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Ecological Characterization of the Ouzini Forest Anjouan Comoros

Anli.M. [1] , Roger.E.[2] , Rabarison.H.[2] , Josoa.A. [3] , Miller Audiat Herindrainy [4] , Amelaide.H. [5] , Ratsirarson.J [6]

[1.] *Eco-BIO Reception Team, EGRND of ESSA University of Antananarivo Madagascar*
[2.] *Department of Plant Biology and Ecology, University of Antananarivo, Madagascar*
[2.]*Department of Plant Biology and Ecology, University of Antananarivo, Madagascar*
[3.] *EGRND of ESSA University of Antananarivo Madagascar*
[4.] *GPCEHP University of Toliara Madagascar*
[5.] *Patsy University of the Comoros website*
[6.] *EDGRND D'ESSA, University of Antananarivo, Madagascar*

Summary: *This study focuses on determining the ecological characteristics of the slope and ridge forests of Ouzini (Anjouan, Comoros) based on floristic and structural diversity and natural regeneration potential. Forest inventories were carried out in 14 plots of 50m x 20m, including 7 in the slope forests and 7 others in the ridge forests. All species found there were recorded. Their bole height, total height, and diameter at breast height (DBH) of seed individuals were measured. 146 species divided into 125 genera and 84 families were recorded in the slope forest, as an example of families and characteristic species, B rachylaena ramiflora var comorensis , Ficus lutea, Chrysophyllum boivinianum, Diospiros comorensis with an average density of 8145 trunks/ha. The diameters of seed trees vary between 10 and 140 cm with an average of 30.88 cm. It contains a basal area of 236.14m ^{2} /ha and a biovolume of 697.25 m ^{3} /ha. The ridge forest has a basal area of 97.42m ^{2} /ha and a biovolume of 378.5m ^{3} /ha. The average DBH is 22.94cm. The giants of these two forests are Weinmania comorensis , Chrysophyllum boivinianum , Girostipula sp , Anthocleista grandiflora, Brachylaena ramiflora var comorensis . The dominant species are Weinmania, Brachylaena ramiflora var comorensis and Girostipula sp . The abundant species are Tambourissa comorensis , Macaranga bailloniana , Nuxia pseudodentata and Brachylaena ramiflora var comorensis. Emerging species are Molutchea sp, Chrysophylum boivinianum, Girostipula sp and Cussonia spîcata. The ridge forest characterized by the species of Anthocleista grandiflora, Syzygium sakalvarum, Macaranga bailloniana, Cyathea boivini, Reedia anjouanensis and Cynometra. These two forests are multi-stratified, almost intact with a low degree of anthropization. The slope forest develops on sandy, rocky soil. The slope is very steep, more than 70%. Those on the ridges grow on lateritic silty-clay soil with a slope of between 30 and 45%.*

Keywords: *Forest, Ouzini, Anjouan, Comoros, ecology, Biodiversity*

INTRODUCTION

The Comorian forests constitute a natural heritage of inestimable value, being part of the tropical forests. The geographical isolation of the Comoros Islands has favored the evolution of many plant and animal species that are found nowhere else in the world. These forests offer a wide variety of habitats, ranging from dense humid forests to dry forests, including mangroves and mountain vegetation formations (Adjanohoun et al. 1982).

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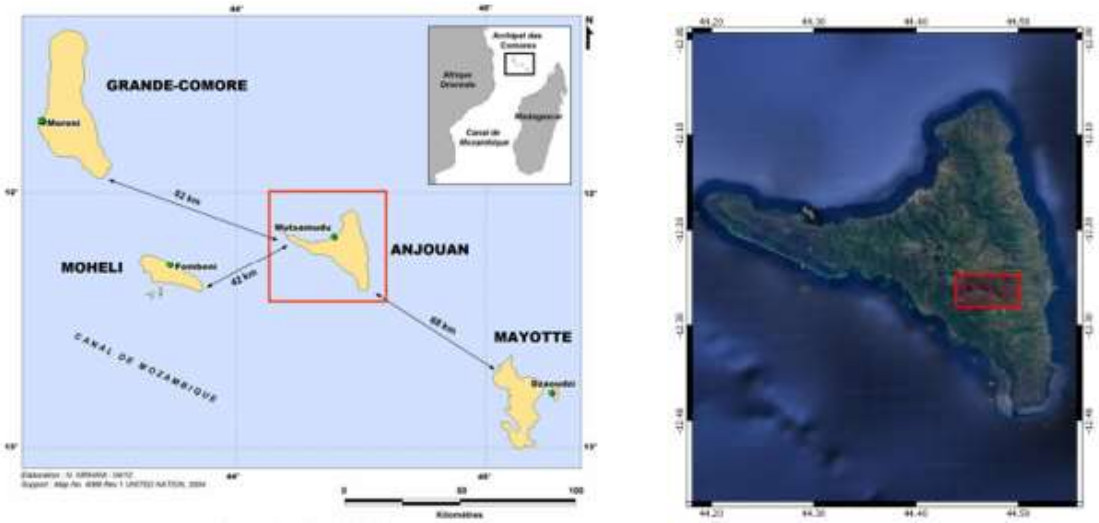
Nowadays, the forests are under strong pressure due to the increase in the human population, political crises and poor governance which frequently lead to their conversion or degradation to unsustainable land use patterns, the forests are cleared or seriously damaged (FAO, 2012). In terms of biodiversity, the 4 islands of the archipelago have their particularity but they constitute a whole that is difficult to dissociate (Bruno, 1999). The rainforests of the Comoros represent one of the 200 most important global biomes of the World Wildlife Fund (WWF). 1277 hectares of natural forests disappear each year at the national level (DGE, 2000). This study aims to (i) characterize the floristic composition of the Ouzini forest, (ii) present the structure of this forest (iii) determine the natural regeneration of the forest and prove the existence of a vast primary forest accessible to Anjouan.

I. MATERIALS AND METHODS

I.1. Study site

The island of Anjouan ranks second in size among the islands of the Union of the Comoros with a surface area of 424 km ^{2} , triangular in shape. Our The study area, the Ouzini forest, is located in the central part of Anjouan in the rural commune of Ngazalé, situated between 12°25' and 12°23' south latitude and between 44°44' and 44°50' east longitude, it covers 2630ha. This study area is made up of four main plant formations: cultivated fields covering 258.17ha, a degraded forest of 795.88ha and an almost intact forest of 1575.9ha. The latter was the subject of our study.



Map 1 : Anjouan in the Comoros archipelago **Map 2** : Location of the study area
(Source: Mirhani, 2011)

I.1.1. Climate of Anjouan

The island of Anjouan has a hot and humid tropical climate (Brouwers, 1973). The climate is influenced by the trade winds and the monsoon (Brouwers and Latrille, 1974), characterized by: An average annual temperature of 25°C with a maximum of 27°C and a minimum of 24°C. The rainy season is from September to April, and the dry season is from May to mid-August. The average annual rainfall is 1845mm of water (from October to November). The interior of the island is more wet (more than 3000mm of water per year with an average of between 1500mm and 2000mm of water) than the coastal regions (less than 2000mm of water per year).

I.1.2 Flora and vegetation

❖ **Vegetation**

The natural vegetation of the 3 islands of the Union of the Comoros is characterized by two types of climax vegetation: low-altitude dry deciduous forests and medium-altitude dense humid forests (Labat, 2006).

❖ **Flora**

The flora of the Comoros Archipelago has been treated in different volumes of the flora of Madagascar and the Comoros 935 species of vascular plants of which 416 are considered native and 136 endemic to the Archipelago in total 2000 plant species (Voltskowa, 1917). Currently, it is estimated at more than 2060 species.

❖ **Wildlife**

The fauna of the Comoros is diverse, although poor in large mammals: 24 species of reptiles including 10 endemic, 98 species of birds including 35 endemic subspecies, 14 endemic species and 17 species of mammals including 2 subspecies and 3 endemic species (UNEP, 2002). 1200 species of insects have been estimated in the Comoros with a relatively high endemism, between 30 and 60% (UNEP, 2002). The coastal and marine fauna of the Comoros includes species of global importance (sea turtles, whales, coelacanths, etc.)

❖ **Plant formation of the study area**

Our study environment, the Ouzini forest, is subdivided into three types of plant formation: a dense humid primary forest of medium altitude, a dense humid primary forest of high altitude. The third type of plant formation is a herbaceous formation where grasses and ferns grow abundantly.

I.2. Study methods

I.2.1 Choice and location of survey sites

The information from our surveys, bibliographic research, and consultations of various maps allowed us to consider the Ouzini Hadda forest as a study site. The choice of survey sites was made after field prospecting, taking into account the criteria of homogeneity (physiognomic, floristic) and the uniformity of apparent ecological conditions, by making seven surveys in each type of forest.

I.2.2. Field equipment:

Equipment used for data collection: GPS; 50 m and 1.5 m tape measures, stakes, markers, machete, wood inventory sheets, digital camera.

I.2.3. Floristic surveys

The floristic studies were carried out using the Braun Blanquet 1965 method. This method consists of spreading out a plot of 20m x 100m in each site which is then subdivided into 10m x 10m plots. All the plant species present in this area were inventoried, the physical, floristic and dendrometric parameters were considered.

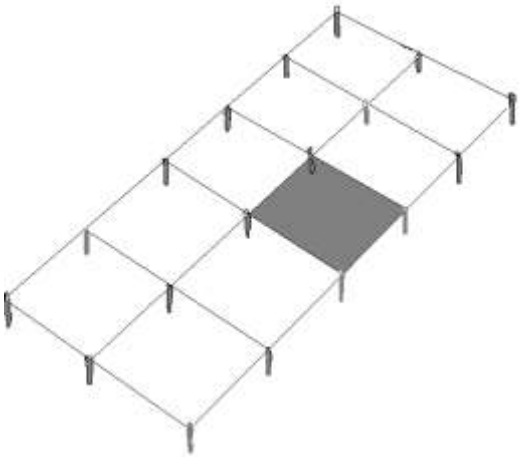


Figure 1: Device of the place of Braun Blanquet (1965)

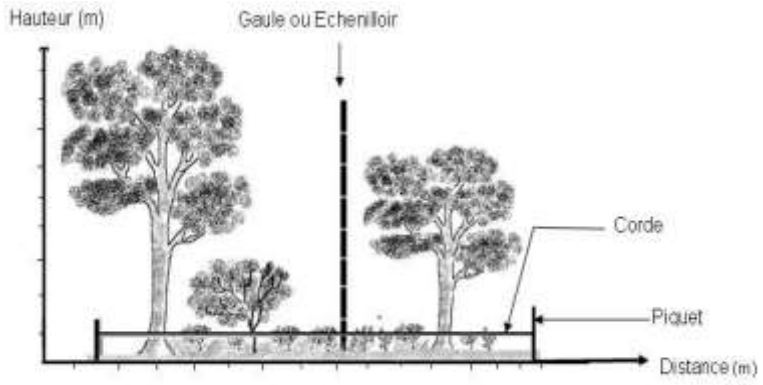


Figure 2 : Device for structural survey according to the Gautier method (1994)

II. RESULTS

II.1. Description of the slope forests

II.1.1. Situational characteristics

It is a medium altitude evergreen rainforest located on the slopes of the forest block between 665 and 1156m above sea level, with a humid tropical climate characterized by an average rainfall of over 2000 mm. Average temperatures vary from 21 to 24°C. Relative humidity between 85 and 92%. The soil is sandy loam with a slightly thick litter.

II.1.2. Physiognomic characteristics

This forest is tall, the tallest tree is estimated at 24m. The average height is 10.28m, the forest is mainly made up of large trees. In the lowlands some species have very remarkable buttresses, this is the case of Molutchea, Anthocleista grandiflora and Ficus lutea. The edge with the degraded area is characterized by the presence of a liana of the Convolvulaceae family "the vaibé", presence of some epiphytes of the Orchidaceae family, ferns and Piperaceae.

❖ **Vertical structure**

Three strata were distinguished: A lower or herbaceous stratum between 0 and 1m with an average coverage rate of 90%. The most represented species are the Rubiaceae family, Myrsinaceae, fern species, a middle or shrubby stratum between 1 and 7 m, a little discontinuous, with a coverage rate of 48.18%. This is characterized by species of the Monimiaceae family, Aphloiaceae, an upper or arborescent stratum between 7 and 11 m, continuous with a coverage rate of 62%, heights vary between 0 and 24 m with an average of 10.28 m. The 6 sites have almost the same structural profile and coverage rates per stratum are substantially equal.

❖ **Horizontal structure**

The distribution of individuals in diameter classes presents a distribution whose appearance is similar to an "L" shaped curve. This distribution reflects the predominance of individuals with small diameter (0 to 10 cm). The large trees listed are *Anthocleista grandiflora* , *Chrysophyllum boivinianum* , *Ficus lutea, Ocotea comorensis, Molutchea sp* with a record reached 130 m diameter (*Weinmania comorensis)* . Classes [0-5] are the best represented. We note a high density of young individuals (regenerated) and a rarity of individuals with large diameter. The average density is 8145 trunks/ha. It contains an average basal area of 236.14 m ^{2} /ha and a biovolume of 697.25 m ^{3} /ha. The diameters of seed trees vary between 10 and 130cm with an average of 30.88cm

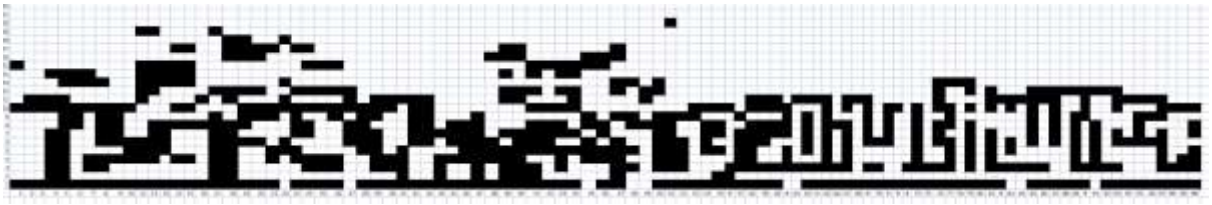
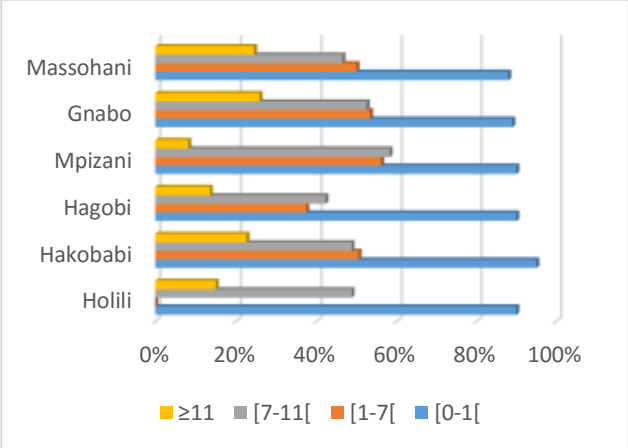


Figure 3: Structural profile of a slope forest site: Holili site



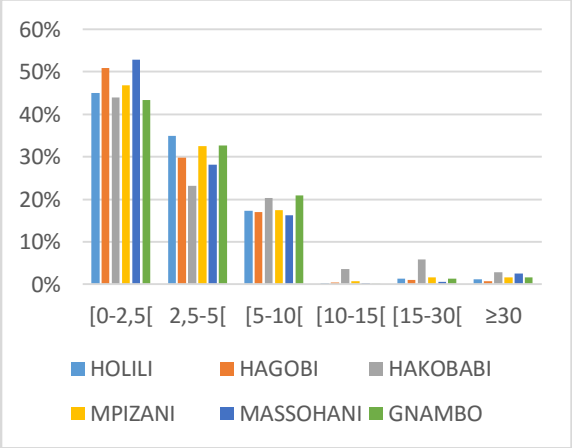


Figure 4 : Coverage diagram **Figure 5** : Plant distribution diagram slope forest sites by diameter class

❖ **Analysis of variance of structure parameters by Rstudio 4.4**

For the comparison of the means of all sites, the significance level is 95%. The columns followed by the same letters (abcde) do not present a significant difference (α=0.05). The normality test of the distribution (Shapiro-Wilk test) was tested with the reference hypotheses: H0: the distribution follows the normal law and H1: the

distribution does not follow the normal law, p-value=0.07>0.05 rejection of H0 at a level of 5% error, the distribution of the linear model follows a normal law

❖ **Table 1** : Distribution of DPH, HF, HT of slope forests

	Hakobambi	Massohani	Gnambo	Mpidzani	Holili	Hagobi Hav	Hakobabi bwani	Hak summit
DPH	23.68 ± 2.6bc	47.45 ± 5.3e	29.59 ± 6.46cd	21.31 ± 2.77abc	36.31 ± 4.87d	21 ± 4.25abc	15.56 ± 5.06ab	9.83 ± 3.22a
HF	3.58 ± 0.36cd	6.32 ± 0.8a	4.53 ± 0.67bc	3.26 ± 0.41	4.95 ± 0.53b	4.37 ± 0.82bcd	2.1 ± 0.68e	1.73 ± 0.87e
HT	10.31 ± 0.58bc	13.66 ± 1.45a	10.18 ± 1.13bc	9.05 ± 0.79bd	11.46 ± 0.76c	10.04 ± 1.26bcd	6.81 ± 1.21d	6.83 ± 1.91d

❖ **Comparison of DHP averages**

The variance is not homogeneous because of the difference in the number of individuals but the distribution is normal, p-value <0.05. H0, the DBH means for all the slope forest sites are the same, H1, the DBH means for the 8 slope forest sites are different, p-value = $2.41e^{-23}$ <0.05. The DBH means for the sites are different. The Massohani site has species with the largest diameter (45 to 47cm) followed by Holili.

❖ **Comparisons of average barrel heights (HF)**

From the reference hypotheses H0 the distribution follows the normal law, H1 the distribution does not follow the normal law, P-value = 0.082> 0.05, rejection of H0 at a 5% error level. The distribution of the linear model follows a normal law, p-value = 7.67e-12 < 0.05, the variance is not homogeneous because of the difference in the number of individuals. However, the distribution is normal.

❖ **Comparisons of average total heights (Ht)**

H_0 the distribution follows the normal law, H1 the distribution does not follow the normal law, p-value=0.5>0.05 rejection of hypothesis H_0 at a 5% error level, the distribution of the linear model follows a normal law. p-value= 1.086e-14< 0.05, the variance is not homogeneous because of the difference in the number of individuals but the distribution is normal. H0 the means of Ht for all the sites of the slope forests are the same, H1: the means of Ht for all the sites are different from each other.

The Massohani site has the tallest species of all the sites with an average height of 13.66m. It differs from the other sites according to the total heights

II.1.3. Floristic characterizations

The results of the floristic analysis reveal that out of the 6 surveys a total of 80 species divided into 71 genera and 49 families were recorded in the slope forest. In each survey the number of species varies between 40 and 60. It is a forest with *Brachylaena ramiflora var comorensis* , *Tambourissa leptophyla* including *Tambourissa, Brachylaena* , *Girostipula* , *Ocotea* dominate and the emerging species are *Molutchea, Chrysophyllum, Girostipula.*

II.1.4. Biological spectrum

Strong presence of phanerophytes which contain more than 96.07% of the total flora recorded of which mesophanerophytes and microphanerophytes are the best represented with 69%. Lianas are weakly represented. The latter are found in the lowlands between the degraded areas and the almost intact forests except the forest of Mpizani and Hagobi, there is also a considerable appearance of hemicryptophyte in the site of Massohani this is due to the degradation of a large part of this forest especially the lowland.

II.1.5. Natural regeneration

Of the 11,010 individuals recorded in the 6 surveys, 389 are seed trees (DH>10cm), and 10,621 are regenerated (diameter less than 10cm). The average regeneration rate is 2,888.25%. The formation has very good regeneration according to the Rothe scale (1964).

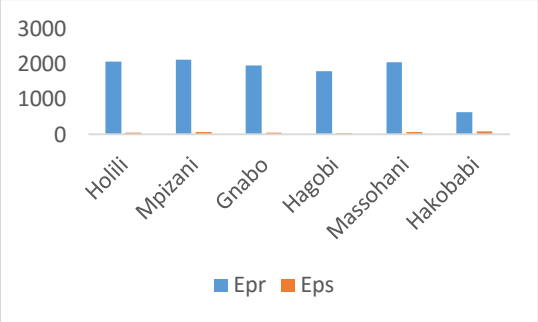


Figure 6: Diagram of natural regeneration of the slope forest

II.2. Description of the ridge forests

II.2.1. Situational characteristics

It is a high altitude evergreen rainforest located on ridges and mountain ranges between 1125 and 1225 m above sea level, tropical humid climate, an average rainfall of more than 2000 mm-3000 mm. Average temperatures of 22 to 24 ° C. Relative humidity between 76 and 85%. The slopes vary between 20 and 40 °, the soil is loamy-clayey with a thick litter of about 12 cm.

II.2.2. Physiognomic characteristics

The trees can reach more than 22 m in height with an average of 11.76 m, there is a presence of some epiphytes of the Orchidaceae family, ferns, Piperaceae, Aralliaceae

❖ **Vertical structure**

Three strata were distinguished: A lower or herbaceous stratum between 0 and 1 m with an average coverage rate of 90%. The most represented species are: the Rubiaceae family and ferns. A middle or shrubby stratum between 1 and 7, a little discontinuous, with a coverage rate of 48.18%. This is characterized by the families of Monimiaceae, Aphloiaceae, Fabaceae, Cyatheaceae, Clusiaceae, Euphorbiaceae, Aphloiaceae **.** An upper or arborescent stratum between 7 and 11 m continues with a coverage rate of 62%.

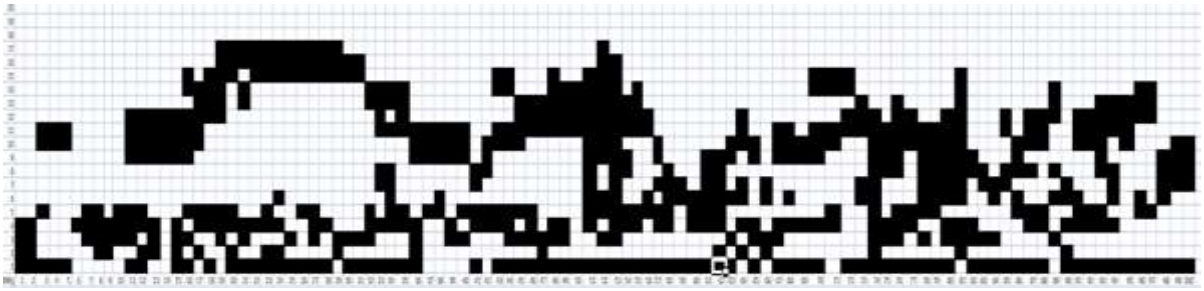
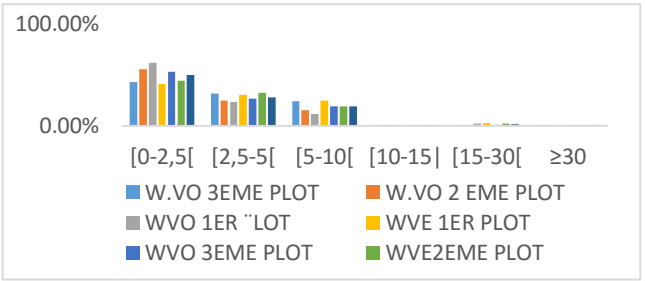


Figure 7 : Structural profile of ridge forests (woujoumoimro east slope 1st [plot])



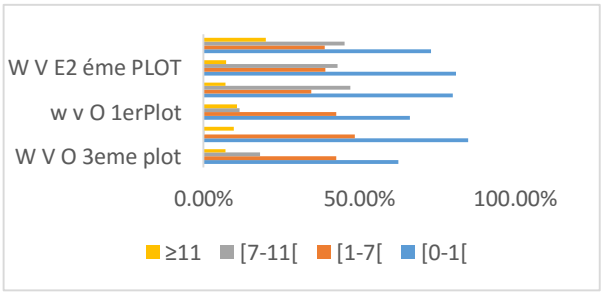


Figure 8 : Ridge forest diameter distribution diagram	**Figure 9** : Ridge forest site overlap diagram

❖ **Analysis of variance of ridge forest structure parameters**

For the comparison of the means (DHP, Hf and Ht) of the 6 readings, the columns followed by the same letters (abcde) do not present any significant difference (α=0.05).

Table 2: Distribution of DPH, HF, HT for ridge forests

	Wuju is1	Wuju est2	Wuju est3	Wuju west1	Wuju west2	Wuju west3
DPH	22.97 ± 4.31a	34.22 ± 12.58a	29.26 ± 8.37a	25.26 ± 4.47a	20.52 ± 6.4a	21.04 ± 6.05a
HF	5.51 ± 0.45a	6.11 ± 1.08a	5.88 ± 0.62a	5.46 ± 0.474ab	4.94 ± 0.77ab	4.29 ± 0.54b
HT	12.22 ± 0.81abd	13.7 ± 1.56ab	14.02 ± 0.86a	11.7 ± 0.92bcd	10.77 ± 1.19cd	10.18 ± 0.79c

❖ **Comparison of DHP averages**

For homogeneity of variance, the Test of normality of the distribution (Shapiro-Wilk test) is adopted with the reference hypotheses. H0: the distribution follows the normal law or H1: the distribution does not follow the normal law, p-value=0.016>0.05, there is therefore rejection of the hypothesis H_0 at a level of 5% error, the distribution of the linear model does not follow the normal law. And for the DPH **Kruskal Wallis Test** of which all the sites do not present a significant difference with p-value=0.78.

❖ **Comparison of Hf averages**

According to the reference hypotheses: H_0: The distribution follows the normal distribution, H_1: the distribution does not follow the normal distribution. p-value=0.08<0.05, rejection of H_0 at a 5% error level, the distribution of the linear model follows a normal distribution by doing the Normality Test of the distribution (Shapiro-Wilk Test). For the Bartlett Homogeneity Test, p-value=0.00057<0.05, the variance is not homogeneous because of the difference in number but the distribution is normal. According to the hypotheses H0: the means of Hf for the 8 sites of the ridge forests are the same. H_1: The means of Hf for all the sites of the ridge forests are different from each other, p-value=0.00066<0.05. The Woujoumoimro west side 3 site (Wuju west 3) contains species with a lower Hf than the sites in the Woujoumoimro east side 1,2,3 part (Wuju east 1,2,3).

❖ **Comparisons of Ht means**

Normality test of the distribution, according to the reference hypotheses H_0: the distribution follows the normal law. H1: The distribution does not follow the normal law, p-value=0.30>0.05, there is therefore rejection of the hypothesis H_0 at a level of 5% error. The distribution of the linear model follows a normal law; p-value=0.016<0.05, the variance is not homogeneous because of the difference in the number of individuals. According to the reference hypotheses, it could be that H0 is verified (H0: the means of Ht for all the sites of the ridge forests are the same), or H1 is verified (H1: the means of Ht for all the sites are different from each other), p-value =6.71e $^{-8}$ <0.05, the means of Ht are different from each other.

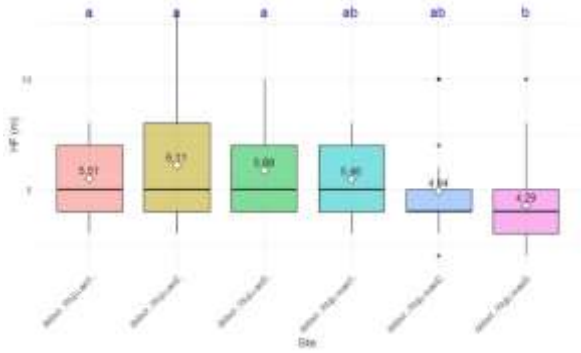


Figure 10 : The distribution of Hf means.

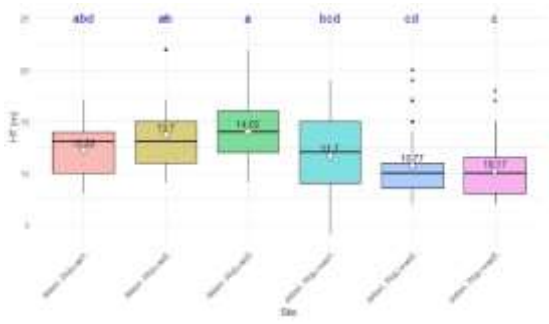


Figure 11: Distribution of Ht means

❖ **Horizontal structure**

The large trees listed are *Weinmania comorensis* , *Anthocleista grandiflora* , *Brachylaena ramiflora and Syzygium sakalvarum* with a record reaching 105 cm in diameter by *Weinmania comorensis* . All diameter classes are

represented of which [0-2.5],] 2.5-5] and]5-10] are the best represented. Overall the 6 sites represented here have an approximately identical distribution. We note a high density of young individuals (regenerated) and a rarity of individuals with large diameter. The average density is 4690 trunks/ha. It contains an average basal area of 236.14 m ^{2} /ha and a biovolume of 378.5 m ^{3} /ha. The diameters of the seed trees vary between 10 and 130 cm with an average of 30.88 cm

II.2.3. Floristic characterization

66 species divided into 54 genera and 35 families have been recorded in the ridge forest. The best represented families: Cunoniaceae, Loganiaceae, Monimiaceae, Cyatheaceae.

❖ **Biological spectrum**

A high proportion of phanerophytes is observed. It comprises 95.58% of the collected flora. Mesophanerophytes (Mp) are the best represented with 60.90%. Hemicryptophytes and epiphytes are poorly represented. Lianas and geophytes are almost absent. However, it is possible to rarely encounter Cheflera and Piper in certain places.

II.2.3. Natural regeneration

Of the 10,627 individuals recorded in the 6 ridge forest surveys, 10,310 are regenerated and 317 are seed trees. The natural regeneration rate of the formation type is approximately 5392.04%. Therefore, this forest has very good regeneration.

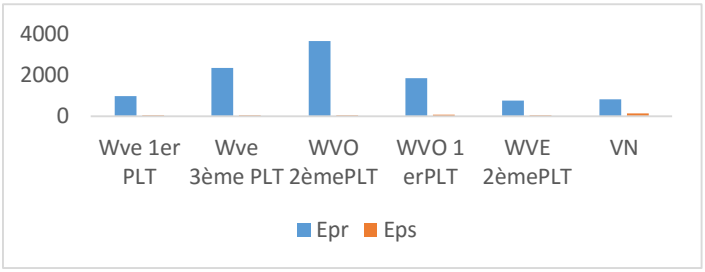


Figure 12 : Ridge forest regeneration diagram.

II.3. Comparative study of the characteristics of the sites studied

II.3.1. Shannon-Pielou index

H: Shannon index J: Pielou index

$$H = -\sum_{s=1}^{S} p_s \ln p_s.$$

$$J = \frac{H}{H_{\max}} = \frac{H}{\ln S}.$$

Abundance is the total number of individuals in a plot . The Shannon index represents the evenness of species in a forest plot. The Pielou index is calculated by obtaining the Shannon index, the Pielou index has a value between 0 and 1. A value of 0 for J indicates that a species has a probability of 1. A value of 1 for J indicates that the species have the same probability of occurrence. The Pielou index then makes it possible to determine the rarity of a species, or more precisely to weight it.

Table 3: Shannon and Pielou value index

Squares	1	2	3	4	5	6	7	8	9	10	11	12	13	14
number of species	42	30	44	28	27	15	26	24	9	10	11	11	9	7
Abundance	188	85	96	83	84	27	66	29	37	33	60	34	26	19
H	3.27	3.09	3.33	2.98	2.73	2.55	2.88	3.11	1.73	1.99	2.04	2.08	1.75	1.81
I	0.88	0.91	0.88	0.89	0.83	0.94	0.88	0.98	0.79	0.86	0.85	0.87	0.8	0.93

The Pielou index of forest plots has a value greater than 0.7, the species have more or less equal probabilities (the values are close to 1). This means that the species previously established in the plots are still present. The forest therefore has a very high biodiversity.

II.3.2. Biological spectrum of all sites studied

All sites show a strong dominance of mesophanerophytes. In addition, the slope forests have a greater percentage of mesophanerophytes than the ridge forests except two of them, the Mpizani and Ha gobi forests. This fact can be explained by the soil conditions of these two sites. The ridge forests have an approximately identical biological spectrum. A slight difference is observed at the Woujoumoimro site, West slope, 2nd ^{plot} (2WVO). The sites on the West slope (1WVO, 2WVO and 3WVO) contain more microphanerophytes than the sites on the East slope (1WVE, 2WVE and 3WVE).

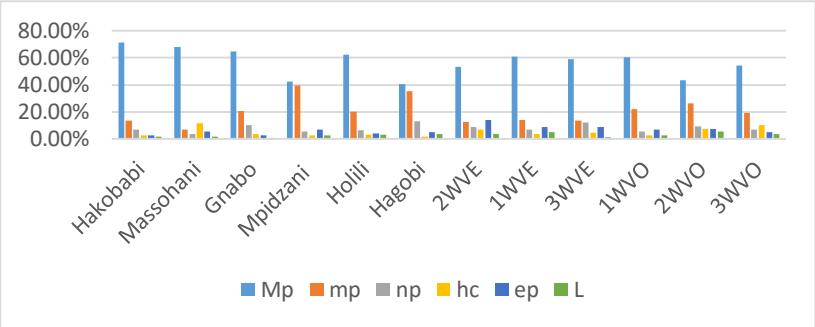


Fig. 13: Biological spectrum of the sites studied

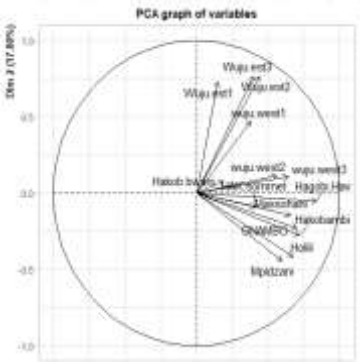
II.3.3 Relationship between the sites themselves and between the sites and the floristic composition

❖ **Correlation between sites**

There is links between sites and species abundance. The woujoumoimro Est 1, 2 and 3 (wuju est1, wujuest2 and wuju est3) and woujoumoimro Ouest1 (Wuju west1) surveys are grouped together, they are strongly correlated according to the specific abundance. A strong correspondence between the four surveys. These two groups located above axis 1 constitute the ridge forests.

❖ **Correlation between sites and species** .

The PCA also made it possible to highlight a correlation between the surveys and the floristic procession. Thus, the wuju ridge forests. Is 1,2,3 and wuju. West 1,2,3 are characterized by *Weinmania comorensis, Tambourissa comorensis, Cyathea boivini, Syzygium sakalavarum, Mystroxylum aethiopicum, Macaranga bailloniana and Reedia anjouanensis* . However, the slope forests are characterized by *Polyscias rependa, Gastonia spicata, Noronhia, Ficus lutea, Girostipula comorensis, Diospiros comorensis, Macphaesonia, Nuxia pseudodentata and Brachylaena ramiflora var comorensis.*



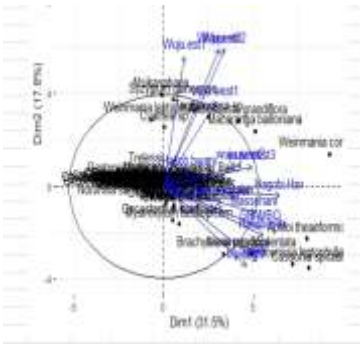


Figure 14: Site correlation diagram **Figure 15:** Correlation between sites and species

❖ **Correlation between sites and species by AFC**

Correspondence factor analysis allows visualizing on a two-dimensional graph the relationships between species (individuals) and the records they belong to. A link study between the two qualitative variables (species and sites) was conducted. The two hypotheses Ho and H1 were taken as reference. According to the chi-2 test, the approximation may be incorrect. However, P-value=2.2e $^{-16}$ <0.05 strictly significant. There is therefore a link between sites and species. Slope forests are characterized by species such as *Chrysophyllum boivinianum, Tambourissa leptophyla, Ravensara areolata.* Ridge forests are mainly characterized by species such as *Reedia anjouanensis, Weinmania comorensis, Ocotea comorensis.*

❖ **Structural analysis of the different surveys**

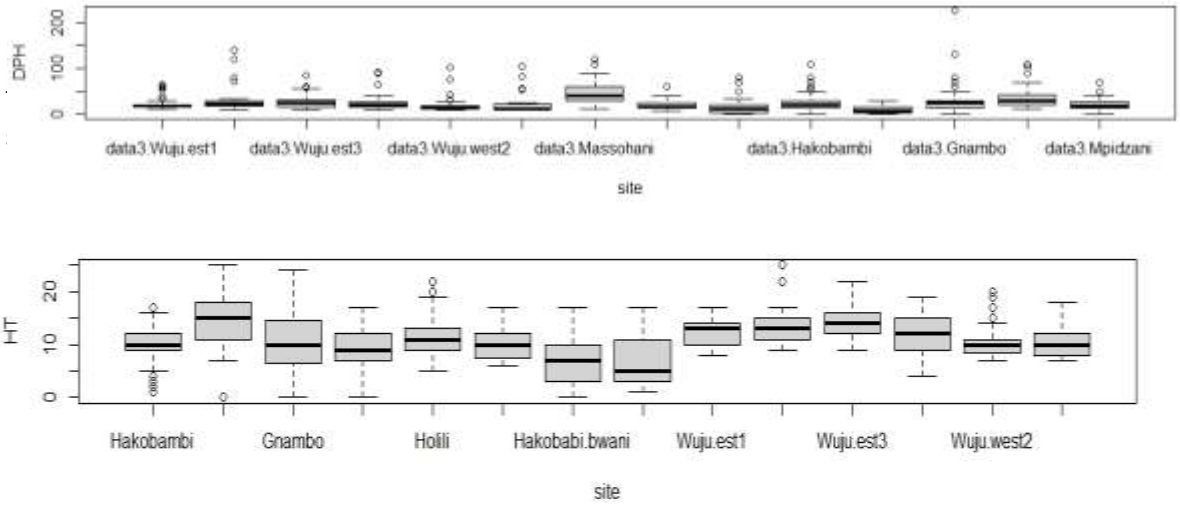


Figure 17 : **Distribution of total site heights**

There is a significant difference between the average HT of the sites. The Hakobabi Bwani and Hakobabi summit sites have the lowest values with average heights of 6.81 and 6.83 m respectively. There could be species in full regeneration or most of the species belong to the microphanerophyte classes. These two sites could be considered as old abandoned clearings.

III. DISCUSSION

The study of the ecological characterization of the Ouzini forest massif showed that the formation does indeed meet the characteristics of a dense, humid, evergreen primary forest of medium and high altitude between 700 and 1222m above sea level. It is multi-stratified with considerable recovery rates per stratum, displaying continuous strata synonymous with a weakly degraded forest. The characteristic species of the strata are similar to certain forests on the island of Anjouan and the forests of the other islands of the archipelago. Case of the Belea forest (N3) Anjouan, Oussodjou/ G3, Karthala Forest (Ngnoubadjou (K1)) **,** Ngazidja **(** Daroussi, 2014). In the Ouzini forest almost all diameter classes are present with a high density between 4690 and 8145 individuals/ha while the trunk density is 600 to 930 individuals per hectare in Karthala, 230 to 630 in La Grille, 430 to 760 in Ntringui and 480 to 680 individuals per hectare in Mzé Koukoulé because the forests of Karthala and Mzé Koukoulé are less exploited compared to the others (La Grille and Ntringui). The forests of Karthala and Mzé Koukoulé represent the highest biovolumes (320 to 377m3/ha) compared to the other two forests (Ntringui and La Grille). They are therefore the least degraded and the highest Daroussi.A,2014). According to ANLI,2008, the biovolume of the slope and ridge forests of the southern zone of the Mzékukulé forest varies between 198.78 to 794.38m3/ha. It should be noted that the basal area of the Ouzini forest is 236.14m2/ha for the slope forest and 97.42m2/ha for the ridge forests. Its biovolume varies between 378.5 and 697.25m3/ha. Thus, we note that

the Ouzini forest has a density, basal area and biovolume significantly higher than those of these two forests Mzékukulé (Mohéli) and Karthala (Ngazidja) considered by (Daroussi, 2014) as being the least degraded or best preserved forests of the archipelago. However, the biovolume of the Ouzini forest is substantially equivalent to the biovolume of the forest on the south side of Mzékukulé. Taking into account the results of ANLI, 2008. The Ouzini forest also rivals these two forests in height provided that some of its trees can reach heights of 24m high. The analysis of the structure of the Ouzini forest made it possible to establish a diagnosis on the state of conservation of the plant species of this forest. As a result, these forests still have great potential in woody forest resources (80 species for the slope forest and 66 species for the ridge forests have been recorded there) and other species have not yet been identified. Despite the numerous pressures they are subject to. This number of species is in the same orders of magnitude as the values found in the work of other authors. 59 species Site II Ongovouleni, 47 species Summit Mzékukulé, 64 species Site I Serandrengué, (ANLI, 2008). The Ouzini forest competes with these two forests for the 1st ^{rank} of the best preserved forest in the Comoros.

IV. CONCLUSION

Located between 700 and more than 1225 m above sea level, the Ouzini forest massif includes a dense humid forest of medium and high altitude. The ecological characteristics of this forest are determined through phytoecological studies based on ecological survey methods. In total, out of the 6 surveys carried out in the slope forest, 80 species divided into 71 genera and 49 families were recorded. Regarding the ridge forest, 66 species divided into 54 genera and 35 families are inventoried. They are multi-stratified with 3 strata: herbaceous, shrubby and arboreal. There are also emerging species. The strata present on the one hand a high rate of recovery expressing a continuity of the strata and on the other hand a less degraded forest. The density, basal area and biovolume of the Ouzini forest are higher compared to those of the Karthala and Mzékukulé forests. These two forests are considered the best preserved forests in the archipelago, the Ouzini forest occupies the first rank of the best preserved forest there. However, some openings can be observed sporadically in this forest, either of anthropogenic or natural origin.

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