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CHANGES IN NEW CALEDONIAN VEGETATION DURING THE TERTIARY :
THE ULTRAMAFIC AREAS

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I - At the end of the Eocene the flora and vegetation of New Caledonia underwent considerable changes following a major geological event : the deposit of a large layer of ultramafic rocks which covered nearly all of the main island.

This cover, reduced by erosion to discontinuous outcrops (fig. 1), occupies nowadays one third of the surface, about 5,500 square kilometres extending from sea level to 1618 metre with a rainfall between 900 and 4000 mm per annum.

From a qualitative and quantitative analysis of the present native flora of the ultramafic areas and its geographical distribution, the present study aims at understanding the mechanisms which during the Upper Eocene have directed the establishment of the new vegetative cover.

II - The ultramafic substrate of New Caledonia consist mainly of peridotites. All these rocks, lacking feldspar and quartz, are characterized by a low content of Ca, P, Al, K, an abundance of Fe and Mg and high levels of certain heavy metals : Cr, Ni, Co, Mn.

Their modification leads to the formation of several different soil types. As regards mineral nutrition the extreme cases are represented by hypermagnesian soils with basic pH very unfavourable to plants, and strongly desaturated ferralitic ferritic soils with clearly acid pH similar to the desaturated soils on acid rocks and therefore less selective.

III- 1 - The total phanerogamic flora of the ultramafic areas (table 1) includes 1815 species in 436 genera of which 91 are endemic.

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Compared with the "other" flora which includes 1807 species, the ultramafic flora is of similar size notwithstanding its occupying only half the area. This underlines its great richness.

Its originality is also confirmed by the presence of 1659 endemic species, or 91 %, a value distinctly higher than that for the endemism in the whole flora (76 %).

The same applies on the family level. Of the 152 families of the native flora, 117 (nearly 77 %) have representatives on ultramafic rocks. Of the 5 endemic families, 4 are present (Oncothecaceae, Phellinaceae, Strasburgeriaceae, Paracryphiaceae).

Amongst the main families the number of species occurring on ultramafics (table 2a) is greater than that occurring on other substrates for all the families in pink or orange which have at least twice as many species here as elsewhere. The difference is still important in the others.

For the following families (table 2b), however, the number of species is about equal for the two types of substrate, or lower for ultramafics in particular Moraceae, Papilionaceae, Compositae and Gramineae.

At the generic level the majority of the new-caledonian genera is represented on ultramafics.

With the largest number of species (table 3) is *Phyllanthus* (77). Numerous others such as, *Eugenia*, *Alyxia*, *Pittosporum*, *Hibbertia*, *Pancheria*, *Cunonia* are all better represented on this substrate. On the contrary, the genera in yellow are under-represented on ultramafics. The same applies to many genera (in blue) mainly occurring in forests.

2 - Occurring exclusively on ultramafic rocks (table 4) are 1171 species or 39 % of the total flora.

This flora is endemic for more than 98 % ; only 21 species are not endemic.

Seven families (in yellow) (table 4 bis), of which 2 endemic ones restricted to forests, occur in New Caledonia exclusively on ultramafics. In nine families more than two third

of the species are restricted to this substrate.

As to genera, 70 (table 5) have all their species on ultramafics. Amongst these 38 are endemic and mostly monospecific (orange). But some larger genera (in green) also belong there.

3 - A study of the distribution of 530 species exclusively occurring on ultramafic rocks, covering 30 families has been made. Two major phytogeographic areas have been distinguished. On the one hand the southern area *sensu stricto* ; south of the line Bouloupari-Thio and with its extension to a line between Mé Maoya and Boulinda.

On the other hand the series of outcrops in the North-West, from the Belep Islands to the Boulinda complex.

Of the 530 species, more than two third are restricted to one of these two major areas. About 35 % are found only south of the line Bouloupari-Thio ; this becomes 49 % if one applies the wider concept of the southern area. 17 % of the species are restricted to the northwestern area.

IV - DISCUSSION.

On the basis of current edaphic and floristic data concerning ultramafic rocks one can perceive the floristic changes which have taken place in New Caledonia during the Tertiary. They are :

1. Disappearance of a certain number of species of the Eocene flora with the peridotite cover which explains the relative poverty of the forest flora on ultramafic rocks.
2. Differentiation of an ultramafic flora.
 - 2.1. Establishment of heliophilous species and appearance of climactic maquis, sclerophyll and riverine forests and swampy vegetation.

The Eocene flora of New Caledonia was largely a forest flora but it contained some heliophilous species which occupied exposed sites. Certain ones pre-adapted to the very special new conditions (efficient physiological ability for selective absorption, exclusion or accumulation of the mineral elements) have been able to establish themselves in these new biotopes.

Obviously these pioneers have to be sought amongst the species (or their ancestors) belonging to the genera nowadays essentially or exclusively found in the open climax formations on this new substrate (with yellow dot).

2.2. Establishment of forest species (rainforests on ultramafics).

Simultaneously pedogenesis favoured in certain cases the formation of ferrallitic ferritic soils, very similar to those existing on schists, which was going to permit the direct establishment of all the Eocene forest species. Amongst these appear evidently numerous Gymnosperms but also Myrtaceae, Sapotaceae, Proteaceae, families shown to have in New Caledonia a good many species with precisely low nutrient requirements.

As to the species nowadays associated with hypermagnesian soils, rich in Ni and Mg, here the peridotites have had an extremely selective filter role because to the poverty in nutrient elements are added the problems of toxicity due to the high Ni and Mg levels. To these belong precisely numerous forest species of the genera *Homalium*, *Xylosma*, *Geissois*, *Hybanthus*, well known to tolerate high levels of Ni in their tissues (JAFFRE, 1980).

2.3. Differentiation of new species.

The consequence of the inability of many species to establish themselves on substrates derived from peridotites has been a reduction in competition and the creation of floristically empty spaces favourable to active speciation by adaptive radiation.

The speciation generated by peridotites has also produced a toxicoresistant flora species capable of restricting the penetration of Ni or Mn in their tissues and some others tolerant to abnormally high levels of heavy metals. To this group belong the species with a high Mn content of the genera *Maytenus*, *Alyxia* and those with a high Ni content of the genera *Sebertia*,

Psychotria.

2.4. The role of conserving old and archaic species occurring in a general way in the rainforests has operated in New Caledonia on all substrates. On ultramafic rocks this role has only been active for a limited time (40 million year) and only on a fraction of the Eocene forest flora. The post-Eocene speciation and the protective role have not yet compensated numerically the initial impoverishment.

This role of conservation has, on the other hand, been significant in the open and excessively poor environments where the interspecific competition is very favourable to species with low nutrient requirements.

2.5. Disjunction in the species distribution.

The ultimate fragmentation of the initially continuous peridotitic mantle has led to disjunct distribution of many species. The difficulty of genetic exchange between populations of the same species, which has been its consequence, has favoured a speciation of which the present situation (microendemic species or subspecies) bears witness.
