the regard of the specialist of which it is almost impossible to over-estimate the importance. Leaving to the zoologist and geologist his work on Coral Islands, and monographs on the *Oligopodium,* and various fossil groups, the botanist claims the great naturalist as his own on the grounds of a series of physiological methods, which, while undoubtedly do serve to illustrate and emphasise the hypothesis of a race which is not at all to appeal with equal success to the anti-Darwinian. The most uncompromising opponent of Darwin's brilliant synthesis cannot fail to appreciate his patient, but no less brilliant, analysis. The theory based on his results may be rejected, or be modified with the laudable aim of adding new knowledge, but the results themselves hold good. In a high degree this is the case with the series of works of which this on the Power of Movement in Plants is the most recent. Each volume is crowded with experimental evidence, given with the scrupulous care which is a special characteristic of our foremost English naturalist.

The qualities impressed upon those researches whereby he revolutionised the study of biological science are met with in all his handiwork, and add to his writings this further value, in that they serve as perfect models for the younger student to follow. If England is to build up a school of botanical philosophy like those of France and Germany, and which ought to be possessed by the country of Bay, of Grew, Hales, Andrew Knight, and Robert Brown, it will be through the careful study by our younger botanists of the method followed by such a master as Mr. Darwin.

Fifteen years ago, the "Journal" of the Linnean Society contained a series of papers (afterwards republished), in which were brought together and most beautifully described a mass of experiments bearing on the movements and habits of climbing plants. They consist of an examination into the nature of certain movements, general or local, which have for their object the placing in a suitable position of a plant which is structurally too weak to support itself. Of such a nature are the climbing of an entire plant by the twining of its stem, and the carrying out of the same object by means of specialised organs called tendrils, or other organically not true organs, such as the leaf-clasts of the clematis, functionally tendrils. Many of these movements had been recognised, with more or less accuracy, from early times; but to Mr. Darwin belonged the credit of analysing their nature, and to a certain extent explaining their cause. The present work may be looked upon as a continuation and amplification of the same line of research, and in it the phenomena are in some respects more remarkable than any with which the author has hitherto dealt. Mr. Darwin has a habit of describing remarkable results. Some of his books might almost lay claim to be ranked as romances, with their hundreds of pages of scenery; here we have a few hours of study, and every stage in the process whereby the perhaps unanticipated goal is attained is clearly and carefully described and copiously illustrated; while the style is easy, and the language sufficiently untechnical not to place unnecessary difficulty in the way even of the "lay" reader.

In twining plants, Mr. Darwin found that the apex of the stem, with a few of the youngest internodes, leaves over to one side in a continually varying position. Now, the end hangs over toward the north, then gradually more and more easterly till it bends toward the east, then to the south, then west, till finally it bends toward the north again, having in a space of a few hours undergone a motion of sometimes considerable size. In its pure form, this "revolving notion," as it was called, is unaccompanied by any torsion or twisting of the axis. That side of the nutting stem which faces the north, faces the north throughout the movement.

In the present work, Mr. Darwin proceeds to show that revolving notion, or "circumvolution," as he now proposes to term it, is one of the means conferring on plants an adaptation to life in the Mountains and Habits of Climbing Plants. On the contrary, it is met with in a more or less modified form in all young and some mature organs; that all the varied movements known to modern science, such as the sleep of leaves, the opening and closing of flowers, &c., are modifications of it; that besides these evident cases, many organs, such as the leaves, where its existence would hardly be suspected, are endowed with it; and, indeed, that the position which every part of a plant assumes, whether in its young or full-grown state, is the resultant of its movements of circumvolution, modified more or less profusely by external causes. Mr.

THE MOVEMENTS OF PLANTS.

Besides those works with which in the popular estimation his name is more intimately associated, Mr. Darwin has claims on

Darwin shows that when young, every part of a plant is in constant motion, the movement being usually not in a true circle (or rather, circular-spiral), but in the form of an ellipse in which the two axes of the successive figures not being continually in the same direction, but intersecting each other at various angles. To take a hypothetical case, assuming that the organ is leaning over so as to point to the east, it gradually alters its position, so that in a series of ellipses it is directed first to the north, then, when going on pursue a rectilinear course (when projected upon a plane), but a more or less pronounced curve by the south; it then returns to the east, but by a line curved to the north. According to the definition of the curvature follows the degree of the curve, the result of the resulting ellipse, as we have seen above, the figure may simulate a true circle; while with leaves it is usually very narrow, often approaching the straight line. This is the movement reduced to its simplest form, but as a rule it is more complex, for the apex, while pursuing this general course, goes out of its way, as it were, to travel in a zigzag, or produces small secondary loops, which may disguise the shape of the ellipse. The very numerous diagrams of movement given in the book show clearly enough that there is, however, always one general direction which prevails. Just as the position of the leaf, the habit of lobation or serration can be disregarded, so in judging of the movements of the parts of plants, such minor eccentricities can be overlooked. As for the cause of the movement, it was at one time the custom to ascribe it to increased growth in varying positions, but it is now appreciated how much more to do with the varying degree of turpuficity in the plastic cells of which the young growing part is built up.

The volume commences with an account of the movements of the different parts of the seedling plant, and it is in these earlier chapters that the most wonderful and unexpected results are recorded. The movements even before the seedling has appeared above the surface of the ground. The radicle, or primary rootlet, the first part of the plant to be developed, is the first to manifest movement. This it does from the moment it is protruded from the seed-coat. Through the sensitive tissue towards the surface (or top); during its elongation it continues to bend and grow, and thus, by displacing the particles of earth, its penetration is rendered more easy; and having once penetrated the soil, it is fixed, it may be by the root-hairs, or by some special and occasionally striking contrivance, and thus a "purchase" is obtained which materially assists the further penetration of the rootlet. The tip of the radicle then, like the thin end of a wedge, pierces between the particles of earth, always with its circumnutating power ready to be manifested if, from any cause, the pressure of its own weight is removed. Thus, through a very slight turpuficiency of the friable soil, and, if it finds a fissure, such as a worm-burrow, it can readily avail itself of it. At the same time, Mr. Darwin shows by numerous experiments, the tip is sensitive to the smallest differential pressure (e.g., one two-hundredth of a grain), turning away at once from the most pressed side, and well, therefore, bend from any obstacle, and, as the author pointedly puts it, "thus follow with unerring skill a line of least resistance." As Sachs had previously shown in general terms, the radicle is sensitive to the direction of moist air, and this sensitiveness also Darwin shows to reside in the tip; but, unlike the irritation of pressure or injury, moisture causes a deflection towards its source,—a happy provision, which gives rise to what one feels tempted to call an instinctive power of seeking the dampest parts of the soil. The functions thus resident in the tip of the radicle may be fairly described as wonderful, and the same is likely referring to a few of their most noticeable manifestations. The tip in this way determining the course of the root, also transmits its sensations to the neighbouring parts; so that, with characteristic boldness, Mr. Darwin compares it to the brain of one of the lower animals, "a true head, impregnated from the sense-organs, and directing the several movements."

More readily noticeable are the properties of the stem portion of the seedling plant. Almost invariably it breaks through the surface of the soil in the form of an arch, while in its case also there is a tendency to circumnutation, kept in check by the pressure of the soil itself; but after its appearance above the surface of the ground. The faintest ray of light acting strongly upon it, and in a manner the reverse of its action on a root, will direct the young stem along any chance fissure in the surface of the soil, or, if the plant be already somewhat grown, through vegetation amongst which it may be hidden. The plant now开发利用the movements of the young stem, the exudation of the external forces which are acting upon them act in different ways and to varying extent. With these generalised or localised movements, of the nature of what Mr. Darwin calls "modified circumnutation," the author deals in the second part of the volume. Here we meet with any old friends, such, for example, as the sensitive plant (Mimosa pudica), which to the botanist occupies almost the same position as the frog to the animal physiologist. The various phenomena of climbing and sleep, and the different actions of light and gravity, are here treated of in full. The author shows that, while growing, every part of the plant, "each shoot, petiole, sub-petiole, and leaflet is constantly describing small ellipses," and the clearly visible movements of many organs are only an exaggeration or modification of their primitive circumnutation, directed to some special end. While reading these chapters, one feels that here at last is the true poetry of motion, and that another world of active life has been included within the ever-receding horizon of human knowledge.

The volume is copiously illustrated, chiefly with diagrams of movement. Owing to the process of drawing adopted, these diagrams do not represent the exact nature and amount of the movement of the part. They serve only, as the author reminds us, to show that the part has moved, and in what general manner. It would have been acceptable if, in some few representative instances of the large number which have been represented diagrammatically by a projection. In the diagrams, as they stand, the greater the obliquity of the movement the greater the distortion of the representative figure. In examining them, in order to get an idea of the actual extent and direction of the movement, the reader must through much the same sort of mental process that would be necessary to enable him to recognise his own features, when viewed as reflected from the back of the bowl of a table-spoon.

It is a constant complaint that modern scientific work is anything but direct, positive, and concise; but with this book construction and construction go hand-in-hand. While none more than he has laboured strenuously to break down the barriers of ignorance and prejudice which, like the "Sea of Ancient Ice," fence around the still un conquered pole of the biologist, with equal zeal has he laboured to build up clearer and, we would fain say, truer conceptions of what, in its diverse manifestations, life is. Whether he look upon his works as models of legitimate deduction, or merely as marvellous showplaces of facts, their value is the same. And equally in laborious accumulation of detail, in lucid exposition of fact, in cogent deduction, and in candid appreciation of the achievements of his historians and contemporaries, The Power of Movement in Plants is the foremost of Mr. Darwin's botanical works.

THE DUKE OF ARGYLL ON NATURE AND THE SUPERNATURAL.*

The essay which the Duke of Argyll has contributed to the January number of the Contemporary Review, under the somewhat misleading title of "The Truthfulness of Human Knowledge," will be generally felt, we believe, to be the most interesting of his present series. We hasten to declare the title out of harmony, in our opinion, with the substance of the article, because it appears to us to suggest, quite untrue, a close and decided distinction which would have very little value, and thus to deal with the reader's interest in a misleading manner. Before we can discuss the truthfulness of human knowledge, we must have some other kind of knowledge to compare it with, some independent acquaintance with the subject-matter of human knowledge by which we might test its value. The Duke, indeed, as he promises, guarantees for the trustworthiness of the faculties which are all we have to work with. As Dr. Newman says, we do not so much trust as use them. Moreover, it does not appear to us that knowledge is the appropriate word for the faculty which the Duke means to defend. The ordinary use of the word coheres only to a name that is acquired by a great many unquestioned beliefs, those at least which there is a consensus of opinion among all educated persons. We cannot but regret that he did not confine himself to the profoundly luminous suggestion as to the limitation of human knowledge which we lately noticed (a suggestion we feel much strengthened by the present

* Contemporary Review, January, 1881.