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DIVERSITY, STRUCTURE AND PRESUMED ORIGINS OF THE WOODY FLORA OF THE KARTHALA FOREST IN THE COMOROS ARCHIPELAGO

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ABSTRACT

The Comoros archipelago is located in the northern part of the Mozambique Channel halfway between Madagascar and Africa. Its plant population results from a combination of elements coming from these two neighbouring entities. The characteristics of the woody flora of Karthala, the only climax forest in Grande-Comore, the largest and most westerly of these islands, have been described and allowed to establish the presumed origins of the plant stand of this island. The collection of data was done using the vegetation survey method and their analyzes were carried out around the diversity of the flora, its structure, biogeography, but also its affinities with the flora of Africa and of Africa. Madagascar. A great diversity of the ligneous flora was noted (95 species distributed in 82 genera and 45 families), with a rate of endemism evaluated at 26% of which 19,3% at the scale of the whole archipelago and 6.3% strict endemic to Grande-Comore. Of all the flora inventoried, and except the endemic species of the archipelago, there are only three species absent from the flora of Madagascar, which suggests that the flora of Grande-Comore would be more Malagasy than African .

Keywords: Inventories, biogeography, Karthala, Comoros, Madagascar, Africa

1. INTRODUCTION

The Comoros archipelago is located in the northern part of the Mozambique Channel halfway between Madagascar and Africa. It comes from an oceanic volcanism and has never been in contact with any landmass.

The combination of relief and insular and mountainous topography, as in most islands of the southwest Indian Ocean, is at the origin of the diversity of these habitats. Natural habitats that have been colonized in geological times by migrating plant and animal species from the nearest continental areas [1]. It is more particularly Africa and Madagascar. It is during the process of adaptation and evolution of the various taxa, in this "closed vessel", that the great biodiversity, nowadays recognized, of these islands has been shaped [2], [3]. The work of [4], based on inventories and herbarium specimens established the diversity of Mayotte, the island of the oldest archipelago and the closest to Madagascar, and highlighted the predominance of species of Malagasy origin in the vegetation of the island.

This predominance of Malagasy elements over African elements may suggest that distance played a large role in the supply of seeds that landed on this island [5]. In this case, and if there are no other factors that would condition the arrival of the seeds on one side or the other, Grande Comore, the youngest island in the archipelago and the most close to the African continent would be logically populated by species more African than Malagasy.

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Based on inventories of Karthala forest [6], the least mobile and most important component of the forest landscape of Grande-Comore, we propose, through the characteristics of the flora, bring elements to invalidate or confirm this hypothesis.

2. MATERIAL AND METHODS OF STUDY

2.1. The natural environment

Grande-Comore is the largest (1025 km²), the most western and the youngest (between 10 000 to 130 000 years) of the islands of the Comoros archipelago whose three other islands are Anjouan (424 km², between 0 , 4 and 1.5 million years ago), Mohéli (212 km², between 1.4 and 3.4 million years), and Mayotte, the oldest (345 km², between 3 and 4 million years) . It is elongated north-south with the central Karthala volcano, the highest point of the archipelago (2361 m). Further north, there is the Grille massif, 30 km long and the Rage 15 km and culminating at 1087 m. To the south, the Mbadjini massif is 15 km long and 10 km wide.

The west coast of this island, which is the windward coast, is colonized by a discontinuous subhorizontal coastal plain of 1 to 2 km wide that is not found in the south and east coasts. [7].

These three volcanic units appeared since the Quaternary era and constitute the three fundamental divisions of Grande-Comore [8]. The Karthala is a shield volcano occupying about two-thirds of the island. This volcano is characterized by a large dome with a steep slope (20 to 30 degrees on the great slopes), a vast summit caldera 3 to 4 km wide and numerous secondary craters on its flanks. The Karthala forest (Figure 1), the only climax forest massif on the island has a total area of 13 000 ha including 6300 ha of dense rainforest, 5000 ha of heath Ericaceae, the rest is practically bare and surrounds the forest. caldera of the volcano.

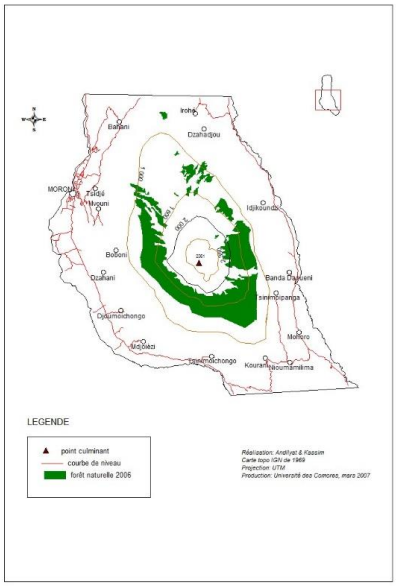

Figure 1: Location of the Karthala Forest

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2.2. The climate

Located south of the equator, Grande Comore has a tropical maritime climate with two seasons well marked as the whole archipelago:

- a wet season from November to April;

- a dry season from May to October

At equal altitude, it is the most watered islands. The annual rainfall can reach 6000 mm, especially at altitude. There is, however, a variation in the amount of rainfall depending on altitude, latitude and exposure. In fact, it rains more in altitude than at the level of the coasts and on the same period of the year, the windward coast situated in the west and in the north / west is more watered than the leeward coast located at the 'East. Figure 2 shows the ombrothermal diagram of the Moroni station, the country's capital, from 1991 to 2009.

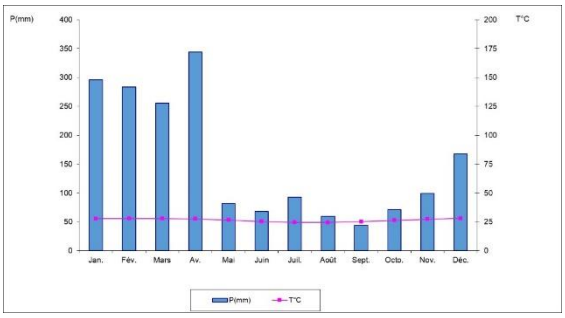

Figure 2: Ombrothermal diagram of Gaussen (period: 1991-2009)

From 1991 to 2009, the average annual rainfall is of the order of 1830 mm and the average annual temperature estimated at 26.5 ° C. The figure clearly distinguishes the alternation of seasons in the island.

2.3. Floor

The relative youth of the island of Grande-Comore determines the nature of the soils found there. It's about :

- on the one hand, soils consisting of little evolved minerals composed mainly of sandstones, amygdaloid rocks, lava and volcanic tuffs,

- on the other hand, andosols (young volcanic soils) strewn at certain places with masses of red or gray matter. A strong smell of chlorine is strongly felt in the rain at the level of its rocks [7]. However, in some places on the southeast slope of the island, where volcanism is the oldest, the process of pedogenesis is more advanced towards brownification and ferralitization [9]. Frequent landslides due to very rugged terrain sometimes dry a lateritic soil of reddish coloring.

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2.4. The vegetation

The main formations of the Comoros are coastal formations, dry formations, humid forest of low and medium altitudes, high altitude humid forests, high altitude ericoid steppes [10], [11] bush shrubs or bushes, savannas, mangroves, plantations and crop areas [12].

The coastal formations where we find mainly shrubs such as Leucena leucocephala, Lantanacamara, Psidium. guajava, Jatropha curcas and the Terminalia catappa tree. These formations are state of advanced degradation.

The dry formations start at sea level and can rise depending on the exposure up to at least 700 m altitude (east side of Karthala Grande Comore). They are similar to herbaceous shrubby savannas and mix at high altitude with dense forests. They are very much altered by anthropization and especially grazing, deforestation, voluntary fires or not, urbanization. We count the same species as in the previous set as well as Senna sp Acacia (A. occidental, A. squamosa, A. mangium, A. auriculiformis) Albizzia. lebbeck and Glyricdia sepium.

Low and medium altitude moist forest occurs at various altitudes depending on the exposure and can start from 200 meters in Mayotte for example and 700 to 800 meters in Grande-Comore. This type of highly degraded and highly man-made forest is largely colonized in Grand Comore by Psidium cattleianum [13].

The humid dense forest of high altitudes begins around 500 m in Mayotte and Mohéli and up to 1800 m in Grande-Comore. These are the best preserved because the most inaccessible. It has altimontane floors, notably in Grande-Comore (absent in Mayotte) and can sometimes be transformed into tree ferns (Cyathea sp.) Or have an interesting density of dwarf or large palm trees some of which are endemic [2

Shrubby or bushy thickets are characteristic of arid or semi-arid climates. They are found mainly in the leeward coasts where the rainfall is less abundant and the dry season is longer (6 months). They extend from the coast to an altitude of about 500 m and are characterized by species of the genera Erythroxylum, Combretum, Jatropha and Rhus.

Savannahs are generally found on plateaus. This is the case of the Diboini plateau, constituting a strip of savannas separating the Karthala massif from that of the Grille in the North. These savannas constitute the forage reserve used during the dry season. The herbaceous layer is dominated by grasses including Heteropogon contortus (L.) P. Beauv. ex Roem. & Schult., Imperata cylindrica (L.) Raeusch and a heliophilic terrestrial fern (Pteridium aquilinum (L.) Kuhn). Mangroves are located in the lagoons. These are small, low-lying forests on salty soils. They are reduced in the north-west and south-east littoral portions and are generally populated by species of the genera Rhizophora, Bruguiera, Avicennia and Sonneratia.

The plantations are represented at low elevations up to 600 m by cash crops, mainly Cocos nucifera L (coconut), Cananga odorata (Lam.) Hook. f. & Thomson (ylang-ylang), Eugenia

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aromatica O. Berg (clove tree) and Vanilla fragrans Ames (vanilla), which are often associated with food crops such as banana (Musa paradisiaca L.), cassava (Manihot esculenta Crantz)) as well as fruit trees such as jackfruit (Artocarpus heterophyllus Lam.), breadfruit (Artocarpus communis JR Forst. & G. Forst.), mango (Mangifera indica L.) and orange tree (Citrus sinensis [L.] Osbeck).There are banana plantations in the undergrowth and taro crops (Colocasia esculenta (L.) Schott) in the middle to high altitude dense forest.

2.5. The methods used

The floristic inventories were carried out between 2009 and 2010 according to the principles of the phytoecological using a sampling of the vegetation by transect. A total of fourteen transects oriented along the gradient and totaling 78 surveys were delineated. The area of each survey is 100 m², equivalent to the minimum area of the area defined by [14]. Part of the species has been identified using the flora of Madagascar and Comoros [15], onwards), the rest being identified thanks to the database (http://coldb.mnhn.fr/Consultation?catalogue = 1) samples of the herbarium of the Museum of Natural History of Paris (P). Inventory plots were spaced from altitudes of 100 m to 200 m on each transect oriented in the direction of the altitudinal gradient from fields and secondary forests from low altitudes to the top of the mountain (approximately 2000 m). altitude). Their coordinates were recorded with a GPS and a precision altimeter. The area of a plot is 100 m², which is equivalent to the minimum area of the area defined by [16]. At each level, the floristic list was established in presence-absence and the structural data of the individuals measured (maximum height, diameter at human height, diameter at 0.30 cm from the ground). Part of the species was identified on the spot using the flora of the Comoros and Madagascar, the rest being identified with the Paris herbarium. The ecological importance of the species used the Importance Value Indexe (IVI) [17]. This index combines:

- relative frequency, which refers to the distribution of a species in relation to the distribution of all species in the sample; it is obtained theoretically by the ratio between the number of surveys where the species has been met and the total number of surveys;

the relative density which corresponds to the proportion of individuals of a species in relation to individuals of all species; it is expressed by the ratio between the number of individuals of the species and the total number of individuals;

- the relative dominance that corresponds to the area occupied by a species (basal area) in relation to the area occupied by all the species in the sample; it is therefore the ratio between the basal area of the species and the total basal area; it is a very interesting parameter in the classification of woody species, because it is rarely equal for two different species. Where appropriate, they are small and poorly represented in number [18].

3. RESULTS

3.1. Floristic aspect

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The inventoried woody flora is rich in 95 species distributed among 82 genera and 45 families [6]. We found one gymnosperm, three monocotyledons with three genera and three species, and 41 broadleaf weeds with 78 genera and 92 species (Table 1).

Table 1. Distribution of taxa

Taxons	Gymnospermes	Monocotylédones	Dicotylédones	Total
Familles	1	3	41	45
Genres	1	3	78	82
Espèces	1	3	91	95

Monogenetic families account for 57.8% of the flora, compared to 42.2% plurigenic. The identified specimens are deposited in the National Museum of Natural History (MNHN) and can be consulted on the SONNERAT database, via the WEB (http://www.mnhn.fr/base/sonnerat.html). Duplicates were deposited at the IFAN Herbarium Cheikh Anta Diop (Senegal) and at the Comoros Herbarium.

The diversity of the families revealed five important families: Rubiaceae (7 genera, 11 species), Euphorbiaceae (7 genera, 7 species), Myrtaceae (3 genera, 7 species), Araliaceae (4 genus, 4 species) and Moraceae (2 genera , 4 species). The specific diversity of the genera revealed that the genus Psychotria is the most important genus with 4 species, followed by the genus Eugenia and Syzygium (3 species each). In addition to these three genera, the flora has seven bispecific genera (Artocarpus, Canthium, Erythroxylum, Ficus, Piper, Vepris, Vitex); the rest is monospecific. The ecological importance of the species (IVI) has made it possible to define the most important species of the forest. The table above (Table 2) groups the 10 most important species in the forest.

Table 2. List of Ten Important Karthala Species

Espèces	Fr	Dr	Dor	IVI
***Weinmannia comorensis* Tul.**	0.1	0.1	1.0	1.1
***Eugenia aromatica (L.)* Baill.**	0.0	0.0	0.6	0.7
***Nuxia pseudodentata* Gilg**	0.1	0.0	0.4	0.5
Psidium	0.1	0.2	0.0	0.3

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cattleyanum var. coriaceum (Mart. ex O. Berg) Kiaersk.				
Ocotea comoriensis Kosterm.	0,1	0,1	0,2	0,3
***Tambourissa comorensis* Lorence**	0,1	0,1	0,1	0,2
Macaranga boutonioides Baill.	0,0	0,0	0,1	0,2
***Eugenia comorensis* H. Perrier**	0.0	0.0	0.1	0.2
Ficus pyrifolia Burm. f.	0,0	0,0	0,1	0,2
***Mangifera indica* L.**	0,0	0,0	0,1	0,2

Fr = Relative frequency; Dr = relative density; Dor = Relative Dominance)

The table analysis indicates that there are no widely dominant species. The low IVI values mean that species do not show large differences in their area of occupancy, spatial distribution, but also in numbers.

3.2. Chorological and biogeographical aspects

Biogeographic studies have firstly made it possible to distinguish two main groups of species: that of species common to other geographical areas (excluding the Indian Ocean) and that of regional species (southwestern islands of the ocean). Indian). Figure 3 represents the different biogeographic types of these two major groups.

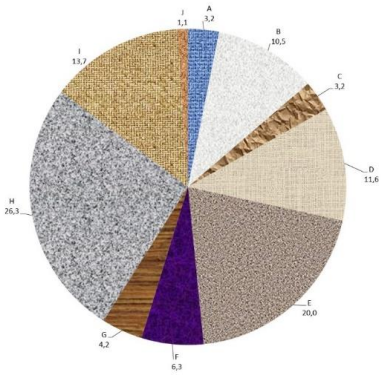

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Figure 3: Geographic affinities of inventoried species in the Karthala forest

The group of species common with other areas.

This group, which totals 40 species, or 41.7% of the number of inventoried species, can be divided into various subgroups:

-The first subgroup (A) groups common species with southern Africa, this group has 3 species, or 3.2% of the flora. They are: Rhus natalensis Krauss, Anthocleista grandiflora Gilg and Morella spathulata (Mirb.) Verdc. & Polhill.

-The second subgroup (B) is that of common species with Africa and Madagascar, there are 10 (10.5%). These are: Albizzia glaberrima Benth, Boehmeria platyphylla D.Don. var. Macrostachya (Wight) Wedd, Mystroxylon aethiopicum (Thunb.) Loes., Oncostemum racemiferum Mez, Piper capense L. f., Pouzolzia guineensis Benth., Schefflera myriantha (Baker) Drake, Urena lobata L. and Vitex doniana Sweet.

- The third subgroup (C), which has only 3 species, is that of common species with Africa, but absent in Madagascar: Cussonia spicata Thunb., Syzygium cordatum (Hochst.) And Maytenus undata (Thumb.) Blakelock.

The fourth subgroup (D) includes Indo Malaysian species, (non-African and non-American), there are 11 or 11.6% of the species richness. These are Artocarpus heterophyllus Lam, Artocarpus communis J.R. Forst. & G. Forst., Chrysophyllum boivinianum (Stone) Baehn, Cocos nucifera L., Jatropha curcas L. Leucaena leucocepahala (Lam.) From Wit, Phyllanthus niruri L., Piper umbellatum L., Solanum mauritianum Scop, Syzygium jambos (L.) Alston and Syzygium malaccense (L.) Merr. & L.M. Perry.

- The fifth subgroup (I) is that of broad-range species. We meet them everywhere. There are 13 of them (13.7%). These are: Apodytes dimidiata E. Mey. ex Arn, Areca catechu L., Celtis philippensis Blanco, Cinnamomum zeylanicum Breyn., Citrus sinensis (L.) Osbeck, Cycas thouarsii Gaudich., Eugenia aromatica (L.) Baill., Filicium decipiens (Wight & Arn.) Thwaites, Fluggea virosa Baill. Leea guineensis G.Don f. comoriensis Desc., Mangifera indica L., Senna septemtrionalis (viv.) H.S. Irwin, Woodfordia fruticosa (L.) Kurz.

The group of regional species

This group brings together species specific to the islands of the southwest Indian Ocean. It totals 55 species, or 57.9% of the flora. Of these species, some are endemic to the Comoros or Grande Comore Archipelago, and others are common with other islands in the region.

The first subgroup that is most important is the one that groups the common species in Madagascar and Comoros (H). It totals 25 species (26.3% of the flora): Acalypha filiformis Poir., Brachylaena ramiflora (D.C) Humb. var comoriensis Humb, Buxus moratii G.E. Schatz & Lowry, Canthium bibracteatum (Backer) Hiern, Canthium sp. Lam, Dicoryphe thouarsii Roem.

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& Schult, Dombeya Cav. sp., Euclea mayottensis H. Perrier, Eugenia L. sp., Ficus pyrifolia Burm. f., Ficus L. sp, Gambeya boiviniana Stone, Gastonia duplicata Thouars ex Baill., Khaya madagascariensis Jum. & Perr., Lasiodiscus articulatus Capuron, Macaranga buttonioides Baill., Malleastrum J.-F. Leroy, Pittosporum ochrosiifolium Bojer, Polyscias felicis Bernardi, Psychotria calothyris (Bremek.) APDavis & Govaerts, Psychotria L. sp, Tarenna grevei (Drake) Homolle, Vitex beraviensis Vatke, Weinmannia comorensis Tul., Wielandia leandriana (Petra Hoffm. & McPherson) Petra Hoffm. & McPherson.

The second sub-group in order of importance is that of the endemic species of the Comoros archipelago (E), which totals 19 species, or 20% of the total flora. They are: Cassine L. sp, Chassalia comorensis Bremek., Croton humblotii Baill., Erythroxylum elegans Baill., Erythroxylum nitidulum Baker, Eugenia comorensis H. Perrier, Gyrostipula comorensis Leroy, Mapouria lavanchiei Bremek., Myrica dentulata Baill., Nuxia pseudodentata Gilg , Ocotea comoriensis Kosterm., Ophiocolea comorensis H. Perrier, Psychotria comorensis Bremek., Psychotria lavanchiei Bremek., Rapanea comorensis Mez, Saldinia boiviniana (Baill.) Bremek., Tambourissa comorensis Lorence, Vepris boiviniana (Baill.) Mziray, Vepris unifoliolata Baill .

The strict endemics of Grande Comore form the third subgroup (F), with 6 species (6.3%). These are: Ravenea hildebrandtii C.D. Bouché, Allophylus gardineri Summerh.,. Begonia comorensis H. Perrier, Philippia comoriensis Engl, Scolopia coriacea Tul. and Senecio humblotii Klatt.

The fourth subgroup is that of the endemic species of the islands of the Indian Ocean, (G). There are 4 species (3%): Hubertia humblotii (Klatt) C. Jeffrey, Aphloia theiformis (Vahl) Benn., Buddleja indica Lam. and Psidium cattleyanum var. coriaceum (Mart ex O. Berg) Kiaersk.

The last group (J) is formed by a single species, it is a common endemic species in Comoros and Seychelles (Pisonia sechellarum F.Friedmann).

Family and gender distribution model.

The types of the same family may or may not have the same provenance and therefore the same distribution. In the first case, these are close relatives from the same biogeographic zone and in the second case, an old and wide dispersion. We will use arithmetic coding to synthesize the distributions of each family and each genus. The following table (Table 3) summarizes the distribution among the 19 families.

Table 3. Distribution among the 19 multi-generational families

Familles	Nbr. genres	Nbr. espèces	Formule chorologique
Anacardiaceae	2	2	A+ I
Araliaceae	4	4	2B+H+C
Arecaceae	4	4	B+D+F+I

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Asteraceae	3	3	H+F+G
Celastraceae	3	3	B+C+E
Euphorbiaceae	7	7	3H+2D+E+I
Fabaceae	2	2	B+I
Lauraceae	2	2	E+I
Loganiaceae	2	2	A+E+G
Meliaceae	2	2	2H
Moraceae	2	4	2D+2H
Myrcinaceae	2	2	B+E
Myricaceae	2	2	A+E
Myrtaceae	3	7	C+2D+E+G+H+I
Rubiaceae	7	11	6E+5H
Rutaceae	2	3	2E+I
Sapindaceae	2	2	F+I
Sapotaceae	2	2	E+H
Urticaceae	2	2	2 B

The table analysis indicates that families with only endemic species in the archipelago and Grande Comore account for 63.2%.Families whose species are common in Madagascar and the Comoros represent 42%. Families of species common to Africa and Madagascar represent 31%.

The Rubiaceae family is the most stable family with 6 endemic species from the Comoros, as well as 6 species common to the Comoros and Madagascar.

The distribution within the families is presented in the same way as the distribution of the species (predominance of the species of Malagasy origin).

Within the same genus, species may or may not have the same biogeographic origins. Table 4 groups the distributions among the 10 multispecies genera of the flora.

Table 4. Distribution among the 10 multispecific genera

Genres	Nbre d'espèces	Formule chorologique
Artocarpus	2	2D
Canthium	2	2 h
Erythroxylum	2	2E
Eugenia	3	E+H+I
Ficus	2	2 h
Piper	2	B+D
Psychotria	4	2E+2H
Syzygium	2	C+D

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Vepris	2	2E
Vitex	2	B+H

We distinguish first among the 10 genera, eight bi-specific, one to three species (Eugenia) and one to four species (Psychotria).Of the bispecific genera, five (5) have the same biogeographic distributions. These are Canthium and Ficus with two species common to Madagascar and the Comoros, Erythroxylum and Vepris each with two endemic species of Comoros and Artocarpus with two Afro-Neotropical species.

The genus Eugenia is the most complex with a species endemic to the Comoros, a species common between Comoros and Madagascar and a species with wide distribution.

The genus Psychotria, like all Rubiaceae, has 50% endemic Comorian species and 50% species common to Africa and Comoros.

Altitudinal gradient of endemicity

The spatial distribution of endemic species along the altitudinal gradient is an interesting tool to understand the vegetation of an island [19]. In general, coastal areas subject to anthropogenic influences are home to few endemic species. Figure 4 shows the evolution of the population of endemic species of the archipelago and the big island according to the altitudinal gradient. Low altitudes and high altitudes exceeding 1600 m are poor in endemic species. The endemicity is concentrated in a range of altitude varying between 1000 and 1600 m altitude

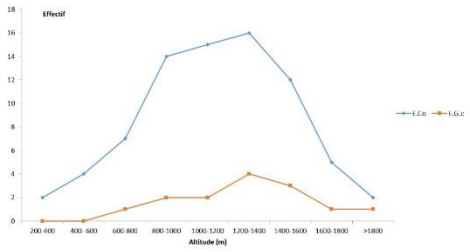

Figure 4: Variation of endemicity according to the altitudinal gradient

4. DISCUSSION

Flora and its characteristics

The flora of the Karthala forest shows a clear predominance of Rubiaceae, and Euphorbiaceae which are also two great families of the flora of western Madagascar [20], [21] and Mayotte, its

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immediate neighbor [4]. Legumes are poorly represented, unlike neighboring islands including Madagascar.

It has also been noted that there are several features common to the flora of oceanic islands, in families as well as in genera and species. These are, for example, the genera Aphloia, Weinnmania, Vepris, Psychotria and Ravenea, which are mentioned in many flora of the region [19].

Flora, its biogeographical origins and affinities

The habitat pattern and the plant stand

Madagascar, particularly in its western region, has strong climatic and environmental similarities with its neighbor, the Comoros archipelago [22]. The habitat patterns of the two entities are similar, not only because of their geographical proximity, but also by the habits of the populations vis-à-vis these spaces. This rapprochement began with the great marine regression of the Quaternary Ice Age (the Würm, from 125,000 to -10,000 years ago). This 1,000-year event brought sea levels down to 100 meters below current levels [4]. The current shallow waters that existed between Madagascar and Comoros were emerging and had to serve as bridges between these two entities and facilitate the migration of plants and animals.

Africa also has climatic and environmental cultural similarities with the Comoros, particularly in its central and southern parts. The same types of seasons and the same amounts of annual rainfall are observed [2]. The winds responsible for its seasons (African monsoon and maritime trade winds) first sweep this region of the continent before arriving in the archipelago. Several ancient seeds are transported by these winds from the African coast, which is still a reservoir of propagules for the Comoros and all the islands of the south-west of the Indian Ocean [20]. In addition, the first men who arrived in the Comoros Islands in the 6th century are probably Bantu from the African coast. These men have brought with them or with them seeds that have settled and evolved to the present day.We used these few elements to try to explain the affinities of the Karthala flora (Grande-Comore) with its two neighbors.

Affinities with Madagascar.

The chorological analysis of the flora showed a clear predominance of species common in Madagascar and Comoros. They represent 26% of the total flora. Of these, six species have been considered until recent years [23] as endemic to Madagascar (Lasiodiscus articulatus, Gastonia duplicata, Wielandia leandriana, Tarenna grevei, Pittosporum ochrosiifolium, and Polyscias felicis) and have recently been recorded in Great Comoros. and in the other islands. In addition, species common to Africa and Madagascar represent 10.4%. This Malagasy predominance is also justified by the fact that in the current Karthala flora, there are only three species absent in Madagascar (Cussonia spicata Thunb, Maytenus undata (Thumb) Blakelock and Syzygium cordatum Hochst, ex Krauss).

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Affinities with Africa

In our list, species of African origin are either from southern Africa, closer to, or common to Africa and tropical America. The total is 16 species (15.7%). Only two species have a typical distribution in southern Africa. It is Anthocleista grandiflora that occurs particularly in Kenya, Malawi and Zimbabwe and Rhus natalensis found in Tanzania and Uganda (Tropicos.org). Other species are found throughout the area, including some in Madagascar. This is the case of Morella spathulata and Lantana trifolia that appear to be introduced into the area. The case of afro-neotropical species gives less effect on the African or Malagasy origins of the Karthala flora because of their wide distribution. Endemic species from the islands of the Indian Ocean may either migrate secondarily from the Big Island (Madagascar), such as Aphloia theaeformis [24], or from Ancient seeds are landing everywhere and are undergoing long-term speciation to become endemic species.

Predominance of Malagasy elements

The starting hypothesis would be that Grande-Comore is populated by elements more African than Malagasy. Which is different from our results.

Recall that for the population of a given geographical area, it is not enough that seeds arrive, they must also germinate and give viable species. This is only possible when the weather conditions are favorable. In our case, it can be said that the species coming from Madagascar would be more suitable than the other species because of the similar island climate between the two islands. The less adapted African species were successively replaced, by interspecific competition, by the Malagasy elements.

To support this explanation, we considered the distribution of species along the altitudinal gradient. Indeed, in coastal areas, subject to anthropic influence, where the natural processes of competition and speciation are too limited, we find more African species, while the interior of the island and high attitudes are dominated by endemic species and common species in Madagascar.

It can also be assumed that the southeastern trade winds coming into the island on the east side via Madagascar would bring more seeds than the northeastern monsoon arriving from the west side via the mainland. Without any information on the nature and characteristics of these winds, it is difficult to go too far on this hypothesis.

The whole analysis, however, has limitations. First, biogeographic groups are released from the species distribution. But these can be due to a small dispersion. Then there is the lack of knowledge on the chorology of species, especially in the flora of the islands [21]. For example, a species may be considered endemic to one country and subsequently encountered in the flora of another country. This is the case of Pisonia sechellarum, which is considered by some authors to be endemic to Seychelles and encountered in our inventories. Several species are also considered native when they could be introduced and vice versa.

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5.CONCLUSION

The affinities of an island flora with that of the neighboring land masses do not depend solely on geographical distance, but on several factors combined. This study showed that the Karthala (Grande Comore) woody flora has more Malagasy and African affinities despite the fact that the island is closer to the mainland than to the Big Island. The climatic and ecological similarities which condition the adaptation of the seeds and their installation are the major causes which would explain the affinities of the flora of these two geographical entities. The study also showed that the rate of endemism (6.3%) is almost equal to that of Mayotte, the oldest and most eastern island of the archipelago.

REFERENCES

[1] Pascal, O. (1997). - The natural vegetation of Mayotte: Quantitative and qualitative studies.

[2] Pascal O. (2002). - Plants and forests of Mayotte. Natural Heritage vol. 53. Paris, National Museum of Natural History / Engineering in Ecology and Biodiversity Management.

[3] Mouly A. (2007). - Systematic study of Rubiaceae from Mayotte and Comoros. Expert report, National Museum of Natural History, Paris, 130 p

[4] Pascal O., Labat J.-N, Pignal M. (2001). - Diversity, phytogeographic affinities and presumed origin of the flora of Mayotte (Archipelago of the Comoros). Systematics and Geography of Plants 71: 1101-1123.

[5] Boullet V. (2007) a. - Flora and vegetation habitat: diversity and originality. Mascarene National Botanical Conservatory 53p

[6] Charahabil M. M. (2011). - Characteristics of the flora and woody vegetation of Karthala (Grande-Comore). Doctoral thesis. Chikh Anat Diop University of Dakar, Dakar, Senegal.

[7] Legris, P., & Blasco, F. (1969). Great Comoros: climates and vegetation. French Institute of Pondicherry.

[8] Charahabil, M.M., Yahaya, I., Labat, J.N., & Akpo, L.E. (2013). Spatial variability of the specific structure of a woody stand and endemicity in mountain areas in the Comoros. International Journal of Biological and Chemical Sciences, 7 (3), 902-923.

[9] Labat, J.N., Pignal, M., & Pascal, O. (2005). Two new species and a new combination in the Rutaceae of the Archipelago of the Comoros. A Festschrift for William G. D'Arcy: the legacy of a taxonomist. (Monographs in systematic botany from the Missouri Botanical Garden 104). St. Louis, Mo .: Missouri Botanical Garden, 361-369.

[10] Boullet V. 2005. - Preliminary overview of vegetation and plant landscapes of Mayotte. Submission in Brief No. 1, 160 p. in ROLLAND R. & Boullet V. (coord.), Mayotte: Biodiversity and Heritage Assessment. Contribution to the implementation of the inventory Z.N.I.E.F.F.

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ISSN: 2456-8643

Local authority of Mayotte, DAF Mayotte and National Botanical Conservatory of Mascarin, 328 p. + appendices and briefs

[11] Vos, P. (2004). Studies of invasive woody plants in the Comoros archipelago (Union of Comoros and Mayotte).

[12] Adjanohoune J., Aké Asssi L., Ahmed A., Eyme J., Guinko S., Kayonga A., Keita A., Paris and Lebras M. (1982). - Contribution to ethnobotanical and floristic studies in the Comoros. Paris, ACCT.

[13] Tilot, V. (1996). - Ecological Characteristics and Recommendations for the Conservation of Biodiversity of the Natural Resources of the Marine, Coastal and Terrestrial Environments of the Island of Grande Comore (Islamic Federal Republic of Comoros, SW Indian Ocean). Mesogee, 55: 65-106.

[14] Charahabil, M. M., & Akpo, L. E. (2018). The red guava: Psidium cattleyanum var. coriaceum (Mart ex O. Berg) Kiaersk. an invasive species, multiple use in Grande-Comore. European Scientific Journal, ESJ, 14 (9).

[15] Campbell, D.G. & Hammond, H.D., [Eds]. (1989). -Floristic inventory of tropical countries: the status of plant systematics, collections, and vegetation, plus recommendations for the future. New York Botanical Garden 545 pp.

[16] Humbert H., Leroy J.-F. (1936-present) Flora of Madagascar andComoros. Paris, National Museum of Natural History.

[17] Curtis J. T. & Mcintosh R. P. (1950). -The interactions of certain analytic and synthetic phytosociological characters. Ecology 32: 434-455p.

[18] Ramade F., (1984) - Elements of ecology. Basic Ecology, 403 pp., Mc Graw Hill.- Papilionoideae of Madagascar. Biogeography of Madagascar. Orstom, Paris, 95-108.

[19] J. Tassin, Derroire G., J.-N. (2004). - Altitudinal gradient of species richness and endemicity of native woody flora on Reunion Island (Mascarene Archipelago). Acta Botanica gallica 151: 181-196.

[20] Faramalala M.H., Rakotoarimanana V., Roger E. & Rakotonirina B. (2005). - Structures of the Angavokely Forest: Case of Mount Angavobe. Collection of documents for ecological monitoring of the Malagasy environmental program.

[21] Labat, J. N. (1996). Biogeography, endemism and origin of Leguminosae

[22] Moizo B. (2003). - Perception and uses of the forest in bara country (Madagascar). Forests destroyed or rebuilt? Woods and forests of the tropics. No. 278 (4).

Vol. 3, No. 05; 2018

ISSN: 2456-8643

[23] Boullet V. 2007 b. - Leaflet accompanying the map of vegetation and habitats of Mayotte / Sohoa Massif and Tsingoni Bay. National Botanical Conservatory of Mascarin, 24 p., December 2007

[24] Pascal, O., Labat, J.N., Pignal, M., & Soumille, O. (2001). Diversity, phytogeographic affinities and presumed origins of the flora of Mayotte (Archipelago of Comoros). Systematics and Geography of Plants, 1101-1123