very distinct portions, which require very different modes of investigation. The first department of geology relates to the inorganic part of our earth, as fitted for being the abode of plants and animals, and comprehends not merely the history of the mutations of the solid parts of the earth's crust, but also the no less important topic of meteorology or climate, and, in short, of every agent which may influence vital phenomena.

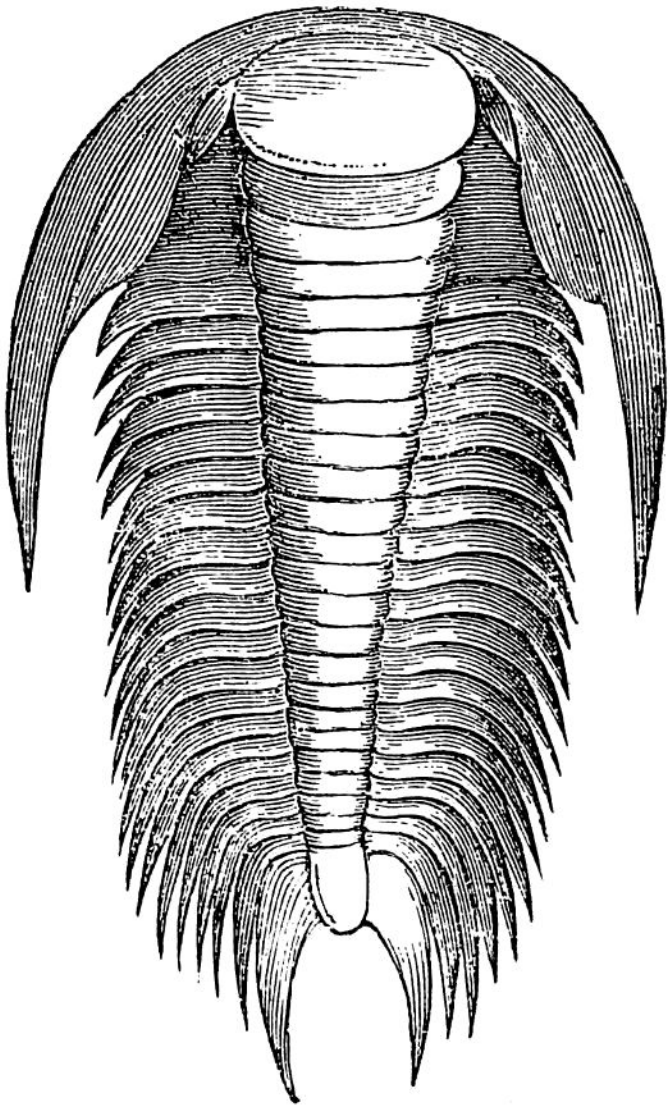
The fitness of the earth's crust, including its atmospheric ocean, for the support of organic beings, depends not on its quiescence, but on its incessant changes. The hard, undecomposed rock cannot afford food even to the moss or lichen; an atmosphere of absolute dryness, like that of the African Sahara, or of a temperature permanently below the freezing point, is scarcely compatible with the support of life. Consequently, rocks must be decomposed and comminuted to afford an appropriate soil: temperature and moisture must also be combined in due proportion, that physical agents may act beneficially on organised beings. These results are brought about by the antagonism of various forces.

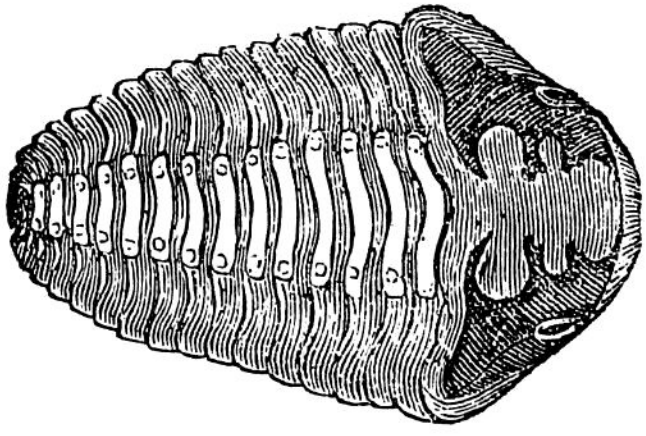
The chief of these is gravitation, transposing loose materials to lower levels, and tending ultimately to reduce the earth to a perfect spheroid, in which all the solid materials would be spread over the channel of the sea, and our globe would be changed into a solid nucleus, enclosed in two spheres of water and the atmosphere. The action of gravitation is counteracted by chemical forces, the source of subterranean heat, which elevates strata, raising them beyond the level of the sea to form islands, and, in many cases, propelling them high into the aerial ocean, producing mountain ranges, the sources of rivers and fertile soils, and also giving rise to a diversity of climates, adapted to every variety of constitution in plants and animals.

Parallel with these unceasing mutations in the inorganic constituents of the earth's crust, we find corresponding mutations in the vegetable and animal kingdoms, whose history constitutes the second division of geology. If our ancient strata were merely aggregates of transported materials accumulated under water, and indurated by pressure and the action of subterraneous heat, we might possibly admit the doctrine of unceasing cycles of changes without trace of a beginning or prospect of an end. Even if organic remains were found in such strata, provided they were identical in species with those at present

existing, such a conclusion might not be invalidated; and some would rather infer that animals and vegetables were everlasting, with the earth they inhabit. This, which was the Aristotelian view, has been completely subverted by the study of the organic remains which occur in such variety and abundance in all, except the oldest stratified rocks. The careful investigation of the remains of former and long-extinct species of plants and animals, has led to the wonderful but incontrovertible fact, that repeatedly whole races and groups of beings have perished, while the earth has again been replenished by new species. To state this fact in all its evidence, we must ascend from the consideration of species to that of genera and families of animals, and illustrate the subject by a reference to the geographical distribution of plants and animals over our actual earth. It is well known that every well-defined region of the globe has its own peculiar creation of plants and animals, which exist in no other division of the earth's surface. Every one knows the very remarkable character of New Holland; by far the greater number of species of plants and animals of that vast region are found in no other country. Not only are the species peculiar to Australia, but also the genera and higher divisions, such as the leafless Acacias, etc., among plants, and the marsupial animals,

An Invertebrated Animal.





The Trilobite.

such as the kangaroo and wombat. In the same manner, the sloths and armadilloes are confined to the warmer parts of America. Similar remarks apply to Africa, and many of the greater islands of the Indian Archipelago.

If we pass from the distribution of animals and plants according to space in the different regions of the present earth, to the distribution of organic beings, according to time, as preserved in the successive strata of past ages, we find an analogous condition. As many regions of the earth, such as Australia, Madagascar, and South America, may be considered as little creations by themselves, each forming, as it were, separate nations of the organised world, in like manner, each successive geological formation has its own characteristic groups of organic fossils. Certain groups, as trilobites, orthoceras, etc., including many genera and hundreds of species, are found only in the older fossiliferous rocks, and every species belonging to them ceased to exist soon after the close of the coal formation. In the newer secondary strata, we find new kinds of shell-fish (molluscs), such as ammonites and belemnites, which did not exist along with the above-mentioned groups, and which also became in turn extinct at the commencement of the tertiary period. This second division of geology, therefore, is merely a portion of botany and

zoology, and to be studied in conjunction with existing species, and may be called biological geology, forming a chapter of the science of biology, which has for its object the investigation of vital laws in the most comprehensive acceptation of that term.

II.

PROVISION HAS BEEN MADE IN CREATION FOR UNITY, VARIETY, AND BEAUTY, AS WELL AS UTILITY.

The proper view of Geology, or the natural history of the earth, is, as has been already stated, to consider it as the science which contemplates the complicated changes of inorganic bodies, as destined to produce those conditions which are requisite for the existence of living beings. In this respect, the system of operations at present in progress, in what we call the modern period, is merely the continuation of that vast series of mutations which reaches back to the deposition of the oldest of the primary strata. Throughout this wonderful history of change, whether gradual or sudden, we find, amidst all the rich variety of organic beings which pass before us, an essential

uniformity amidst endless diversity of structure and adaptation. Strange and anomalous as many of the extinct genera, whether of plants or animals, appear to us when compared with existing races, they were still parts of one creation, and possessed the same essential organs,—they were vertebral or invertebral, cold-blooded or warm-blooded. The ichthyosaur, with the head of a porpoise, the teeth of the crocodile, and the swimming feet of a turtle, was as essentially a reptile as the alligator or lizard; and although its soft parts have long since been decomposed, we are still as certain that its reproduction was oviparous, that its heart had not more than three cavities—and consequently that it was cold-blooded—as if we had the living animal before us. This system of unity in variety is equally apparent when we take a view of any extensive groups of animals; such, for example, as the ruminants and the pachyderms. In the former, if we confine our attention to the species disseminated over our present earth, we find a tolerably complete series, with few abrupt or sudden transitions; from the deer on the one extreme, to the camel on the other, we have many intermediate and connecting species. Among the pachyderms of the present earth the case is very different; the genera stand boldly out and widely apart from each other. We have the elephant with his five hoofs and

long proboscis; the rhinoceros and hippopotamus with their ponderous bodies and great variety in the number and arrangement of their teeth; and lastly, the horse tribe walking upon members furnished with only a single toe to each foot. It is very remarkable that the pachyderms, whose representatives are so few in the present day, were far more numerous in ancient times; and their remains are found in great abundance, both in tertiary and post-tertiary deposits. What is still more remarkable is, that when we class together the recent and fossil genera, we construct a series as complete as that of the modern ruminants. All the voids between the genera of our present pachyderms can be filled up from the rich store of relics preserved in the strata. In this manner, not only has the series of pachyderms been almost completed, but the interval which separates them from the ruminants, has been greatly abridged. To quote an example, the camel is, of all the living ruminants, the most peculiar. Unlike its congeners, but resembling the pachyderms, it has incisor and canine teeth to the upper and lower jaws, and instead of cloven hoofs, has a single or united one, like the pachyderms. This structure of the camel is best illustrated, not by any living animal, but by going back to a pachyderm whose remains are found in the gypsum quarries of

Paris. This curious animal, the anoplotherium, had its teeth arranged on a plan very similar to that of the camel; but, on the other hand, it had cloven hoofs like the ruminants; so that in the two genera which we have selected, the characters of ruminant and pachyderm seem to be blended together, although the last anoplotherium had ceased to exist myriads of years before the camel was created, or, indeed, before the arid deserts which it inhabits had emerged from under the ocean.

In these and numberless examples we find unity of plan under great diversity of execution, pervading alike all past and present creations; and to go still farther, we find the same end often accomplished by very opposite means. While every animal must be adapted to the conditions under which it lives, it is by no means necessary that the same arrangement of structure should be invariably adopted. The giraffe feeds on leaves by the aid of his tall limbs and long neck; while the elephant accomplishes the same end by his elongated nose converted into a prehensile organ. In some opossums the young are carried about in the pouch of the mother; in other species the pouch does not exist, and the young fix themselves to the back of the parent by means of their long prehensile tails. In like manner, in the vegetable kingdom, the common butchers-broom

has no leaves, but the branches become flattened and expanded, so as to assume the form and fulfil the function of leaves.

Following out these views throughout the wide range of extinct and living species, we find that, with adaptation, design, and general laws, there is also choice and unbounded selection of means. The plan of creation is not one of parsimony and mere utility alone: it comprehends not the being only, but the wellbeing and the beauty of the universe. This is equally apparent, whether we consider the inhabitants of the primeval seas and lands, or the plants and animals of our present world. Although the organisation of living bodies must have certain necessary relations to external nature—that is, to temperature, moisture, and food—still this is only a part of their nature, and by no means comprehends their whole history. Thus the squirrel and perroquet of the tropical forests are both fitted, by their constitution, for a high temperature—both are climbers, and consume the same food, and perform the same duty of keeping the members of the vegetable population within due bounds; and how differently is the end accomplished in the two instances quoted? We allude to this circumstance as one upon which a great deal of the beauty and variety of the world depends, and which enables us to take far juster and more comprehensive views of crea-

tion than are usually entertained. From this principle of accomplishing the same means by a diversity of ends, we deduce all the vast diversity of genera and species which are to be found in different regions and in strata of various ages. The intertropical regions of the three continents, for example, and the great islands of the Indian Archipelago, are, in as far as climate and inorganic nature are concerned, remarkably similar; but in living nature this uniformity vanishes—each region is ornamented by its peculiar vegetation, and animated by its characteristic races. It is only requisite to take a general view of the distribution of organised bodies to see how much of contrast and variety exists in different regions. In Southern Africa, we find a wilderness of heaths, astonishing from their numbers and variety of species. On the other hand, not a single heath is found on the American continent, while the uncouth forms and beautiful flowers of the cactus everywhere meet the eye; and again in Australia we find the epacrids are substituted for the heaths, which they so closely resemble in general appearance. This grouping of certain forms of vegetation gives an individuality to the different regions of the earth. The forests of New Holland exhibit a weary uniformity to the eye of the European. The leaves of the trees are vertical, and not horizontal, and destitute of

that glossy green which we admire in other regions; and as there is no periodical fall of the leaves, there is not only the absence of light and shade, but of that noble awakening from death to life, which we enjoy with every returning spring. In striking contrast, we may turn to an autumnal scene in the north of Europe—we have the birch with its white bark and pendulous and slender branches, and the pines loaded with cones, and the boulders of granite covered with the cranberries and their yellow fruit. Nor is the charm of colour wanting, although flowers are absent. Not to speak of the tints of the foliage, the mushroom tribe supply the place of flowers, the amanita resembles a brilliant orange parasol, and other plants of the same tribe afford every variety of form and colour.

But passing from the consideration of these groups of organic beings, which give character and distinction to the different divisions of the earth, we may contemplate this endless variety from another point of view, as exhibited in the different types or great divisions of the animal and vegetable kingdoms. When we survey any such marked botanical or zoological family, we find a rich series of variations, distinct from those depending on necessary conditions. These variations may be considered as ornamental, and the

following examples will sufficiently illustrate our meaning:—The humming-birds inhabiting the tropical parts of America may be estimated at about a hundred species, all of them of minute size, and presenting scarcely any difference in the structure of their organs or the nature of the food they consume. It is no unphilosophical statement to maintain, that the duty assigned to these beautiful birds in the polity of nature might be as effectually performed by the same number of individuals, whether restricted to a single species or extended to a hundred. The only distinctions we observe between them is in the form of the feathers or in grouping of colours, and all this harmony and contrast as artificial and intentional as the adaptations of the most essential organs of locomotion and digestion. The same reasoning applies to the cowry-shells (Cypræa), of which there are so many species distinguished by the artificial workings; some in exhibiting circles of various colours, and lines resembling written characters; and hence their names of Cypræa, Arabia, and Hebraica, from the lines resembling the square or cursive characters employed in these languages. In the vegetable kingdom, the intelligent observer must be struck with the same diversity. In the class of orchideous plants, whether native or those cultivated in our stoves, we find not merely artistic arrangements

of colouring, but also the most remarkable forms. In one species the flower has the form of a spider, a fly, or a bee, and in others that of the pigeon or a butterfly; and all these forms so obvious as to occur to every observer. Even in the siliceous shields of the microscopic animalcules, as figured by Ehrenberg, we find forms so complicated and beautiful that they deserve attention, as affording patterns for the manufacturer or the artist.

These observations hold true not only with respect to the actual creation, but to those extinct ones of which fragments only have come down to us. There are several great divisions of the organic kingdoms which have left but few memorials of their past history, the remains of birds and insects are very scanty; and the same observation extends to the vegetable kingdom. In as far, however, as we can ascertain, the same richness of variation existed then as now. The tribe of ferns is as remarkable for the beauty as for the immense variety of forms which it displays; but these manifestations are not exhaustible by the present generation; our coal-fields are rich in impressions of the fossils of ferns, but even the genera under which they are ranged are different from those of our actual flora. The same richness of forms may be seen in the tribes which have either no representatives or very few

in our present lands or waters. We need only mention the hundreds of species of ammonites and other chambered shells, the encrinites, or lily-shaped zoophytes, and the remarkable forms of the extinct fishes. In this, as in many other things, geology carries us in our inferences far beyond what the data of merely contemporaneous natural history could conduct us. The extinction not only of species, but of entire families of organic beings, proves beyond all doubt that the course of events in creation is not one of fixed and inflexible necessity, in which there is room for nothing but development, and for a mere expansion of certain forms and organs. On the contrary, there is every conceivable variation, under uniform laws, and a series of arrangements beyond what is requisite for mere existence, and which adds to the beauty and happiness of creation. We find not merely displays of power and wisdom, but of benevolence and goodness.

III.

DOCTRINE OF THE TRANSMUTATION OF SPECIES.

Biology, or the science of life and vital phenomena, has its principles and rules of philosophis-

ing, although, unfortunately, they are far from being universally recognised and fully carried out. Of these we shall only mention two which have been acknowledged by almost all the more eminent philosophical naturalists, as Aristotle, Ray, Harvey, Linnæus, and Cuvier, namely, the doctrine of final causes, not merely as evidence of creative power, but also as a powerful instrument of investigation in discovering the functions of an organ, or restoring the structure of some lost animal, of which only fragments remain. The other doctrine is the permanence of species, which maintains that although the individuals of a species may vary within certain limits, still, when the disturbing force ceases to operate, they all return to the original type, and that no effects of domestication, nor of diversities of climate, however long exerted, nor any results from breeding, can transmute one species into another. These principles, if admitted, place an inseparable barrier in the way of hypothesis and conjecture, and limit our field of investigation within the circle of what is possible to be known.

Many naturalists, men of ingenuity and imagination, have refused to confine their speculations within narrow limits, and have expatiated into regions of cosmogony, where brilliancy of fancy or beauty of diction have afforded some

small recompense for the absence of solid philosophy. Hypotheses, which reject the consideration of final causes, and along with it the doctrine of the permanence of species, are not of modern origin, although they have found advocates down to the present day. Of these systems, the most prevalent in antiquity were the mechanical or atomistic, in which not merely vital, but even mental phenomena were explained, solely from a consideration of the mechanical properties of matter, as figure, magnitude, and motion. Such were the notions of Democritus and Epicurus, which have obtained more popularity from the poetry of Lucretius than from the logic of more systematic writers. The atomism of the Democritic school could only have arisen at a period when mathematics and mechanics constituted the entire stock of positive knowledge, and when chemistry was unknown, and existence of electro-magnetic force unsuspected. No one at the present day would attempt to account for chemical phenomena, much less for vital actions, on purely mechanical principles; and the vibrations and vibratiuncles of Hartley may be regarded as the last vestige of this mode of philosophising in mental science.

Another mode of accounting for the origin of organised beings equally well known, but less popular in ancient times, was the dynamical,

which, in addition to the mechanical properties of inert matter, superadded qualities, tendencies, and appetences, producing organic parts, and propelling them onwards in a course of development. These dynamical views, which assume something analogous to life as the cause of all the phenomena in nature, have, from their very vague but comprehensive character, been more prevalent among modern physiologists. Unfortunately, we have no detailed exposition of this dynamical system, such as that which Lucretius has presented to us of the Democritic; but in its outlines it was nearly identical with the notions put forward by La Marck and other recent writers. According to Anaximander, the earth assumed its present form in consequence of the evaporation of the primæval water occasioned by the heat of the sun. When the earth acquired a muddy consistence, vesicles were formed by the escape of air, as takes place at present in fermenting marshes. In consequence of evaporation, these vesicles acquired spiny shells or crusts, and became vivified by the sun's rays. These ova, or animals, at last burst their shells, and came upon the dry land. Both the earth and animals went through a process of development, until more perfect animals were produced. Man was the last formed, and according to Anaximander and the author of the

'Vestiges of Creation,' he commenced his career as an aquatic animal before he was fitted for encountering the perils of dry land. It will be seen from this brief outline, when we have stated the opinions of La Marck and De Maillet, how little originality can be claimed by modern speculators.

An inheritor of the doctrines of Anaximander, and the precursor of La Marck, was De Maillet, a French writer, who died in 1738. His book was published in Holland, and has for title, Telliamed, (the anagram of his name,) or Discourses between an Indian Philosopher and a French Missionary, concerning the diminution of the sea, the formation of the earth, and the origin of man. His motive for writing the book was very extraordinary, and reminds us of a similar circumstance in the life of Lord Herbert of Cherbury. When he was labouring under a severe illness, a voice revealed to him that he was not to die, but was destined to communicate very important matters to the world, and this was the origin of the Telliamed. According to De Maillet, the sea, which once covered the loftiest mountains, has been gradually subsiding. As even marine animals can only subsist in the vicinity of land, they did not appear until some portions of the earth had emerged, and hence we find no organic remains in the primary strata. All

animals originated in the water. When fishes were thrown on dry land, their pectoral fins and scales, split up from evaporation, became feathers, while the posterior fins were, at the same time, changed into feet. Those animals which crawled under the water became seals and terrestrial quadrupeds. In his account of the origin of man, De Maillet certainly cannot be charged with incredulity, and he entertains his readers with many extraordinary narrations. He informs us that the Dutch sometimes catch Mermen, and some of them could speak Dutch, and one of them asked for a pipe of tobacco. He also mentions a sailor who had fallen overboard, and lived in the water for eight years, until he became covered with scales from the squammifying power of the sea.

Passing over the opinions of Rodig, who, as a German, merely expounded and systematised the notions of De Maillet, we may devote a few sentences to the system of La Marck. The writer we have mentioned is an instance of the not unfrequent occurrence of great scientific aptitude in one direction, with little capacity for other lines of investigation. As a systematist, whether in botany or zoology, his merits are very great, while in matters requiring abstract reasoning he shows a singular deficiency of judgment. His notions respecting the origin

of plants and animals differ but little from those of De Maillet and Rodig, although mixed up with some speculations of his own. Our globe was at first liquid, and afterwards became peopled by vegetables and animals of the simplest structure, which became more highly organised in process of time and by the *force of circumstances.* What is still more wonderful, the solid earth itself was produced by the actions of those microscopic creatures. The animals transmuted the water into calcareous earth, the origin of our limestones, and the vegetables changed the same liquid element into earthy matter, the source of argillaceous deposits.

Any change in internal conditions will occasion new wants in the animal, and these will produce new habits, which in their turn will give rise to new functions and organs, and so, according to the doctrine of La Marck, the tiger possessed carnivorous desires, faculties, and habits before he obtained cutting teeth and sharp retractile claws.

In Germany, similar opinions to those of La Marck, have found numerous advocates, but, as might be anticipated, under a less positive and more mystical form, and deduced from the pantheistic dogma of absolute identity; the nature of all things being the same, and differences unreal and merely apparent, or as Goethe

has it in his poem on the metamorphoses of plants:

All forms are resembling, and no one is like to another.

We may easily, by the use of a few phrases and metaphors, account for every diversity of form and structure in plants and animals. We can only allude to those speculations which may be found at length in the works of Schelling and Oken; and the following examples of their application to structure of animals will be sufficient for this sketch. Not only do all animals consist of the same parts, but each part of an animal repeats or represents the whole. The upper and lower extremities consist of the same parts, as is the case with the right and left side, and also the sternum, or breast-bone on the abdominal aspect, is the repetition of the vertebral column on the dorsal. The cranium, in like manner, is a miniature of the whole body; the nose is the head of the head, the spongy bones of the nose the lungs of the head, the upper and lower jaws are the arms and legs, and the teeth naturally represent the fingers and toes, or, it may be nails and claws. To readers unacquainted with such speculations, these statements might appear unbecoming and ridiculous on the part of the writer, and we must state that they are extracted from costly folios,

where they are illustrated by excellent engravings, and they form the basis of the prelections of many a learned professor.*

Since the theory of the development and transmutation of the species has been supposed to obtain support from the succession of organic remains which we observe in the strata, we have thus briefly indicated some of the principles which that theory involves, and shall now endeavour to explain some of the numerous facts and arguments which may be opposed to it. The power of external agents, such as varied conditions of temperature, moisture, and food, have, no doubt, some influence in modifying animals and also vegetables. The plant which has smooth leaves and stem when found in the low countries, becomes stunted and covered with hairs on the summit of the mountain; and the Shetland pony, the London dray-horse, and the Arabian courser, are illustrations of the influence of food and climate. In addition to this, we are informed that the desires of the animal becoming, from repetition, habits, produce in the course of ages instruments by means of

* The following are the titles of some of the chapters of a work on natural history, published by an eminent professor: On Nothing. Mathematics is based upon Nothing, and consequently arises out of Nothing. The Essence of Nothing. Forms of Nothing. Something.

which these desires are gratified. The timid deer, afraid of every enemy, by habit acquires vigorous limbs, and listening to every sound, it acquires ears; but opposite desires may co-exist, and the deer is also bold and pugnacious, and his desire to fight produces horns, instruments of defence. In addition to these causes, animals of different species may breed together, and hence we have mixed races; so that by this circumstance alone we may transmute species, just as the descendants of a negro, by repeated intermarriages with Europeans, will lose every vestige of African features.

The following objections may be offered to these statements:—Almost all changes produced in plants and animals are the results of human interference; they are forced states, maintained by incessant care, and vanishing when the species is withdrawn from domestication. The wild horses or dogs, in all quarters of the world, recur to a common standard, varieties of stature and colour disappear, and the influence of climate and food ceases to be apparent. The same remark applies to hybridism; it is produced by man, and in the animal kingdom at least appears to be scarcely known among the wild races of the forest. If, on the one hand, such modifications as we have noticed are chiefly due to the perseverance and industry of man, we must also remember

that without his care such changes are impossible. Animals in a wild state are confined as rigorously to a uniformity of external conditions as if they were shut up in an enclosed park or the cages of a menagerie. Mountain ranges and an expanse of ocean confine the quadruped to his native region; the kangaroo has not made his way from Australia to New Guinea or New Zealand, and the quadrupeds of Brazil have not wandered across the Andes to Quito or Peru.

If the range of external influence is thus limited, the range of desires, habits, and faculties, is confined to an equally narrow compass. A theory, to be deserving of consideration, must comprehend the whole of the phenomena. Now, the doctrine of appetites and desires only comprehends the half. In the vegetable kingdom it can have no place. If carnivorous desires gave the eagle his crooked bill and sharp talons, then similar desires may have given the Dionæa musupula its fly-catching leaf. In the transmutation of vegetable species, we are therefore deprived of a cause which operates in the animal kingdom. Even among animals there are a class of structures and arrangements which are perfectly inexplicable on any principle included in the development hypothesis. The train of the peacock, with its ocelli so regularly formed, and colours so beautifully arranged, the crest of the

cockatoo, and a crowd of similar instances, are inexplicable by any influence of external circumstances or internal desires, for the same circumstances occur in the vegetable kingdom; thus the flower of the orchidium is the *fac simile* of a butterfly, and in plants of the same group we find flowers resembling almost every kind of animal.

There is, however, another objection which has been urged by Cuvier, which is of itself sufficient to set the question at rest in so far as the influence of desires can produce the transmutation of an animal species. In such a case an animal must desire in opposition to its own proper nature, as when an eel quits the waters and adopts the habits of a snake; or when a seal, so well organised for swimming, and whose favourite food is fish, attempts to run upon land and pursue its food like a bear. La Marck, Geoffrey, St. Hilaire, and other transmutationists, reject all final causes; and what is still more remarkable, they do so under a form still more incomprehensible than that of Lucretius himself. The old atomists maintain that the organ fortuitously produced suggested its use, '*quod natum est id procreat usus.*' The modern dynamists assert that the function existed first, and this produced its organ. Lucretius would have said the eye formed by chance produced the faculty of vision.

La Marck, vision existed first, and this produced an eye to see with.*

It is, however, with the geological bearing of the transmutation theory that the public has of late been chiefly interested, and a few observations will be requisite to place the subject in a proper light. Here we have to remark that if organic remains were found classified in the strata from the oldest beds up to the newest, precisely as the most learned and skilful transmutationist could desire, this alone would never prove the truth of his hypothesis. If in the oldest fossiliferous rocks we found only the simplest of

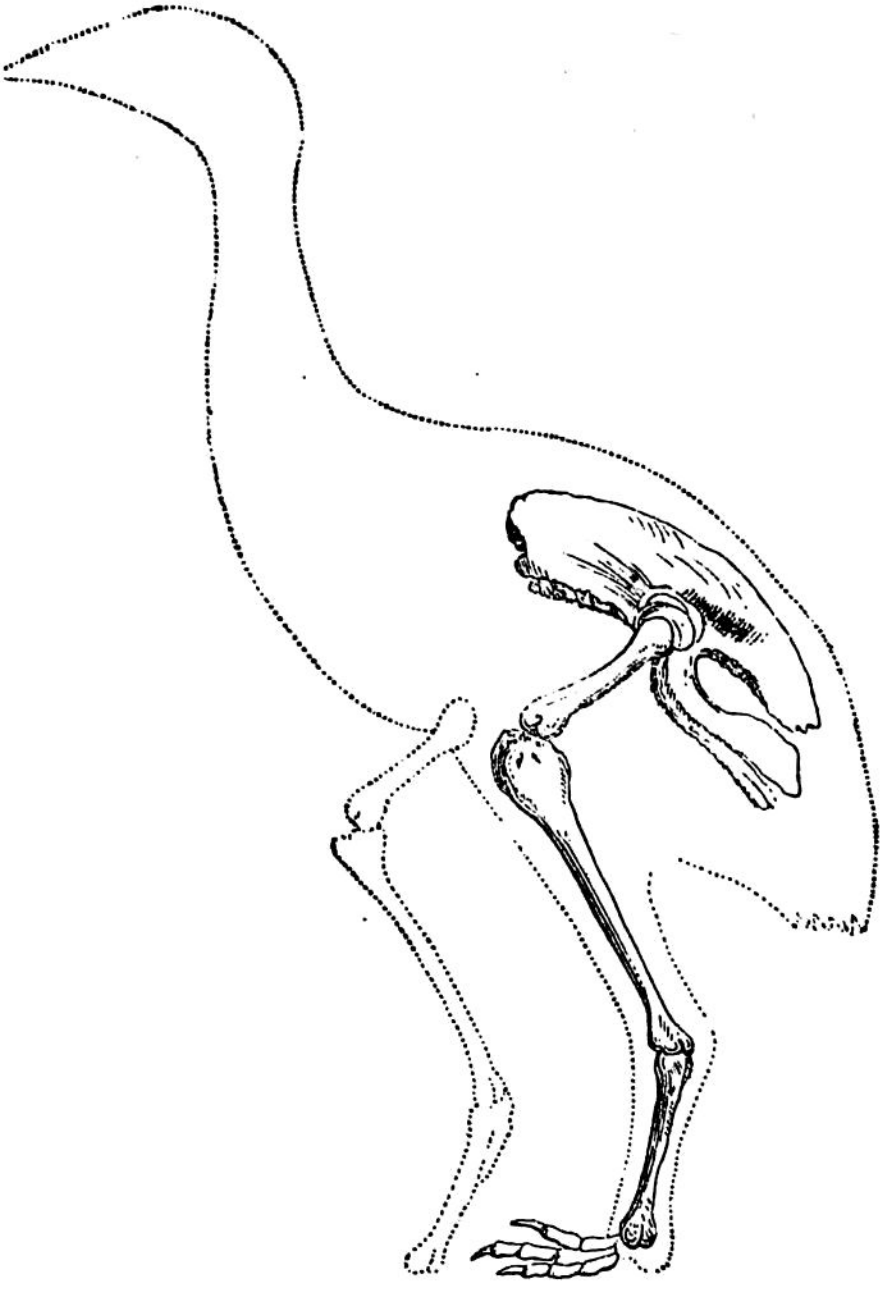
* This absurdity of Lucretius has been exposed by our poet Prior, with his accustomed humour and good sense.

Note here Lucretius dares to teach
(As all our youth may learn from Creech)
That eyes were made and could not view,
Nor hands embrace, nor feet pursue;
But heedless Nature did produce
The members first and then the use.
What each must act was yet unknown,
Till all was moved by chance alone.
A man first builds a country seat,
Then finds the walls not fit to eat.
Another plants, and wondering sees
Nor books nor medals on his trees.
Yet poet and philosopher
Was he, who durst such whims aver.
Blest for his sake be human reason,
Which came at last, though late in season.

organic bodies, and if in each succeeding formation they increased in complication of structure, it would only prove that a different order of succession prevailed from that which actually occurs. It would never of itself prove the transmutation of species. It is, however, a very proper investigation to ascertain whether there are any proofs that organised beings are of more complicated structures in the newer than in the older strata. In such an inquiry the history of the remains of terrestrial and aquatic animals should be considered separately. We can never acquire so complete an insight into the past creations of terrestrial plants and animals as we can of marine species. It is comparatively seldom that remains of terrestrial animals become embedded in marine deposits, and most of the older fossiliferous strata were accumulated in deep water, and remote from land. At the present day vast calcareous deposits are forming in the coral archipelagos of the Pacific, but how rarely will remains of mammiferous animals be found embedded in these modern formations? It will be admitted that of all the divisions of the animal kingdom, the mollusca or shell-fish tribe affords the completest series of species, and in uninterrupted succession, from the oldest secondary formations down to the actual inhabitants of our present seas. If we now inquire

whether the history of fossil mollusca afford any evidence of progressive development, we can reply in the negative. Of all the divisions of the mollusca, the cephalopoda or cuttle-fish tribe, to which also the nautilus belongs, are unquestionably the most perfect, and fully developed. The chambered shells of the cuttle-fish tribe, are found in great abundance in the silurian strata. The species are extremely numerous, belonging to many genera, some of great size and very complicated structure. Animals of this division, still more abundant, and of new and strange forms, are found everywhere in the upper secondary strata. They become rare in the tertiary formations, and in our present seas we can only enumerate about three species of chambered shells. In this case the theory of a progressive deterioration of the mollusca would be more feasible than that of a progressive development.

Before concluding, we are anxious to call attention to another view of the subject, which, we think, is decisive of the question of transmutation of species, and consequently of that of development also. It may, we think, be demonstrated that such transmutations involve anatomical impossibilities. There are two orders of truths in zoology, one of them, when exclusively pursued, apparently favourable to the doctrines of the transmutationists, and the other,



The Dinornis.

although equally true, is but rarely insisted on. The gradation of lizards to serpents is of the most imperceptible kind, and there are animals, regarding which it is difficult to decide to which division they should belong. The gradation from the frog tribe to fishes is still more remarkable, and animals have been recently discovered of so intermediate a nature as to render it a delicate matter to pronounce whether they are to be referred to the batrachia or to fishes. These facts are apt to carry away the imaginations of young naturalists, especially when the other point of view is neglected. There are groups of animals in which transitions are impossible, and combinations of organs which can never occur. A tiger with cloven hoofs, and still more, a winged serpent, cannot exist. In like manner there are some divisions of the animal kingdom so well defined, and whose differences from all other classes are so great, that we can scarcely imagine a transition to another class. Thus, to take an obvious instance, there is no middle term between a vertebral and an invertebral animal. In the vertebral the mass of the nervous system is included in a long cavity extending from the head down the hollow of the spine: the hard parts, the bones, are internal. In the invertebral, on the other hand, the nervous cords run along the abdomen, and under the viscera, not above, as in verte-

brals, and the hard parts are external, and include the muscles; in fact, the two classes are contrasts to each other, and it is difficult even to conceive a being half vertebral, half insect. In this direction, therefore, a transmutation of species cannot be looked for. To quote only one other example, the class of birds stand alone. They may be defined oviparous, warm-blooded bipeds, with anterior limbs for flying. What Cuvier said in a similar discussion respecting the cuttle-fish, is equally true here: the birds lead to nothing, they graduate into no other class. They stand between mammifers and reptiles. To convert a bird into a mammifer, or even into something intermediate, is inconceivable, and the impossibility of such a physiological alchemy will appear strongest to those whose knowledge of organisation is most extensive. The idea of a mammiferous animal includes not one condition, but many, all inseparable, viz., utero gestation, mammary glands; and these again involve fleshy lips and tongue for suction, an epiglottis to protect the windpipe, a diaphragm and abdominal muscles, which are also necessary for the same ends. None of these conditions exist in birds, nor are they compatible with the structure of a vertebrate destined to fly, as we might clearly show by fuller illustration. On the other side of the birds we find the

reptiles; but here also the void between the two groups is deep and wide. Both are oviparous, but the reptiles are cold-blooded, while birds possess the highest temperature of any class of animals. The vigour of the muscular force depends upon the activity of the respiratory function, which is also equivalent to a high temperature, and hence great powers of flight are observed in warm-blooded animals. This circumstance places a barrier between the birds and the reptiles which cannot be passed, and involves along with it a vast number of subordinate conditions. The reptile only displays activity when stimulated by heat, or urged by fear or hunger, and sinks into torpor on the smallest change of temperature or deprivation of moisture; while the bird, from his power of generating heat and active respiration, can support any change of temperature, and his muscles seem incapable of fatigue. The swallow, in its migrations, crosses the whole breadth of the Bay of Biscay without giving a moment's rest to its wings, and the condor can remain for hours on the wing, far above the summits of the Andes, where the temperature must be as low as at Spitzbergen, and the atmosphere so rare as to demand a muscular power on the part of the bird which is scarcely credible.

IV.

RECENT APPEARANCE OF MAN.

Although resting chiefly on negative evidence, the recent origin of man is one of the best established facts in geological science. The absence of human remains from all but the most modern and superficial deposits, although very remarkable, is only a fragment of the evidence we can adduce. Man, even in the most savage condition, leaves memorials behind him still more durable than the hardest parts of his frame; stone hatchets, flint arrow-heads, and fragments of pottery, may be preserved for untold ages, when embedded in aqueous deposits; but no such relics have ever been observed in any but the most modern formations. While the purely geological argument is free from exception, and neither bones of man, nor the rudest productions of human art, are to be found in ancient strata, this is only a portion of the induction. If the human race had existed not from eternity, but even for a few myriads of years, we may well wonder at the small progress which has been made in science, and that it is not yet four centuries since America and Australia became known to Europe. This argument is well put by Hume, in one of his most objectionable works: 'It is not two thou-

sand years since vines were transplanted into France; though there is no climate in the world more favourable to them. It is not three centuries since horses, cows, sheep, swine, dogs, corn, were known in America. Is it possible that during the revolutions of a whole eternity, there never arose a Columbus, who might open a communication between Europe and the Continent? To this remark we may add, that from the moment that mankind began to explore the shores of the Atlantic Ocean, the discovery of America was inevitable; and had the great enterprise of discovering a new world been denied to Columbus, in 1493, it would have been the chance achievement of the Portuguese, Alvarez Cabral, who, on his way to India, was driven by a storm on the coasts of Brazil, only seven years after the first voyage of Columbus.

The recent origin of man is a fact of great value in its bearings on the question of the transmutation of species. The entrance of man upon the world is, so to speak, abrupt, and in the vast variety of fossil remains we find nothing intermediate between biped, two-handed man, and the four-handed ape tribe.

While man is thus a modern inhabitant of the earth, and in his bodily structure exhibits contrasts rather than resemblances to the ape tribe, we find that his organisation would be an

enigma unless united with reason and a high capability for instruction. The breadth compared with the small depth of his chest, his pelvis, the mode in which his head is articulated to the vertebral column, and the structure of his foot, all indicate a being made for erect progression, while the anterior extremity, no longer of any use as an organ of locomotion, becomes an instrument of mind—the organ *par excellence* (οργανον οργανων), as Aristotle long ago termed it. Even the nature of his visual faculty is an anomaly which is only in harmony with his nature as an improvable and reasoning being, not guided by blind impulse. The beautiful researches of Berkeley and his followers have proved beyond doubt that it requires a long education, aided by the sense of touch, to enable the eye to judge of the magnitude and distance of objects. In the inferior animals it is not so; the chick the moment it quits the shell, and the lamb from the instant of its birth, see objects in their true position and distance. Of all animals man alone is artificially taught to use his senses. If such be the case, the first human beings would require instruction for their guidance, to see objects in their true position, and to distinguish the nourishing from the noxious fruit: for them experience would come too late. Something similar to what is supposed often occurs at the present day. The Australian

savage, whose physical education is, however, very perfect, will obtain abundance of food where the best naturalist from Europe would starve; he knows those trees which conceal caterpillars under their bark, where fresh water shell-fish are to be found, and what roots may be eaten. We may infer that, in the first instance, man, however perfect may be his reasoning powers, would require from a higher source even that knowledge which experience confers on his descendants.

INDEX AND GLOSSARY.

Page

ABDOMINAL. Belonging or relating to the belly, 80, etc.

Agassiz. On fish of the Magnesian limestone, . 21
On classification of fishes, . . 22

Alluvial deposits. Deposits consisting of materials, such as earth, sand, gravel, or stones, which have been washed away by floodings of rivers, and thrown down on land not permanently submerged under water, ... 63

Ammonia. A gas, consisting of azote and hydrogen. This gas evaporates from smelling salts, and to it their strong smell is due, . . 128

Ammonites, ... See pp. 18, 86, etc.

Anaximander. On cosmogony, . . . 173

Animalcules. Minute animals, most of which are so small as to be invisible, except when viewed through a microscope. In precise language, the name is now restricted to a division of infusorial animalcules, termed polygastrica, . 96, etc.

Ansted, Professor. On the fossils of the sedimentary strata, . . . 19
On the Megatherium, . 80, etc.

Page

Anterior. Before in time or place, . . 81

Ape. Anatomy of, compared with that of man, . 110

Argillaceous. Clayey, composed of clay.

Arran. The rocks of, ... 13

Articulated. (*Articulus*, a joint) jointed, or having joints, ... 80

Assimilation. A process by which animals and vegetables transform into their own peculiar substance the materials they receive from without, 128

Asterolepis. This name signifies star-scale, and was applied to a fossil fish of the celacanth family, on account of the stellar aspect of the scales. Mr. Miller states that its true scales were not stelliferous, and that the stellate markings were restricted to the dermal plates of the head. The asterolepis presents the oldest example of vertebral structure discovered, as yet, in the most ancient geological system of Scotland, . . . 141

Atheism. (*α*, priv, and *θεος*, God;) a system maintaining that there is no God, . . . 142

Atom. (*α*, priv, and *τεμνω*, to cut;) an ultimate particle of matter; a particle so minute as to be invisible. Atoms are conceived to be the first principles or component parts of all bodies, . 172

Azote. (*α*, priv, and *ζωη*, life;) a gas, called also nitrogen. It forms a principal part of the atmospheric air; and it exists, in various quantities, in different animal substances. Substances are said to be azotised when they contain azote in their composition, ... 128

Page

Basin. This name is given to deposits lying in a cavity or depression of more ancient strata. The London and Paris Basins are well-known examples.

Belemnite. (*βελεμνον*, a dart;) an extinct genus of cephalopodous shell-fish. They were allied to the cuttle-fish, and had a long straight chambered conical shell in the interior of the body. From the resemblance of the shell to a dart, the name has been derived, ... 92

Bimanous. (*Bis*, twice, and *manus*, a hand;) two-handed. Bimana is the name given to the first order of the mammalia, including the human species alone, ... 112

Biology. (*βιος*, life, and *λογος*, discourse;) the science of life, ... 161

Biped. (*Bis*, twice, and *pes*, a foot;) a two-footed animal, ... 110

Bivalves. Shells consisting of two parts or valves hinged together. The common cockle and muscle are examples, ... 134

Boué, M. On the deluge, ... 69

Boulders. Large rounded blocks of stone, which are found either exposed on the surface of the ground, or embedded in loose soil, and which have been transported by natural causes from a distance. Their transportation is ascribed by some to currents, and by others to floating ice, . 167

Brachiopoda. (*βραχιων*, an arm, and *πους*, a foot;) a division of mollusca, so named by Cuvier, from

Page

their having two long spiral arms placed on each side of the mouth, which in many species can be unrolled to a considerable length, and protruded to some distance in search of food.—*Hobbyn*, 104, etc.

Buckland, Dr. On the six days of creation, . 41
On the deluge, . . . 68

Calcareous. Composed of carbonate of lime. Common limestone and chalk are calcareous rocks, ... 9, etc.

Carbonic acid. A gas, composed of carbon and oxygen. This is the gas which is produced and given off by the burning of charcoal. It is also the gas which rises in bubbles, when a bottle of brisk beer or of champaigne is opened, . . 128

Carnivorous. (*Caro*, flesh; *voro*, to eat;) a term applied in zoology to a group of mammiferous animals which feed on flesh, . . . 20

Carse. A provincial term, applied to certain flat lands in valleys among the hills of Scotland, . 8

Causes (final). The final cause is the end contemplated in an act—that for which the act was performed, ... 3 etc.

Caudal. (*Cauda*, tail;) belonging to the tail, . 82

Cephalopoda. (κεφαλὴ, the head, and ποῦς, the foot;) a term in zoology applied to an order of the Mollusca, comprehending those invertebral animals, such as the sepiæ and the nautilus, whose organs of locomotion and prehension are placed around the head, ... 104

Page

Chalk. For explanation, see page 18.

Chalmers, Dr. On the interpretation of Genesis, Preface, note.
On the origin of our present races, 180
On meeting of forces, to produce results which are desirable, . 117
On the amount of proof for the being and perfections of God, . 138

Clay. The varieties of clay are essentially silicates of alumina.

Cleavage. The cleavage of rocks is an apparently crystalline structure, which sometimes belongs to them, and on account of which they are more easily split in one direction, distinct from that of the planes of stratification, than in others, . 36

Cold-blooded. Cold-blooded animals are those in which the temperature of the body differs little from that of the air or water in which they live. Fishes and reptiles are examples, . . 162

Comparative anatomy. The science in which the anatomical structures of various animals are considered and compared, ... 30

Conchifera. A name in zoology given to a tribe of molluscous animals, comprehending all those which are furnished with bivalve shells, 104, etc.

Congeners. (*Con* and *gener*, kind, race;) of the same class, of a closely-related nature. . . 163

Conglomerates. (*Con*, together, and *glomero*, to heap;) rocks composed of rounded, water-worn

Page

fragments of stone, cemented together by another mineral substance, which may be of a siliceous, calcareous, or agillaceous nature, . . 13

Coral. The calcareous trunk, or base of certain marine zoophytes, ... 17

Cosmogonies. (*κοσμος*, world; *γινομαι*, to be born, or exist.) Hypotheses or theories for explaining the origin of the universe, . . . 24

Cotton trees. 'What European forest has ever given birth to a stem equal to that of the ceiba, the wild cotton tree, which alone simply rendered concave, has been known to produce a boat capable of containing one hundred persons?'—*Bryan Edwards*, ... 79

Cowper, Verses by, on Geologists, Preface.

Crania, Remarks on, ... 34

Crater. The cavity at the summit of a volcano through which the volcanic matters are ejected, 123

Cromwell, Oliver, Story of in childhood, . . 114

Crustacea. A class of animals in which the exterior of the body is a hard crust. Crabs and lobsters are examples, ... 104

Crystals are substances possessing certain regularities of internal structure, and usually also of external form. The peculiarities of crystals are commonly produced during the solidification of the substances from the liquid or gaseous state.

Cuvier, Baron. On ancient monuments, . . 63

On the cuttle-fish, . . . 105

Page

DEATH. On death of animals before the Fall, . 50

Delta. A term applied to the low alluvial land which is frequently found at the mouths of rivers. A river emptying itself into the sea, frequently deposits at its mouth the material for new land. The flatness of the land so formed usually causes the river to divide into several branches, which discharge themselves by different and shifting mouths into the sea. The land contained between the two extreme branches and the sea, being of a triangular form, has got the name Delta, from the Greek capital letter Δ, of the same name, ... 8

Detritus. (*De*, from; *tero*, to rub;) materials, such as gravel, sand, and clay, rubbed off or worn away from rocks, ... 8

De Maillet, doctrines of, ... 174

Devonian system. (Name derived from Devonshire, where the system is extensively developed.) For description, see page 15.

Diaphragm. In anatomy, the midriff; a muscle separating the thorax, or chest, from the abdomen, or belly, ... 186

Diluvial deposits. Deposits transported and thrown down by a deluge, ... 66

Disintegration. The process of breaking up a mass into fragments, or of wearing it away, . . 124

Double refraction. A property possessed by some transparent minerals of making objects seen through them appear double, ... 141

Page

EARTHS. An earth in chemistry is a solid, opaque, friable substance, without lustre, and incombustible; it is thus distinguished from metals on the one hand, and from carbon and other combustible substances on the other.—*Hoblyn*, . . 141

Echinus, Remarks on—(See spine,) . 34, 35

Edinburgh Review. See Preface.

Elephant, Structure of, ... 107

Encrinites, Remarks on, ... 92

Entozoa. (εντος, within; ζωον, an animal;) intestinal worms; a class of articulated animals comprising the parasites, which inhabit the internal parts of other animals, ... 96

Epiglottis. (επι, upon, and γλωττα, the tongue;) in anatomy, one of the cartilages of the larynx, whose use is to cover the glottis when food or drink is passing into the stomach, to prevent it from entering the larynx and obstructing the breath.—*Quincy*, ... 186

Equinoxes. (*Æquus*, equal, and *nox*, the night, implying the signification, *day equal to night*;) the two times of the year at which the sun passes over head at the equator, or at which the day is equal to the night over all the world. The precession of the equinoxes denotes a slow, regular retrogradation of the equinox along the ecliptic from east to west, or in the contrary direction to the apparent motion of the sun, . 64

Equivocal generation is the supposed production

Page

of animals without sexual intercourse, and of plants without seed—a doctrine now exploded. —See remarks on page 92, note.

Eroded. (*E*, out, and *rodo*, I gnaw;) eaten into, or eaten away. A term frequently applied to rocks which have been wasted by water, . 28

Exuviæ. (*Exuere*, to put off;) properly speaking, the transient parts of certain animals which they put off or lay down, to assume new ones, as serpents and caterpillars change their skins; in geology, it refers not only to the cast-off coverings of animals, but to fossil shells, and other remains which animals have left in the strata of the earth.—*Lyell*, ... 133

Facet or Facette. (French, *facette*, from face;) little face; flat surface with definite boundaries, 141

Falconer's Shipwreck, quoted, . . . 123

Femur. Thigh bone, ... 81

Fern. A plant of several species, constituting the tribe or family of Filices, which have their fructification on the back of the fronds, or leaves, or in which the flowers are borne on footstalks which overtop the leaves. The stem is the common footstalk, or rather, the middle rib of the leaves, so that most ferns want the stem altogether. The ferns constitute the first order of cryptogams in the sexual system. —*Milne*, ... 169

Ferruginous. (*Ferrum*, iron; *ferrugo*, rust of iron;) containing particles of iron, . . . 137

Page

Fibula. The outer and lesser bone of the leg, much smaller than the tibia.—*Quincy.* See Tibia, . 81

Fleming, Dr. On the deluge, . . . 56

Flint. A mineral consisting of siliceous earth, . 125

Flux. In metallurgy, any substance or mixture used to promote the fusion of metals or minerals, 137

Formation. A group, whether of alluvial deposits, sedimentary strata, or igneous rocks, referred to a common origin or period.—*Lyell,* . . 19

Fossils. (*Fodio*, to dig; *fossils*, what may be dug up;) the term was formerly applied to all minerals; now it is restricted to the remains of plants and animals embedded in the strata of the earth.

Glyptodon, Remarks on the, . . . 90

Gneiss. (A German mining term.) The Gneiss system consists of contorted and laminated beds of quartz, felspar, and mica, irregularly stratified; which may, in truth, be regarded as stratified granite, for the same substances enter into their composition, as prevail in the amorphous masses of that rock.—*Mantell.* . . . 23

Goniatites. (γωνια, an angle.) The name of spirally-twisted species of cephalopods, which inhabited the seas during the carboniferous period, and are characterised by the angular markings made by the intersections of the walls of the chambers and the outer shell.—*Hoblyn.*

Page

Grain of sand. Its properties, . . . 140

Graminivorous. (*Gramen*, grass; *voro*, to eat;) feeding on grass, ... 83

Granites. An igneous rock, usually composed of three simple minerals (felspar, quartz, and mica). It derives its name from its granular structure, (*granum*, a grain.) On the mode of its formation. See page 12, etc.

Gravitation. (*Gravitas*, weight.) The mutual tendency of bodies towards one another. Newton laid down those laws of gravitation,—(1st) The gravitating forces of bodies are directly as their masses. If the mass of a body be twice that of another, its gravity is also double. (2d) The gravitating forces of bodies are inversely as the squares of their distances. When the distance of bodies is doubled, their gravity is reduced to a fourth. When the distance is tripled, the gravity is reduced to a ninth, etc., . . 107, etc.

Gypsum. A mineral composed of lime and sulphuric acid; hence also called sulphate of lime. Plaster and stucco are obtained by exposing gypsum to a strong heat. It is found so abundantly near Paris that plaster of Paris is a common term in this country for the white powder of which casts are made.—*Lyell.* (γυψος, chalk; from γη, earth, and ἑψω, to bake.) This is the

Page

etymology which some give. Lyell says that the derivation is unknown, ... 163

HARE, Instincts of, ... 156

Hemisphere. Half-sphere. The equator divides the mundane-sphere into two equal parts—the northern and southern hemispheres, . . 47

Herbivorous. (*Herba*, herb; and *voro*, to eat;) eating herbs; feeding on vegetables. The ox and all the bovine genus of quadrupeds are herbivorous animals, ... 17, etc.

Hitchcock, Professor. On the explanations of Genesis, Preface, note.

On the antiquity of the globe, 26, etc.

On the deluge, . . 68

Hume. On miracles, ... 99

Hutton's Theory of the Earth, . . . 156

Hybridism. (*Hybrida*, a mongrel;) artificial fecundation. A hybrid is a plant or animal obtained by crossing two varieties of the same species, or two distinct species of the same genus. Such plants or animals are also called mules, . . 179

Hypothesis. (υποθεσις, a supposition;) a proposition or principle taken for granted, or supposed, in order to account for certain results, . 33, etc.

ICHTHYOSAURUS, Remarks on the . . 91, and 162

Induction. The method of reasoning from particu-

Page

lars to generals, or the inferring of one general proposition from several particular ones.—*Webster*, ... 95

Infusorial. Animalcules are found in many infusions; but the term infusorial, or infusory, is applied to all minute living creatures found in liquids, whether infused or not, as in stagnant water or vinegar, ... 96

Insects. (*Insectus*, cut into or divided into segments.) This name seems to have been originally given to small animals whose bodies appear cut in and almost divided.—*Webster*. A class of articulated animals, which are furnished with two antennæ, six thoracic legs, and spiracula for respiration.—*Palmer*, ... 92

Joints. In geology, fissures or lines of parting in rocks often at right angles to the places of stratification. The partings which separate columnar basalt into prisms, are joints. Professor Sedgwick mentions that the portion of rock intervening between two joints has no tendency to cleave in a direction parallel to the planes of the joints, whereas a rock is susceptible of indefinite subdivision in the direction of its slaty cleavage. Joints and cleavage are thus discriminated, . 36

Lacustrine. (*Lacus*, lake;) belonging to lakes, . 46

La Marck, character and notions of, . . 175

Page

Laminæ. In Geology, the platings or smaller layers of which a stratum is composed, . . 36

Layer. (From *lay*, the verb.) A name applied to matter, such as clay or sand laid or spread over other bodies.

Lias. One of the secondary groups of fossiliferous strata. So named probably from the appearance of the bed in riband-like layers of different colours, observed in some parts of England.—*Ansted.*

Lichen. Belongs to the aphyllæ, or leafless plants. These plants spread themselves over the dry surfaces of trees, stones, etc., and derive their nourishment from the air. Their reproductive organs are sporules. The lichen is a genus of the class *cryptogamia*, and of the order *algæ*, . 157

Limestone. A limestone or calcareous rock is composed of lime and carbonic acid. Shells and corals are formed of the same elements, with the addition of animal matter. On the derivation of limestone from the exuviæ of animals, Mrs. Somerville says:—'Since the commencement of animated existence, zoophytes have built coral reefs, extending hundreds of miles, and mountains of limestone are full of their remains all over the globe. Mines of shells are worked to make lime; ranges of hills and rock, many hundred feet thick, are almost entirely

Page

composed of them, and they abound in every mountain-chain throughout the earth. The prodigious quantity of microscopic shells discovered by M. Ehrenberg is still more astonishing; shells not larger than a grain of sand form entire mountains: a great portion of the hills of Casciana in Tuscany consist of chambered shells so minute that Signor Saldani collected 10,454 of them from one ounce of stone. Chalk is almost entirely composed of them,' 132

Limuli. The limulus, or king crab, belongs to a division of the crustacea. It has a distinct carapace or buckler, with two eyes in front of the shield. A small fossil species is found in the ironstone nodules of Coalbrookdale.—*Mantell*, . 104

Lithological. (λιθος, a stone, and λογος, discourse.) Pertaining to the science of stones.

Loins. The loins are the space on each side of the vertebræ, between the lowest of the false ribs, and the upper portion of the os ilium or haunch bone, or the lateral portions of the lumbar region: called also the reins.—*Webster*, . . 79

Lumbar. (From *lumbus*, loins;) pertaining to the loins. The lumbar region is the posterior portion of the body, between the false ribs, and the upper edge of the haunch bone.—*Parr*, . . 80

Lyell, Sir C. On aqueous and igneous rocks, . 6
On the groups of fossiliferous strata, 16, etc.

Page

Lyell, Sir C. On the difficulties of Geology, 36, etc.
On the low antiquity of our species, 45
On the possibility of a deluge, . 65

Macculloch on mineral veins, . . . 135
Macrauchenia, Remarks on the, . . . 90
Mammalia. Mammiferæ. (*Mamma*, the breast.) The mammalia are the first class of vertebrate animals in Cuvier's fourfold division of the animal kingdom. They suckle their young by means of lactiferous teats; and hence their name, . 17, etc.
Manipulation. (*Manipulus*, manus, hand; and the Teutonic full;) hand-work, . . . 111
Mantell, Dr. On fossils in the sedimentary strata, 17, etc.
Marine. (*Mare*, the sea;) belonging to the sea, . 55
Marble. Limestone is so called, when it is capable of receiving a high polish, or when it has been so altered by igneous agency as to admit of being worked into statuary, ... 125
Marl. A mixture of clay and lime; usually soft, but sometimes hard, in which case it is called indurated marl.—*Lyell*, . . 19, etc.
Marsupial animals. (From *marsupium*, a pouch.) An order of mammalia, having a sack or pouch under the belly, in which they carry their young, like the kangaroo and opossum. They are ovo-viviparous animals, being intermediate between the truly viviparous mammalia, and the ovipa-rous birds and reptiles.—*Hoblyn*, . . 159

Page

See remarks on different species of opossums. 164

Measures (Coal); same as beds, ... 22

Megatherium. (*μεγα*, great; *θηριον*, beast.) For description of, see 77

Metals. (*μεταλλον*, a mine, mineral;) simple elementary bodies, characterised generally by their peculiar metallic lustre and great specific gravities. They have been distributed into different classes, according to their affinity for oxygen and the properties of their oxides. See an account of, ... 134, etc.

Metamorphic. Transformed. (*μετα*, trans; *μορφη*, forma.) This is a name suggested by Sir C. Lyell, for rocks which he was the first to regard as stratified rocks, altered by igneous agency, . 23

Meteorology. (*μετεωρος*, lofty, and *λογος*, discourse;) the science which treats of the atmosphere and its phenomena, ... 157

Miller, Mr. Hugh. On old red sandstone, and on the ichthyolites of Orkney, . . . 22

Milton. Quoted, ... 3, 61

Mollusca. (*Molluscum*, from mollis, soft.) In zoology, a division or class of animals whose bodies are soft, without an internal skeleton or articulated covering. Some of them breathe by lungs, others by gills; some live on land, others on water; some of them are naked, others testaceous, or provided with shells. Many of them are fur-

Page

nished with feelers or tentacula.—*Cuvier*, *Ed. Encyc.*, ... 93

Moss. In the Sexual System of Botany, the mosses are the second order of the class cryptogamia, which contains all the plants in which the parts of the flower and fruit are wanting or not conspicuous.—*Webster*, ... 157

Nautilus. The nautilus belongs to the cephalopodous shell-fish. The shell consists internally of a series of chambers, all of which are pierced through by a siphunculus, or tube. The fish has the power of filling this tube with a fluid, and of exhausting it; and by altering in this way its specific gravity, it can sink or swim at pleasure, ... 86, 104, etc.

Nebular. (*Nebula*, cloud.) In astronomy, a nebula is a cluster of fixed stars, which cannot be distinguished from each other by the naked eye, or in some instances even by the telescope. Their dim, hazy light has somewhat the appearance of a luminous cloud. It has been an opinion with some that there is a nebular matter diffused through space, and constituting the material out of which stars are formed.* See page 102.

Nile, detritus of, ... 8

Nodule. A rounded mineral mass, as flint.—*Mantell*, 36

* This is the doctrine of the Nebular Theory, which received its most fascinating exposition and defence from Professor Nichol in his 'Architecture of the Heavens.'

Page

North British Review. Quoted, page 104–5.

Ocelli. Markings resembling eyes may be called by this name, ... 180

Oken. On structure of plants and animals, . 177

Opossum. The opossums belong to the group of marsupial, or pouched animals, and are peculiar to America. See Marsupial, . . . 164

Ore. A term applied to the natural substances from which metals are obtained. See Oxide, . 135

Organisation. Organic. These words have relation to the structure of plants and animals. Organs are the parts or natural instruments by which vital processes are carried on.

Orthoceras. (ορθος, straight; and κερας, a horn.) The name of an extinct genus of cephalopods which inhabited a long chambered, conical shell, like a straight horn, ... 160

Ova, Eggs, ... 97

Oviparous. (*Ovum*, an egg; *pario*, to bring forth.) A designation of those animals which produce their young in an egg, the egg being hatched after its exclusion from the parent, as in the cases of birds and most reptiles.—*Hoblyn*. . . 162

Oxide. An oxide of a substance is a compound of that substance with oxygen. Many of the ores from which metals are obtained are oxides of the metals.

Page

Oxygen. A gas which is a principal constituent of the atmospheric air.

Pachyderms. (παχυς, thick; and δερμα, the skin.) A name applied to a group of mammiferous animals, comprising some with a very thick skin, such as the elephant, the rhinoceros, and the hippopotamus, ... 162

Palæontology. (παλαιος ancient; ονται, beings; and λογος, discourse.) The science of fossil remains, both animal and vegetable.

Pantheistic. Confounding God with the universe: supposing the universe to be God, . . 176

Parasitical. (παρα, by; and σιτος, sustenance.) In botany, a parasite is a plant growing on the stem or branch of another plant, from which it derives nourishment. In zoology, animals are said to be parasites when they attach themselves to, and live at the expense of other animals.

Pectoral Fins. The fins which are situated at the sides of a fish, behind the gills, . . 175

Pelvis. (*Pelvis.*) The cavity of the body formed by the os sacrum, os coccyx, and ossa innominata, forming the lower part of the abdomen.—*Webster*, 79

Petrified. (*Petra*, a rock; *facio*, to make.) See remarks on Petrifaction, page 7.

Phillips, Professor. On the gradual enrichment of organisation, ... 104

Page

Plesiosaurus. (πλησιον, near, and σαυρα, a lizard.)
Remarks on the, ... 92

Prehensile. (*Prehendo*, to take, or seize; *prehensus*.)
Adapted to seize or grasp. The tails of some monkeys are prehensile, as the animals have the power of coiling them around the branches of trees, so as to take hold of the branches. 110, etc.

Primitive. The granite and the crystalline strata were formerly called primitive, under the idea that they were the first formed, and that the aqueous and volcanic rocks were afterwards superimposed. All formations were then supposed to be of aqueous origin.

Prior, the Poet. On the absurdities of Lucretius, 182

Processes. Projecting parts.

Quartz. A simple mineral, composed of pure silex. The very hard white translucent stones frequently met with on gravel walks, are quartz. So also is rock crystal.

Rabbit, instincts of, ... 106

Refrigeration. (*Re* and *frigus*, cold.) The act of cooling: state of being cooled, ... 30

Reid, Dr. Thomas. On maternal carefulness, . 113

Reptiles. The class reptilia constitutes one of the great groups of the vertebrated animals. Respiration is effected in some of the reptiles by lungs and gills, in others by lungs only. The blood is

Page

cold. The heart consists of three cavities. The young are produced from eggs.—*Patterson*, 20, etc.

Revolution of the earth. The word revolution frequently denotes the circular motion of a body on its axis. It also expresses the motion of a body round any point or centre; and thus the earth in its annual course performs a revolution around the sun, ... 140

Richardson, Mr., verses by. On the nautilus and the ammonite, ... 86

Rotation of the earth, is the turning of the earth on its axis as distinguishable from its progressive motion in its orbit, while revolving around the sun as a centre, ... 140

Ruminants. 'The order ruminantia is distinguished from all the other orders of mammalia, by the existence of four stomachs, arranged for the act of ruminating or chewing the cud. These animals are essentially herbivorous, and are all possessed of the cloven hoof; and it is only among them that species are met with, whose foreheads are armed with horns.' . . . 162, etc.

Salt, rock salt. The common culinary salt, or chloride of sodium, is called rock salt when it is found in large solid masses.

Schelling. On structure of plants and animals, . 177

Schist, micaceous. Slate admits of being split into an indefinite number of parallel laminæ. The

Page

term schist is most properly applied to those metamorphic rocks which have a less regular cleavage. Schist is said to be micaceous when it contains mica, a mineral so named from its glittering appearance. 23

Sedgwick, Professor. On so-called Scripture geologies, ... 71

Sediment. (Lat. *sedimentum*, from *sedeo*, to settle.) The matter which subsides to the bottom of liquors; settlings, lees, dregs.—*Bacon.*

Sepiæ. The sepia is another name for the cuttle-fish. It belongs to the cephalopoda. 'The soft body of the existing sepia is supported by a skeleton formed of a single bone of very extraordinary structure; when dried and reduced to powder, it is the substance called *pounce*. The cuttle-fish has the power of secreting a dark-coloured fluid, or ink, which it ejects when pursued, and by thus rendering the water turbid, escapes from its enemies. This fluid is contained in a bag, and forms, when properly prepared, the *sepia* colour employed in the arts, and enters into the composition of Indian ink.'—*Mantell.*

Shale. (From German *schalen*, to split.) Hardened slaty clay.

Silex is the name of one of the pure earths, being the Latin word for flint, which is wholly composed of that earth; the term is sometimes used

Page

generically for all minerals composed entirely of that earth, whatever may be their external forms. *Siliceous*, belonging to the earth of flint; rocks mainly composed of silex are so called. When silex and another substance are chemically combined, the compound is called a silicate, as the silicate of iron. See pages 9, 18, etc.

Simple minerals. The minerals so called are not absolutely simple; they are compounded of elements which may be separated by chemical analysis, but they are designated simply as being individual mineral substances, and not rocks formed from an aggregation of such simple minerals.

Slate. In what sense to be considered an igneous rock. (See Schist.) 12

Sloth. Remarks on the, ... 77

Smelting. The reduction of a metallic ore, in order to extract the pure metal. A third substance is usually added to the ore and fuel, to make a fusible compound with the earthy matter of the ore. See Flux, ... 137

Smith, Dr. Pye. His explanation of the beginning of Genesis, ... 42

Snowdonian Rocks, fossils of. A slaty sandstone forming the bottom of the Cambrian system in Snowdon, contains shells of the family Brachiopoda, and a few zoophytes.—*Lyell*, . . 104

Solstices. (*Sol*, the sun; *sto*, to stand.) The two extreme points of the sun's apparent course, north

Page

and south of the equator. These are the first points of Cancer and of Capricorn, where the sun *appears to make a stand*, going neither northwards nor southwards.—*Hoblyn.*

Solution. (*Chemical.*) This term denotes that a perfect chemical union of the solid with the liquid is produced in accordance with the laws of definite proportions. Both the constituents of the compound exhibit a change in their properties, and are combined in an entirely new substance. —*Hoblyn.*

Somerville. On the partial location of animals, . 60

Spar. This name is given to stones of which the broken surfaces present smooth shining plates lying over each other horizontally. Calcareous spar is crystallized carbonate of lime; Iceland spar is one of its purest varieties, . . 141

Species. In natural history, the term species is applied to organised beings, whether plants or animals, descended from a common stock, or having resemblances compatible with such descent.

Spheroid. (σφαιρα, a sphere, and ειδος, likeness;) a body, of which the figure resembles a sphere, while it is not perfectly spherical. There are two kinds of spheroids—the oblate, and the prolate. A semi-ellipsis, moving round its lesser axis, describes an oblate spheroid. A semi-ellipsis, moving round its greater axis, describes a prolate spheroid. The earth is an oblate spheroid, being flattened at the poles, . . . 158

Page

Spine. The back-bone of an animal. Also a sharp process from the woody part of a plant. Also employed to designate those processes attached to the papillæ of the Echinites, or sea-urchins, which are their instruments of motion. When the animal dies, the tendons which fixed the spines to the shell decompose, and hence the processes fall off, and are wanting in almost all fossil specimens. See p. 26.

Subsidence. This term is applied to the sinking of land, as distinguished from its upheaval or elevation. For an explanation of the manner in which these effects may result from igneous agency, see p. 121.

Sweden. Land of rising, p. 122. In parts of Sweden, the land is experiencing, and has experienced for centuries, a slow upheaving movement. —*Lyell.*

Thin out. When a stratum gradually diminishes in thickness till it disappear, it is said to thin out, 107

Tibia. In anatomy, the larger of the two bones of the human leg. Situated internally and anteriorly to the fibula.—*Palmer.*

Toxodon, remarks on the, ... 90

Trap Rocks. (From *trappa*, Swedish, a stair.) Volcanic rocks, composed of felspar, augite, and hornblende. The various proportions and state of aggregation of these simple minerals, and differences in external forms, give rise to varieties which have received distinct appellations, as basalt, amygdaloid, dolorite, greenstone, and others.

Page

The term is meant to denote that the rocks of this class sometimes occur in large tabular masses, which rise one above another like steps and stairs.—*Hoblyn.*

Trilobites. These are a family of the order of *crustacea*, which became extinct at the close of the carbouiferous epoch.—*Richardson.* Called trilobite, or three-lobed, from their general form.—*Mantell.*

Tropics. (From τροπη, a turning.) In geography, two lesser circles of the globe, drawn parallel to the equator, through the beginning of Cancer and of Capricorn.

Turrilites. Conspicuous among the fossil mollusca of the cretaceous group, and foreign to the tertiary and recent periods: of the family cephalopoda, to which the living cuttle-fish and nautilus belong.—*Lyell.*

UNCONFORMABLE. Strata are said to be conformable, when their planes of stratification are parallel; otherwise, they are unconformable, . . 28

VALVE. (From *valvæ*, folding doors;) one of the lids or pieces in bivalve and multivalve shells, . 34

'Vestiges of Creation.' Remarks on that work, . 101

Vertebræ, vertebrata. A vertebra is a joint of the back-bone. The vertebræ in man are the twenty-four bones which constitute, by their articulation, the vertebral column. They are distributed from their relative situations, into the clavical, dorsal, and lumbar.—*Palmer.* The vertebrata are a large

Page

division of the animal kingdom, including all those species which are furnished with a back-bone or vertebral column, as the mammalia, birds, reptiles, and fishes.—*Hoblyn.* . . . 20

Viscera. The bowels, or intestines; the contents of the thorax and abdomen.

Viviparous. (*Vivus*, alive, and *pario*, to bring forth;) applied to animals which bring forth their young alive and perfect, and do not produce them in eggs, like the oviparous animals.

Woodward, Mr. On the teeth of elephants found in Norfolk and Suffolk, ... 17

Zodiac. A broad circle in the heavens, containing the twelve signs through which the sun passes in its annual course. The centre of this belt is the ecliptic, which is the apparent path of the sun. The name zodiac is from ζωδιον, zodion, little animal, and it has reference to the figures of animals employed as signs, ... 63

Zoological. (ζωον, an animal, and λογος, discourse;) relating to zoology or the science of animals, . 6

Zoophites. (ζωον, an animal, and φυτον, a plant.) In natural history, a body supposed to partake of the nature both of an animal and a vegetable, as madrepores, corallines, etc. The animals construct and occupy habitations, which are fixed to the ground, and which have the form of plants.