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*"To the solid ground
Of Nature trusts the mind which builds for aye."* --WORDSWORTH.

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SCIENTIFIC WORTHIES.

XXXV.—EDUARD SUSS.

AMONG the living leaders of geology none is more widely known and more highly honoured than Eduard Suess. The amount and value of his original contributions to science, the broad, philosophic grasp he has displayed of every department of research on which he has entered, the vivid, imaginative insight which has enabled him to marshal a multiplicity of scattered facts into connected order and sequence, the unwearied industry with which he has made himself acquainted with the geological literature of almost every country on the face of the globe, and the noble march of the literary style in which he has clothed not a little of his reasoning and speculation, have combined to give him a place apart, like that of one of the great masters in the heroic age of geology. Full of years and honours, and president of the Academy of Sciences, he still moves as the centre of the scientific life of Vienna, still enriches the world with his impressive pictures of the structure and history of the earth, and still manifests an ardent interest and enthusiasm in all that concerns the advancement of natural knowledge.

But for a wave of change in the world of commerce we might have claimed Suess as an Englishman, and his achievements might have added their lustre to the scientific fame of this country instead of Austria, for he was born in London and spent here the earliest years of his childhood. His father, who was a native of Saxony, had settled here as a German merchant, importing wool from Bohemia, and it was during the residence of the family in London that the eldest son and future geologist was born on August 20, 1831. When wool began to arrive in abundance from the vast sheep-runs of the Australian colonies, the trade in the

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Bohemian product declined so much that at last, in November, 1834, the Suess family left England for Prague. The father in 1845 became a partner in a great industrial establishment in Vienna, and that city was thenceforth the family home. It had been at first intended that the son should enter the same business, and accordingly at the end of the usual school training he was placed in the polytechnic school. But it soon became apparent that his natural bent did not lie in the commercial direction, but wholly towards natural history studies. As early as the year 1850, when he was only nineteen years of age, he ventured upon his first publication—a short sketch of the geology of Carlsbad and its mineral waters, specially prepared for the use of foreigners. So completely had his tastes now decided his future life that in the following year he was appointed an assistant in the Imperial Museum of Vienna, and thus made his formal entry into the official ranks of science. From that day until now the long intervening half-century, though uneventful in personal experiences, has been with him a time of ceaseless industry and fruitful research. A few more specially notable epochs in his career may here be noticed.

In the vast palæontological collections of the Vienna Museum Suess found a wide domain for the exercise of his powers of observation and comparison. He at first specially devoted himself to the study of the brachiopods of the Palæozoic and Mesozoic formations, and for some ten years continued to publish the results of his researches among these interesting and important fossils, but with incursions into other departments of the animal kingdom, which displayed a general enthusiasm for biological inquiry from the geological point of view. His zeal and ability were soon recognised by his being appointed in 1857, at the age of twenty-six, professor in the university. In 1862 he relinquished his post in the museum and devoted himself thenceforth to the duties of his chair. It was in this early part of his life that he entered upon those studies in palæogeography on which his scientific renown

now largely rests. As far back as 1863 he published a brief statement of the results to which his inquiries had led him as to the former connection of northern Africa with southern Europe. In 1855 he married the daughter of Dr. Strauss, a distinguished physician in Prague, and then entered on a life of great domestic happiness, which largely contributed to the success of a strenuous career wherein science and politics came to be strangely blended.

From his youthful days, when he described the Carlsbad springs, he had been interested in underground waters, and among the inquiries which he pursued while attached to the museum was one that embraced the relations of the soil and water supply of Vienna to the life of its inhabitants. In 1862 he published a small volume on this subject,¹ in which he gave a comprehensive account of the economic geology of the district. At that time the city was suffering from an impure water supply and consequent typhoid fever. The luminous essay of the young professor at once attracted attention. He was the same year elected into the town council, that he might give the benefit of his advice in the steps to be taken towards the attainment of better sanitary arrangements. He boldly advocated a scheme for bringing the abundant pure water of the Alps into Vienna by means of an aqueduct 110 kilometres in length. This project, eventually adopted, was brought to a successful termination in 1873. So grateful were his fellow-citizens for the signal service thus conferred on them that they bestowed on him their highest civic distinction by electing him an honorary burgess. By this time he had made his mark in the town council as one of its most useful and able members, so that it was not surprising that he should have been chosen as one of the parliamentary representatives. For more than thirty years he sat in the Austrian Parliament as a powerful leader of the Liberal party, only retiring in 1896, when advancing age made the strain of the two-fold life as a politician and man of science too great to be longer borne. When the political history of the country during the last half of the nineteenth century comes to be written, a prominent place in it will be given to Eduard Suess.

But it is his scientific work that has to be chiefly dwelt upon here. As an enthusiastic and able teacher he has exerted a notable influence on the successive generations of students at the university, until after forty-four years he resigned his professorship in the summer of 1901. Throughout his career he has shown a keen interest in those branches of geology which more especially deal with the evolution of the earth's surface features. The problems of mountain-building were suggested to him by his excursions among the eastern Alps, and in 1875 his views were so far matured that he published a little volume entitled "Die Entstehung der Alpen." This work contains the germ of those later contributions to science which have placed

him on so conspicuous an eminence among the geologists of the day. It sketches the general principles of mountain-architecture, especially revealed by a study of the Alpine chain. But he did not confine his view to the particular area with which he was himself personally familiar. Already his eye looked out on the wider effects of the unequal contraction of the terrestrial crust, and swept across the European continent eastwards into Asia, and westwards across the Atlantic into America. He still held the general belief in the upheaval and depression of continental areas, and dwelt on the evidence of these movements in Scandinavia, which he has since rejected with much elaboration of argument. To thoughtful students of the science this treatise, in its firm hold of detail combined with singularly vivid powers of generalisation, was full of suggestiveness. But the interest and importance of its subject did not obtain general recognition until it was followed ten years afterwards (1885) by the first volume of the great "Antlitz der Erde"—the work which has chiefly given Suess his place among his contemporaries, and by which his name will be handed down to future time.

In its striking arrangement of subjects, in its masterly grouping of details which, notwithstanding their almost bewildering multiplicity, are all linked with each other in leading to broad and impressive conclusions, and in the measured cadence of its finer passages, the "Antlitz" may be regarded as a noble philosophical poem in which the story of the continents and the oceans is told by a seer gifted with rare powers of insight into the past. The order of treatment is not that of a systematic text-book. On the contrary, the casual reader who looks over the contents of the chapters might suppose them to consist of a series of desultory essays with no very clear sequence of thought. Yet a more leisurely study soon shows him how closely interwoven is the texture of the whole composition. He is astonished at the almost incredible range of literature which the author must have consulted, and he finds himself borne onward page after page by the luminous array of facts and the brilliant conclusions drawn from them. From the ancient traditions of the Deluge he is led through other human records, and made to see by what combination of physical conditions changes are worked on the surface of the earth. Upheaval and subsidence, volcanic eruptions, the elevation of mountain-chains, the depression of sea-basins, the structure and disposition of continents, the formation and boundaries of the different oceans in the past as well as at the present day, the successive plications that in the course of geological time have produced the land areas and mountain-ranges of the globe—in short, the gradual evolution of the existing topography of the surface of the globe—this vast theme is here treated with a fulness of knowledge and a breadth of view which are to be found in no other author.

The work at once commanded attention among the geologists of every country, and the influence of its

¹ "Der Boden der Stadt Wien nach seiner Bildungsweise, Beschaffenheit, und seinen Beziehungen zum Bürgerlichen Leben." (Vienna, 1862.)

teaching before long became apparent in geological literature. It was first translated into French in an edition which, thanks to the singular erudition of its editor, M. E. de Margerie, has been so enriched with footnotes as to become an invaluable work of reference for published papers in every department of the wide range of subjects whereof it treats. Within the last few months the first volume of an English translation by Miss Hertha Sollas, under the direction of her father, Prof. Sollas, of Oxford, has been issued by the Clarendon Press. The labours of Prof. Suess are thus placed within the reach of all English-speaking geologists in a version which reads more like an original treatise in our language than as the translation of a German work.

That in covering so wide a field as that of the "Antlitz" the author has necessarily had to rely on recorded observations of unequal value, and that consequently the deductions he has drawn may need to be corrected from subsequently obtained fuller and more accurate data, will doubtless be admitted by no one more frankly than by himself. But even in regard to questions which have long been discussed, and regarding which abundant facts have long been known, there is room for different interpretations from those which the professor has adopted. Thus the phenomena of submergence and emergence of land in Sweden and the basin of the Baltic are treated by him in great fulness and with much ingenuity, but he arrives at conclusions strongly opposed to those to which prolonged study has led the northern geologists. This problem is one of fundamental importance in regard to our conceptions of the nature of the movements to which the surface of the globe is subject, and it is much to be desired that some general agreement in regard to it should be attained.

Nevertheless, apart from differences of opinion, which are inseparable from the growth of such a science as geology, and even where one may be most disposed to dissent from the views of Prof. Suess, the transcendent value of his life-long labours is none the less vividly realised now by all who have studied his writings. Their importance in the history of science will assuredly be no less fully acknowledged by the future generations who will gain from them inspiration and enlightenment. Meanwhile, he has the satisfaction of abundant recognition from all civilised countries. The learned societies of Europe have vied with each other in doing him honour, and not the least prominent among them has been our own Royal Society, which ten years ago elected him as one of its foreign members, and in the year 1903 awarded him the Copley medal—the highest distinction which it has to bestow. The "Antlitz" is not yet completed, but the second part of the third volume is far advanced. Let us trust that years of rest and quiet work are in store for the illustrious geologist, and that he may live to finish his work amidst the hearty congratulations of the many fellow-workers who look up to him as their master.

ARCH. GEIKIE.

THE RUDIMENTS OF BEHAVIOUR.

Contributions to the Study of the Behaviour of Lower Organisms. By Prof. Herbert S. Jennings. Pp. 256. (Washington: Carnegie Institution, 1904.)

THE author has been for about ten years a careful observer of the rudiments of behaviour which are exhibited by unicellular and other relatively simple animals, and we have read with interest several of his previous studies on the reactions of infusorians and the like to various sets of stimuli. The general impression conveyed was that infusorians and the like gave evidence of an exceedingly simple and stereotyped mode of behaviour—a mere reaction method. When effectively stimulated by agents of almost any kind, the animalcule moves backwards and turns to a structurally defined side of its minute body, while at the same time it may continue to revolve on its long axis. In relation to all sorts of stimuli, the behaviour seemed exceedingly simple and machine-like. But Prof. Jennings has been gradually discovering that the simple reaction-formula does not cover all the facts, and he now gives us news which seems almost too good to be true.

He finds that even among unicellulars "the behaviour is not as a rule on the tropism plan—a set, forced method of reacting to each particular agent—but takes place in a much more flexible, less directly machine-like way, by the method of trial and error." This is a momentous conclusion, notably in relation to comparative psychology. The data are foundation-stones for the science of animal behaviour, and the author is to be congratulated on his demonstration that the ways of even very simple creatures are more than series of "tropisms."

In his "Introduction to Comparative Psychology" (1894), Dr. Lloyd Morgan told the story of his dog's attempts to bring a hooked walking stick through a narrow gap in a fence. The dog "tried" all possible methods of pulling the stick through the fence. Most of the attempts showed themselves to be "error." But the dog tried again and again, until he finally succeeded. He worked by the method of trial and error; and so, Prof. Jennings now assures us, do the infusorians.

"This method of trial and error involves many of the fundamental qualities which we find in the behaviour of higher animals, yet with the simplest possible basis in ways of action; a great portion of the behaviour consisting often of but one or two definite movements, movements that are stereotyped when considered by themselves, but not stereotyped in their relation to the environment. This method leads upward, offering at every point opportunity for development, and showing even in the unicellular organisms what must be considered the beginnings of intelligence and of many other qualities found in higher animals. Tropic action doubtless occurs, but the main basis of behaviour is in these organisms the method of trial and error."

This is not the first time that the dawning of intelligence has been discovered in the Protozoa, but on previous occasions the discovery has been reported by casual observers or by investigators unacquainted with the tropisms. Prof. Jennings has made a special