13. On *NUMMULOSPERMUM*, gen. nov., the PROBABLE MEGASPORANGIUM of *GLOSSOPTERIS*. By A. B. WALKOM, D.Sc. (Communicated by Prof. A. C. SEWARD, Sc.D., F.R.S., F.G.S. Read May 4th, 1921.)

[PLATE XXI.]

AMONG the fossil plants of Permo-Carboniferous age in the collections of the Queensland Geological Survey, it was my good fortune to find the specimens which form the subject of this communication. The results of the examination of the whole flora are being published by the Queensland Geological Survey as a continuation of my studies of the Queensland fossil floras. As, however, the specimens above mentioned represent, if my interpretation of them is correct, a very important discovery in fossil botany, it was thought that the subject merited a separate communication. In doing this I hope that the attention of palæobotanists may once more be drawn to the subject of the systematic position of *Glossopteris*, and that the evidence here brought forward may be critically considered in its bearing on this problem.

From time to time there have been suggestions that specimens of *Glossopteris* have been found showing structures regarded as sori, but in no case has anything definite been proved in this direction. As regards Australian specimens, these suggestions date back to 1872, when William Carruthers, in describing *G. Browniana* collected by Daintree from Queensland, said:

‘ one shows some indications of fruit in the form of linear sori running along the veins, and occupying a position somewhat nearer to the margin of the frond than to the midrib.’ (Bibliography, No. 3, p. 354.)

In 1905 perhaps the first definite step was taken towards the solution of the problem of the systematic position of this plant, in Arber's discovery of small bodies attached to the scale-leaves of *Glossopteris*, which he described as probable microsporangia (Bibliography, No. 1, p. 324; No. 2, p. 41). Then, in 1908, David White noted the intimate association, in Brazil, of seeds of the *Samaropsis* type with *Gangamopteris* (Bibliography, No. 8, p. 559), and went so far as to state his belief that the seeds were those of *Gangamopteris*, referring to them as *Gangamopteris* (*Samaropsis*) *Seizasi*, sp. nov. Prof. Seward (Bibliography, No. 7, p. 354) suggests also that *Samaropsis* *Milleri*, a species occurring in the Karharbari Beds in India, may be the seed of a species of *Glossopteris*, one specimen occurring partly covered by a scale-leaf of a type very similar to that generally recognized as belonging to *Glossopteris*.

These are, so far as I know, the most important contributions hitherto made towards the elucidation of the real nature of *Glossopteris* and *Gangamopteris*.

A detailed description is appended of the Queensland seeds, for which the new genus *Nummulospermum* is proposed, and this is followed by a discussion of the grounds on which their connexion with *Glossopteris* is based.

NUMMULOSPERMUM, gen. nov.

This name is proposed for a number of seeds occurring in association with *Glossopteris* at Three-Mile Creek, Bowen. Three-Mile Creek is a small tributary of Pelican Creek, which is a branch of the Bowen River. The question of their occurrence and association is discussed below.

Seed platyspermic (?); circular or oval, with broadly acute apex. Integument consisting of wide outer sarcotesta and (?) narrow inner sclerotesta. Nucellus circular, with prominent beak projecting into the narrow micropyle. Vascular system consisting of a single strand entering the base, giving off a pair of strands in the sarcotesta, then passing through the sclerotesta and (?) dividing into a number of strands enveloping the megaspore, and extending nearly to its apex.

Genotype: *Nummulospermum bowenense*, sp. nov.

The foregoing description summarizes what appear to be the essential characters of these seeds, which are discussed more fully below under *N. bowenense*.

The characters of the seeds seem to be sufficiently well indicated to warrant some more distinctive name than *Samaropsis*, and at the same time the structure does not conform to that of any of the described fossil genera known to me.

NUMMULOSPERMUM BOWENSE, sp. nov. (Pl. XXI, figs. 1-4. & text-fig., p. 291.)

Characters as described for the genus.

Type: F 1900 in the collection of the Queensland Geological Survey, from Three-Mile Creek, a tributary of Pelican Creek.

On a large specimen (F 1900) from Three-Mile Creek, Bowen (Pl. XXI, fig. 1), there are remains of at least twenty-eight of these seeds, and all of them present the same view of the seed. From their general appearance, and the fact that all the seeds known are preserved showing the same aspect, one might reasonably conclude that the seeds were platyspermic, and had split along a principal plane. We must remember, however, that in several of its characters the genus *Nummulospermum* shows close affinities with members of the Trigonocarpaceae, in which the seeds are radially symmetrical (Radiosperms).

The impressions as preserved appear to represent the features of the seeds as seen on a principal plane, along which they apparently

split readily. They are approximately circular, or oval, with a broadly acute apex, in which, in some cases, there is a marked depression (Pl. XXI, fig. 3). The length of the impression varies from 9 to 11 mm., and the breadth from 8 to 11 mm.

The sarcotesta is well-developed, and is much wider in the lateral and apical regions than in the basal portion, where it becomes comparatively narrow. Near the apex it varies from 3 to 5 mm. in thickness, while near the base it is not more than 1 mm. thick.

Very little definite indication can be obtained from the specimens regarding the nature of the sclerotesta. In some of them there is a suggestion of a distinct narrow layer immediately outside the nucellus (Pl. XXI, fig. 4, *sc*), and this may indicate a thin inner sclerotesta, outside which there is the thick sarcotesta.

Diagrammatic restoration of Nummuluspernum bowenense, gen. et sp. nov.

Section through principal plane ($\times 4$). *mi*=micropyle; *nb*=nucellar beak; *nt*=nucellar bundles; *pc*=pollen-chamber; *sa*=sarcotesta; *sa.t.*=bundles in the sarcotesta; *sc*=sclerotesta; *vb*=vascular bundle entering the base of the seed. The degree of attachment between nucellus and sclerotesta cannot be determined from the specimens.

There would appear to be no inner layer of sarcotesta, as is the case in some such seeds.

The nucellus is circular in the principal plane, its diameter being about 6 mm., with a distinct nucellar beak up to 2 mm. long and somewhat less than 1 mm. broad. This nucellar beak would contain the pollen-chamber, which would appear to be of comparatively large size. In some of the specimens it is obvious that the nucellar beak is placed opposite the narrow micropyle leading to the apex of the seed.

In general shape the nucellus resembles that of *Stephanospermum akenioides*, as figured by Coulter & Chamberlain (Bibliography,

No. 4, p. 43, fig. 45), and of *Trigonocarpum Parkinsonii* (*ibid.* p. 44, fig. 46), both of which are Radiosperms. The nucellar region in a number of examples is occupied by a dark, somewhat vesicular-looking mass; but this does not show any preservation of structure when examined under the microscope.

As in many fossil seeds, the preservation of details is not sufficiently good to enable one to determine to what extent the nucellus may have been free from the integument.

There are indications, in some of the examples, of the nature of the vascular system. In one or two specimens there is a distinct ridge running from the base of the seed to the base of the nucellus (Pl. XXI, fig. 2). This ridge gives off a pair of ridges, one on each side, into the sarcotesta, and these two ridges continue for some distance parallel to the junction between nucellus and integument. This seems to be a plain indication of a single vascular bundle entering the base of the seed, giving off a pair of bundles running through the sarcotesta in the principal plane of the seed. It cannot at present be determined how far this pair of bundles extends towards the apex of the seed; but it is not improbable that they will be found to extend almost, if not quite, to the micropyle. Further, in some specimens, the body of the nucellus shows a number of distinct vertical ridges; it is not unlikely that these represent a series of distinct strands arising from an expansion of the main bundle where it reaches the base of the nucellus, as is the case in *Cardiocarpus* (see Oliver, Bibliography, No. 5, pl. xxiv, fig. 1), and in some *Radiosperms*. These ridges extend almost to the upper margin of the circular portion of the nucellus (that is, excluding the nucellar beak).

The specimens exhibit very little variation in size, and it may reasonably be concluded that they represent the dimensions of the mature seed; their diameter is about 10 mm. in the principal plane of the seed. None of the specimens gives an idea of the thickness perpendicular to this plane.

Species associated with *Nummulospermum bowenense*.

A number of specimens have been collected from Three-Mile Creek, Bowen, and, in addition to the seeds just described, the only species observed from that locality are *Glossopteris indica*, *G. ampla*, and *G. Dunstani*, sp. nov. On the actual slab in which the seeds are preserved there are only examples of *G. ampla*. Apart from actual connexion of the seeds with *Glossopteris*, it would hardly be possible to obtain stronger evidence of close relation between them than this. But this is not quite all: the evidence is somewhat strengthened by the following occurrences among the Queensland collections:

- (a) Near Pentland, a single seed (*Samaropsis Etheridgei*, sp. nov.) occurs on the same piece of rock as fronds of *Glossopteris indica*; the only other species noted from the same locality is *G. ampla*.
- (b) From Minnie Creek, there is also a single seed, probably an example of *Nummulospermum bowenense*. It occurs in association with *Glossopteris Browniana*, *Sphenopteris lobifolia*, and scale-fronds of *G. Browniana*.
- (c) From Barwon Park, there are three flattened seeds, also probably *N. bowenense*, occurring on the same specimen as *G. Browniana* and a *Sphenopteris*. The only other species from the same locality are *G. indica* and ? *G. tortuosa*.

Add to these David White's description (Bibliography, No. 8,

p. 559) of the association of seeds of somewhat similar type with *Gangamopteris* fronds in Brazil, and Prof. Seward's record of the association of *Samaropsis Milleri* with scale-leaves of the *Glossopteris* type; wherefore the evidence of association seems sufficiently strong to justify the statement that the seeds under discussion are those of a species of *Glossopteris*.

They would represent the megasporangia, the microsporangia having been discovered and described by Arber some fifteen years ago (Bibliography, No. 1, p. 324; No. 2, p. 41) on specimens from Port Stephens, New South Wales.

Of the Queensland localities mentioned above, Pentland is 148 miles west of Townsville on the railway-line; Three-Mile Creek is approximately 150 miles east of Pentland, and its position is roughly $147^{\circ} 48'$ long. E., $20^{\circ} 35'$ lat. S.; Barwon Park is on the Mackenzie River, and is about 180 miles south 25° east of Three-Mile Creek; Minnie Creek is about 30 miles south of Barwon Park, and 10 or 12 miles from Blackwater Railway-station, which is 125 miles from Rockhampton on the Central Railway.

From this it is seen that the localities at which these seeds are associated with *Glossopteris* are widely scattered, a fact tending rather to strengthen the evidence.

Scale-Fronds of *Glossopteris*.

It may be noted here that the scale-fronds occur in association with *Glossopteris* in Queensland. They cannot be distinguished from specimens figured by Zeiller from India (Bibliography, No. 9, pl. iii), and for comparison two of them are figured (Pl. XXI, figs. 5 & 6). There is no doubt that those resembling Pl. XXI, fig. 6, are in Queensland associated with *Glossopteris Browniana*; whereas in India both the types here figured are referred by Zeiller to *G. indica*. This goes to indicate that probably these two so-called 'species' really represent portions of one very variable species, Brongniart's original *G. Browniana*. Further details of these scale-fronds will be published with the full account of the Queensland Permo-Carboniferous flora mentioned above (p. 289).

Relationships of *Glossopteris*.

Although we have advanced a stage in our knowledge of *Glossopteris*, there is still much to be learned. The megasporangia show that the genus belongs either to the Cycadofilicales or to the Cordaitales, which two groups cannot be separated on the evidence of their seeds alone. If we take into account other features in connexion with *Glossopteris*, the balance of evidence appears to be in favour of its reference to the Cycadofilicales. The association of scale-fronds and perhaps the venation of the leaves support this; further, if we accept *Vertebraria* as being the underground rhizome of *Glossopteris*, the indication is that it belongs to the Cycadofilicales rather than to the Cordaitales. Parenthetically, it may be remarked that our knowledge of the fossil *Vertebraria* is

very far from complete, and we still lack a satisfactory explanation of its structure.

We have next to consider to which group of the Cycadofilicales the seeds described above as *Nummulospermum* belong. The vascular system is similar to that found in *Cardiocarpus* (a platyspermic seed belonging to the Cardiocarpales¹), and also in some of the Trigonocarpales. *Nummulospermum* itself appears to be a platyspermic type of seed; it is distinguished from a number of the Upper Palaeozoic Cardiocarpales (*Cyclospermum*, *Rhabdospermum*, *Cycadinocarpus*, and *Mitrospermum*) by the way in which the two vascular strands are given off from the main vascular strand entering the base of the seed before it reaches the sclerotesta (see B. Sahni, Bibliography, No. 6, fig. 7).

In the apparent possession of a large pollen-chamber, *Nummulospermum* shows a feature which is one of the characteristics of the Trigonocarpales.

The anatomical features then, so far as they can be made out with any degree of certainty, appear to favour the reference of this genus to the Trigonocarpales.

In conclusion, it is hoped that, as a result of this paper, renewed interest may be awakened in the possibility of proving or disproving the intimate association of seeds with *Glossopteris* in other areas where this widely-occurring genus is found.

I have once more to express my gratitude to Mr. B. Dunstan, F.G.S., Chief Government Geologist of Queensland, at whose suggestion I first undertook the study of the fossil floras of Queensland, and whose broad view of his subject is responsible for the comparatively large amount of palaeontological work (palaeozoology as well as palaeobotany) that has been carried out in recent years on Queensland material. I have also to thank Prof. A. C. Seward for reading the proofs of this paper, and I may perhaps be permitted to express an appreciation of his kindly interest in my work at the other end of the world, an interest which has helped me over many difficulties, particularly in the earlier stages of my investigations.

BIBLIOGRAPHY.

- (1) E. A. N. ARBER. 1905. 'On the Sporangium-like Organs of *Glossopteris Browniana* Brongn.' Q. J. G. S. vol. lxi, pp. 324-38 & pls. xxx-xxxi.
- (2) E. A. N. ARBER. 1905. 'The Fossil Plants of the *Glossopteris* Flora.' Catal. Brit. Mus.
- (3) W. CARRUTHERS. 1872. 'Notes on Fossil Plants from Queensland, Australia' Q. J. G. S. vol. xxviii, pp. 350-56.
- (4) J. M. COULTER & C. J. CHAMBERLAIN. 1917. 'Morphology of Gymnosperms.' Univ. of Chicago Press.

¹ Following Prof. A. C. Seward's (Bibliography, No. 7, pp. 307-308) subdivision of Palaeozoic Gymnospermous seeds into Lagenostomales, Trigonocarpales, and Cardiocarpales.

- (5) F. W. OLIVER. 1903. 'The Ovules of the Older Gymnosperms' Ann. Bot. vol. xvii, pp. 451-76 & pl. xxiv.
- (6) B. SAHNI. 1920. 'On certain Archaic Features in the Seed of *Taxus baccata*, with Remarks on the Antiquity of the Taxineæ' Ann. Bot. vol. xxxiv, pp. 117-33.
- (7) A. C. SEWARD. 1917. 'Fossil Plants' vol. iii.
- (8) D. WHITE. 1908. 'Fossil Flora of the Coal Measures of Brazil' in Final Report of Dr. I. C. White, Chief of the Brazilian Coal Commission, from July 1st, 1904, to May 31st, 1906, Part iii. Rio de Janeiro, 1908.
- (9) R. ZEILLER. 1902. 'Observations sur quelques Plantes Fossiles des Lower Gondwanas' Mem. Geol. Surv. India (Pal. Indica), n. s. vol. ii, Mem. No. 1.

EXPLANATION OF PLATE XXI.

- Fig. 1. Photograph of specimen showing *Nummulospermum bowenense*, sp. nov. and *Glossopteris ampla* from Three-Mile Creek, Bowen. (Half of the natural size.) Specimen F 1900.
2. *Nummulospermum bowenense*, sp. nov. ($\times 2$.) At the base can be seen a vertical ridge giving off a curved ridge to the left in the sarcotesta. (These ridges show as light-coloured lines.) The dark central mass is sclerotesta plus nucellus. Traces of the micropyle can also be seen near the top. (See p. 292.)
 3. *Nummulospermum bowenense*, sp. nov. ($\times 2$.) Showing apex of seed with depression; also trace of micropyle from apex to nucellar beak. (See p. 291.)
 4. *Nummulospermum bowenense*, sp. nov. ($\times 2$.) Showing sclerotesta (sc) and pollen-chamber (pc), also traces of the vertical ridges on the nucellus which may represent vascular strands enveloping the nucellus. (See p. 291.)
 5. Scale-leaf of *Glossopteris*, Dinner Creek, Stanwell. Specimen F 1888. (Natural size.) See p. 293.
 6. Scale-leaf of *Glossopteris Browniana*, Dawson R. Specimen F 1895. (Natural size.) See p. 293.

DISCUSSION ON THE TWO FOREGOING PAPERS.

Mr. W. N. EDWARDS remarked on the desirability of finding in the *Glossopteris* flora either petrified specimens showing internal structure, or those possessing a cuticle which could be studied after chemical treatment, since conclusions based mainly on association must at present remain tentative.

Dr. A. M. DAVIES enquired as to the apparent resemblances between *Nummulospermum* and *Ottokaria*, and their relative size.

Dr. F. A. BATHER emphasized the need for the collection of fossils being made by specialists themselves. The museum and laboratory workers should be encouraged to go into the field.

The PRESIDENT (Mr. R. D. OLDHAM) said that the papers had been of personal interest to him, as he had long been concerned with the *Glossopteris* flora and problems arising out of it, and had followed with interest the successive additions to our knowledge of the plant which for long was only known as impressions of

1 ($\times \frac{1}{2}$)

2 ($\times 2$)

3 ($\times 2$)

4 ($\times 2$)

5

6

A.B.W. photo.

NUMMULOSPERMUM BOWENENSE, GEN. ET SP. NOV.,
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fronds. He could assure Mr. Edwards that in India the discovery of petrified remains of these plants, which would give some insight into the structure, had long been desired; but the search had, so far, been without success, in those beds which yielded *Glossopteris*.

Mr. THOMAS thanked the Fellows for their reception of his paper, and expressed the opinion that it might prove possible to obtain cuticular preparations from some of the specimens of *Nummulospermum* figured by Dr. Walkom, although in the case of *Ottokaria* the plant-tissue had undergone a more complete change, and little trace of the outside surface was left. In reply to Dr. Davies, he said that the seeds which *Ottokaria* perhaps produced might possibly have been similar in form to those described as *Nummulospermum*; but the two structures differed considerably in size. He thought that knowledge of both forms was still so incomplete as to render any conclusions regarding their relation to *Glossopteris* very speculative. The main value of these communications was to draw attention to the various reproductive structures of doubtful affinities found with the *Glossopteris* flora, in the hope that further work and collections would show whether they belonged to *Glossopteris*, *Gangamopteris*, or to one of the other genera in this flora.