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II. On some of the Stages of Development in the Female Flower of *Dammara australis*

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ale; *Campanula latifolia*; *Calamintha Clinopodium*; *Carduus heterophyllus*; *Hieracium prenanthoides*; *Solidago virgaurea*; *Listera ovata*; *Carex remota*, *C. sylvatica*, *C. pallescens*; *Milium effusum*; *Melica uniflora*; *Equisetum umbrosum*; *Asplenium viride*, *A. Trichomanes*; *Lastrea Oreopteris*; *Polypodium Dryopteris*, *P. Phegopteris*; *Polystichum aculeatum*; *Lycopodium selaginoides*. The glen possesses a chalybeate spring which is sometimes resorted to, and of which chloride of sodium and bicarbonate of lime are the principal constituents.

The following is a list of the mosses collected in Moness Woods and on Ben Lawers by Mr William Bell during the excursion:—

Andreaea alpina, *rupestris*, *Rothii*; *Sphagnum cuspidatum*, var. *plumosum*, *compactum*, *rubellum*; *Gymnostomum rupestre*; *Anectangium compactum*; *Conostomum boreale*; *Encalypta streptocarpa*, *ciliata*, *rhabdocarpa*; *Grimmia spiralis*, *torta*, *apocarpa*, *α stricta*; *Didymodon rigidulus*, *capillaceus*, *longirostris*, *heteromallus*; *Trichostomum patens*, *microcarpon*, *aciculare*; *Fissidens adiantoides*, *polyphyllus*; *Dicranum cerviculatum*, *virens*, *polycarpum*, *falcatum*, *fuscescens*, *majus*; *Tortula tortuosa*; *Polytrichum hercynicum*, *alpinum*, *aloides*, *urnigerum*; *Bartramia ithyphylla*, *fontana*, *gracilis*, *arcuata*, *Halleriana*; *Pterogonium gracile*, *filiforme*; *Anomodon curtispendus*; *Neckera crispa*; *Fontinalis antipyretica*; *Bryum julaceum*, *crudum*, *Zierii*, *pallens*, *pallescens*, *nutans*, *elongatum*, *acuminatum*, *alpinum*, *punctatum*, *subglobosum*, *ventricosum*, *cuspidatum*, *Ducalii*; *Hypnum complanatum*, *undulatum*, *denticulatum*, *stramineum*, *moniliforme*, *catenulatum*, *plumosum*, *lutescens* var., *rufescens*, *alopecurum*, *curvatum*, *confertum*, *stellatum*, *proliferum*, *sarmentosum*, *atrovirens*, *rugosum*, *revolvens*, *aduncum*, *scorpioides*, *Muhlenbeckii*; *Orthotrichum affine*, *Bruchii*, *crispum*, *Drummondii*, *fastigiatum*, *leiocarpum*, *Lyellii*, *pulchellum*, *rupestre*, *speciosum*, *pumilum*; *Zygodon Mougeotii*. On the top of Schihallion—*Fissidens osmundoides*; *Hypnum denticulatum*; and *Trichostomum lanuginosum*.

II. On some of the Stages of Development in the Female Flower of *Dammara australis*. By ALEXANDER DICKSON, M.D. Edin. (Plate V.)

In a short notice upon the morphology of the cones of *Araucaria*, *Dammara*, &c., which I read before this Society in January last, I called in question the ordinarily received interpretation of the structures in the female cones of these plants.

In the first place, I drew attention to the easily demonstrated and incontestable fact, that the so-called *squamæ fructiferae* in *Araucaria* are serially continuous with the leaves of the shoot which the cone terminates, and that, therefore, these “squamæ” are in the position of the bracts, and not of the scales of a larch, or any of our ordinary *Abietineæ*. It is a fact which cannot be too strongly insisted upon, that in *Araucaria* the leaves of a cone-bearing shoot pass by gradual transitions into the so-called “*squamæ fructiferae*” of the cone;

these leaves and "scales" forming a continuous series of homologous parts.

Regarding *Dammara*, I could not at that time give any special particulars of importance, as the specimens (cones developed in the summer of 1859 ?) which I then obtained were about half-grown, and had lost the bud-scales surrounding the base of the cone. I could only argue from the close analogy between *Dammara* and *Araucaria*, that what holds good for the one genus may be presumed to do so for the other. Being compelled to recognise in the so-called scales of *Araucaria* structures corresponding to the bracts in *Abies*, *Pinus*, &c., I endeavoured to show that the scale-like "appendage to the seed" in *Araucaria* might be considered as representing the free portion of an otherwise adherent true *squama fructifera*; this view being supported by the somewhat similar structure in *Cunninghamia*, and by the greater or less amount of adhesion between bract and scale even in our ordinary coniferæ. As to *Dammara*, I held that the free portion of the true *squama fructifera*, which is much reduced in *Araucaria*, had here entirely disappeared.*

Since offering this explanation of the structures in question, I have fortunately had an opportunity of examining, to a certain extent, the development of the female flowers of *Dammara australis*, a plant of which has this summer produced cones in one of the hot-houses in the Botanic Garden here.†

* In my paper on the Morphology of *Araucaria*, &c., (Edin. New Philosophical Journal, April 1861, pp. 198-9), I erroneously referred to an absence of the *squamula* in the "scales" of *A. brasiliensis*. I have since then, through the kindness of Mr Bennett, obtained some of these scales, in which the *squamula* is very distinctly developed, even more fully than in *A. imbricata*. This error on my part arose from my having inadvertently misread a passage in Richard's *Mémoires*, in which he speaks not of the *squamula* but of the apex (*languette*) of the scale as being absent in *A. brasiliensis*. As, however, the state of the question under discussion is not materially affected, any evils resulting from my unfortunate mistake can be but trifling.

† This plant had produced cones previously (in 1859 ?), some of which I examined last winter. I accordingly asked one of the gardeners, William Bell, an enthusiastic and intelligent botanist, to look at the plant from time to time, so that the cones might be obtained early, in the event of its flowering this season. To his attention, and to the kind permission of Mr McNab and Professor Balfour, I am indebted for the materials of this investigation.

These cones were first observed in the early part of May, but would have attracted attention sooner had they not been confined to the uppermost branches of the tree. The cones which I then obtained (May 10th) are axillary shoots. They are roundly oval in form, and vary from a little under to a little above an inch in length, exclusive of the stalk and that portion bearing the bud-scales of the cone.

The scales of the cone are nearly triangular in outline, and more or less elongated; broadest a little above the base, at that part where the scale is bent upon itself. Just at its base the scale is rounded at its angles or slightly auricled. (See fig. 1.)

In the best developed of these cones (see fig. 7) the scales are more or less patent, the lower ones deflexed. The lower scales are more elongated and acute than the upper; and a good number of them, although persistent and becoming enlarged along with the other scales, are sterile. The bud-scales vary in extent of development in different cones. In the cone represented in fig. 7 the lowermost pair, which are identical in form to those found in leaf-buds, present a diminished, almost bar-like lamina, with dilated base (fig. 7, *a*). In the pair next above, the lamina is still further reduced, with the base more manifestly dilated. In the succeeding ones we lose the appearance of a lamina altogether; the scales being short and rounded, or slightly pointed. They soon pass off above into more elongated and pointed structures (fig 7 *d*), which lead at once to the so-called *squamæ fructiferæ*. Of these bud-scales the first two pairs are opposite and decussate, but they gradually pass off above into the more complex spiral of the cone. They soon wither, and ultimately fall off.

Thus, since the lower of these bud-scales do not differ from the first leaves of the leaf-bud, and since they certainly form a continuous series with the cone-scales, it follows, as might have been anticipated, that in *Dammara*, just as in *Araucaria*, the scales so called are in fact the *leaves* of the cone-shoot.

Not to pursue this subject further at present, I will now proceed to detail the principal points which I have been able to investigate in the development of the female flower.

The earliest condition which I have seen is that represented

in Plate V. figs. 1 and 2. It consists in a small, somewhat flattened mammilla, springing from a broadish base, on the inner or upper surface, and in the middle line of the scale close to its base. Even at this period it is inverted, its apex being directed towards the axis. The attachment of the mammilla is about $\frac{1}{10}$ of an inch from the base of the "scale;" the length of the "scale" itself being about $\frac{1}{4}$ of an inch, or a little more.

In a further advanced stage two shoulder-like projections are to be seen, one on either side of the apex of the mammilla (Plate V. fig. 3); which, when looked at in the direction of the apex (Plate V. fig. 4), are found to be two semilunar elevations embracing it. These manifestly correspond to what Baillon has described as carpels occurring in *Pinus*, *Taxus*, &c.

I cannot say that I have seen these elevations actually free from one other at their bases, although *very nearly so*. At first they appeared to me as being quite free from each other, and I had even made a drawing representing such to be the case; but on closer scrutiny and more careful adjustment of them to the light, there can always be detected an extremely faint elevation of the surface between their bases. I regret extremely that my materials have not enabled me to make certain of this point, as it is of great importance in confirming Baillon's view of the primitive duality of the structure enclosing the "nucleus" or ovule, and which I am strongly inclined to hold as correct.*

In the next stage, the connation of the carpels by their bases is very manifest (Plate V. figs. 5 and 6). The central mammilla is now very well marked, and, I daresay, may with propriety be termed "ovule." After this stage there exists a slight gap in my materials, as I was somewhat delayed in obtaining my second supply.

In the flower represented in fig. 8, the different parts, although

* I must here state that the flowers near the apices of the cones, and whence I obtained the specimens such as are represented in figs. 1 and 3, are often imperfectly developed, and that many of the apparently very young flowers are probably in reality older than they seem, and so are liable to induce misconception. Even the structure represented in figs. 1 and 2, although no doubt representing truly enough the essentials of the early stage, yet in minor particulars may not be perfectly trustworthy.

very considerably grown, are easily recognised in their relation to the corresponding parts in the earlier stage. (To avoid confusion in description, I shall term that surface of the pistil which is applied to the "scale" the posterior, and that which is exposed, the anterior.)

The "nucleus" still projects to a comparatively large extent beyond the two carpels which surround it, and by whose connate-bases it is covered to about its middle in front, and to a somewhat less extent behind. The pointed apices of the free portions of the carpels extend at the sides nearly as far as the extremity of the ovule, falling only a little short of it. There is thus a deep, rounded notch, both before and behind, between the apices of the carpels; the posterior notch being the deeper. The pistil is somewhat compressed from before backwards, but it is more convex before than behind. Its thin lateral margins (corresponding to the mesial dorsal lines of the carpels) do not yet exhibit any of that want of symmetry which afterwards occurs, from the formation of a wing on one side.

The extremity of the ovule ("nucleus") is now found to be compressed from before backwards, or, better to express it, thinned off to an edge which is curved slightly forwards (see Plate V. figs. 8 and 9). In the subsequent stages this edge is often developed into a more or less leaf-like lamina, which is folded over the anterior surface of the exposed portion of the ovule. This lamina varies very much in the extent of its development; it is usually small and irregularly shaped, as in fig. 13; but in one specimen which I possess, it is produced into a beautifully tapered point (Plate V. fig. 14). This prolongation of the extremity of the ovule, although very curious, cannot I think be of much importance, either morphologically or physiologically, since it is comparatively late in appearing, and, although of very frequent, is not of universal occurrence.

Regarding the subsequent stages in the development of the pistil, I need not say much. The ovule always remains exposed by the anterior and posterior notches between the apices of the carpels, but to a relatively less extent as development advances. The apices of the carpels never project as style-

like prolongations, but are closely applied to the sides of the ovule. (See figs. 12 and 13.)

In the flower represented in fig. 10, the unsymmetrical development of the wing-like margins of the pistil has commenced.

The *great wing* is developed sometimes on the right, sometimes on the left side of the pistil; but the side upon which it occurs is constant in any given cone. This, I find, is dependent upon, or at least correlated with, the direction of the generating spiral of the cone. *If the cone-spiral be from right to left (supposing the observer to be in the axis of the spiral), the wing is developed on the right side of the pistil; but if, on the contrary, the cone-spiral be from left to right, the wing is developed on the left side of the pistil.** The relation of the unequal development to the disposition of the scales may be briefly described as follows:—If we take a bract-scale—say No. 1 of the cone-spiral—we find that of the two bract-scales immediately applied to its upper or inner surface, No. 6 extends from one side to past its middle line, and entirely covers the flower of bract No. 1; while bract No. 4 extends from the opposite side just to the margin of No. 6, without overlapping it. It would appear almost as if the development of the margins of the pistil was limited, on the one side by the margin of its own bract (No. 1), and on the other by that of bract No. 6; so that, according to the position to right or left of bract No. 6, so is the great wing developed on the right or left side of the pistil. Rarely, nearly equal wings are developed on both sides of the pistil.

Diagram illustrating the arrangement of the bract-scales in relation to the unsymmetrical development of the sides of the pistil, as described in the text. A bract-scale (No. 1 of the spiral) and its flower are represented, together with dotted outlines of the bract-scales Nos. 4 and 6 (*br 4*, *br 6*), which are those immediately applied to the upper or inner surface of No. 1.

The “scales” of the cone, as development advances, become much broader, with thin auricled margins at the base. A

* I have examined six cones with reference to this point—three with right-handed, and three with left-handed spiral—and all with the result stated above.

great increase in thickness occurs at the angle which the apex of the scale makes with the basal portion, so that the back of the scale at that part projects as a well-marked gibbosity. This thickening is precisely analogous to what is seen in the "scales" of *Araucaria*, where it is also well marked. In the furthest developed cone* which I have examined, this swelling is so great that the apices of the scales appear almost as if sunk among the gibbosities. Almost the only increase in the length of the scale, and that is considerable, occurs in its basal portion. To illustrate this last point, I have given a series of drawings representing longitudinal mesial sections of scales at different stages. During its growth the form of the cone becomes considerably altered. As before mentioned, it is oval at first; from this it passes to pyriform (in second season?); and, finally, it becomes oblately spheroidal, or orange-shaped.

In conclusion, I must express my regret that these observations are so imperfect. Indeed, I hesitated for some time whether I should publish any of these results before I could render them in some measure more complete. But when I reflected that possibly I might not have another opportunity of continuing the investigation, and that what facts I had observed were not without importance, I decided upon laying them before the Society.

Although I have not been able actually to demonstrate the perfect independence of the two carpels in their origin, yet I have shown sufficient to make it highly probable that they are so.

As regards determining the relations between the "scale" and pistil, it is unfortunate that I obtained no cones sufficiently young to allow of tracing the floral rudiment to its first origin. When, however, we review the phases in the development of the scale, and take note of the manifestly determinate or "basipetal" character of its evolution; when, in running the eye back upon the different stages, we find the basal portion becoming rapidly shorter, while the terminal portion remains comparatively stationary, until we find the attachment of the floral rudiment only $\frac{1}{10}$ th of an inch from the base of the

* One of those developed, as I suppose, in the summer of 1859, and picked in the middle of last month.

scale, I think we may confidently expect a still earlier condition in which the mammilla will be found to be actually at the base of the bract-scale, in the position of axillary bud. Add to this, the extreme improbability that a structure such as I have described in the female flower should be developed, *ab origine*, from a leaf, which the bract-scale certainly is, and the truth of the theory which I proposed as to a connation between the bract-scale and the peduncle of the flower, may be considered as virtually proved.

Description of Plate V.

Fig. 1. Bract (*br*) from young cone of *Dammara australis*; with floral rudiment (*m*) close to its base.

2. Base of the same, more highly magnified, showing the floral mammilla (*m*).

3. Flower further advanced, showing the carpellary elevations (*cc*) on either side of the apex of the mammilla (*ov*), and which are almost free from one another at their bases.

4. A similar flower looked at towards the apex; *c c*, the two semilunar carpellary elevations, embracing the termination of the mammilla or ovule (*ov*).

5 and 6. A still further developed flower seen from the same points of view as the preceding. The carpel (*c*) are now very manifestly connected by their bases, and the ovule (*ov*) is more distinctly marked.

7. Young cone (natural size), whence the flowers represented in Figs. 5 and 6 were taken; (*a*), (*b*), (*c*), and (*d*), bud-scales, showing the transition between these and the "scales" of the cone.

8. Flower considerably further advanced than the preceding (its length being rather more than double of that represented in fig. 5). The ovule ("nucleus") (*ov*) is still exposed to a relatively great extent from between the apices of the carpels (*c, c*). The extremity of the ovule is thinned off or compressed antero-posteriorly.

9. Longitudinal mesial section of a flower, a little older than the preceding; (*br*) portion of base of bract, (*a*) anterior higher, an (*b*) posterior lower wall of the pistil. The extremity of the ovule compressed to an edge, which is slightly curved forwards, is well seen.

10. Flower considerably further advanced. The thin margin of the pistil on the left side is now becoming developed as a wing (*w*), while that opposite (*m*) remains small; (*ov*) ovule exposed between the apices of the carpels.

11. Longitudinal mesial section of a similar flower; (*br*), (*a*), (*b*), and (*ov*) as in fig. 9. The edge of the termination of the ovule (*ov*) has here become developed into a lamina (*l*), which is turned over upon the anterior surface of the exposed portion of the ovule.

12. Pistil much further developed (in second season?); (*w*) the developed,

and (*m*) the undeveloped, wing of the pistil, the great wing being here on the right side.

- Fig. 13. Portion of the extremity of the same, showing a small irregularly-shaped lamina (*l*) turned over upon the anterior surface of the exposed portion of the ovule, between the apices of the carpels (*c*, *c*).
14. Portion of the extremity of the nucleus from a flower of the same age, with its leaf-like process (*l*) elegantly pointed. The carpels have been removed.
15. Longitudinal section of bract, with its flower at a stage corresponding to fig. 5; (*br*) bract, (*f*) flower.
16. Similar section, at a stage corresponding to that in fig. 9.
17. Similar section, corresponding to fig. 10.
18. Similar section, corresponding to fig. 12; (*p*) walls of pistil; (*ov*) ovule; (*x*) vascular bundle supplying the pistil; (*w*) mesial vascular bundle of the bract.
19. Similar section from cone in its third season (?).

III. On the Homologies of the Floral Organs of *Phanerogamia* and the *Higher Cryptogamia*. By JOHN LOWE, M.D., Lynn.

The theory of alternation of generation is evidently but an easy mode of getting rid of a difficulty, in the development of cryptogamic plants, which has been universally allowed. That it is unsatisfactory in its results, is tacitly admitted by many eminent botanists; but as yet no more available explanation of the received facts has been offered. The intricacy of the subject is so great, that years will probably elapse before we arrive at anything like a valid theory, which will serve to explain the seeming deviation of one of the subdivisions of the vegetable world from what we should consider to be the normal or typical formula of reproduction.

The real signification of the spores of ferns and their allies appears to me to have been to some extent lost sight of, in a too rigid adherence to, and observation of, their *order* of development; the different stages in the process having been regarded and compared *pari passu*. Confusion, too, arises from the term *spore* being imperfectly defined. It is applied indiscriminately to bodies having the greatest difference, both structurally and morphologically considered; hence their proper value and position become vague and obscure. The various definitions which