Spores and Pollen Grains in Palaeobotanical Research in N.Z.

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In the study of our past forests the bulk of the evidence has come until recent years from fossilized leaves, stems and fruits of plants. However, about the beginning of this century another line of evidence was opened up, namely, the study of fossil spores and pollen grains.

The presence of fossil spores was probably first observed as long ago as 1833, and one of the most important contributions to the study of isolated plant remains found in carbonaceous beds was made by Franz Schultze in 1855. He discovered that carbonaceous matrices could be macerated by chemical means without harm to the botanical ingredients. Thus, almost one hundred years ago there were known two methods, thin section and maceration, by which plant remains in coals, lignites and other carbonaceous beds could be studied microscopically. These two methods, with minor refinements, are used to this day.

From 1855 to 1931 was a period of largely specialised work by a few investigators on certain types of coal and of the development of thin section methods by Thiessen at the United States Bureau of Mines. Numerous papers have appeared from 1931 onwards mainly dealing with spores of Palaeozoic coals. Also, over about the same period great advances were made in studies of spores and pollen grains from peats by a number of Scandinavian workers, such as von Post and Erdtman.

In New Zealand in 1935 a detailed study of the spores and pollen grains of the Recent Flora was begun by Miss Lucy M. Cranwell at the Auckland Museum. She was joined in 1937 by Mr. W. F. Harris (now of Botany Division, D.S.I.R.). This early work was aided by a grant from the D.S.I.R. (obtained largely through the efforts of Dr. H. H. Allan). Mr. M. T. Te Punga, of the Geology Department of Victoria University College, began in 1945 to study spores and pollen grains from New Zealand coals, while to bring the record up to date I was appointed in 1948 to the New Zealand Geological Survey to work on plant micro-fossils from Mesozoic and Tertiary carbonaceous deposits. I would like to acknowledge here the great help of Mr. W. F. Harris with whom I work in close liaison.

Nature of the Fossil Record. Spores and pollen grains are extremely small, the majority being less than 1/500 inch in diameter. They are also extremely resistant to decay. When these two factors are considered it is not surprising that in peats and in certain types of rock, such as coals and lignites, lake, river

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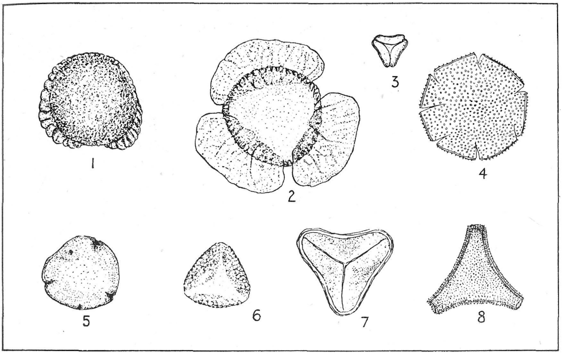

Some Fossil Spores and Pollen Grains from Upper Tertiary (Pliocene) Beds near Wanganui, × 500.

Fig. 1, *Dacrydium cupressinum* (rimu); Fig. 2, *Podocarpus dacrydioides* (kahikatea); Fig. 3, *Leptospermum* sp. (manuka); Fig. 4, *Nothofagus menziesii* (silver beech); Fig. 5, *Coprosma* sp.; Fig. 6, *Phormium* sp. (N.Z. flax); Fig. 7, *Cyathea dealbata* (silver tree-fern); Fig. 8, *Knightia excelsa* (rewarewa).

and estuarine silts, they are found in great abundance, with even the finest details of structure clearly preserved. Another factor contributing to the abundance of pollen grains in some deposits is that wind-pollinated plants, such as pines, beeches and raupo (*Typha muelleri*), shed them in astronomical numbers. For the various pines an estimation of the number of pollen grains per inflorescence is from 5,000,000 to 22,000,000, and for raupo, 174,000,000.

On this page are illustrated some specimens from younger Tertiary (Pliocene) carbonaceous silts and lignites. As an example of how the finest details are preserved, the delicate, reticulate sculpture of conifer air-sacs (the wing-like appendages of kahikatea in fig. 2) can be clearly seen. In older (Cretaceous) coals such features are normally still clearly visible.

Aims of Palaeobotanical Research. Briefly the aims can be discussed under three main headings: pure botanical research; geological applications; and nature of past climates. Considering first pure botanical research, we are fortunate in New Zealand in having deposits from which it is possible to obtain spores and pollen grains covering every major geological division of the Cretaceous and Tertiary. The geological records of some of the more important families and genera of the New Zealand flora are shown in the diagram on the opposite page. It is based on micro-floral studies of 35 Mesozoic and Tertiary localities. The thickness of the lines indicates broadly the importance of a particular family or genus during the various geological periods. This estimation of importance is based mainly on the number of species distinguished. A point I should like to emphasise is that many more micro-floras will have to be examined in order to evaluate the stratigraphical ranges shown in this diagram. Nevertheless the diagram does bring out the general trends in the evolution of our flora. Four intergrading phases of forest history can be distinguished.

First, there are the very distinct pre-Cretaceous floras characterized by the absence of flowering-plants (angiosperms) and by the dominance of ferns, fern-like plants and gymnosperms. Secondly, we have the early Cretaceous to upper Eocene floras characterized by the incoming of the angiosperms and by a particularly characteristic assemblage of extinct species of conifer. These Cretaceous and Eocene conifers in New Zealand appear to have been the dominant forest element of that time, for in every flora they are by far the most abundant of forest pollens. The family Proteaceae also appears to have been a more important element in the flora than it is today in New Zealand.

The sudden disappearance of the Cretaceous-Eocene conifers marks the beginning of the third phase. These floras can be looked upon as transitional and cover the Oligocene to middle Miocene. There is recorded in this period the incoming of a number of important families, including the Myrtaceae and Compositae. A point of interest is that conifers played a minor role in the forests of this period, for in most floras beech (*Nothofagus*) forests are clearly indicated. Pollen grains of the mistletoe (*Elytranthe*) also make their first appearance in the fossil record during the Oligocene and are known from a number of localities. This genus is today commonly parasitic on beeches and the association in the Oligocene with abundant beech pollen suggests that the parasitic habit dates at least from this time.

Finally, there are the upper Miocene-Pliocene floras of essentially modern aspect. There are a few extinct species, notably of *Nothofagus*, but generally speaking micro-floras of this age are virtually indistinguishable from those found in Recent peats.

Space does not permit a full discussion of the second of the aims listed above, namely, geological applications. It will have to suffice to say that the work so far accomplished indicates that, using plant micro-fossils in the same way as fossil mollusca or foraminifera, it is possible to subdivide non-marine beds in New Zealand into eight divisions, corresponding approximately to the major divisions of the Cretaceous and Tertiary. Also, in the Ohai coalfield plant micro-fossils have been used to distinguish various

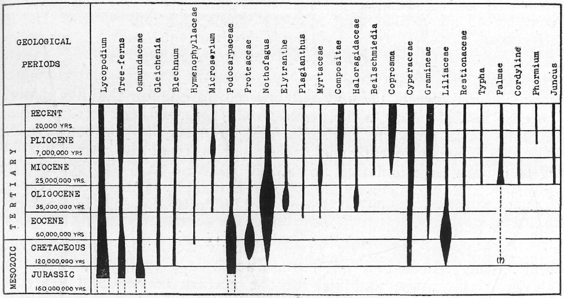

Diagram showing known geological record of some of the more important families and genera in New Zealand, based on micro-floral studies of 35 localities.

coal horizons. This provides a valuable check on the validity of the interpretations of geological structure obtained from purely geological evidence.

Considering now plants as climatic indicators, I will give two examples to illustrate this aspect of the work. From Miocene beds at Coopers Beach, near Mangonui, North Auckland, there are found numerous specimens of an extinct coconut (*Cocos zeylandica* Berry). I have studied the spores and pollen grains found in the same beds as the coconuts, and from the flora as a whole it is possible to estimate that the mean annual temperature was at least 12 degrees F. higher than at present, i.e., the climate was like that of present-day northern Queensland.

As a marked contrast there is a Pleistocene flora from Orepuki, in the extreme south of the South Island. This flora clearly indicates that the beds from which it was obtained were laid down during one of the Pleistocene glacial periods. All forest trees appear to have migrated northwards and the main plants growing in the area at the time appear to have been grasses and various members of the Compositae. This flora is remarkably similar to a flora from a Recent peat from the Snares (65 miles S.S.W. of Stewart Island) examined by Mr. Harris.

In conclusion I should like to point out that Mr. D. R. McQueen has recently been appointed to the Geological Survey to work on macroscopic plant remains. With the exception of the work of Oliver, Arber, Penseler and a few others, palaeobotany has long been the "Cinderella" of palaeontological research in New Zealand. With both macro and microscopic studies of our past flora now being made, however, it can perhaps be said that this stage has been passed.