A Botanical Physiologist of the Eighteenth Century.

BY

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With Plates XLIV.—XLVI.

British physiologists are justly proud of their great countryman Stephen Hales, and any evidence of the persistence of his influence on the study of Botany in this country is of interest. The true spirit of experimental inquiry, as practiced by Hales, is evident in the interesting collection of drawings made for Professor Hope[1] of Edinburgh between about 1770 and 1785, which Professor Balfour has been good enough to place in my hands.

I have also been allowed to see a manuscript volume containing John Hope's *Lectures*. They are obviously written with zest, and are clear and vigorous. He makes frequent reference to the work of Hales, Du Hamel, Mariotte, Bonnet, and others, and marshals the facts he borrows so as to form interesting discussions. But he is by no means solely dependent on the work of others; he is continually quoting his own experiments on growth in length and in thickness, on the ascent of water, on root pressure, on the much-discussed circulation of the sap (against which he argues forcibly), on the position assumed by leaves, on heliotropism, &c. The experiments are well devised and the results clearly given. The amount of his own contributions is sufficient to give an attractive atmosphere of originality to the whole.

[1] John Hope succeeded Charles Alston as King's Botanist in Scotland, Regius Keeper of the Royal Botanic Garden, Edinburgh, and Professor of Botany in 1761, and held these appointments until his death in 1786. For a time also the teaching of Materia Medica was attached to his botanical offices. An account of his life and work will appear in an early number of these "Notes," and here it need only be said that, as was the custom of his time, John Hope combined his botanical work with that of a Physician and teacher of Clinical Medicine, and consequently one might have expected that, like other botanists in his century in like positions, Botany as ancillary to Medicine and Materia Medica would have sufficed as a field of his investigations. It is therefore all the more interesting to have the evidence which Mr. Darwin has sifted here, that problems of life and response to factors of environment attracted him.—*I.B.B.*

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Some further reference to this valuable MS. will be made in discussing Hope's drawings—with which I am chiefly concerned.

These are some 80 in number, about half being duplicates, and are grouped according to subject in folded sheets of drying paper. In spite of their small size—the majority are about 10 x 13 inches—they seem to have been employed in lectures, because we find on them such notes as "Not used, 1785." Most of them seem to have been drawn[1] from nature in red chalk and carefully re-copied in sepia or some dark-coloured water-colour. Why they were so reproduced is not evident, since the chalk drawings are clearly superior to the copies.

Fig. 1, Plate xliv., is a good representation of the nyctitropic movements of a clover (*T. repens*). It is certainly drawn from nature, and, indeed, Hope could not, as far as I know, have found at that time any published figure of a sleeping clover leaf to copy from. Clover is not figured in Peter Bremer's dissertation on *Somnus Plantarum*,[2] where, moreover, the description of the sleep-movements, in this genus, is very imperfect.

Fig. 2, Plate xliv., is also drawn from life and is probably the earliest existing illustration of a sleeping *Desmodium*. In the figure in the *Power of Movement in Plants* the fact that the little lateral leaflets are not depressed like the terminal one is clearly shown.[3] It seems probable that Hope did not notice this; at any rate it is not made clear in his sketch.

Fig. 3, Plate xliv., is described as an *Acacia*, but as Hope notes that the upper surfaces of the leaflets meet each other it is practically certain that it represents a *Cassia*. It is difficult to understand how Hope could have made this mistake, and it is conceivable that the drawing was inscribed "Acacia" by the artist. Moreover, there is in the *Amœnitates* a good figure of a sleeping *Cassia*, from which, however, Hope's diagram is certainly not copied.[4]

The most interesting of Hope's experiments are those dealing with the combined action of light and gravity. Du Hamel[5] made

[1] The majority are signed J. Lindsay or J.L.; some are by Bell, and an occasional one is signed A.F.

[2] *Amœnitates Academicæ*, vol. iv., 1760, p. 333.

[3] P. 358; the fact that the small leaflets are awake, at any rate during the early part of the night, is given at p. 362.

[4] The *Cassia* figured (p. 371) in the *Power of Movement* is possibly the same species as that in the *Amœnitates*.

[5] *Physique des Arbres*, 1758, vol. ii, p. 148.

an inconclusive experiment bearing on this point. He says that seedlings, over which a horizontal plate of an opaque material is suspended, do not grow straight upwards, but curve outwards from the centre. He notes that, if the plate is made of glass, the seedlings grow vertically up until they nearly touch it. But it is not clear that he recognised a heliotropic effect, since he seems to have expected to get different results by employing copper, porcelain, and cardboard as his opaque material. Hope made this experiment (*MS. Lectures*, p. 94) and illustrates his method in Fig. 12 on the plate following p. 102. He clearly understood that the outward curvature of plants shaded by a piece of board is an effect of light, for he gives other experiments to settle the question whether such movements are "to get at the light or the air," and decides in favour of light.

Another set of excellent experiments directed to the same point are illustrated in his diagrams.

Fig. 4, Plate xlv., shows *Asperula odorata* curving upwards "in the open air," *i.e.*, probably when lighted from above.

In Fig. 5, Plate xlv., the same plant shows apogeotropism when but faintly lighted from below.[1]

Fig. 6, Plate xlvi., shows that when the plant is well illuminated from below by means of a mirror, the geotropic curve is straightened out by the stimulus of light.

Fig. 7, Plate xlvi., shows another method for demonstrating the victory of heliotropism.

These experiments were made in June 1780, but the facts were not known to physiologists until nearly 100 years later, when H. Müller Thurgau[2] and Elfving[3] published them. It is true that in 1833 Schultz Schultzenstein[4] says that "seeds of *Brassica oleracea*, *Sinapis alba*, and *Phaseolus vulgaris* placed in moss and arranged so that they receive the sun's rays by means

[1] It is not certain that the curve shown in Fig. 5 was produced under these conditions. Probably it is meant to show that the curvature obtained in Fig. 4 remains under the conditions of Fig. 5.

[2] *Flora*, 1876, p. 94.

[3] *Acta Soc. Sc. Fennicæ*, T. xii, 1883, p. 25: Elfving's paper is, however, dated 1880. The experiment is included in F. Darwin and Acton, Practical Physiology, ed. iii, p. 182.

[4] See "Rapport sur le grand prix de physique" in the *Archives de Botanique* ii., p. 431. The author's name is here given as Schultz, but from the nature of the *Rapport* it is clear that he is the Schultz Schultzenstein celebrated for his unconvincing work on latex.

of a mirror, from below, and not otherwise, direct their stems towards the earth and their radicles towards the sky." But this discovery seems to have been generally overlooked, though it is mentioned in Treviranus' *Physiologie*.

Among the remaining diagrams, the most interesting are those which give the result of Hope's investigation of the distribution of longitudinal growth in stems. In this he was probably following Hales,[1] who marked both leaves and stems at regular intervals, which being remeasured gave the desired result. As far as stems are concerned Hales' method is not nearly so good as that of Hope. Hales marked a vine shoot in the spring and only remeasured it in September. Hope marked the young shoots of trees and of a hop and measured the increase of each zone at intervals of either one or two days. If he had persevered he would certainly have made out the laws of the distribution of growth which we owe to Sachs. But he seems to have been careless in measuring the marked zones, and though he notes as remarkable that the quickest growth was not necessarily in the zone nearest the apex, there is no evidence that he had mastered the problem: his observations and the diagrams in which they are embodied are hardly worth reproducing. In his *MS. Lectures* (p. 50) he draws the interesting conclusion "that stems do not elongate exactly as roots do (according to Mr. Du Hamel), but that they elongate not only at the extremity but even in the part near it." This generalisation is an approximation to Sachs' teaching on the subject.

Hope also made experiments on the "descent of sap" by the well-known methods of "ringing" and of compression by means of ligatures. His diagrams are records of actual experiments, but they are hardly worth giving, since both Hales and Du Hamel had previously published drawings illustrating this method of inquiry. Nor does it seem necessary to reproduce Hope's records of the healing of injured tree-trunks, though they are not without a certain interest.

[1] Vegetable Staticks, 1727, p. 330.

Fig. 1. Fig. 2. Fig. 3.

Professor Hope's Diagrams.

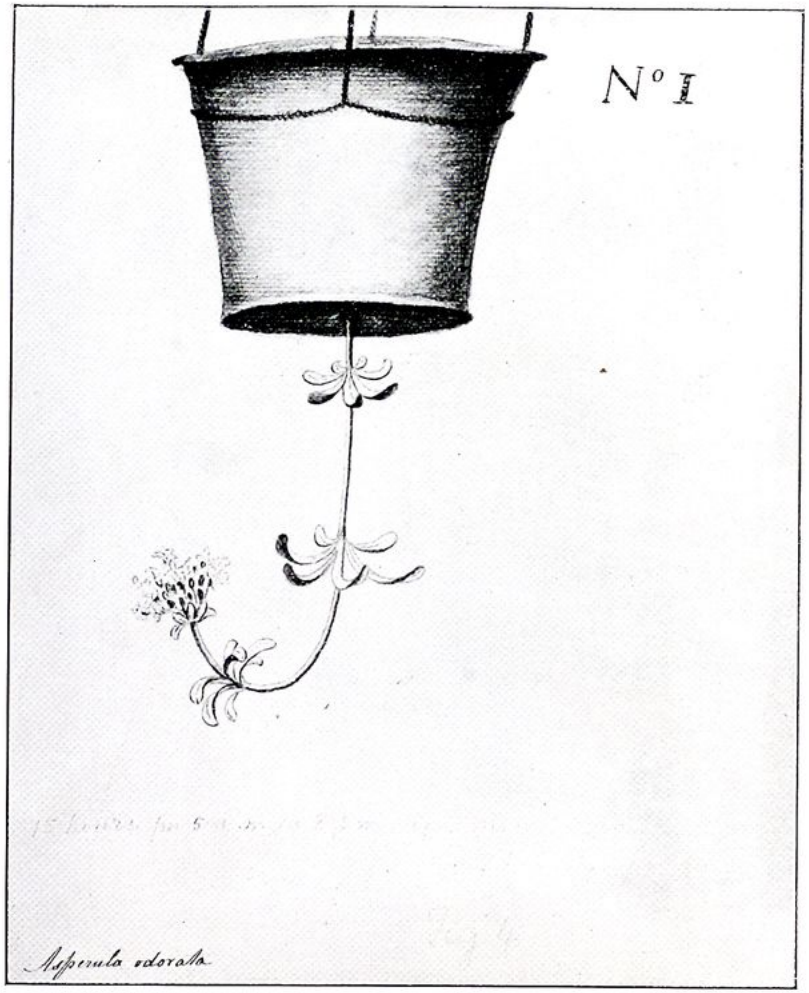

Fig. 4.

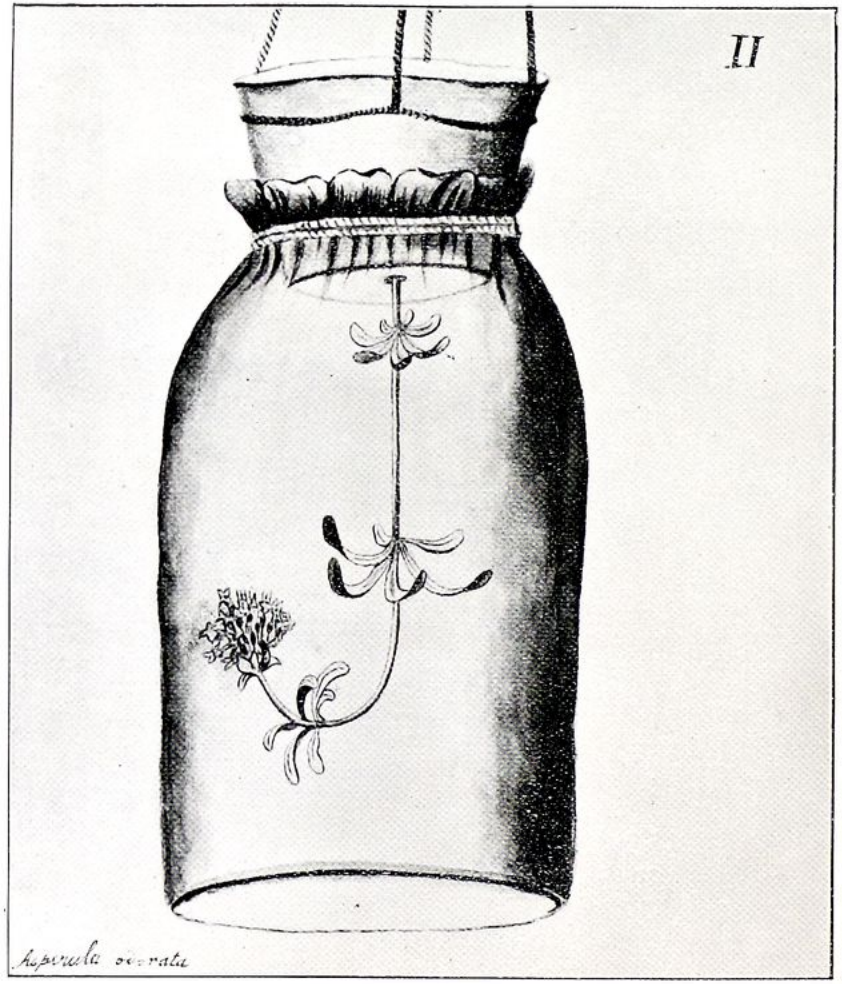

Fig. 5.

Professor Hope's Diagrams.

Fig. 6.

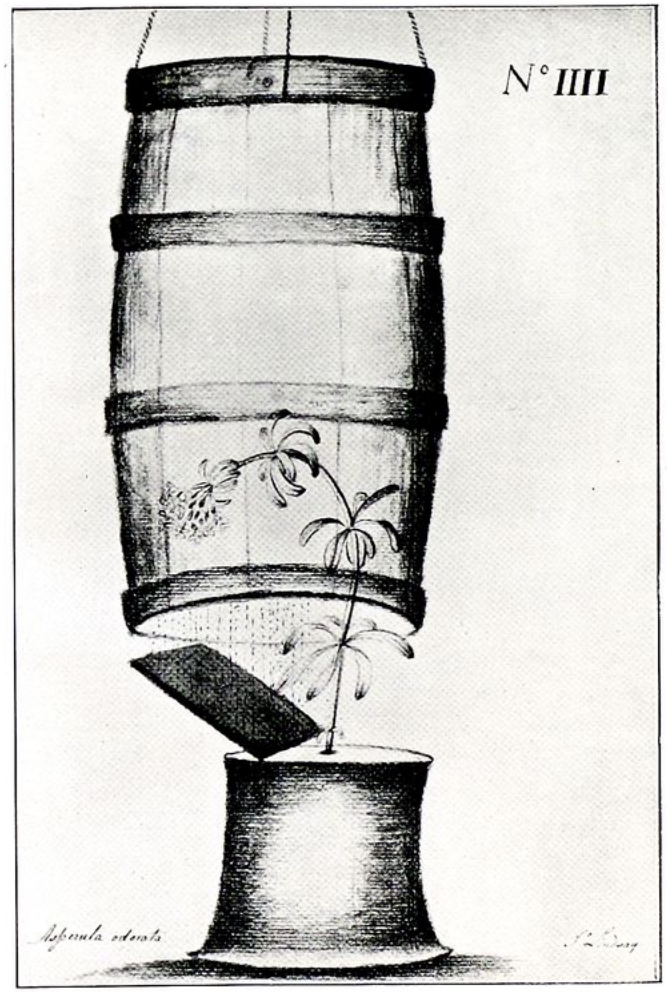

Fig. 7.

Professor Hope's Diagrams.