points of detail, however, the reproductive bodies in question differ from the seeds of any known Gymnosperms; they afford no proof of the origin of the latter Class from the Lycopods. The newly discovered fructification nevertheless shows that certain Palaeozoic Lycopods, with strobili at first indistinguishable from *Lepidostrobus*, crossed the boundary line which we are accustomed to draw between Sporophyta and Spermatophyta.

As these fossils appear worthy of generic rank, I propose to found the genus *Lepidocarpon* for their reception; it may be briefly characterized as follows:—

Lepidocarpon, *gen. nov.*—Strobilus, with the characters of *Lepidostrobus*, but microsporangia and megasporangia each surrounded by an integument, growing up from the upper surface of the sporophyll. Megasporangium completely enclosed in the integument, except for a slit-like micropyle along the top. A single functional megaspore developed in each megasporangium. Sporophyll, together with the integumented megasporangium, detached entire from the strobilus, the whole forming a closed, seed-like, reproductive body.

It is proposed to name the Coal-measure form *Lepidocarpon Lomaxi*, and that from Burntisland *L. Wildianum*. Both were included by Williamson under his *Cardiocarpon anomalum*, which, however, is quite different from the seed so named by Carruthers.

A full illustrated account of these fossils is in preparation, and will shortly be submitted to the Royal Society.

THE AFFINITIES OF THE MESOZOIC FOSSIL, BENNETTITES GIBSONIANUS, CARR.—Carruthers¹, in 1870, described and figured the general features of the vegetative axis of certain specimens of *Bennettites*. This was shown (as in *B. Saxbyanus*)² to be eminently Cycadean in character, and possessed a single vascular cylinder. But this fossil stem clearly exhibits a more primitive type of structure than that of the stem of modern Cycads, the two chief indications of this being (1) the course of the leaf-traces from the leaves to the central cylinder which, as in the most primitive parts of the axis of modern Cycads such as the primary node and the cone, is

¹ Carruthers, W., On Fossil Cycadean stems from the secondary rocks of Britain, Trans. Linn. Soc., Vol. xxvi, 1870.

² loc. cit., Plate 57, Fig. 3.

direct and radial, instead of girdle-like and tangential in direction; and (2) the large size and arc-shaped character of the leaf-traces as they leave the central cylinder, and the splitting up of these large leaf-bundles into numerous smaller ones as they pass into the leaf; this is essentially the phenomenon met with in the Medulloseae. The Bennettiteae, therefore, in the character of their vegetative stem, are more primitive than modern Cycads.

Carruthers, in the same paper, describes and figures the fructification of *Bennettites Gibsonianus*, Carr. The structure is briefly this: the short axes, arising in the axils of the vegetative leaves of the stem, terminate in what the author terms a 'cellular cushion'; this latter bears all over its upper surface great numbers of 'vascular cords,' each such 'cord' terminating at its apex in a seed. These 'cords' are completely enveloped, except for tiny orifices communicating with the apices of the seeds, by a 'pericarp' or a 'mass of irregular cellular tissue.' He regards the seeds as being borne on axial organs, as distinct from the foliar organs which bear the seeds of modern Cycads. The fruit is a compound one. The general conclusion is that 'in comparing the structure of this plant with the inflorescence of the recent Cycadeae, the points of difference are more obvious than those in which they agree.'

Further researches undertaken by Solms-Laubach¹ resulted in showing that the 'pericarp' of Carruthers consists of a number of appendages of the axis, probably of foliar nature, arising between the seminal 'cords' or on these 'cords' themselves which, protruding above the latter, overlap and form a dense protective covering for them. The whole fructification is itself enclosed within an involucre of long, lanceolate bracts arising below the 'cushion'.² Solms puts forward three views as to the morphology of the appendages: they may be either (1) all foliar organs, some being fertile carpels bearing a terminal ovule, the remainder sterile carpels; or (2) all the organs may be axial members; or, finally, (3) the seed-stalks may be axes, and the interstitial organs leaves. Carruthers did not, apparently, regard the seminal 'cords' as possessing a foliar nature, but considered the whole as an axial structure. Solms, while admitting the possibility of the seed-stalks being axial organs, is quite prepared to entertain the view that the entire shoot is 'a flower with numerous leaves, some of which

¹ Solms-Laubach, Bot. Zeit., 1890.

² Solms-Laubach, Einleitung in die Palaeophytologie, 1887, Fig. 5 A, p. 98.

are sterile and serve to form the involucre, while the others bear the ovules.'

In carefully pondering over the morphological character of the fructification of the fossil plant under consideration, I cannot resist the final conclusion that the view which regards the seminal stalks or 'cords' as being *foliar* in nature is the only admissible and correct one. Further, I adopt the view put forward by Čelakovský¹, viz. that the sporophyll is originally and primitively *radial* in structural symmetry, bearing the sporangium in a *terminal* position.

This view is founded on the theory that all vascular axes with their appendages, the foliar organs, have had their origin in the sporogonium of a Bryophyte such as *Anthoceros*. This sporogonium is a structure of essentially *radial* symmetry; its earliest branches or appendages must necessarily also have possessed the same character. As sterilization proceeded apace in these radially-constructed appendages, the sporogenous tissue would become for obvious reasons projected towards the apex of the appendage and would thus in time come to represent a sporangium situated *terminally* to its radially-constructed sporophyll. This type of compound sporogonium or of strobilus is preserved for us in the female cone of *Ginkgo*, and in *Osmunda* and a few other Ferns. In modern Cycads there is a clear case of transition from the radial type of sporophyll to the later dorsiventral type, and in Angiosperms, at least on the female side, this transition has become complete, where the carpels are always dorsiventral in construction and bear the ovules marginally or ventrally. This latter type of sporophyll, therefore, is that which is found in the group of plants which stand highest on the evolutionary scale, and represents thus the type towards which all primitive radially-constructed sporophylls must evolve, for it is obviously the one best adapted for the purposes of fertilization and dissemination of the seed.

It is on account of the above views that I regard the fructification of *Bennettites* as being essentially *more primitive* in character than that of modern Cycads, in contradistinction to the view hitherto propounded that in the cone of *Bennettites* we see an advance, beyond that of modern Cycads, in the Angiospermous direction. In my opinion, no *advance* may rightly be spoken of except in connexion with those *essential* organs of a plant which have always formed the basis for the

¹ Čelakovský, Nachtrag zu meiner Schrift über die Gymnospermen; Engler's Jahrbuch, 1897.

classification, *on evolutionary lines*, of the great groups of the vegetable kingdom. Now the distinguishing feature of the great group, the Angiosperms, which to-day head the evolutionary line, is the character of one set of its essential organs, the female sporophylls or carpels, which are dorsiventral in structure and bear the ovules *marginally* or on their ventral surface, and are, moreover, closed together over the ovules to form the characteristic ovary. But *Bennettites* shows absolutely no indication of such an advanced structure in its essential organs, the sporophylls, which remain primitively *radial* in structure, bearing the ovules in a *terminal* position; the angiospermous condition (using this term as in no sense referring to the 'Angiosperms') being brought about solely by the *unessential* organs: the interstitial bracts or sterile sporophylls, and the large ensheathing bracts springing from the base of the entire cone; these together form an adequate protection for the seeds. That modern Cycadean plants still retain the primitive radial symmetry of their sporophylls here and there may be seen in the female sporophylls of Cycads generally (although in these the ovules have become relegated to a marginal, or rather a sub-dorsal position), in the radially-constructed short ovuliferous segments of the female sporophyll of *Cycas*, which bear the ovules in a terminal position, and in the female cone of *Ginkgo*, which, as clearly observed in abnormal cases, produces the ovules terminally on radially-constructed sporophylls.

The conclusion which is, therefore, to be drawn, is this: that the fructification (or cone) of *Bennettites Gibsonianus*, Carr., is to be regarded as *more primitive in structure than that of modern Cycads* owing to the fact that its sporophylls possess both a *radial* symmetry of structure and (what is, probably, a necessary condition) bear the ovules in a *terminal* position. This view of the matter will save the incongruity of a plant, like the one under consideration, possessing a vegetative structure (as of the stem) considerably more primitive and a fructification much more advanced than that of modern Cycads. And I would further point out that *complexity* of differentiation in a structure (as in the cone of *Bennettites*) is by no means necessarily synonymous with an *advance* in *evolutionary* development, and this for the reasons above given.

In conclusion, the relationships between the structure of the cone of *Bennettites*, of the cone of modern Cycads, and of *Ginkgo*, may be indicated, on the lines laid down above, in tabular form, thus:—

BENNETTITES.	MODERN CYCADS.	GINKGO.
<i>Female Cone.</i>	<i>Female Cone.</i>	<i>Female Cone.</i>
Axis extremely short and flattened.	Axis much elongated.	Axis much elongated.
Linear-lanceolate bracts permanently ensheathing entire cone.	Linear-lanceolate bracts ensheathing entire cone when young.	
Sporophylls radial in structure.	Sporophylls usually radial or subradial in structure (that of <i>Cycas</i> dorsiventral, but its ovuliferous segments radial).	Sporophylls when (as in abnormalities) developed, radial in structure.
Ovules terminal on sporophyll.	Ovules marginal or subdorsal on sporophyll (those of <i>Cycas</i> terminal to segments of sporophyll).	Ovules terminal on sporophyll.
Sporophylls terminal and sub-terminal to axis of cone.	Sporophylls mostly lateral, upper ones terminal to axis of cone.	Sporophylls both terminal and lateral to axis of cone.
Interstitial organs (sterile sporophylls?) between the fertile sporophylls which overtop and envelop latter.	Interstitial organs absent; protection afforded by swollen terminal portion of each fertile sporophyll.	Ovules exposed, without any protective covering.
Two fleshy, hypogaeal cotyledons; very little endosperm to be seen.	Two fleshy, hypogaeal cotyledons embedded in endosperm of seed.	Two fleshy, hypogaeal cotyledons embedded in endosperm of seed.

W. C. WORSDELL.

KEW, June 29, 1900.

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