

bending could be proved to occur within fifteen to thirty minutes, if bright sparks were supplied at the rate of only one per minute. The most extreme sensitiveness that I have observed in these experiments was that of perceptible bending after half-an-hour's exposure to electrical sparks following one another at the rate of fifty in an hour. This result would appear to indicate that in heliotropism under flashing light there need be no summation or "staircase effect"; but that each flash or spark may produce its own effect independently of its predecessors or successors.

IV. It is noteworthy that, while the heliotropic effects of flashing light are thus so remarkable, they are unattended with the formation of any particle of chlorophyll. In the many hundred pots, and therefore many thousands of plants, which have passed under my observation in this research I have never seen the slightest shade of green tingeing the etiolated seedlings which had bent towards flashing light. On one occasion I kept a stream of 100 sparks per second illuminating some mustard seedlings continuously for forty-eight hours; and although this experiment was made for the express purpose of ascertaining whether any chlorophyll would be formed under the most suitable conditions by means of flashing light, no change of colour in any of the seedlings was produced.

With the exception of those mentioned in the last paragraph, all these results were obtained by using sparks from the coil condenser, as above explained. These sparks were very brilliant, and yielded the maximal results, which alone are here recorded.

V. "Experiments in Germination." By G. J. ROMANES, F.R.S.
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The primary object of these experiments was to ascertain whether the power of germination continues in dry seeds after the greatest possible precautions have been taken to prevent any ordinary processes of respiration for practically any length of time.

The method adopted was to seal various kinds of seeds in vacuum tubes of high exhaustion, and after they had been exposed to the vacuum for a period of fifteen months to remove them from the tubes and sow them in flower-pots buried in moist soil. In other cases, after the seeds had been *in vacuo* for a period of three months, they were transferred to sundry other tubes respectively charged with atmospheres of sundry pure gases or vapours (at the pressure of the air at time of sealing); after a further period of twelve months these sundry tubes were broken, and their contents sown as in previous case. In all cases, excepting that of the clover, the seeds sown were weighed individually in chemical balances, and seeds of

Kinds of seed.	Air (control).	Vacuum.	Oxygen.	Hydrogen.	Nitrogen.	Carbon monoxide.	Sulphuretted hydrogen.	Aqueous vapour.	Ether.	Chloroform.	Totals.
Mustard	6	1	8	6	1	1	6	1	8	8	46
Red beet	14	1	14	16	17	12	19	10	17	13	133
Clover	4	3	1	5	2	1	4	0	1	0	21
Peas.....	6	1	8	9	8	6	6	9	9	0	62
Beans	2	2	2	2	2	2	0	2	2	2	18
Spinach	4	3	3	4	3	4	1	4	3	2	31
Cress	9	8	10	10	10	6	8	0	4	5	70
Barley	2	4	4	4	4	1	0	4	6	3	32
Radish	4	8	1	1	9	1	0	6	4	8	42
Totals	51	31	51	57	56	34	44	36	54	41	455

similar weights taken from the same original packets were similarly sown as controls.

The table on p. 336 gives the results of one such series of experiments, where the exhaustion of the tubes was kindly undertaken by Mr. Crookes, F.R.S., to whom I must express my best thanks for the assistance he has given. But it may be mentioned that other series of experiments yielded virtually the same results.

With the exception of the beans, where only two were sown, ten weighed seeds were sown out of each of the tubes, and also out of each of the control packets which had been kept in ordinary air from the first. These results amply prove that neither a vacuum of one-millionth of an atmosphere, nor the atmospheres of any of the gases and vapours named in the above list, exercised much, if any, effect on the germinating power of any of these seeds. I may add that the same remark applies to an atmosphere of carbon dioxide, although in the particular series of experiments quoted this gas was accidentally omitted.

A subsidiary object of these experiments was to ascertain whether any appreciable variations would be caused in plants grown from seeds which, before germination, had been submitted to the conditions above explained. Hundreds of plants of the kinds named in the above table were grown from the seeds in the various tubes. But in no one instance was there the smallest deviation in any respect from the standard type grown from the corresponding control packet.

It will be observed that, in the case of the beet-root, a larger number of plants were developed in many of the pots than the ten seeds which had been sown in each. This I found to be due to the fact that beet-root seeds very frequently throw up two seedlings apiece. Not so frequently, but still very often, they yield three, and sometimes even four.

Further experiments are in progress.

Presents, November 16, 1893.

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