Morphological Notes.

BY

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With Plates XXIV and XXV, and a Figure in the Text.
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VIII. ON POLYCOTYLEDONY.

IT is the object of these notes as much to suggest problems as to solve them. In the present case I propose to tell a story of which I do not quite see to the bottom. I impose no restrictions on any one disposed to make it a subject of speculation.

My friend Professor Bayley Balfour, in the very suggestive address which he delivered from the chair of Section K. at the Glasgow Meeting of the British Association, gave a theory of the Dicotyledonous Embryo, the main points of which I will quote:—

‘We ought, I think, to look upon the embryo as a protocorm of embryonic tissue adapted to a seed-life. . . . Confining ourselves to the general case, the axial portion of the protocorm of the Dicotyledon, the hypocotyl, bears a pair of lateral outgrowths, the cotyledons, and terminates in the plumular bud and in the primary root respectively. The cotyledons are its suctorial organs, and the hypocotyl does

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the work of rupturing the seed and placing the plumular bud and root by a rapid elongation which commonly brings the plumular bud above ground, protected it may be by the cotyledons. These latter may then become the first assimilating organs unlike or like to the epicotylar leaves¹.

This, though a guarded statement, appears to imply that the cotyledons are more or less organs *sui generis*, and not homologous with ordinary or epicotylar leaves. It brought to my recollection some observations which I made some years ago, and which it now seems worth while to put on record. It is well known that the Sycomore (*Acer Pseudo-platanus*) reproduces itself spontaneously from seed with great readiness. This was the case with a tree at Kew which was ultimately, for unavoidable reasons, cut down. A notable proportion of the seedlings of this tree came up with three cotyledons. The circumstance is not, however, unusual, and similar cases are discussed in Duchartre's classical *Mémoire sur les Embryons qui ont été décrits comme Polycotyles* in the 'Annales des Sciences naturelles' (3^e sér., x, pp. 210-11). I quote his account:—

'Embryons à cotylédons accidentellement partagés.'

'Sur plusieurs points des environs de Paris, notamment à Meudon et Bellevue, on remarque au printemps, le long des allées, dans le voisinage des jardins et des parcs, une quantité considérable de germinations des Érables Plane [*Acer platanoides*] et Sycomore. Leurs grandes feuilles séminales, lancéolées-oblongues, entières, y forment quelquefois une sorte de gazon: or, parmi ces nombreuses germinations il est facile de trouver tous les degrés de division médiane des feuilles séminales, depuis une simple échancrure jusqu'à une partition tellement profonde, qu'elle ferait croire, dans certains cas, à l'existence de trois cotylédons distincts et séparés. Je me borne à figurer ici deux de ces germinations, choisies entre beaucoup d'autres; dont l'une présente un

¹ Nature, lxiv, pp. 560, 561.

cotylédon bifide, tandis que l'autre en montre un profondément biparti. Dans celle-ci, les deux lobes cotylédonaire ressemblent assez, de grandeur et de configuration générale, au cotylédon entier, pour que chacun d'eux pût facilement être regardé comme un cotylédon distinct et séparé. Mais si l'on observe que la fente qui les sépare descend un peu moins profondément que celle qui existe entre les deux vrais cotylédons; si, de plus, on fait attention à la situation des deux petites feuilles primordiales déjà développées, qui alternent avec le cotylédon biparti comme avec celui qui est resté entier, on ne pourra conserver le moindre doute sur le phénomène de division qui a valu à cette germination son apparente polycotylédonie.'

Nothing apparently could be clearer than this explanation, but unfortunately it does not meet the facts as they presented themselves at Kew. In Pl. XXIV, Fig. 2, I have figured a seedling with three perfectly distinct and normal cotyledons and three equally normal young leaves developed from the plumule. It is difficult to see how such a case is to be reduced to the ordinary type by any theory of bipartition. A number of such anomalous seedlings were carefully taken up, potted and grown on. Pl. XXV, Fig. 4, shows the result at the end of the second year. It will be seen that I obtained a young sycomore with ternary instead of opposite leaves, and I was in hopes that I had secured a new seminal variation which would be constant. These hopes were, however, frustrated, as in the third and following year the seedlings reverted to the ordinary type with opposite leaves.

Such cases of plants with opposite varying with whorled leaves are not uncommon, though in some species it is rarer than in others. Of the former *Stachys palustris*, in which I have met with three leaves in a whorl, is an example. The fact was not overlooked by Linnaeus, who observes:—'*Opposita folia* saepe evadunt Terna, seu Quaterna, et tum ex caule Quadrangulari fit caulis Polygonus' (Philosophia Botanica, 241).

I mentioned the matter in conversation to the late Professor

Decaisne, and he remarked that he thought there was a tendency in *Acer* to a ternary distribution of parts, reminding me that the sycomore occasionally develops a third samara in its fruit. This is true, but in the Kew Museum there is a series of fruits of the common maple (*Acer campestre*) in which the number of samaras varies from two to eight: it is therefore apparently fluctuating.

In Pl. XXIV, Fig. 1, I have illustrated a case similar to those which Duchartre studied. In Fig. 3 I have shown one, which he apparently did not meet with, in which three cotyledons are followed by a pair of opposite leaves, one of which is bipartite. In the former, according to Duchartre's view, the embryo started with a pair of cotyledons, one of which subsequently branched. This, however, is *a priori* an improbable supposition, as cotyledons, unlike leaves, are generally simple and, except in the somewhat rare cases now under discussion, rarely show any disposition to be otherwise.

Masters (Vegetable Teratology, p. 370) gives several instances of tricotyledonous embryos, to which I may add one in the oak for which I am indebted to a former pupil, Mr. G. Cross. Masters quotes Reinsch for a seedling beech 'associated with a union of the margins of two out of the three cotyledons, and of those of two out of the three leaves next adjacent.' Masters thinks with Duchartre that 'some of these cases may be accounted for by chorisis or by a cleavage of the original cotyledons.'

I arrive, however, at the conclusion that the simplest explanation is, that in all the cases now described, the embryo is provided with three instead of two primordial lateral outgrowths, and that these either develop completely into three normal cotyledons or that two of them sooner or later coalesce into one which is more or less deeply bifid. If this explanation is true of cotyledons it must equally apply to the similar phenomena exhibited by the epicotylar leaves.

Professor Bayley Balfour looks upon the cotyledons as 'suctorial organs,' and in cases where an endosperm is present this is no doubt true. But an inspection of the large series

FIG. 30.

of illustrations drawn from all parts of the vegetable kingdom accumulated by Lord Avebury in his work on 'Seedlings' will show that in an immense proportion of cases, cotyledons are foliaceous. Nor can they be regarded as suctorial in cases such as are present in the Leguminosae, where they have become mere reservoirs of accumulated food-material destined for the future nutriment of the young plant.

I confess that all the evidence seems to me to point to the fact that cotyledons, whether suctorial, store-organs or foliaceous, must still be regarded as foliar organs. Lord Avebury (Vol. I, pp. 9, 10) cites the opinion of Klebs, who observes that 'on the whole the forms of cotyledons are much simpler than those of leaves, and . . . that while in some cases perhaps, like the first leaves, they retain the form which characterized the species in bygone ages, we may rather, as a more generally applicable explanation, apply to them the suggestion of Goebel with reference to stipules, and regard them as simplified by arrest.' Lord Avebury adds that another suggestion has been that cotyledons are 'a survival of the universal foliage of deciduous trees in olden geological days, ere time had differentiated them into their present varied forms.'

That cotyledons preserve a more ancient and primitive type of foliage is in accordance with the general facts of embryology. The cotyledons have their own battle to fight, but it is not that of the adult plant, and adaptations suitable for the more strenuous struggle would be superfluous in the simpler conflict. This consideration is strengthened by the case reproduced in Fig 30 of a young seedling of *Libocedrus macrolepis*. In this after a time there is a complete change in the form and disposition of the foliar organs. The primitive leaves, which are not very different to the cotyledons with which they are serially continuous, no doubt represent a generalized and unmodified type of foliage.

An analogous but distinguishable phenomenon is described by Asa Gray in the case of the common pea (Botanical Text-book, p. 19):—

'The plumule . . . usually rises as a stout stem of several

internodes lengthening almost simultaneously, or at least the upper strongly developing long before the latter have finished their growth; and the latter are practically leafless, having only small and scale-like and useless rudiments of leaves. . . . The abortion of the earliest leaves of the plumule is in correlation with the hypogaeous situation of the cotyledons throughout the germination.'

Finally I may suggest that the anatomy of cotyledons affords a promising field of investigation, at present almost wholly unworked, which may throw much light on their history.

Fig. 1.

Fig. 2.

H. T. D. del.

THISELTON-DYER. — ACER PSEUDO-PLATANUS.

Fig 3.

Fig. 4.

H. T. D. del.

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THISELTON-DYER.—ACER PSEUDO-PLATANUS.

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