PEAT DEPOSITS OF NORTHERN NEW ZEALAND AS BASED ON IDENTIFICATION OF PLANT FRAGMENTS IN THE PEAT

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SUMMARY: Based on the identification of plant fragments four main types of peat may be distinguished in northern New Zealand, namely forest peat, sedge peat, restiad peat and moss peat.

INTRODUCTION

Progressively over the last century the surface vegetation in vast peat areas of northern New Zealand has been altered by drainage, burning, cultivation and grazing. The present grass-clover productive pastures of the Waikato farmlands, for instance, give no indication of the former plant cover. Written accounts are meagre and maps, even when indicating bog areas, refer to the vegetation in vague terms, such as rushes, fern and scrub.

However it has been found possible to determine former vegetative cover by digging up samples of peat, analysing these in several ways and comparing the plant remains with present-day bog plants. Only certain parts of plants are sufficiently resistant to decay to be preserved. Pollen and spores have extremely resistant coats and many have distinctive shapes or markings. However, since they are often wind-borne for considerable distances, their presence does not necessarily indicate that the plants which produced them were growing nearby. In some places tree-trunks are preserved in peat. From examination of sections of the wood of these it has been possible to identify specimens (Pullar and Patel, 1972). If we exclude the possibility that trunks have been transported by flood-waters, we can assume that they belong to the site. Smaller fragments may also be identified (Moar, 1966; Lintott and Burrows, 1973). In the northern peats the fragments are practically entirely from underground, or at least under water, portions of the plant, for example roots, rhizomes, moss stems. It can be assumed that they are *in situ*. Identification is dependent on the characteristic arrangement of cells and on distinctive shape or wall markings of individual cells.

This last approach is the one with which I am most familiar. The information obtained may be used in conjunction with that from other sources. The method proved very useful in a study of peats from the Rangitaiki Plains and Maketu Basins where the peat is bedded between tephra layers whose date of deposition has been determined (Campbell, *et al.*, 1973). Earlier it was used in a study of the lower Waikato peats (Campbell, 1964).

Four main types of peat may be recognised in northern New Zealand, namely forest peat, sedge peat, restiad peat and moss peat.

METHOD OF INVESTIGATION

Since herbarium specimens rarely include roots and since plant descriptions rarely refer to underground parts, it was necessary in the first place to dig up plants from the bog and to study their morphology and anatomy. It was necessary to determine which parts decayed readily and which were resistant, for often the fragment preserved in the peat is not an intact root but just a portion of it, such as an epidermal strip or an endodermis.

For detailed analysis blocks of peat approximately 24 x 24 x 24 cm were dug out from the sides of drains and kept in sealed plastic bags under refrigeration. From these large blocks small blocks of approximately 8 cm^3 were cut out and soaked in distilled water. Samples were then examined under a dissection microscope. Promising pieces were extracted from the water and soaked overnight or longer in lacto-glycerine or in glycerine-alcohol-water. From some specimens it was then possible to cut sections by hand. Other material was dissected with needles. The preparations were mounted in

glycerine or lacto-glycerine and examined with an optical microscope for distinctive arrangements of cells and for distinctive wall features in individual cells.

FOREST PEAT

A considerable depth of friable peat may accumulate on the floor of kauri forest. It is composed almost entirely of bark and wood in varying stages of decay together with root fragments and fine nodulated roots of kauri, *Agathis australis* Salisb. In places there may be a few fine roots of podocarps of Angiosperms or of ferns.

SEDGE PEAT

Sedge peat which is derived from roots of various species of *Baumea* is produced in a low-moor or basin bog. Many basin bogs in the Waikato have arisen in shallow lakes which have been cut off from a stream by deposits of alluvium. The same effect was produced artificially at Mercer when a causeway giving access to an open-cast mine was thrown across a swampy river-flat, so cutting off an area of impeded drainage and at the same time protecting it from intermittent flooding by the river.

In the early stages of basin bogs which have been investigated in the Waikato the development of vegetation is seral. Gradually the lake becomes reduced in size as the vegetation progressively extends from the periphery inwards towards the open water. Farthest out in the water is a belt of reed-like plants up to 1 m in height. Behind this lies a quaking, partially floating mat held together by the rhizomes and roots of *Tetraria capillaris* (F. Muell.) J. M. Black, *Baumea huttoni* (Kirk) Blake, *B. rubiginosa* (Spreng.) Boeck and *B. teretifolia* (R.Br.) Palla. Each *Baumea* or *Tetraria* plant has a kind of platform around it built from rhizomes and intermatted roots and this, as a rule, but not always, will support a person's weight. Between the *Baumea* clumps there may be *Sphagnum cristatum* Hpe. along with a small amount of *S. falcatulum* Besch. and the introduced *Juncus articulatus* L. Gradually the landward edges of the mat become grounded as decaying vegetation accumulates beneath it and the surface becomes firmer and more compacted as the spreading *Baumea* plants form a closed cover. The roots of the *Baumea* species, more particularly of *B. huttoni,* are resistant to decay. In time these roots form the main components of a distinctive type of peat, here called sedge peat, which is difficult to cut with a spade and in profile resembles the brown paper packing in chocolate boxes.

Sedge peats investigated in the Rangitaiki Plains and Maketu Basins differ from those of the Waikato in that *Baumea complanata* (Bergg.) Blake is a major component. Both the roots and also crowns with a covering of leaf-bases are preserved. Minor components in the areas sampled are more slender roots belonging to other *Baumea* species as well as fine roots of *Cortaderia,* of *Dacrycarpus* and of *Laurelia* suggesting that the bog vegetation had a few dwarf shrubs and large clumps of *Cortaderia* amongst the *Baumea.*

The low-moor community dominated by *Baumea* species is an unstable one when we take a long-term view of the situation. If the surface of the bog dries out sufficiently, *Leptospermum scoparium* J. R. and G. Forst. (manuka) and *Gleichenia* fern may become dominant. The roots and in some cases stems of manuka, and roots and rhizomes of *Gleichenia* persist as woody or twiggy material in the peat. Under conditions of high rainfall there may be a transition to a raised bog (see below). If, in addition to high water content, the mineral content of the area is maintained by surface run-off from surrounding hills or by occasional flooding, the low-moor *Baumea* vegetation tends to persist.

RESTIAD PEAT

Restiad peat is formed in a high-moor or raised bog, as at Rukuhia, Moanatuatua and Motomaoho The largest of these in the Waikato Basin extends over an area of 23000 hectares. Raised bogs have a convex surface (the dome) falling away by a rather steep edge (the rand) to a moat (the lagg) drained by the lagg stream. The lagg stream also carries off any drainage from surrounding hills. The lagg vegetation is either a scrub and *Phormium* type or else a swamp-forest type. It contrasts with the low-nutrient bog vegetation of the dome. Overlying a comparatively fertile soil and being relatively easily accessible, the lagg vegetation is usually the first to be destroyed. In many places today its location is indicated only by stumps.

The essential conditions necessary for the formation of a raised restiad bog are a consistently high though fluctuating water table of telluric origin which is brought about by high rainfall, impeded drainage and suitable plants. These latter must be retentive of rainwater, and capable of creating acid conditions where the cycle of decay remains uncompleted with the resultant accumulation of extensive deposits of peat.

The dominant plants on the dome region of the Waikato raised bogs are also the main components

of the restaid peat. They are two members of the Restionaceae or jointed rushes, namely *Sporadanthus traversii* F.v. Muell. ex. J. Buchanan and *Empodisma minus* (Hock.f.) Johnson and Cutler. The name *Empodisma* (Johnson and Cutler, 1973) replaces *Calorophus* and a still earlier name *Hypolaena.*

Sporadanthus is endemic to northern New Zealand and the Chatham Islands. It grows as clumps of reed-like stems, reaching to a height of 1.2-1.8 m and provides shelter from sunlight and wind for smaller plants of other species. Below the bog surface the stout rhizome system of *Sporadanthus* by interweaving and branching at wide angles forms a platform anchored by long stilt-like roots and supporting the weight of the remaining bog vegetation.

Empodisma minus is found throughout New Zealand and also in eastern Australia from south-eastern Queensland through New South Wales, Victoria and Tasmania to south-eastern South Australia. In the Waikato bogs its slender, straggling, wiry stems reach to a height of 0.6 m in the open and up to 1.2 m amongst the *Sporadanthus* clumps. Often the stems grow so densely that no light penetrates beneath. It is, however, the roots of *Empodisma* when growing under bog conditions which are the most unusual feature of the plant. From a short, erect rhizome beneath the bog surface numerous, horizontally growing roots arise and these in turn develop prolific masses of fine roots most of which grow erect above the surface and intertwine into a thick, felted mat of a whitish or pinkish colour. Throughout their length the roots are covered with an amazing abundance of persistent root-hairs of length up to 1.0 mm. Such is the tremendous quantity of roots produced and their resistance to decay that together with the roots of *Sporadanthus* they form the main component of a fibrous peat which in places is 12 m deep.

In the restiad bogs there are a number of subordinate plants but these make little contribution to the peat. Examples are the heath-like, *Epacris pauciflora* A. Rich., the sedges, *Schoenus brevifolius* R.Br. and *Baumea teretifolia* (R.Br.) Palla, and groundcover plants such as lycopods, bladderworts, sundews, orchids, liverworts and mosses, including some cushions of *Sphagnum cristatum* Hpe.

Long-term, the restiad bog like the *Baumea* bog is unstable, since it is delicately balanced with regard to climate and drainage. The rate of change has been accelerated by man's activities.

MOSS PEAT (*Sphagnum* peat)

Extensive deposits of *Sphagnum* peat occur off Torehape Road in the Hauraki Plains indicating that formerly the area was a vast *Sphagnum* bog. Unfortunately, we can only speculate as to former conditions for, as a consequence of drainage and burning, the surface vegetation has greatly altered and *Sphagnum,* though present, no longer dominates. Of the four species of *Sphagnum* growing in the area only one, *Sphagnum cristatum* Hpe., has made a significant contribution to the peat. It differs from the other species in having a fibrose and porose epidermis on its stem and in being more resistant to decay.

The area lies 8 to 11 km from the coast near two large rivers. Conditions at the time of peat formation were probably those of a vast ponding area where the water-table was consistently high both in winter and summer. As a result the surface of the *Sphagnum* cushions was never killed by drying out as happens in restiad bogs. There were probably other plants present besides *Sphagnum* but of these only *Baumea* contributes to the peat. Evidence is available (Schofield, 1960) that the sea-level in the Firth of Thames was 2.1 m higher 4000 years ago. The gradual sinking of the land would permit the *Sphagnum* peat to build up higher and higher without risk of desiccation of the living plants at the surface.

DISCUSSION

It is possible to recognise four main types of peat in northern New Zealand.

Forest peat derived from kauri forest is found only in northern New Zealand. Since it breaks down readily on clearing of the forest, much of it has already disappeared, but deposits over 2 m thick can still be seen at Ngawha Springs, Northland.

Moss peat occurs not only in the Hauraki plains but under cooler climates in other parts of New Zealand.

Low moor peats also occur in many parts of New Zealand but vary greatly in composition. Usually they are a mixture derived from one or other species of *Baumea* together with *Sphagnum, Gleichenia. Leptospermum* and a little *Empodisma.* Those of the Rangitaiki Plains differ from ones further south in having *B. complanata* as a major component

Restiad peat of the type and depth found in the lower Waikato is peculiar to this area. It is formed in a raised bog of a unique type. Its geological background is one of volcanicity, and not of glaciation as in raised bogs of the northern hemisphere; the climate is warm temperate and variable; and the peat-forming plants grow in association today only in this region, although formerly they also grew and produced peat in parts of Northland and in the Bay of Plenty. Restiad peat in Southland is somewhat different in that *Sporadanthus* is absent there.

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