MORPHOLOGY, DISTRIBUTION AND ECOLOGY OF PALMS IN NEW CALEDONIA

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Introduction:

The palms of New Caledonia belong to two subfamilies, the Coryphoideae represented by the genus *Pritchardiopsis* with palmate leaves and bisexual flowers, and the Arecoideae with sixteen genera totalling thirty one species with pinnate leaves and unisexual flowers in triads. Among those last named, the genus *Basselinia* with eleven species in two sections is the most diverse. Only the genus *Cyphosperma,* present in Fiji and Vanuatu, has an extra-territorial distribution.

This article's aim is to present the morphological and architectural characteristics of palms in New Caledonia, to define their distribution regulated by ecological factors in their environment and also their localities in New Caledonia.

Morphological Architecture:

All the palms in New Caledonia are phanerophytes, not one species is climbing nor do any have spines.

At maturity, the majority are 10 to 18 metres in height. Among the smaller species there are *Basselinia deplanchei* (4-5m), *B. gracilis* (2-8m), *B.iterata* (7m), *B.porphyrea* (5m), *B.vestita* (.5-5m), *Brongniartikentia lanuginosa* (1-6m) and *B.vaginata* (1-6m). In taller species there are *Basselinia tomentosa* (20m), *Burretiokentia vieillardii* (18-20m), *Kentiopsis oliviformis* (30m), *Mackeea magnifica* (20-25m) and *Moratia cerifera* (20m).

All the species are unbranched with slow growth and smoothish trunks with more or less prominent annular rings. One-third of the species have prominent annular rings, remarkable in *Basselinia humboldtiana, B.sordida, Brongniartikentia lanuginosa, Burretiokentia vieillardii* and *Campecarpus fulcitus.*

Most species have a swollen trunk at the base, forming in some cases *(Cyphokentia macrostachya, Lavoixia macrocarpa)* circular disc at ground level. One-third of the species have aerial roots and three of them *(Alloschmidia glabrata, Burretiokentia vieillardii, Campecarpus fulcitus)* possess stilt roots arranged in several cones.

They all have a spiral phyllotaxy and the number of functional leaves varies from four *(Actinokentia divaricata)* to about twenty *(Cyphosperma balansae).* All the *Basselinia* of section Taloua have about ten. The inflorescences are lateral, situated under the crownshaft, except in the two species of *Brongniartikentia,* in *Cyphosperma balansae* and *Pritchardiopsis jeanneneyi* where they are among the leaves. The number of inflorescences varies, but is most often two, although more than ten can be attained by *Alloschmidia glabrata* and *Cyphosperma balansae,* however, in that species and in *Brongniartikentia vaginata* the inflorescences are situated at the extremity of a long peduncle which can attain 1.5 metres.

The architecture of palms in New Caledonia (Veillon 1976) corresponds to two models defined by Halle' et al (1978), the model of Corner for species with solitary trunks, the model of Tomlinson for the four caespitose species: *Basselinia deplanchei, B.gracilis, B.vestita* and *B.pancheri.* The case of *B.pancheri* is very interesting to note. This palm most often presents the model of Corner but occasionally (Moore & Uhl 1984) it branches at the base of the trunk which makes it conform to the

Figure 74: Opposite previous page. Upper left. *Basselinia pancheri* in habitat, slopes above Lake Yate, southern New Caledonia (AD)
Upper right. *Basselinia deplanchei* in habitat (O)
Lower. The view downstream from Pont Germain toward the entrance of Lake Yate, Riviere Bleue, New Caledonia (AD)

Figure 75: Previous page. Upper left. Infructescence with mature fruit of *Cyphokentia macrostachya,* Riviere Bleue basin (AD)
Upper right. Crown of *Cyphokentia macrostachya* (AD)
Lower. Location board of the Riviere Bleue Terratorial Park (AD).

in: Palms of the South-we

model of Tomlinson. This example illustrates the possible transition between the two close architectural models within the same genus. Outside the forest environment, the adaption of the caespitose species in full light is marked not only for an important reduction in size or a lesser number of leaves which become tougher, but also by a multiplication of stems often reduced to simple clusters at the base (10-12 stems) for *Basselinia deplanchei* in the "maquis" of Haute Tontouta and Ouenghi. Generally, morphological transformations concerning essentially the reduction of the size of the trunk, the leaves, the spathes and of the inflorescences are observed in a good number of species when they are in an over-exposed environment.

Distribution and Ecology:

The distribution of palms in New Caledonia has been approached by different authors (Schmid 1973, 1974: Moore & Uhl 1984: MacKee et al 1985).

We can recognise five different phytogeographic sectors including within them areas of dense humid forest and the scrub derived from it.

The south is constituted essentially of ultrabasic rocks, the north-east of micaschists and glaucophanites and the others of ultrabasic and acid rocks (schists and micaschists).

The distribution of the species, the nature of the geological substratum and the edaphic conditions are given in Table I.

Geographic and Geological Distribution:

The southern sector, essentially constituted of ultrabasic rocks (mainly peridotites), has fourteen species. Six of them belong to five genera *(Actinokentia huerlimannii, Basselinia humboldtiana, B.porphyrea, Brongniartikentia vaginata, Campecarpus fulcitus, Pritchardiopsis jeanneneyi)* are strictly associated with them. We also find *Burretiokentia vieillardii* and *Basselinia gracilis* from north to south on La Grande-Terre on various substrata. *Clinosperma bracteale* and *Cyphokentia macrostachya* are present in the central sector on acid rocks. Three species, *Actinokentia divaricata, Basselinia deplanchei* and *B. pancheri,* are localised in ultrabasic regions, the first two being distributed in the south, central and west, the third in the south and north-east.

Nine species are found in the east-central sector but only one species, *Basselinia tomentosa,* reported in only one location on schists (Mt. Nakada), is endemic to that region. *Basselinia sordida* is associated with ultrabasic rocks, the other six are indifferent to the substratum.

The central-west sector has 13 species. Only *Basselinia vestita,* known in a single locality, Le Me' Ori on peridotites, is endemic to that sector. four other species, including *Actinokentia divaricata* and *Basselinia deplanchei* are also found in the south sector. *Basselinia deplanchei,* with a large distribution, is always associated with ultrabasic rocks. Two species, *Kentiopsis oliviformis,* which is exclusive to the central-west sector and *Basselinia velutina,* the only species having a disjunct distribution (present at Dogny in the central-west sector and at Mt.Panie' in the north-east sector) are associated with acid rocks. Six species are indifferent to the substrata and all except *Cyphosperma balansae* are present in the south sector.

Of the species found in the north-east sector, only *Burretiokentia vieillardii* (the only species represented in the five phytogeographic regions) is indifferent to the substratum. *Basselinia pancheri* is exclusive to the ultrabasic rocks in the south and central sectors and *Burretiokentia hapala* is associated with limestone rocks (but more frequently on acid rocks) in the north-east. Sixteen species have been found in the north-east sector. Ten of them, with five being monotypic genera *(Alloschmidia, Lavoixia, Mackeea, Moratia* and *Veillonia)* and five belonging to *Basselinia* (two species), *Chambeyronia, Brongniartikentia* and *Cyphophoenix,* are endemic to that sector. Of the last two genera, *Brongniartikentia lanuginosa* is found on Mt. Panie' and *B. vaginata* on ultrabasic rocks in the south

Figure 76: Following page. Upper left. *Basselinia gracilis* in habitat (AD)
Upper left. Leaves of *Basselinia pancheri* (AD)
Lower. Mature infructescence of *Basselinia pancheri;* note the kidney shaped fruit (AD)

Figure 77: Opposite following page. Upper left. *Cyphophoenix nucele* on Lifou Island, Loyalty Islands, New Caledonia (O)
Upper right. *Lavoixia macrocarpa* in habitat at 500m asl on Mt. Panie', north-eastern New Caledonia (O)
Lower. Fruit of *Pritchardiopsis jeanneneyi* (O)

Species	S	C.E	C.W	N.W	N.E	Habitat	Acid or Calcium Rocks	Peridotes	Altitude (m)
Actinokentia divaricata	X		X			FU		e a	200-700
Actinokentia huerlimannii	X					FU		e r	850-1000
Alloschmidia glabrata					X	FA			10-1000
Basselinia deplanchei	X		X			MU		e f r a	500-1500
Basselinia favieri					X	FA	f		300-500
Basselinia gracilis	X	X	X		X	MI	e f	e f r	10-1600
Basselinia humboldtiana	X					FU		e r	800-1000
Basselinia iterata					X	FA	e		1000
Basselinia pancheri	X		X	X		MU		e f r	200-1200
Basselinia porphyrea	X					FU		e r	900-1000
Basselinia sordida		X	X			FU		r	100-1400
Basselinia tomentosa		X				FA	e		1000-1100
Basselinia velutina			X		X	FA	e f		400-1600
Basselinia vestita			X			FU		e	900-1000
Brongniartikentia lanuginosa					X	FA	e f		700-1250
Brongniartikentia vaginata	X					FU		e f a	200-1000
Burretiokentia hapala				X	X	FAC	e c		50-400
Burretiokentia vieillardii	X	X	X	X	X	FI	e f	e f r	900-1200
Campecarpus fulcitus	X					FU		e f	20-800
Chambeyronia lepidota					X	FA	e f		300-1400
Chambeyronia macrocarpa	X	X	X		X	FI	f	f a	10-800
Clinosperma bracteale	X	X	X			FI	e f	e f r	40-1200
Cyphokentia macrostachya	X	X	X			FI	f	e f a	150-900
Cyphophoenix elegans					X	FA	f		20-550
Cyphophoenix nucele						FC	c		60
Cyphosperma balansae		X	X		X	FI	f	f	10-950
Kentiopsis oliviformis		X	X			FA	e f		30-300
Lavoixia macrocarpa					X	FA	f		500
Mackeea magnifica					X	FA	f		500-700
Moratia cerifera					X	FA	f		10-800
Pritchardiopsis jeanneneyi	X					FU		e	200
Veillonia alba					X	FA	f		10-600

Legend for Table I:

Geographic Separation: S-South, C.E.-Central East, C.W.-Central West, N.W.-North West, N.E.-North East

Plant Formation, Geological Substrata:

FU - forest on ultrabasic rocks
FA - forest on acid rocks
MU - forest and marquis on ultrabasic rocks
MI - forest on acid rocks, forest and marquis on ultrabasic rocks
FI - forest on acid and ultrabasic rocks
FC - forest on limestone
FAC - forest on acid rocks and limestone

Soils:

On Acid Rocks or Limestone

e - developed soils on schists, micaschists and glaucophanites
f - ferrallitic soils on schists, micaschists and glaucophanites
c - brown soils on limestone

On Ultrabasic Rocks

e - developed soils on peridotites
f - humiferous ferrallitic, ferritic soils on peridotites
r - juxtaposition of developed soils and organic rankers on peridotites
a - serpentine alluviums

Figure 78: Table 1. Distribution of Species, Nature of Geological Substratum and Edaphic Conditions.

whilst *Cyphophoenix elegans* on the Panie' massif and *C.nucele* on limestone on Lifou. They are examples of genera adapting to different soil conditions.

Cyphophoenix nucele, located at only one place at Lifou, has the peculiarity of being the only palm endemic to the Loyalty Islands. It is necessary to acknowledge the absence of palms from the Isle of Pines.

The number of species on different categories of geological substrata shows that thirteen species (40.6% of the total) are associated with schists and micaschists. Eleven species (34.4%) are associated with mining terrains. Six species (18.75%) are found either on acid rocks or on ultrabasic rocks. Only one species is associated with limestone and another is found on both limestone and acid rocks.

The importance of palms in the south sector (nine genera and fourteen species, of which ten are endemic), demonstrates the bipolarity of their distribution. However, the north-east sector, richer, despite an area about seven times inferior to the south sector, appears to be the favorite sector of the family.

In respect to palms being exclusively restricted to forests, a thesis developed by Morat et al 1984, concludes that the moist forests, and particularly those of the north-east on micaschists, could have had a preponderant role in the conservation and diversification of the flora in the forests of New Caledonia. This role, conservator and diversificator, is also played but to a lesser degree, by the forests on ultrabasic rocks and particularly in the large south Massif which occupies one quarter of La Grande-Terre and culminates as does Mt.Panie' at more than 1,600m in altitude at Mt.Humboldt at 1,618m.

Edaphic Conditions:

It appears as indicated in Fig.I. that the palms of New Caledonia are generally associated with dense, humid forests.

Four species only occur also in "maquis" derived from forest on ultrabasic rocks and are found on seven main types of soil whose characteristics are mainly determined by the geological substratum. On schists, micaschists and glaucophanites they occur on or at the base of steep slopes of immature eroded soils or in flattish areas of slightly leached fersiallitic or ferrallitic soils.

The undeveloped humiferous soils of the metamorphic Mt. Panie' (Latham 1985), have a silty texture. They are rich in organic matter (5-10%), poor in nitrogen (0.4%), very acidic (pH 3.9 to 4) and very desaturated in bases. They are poor in phosphorous (0.3% of P_2O_5 in the humifere horizon) but have a very high reserve of potassium (0.7% to 0.9% of K_2O).

The fersiallitic and ferrallitic soils are less desaturated than the previous ones, their pH often being near 5, but they are relatively poor in nutritional elements like phosphorus. They are distinguished, especially from underdeveloped soils, by a deeper and distinctly differentiated pedologic profile. They offer more favorable conditions for root development and alimentation.

On limestone, *Burretiokentia hapala* (only one location in this case) and *Cyphophoenix nucele* are found on brown soils in juxtaposition with fersiallitic soils for the first one and skeletic for the second. These neutral or slightly acid soils (Latham and Mercky 1983) are silty clay of lumpy structure, rich in organic matter (more than 20%) and in nitrogen (average 1%). Among the exchangeable bases, calcium dominates (more than 15 me'/100g). The reserves in phosphorus are very high (2%) on limestone at Lifou and very low (0.1% of P_2O_5) on limestone in the north-east sector. In general, these soils are more fertile than the soils on acid or ultrabasic rocks particularly at Lifou, because they are too shallow to favour a good water supply in dry periods.

On ultrabasic rocks, the four categories of soils named offer to the palms very special conditions of mineral nutrition because of their extreme poverty in every element except magnesium, sometimes in excess, and more or less high content in heavy metals (nickel, chromium, copper and manganese).

In every case, their total contents in calcium and potassium and in phosphorus are extremely low (in order of 0.01%). In the exchange complex the magnesium is the dominant element: from 5 to 10 me'/100g on underdeveloped soils in erosion, inferior from 2 me'/100g on ferrallitic soils and also on the organic rankers (3 to 3.5).

The non-developed soils on alluvial deposits, or on the slopes, have a very high content in nickel (from 0.5 to 1%). Although palms are frequently close to species rich in nickel (more than 1% of dry matter in

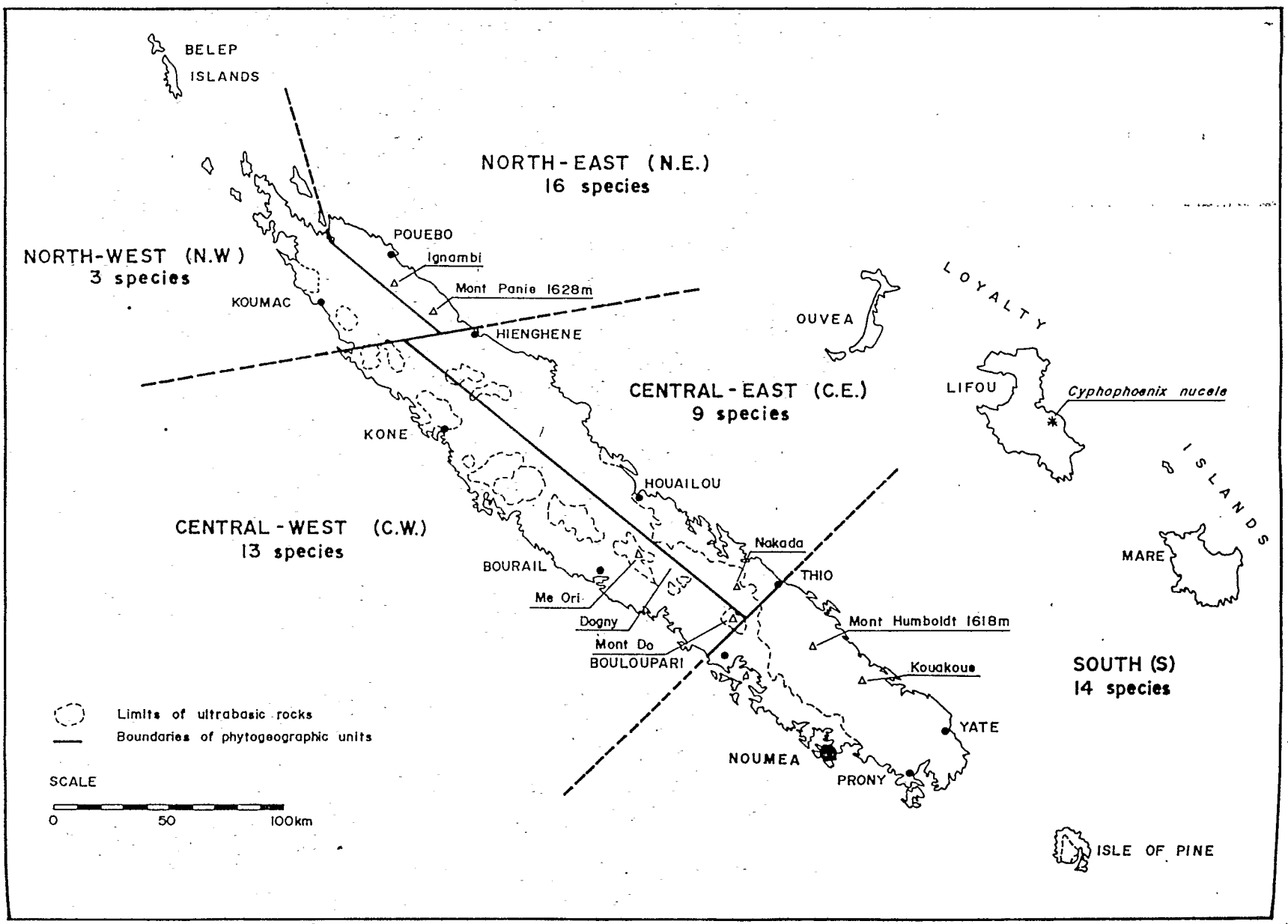

Figure 79: (Fig. 1.). Distribution of Palms in New Caledonia.

Sebertia acuminata, Psychotria douarrei and *Hybanthus austrocaledonicus),* none of them has a very high content of nickel. Palms associated with soils rich in nickel on ultrabasic rocks, like monocotyledons in general (Jaffre' 1980), would resist the toxicity of nickel by limiting the penetration of this element in their tissues. It appears, and this tends to be proven by the successful culture of many palms associated with mining terrains on substrata well balanced in nutritious elements, that species capable of enduring the conditions of mineral nutrition on ultrabasic rocks have no specialphysiological requirements in mineral nutrition.

On very deep alluvial soils, palms have to face a temporary hydromorphy of the soil. On ferrallitic soils and on gentle slopes, the root system development is impeded by the shallow rocky soil. It is the same on ferrallitic ferritic soils where *Basselinia pancheri* is found and in the organic rankers on which the humiferous soils can attain up to 1 m in depth. This explains why the high altitude palms are found preferring organic rankers in juxtaposition with soils not affected by erosion.

Distribution in Relationship to Climatic, Microclimatic and Altitudinal Conditions:

All the palms in New Caledonia are found in dense humid forests (rainforest). Three species, *Basselinia deplanchei, B.gracilis* and *B.pancheri* are also found in caespitose form in the maquis derived from forest on ultrabasics, as observed particularly in the massifs of Kouakoue, Humboldt, Boulinda and Tchingou.

There are no palms under the rainfall level of 1,200mm per annum. As a result, they are absent from the sclerophyllous forests on the west coast which are associated with an annual rainfall not exceeding 1,100mm per annum. The palms of low altitude are more concentrated on the east coast (particularly at the base of Mt.Panie': Fig. 2.) and in the well watered south massif. On the west coast they are found only under 300m on river banks in gallery forest.

The altitudinal distribution of every species is given in Table I. Twenty-seven species (85% of the total collection) are present between 300m and 1,000m in altitudes which correspond with the dense humid evergreen forests of low and medium altitude (Morat et al 1981) which receive between 1,500mm and 3,500mm of rain per annum. Most species belong to the understory of the forest, however, five species, *Burretiokentia vieillardii, Cyphokentia macrostachya, Kentiopsis oliviformis, Lavoixia macrocarpa* and *Mackeea magnifica* may emerge from the forest top which in these forests is about 20 metres high.

A study of the density of the palms in rainforest, on either the slopes or on the alluvium, has been undertaken on the Riviere Bleue in the south massif. The results (Table II) indicate that *Actinokentia divaricata, Basselinia pancheri, Campecarpus fulcitus* and *Cyphokentia macrostachya* are found in the two types of station, whilst *Basselinia gracilis* and *Chambeyronia macrocarpa* exclusively on alluvium and *Brongniartikentia vaginata* exclusively on the slopes. They all have diameters less than 20cm and belong to the understorey, occupying the interstices between the tall trees.

	ALLUVIUM				SLOPES			
	No. of Palms per hectare	%	Surface area cm^2	%	No. of Palms per hectare	%	Surface area cm^2	%
2-5cm	27	0.84	475	1.37	186	3.18	2293	4.84
5-10cm	159	7.40	5891	6.82	517	19.49	20753	19.80
10-20cm	32	4.09	4112	3.44	223	19.61	27799	16.65
>2<20cm	229	3.86	10479	3.88	926	14.09	30845	13.75

Figure 80: Table II. Comparison of Palms in Numbers and Ground Surface Area Covered in Forest on Alluvium and on Slopes in the Riviere Bleue Basin (South Massif).

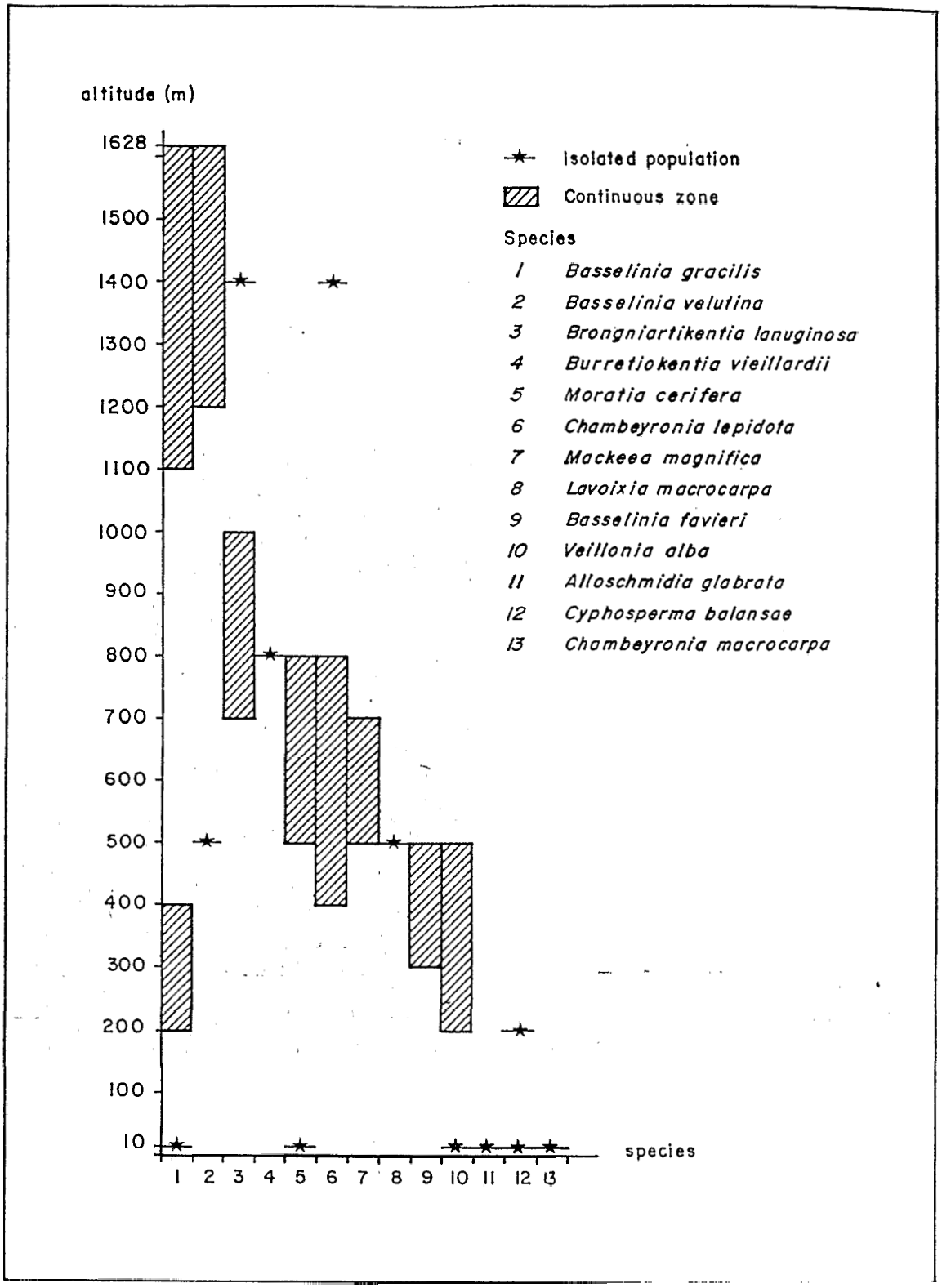

Figure 81: (Fig. 2). Altitudinal Distribution of Palms on Mt. Panie' between 10m (Creek Pouai) and 1628m (The Summit).

It also indicates that the palms are relatively more important on the slopes where they preferably occupy ancient chablis (naturally open areas), a phenomenon also observed in French Guyana by Granville (1978), than on the alluvium where the canopy is more level and closed.

In forests on alluvium where the diameter class is less than 20cm, the palms represent 3.86% of the tree and shrub population and 3.88% of the ground surface (ground surface: total of the trunk sections at 1.3m high). On the slopes these values are respectively at 14.09% and 13.75%.

It is in the range from 5cm to 10cm in diameter that palms are in the greatest number, with 159 per hectare on alluvium and 517 on the slopes. In the last instance, the importance of palms on ground surface increases between 10cm to 20cm in diameter.

In comparison to forest plants with a diameter greater than 2cm, the palms represent respectively 2.97% of population and 9.28% of ground surface on the slopes and 1.77% and 4.77% on flat surface.

Though below the values given by Kahn (1986) for the Amazonian forest in the Rio Negro Basin (2,122 palms per hectare and 32 species per hectare), the results show the importance of palms in dense humid forests (rainforests) at low to medium altitudes in New Caledonia which gives, especially on the slopes, a distinct appearance.

Only three species, *Basselinia iterata, B.sordida* and *B.tomentosa,* all of section Taloua, are strictly associated with the dense, humid evergreen forest at high altitude (above 1,000m), but fourteen others are also found in altitudes attaining 1,000m (Table I). This means that more than half of New Caledonian palms are found in forests frequently covered with clouds, receiving 3,000mm to 4,000mm of rain per annum and subjected to low temperatures, close to 0°C in the cold season (July- August).

Among the species associated with high altitude forests, only *Basselinia iterata* is exclusive to the undergrowth, the others frequently emerging from above the trees which are most often 15m in height.

Rare and Endangered Species:

Palms occupy a primordial position among the monocotyledons of the New Caledonia forests, as illustrated by their importance in certain biotopes and their richness in species. With 32 species, they constitute about 13.5% of the monocotyledon flora in the forests. This abundance cannot however hide the fact that many species are rare and even threatened with extinction.

A number of species are locally abundant, including *Basselinia humboldtiana, B.porphyrea* and *Actinokentia huerlimannii* of La Montagne des Sources and Mt.Humboldt between 800m and 1,000m and *Basselinia favieri* on Mt.Panie' between 300m and 500m.

Two species, *Basselinia iterata* known only at Mt. Ignambi and Mt. Colnett at 1,000m and *B. vestitia* of Me' Ori between 900m and 1,000m, should be considered endangered because of their restricted locations.

Cyphophoenix nucele, Lavoixia macrocarpa and *Pritchardiopsis jeanneneyi,* known only in one location with a very limited number of individuals, are rare species threatened with extinction. They deserve particular attention.

Cyphophoenix nucele:

This species, discovered by Daniker in 1925, has a population of about 100 individuals, concentrated in one location on madreporic limestone on the Isle of Lifou (Loyalty Islands). The population is situated in dense forest on raised coral terraces and is naturally protected from bushfire and destruction by man. The population consists of individuals of different ages which indicates a good reproduction of the species.

Lavoixia macrocarpa:

Discovered more than 20 years ago (1968) on Mt.Panie' by L.Lavoix, this species is known to have only five plants, (four adults) distributed on less than 0.5ha. Although the species bears abundant fruit, no germination has been observed in the vicinity of the trees. After many unsuccessful attempts to germinate seeds in the laboratory, the survival of this species seems to be threatened in the more or less long term. However, the search for other populations on nearby slopes and areas with difficult access merits to be pursued.

Pritchardiopsis jeanneneyi:

Collected for the first time by Jeanneney in 1893, this species has had, as emphasised by Morat, (1986) a history rich in changing fortunes. Although it was believed extinct at the beginning of this century, supposedly destroyed by the convicts from the penal settlement at Prony, it was found again in 1977 by a hunter, J.C. Lecren. He notified in 1980 R. Aymard who a few years earlier had participated in the fruitless search for this palm, organised by Lavoix. A specimen collected by these two was immediately authenticated by Dr. H.E. Moore Jr. who was present in Noumea at the time. The unique population of this species, spread on about 1 ha, is of three small populations totalling 30 plants with only one fertile adult of about 12m high. All the others have a size less than 4m. This disparity in the size of individuals could be the result of a vegetative dormancy or the consequence of an unreliable reproduction in the field. However, seed production has been regular since 1980 and numerous germinations have been obtained in the laboratory.

Lavoixia macrocarpa and *Pritchardiopsis jeanneneyi* are the beneficiaries of a careful surveillance by the Forests and Natural Patrimony Service of New Caledonia. Seeds of these two species and seedlings of *Pritchardiopsis jeanneneyi* have been sent to various botanical gardens in France and elsewhere in order to diversify the chances of reproduction and survival.

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Figure 82: *Basselinia deplanchei* in habitat (O).