INPUT OF THE DIFFERENT VEGETATION UNITS TO THE RICHNESS AND ENDEMICITY OF THE NEW CALEDONIAN FLORA

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1. ABSTRACT

The floristic richness and endemicity rates of vascular plants of different vegetation units, defined by edaphic and physiognomic bases, are compared. Flora on ultramafic rocks (2145 species of which 81.4% are endemic species) is richer and more specific than flora on acidic rocks (1888 species, 63.7% endemic) or calcareous rocks (485 species, 39.2% endemic). Flora of wetlands and aquatic areas as well as flora on salty soils and mangroves, each with fewer than 200 species, are on limited areas. The first one with its endemicity rate of 55 % is more particular than the second one (only 10.4%). Flora in the dense humid forests has 2013 species and an endemicity rate of 82 % i.e 870 species more than in the ultramafic maquis (shrubland), but this one has a higher endemicity rate (88.8%). The dry forest as well as savannas and thickets have quite the same number of species (424 and 410), but this flora in the dry forest covers less than 300 km² with an endemicity rate of 55%, when the endemicity rate of the flora in the savannas and thickets spread on more than 6000 km² is only 11%. The results of the study show how important are the influence of the extent of the forest, the diversity of the environmental conditions, the consequences in the vegetation change after disturbance (depending on the nature of the substrates), on the flora diversity of many a vegetation units. The whole floras on ultramafic rocks as well as the one in the dense humid forests on acidic rocks make most of the floristic diversity of New Caledonia.

Keyword: Flora – vegetation units – edaphic conditions – ultramafic substrates - New-Caledonia.

2. INTRODUCTION

New Caledonia, a French overseas territory located in the southwest Pacific (20°-23°S, 164-167° E) which is renowned for it exceptional flora [1. 2], has about 3260 species of vascular plants with an endemicity rate of 74% [3]. The aim of the study is to compare and analyse the part played by the flora of different vegetation units on an edaphic and on a physiognomic base towards the global floristic diversity of New Caledonia. It's based on publications about characterisation and flora of different vegetation units, taken into account in the book " Composition and characterisation of the native flora of New Caledonia" [3], with an addendum to the second publishing in 2004, together with the personal communications of Ph. Morat on the genus *Acropogon* and of H. Hopkins on the genera *Codia and Geissois.*

3. THE DATA

3.1 Edaphic units

They correspond to different geological substrates [4] and specific ecological environment. They cover 5 main units: substrates on ultramafic rocks, on acidic rocks, on calcareous rocks, salty soils (mangrove and strand areas), wetlands and freshwater aquatic areas (including swamps, flooded river banks, pools and dolines).

- Ultramafic rocks or "terrains miniers" cover 5600 km², including a massif occupying the entire South of the main island (culminating point 1618 m) with an extension on the East coast and several isolated massifs along the West coast. These rocks generate soils extremely poor in phosphorous, potassium and often calcium, even unusually rich in phytotoxic metals (Ni, Cr, Mn) and in Magnesium [5]. They include: ferralitic ferritic soils [6] (syn. acric ferralsols and oxisols), the more extensive, and brown hypermagnesian soils *(*syn: inceptisols) [7] at the base of the massifs. The first ones composed mainly of oxides and hydroxides of Fe are deficient in aluminium clays. They are acidic (pH 4 to 6) and have a very low cation exchange capacity (CEC). They vary in depth (from 10 cm to more than 20 m) according to their topographic position. Brown hypermagnesian soils are often shallow and stony. They contain smectite clays and have a pH around neutral, a high CEC which is dominated by Mg.

- Substrates on acidic rocks covering about 9000 km² are made of metamorphic rocks of the Central Chain and the Chain of Mt Panié culminating at 1628 m. as well as the siliceous (phtanites) of the extreme North of the Grande Terre. Metamorphic rocks produce ferriginised unsaturated brown soils associated with leached – or not – unsaturated fersiallitic soils. These soils have a rather high cation exchange capacity, a low base saturation and an acidic pH (4.5 to 5.5). Their content is very high in silica and rather high in iron and alumina. Content in potassium and calcium vary and phosphorous content is low. Soils on phtanites belong to leached fersiallitic soils with podzolic A2 horizon. They are strongly acidic (pH 3.8 to 4.7). Considering all the major elements they are poorer than the first ones [8].

- Substrates on calcareous rocks cover 3800 km². They encompass 2000 km² derived from coral reefs on the Loyalty Islands and on the Isle of Pins and 1800 km² of sedimentary rocks. These include limestone pavement ("karst lapiazé") in the area of Hienghène, Koumac, Poya, Bourail and various calcified rocks occurring sporadically along the West coast between Poum and Nouméa and in the center of the main island [9]. They produce carbonate soils (rendzinas) associated on the Loyalty Islands with allitic ferralitic soils. These soils have a pH around neutral or basic, a high concentration of exchangeable bases and high level of phosphorous.

- Salty soils are found mainly on the West coast. They cover about 500 km² including 20 000 ha of mangroves [10. 11].

Wetlands and aquatic freshwater zones cover on one side swamps spread on sedimentary rocks along the West coast and the North of the Grande Terre and on the other side pools and wetlands drained by rivers on ultramafic rocks at the South end of the Grande Terre. They cover less than 500 km².

3.2 The flora of the edaphic units (Table 1)

Table 1. Characteristics of the flora of the edaphic units

Edaphic units	Number of indigenous species	Number endemic species	
		Total and (endemicity %)	Only in one edaphic unit
Ultramafic rocks	2145	1747 (81.4)	1169
Acidic rocks	1888	1203 (63.7)	528
Calcareous rocks	485	190 (39.2)	38
salty soils	183	19 (10.4)	3
Wetlands and aquatic areas	162	89 (54.9)	22

Flora on ultramafic rocks is made of about 260 species more than flora on acidic rocks spread yet on a larger area of about 3400 km². Flora on calcareous rocks, spread on about 3800 km², is quite poor compared to the two first ones. But it's nevertheless richer than the one on salty soils or even on the wetlands and aquatic zones spread on reduced areas. The endemicity rate of the flora on ultramafic rocks is 81.4 %, i.e 17.7% more than the one of flora on acidic rocks substrates. The endemicity rate of the flora in wetlands and aquatic areas is over 50% and is higher than the one of the flora on calcareous rocks (39.2%). The lower endemicity rate is noticed on the flora of the salty soils and mangroves (10%).Endemic species recorded solely on ultramafic rocks are twice as many as the ones recorded solely on acidic rocks and 29 times as many as these recorded on calcareous rocks. The flora of the wetlands and aquatic areas, in spite of its floristic poverty, presents 22 endemic species strictly bound to them.

3.3 The physiognomic units

They are: dense humid forests, maquis (shrublands), dry forests, savannas and thickets ("fourrés secondaires") [12]

- Dense humid forests [12] are developed in areas receiving between 1300 and 3500 mm of rain per year and are spread on 3800 km². They have diminished in size because of wildfires and human activity. The largest forests are located in altitude and mainly on acidic rocks (about 1800 km², against 1100 km² on ultramafic rocks and 900 km² on calcareous). Different types of forests exist depending on the composition of the soil, the climate, the topography, the altitude together with the anthropic and natural atmospherics affecting them in the process of time [12. 13].

- Maquis (Shrublands) are opened vegetation units, with a top stratum of less than 5 to 6 m, sclerophyllous, evergreen, composed of light demanding species. The herbaceous stratum is Cyperaceae. They cover an area of about 1600 km² on acidic rocks and 4600 km² on ultramafic rocks. On acidic rocks they lay mainly at lower and middle altitudes, on siliceous soils, strongly deficient in nutrients [12]. They also cover the top ridges [14]. They present a majority of similar species to some maquis on ultramafic rocks, but, on the floral side, they are poor because of the repeated wildfires. These maquis are much more diversified on the ultramafic rocks and can be classified in four main types [5]: "le maquis arbustif", on brown hypermagnesium soils, "le maquis lingo herbacé" on eroded and colluvial ferralsoils, "le maquis arbustif buissonnant" on gravelly or indurated ferralsoils, "le maquis paraforestier" which includes tall maquis on all types of soils. They spread between the sea front to the highest mountains (1600 m) getting more than 3000 mm of rain a year. Most of them arise from the destruction of the forest due to these repeated wildfires. Only few maquis in altitude or the driest coastal zones of the West coast could be deteriorated forms of primary maquis [5]. Due to the conjunction of a strong hydric shortage in the dry season and poor conditions of mineral nutrition, the latter could be described as "stunted dry forests" on brown hypermagnesian soils [15]

- The dry forest or "sclerohyllous forest" [12. 16. 17] grows on sedimentary rocks and on basalts, under 300 m high, on the West coast of the main island (Grande Terre) in areas with less than 1100 mm of rain a year. Only deteriorated facies are left, the most preserved ones have a mesic type [18]. This cover is only on few hundreds km².

- Savannas and thickets are modified vegetation after disturbance on sedimentary rocks (siliceous and calcareous) and basalts resulting from the destruction of forests and extension of many new introduced species. Savannas are herbaceous vegetation often strewed with arborescent niaoulis (*Melaleuca quinquenervia*), small trees and few bushes. When these become dense, savanna becomes thicket. This unit of vegetation spreads on more than 6000 km² to 700 m high [12].

3.4 Flora of physiognomic units (Table 2)

Table 2. Characteristics of the flora of the physiognomic units

Physiognomic units	Number of indigenous species	Number endemic species	
		Total (endemicity %)	Only in one physiognomic unit
Dense humid forest	2013	1648 (81.9)	1160
Maquis	1144	1016 (88.8)	534
Dry forest	424	233 (54.9)	67
Savannas and thickets	410	45 (10.9)	4

The dense humid forest is the richest vegetation unit in species. It has about 870 species, more than the maquis though occupying an area of more than 2000 km². Despite an area 20 times smaller than the area of savannas and thickets, the dry forest has roughly the same amount of species. The number of endemic species of these units of vegetation decreases exactly like the total amount of species, but the rate of endemicity of the flora of the maquis (88.8%) is slightly superior to the one of the flora of forests (82%). The endemicity rate of the flora in dry forest (55%) is clearly higher than the flora of savannas and thickets (11%). Endemic species present only in the flora of dense humid forests are twice as many as the endemic species belonging solely to the flora of the maquis. They are 17 times more than the endemic species belonging only to the flora of the

dry forest and 380 times more than these belonging to the flora of savannas and thickets.

4. DISCUSSION CONCLUSIONS

The richest flora in species and the most special on account of its high and specific endemicity rate is seen on ultramafic rocks. It belongs first to the dense humid forests, with many species, except these on calcareous substrates [17] and also to ultramafic maquis. This last unit, an opened vegetation resulting of forest destruction, has a very high amount of species with a very high rate of endemicity [5].

Flora on acidic rocks despite of an occupation area much larger has less species and has an endemicity rate lower than flora on ultramafic rocks. It belongs to humid dense forests, quite rich in indigenous and endemic species but also to large areas of savannas and thickets poor in indigenous species. Maquis on siliceous rocks, where flora is impoverished by frequent wildfires [12] together with dry deteriorated forests limited on a small area, contribute slightly to the flora of the acidic rocks.

The highest inputs to the flora of substrates on calcareous rocks are brought by the forest, poorly diversified on this substrate [19] and by the restricted dry forest.

Flora of the wetlands and aquatic zones on reduced areas, under repeated wildfires, stay quite poor. It's however very specific and strongly specialised on ultramafic rocks [5] like the maquis on these same substrates.

Salty soils have a strongly specialised flora, particularly in mangroves, but quite poor with very few endemic species [10 11]

The difference in diversity and endemicity between the floras of the different substrates is due to the importance of the dense humid forests and to the diversity of ecological conditions on a same substrate. The most important areas of the forest are on acidic rocks, whereas environmental conditions, particularly edaphic, are the most diversified on ultramafic rocks. On calcareous substrates forests areas are small and ecological variations (altitudinal and edaphic) vary little. Differences are due to the effects of the vegetation transformation after disturbance, which vary according to the nature of the substrate. On ultramafic rocks, the substitution of forests by modified vegetation results in the development of a maquis flora, largely endemic and specialised. This flora is composed of taxonomic groups pre-adapted to very poor soils, sometimes unusually rich in magnesium and in potentially toxic metals [20]. Moreover these particular substrates have established ecological barriers against introduced species [5] which on the contrary have largely spread in the dry forests and taken the place of the indigenous flora of savannas and thickets. On acidic rocks, maquis are little diversified, impoverished floristically and less spread than on maquis on ultramafic rocks. They also have little influence on the whole flora on acidic rocks.

Finally, it shows ultramafic substrates, carrying floristically diversified forests and maquis with a very specialised and quite rich flora, contribute mainly, with the dense humid forests on acidic rocks, to the special richness of the flora of New Caledonia.

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