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STUDY OF THE POTENTIAL DISTRIBUTION OF RARE AND ENDANGERED SPECIES OF THE EUPHORBIACEAE FAMILY OF CÔTE D'IVOIRE

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ABSTRACT

The main objective of this study is to contribute to the knowledge of the species of the Euphorbiaceae family from Côte d'Ivoire. Specifically, this involves carrying out a floristic analysis of Euphorbiaceae from Côte d'Ivoire, determining the species with special statuses of the Euphorbiaceae family from Côte d'Ivoire and analyzing their potential distribution. The endangered species database (Aké Assi, 1988) and the IUCN Red List (2019) were used to identify species with special status. Quantum GIS software and the Maxent model were used for the realization of the potential distribution maps. Four special status species have been listed: *Croton membranaceus* Müll. Arg., *Croton aubrevillei* J. Léonard, *Macaranga beillei* Pan. and *Sapium caterinum* J. Léonard. The potential distribution map of *Sclerocroton carterianus* (J.Léonard) Kruijt & Roebers, was not produced due to insufficient number of samples. Floristic analysis revealed that 75% of species are microphanerophytes, 50% are endemic to the forest block west of Togo, including Ghana, Côte d'Ivoire, Liberia, Sierra Leone, Guinea Bissau, Gambia and Senegal.

Keywords: Euphorbiaceae, Potential distribution, Biodiversity, Côte d'Ivoire.

1. INTRODUCTION

According to the Convention on Biological Diversity ISBN: 92-9225-129-5, two-thirds of the world's plant species are in danger of extinction due to increasing pressure from the human population, habitat modification, deforestation, overexploitation, pollution and the increasing impact of climate change. This phenomenon directly contributes to the loss of biological diversity and the decline of ecosystems around the world. Thus, West African ecosystems, the most diverse on the planet, with a high rate of endemism (Koffi et al., 2008), are unfortunately, like those of the world, subject to all kinds of pressure, hence its progressive degradation. The most common causes of this degradation are the felling of trees, shifting cultivation, the extension of family farming to industrial agriculture and intensive animal husbandry (Vroh Bi et al., 2011). In this context, particular priority is given to species with special status. In Côte d'Ivoire, according to the fifth national report on biological diversity in 2014, by 2020, surveys on the status of species with special status, their distribution and their ecology, the results of linkage to the management of conservation, and specific safeguard measures are implemented for 100% of the priority species identified. As a result, by 2020, the extinction of known endangered species is avoided and their conservation status, especially those that are falling most in decline, is improved and maintained.

It is in this perspective that this study is oriented by using species of the family Euphorbiaceae. Indeed, the Euphorbiaceae family, considered to be one of the largest and most cosmopolitan families in the Angiosperms sub-phylum, includes around 10,000 species grouped into 300 genera worldwide (Haba, 2008).

In Côte d'Ivoire, it contains 160 taxa divided into 50 genera (Aké Assi, 2001).Also, the Euphorbiaceae family has within it various species with several importance observed in several fields, namely the industrial field (Aké Assi, 2001), the food sector (Edouard, 1974; Aké Assi, 2001), the medical field (Bouquet and Debray, 1974) and the ornamental domain (Aké Assi, 2001).

Thus, this preliminary study, comes as a contribution to the knowledge of the species of the Euphorbiaceae family of Ivory Coast in general. Specifically, it will be a question of (1) carrying out a floristic analysis on all the species of the Euphorbiaceae family recorded in Côte d'Ivoire, (2) of determining the rare and / or endangered species of this family and (3) analyze the potential distribution of these rare and endangered species of the Euphorbiaceae family from Côte d'Ivoire.

2. MATERIAL AND METHODS

2.1. Material

The biological material used in this work is mainly composed of species of the Euphorbiaceae family extracted from the SIG IVOIRE database (Gautier et al, 1999) and flora from Côte d'Ivoire (Aké Assi, 2001). Excel software is used to establish the list of species to be processed. The list of threatened species (Aké Assi, 1998) and the IUCN red list (2019) have made it possible to identify the species of Euphorbiaceae with special status. The QGIS software (Quantum GIS) Lyon version 2.12.3 and the MaxEnt (Maximum Entropy) model were used to produce maps of the potential distribution of species.

2.2. Methods

2.2.1. Floristic analysis

The floristic analysis made it possible to determine the number of genera, the number of species, the most important genera in terms of number of species, the most important species in number of samples. The list of species of the flora of Côte d'Ivoire (Aké Assi, 2001) made it possible to group the species according to their chorological type and their biological type. Indeed the chorological type can be defined as being the geographical distribution of the species. As for the biological type, it can be defined as the organization of plants according to the positioning of the survival organs during the unfavorable period.

2.2.2. Determination of threatened species of the Euphorbiaceae family

The IUCN (2019) model was used to list Euphorbiaceae species according to the different IUCN threat categories in the database. In this same Euphorbiaceae database, the rare endemic species of Côte d'Ivoire according to Aké Assi (1998, 2010) were identified.

2.2.3. Realization of potential distribution maps

Potential distribution can be defined as the probable spatial distribution of a species. These models will provide a better understanding of the ecology of species and allow more reliable predictions. On the other hand, a region that has the appropriate set of biotic and abiotic factors and that is accessible to the species (through dispersal) constitutes the potential geographic distribution of the species (Soberon, 2007). The species to be modeled in this work are those with a particular status. A matrix with species and geographical coordinates was produced with the database of special status species. All these data, after having been transformed into csv format (separator, semi-colon), were submitted to the MaxEnt Species Distribution Modeling model (Phillips et al., 2004), version 3.3 for the realization of potential distribution maps. The environmental variables were obtained from Worldclim (Hijmans et al., 2005; http://www.worldclim.org/). They cover the period from 1950 to 2000. The variables are the average precipitation, the minimum and maximum temperature and 19 bioclimatic variables (BIOCLIM: http://www.worldclim.org/bioclim.htm) which can have an influence on the distribution species (Table I). The software does 1000 iterations before predicting the potential areas of species, taking into account the environmental variables that are most critical for the species concerned. The use of bioclimatic variables for the realization of potential distribution maps is an advantage because they are independent of the degree of exploration. However, there are limits to identifying poorly sampled areas (Engler et al., 2004), as species with many samples will have a wider range compared to those with few samples. On the other hand, bioclimatic variables do not take into account anthropogenic factors and also abiotic factors (Hamilton and Taylor, 1991). So, to have meaningful results, we will realize the potential distribution of species with at least 10 samples.

Table I: BIOCLIM environmental variables used to generate the potential distribution maps (http://www.worldclim.org/bioclim.htm)

	Bioclimatic variables
Bio_1	Annual Mean Temperature
Bio_2	Mean Diurnal Range (Mean of monthly (max temp - min temp))
Bio_3	Isothermality (BIO2/BIO7) (×100)
Bio_4	Temperature Seasonality (standard deviation ×100)
Bio_5	Max Temperature of Warmest Month
Bio_6	Min Temperature of Coldest Month
Bio_7	Temperature Annual Range (BIO5-BIO6)
Bio_8	Mean Temperature of Wettest Quarter
Bio_9	Mean Temperature of Driest Quarter

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Bio_10	Mean Temperature of Warmest Quarter
Bio_11	Mean Temperature of Coldest Quarter
Bio_12	Annual Precipitation
Bio_13	Precipitation of Wettest Month
Bio_14	Precipitation of Driest Month
Bio_15	Precipitation Seasonality (Coefficient of Variation)
Bio_16	Precipitation of Wettest Quarter
Bio_17	Precipitation of Driest Quarter
Bio_18	Precipitation of Warmest Quarter
Bio_19	Precipitation of Warmest Quarter

The prediction of habitats is obtained from the interpolation of the bioclimatic characteristics of each point of presence of the species. One of the parameters used to evaluate the predictive capacity of a model generated by MaxEnt is the AUC (Area Under Curve) which is the area under the ROC (Receiver Operating Characteristic) curve. AUC can then be interpreted as the likelihood that a randomly chosen point of presence is located in a raster cell with a greater probability of species occurrence than a randomly generated point (Phillips et al, 2006). The results obtained are useful for a better understanding of the ecology of the species and more reliable predictions. For Araújo et al. (2005), for a model generated by MaxEnt, recommend an interpretation of AUC (Table II).

For the finalization of the maps generated from the MaxEnt model, we used the extension files (.asc) which present pixel maps then imported into the QGIS software (Quantum GIS) version Lyon 2.12.3 to establish the maps of potential distribution.

Table II: Validity of the MaxENT test according to the AUC values obtained (Araújo et al., 2005)

Interpretations	Values
Excellent	1,00 > AUC > 0,90
Good	0,80 < AUC < 0,90
Acceptable	0,70 < AUC < 0,80
Bad	0,60 < AUC < 0,70
Invalid	0,50 < AUC < 0,60

3. RESULTS

3.1. Floristic analysis

3.1.1. Description of the flora of Euphorbiaceae

This study involved 1,430 samples collected from 1905 to 1999 by about 59 collectors and in almost 42 localities of Côte d'Ivoire. Thus, following the verification carried out, it turned out that some species of the Euphorbiaceae family have changed families. The different host families are Phyllanthaceae (43 species), Putranjivaceae (11 species), Pandaceae (2 species) and Urticaceae, Thymelaeaceae, Picrodendraceae (1 species each). Also, 22 species of the Euphorbiaceae family have gone into synonymy. Among them, we can cite: *Acalypha racemosa* Baill now *Acalypha paniculata* Miq; *Croton lobatus* L. now *Astraea lobate* Klotzsch etc.

After verifying the scientific names of the sampled species, it appears that the database at our disposal includes 38 genera, 102 species and 899 samples (Annex). The most represented genera are the genus *Euphorbia* (19 species) and the genus *Croton* (15 species). The least represented genus is *Hura* with only one species. The most harvested species are *Mallotus oppositifolius* (Geisler) Müll. Arg. and *Mareya micrantha* (Benth.) Muell. Arg. with 45 and 33 samples each, respectively. The least collected species is *Tragia vogelii*Keay with a sample. Other species are moderately harvested and the number of their samples varies between 6 and 17. One can quote *Tetrorchidium didymostemon* (Baill.) Pax & K. Hoffm. (17 samples), *Manniophyton fulvum* Müll. Arg. (14 samples), *Micrococca mercurialis* (L.) Benth. (6 samples).

3.1.2. Chorological type

Figure 1 shows that the Guineo-Congolese (GC) species are the most represented with 50% of all species. The other species are represented as follows: GC-SZ (22%), GCW (13), SZ (11%) and GCi (4%). This last group which characterizes the endemic species of Côte d'Ivoire is represented by: *Macaranga beillei* Prain, *Shirakiopsis aubrevillei* (Léandri) Esser, *Drypetes singroboensis* Aké Assi, *Tragia polygonoides* Prai.

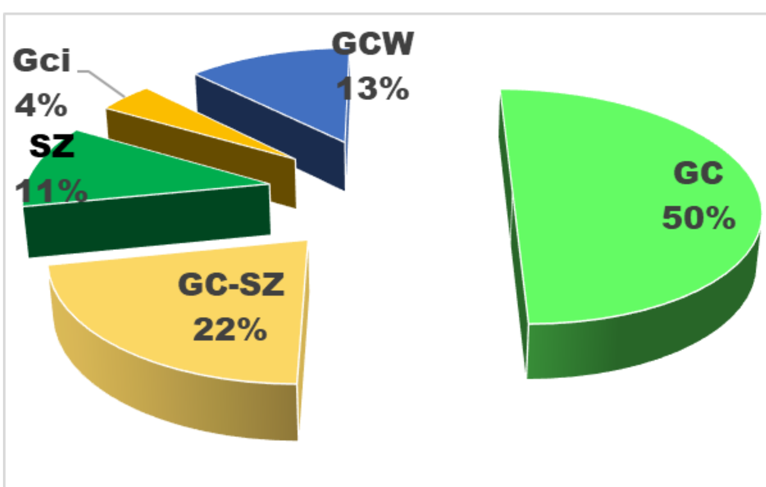

Figure 1: Chorological type of species of the family Euphorbiaceae

(GC: Guinean-Congolese;GC-SZ: Guinean-Congolese -Sudano-Zambezians;SZ: Sudano-Zambezians;GCW: endemic species of the forest block west of Togo, including Ghana, Ivory Coast, Liberia, Sierra Leone, Guinea Bissau, Gambia and Senegal;GCi: endemic species of Côte d'Ivoire).

3.1.3. Biological type

Floristic analysis revealed that microphanerophytes (mp) are largely dominant with a rate of 44%. Lianescent microphanerophytes Lmp (mp) are the weakest represented with a rate of 1% (figure 2).

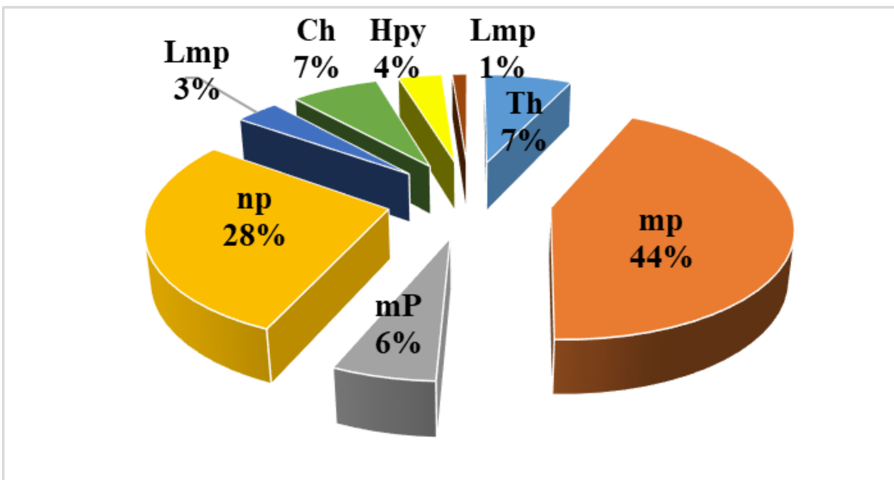

Figure 2: Biological type of species of the family Euphorbiaceae

(mp: microphanerophytes; np: nanophanerophytes; Lmp: lianescent microphanerophytes; Ch: Chaméphytes; Th: Therophytes; Lmp (mp): lianescent microphanerophytes, mP: mesophanerophyte; Hc: hemicryptophyte)

3.1.3. Identification of threatened species

Four species with special status have been listed. This is *Croton membranaceus* Müll. Arg., *Sapium caterinum* J. Léonard, *Croton aubrevillei* J. Léonard. And *Macaranga beillei* Pan. However, the potential distribution map of *Sclerocroton carterianus* (J.Léonard) Kruijt & Roebers was not produced due to the insufficient number of samples (3 samples collected in the forests of Ningue, Teke and in the Botanical Garden of Adiopodoume).

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3.2. Potential distribution of threatened and rare species of the Euphorbiaceae family

The potential distribution map shows the points sampled and the probability of the presence of the harvested species. Indeed, the analysis of this map shows that *Croton membranaceus* Müll. Arg has a high probability of occurrence in the Center-East, North-East and East of the country (figures 3). These areas correspond to the probable ecological niche of this species.

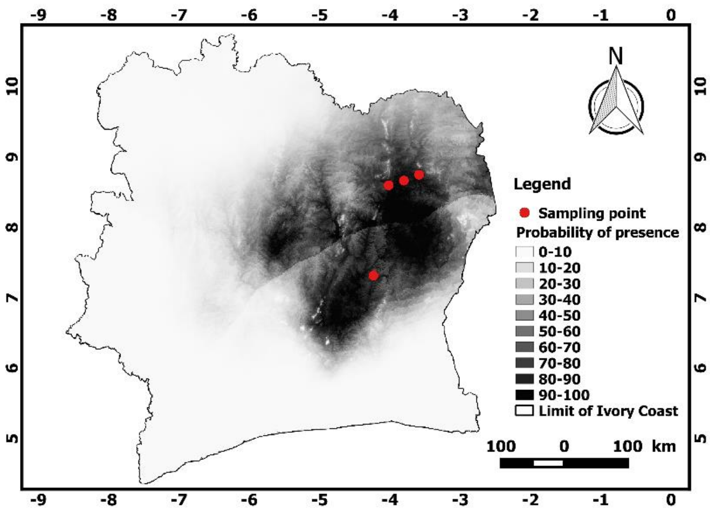

Figure 3: Potential distribution map of *Croton membranaceus* Müll. Arg.

The environmental variables that most influence the potential distribution of *Croton membranaceus* Müll. Arg. are the temperature seasonality (bio_4) with a rate of 26.9% and the seasonality of precipitation (bio_15) with a rate of 21.3. From a certain threshold (50 ° C for the seasonality of the temperature and 30 mm), any increase in the seasonality of the temperature (fig 4) and the seasonality of the precipitation (figure 5), cause a rapid decrease the probability of the presence of *Croton membranaceus* until it disappears in the environment. The model gives a test AUC value of 0.963 which means that the estimate of the distribution is excellent. The Jackknife test based on AUC data presents the minimum temperature of the coldest month as the major contributing parameter (Figure 6).

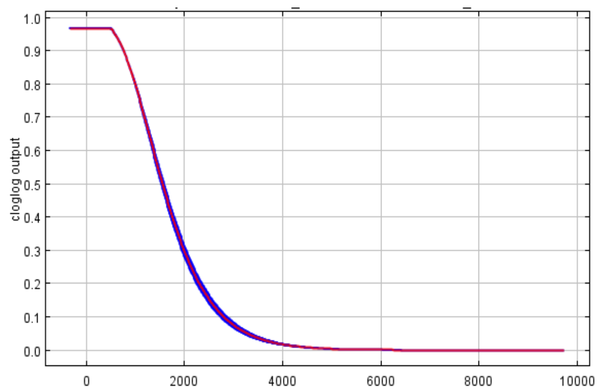

Figure 4: Temperature seasonality (bio4) (degree Celsius)

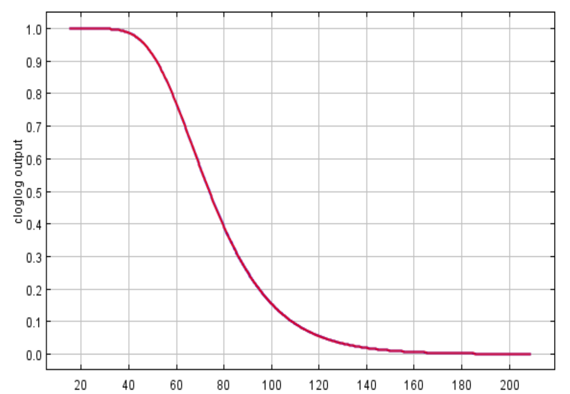

Figure 5: Precipitation seasonality (bio 15) (mm)

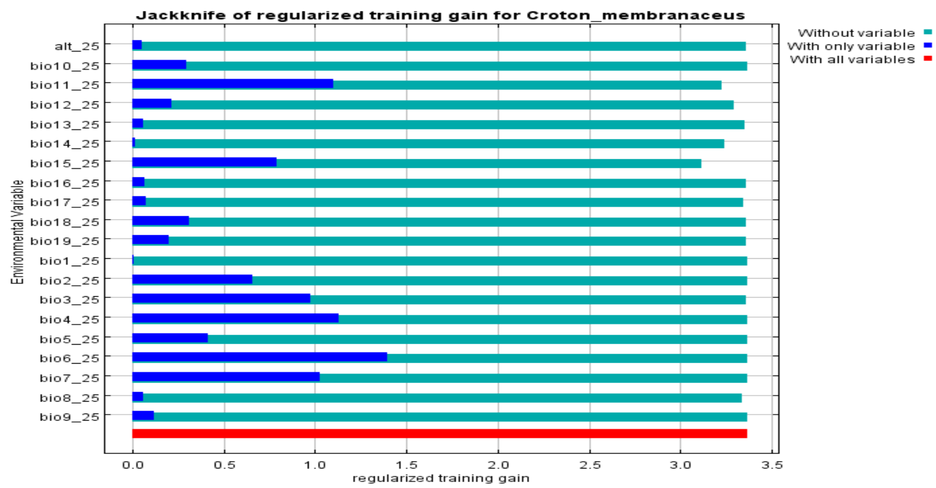

Figure 6: Importance of environmental variables on the distribution of *Croton membranaceus* Müll. Arg.

The potential distribution map of *Croton aubrevillei*s hows the points sampled and the probability of occurrence (Figure 7). Indeed, analysis of this map reveals that *Croton aubrevillei* has a probability of occurrence almost throughout the country. However, the North, North-West and South-West are not favorable for the distribution of *Croton aubrevillei*.

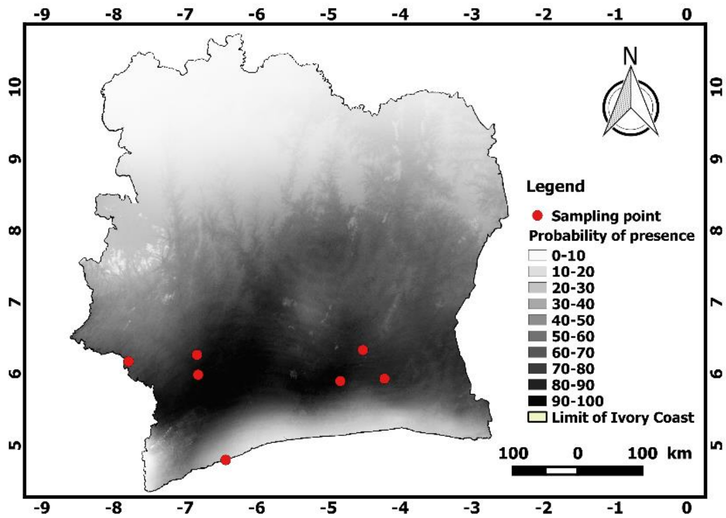

Figure 7: Map of current potential distribution of *Croton aubrevillei*J.Léonard.

The environmental variable that most influences the potential distribution of *Croton aubrevillei* J. Léonard is the minimum temperature of the coldest month with a percentage of 34.7 (figure 8). From a threshold value (150 ° C) of the minimum temperature of the coldest month, we observe a rapid increase in the probability of the presence of *Croton aubrevillei* in the medium until reaching a stationary value from 250 ° C. So, for a good distribution of *Croton aubrevillei* in a medium, a minimum temperature of the coldest month above 150 ° C is needed.

The AUC test value is 0.960; which means that Maxent's model for this analysis is excellent. The Jackknife test based on AUC data shows the following parameters as being of major contribution: annual temperature variations and the ratio of daily thermal amplitude to annual thermal amplitude (Figure 9).

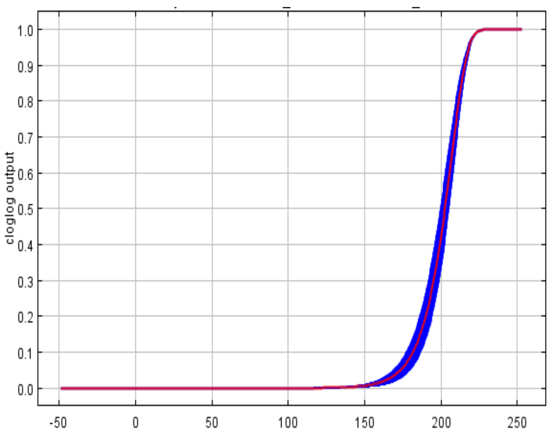

Figure 8: Minimal Temperature of Coldest Month (Bio_6) (degre Celsius)

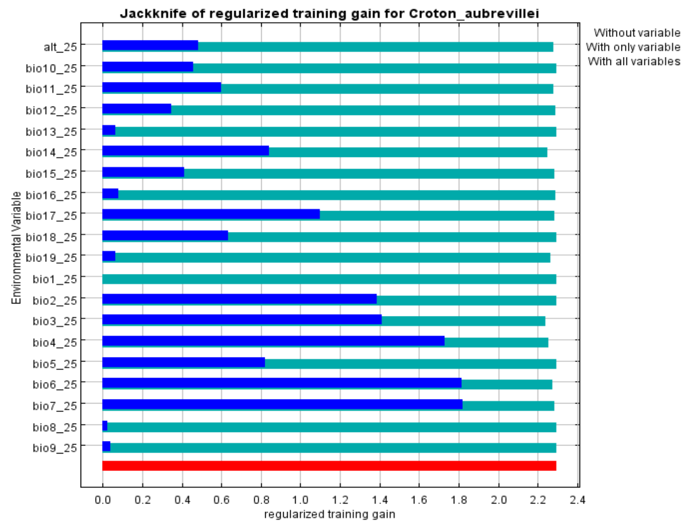

Figure 9: Importance of environmental variables on the current distribution *Croton aubrevillei* J.

The potential distribution map of *Macaranga beillei* Prain shows the points sampled and the probability of occurrence (Figures 10). Indeed, the analysis of this map reveals that *Macaranga beillei* Prain has a probability of occurrence only in the south of the country. The other regions of the country are not favorable to the distribution of *Macaranga beillei* Prain.

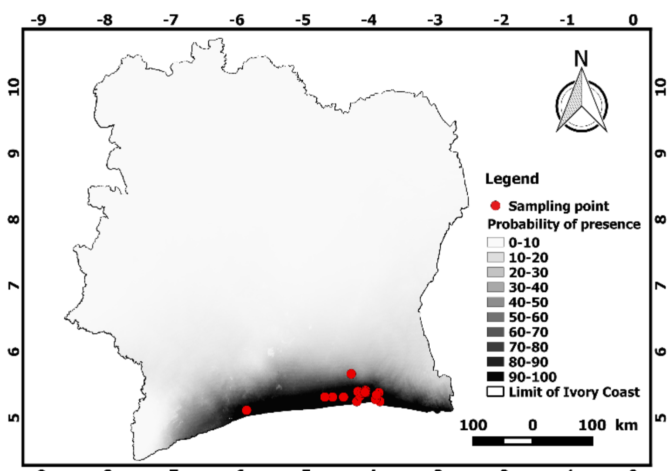

Figure 10: Potential distribution map of *MacarangabeilleiPrain*

The environmental variables that most influence the potential distribution of *Macaranga beillei* Prain are the average daily temperature variation (bio_2) with a rate of 18% and the precipitation of the driest quarter (bio_17) with a rate of 18.1. From a certain threshold of 40 ° C, any increase in the average daily variation in temperatures (fig 11) causes a rapid decrease in the probability of the presence of *Macaranga beillei* Prain until it disappears in the environment for a value of

120 °C. Regarding the precipitation of the driest quarter, there is an interval of precipitation of the driest quarter (from 0 to 550 mm of rain) outside which *Macaranga beillei* Prain cannot live (figure 12). For a value of 250 mm of precipitation in the driest quarter, the species (*Macaranga beillei*) reaches its maximum population in its range.

The model gives a test AUC value of 0.998 which means that the estimate of the distribution is excellent. The Jackknife test based on AUC data presents the average daily temperature variation as the major contributing parameter (Figure 13).

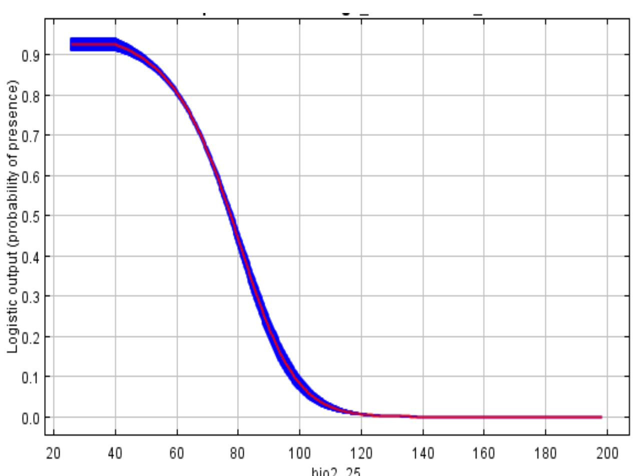

Figure 11: Mean Diurnal Range (Mean of monthly (max temp - min temp)) (bio_2) (degré Celsius)

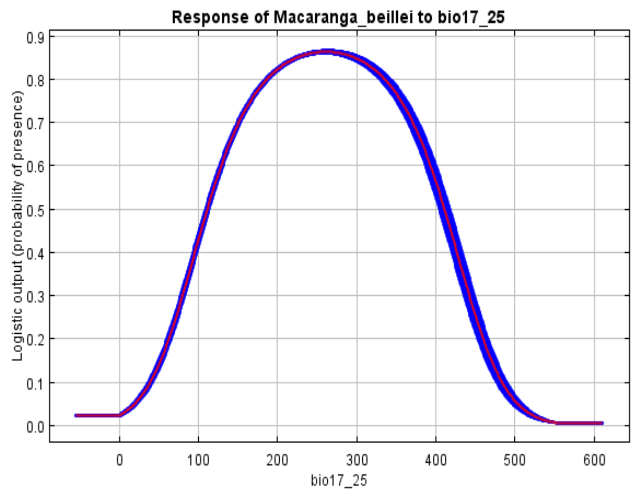

Figure 12: Precipitation of Driest Quarter (bio_17) (mm)

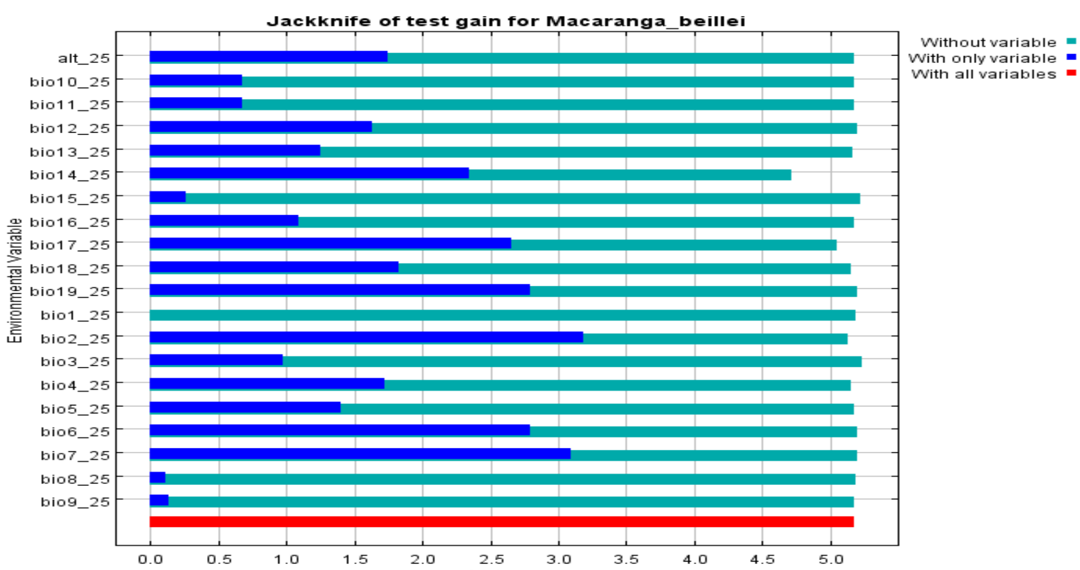

Figure 13: Importance of environmental variables on the distribution of *Macaranga beillei* Prain

4. DISCUSSION

The floristic analysis carried out on all the species of the Euphorbiaceae family of the Ivorian flora, revealed that the Guineo-Congolese (GC) and Guineo-Congolese-Sudano-Zambezian (GC-SZ) type species are largely dominant. . This chorological structure as it appears in our results is very comparable to that of dense humid evergreen forests, wooded savannah, trees, shrubs and / or open forest (Kouamé, 1998). According to Sonké (1998), the high proportion of Guinean species in the floristic background of an area is proof that this area does indeed belong to the Guineo-Congolese center of floristic endemism of White (1986). For the biological types, microphanerophytes dominate, which clearly shows that the Euphorbiaceae family contains small and stocky species (Aké Assi, 2001).

This study provides phytogeographic information from the detailed analyzes provided and the establishment of a map of the sampling effort. This information relating to species with particular statuses in occurrence *Croton aubrevillei* J. Léonard, *Croton membranaceus* Müll. Arg. and *Macaranga beillei* Pan should guide new botanical surveys in Côte d'Ivoire. Moreover, *Croton aubrevillei* J. Léonard has a large ecological amplitude compared to that of *Croton membranaceus* Müll. Arg. and *Macaranga beillei* Pan. Indeed, *Croton aubrevillei* J. Léonard is a shrub present in evergreen and deciduous forests, at low altitude. The evergreen forest is linked to a climate of the equatorial or subequatorial type characterized by a little marked dry season not exceeding 4 months lacking in water, high annual rainfall, greater than approximately 1,700 mm, and an annual water deficit not exceeding 300 mm. Species from this region are able to adapt to divergent edaphic and abiotic factors. This is the case of *Croton aubrevillei* J. Léonard. However, the vulnerable species status of *Croton aubrevillei* J. Léonard is mainly due to its use and its range which is strongly threatened by the destruction of its range. This observation was also made by Schmelzer and Gurib-Fakim (2008). Indeed, it emerges from their work that *Croton aubrevillei* J. Léonard is threatened by the destruction of his environment. Regarding *Croton membranaceus* Müll. Arg., it is a herbaceous species of shrub savannah. The range of this species is restricted to the center-east, east and northeast. These regions are included in the Sudanese sector. The climate in this region is semi-arid tropical (Sudanese) with a single dry season and an annual water deficit often greater than 900 mm. In addition, the harmattan, a hot and dry north-easterly wind, is responsible for the sharp drop in relative humidity during the dry season; the minimums are less than 20%. and the maximums are between 45% and 75%. The characteristics of this climate are found especially in the northeast of Côte d’Ivoire (region of Bouna) where rainfall remains sufficiently low (Guillaumet and Adjanohoun, 1957). To these climatic hazards are added the destructive actions of man by bush fires, agriculture and also the misuse of certain plant species. In such a context, the disruption and vulnerability of a species becomes unprecedented. This is the case with *Croton membranaceus* Müll. Arg. present in such an environment. This observation corroborates that of Lassina et al. (2011), in their work in Burkina Faso. As for *Macaranga beillei*, it is a species with restricted distribution in the littoral region. Its vulnerability is mainly due to urbanization and agricultural activities. Added to this is its use in traditional medicine (Adjanohoun and Aké Assi, 1979). It should be noted that *Macaranga beillei* is a species endemic to the Côte d’Ivoire and more precisely endemic to the Coastal region of the Coast. As a result, a low pressure exerted on it or on its area of distribution, whether anthropogenic or environmental, would be enough to put it in a vulnerable state. Indeed, it emerges from this work that vulnerability corresponds to the degree of exposure to the risks of

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reduction or disappearance of certain plant species caused by inappropriate harvesting methods in an environment subject to increasing human pressure and climatic variations.

The modeling of the fundamental niches made it possible to observe the potential distribution area of these three species. Indeed, the actual and potential distribution maps of *Croton membranaceus* Müll. Arg., de *Croton aubrevillei* J. Léonard and *Macaranga beillei* Pan make it possible to identify priority areas within the framework of development plans for the benefit of different climatic zones. They constitute a basis for conservation actions for species threatened with extinction, mainly due to anthropogenic influence within the limits of their distribution areas. These actions can only be effective if the potential areas are not overestimated compared to the actual distribution areas (Thiombiano et al., 2006). The different data on the study site can therefore be used to build models from MaxEnt. Better knowledge of its structure and floristic composition is also useful in developing policies for better management of biological resources on a larger scale. The models produced make it possible to bring out the different levels of influence between environmental variables and the dispersion of these species. The MaxEnt model was applied due to the abundance of species in the environment, estimating that their dispersion is still subject to these environmental variables. These factors are respective determining factors in the dispersal of each of these species. It can be seen that *Croton aubrevillei* J. Léonard is a species sensitive to annual variations in temperature while *Croton membranaceus* Müll. Arg. Hutch is more sensitive to the seasonality of precipitation and the seasonality of temperature. From this, we can deduce that the existence of a species in a given region is conditioned by several factors including climatic factors.

The seasonal inversion phenomenon and the presence of a more drastic dry season in the North and the significant climatic variations, could be the cause of the limitation to the dispersal of certain species such as *Croton membranaceus* Müll. Arg. Hutch. Only the maintenance of favorable conditions for long periods can explain their distribution throughout the area. Regarding *Macaranga beillei* Pan, there is a great sensitivity to the average daily variation in temperature and precipitation in the driest quarter. These factors are respective determining factors in the dispersal of this species. Likewise, for this species, harvests are restricted to the Guinean domain more precisely in the littoral cordon. We can conclude that this is a kind of forest.

Also, it is important to note that biological diversity is strongly threatened because the majority of species of the Euphorbiaceae family in the database such as and especially rare and endangered species have a potential presence in the priority area of conservation. These threats, which considerably affect both ecosystems and the living organisms they shelter, have a decisive effect on the economy and the quality of human life.

5. INVOLVEMENT IN CONSERVATION

This chapter highlights the involvement of protected areas in the conservation of biological diversity and ecosystems. In fact, *Croton membranaceus* Müll. Arg. Hutch, *Croton aubrevillei* J. Léonard and *Macaranga beillei*, three vulnerable species, are mostly harvested in national parks or classified forests in Côte d'Ivoire (figure 10). Analysis of the spatial distribution of *Croton*

membranaceus Müll. Arg. Hutch shows that it is mostly harvested in Comoé National Park. As for that of *Croton aubrevillei*J. Léonard, it emerges that it was generally collected in classified forests such as classified forests of Monogaga, Mopri, Kinkéné, Bamo, Mando. As for *Macarangabeillei* Pan, it is mainly harvested in the Banco National Park.
Following these observations, it is indisputable that protected areas have an important implication in the conservation of biological diversity. In fact, most of the protected areas are for certain species like refuge areas. Because of controlled population access and prohibited or controlled harvesting, the species that house these ecosystems can easily multiply outside of climatic hazards. This remark was also made by Jan Bogaert et al (2008).

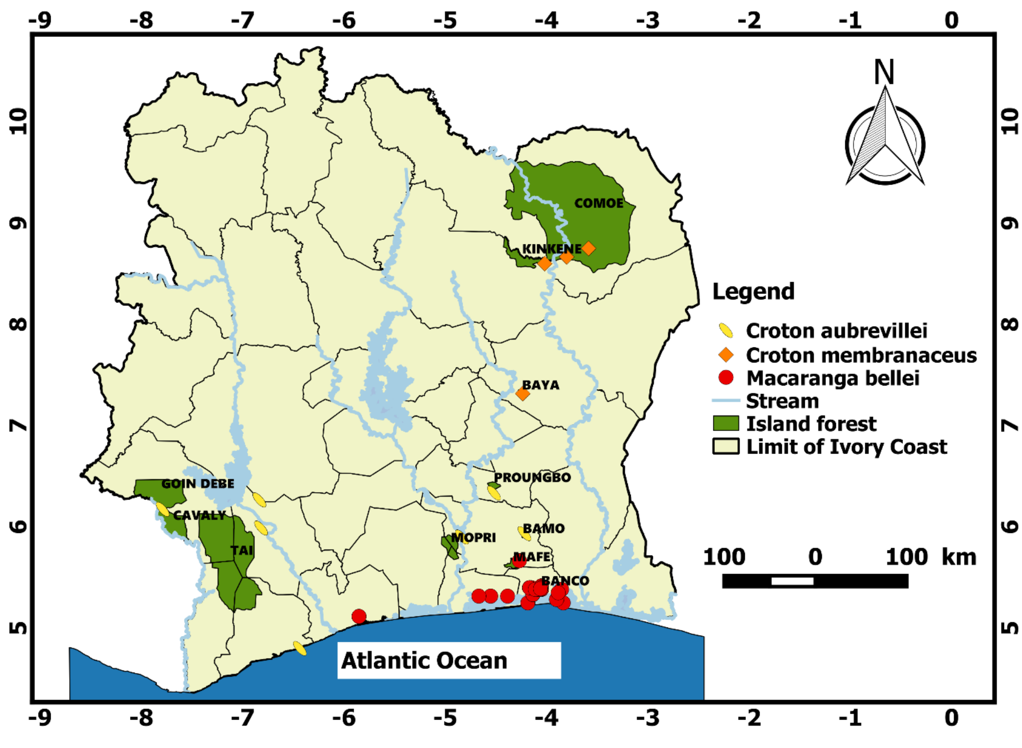

Figure 10: Spatial distribution of *Croton membranaceus* Müll. Arg. Hutch, *Croton aubrevillei* J. Léonard and *Macaranga beillei* Pan

5. CONCLUSION

At the end of this work, it emerges that in Côte d'Ivoire, the Euphorbiaceae family occupy an important place in the composition of the flora. The species are variously distributed in the country. Among the species collected, some are endemic to the West African sub-region, and others endemic to Côte d'Ivoire. More than half of the species are of the microphanerophyte type and are found in the Guineo-Congolese zone.

We were also able to determine four species with special status. These are endemic species, rare in Côte d'Ivoire according to Aké Assi (1998) and according to the IUCN Red List (2019). These various findings allow us to conclude that the distribution and abundance of Euphorbiaceae in the Guineo-Congolese region are determined by various environmental factors such as temperature and precipitation. Thus, the geographical position of Côte d'Ivoire allows it to benefit from very diverse ecosystems for conservation. However, their distributions remain subject to environmental conditions. Therefore, given its multiple importance, it is therefore appropriate for the Ministry of the Environment, the Ministry of Agriculture, environmental structures, research centers and units, universities to conduct a campaign to raise awareness among the population and in particular the peasants, for the promotion and the protection of the species of the Euphorbiaceae family in Côte d'Ivoire for a sustainable use and for the balance of plant biodiversity.

CONFLICT OF INTEREST

The authors of this manuscript declare that there is no conflict of interest between them.

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ANNEX: Exhaustive list of species of the Euphorbiaceae family recorded in Côte d'Ivoire

Species status: LC: Species of least concern; VU: Vulnerable species; LR / nt: Minor risk species; LR / lc: Species of Least Concern; AA: Rare species according to Aké-Assi.

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N°	Species	Status	Chorological types	Biological types
1	*Acalypha ciliata* Forssk.		GC	Th
2	*Acalypha racemosa* Baill.		GC	np
3	*Acalypha segetalis* Müll. Arg.		GC-SZ	Th
4	*Alchornea cordifolia* (Schumach. &Thonn.) Müll. Arg.		GC-SZ	Lmp (mp)
5	*Alchornea floribunda* Müll. Arg.		GC	mp
6	*Alchornea hirtella* Benth. f. *glabrata* (Müll. Arg.) Pax &Hoffm.		GC	mp
7	*Amanoa bracteosa* Planch.		GC	mP
8	*Amanoa strobilacea* Müll. Arg.		GC	mP
9	*Anthostema aubryanum* Baill.		GC	mP
10	*Anthostema senegalense* A. Juss.		GC	mP
11	*Antidesma laciniatum* Müll. Arg. subsp. *laciniatum*		GC	mp
12	*Antidesma membranaceum* Müll. Arg.		GC	mp
13	*Antidesma nigricans* Tul.		GCW	np
14	*Antidesma rufescens* Tul.		GC-SZ	mp
15	*Antidesma venosum* Tul.		SZ	mp
16	*Argomuellera macrophylla* Pax		GC	np
17	*Caperonia serrata* (Turez.) C. Prest		GC-SZ	Th
18	*Chrozophora senegalensis* (Lam.) A. Juss. ex Spreng.		SZ	np (Ch)
19	*Croton aubrevillei* J. Léonard	VU	GCW	mp
20	*Croton dispar* N. E. Br		GCW	Lmp
21	*Croton gratissimus* Burch.		GC	mp
22	*Croton hirtus* L'Hér.		GC	np (Th)

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23	*Croton lobatus* L.		GC-SZ	Th
24	*Croton macrostachyus* Hochst. ex Delile		GC-SZ	mp
25	*Croton membranaceus* Müll. Arg.	VU/ AA	GC	np
26	*Croton mubango* Müll. Arg.		GC	mp
27	*Croton nigritanus* Scott-Elliot		GC	np
28	*Croton penduliflorus* Hutch.		GC	mp
29	*Croton pseudopulchellus* Pax		SZ	mp
30	*Croton scarciesii* Scott-Elliot		GCW	np
31	*Crotonogyne caterviflora* N. E. Br.		GCW	np
32	*Crotonogyne chevalieri* (Beille) Keay		GCW	np
33	*Crotonogynopsis akeassi* J. Léonard		GCW	np
34	*Dalechampia ipomoeifolia* Benth.		GC	Lmp
35	*Discoclaoxylon hexandrum* (Müll. Arg) Pax & K. Hoffm.		GC	mp
36	*Discoglypremna caloneura* (Pax) Prain		GC	mP
37	*Erythrococca Africana* Baill.		GC	mp
38	*Erythrococca anomala* (Juss. ex Poir.) Prain		GC	np
39	*Euphorbia baga* A. Chev		SZ	Hpy
40	*Euphorbia convolvuloides* Hochst. ex Benth.		SZ	Ch
41	*Euphorbia deightonii* Croizat		GC	mp
42	*Euphorbia forsskalii* J. Gay		GC-SZ	Ch
43	*Euphorbia glaucophylla* Poir.		GC	Ch
44	*Euphorbia glomerifera* (Millsp.) L. C. Wheeler		GC	Th
45	*Euphorbia grandifolia* Haw.		GC	mP
46	*Euphorbia heterophylla* L.		GC	Th

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47	*Euphorbia hirta* L.		GC-SZ	Ch
48	*Euphorbia kouandenensis* Beille		SZ	H(Hpy)
49	*Euphorbia macrophylla* Pax		SZ	np
50	*Euphorbia polycnemoides* Hochst. ex boiss.		SZ	Th
51	*Euphorbia prostrata* Aiton		GC-SZ	Ch
52	*Euphorbia thymifolia* L.		GC-SZ	Ch
53	*Euphorbia unispina* N. E. Br.		SZ	mp
54	*Excoecaria grahamii* Stapf		GC-SZ	np (Hpy)
55	*Excoecaria guineensis* (Benth.) Müll. Arg.		GC-SZ	mp
56	*Flueggea virosa* (Roxb. ex Willd.) Voigt		GC-SZ	np
57	*Grossera vignei Hoyle*		GC	mp
58	*Hymenocardia acida* Tul.		GC-SZ	mp
59	*Hymenocardia heudelotii* Müll. Arg.		GC-SZ	mp
60	*Hymenocardia lyrata* Tul.		GCW	mp
61	*Jatropha atacorensis* A. Chev.		SZ	H (Hpy)
62	*Jatropha curcas* L.		GC-SZ	np
63	*Jatropha gossypiifolia* L.		GC-SZ	np
64	*Macaranga beillei* Prain	V	GCi	mp (Lmp)
65	*Macaranga barteri* Müll. Arg.		GC	mp
66	*Macaranga heterophylla* Müll. Arg.		GC	mp
67	*Macaranga heudelotii* Baill.		GC	mp
68	*Macaranga hurifolia* Beille		GC	mp
68	*Macaranga spinosa* Müll. Arg.		GC	mp
69	*Macaranga schweinfurthii* Pax		GC	mp
70	*Mallotus oppositifolius* (Geiseler) Müll. Arg. var.		GC-SZ	mp

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	oppositifolius			
71	*Mallotus subulatus* Müll. Arg.		GC	np
72	*Manniophyton fulvum* Müll. Arg.		GC	Lmp
73	*Mareya micrantha* (Benth.) Müll. Arg.		GC	mp
74	*Margaritaria discoidea* (Baill.) Webster		GC-SZ	mp
75	*Martretia quadricornis* Beille		GC	mp
76	*Micrococca mercurialis* (L.) Benth.		GC	np
77	*Plesiatropha paniculata* (Pax) Breteler		GC	mp
78	*Necepsia afzelii* Prain subsp. *Afzelii*		GC	mp
79	*Neoboutonia mannii* Benth. & Hook.f.		GC	mp
80	*Oldfieldia africana* Benth. &Hook. f.		GC	mP
81	*Pycnocoma angustifolia* Prain		GCW	np
82	*Pycnocoma macrophylla* Benth.		GC	mp
83	*Ricinodendron heudelotii* (Baill.) Pierre ex Heckel subsp. *africanum* (Müll. Arg.) J. Léonard		GC	mP
84	*Sapium aubrevillei* Léandri		GCi	mp
85	*Sclerocroton carterianus* (J.Léonard) Kruijt & Roebers	VU	GCW	np
86	*Microstachys dalzielii* (Hutch.) Esser		SZ	np (Hpy)
87	*Sapium ellipticum* (Hochst.) Pax		GC-SZ	mp
88	*Sebastiania chamaelea* (L.) Müll. Arg.		SZ	np
89	*Spondianthus preussii* Engl. subsp. *glaber* (Engl.) J. Léonard & Nkounkou		SZ	mP
90	*Suregada ivorensis* (Aubrév. &Pellegr.) J. Léonard		GCW	mp
91	*Suregada occidentalis* (Hoyle) Croizat		GC	mp

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92	*Tetrorchidum didymostemon* (Baill.) Pax & K. Hoffm.		GC	mp
93	*Thecacoris stenopetala* (Müll. Arg.) Müll. Arg.		GC	np
94	*Tragia benthamii* Baker		GC	Lnp
95	*Tragia chevalieri* Beille		GC	Lnp
96	*Tragia laminularis* Müll. Arg.		GC	Lnp
97	*Tragia polygonoides* Prain		GCi	Lnp
98	*Tragia senegalensis* Müll		GC-SZ	np
99	*Tragia spathulata* Benth.		GC-SZ	Lnp
100	*Tragia tenuifolia* Benth.		GC	Lnp
101	*Tragia vogelii* Keay		SZ	Lnp
102	*Tragia wildemanii* Beille		SZ	H (Hpy)

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