heredity and variation. Darwin recognized many different grades of variations among animals and plants. These range from the sudden large change which De Vries calls mutation to the minute fluctuations which separate individual from individual. But Darwin saw no fundamental difference between the wide and the narrow oscillation, nor has such difference been clearly shown by any one. With all admiration for the painstaking and illuminating work of De Vries, I do not think that the question of the origin of species has been affected by it. Species in general do not arise through mutation, or the abrupt separation of one individual from the rest of its kind. If any single species should be shown to have arisen in this way, it would not change the general relation of the recognized factors in evolution, for a mutation, like any other variation, is dependent for preservation on heredity, on selection and on separation or isolation.

Since Darwin's time, natural selection has been exalted as all-powerful by many writers who, as Darwinians, went far beyond Darwin himself. In reaction, other authors have denied to selection, not merely "*allmacht*," or all-sufficiency, but any sufficiency or reality at all. It is enough for our discussion to disclaim all these extreme views. Selection must find its place in the heredity of any individual or species. We know no other cause for the myriad adaptations of life to its environment. We know no other reason for progressive adaptation. And yet the actual traits of actual species are largely non-adaptive.

The splitting of forms into different species is everywhere associated with geographical separation. One form may be as well fitted as another, one set of color markings as convenient as another, but if barriers of land, or sea, or climate, or food shut off one from another, each will persist in its own place, in its own way.

The study of the geographical, faunal and geological distribution of life on the earth, which has been pursued with such energy and with such success since Darwin's time, has laid greater and greater stress on the effect of barriers in producing species. With this, the effect of constant pressure in the same direction, extending through long periods of geological time, has been dimly perceived and recognized under the term Orthogenesis. If all individuals could move anywhere on the earth without friction, all animals closely enough related to interbreed would assume a common character. There is everywhere friction in geographical distribution. As dialects form in human speech, where men cease to mingle evenly, so species form among animals or plants where there exists a check to migration. The separation of forms by barriers is a natural process, but it is not a part of natural selection, but rather a distinct factor, natural separation. But the extension of our knowledge of this or other factors has not changed the general situation, for the general facts of geographical distribution were clearly recognized by Darwin. It is, in fact, from a study of these phenomena as shown in species inhabiting the coasts of South America that Darwin was first drawn to the problem of the origin of species. Prof. Conkin observed not long ago, "On the whole, then, I believe the facts which are at present at our disposal justify a return to the position of Darwin." This he said with reference to a special problem in heredity, but these words apply to many others. "The position of Darwin" is very safe standing ground. What we have learned with better tools and keener insight into minor details has not changed the large problems very much, and this, as Conklin said again, is "but another testimony to the greatness of that man of men, that, after exploring for a score of years the ins and outs of pure selection and pure adaptation, men are now coming back to the position outlined and unswervingly maintained by him."

The chief and essential contention of Darwin, that species are formed by natural tangible processes, is now absolutely beyond question from those competent to form an opinion. That the animals and plants today, man included, are descended from the animals and plants of earlier periods by natural lines of descent with natural modifications, due to innate and external causes, is one of the certainties of science.

ELECTROCULTURE OF PLANTS.

AN ACCOUNT OF SOME RECENT EXPERIMENTS.

The first experiments on the influence of electricity upon the growth of plants date from the year 1885, when Prof. Lemström, of Helsingfors University, demonstrated the favorable results obtainable by "electroculture." Since then little progress has been made in this field, notwithstanding the fact that a number of investigators have given it their attention, and that the modern developments of electrical engineering have placed at our disposal many new resources. In fact, until recently the work had nowhere passed beyond the purely experimental stage. Of late, however, investigations have been carried out on a large scale in England by Sir Oliver Lodge in conjunction with the well-known agriculturist J. E. Newman and Mr. R. Bromford, the last mentioned of whom is the owner of large estates. The experiments have been planned under conditions resembling as closely as possible those met with in actual practice. The work was begun in 1906, using at first a plot of about ten acres. Latterly this has been extended to about twenty-five acres. The electrical installation is in general character similar to that used by Lemström. It consists of a system of wires strung from insulating supports over the field. This system is connected to the positive pole of a small dynamo, giving three amperes at 220 volts. The other pole of the dynamo is earthed. The motive power is supplied by a 2-horse-power benzine motor. The alternating current from the generator is transformed up to 100,000 volts, and is then rectified by means of a special mercury rectifier due to Lodge. This high tension is quite free from danger, as the quantities of energy involved are very small. Its advantage is that the wires can be placed at a considerable distance from the ground without greatly diminishing the effect on the plants. The distance chosen was 17 feet, which gives ample space for carrying out all the necessary labor, and for the passage of heavily-loaded wagons beneath the wires. This represents a very important step forward, as it was necessary hitherto to place the wires within about two feet from the ground, an arrangement which is obviously so inconvenient as to practically bar it from actual use on a commercial scale. The proper insulation of the wires carrying the high-tension current presents no difficulty with the means which modern methods place at our disposal.

When the current is turned on, a discharge occurs from the wires to the ground, often accompanied by a crackling sound, and at night by a glow. In 1906 the field was sown partly with English, partly with Canadian wheat, and exposed to the action of electricity on 90 days, in all during 622 hours. At night the current was switched off. The experiments seem to show that favorable results are obtained if through the summer the discharge is allowed to take place during the hours of early morning, while in spring and on dull days it is best to continue the discharge all day. The principal effect appears to be produced on young plants. The seedlings raised under the influence of electricity were found to be more deeply colored and altogether more vigorous than those grown for comparison in a blank experiment. At a later stage the stalks measured 10 to 20 per cent more in length than those in the check experiment. When flowering began, the current was turned off. The ear began to form about the same time both in the treated and the untreated field, but the grain was ripe for cutting three or four days earlier in the former than in the latter.

The increase in yield thus produced by electroculture was 39.2 per cent in the case of Canadian wheat, and 29 per cent in the case of English wheat. The product is said to be also of better quality.

The experiments were repeated in 1907, and were also extended over a large strawberry bed. The current was supplied on 115 days during 1,014 hours in all. There was 29 per cent increase in the crop of Canadian wheat. The strawberry crop exceeded that of the check experiment by 35 per cent. Good results were also obtained with tomatoes and raspberries. In the case of the latter it appeared that the older plants were not affected, while there was a strong influence on young stocks.

An entirely different method of electroculture has been followed by an Italian investigator, Philipo Campanile. A very considerable improvement in the crops on poor, unfertilized soil was obtained by burying under it at intervals plates of zinc, copper, and iron connected by inducting wires. The copper-zinc pairs were formed throughout to give better results than the copper-iron couples. Campanile's observations agree with those of Lodge in that the principal effect appeared to be on the young plants, germination taking place two to four days earlier under the influence of electricity than under the ordinary conditions.

Another application of electricity to agriculture was exhibited by Le Roy at the exposition at Marseille. Especially good results were obtained by Le Roy's method in the case of asparagus and strawberries. In this case it is not the direct action of electricity that is brought to bear on the plants, but the heat generated in a network of resistance wires buried in the ground. It seems somewhat doubtful whether equal results might not be obtained here by other, more economical methods of heating.

The question of expense will no doubt be the principal factor in determining whether or not electroculture is to be ultimately introduced in practice, now that technical difficulties have been removed by Lodge and his collaborators. As regards running expenses the system placed under trial in England seems to be very satisfactory, considering that an increase of 30 to 40 per cent in the output was attained with an expenditure of only about two thousand horse-power hours. The conditions appear a little less favorable as regards cost of installation, which may run somewhat high for posts, wires, insulators, etc. As regards the power plant, it should be possible to make this repay fully its own cost, by using it in fall and winter for a variety of agricultural duties, such as threshing, grinding, cutting, etc., to say nothing of furnishing light. The cost of maintenance of the wires would probably be small. The outlook seems favorable, and we may expect before very long to hear of large-scale practical applications. Probably, however, the first developments will be not so much in general agriculture as in horticulture, in market gardening, and in raising "forced" products in our temperate latitudes.—Translated for Scientific American Supplement from Prometheus.

PETROLEUM IN 1908.

The great gain in production of petroleum in 1907 over 1906 required such a drain on all the great pools and developed so large a stock of unused crude oil that a further increase in 1908 was not logical, as a matter of either finance, trade requirements, or available petroleum resources. As the year went on, unprecedented floods in May and June and again in November brought disaster to the pipe lines of Oklahoma; and these storms also left a record of numerous oil tanks destroyed by lightning. In the eastern fields the severe drought also seriously interfered with well drilling. The decline in production in the Glenn pool and in various Texas and Louisiana pools increased the likelihood of a total smaller than in 1907.

Nevertheless, the actual record of the year shows a total beyond all records—between 175 and 180 million barrels, compared to 166 millions in 1907, or between 5 and 9 per cent increase. The total value is proportionately greater still, for the price of the product in California increased and it remained steady in other fields, except the Gulf, where a comparatively groundless fear of overproduction from the new Markham and Goose Creek fields caused depression.

The increase came from the steady growth in Illinois and California. Neither field showed phenomenal development. California responded to the higher prices consistent with depleted stocks, and Illinois showed the continued effect of the great investments of the previous year in this new territory.

The year, however, had its sensations. They came in midsummer. On July 2nd a large gusher was drilled in at Goose Creek, Harris County, Texas, and three days later a gusher of the Spindletop type came in at Markham, in Matagorda County. This turned the attention of the oil producers in the Gulf field significantly farther south.

July 4th proved memorable in three widely separated regions. At Anse la Butte, La., a large gusher known as Lake No. 9 was drilled in. On the same day the Pearsons in Mexico opened a well that assumed the proportions of a volcano and made a new world's record for an outburst of oil and water. Incidentally it is interesting to note that on the same day the Oil City well at Tustanowicz produced the record spouter for Galicia.

The elasticity of the American oil trade is shown by the fact that stocks did not increase as much as would have been expected from the great product. The preparations of the year before led to better ability to transport the product to points of consumption.

In the isles of the Pacific and certain regions of South America the natives use a so-called "candle-nut" to furnish them with light. This nut burns without smoke or odor, giving a good white flame. It is provided by nature with a channel or perforation which forms a very convenient space for inserting the point of any suitable object to support the "lamp." The nut also serves as food to the natives.