grandest forest in Sikkim, and surely one of the grandest in the world. A mixture of tropical and temperate forms in highest perfection occurs, oaks, chestnuts, magnolias, laurels, and many other giant trees, laden with climbers, orchids, ferns, aroids, and other epiphytes, till the branches break with their weight, mixed with a number of beautiful shrubs and herbaceous plants. But this forest is almost everywhere, unless strictly protected by the forest department, or growing on slopes too steep for cultivation, destroyed by fire or axe, for the purpose of cropping with rice, millet, Indian corn, and potatoes, which are the principal crops of the natives; and owing to the great extension of cultivation, and the immigration of Nepalese into Sikkim and British Bhotan, a tract of really virgin forest between 3000 and 6000 feet is becoming quite a rarity.

Partly on account of this destruction of the native trees, which are replaced in abandoned cultivation by worthless weeds, such as artemisia, and by quick-growing soft-wooded trees of no value, the species of butterflies peculiar to this zone are much fewer in numbers, both of species and individuals, than lower down, and some of the finer and larger species of Adolea, Limenitis, and Athyona, which formerly were not rare in Sikkim collections, appear to be now very scarce or extinct in their old haunts. A little higher up, however, we find a forest of much the same character, though denser, darker, and the trees much more overgrown with moss. At 7000 and 8000 feet rhododendrons appear, and a dense undergrowth of hill-bamboo, called "maling," which forms the principal fodder for ponies in Darjeeling, in some places makes the forest quite impenetrable. Here the sun shines but rarely during the rainy season, and even in the cold weather mist is very prevalent. This forest is the home of some of the most superb insects in the world.

Let us walk up a few miles above Darjeeling into the great forest which covers Sinchul on a sunny morning early in June, and wait on one of the highest peaks, where a small bare space can be found. Flying over the tops of the trees with a rapid soaring flight we shall see that grand insect *Teinopalpus imperialis*, peculiar to these forests, and if lucky enough to attract him to the ground by a bait, or able to reach his resting-place, we may catch one or two in a morning. But his female so rarely flies from her leafy perch that in sixteen years I only know of three or four examples having been taken, and these one may say by accident in unexpected places. *Papilio Krishna* and *P. Minercus*, again, frequent the same forest; but of the former, though males are in places abundant, the female is hardly, if ever, taken. *Herda duma*, *Picris Horsfieldi*, *Neptes Zaida*, and other species, have the same peculiarity, that the females are hardly ever seen; and only long and patient waiting in spots where sunshine is of rare occurrence, will enable the most sharp-sighted collector to obtain them. Some beautiful, though sombre-coloured, Satyridæ, such as *Lophoessa goalpara*, *Yama*, and others, *Raphicera satricius*, *Lethe scanda*, *Dinarba* and *Sidonis*, are peculiar to these shady, damp forests, and flit along the roads when disturbed in dull weather as well as in sunshine; but however active the search, the number of species and of individuals seen in a day will be small compared to the results of a day in the tropical valleys. Higher up still, from 9000 to 12,000 feet, the outer ranges of Sikkim are very poor in diurnal species, though rich in Geometra, and Micro-Lepidoptera, as the climate is too damp and sunless in summer to encourage the appearance of species of Palæarctic genera, which are in places so abundant on the more sunny, grassy hills of the North-West Himalaya.

In the interior, however, where the climate is drier, and where Coniferæ and rhododendrons form the principal features of the forest from 8000 to 11,000 feet, there are a number of European genera and species which I have at present only procured through native collectors, but which I hope to see for myself before long in life. *Papilio Machaon*, *Colias Fieldii*, *Picris brassica*, *Vanessas*, *Argynnis Lathonia*, the lovely *A. gemmata*, are common in these higher, drier, and more flowery regions, whilst *Parnassius*, *Aneis*, *Melitæa*, and other Alpine genera are also found in certain places. The moths of the interior hills are too little known for me to say much about them, but there are great numbers of species of European aspect, and many novelties amongst them may be expected whenever the Tibetan frontier is crossed.

H. J. ELWES

SKETCH OF THE EARLY HISTORY AND SUBSEQUENT PROGRESS OF PALÆOBOTANY[1]

AMONG the many memoirs included in the Fifth Annual Report of the U.S. Geological Survey, just distributed, none evinces more laborious research than the sketch of palæobotany, and no part of this will prove more valuable, both from its exhaustive treatment and its wealth of references, than the section with the above title. The matter divides itself naturally into a history of the scientific, and of the pre-scientific period. To the latter of course belong the speculations of the early Greek philosophers, whose ideas were far more correct than those held fifteen or sixteen centuries later, for they at least recognised that petrifactions had once been living things, and that the mountains in which sea-shells were embedded had once been under the sea. These doctrines were it appears the popular belief of the Romans, and continued to be held until the spread of Christianity caused them to be rejected, and that long period of stagnation to set in, when all natural science was weighed down and subordinated to the religious cosmogony.

We do not find, however, any direct and unequivocal references to fossil plants or wood in either Greek or Latin writers, though such must have been far from uncommon objects in limestone districts, and the history of palæobotany cannot therefore be said to have commenced before the thirteenth century, when Albertus Magnus described most unmistakably the occurrence of petrified wood.[2] Little further mention, however, is made of any fossil vegetable organism until the latter half of the sixteenth century, when we find several writers describing and discussing the origin of petrified wood, which seems to have added fuel to a controversy that had already for centuries been raging concerning the genesis of petrifactions. Building upon Aristotle's doctrine of spontaneous generation, scholastic writers had come to affirm that it was equally possible for stones to grow of any required form as for living animals and plants. Avicenna in the tenth century had conjured up a *vis lapidifica*, and Albertus Magnus in the thirteenth century had imagined a *virtus formativa*. Bauhin dreamed of some subtle Spirit of the Universe, while Libavius opined that fossils grew, like living things, from germs or seeds. Balthasar Klein obtained a petrified stem, one side being stone, the other coal, an object which excited the liveliest curiosity. He sent the specimen to Matthiolus, who, after studying it, came to the conclusion that coal was a third and final step in the process of transmutation, and that just as wood turned into stone, so stone in turn became transformed into coal. Klein's own views about it seem, however, to have been more rational. The discovery in the mines of Joachimsthal of a petrified trunk with the bark on added to the interest already aroused, and kept alive the discussion.

In 1565, leaf-impressions incrusted in tufa were

[1] From the Fifth Report of the U.S. Geological Survey, by Lester F. Ward, condensed by J. S. Gardner.

[2] For all references the Fifth Report of the U.S. Geological Survey, p. 388 *et seq.*, must be consulted.

described by Kentmann, and in 1664 the existence of leaf-impressions in true rock was for the first time published by Major. In 1699, Lhywd, a Londoner, figured and described a number of ferns from the Coal-Measures, which can even now be recognised. These he was inclined to consider due to the *succus petrificus*, a petrifying juice whose action was controlled by the *vis lapidifica*, both petrifying forces having been invented by Kircher in 1655, when he propounded his theory of *seminaria de corpuscula salina* as the true faith regarding petrifactions. Sperling believed in a special stone-making spirit, and Camerarius (1712) held that in the beginning God had supplied the earth's interior with these varied forms, just as he had placed grass and herbage on its surface. Still others were content to regard fossils as mere freaks of Nature. Such-like ideas held the field, and only began to give way during the early years of the eighteenth century, for we find that, as late as 1733, infinitesimal particles were believed by a Dr. Arnold to have been brought together at the Creation to form dead outlines or images of all the living creatures upon or within the world. During all these dark ages, however, there were not wanting writers who held more rational views as to the nature of fossils, and even combated the supernatural explanations of the dominant schools. It was due to fossil vegetables, according to Brongniart, that these crude ideas came to be abandoned. All these theories were swept away by the "Flood theory," the first germ of which is apparently to be found in Luther's commentary on Genesis, where he expresses the belief that surviving indications of the Deluge would be found in the form of wood hardened into stone around the mines and smelting-mills. Several writers between Luther's time and the close of the sixteenth century held the same view, but the Flood theory was for a time drowned in the more fantastic speculations then in vogue, not to come to the surface again until another century had passed. In 1695 Woodward published a work on fossils, in which he maintained that all the solid parts of the earth's crust were loosened by the Flood and mingled promiscuously in its waters, and that at its close everything sank back to the surface according to its specific gravity, the remains of animals and plants assuming the positions in which they are found petrified. The chiefest expounder of this hypothesis, however, was Scheuchzer, whose great work on fossils, in 1709, laid the foundations of palæobotany, though he subsequently rendered himself even more notorious by describing a large fossil Salamander as *Homo diluvii testis*. His work, however, aroused so deep an interest that for many years collectors and writers were busy searching for and describing fresh evidences in support of the Diluvial theory. It had indeed for some time no serious rival, and remained all but universally accepted down to the second half of the eighteenth century, when dissentients first ventured to make themselves heard. The last two decades of the eighteenth century were destined to witness a collapse of the Diluvial theory as rapid as its rise in the first decade, though Hugh Miller even found supporters of it in our own time.

During the seventeenth century the occasional protests of the rational minority, among whom we find Steno, made few disciples; but during the eighteenth their arguments were felt with increasing force. The Deluge hypothesis, faulty as it was, was a great actual advance, for it at least recognised the real nature of the objects, and turned discussion towards the means through which fossils came to be embedded. Though several authors wrote in a truly scientific spirit during this century, it was Blumenbach who first taught with authority that the beings to whose former existence these fossil forms were due were not only antediluvian, but pre-Adamitic, and that, moreover, there had been a series of faunas and floras inhabiting the earth before the age of man. The change in opinion, however, had long been preparing, and prominent among the questions that led up to it were: Are these the remains of the same kind of plants that are now found growing upon the earth? and, When did the originals live that have been preserved by changing into stone? Only two generations since the answers would have been universally that they were plants that grew but a few thousand years ago, and that they either grew where found, or had been brought from other countries by some such agency as the Flood, or else had been destroyed by these agencies and become extinct. Scheuchzer regarded them as plants which could still be found living, citing a number of genera as examples. Among many others who embraced this view was Lehmann (1756), who laboured hard to prove that the impressions of *Annularia sphenophylloides* were flowers of *Aster montanus*, caught in full bloom, and petrified *in situ*. The exotic theory, as it may be called, first appears in a note of Leibnitz, 1706, on the occurrence of impressions of Indian plants in Germany; and in 1718 Antoine de Jussieu discussed the resemblances of the coal plants of St. Chaumont to ferns of the tropics. Parsons (1757) stated that the Sheppey fruits were absolutely exotic, and Dulac soon after compared the coal plants of St. Etienne to American species. These instances are only a few among many, for similar views became commonly held. Volkmann (1720) and others held what may be described as a degeneration theory, believing that antediluvian vegetation was of a higher order, and free from thorns, thistles, and other scourges, while comprising many fruit-bearing trees of which our modern ones are the degenerate representatives. The same authors held at the same time mixed views, thinking that many of the petrified plants might have become extinct during the Deluge or other physical changes, and it was probably this idea that led to the more critical investigation of the stratified rocks, and brought the question as to when the originals lived within the region of practical science.

THE RECENT EARTHQUAKES AND VOLCANIC ERUPTIONS

TERRIBLE as has been the tale of destruction to life and property during the last six years owing to the exceptional activity of the subterranean forces in nearly every part of the globe, we cannot avoid the reflection that scientific men in the future will feel that there have been at least some compensating advantages for these sad losses. Never before, perhaps, have greater opportunities been afforded to us for collecting the real facts, and for testing, verifying, or correcting hypotheses concerning these interesting phenomena; and never, certainly, have such organised efforts been made to deal adequately with the great opportunities which have been afforded to us.

After the earthquakes at Agram, a Commission appointed by the Hungarian Government was sent to examine the district, and the result was a Report of great value and interest, in which the exact details of the actual phenomena observed were carefully sifted from the mass of vague rumours and gross exaggerations with which they had become involved. Admirable monographs on the terrible earthquakes of Ischia in 1881 and 1883 have been prepared by Prof. Mercalli, of Monza, and by our own countryman, Dr. Johnston-Lavis. The tremendous catastrophe which occurred in the Sunda Straits three years ago has already given rise to a vast mass of literature bearing on the subject. Commissions, including very competent observers, were sent to the district by the Dutch and the French Governments, and the former of these has already completed and published its very valuable Report. We may be certain, too, that the more