With these must also go the impressions from the Lower Silurians of Sweden which constitute the genus *Eophyton.* These were always known to be only surface markings, but so remarkably did they imitate stems and leaves of plants that it was very difficult to gainsay those who unhesitatingly placed them among vegetables. And if vegetables, it seemed certain that they belonged to Phanerogamous plants, and not to any of the lower groups of Cryptogamous plants whose remains are the earliest vegetable fossils met with. Mr. Nathorst has produced typical specimens of *Eophyton* from the trails of plants over soft mud. So that while *Eophyton* testifies to the existence of life on the shores when the markings were made, these markings supply no evidence as to the nature or form of the plants by which they were produced.

It may be worth while to add a sentence to this notice in order to record that the doubt already thrown on Saporta's Lower Silurian fern *Eopteris Morieri* was confirmed by the examination of a specimen exhibited at a recent meeting of the Geological Society. And that the mineral nature of the markings was completely established, and the impossibility of its being a plant was pointed out by Dr. Sterry Hunt when he showed that it lay along the lines of the slaty cleavage, and not on a surface of deposition.

NOTICES OF MEMOIRS.

I.—Om Aftryck af Medusor i Sveriges Kambriska Lager. Af A. G. Nathorst, Kongl. Svenska Vetenskaps-Akademiens Handlingar. Bandet 19, No. 1. Med 6 Taflor. Stockholm, 1881. On Impressions of Medusæ in the Cambrian Rocks of Sweden. By A. G. Nathorst.

IN this Number of the Magazine a notice is given by Wm. Carruthers, Esq., F.R.S., of a paper by Herr Nathorst, in which he brings forward reasons to show that the impressions on beds of sandstone of Cambrian age, hitherto regarded as plants, and known under the generic name of *Eophyton,* were more probably markings produced by the trails of Medusæ. In the present paper the author endeavours to prove that the same beds contain impressions and casts of these organisms. The possibility of jelly-fishes leaving proofs of their existence in the rocks is well known from the indubitable impressions left by these animals in the Solenhofen slates. The Eophyton sandstones are, however, much less fitted to receive and retain the markings of delicate organisms than the lithographic beds of Solenhofen, and it is not, therefore, to be wondered at that the impressions they contain, being ruder and more indefinite in their character, should have been variously interpreted. This accounts for the circumstance that the forms now referred by the author to Medusæ have been previously described by Torell and Linnarsson under the generic names of *Spatangopsis, Agelacrinus ?, Protolyellia,* and *Astylospongia,* and thus attributed to Sponges, Corals, Crinoids and Echinoderms! These fossils retain no organic structures, and only the form has been preserved. As regards those described as corals and sponges, such authorities as Lindström and Roemer repudiate their connexion with these groups.

It appears that Herr Nathorst was led to compare these fossils to the impressions of Medusæ by casually observing the similarity of form between some specimens of the existing Medusa, *Aurelia aurita,* thrown up on the beach at Öresund, and specimens of so-called *Spatangopsis* from the Eophyton sandstone at Lugnås, which are in the Stockholm Museum. This similarity induced him to try the experiment of obtaining casts of these existing Medusæ by means of dilute plaster, and the resemblances between the artificial and the natural impressions were so close that the author regards it as proved that the fossil impressions result from Medusæ. The impressions most commonly met with, have the shape of a central, elevated pyramidal body, from which radiate four or five arms or rays. This form has resulted from the settling down of the Medusa into the mud, which, by the infilling of the gastral cavity, has produced the pyramidal body, whilst the radiating impressions are those of the prolonged angles of the mouth. Another form which generally occurs free is believed by Nathorst to result from the infilling of the gastral cavity of those animals which have died or been thrown on the strand with the mouth uppermost.

The author treats at length the various points of comparison between the fossils and existing Medusæ of various families, and refers the forms to three species:—*Medusites radiatus,* Linnars. sp. =*Astylospongia radiata,* pp. Linnars.; *M. favosus,* n.sp=*Protolyellia princeps,* Torell, and *Astylospongia radiata,* pp. Linnars.; and *M. Lindströmi,* Linnars. sp.=*Spatangopsis costata,* Torell, and *Agelacrinus? Lindströmi,* Linnars. In addition to these forms, which are regarded as resulting from the impressions and infillings of the central portions of Medusæ, the author attributes the peculiar spiral casts in the same rocks, named by Torell *Spiroscolex spiralis,* to the tentacles of Medusæ.

In a supplement the author thinks that the life-habits of the existing genus *Polyclonia,* recently described by Profs. Moseley and Agassiz, tend to show further the probability of the Medusa-origin of these fossils. *Polyclonia* lives in great numbers near the muddy bottom of certain seas, and its movements would tend to produce the Eophyton markings, whilst it has also the habit of turning its bell uppermost, and this, in the dead specimens, would facilitate the entrance of sediment into the gastric cavity.

The facts brought forward in this paper indicate at least great probability that the author's conclusions are correct, and he may be congratulated on having carried our knowledge of the existence of these organisms back from Jurassic to Cambrian times.

G. J. H.

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II.—New Zealand Geology. Reports of Geological Explorations during 1879–80. James Hector, M.D., F.R.S., Director. (Wellington, 1881.)

THE Geological Survey of New Zealand appears to be making good progress. During the season 1879–80 a number of important explorations have been made, so that nearly four thousand square miles have been added to the general mapping of the colony, mostly in the Auckland, Canterbury, and Otago districts.

Full details of these surveys are given by Messrs. Cox and McKay, accompanied by maps, sections, and lists of the fossils collected. In a prefatory chapter or progress report, Dr. Hector summarizes the general results of the work done, and shows the important additions they have made to the knowledge of the geological structure and economical substances of the districts examined, and introduces some remarks on the comparison of the geology of New Zealand with that of Australia, and gives a table of the fossiliferous formations of the two countries.

"On the whole, the geological record, so far as yet known, is more complete in the New Zealand than in the Australian area. The Tertiary strata are perhaps equally well developed, and the distinguishing facies of each existing fauna is discernible as early as the Eocene formations. The Upper Mesozoic formations are very imperfectly represented in Australia, but have enormous development in New Zealand, in which country, as in America, the Tertiary facies of the fauna and flora springs from a shore-line and land-surface of pre-Cretaceous age. This is the period of the chief coal deposits in New Zealand.

"It was in the Lower Mesozoic period that the greatest divergence in the character of the deposits prevailed in the several areas. In Australia marine Jurassic formations, which can be determined by their fossils, are not extensively developed, while the characteristic fauna of the Trias has not yet been detected (with the exception of *Estheria*, recently noticed in the core excavated by the diamond drill from under the Sydney sandstone); fossil plants, which are most uncertain guides, being alone found in the strata which must be referred to that period. In New Zealand, on the other hand, three divisions of the Jurassic formation have been distinguished by their abundant fossil contents. A Liassic formation has a fair development, while an Upper Trias or Rhætic formation has an importance due to thickness and variety of fossils which is unknown elsewhere. The Trias, with its very characteristic molluscan fauna, is largely developed, and also occurs in New Caledonia. Without any marked break the sequence in New Zealand passes down into a thick formation with Permian fossils, but associated with forms found in the Trias, while the more strictly Palæozoic elements of the Permian fauna are absent. This is followed in New Zealand by a gap, and the next formation, which is the Lower Carboniferous and Upper Devonian, is the latest formation, according to our present evidence, which appears to have been common to Australia and New Zealand, and to have been deposited in both areas under the same physical conditions, and within a common biological province.

"The attempt to correlate the lower Mesozoic formations in the two countries is therefore a matter of some difficulty; but as plant-beds occur at intervals, interstratified with the marine strata of New Zealand, these may be perhaps yet employed successfully as indications of relative age.

"This would be a most useful labour, as the strata concerning the age of which there is so much uncertainty are in Australia and India of the highest economic importance from their containing workable coal-seams; but while the Upper Jurassic flora is well developed in New Zealand, and can be successfully compared with that of corresponding age in Australia and India, the lower plant-beds of Rhætic, Triassic, and Permian age have only yielded specimens in a bad state of preservation. The following attempt at a tabular comparison of the age of the formations in the two countries is therefore not made altogether on palæontological evidence, and is only the reading of the Australian record from the New Zealand point of view, so far as the characters and subdivisions of the Australian formations have been described by various authors.

"TABLE OF FOSSILIFEROUS FORMATIONS.

New Zealand.	Australia.
I.—Recent— Moa beds. Alluvia. Volcanic. Shingle plains.	Newer gold drift, scoriaceous lavas of Victoria.
II.—Pliocene— Shingle plains. Pumice sands. Lignite beds. Kereru beds.	Older gold drift and deep leads of Victoria.
III.—Upper Miocene— Wanganui beds. Awatere beds.	Limestones of South Australian Bight.
IV.—Lower Miocene— Ross beds. Mangapakeha beds. Pareore beds.	Portland beds of Victoria, Murray River beds.
V.—Upper Eocene— Mt. Brown Beds. Oamaru beds. Nummulitic beds.	Schnapper Point beds of Victoria. Table Cape, Tasmania.
VI.—Cretaceo-Tertiary— Grey Marls. Ototara stone. Fucoidal greensand. Amuri limestone. Island sandstone.	New Britain? New Caledonia. Queensland.

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New Zealand.	Australia.
Coal Formation of New Zealand.	
Black grit.	
Conglomerate.	
Propylite breccias.	
VII.—Neocomian—	Flinders River beds, Queensland.
Conglomerates with coal.	New Caledonia.
Porphyries.	
Greensands.	
VII.—Jurassic.	Queensland, West Australia.
Upper—	
Matura beds.	Clarence River Coal, N.S.W.
Coal seams.	
Middle—	Jerusalem coal, Tasmania.
Putataka beds.	Rajmahal plant-beds, India.
Lower—	
Flag Hill beds.	Cape Paterson, Victoria.
IX.—Liassic—	Queensland?
Çatlin's River beds.	
Bastion beds.	
X.—Rhætic and Triassic.	Wianamatta shales, N.S.W.
Otapiri beds.	
Wairoa beds.	New Caledonia.
XI.—Permian—	Hawkesbury sandstone.
Upper—	Conglomerate, Lake Macquarie?
Oreti beds.	
Great conglomerate.	Gondwana series, India.
Great sandstone.	
Lower—	Newcastle Coal Measures, N.S.W.
Mount Potts beds.	
Kaihiku beds.	
Glossopteris beds.	
Conglomerates.	
Red Sandstones.	
Wanting?	Stony Creek beds and Wollongong beds, [N.S.W.
XII.—Lower Carboniferous.	Port Stephens beds, N.S.W.
Maitia slates.	
Te Anau beds.	Tasmania.
	Gympie Creek, Queensland.
XIII.—Lower Devonian—	Murrumbidgee beds, N.S.W.
Reefton beds.	
XIV.—Upper Silurian—	Yass and Hume beds, N.S.W.
Baton River slates.	
Limestones.	Gordon River, Tasmania.
Serpentinous slates.	
XV.—Lower Silurian—	Auriferous slates of Victoria.
Graptolites.	
Marbles.	
Hornblende rocks."	

III.—On the Strata between the Chillesford Beds and the Lower Boulder-clay. "The Mundesley and Westleton Beds." By J. Prestwich, M.A., F.R.S., F.G.S., Professor of Geology in the University of Oxford.

(British Association Reports: York Meeting.)

WHERE a particular series of strata presents, in adjacent but conterminous areas, markedly different palæontological and lithological characters, it may be sometimes convenient, as in the case of the "Reading and Woolwich Series," to give them a double geographical term, indicative of the localities where each type is well developed, and its relation to the overlying and underlying strata well shown.

The beds between the Chillesford Clay and the Lower Boulder-clay present such a series. Its exhibition on the coast of Norfolk, although very limited, is accompanied by special palæontological features, that have caused it to be divided into the number of local beds which have been described by Trimmer, Green, Gunn, Wood, and Harmer, the author, Reid, Blake, and others. It includes the "Laminated Clays" of Gunn, the "Bure Valley Crag" of Searles Wood, the "Westleton Shingle" of the author, and the "Rootlet-bed" and "Norwich Series" of Blake. Without reverting at present to the exact correlation of the several beds in the Norfolk area, respecting which there is still some difference of opinion, the author suggests that they should be included under a general term founded on the localities where, on the one hand, their varied palæontological characters are exhibited, and on the other, where their peculiar petrological characters are well marked—characters which the author proposes to show, in another paper, have a very wide range, and serve to mark an important geological horizon in some interesting questions of local physical geology.

The Mundesley beds were described by the author in 1860, and consist of alternating beds of clay, sands, and shingle, some containing freshwater and others marine mollusca, with a forest-growth and mammalian remains at their base; and again in 1871, including them in his Westleton group (No. 5 in the author's sections), which he showed to consist entirely of great masses of well-rounded shingle, with intercalated seams containing traces only of marine shells. Seeing the inconvenience of attaching the same term to the two very distinct series of beds, and that it may conflict with other local terms, the author now proposes to group this series under the term of "The Mundesley and Westleton Beds," indicative of their stratigraphical position in Norfolk, and of characters in Suffolk which serve to trace them in their range westward and inland to considerable distances beyond the Crag area, to which alone these beds have hitherto been restricted. At the same time, it may be convenient, for brevity, to use one term only in speaking of typical cases.

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IV.—Some Observations on the Causes of Volcanic Action. By J. Prestwich, M.A., F.R.S., etc., Professor of Geology in the University of Oxford.

(British Association Reports: Section C. York Meeting.)

CONSIDERABLE difference of opinion still exists as to the cause of volcanic action. The hypothesis, however, generally accepted in this country is that of the late Mr. Poulett Scrope, who considered that "the rise of lava in a volcanic vent is occasioned by the expansion of volumes of high-pressure steam, generated in a mass of liquefied and heated matter within or beneath the eruptive orifice." According to his view, the expulsion of the lava is effected solely by high-pressure steam generated at great depths, but at what depths is not mentioned, nor is it explained how the water is introduced, whether from the surface or whether from water in original combination with the basic magma.

The objections to this hypothesis are—1st. That during the most powerful explosions, *i.e.* when the discharge of steam is at its maximum, the escape of lava is frequently at its minimum.

2ndly. That streams of lava often flow with little disengagement of steam, and are generally greatest after the force of the first violent explosion is expended.

3rdly. That it is not a mere boiling over, in which case, after the escape of the active agent—the water—and the expulsion of such portion of the obstructing medium, the lava, as became entangled with it, the remaining lava would subside in the vent to a depth corresponding to the quantity of lava ejected; but the level of the lava, *cæteris paribus*, remains the same during successive eruptions. Of the important part played by water in volcanic eruptions there can be no doubt, but instead of considering it as the primary, the author views it as a secondary cause in volcanic eruptions.

All observers agree in describing ordinary volcanic eruptions as generally accompanied or preceded by shocks, or earthquakes, of a minor or local character, to which succeed paroxysmal explosions, during which vast quantities of stones, scoriæ, and ashes, together with volumes of steam, are projected from the crater. The first paroxysms are the most violent, and they gradually decrease and then cease altogether. The flow of lava, on the other hand, which commences sooner or later after the first explosions, is continued and prolonged independently. Ultimately the volcano returns to a state of repose, which may last a few months or many years.

Adopting the theory of an original igneous nucleus, but without going into the controverted question of the present state of that nucleus and the outer crust, the author considers a certain fluidity of the former, and mobility of the latter, or of a portion thereof, to be proved by the facts of the case. The one and the other feebly represent conditions of which the phenomena of the rocks afford clearer and stronger evidence as we go back in geological time. Although thermometrical experiments of the necessary accuracy and length of time are yet wanting, it has been estimated that a small quantity of central heat still reaches the surface and is lost

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by radiation into space. Besides, it is evident that even the escape of liquid lava and steam from volcanos, and of hot springs from these and other sources, must bring, in however small a quantity, a certain increment of heat from the interior to the surface, where it is lost. This should lead to a certain contraction at depths, and of re-adjustment of the external crust, in consequence of which the fused masses of the interior will from time to time tend to be forced outwards, whenever tension became sufficient to overcome resistance. In this the author agrees with many other geologists. The further hypothesis respecting volcanic action which he now suggests, he has, however, been mainly led to form by his researches on underground waters, and may be stated in a few words as follows :—

A portion of the rain falling on the surface not only of permeable and fissured sedimentary strata, but also of fissured and creviced crystalline and other rocks, passes below ground, and is there transmitted as far down as the permeable rocks range, or as the fissures in the rocks extend, unless some counteracting causes intervene. Those causes are the occurrence of impermeable rocks, faults, and heat. The former two are exceptional, the latter constant. The increase of temperature with depth being 1° Fahr. for every 50 to 60 ft., the boiling-point of water would be reached at a depth of about 10,000 ft., but owing to the pressure of the superincumbent rocks, it has been estimated that water will retain its liquidity and continue to circulate freely to far greater depths. Unfortunately, very little is known of the substrata of volcanos. Etna and Hecla apparently stand on permeable Tertiary strata, Vesuvius on Tertiary and Cretaceous strata, while in South America some of the volcanos are seemingly situated amongst Palæozoic and crystalline rocks. Under ordinary circumstances, all the permeable strata and all fissured rocks become charged with water up to the level of the lowest point of escape on the surface, or if there should be an escape in the sea-bed, then to that level, *plus* a difference caused by friction.

The extreme porosity of lavas is well known. All the water falling on the surface of Etna and Vesuvius (except where the rocks are decomposed and a surface soil formed) disappears at once, passing into the fissures and cavities formed by the contraction of the lava in cooling. Not only are these fissures filled, but the water lodges in the main duct itself, and occasionally rises to a height to fill the crater. Beneath the mass of fragmentary and cavernous volcanic materials forming the volcano, lies the original compact mass of sedimentary strata, etc. Owing to the fortunate circumstance of an artesian well having been sunk at Naples, we know the underlying sedimentary strata there to consist of alternating strata of marl, sands, and sandstones, some water-bearing, others impermeable. The water from the lowest spring reached in this boring, rose at first 8 feet above the surface, and 81 feet above the sea-level. Where the strata crop out in the sea-bed, the same pressure of the column of inland water forces the fresh water outwards, so as to form a fresh water spring in the sea, as at

Spezzia and elsewhere on the Mediterranean coast. It is this fundamental hydrostatic principle which keeps wells in islands, and in shores adjacent to the sea, free from salt water, as in the Isle of Thanet. Where, however, the head of inland waters is small or impeded, sea-water will enter the permeable strata, and spoil the springs, as in the case of the Lower Tertiary Sands at Ostend, and the Lower Greensand at Calais and in the Somme, in which latter department the underground spring was found affected to a distance of about 1 mile from the sea, but pure at a distance of 9 miles. Further, if where the head of inland water is sufficient to force back the sea-water under ordinary conditions, these ordinary conditions are disturbed by pumping to an extent that lowers the line of water-level to below that of the sea-level, then the sea-water will flow inwards until an equilibrium is established. The flow of water under a volcanic mountain may be also influenced by the quaquaversal dip, which there is some evidence that the underlying strata there take, owing probably to the removal of matter from below, and the weight of the mountain. If we are to assume that the volcanic ashes and tufas below Naples are subaërial, the original land-surface has sunk not less than 665 feet, and a dip of the underlying strata from the seaward, as well as from inland, has in all probability been caused. This artesian well was carried to the depth of 1524 feet, and passed through three water-bearing beds —one in the volcanic ashes, the second in the Sub-Apennine beds, and the third in the Cretaceous strata at the bottom.

When undisturbed, the underground fissures and cavities of the volcanic materials forming a volcano must soon become filled by the infiltration of rain-water from the surface, while the strata on which they rest are charged, or not, with water, according as they are permeable or impermeable — following the usual laws affecting underground waters. No eruption of lava can then take place without coming in contact with these underground waters. The first to be affected will be the water in the cavities of the mountain in and around the crater. As the pressure of the ascending column of lava splits the crust formed subsequently to the preceding eruption, the water finds its way to the heated surface, and leads to explosions more or less violent. When the fluid lava breaks more completely through the old crust, and the mountain is fissured by the force and pressure of the ascending column, the whole body of water stored in the mountain successively flows in upon the heated lava, and is at once flashed off into steam. Then take place those more violent detonations and explosions—those deluges of rain arising from the condensed steam—with which the great eruptions usually commence. As the more superficial waters of the superincumbent lavas and ashes are exhausted, the springs in the deeper underlying strata, cut through by the fissures in which the main ducts are situated, come into play, and varying with the pressure consequent on the rise and fall of the column of lava, discharge their contents more or less rapidly into those ducts, where, when they reach the point, when pressure

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permits, they flash into steam and rise in vast bubbles of vapour to the surface of the land. Of the quantity of this underground water some notion may be formed by the fact that the deepest of the three springs under Naples discharged, when first tapped, two cubic mètres (430 gallons) per minute. The water may pass in bodily in consequence of the powerful shocks and vibrations shaking and breaking the strata, and so causing masses of rock to fall in from the sides of the main duct, accompanied by the water held in the beds, or it may pass in by capillarity. for it is well known that this state exercises a remarkable influence on the conditions of equilibrium on the two sides of a porous body, and Mr. Daubrée has shown that water will pass through sandstone notwithstanding the stronger resistance of steam. The experiments were only carried to the extent of a steam-pressure of two atmospheres, but it was evident that the limits of the power were not reached. They further also showed that heat materially increased the power. There is reason to suppose that water, under the considerable hydrostatic pressures that exist beneath volcanic mountains, and assisted by capillarity, may flow into the volcanic ducts with facility, especially when aided by the intermittent relief of pressure, afforded by the rise and fall, or pulsations, of the column of lava.

As the underground springs fed by the rainfall are exhausted by the expulsion of the large volumes of water converted into steam, another agent comes into operation. The surplus water, one portion of which usually goes to feed the surface springs, while another portion passes through the permeable strata into the sea-bed, is not only removed, but the level of the underground waters in the sedimentary strata is so lowered that the hydrostatic pressure is no longer equal to that exercised by the column of sea-water, so that, instead of an outflow from the land, an inflow from the sea necessarily takes place through the same channels or strata, and thus, taking the place of the displaced fresh-water, finds it way to the volcanic ducts. It is only when from the exhaustion of the fresh-water sources and the impeded access of sea-water, whether owing to the resistance of the strata or to a decreasing hydrostatic pressure, that the lava flows quietly and unaccompanied by the violent explosions which mark the commencement of an eruption. If, on the other hand, the sea-water gains access more freely through the more porous volcanic materials, as in Stromboli and Kilauea, a constant volcanic activity may be maintained. In ordinary cases, however, where the inland waters, after the force of the eruption is expended, regain the ascendant, they again exclude the sea-water, and return to a state of equilibrium, which lasts until the strata are again disturbed and fractured by a renewed eruption of lava.

In conclusion, the author conceives that the first cause of volcanic action is the welling up of the lava in consequence of pressure due to slight contraction of a portion of the earth's crust. Secondly, the fluid lava coming into contact with water stored in the crevices of the masses of lava and ashes forming the volcano, the water is at once flashed into steam, giving rise to powerful detonations and

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explosions. Thirdly follows an influx of water from the underlying sedimentary or other strata lying at greater depths into the ducts of the volcano; and, lastly, as these subterranean bodies of water are thus converted into steam and expelled, the exhausted strata then serve as a channel to an influx of sea-water into the volcano. A point is finally reached when, owing to the cessation of the powerful shocks and vibrations, and the excessive drainage of the strata, the flow of the lava is effected quietly, and so continues until another equilibrium is established and the lava ceases to escape.

REVIEWS.

Illustrations of the Earth's Surface. Glaciers. By Prof. N. S. Shaler and W. M. Davis. 4to. pp. 198; 26 Plates. (Boston, 1881: J. Osgood & Co.).

THIS volume, which, according to the preface, is designed for students, is presented to us with such a luxury of appearance, and wealth of illustration, that only an affluent publishing house could display. It forms the first of a series destined to portray the actual features of the earth's surface under the action of geological agencies by means of sun-pictures, together with an explanatory commentary. The idea seems to us a happy one. In the present case advantage has been taken of the admirable views of Swiss glaciers which are to be had, owing to the enterprise of photographers, to place a selection of them reproduced by the heliotype process before students and the geological public; such being chosen as are most typical of glacial phenomena. A few from India, Colorado, Norway, etc., are also included.

We do not imagine that the book will be confined to students in the ordinary sense of the term; it is suitable for and will doubtless be found on many a drawing-room table. That large part of an intelligent public who go again and again to Switzerland to revel in the fascination of snow and ice scenery, will find in the views of familiar glaciers what will bring the original scene vividly before them, while in the letterpress and descriptions are pointed out details which, perhaps, they did not notice, and of which, now, for the first time, they see the meaning and importance.

All know that a glacier moves; their guides will not fail to tell the tourist that, and, indeed, this fact was known to dwellers in the mountains before scientific men paid any attention to it. In the twelfth chapter the growth of our knowledge on the subject of Glaciers is passed in review, for, to use the author's words, "the student of nature will find that the best way into any science is through the history of the discoveries that have made it a science." In the opening chapter the physical phenomena are described; in the first place, those of the existing Swiss glaciers; the grotto at the lower end whence issues the stream of water, milky-white, from the abraded mud, which has been the result of friction of the ice or of stones imbedded in it like graving tools—the dirt bands, moraines,