Letters to the Editor.

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Palæobotanical Evidence for the Age of the Late Palæozoic Glaciation in South Africa.

IN an article in NATURE of June 22, 1929, p. 946, Dr. H. Dighton Thomas discusses the age of the glaciation which has left its traces in the Late Palæozoic rocks of India and in various parts of the southern hemisphere. He reviews some of the considerable volume of evidence on this subject which Prof. Schuchert of Yale has so fully summarised in a recent paper (*Bull. Geol. Soc. Amer.*, vol. 39, p. 769). Prof. Schuchert concludes that the evidence is in favour of regarding the glaciation as of "Middle Permian and probably Late Middle Permian time". Prof. Schuchert here uses the term Middle Permian for the upper part of the Lower Permian of most authors.

Dr. Thomas considers that the evidence on the whole supports the view that the glaciation was in Uralian (Upper Carboniferous) times, and this is the view generally accepted by most British geologists. Dr. Thomas refers to the work of Prof. A. C. Seward and Mr. T. N. Leslie on the fossil plants found below the glacial beds in South Africa. Representatives of this flora, which has *Gangamopteris* and the closely related *Glossopteris* as its most characteristic plant genera, are also found in beds interstratified with the relics of glaciation in Australia. This flora is found in many parts of the southern hemisphere, where, as Prof. Sahni remarks, the "close relation of the Gondwana plant beds [that is, the *Gangamopteris* flora] with the glacial deposits over enormous areas" is of great significance. We are amply justified in assuming that the *Gangamopteris* flora and the glaciation were approximately contemporaneous. Of these two important plant genera, *Gangamopteris* is more characterisitic of the early (Palæozoic) phase of the flora, while *Glossopteris* has a much greater range and persists into the Mesozoic.

One of the chief difficulties up to the present has been to find points of correspondence between the *Gangamopteris* flora and the sequence of floras of the European type in which no *Glossopteris* or *Gangamopteris* occurs. These floras have a completely different floristic composition and are characteristic of the northern hemisphere, particularly of Europe, with the exception of that part of Russia in which a *Glossopteris* flora has been found.

Recently, I have had the opportunity of examining some fossil plants which Mr. B. Lightfoot found in the Upper Wankie sandstones in the Wankie district in Rhodesia. The majority of the specimens are leaves of various species of *Glossopteris* (*Gangamopteris* is not represented), but the special interest and importance of Mr. Lightfoot's collection is the presence of several species and genera of plants which have not been found associated with *Glossopteris* before but are characteristic of the European type of Upper Palæozoic flora.

The following is a list of the plants which have been identified, *G* indicating that the species is characteristic of the typical *Gangamopteris* flora, *ES* and *EL* of the European Stephanian (Upper Carboniferous) and European Lower Permian respectively, and *A* of the Upper Palæozoic of the Shansi coalfield in China: *Phyllotheca sp.* (*G*), *Sphenophyllum speciosum* (*G*), *S. Thonii* (*EL*), *S. Thonii var. minor* (*EL*, *A*), *S. oblongifolium* (*ES*, *EL*), *Chansitheca sp. cf. Kidstoni* (*A*), *Pecopteris unita* (*ES*, *EL*, *A*), *P. arborescens* (*ES*, *EL*), *P. cf. cyathea* (*ES*, *EL*), *Asterotheca sp.* (*ES*, *EL*), *Cladophlebis sp.* (*? G*), *Glossopteris indica* (*G*), *G. Browniana* (*G*), *G. Retifera* (*G*), *G. tortuosa* (*G*), *G. cf. angustifolium* (*G*), and *Cordaites Hislopi* (*G*). (An illustrated account of the flora will be published shortly in the *Bulletin of the Geological Survey of Southern Rhodesia.*)

Although in the collection the specimens of *Glossopteris* leaves preponderate numerically, it is seen in the list that the European and *Gangamopteris* types are, from the point of view of number of species, equally well represented. It has been suggested that the *Gangamopteris* flora flourished in a rather cooler climate than that of the warm or even sub-tropical type of the European province. The Wankie terrain may have had an intermediate type of climate accounting for the intermediate type of flora which is found there in the Upper Wankie sandstones.

The known vertical distribution of the northern species which form, roughly, half of the collection, shows that the flora is closely related to that of the Stephanian and Lower Permian and is therefore in all probability early Lower Permian in age. The elements of the *Gangamopteris* or *Glossopteris* flora in the collection suggest a close comparison with the Beaufort or somewhat older, Ecca series of the succession found farther to the south in Africa. Now in South Africa the glacial beds with *Gangamopteris* interbedded in them form part of the Dwyka series, which lies below and is therefore older than the Beaufort or the Ecca series, so that the glacial beds are older than early Lower Permian and must be early Lower Permian or even Upper Carboniferous themselves. The evidence furnished, therefore, by the Wankie flora is antagonistic to the view that the glaciation in South Africa is late Middle Permian, but supports the view that it is either early Lower Permian or possibly Upper Carboniferous. J. WALTON.

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THE new occurrence recorded by Dr. Walton is of great importance both for showing members of the northern and southern late Palæozoic floras in association and for indicating the age of this and other deposits. To my mind, the age assigned to the Wankie flora by Dr. Walton cannot be questioned. In one respect I should be even more definite than he. His comparison with South African floras is highly suggestive, but, on the strength of such a correlation, I should consider the Dwyka glacial beds with *Gangamopteris* to be definitely Upper Carboniferous in age. This gives independent support to the determination obtained in other ways.

The association of elements of the northern and southern floras in the Upper Wankie sandstones can but prove that the two floras were contemporaneous. Taken in conjunction with the age of the Rhodesian plant assemblage, the association gives, therefore, additional reason for believing that the *Glossopteris* flora first appeared in Upper Carboniferous times, and that the different floral facies exhibited by the northern and southern regions are to be explained by differences in geographical distribution rather than by differences in age. As Prof. Seward has said: "No Upper Carboniferous flora was in the strict sense cosmopolitan" (Presidential address to Section K of the British Association meeting in South Africa, *vide* NATURE, Sept. 21, 1929, p. 450). A certain intermingling of the northern and southern floras is to be expected in an intermediate region, such as Rhodesia appears to be. Doubtless other