

Global Overview of Flora and Plant Diversity in Togo (West Africa)

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Abstract

The flora constitutes an important reference tool very used in biology. Its constant update is fundamental in order to promote new directions in conservation. The current study was developed as a synthesis of the analytical flora in Togo. It aims to produce an inventory of this flora by emphasizing its distribution along ecological zones. Its purpose is to make an assessment of the greatest entities of the flora including those of introduced, threatened to disappearance plant species. This synthesis was possible thanks to the use of data retrieved from the existing analytical flora associated with some reports on this flora. Information was organized according to the junctions, of introducing and threatened to disappearances species. They were analyzed on the basis of the phytogeographical types and life forms, and then classified according to ecological zone. From this synthesis it appeared that the flora of Togo would lay out 3468 species distributed among the algae (201especies), Bryophytes (13 species), Pteridophyts (129 species), Gymnosperms (13 species), and Angiosperms (2992 species). The phanerophytes, therophytes, the lianas, and hemicryptophytes dominate the biological spectrum, whereas the guineo-congolian (GC), Sudano-Zambeian (SZ), and transition zone species (GC-SZ) represents phytogeographical types. Face to the new challenges, especially economic, and environmental which fit all in a sustainable context of resources management, an update of all the flora will be a strategic element in the framework of management and conservation of biodiversity.

Keywords: Flora, Life form, Chorology, Introduce species, Threatened species, Vascular plants, Phanerophytes, Angiosperms, Biodiversity, Togo.



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1. Introduction

The knowledge of floristic units in the current context of sustainable management of phyto-genetic resources is well established. The availability and the mastery of these informations allow to direct the uses and crucial services of them by laying a priority on ecosystem balance.

The flora in general speaking is constituted by the plant species and micro-organisms except the viruses. However, according to [1], the plant kingdom is composed of two lines, algae and terrestrial plants (bryophytes, Pteridophytes, gymnosperms and angiosperms). Flora by its composition present complex entities, whose exhaustive knowledge remain few obvious. Flora of Togo does not escape to this rule because of the growing discoveries of new taxa identified by posterior work [2, 3] to the analytical flora of Togo [4].

From all the junctions of this flora, vascular plants have been the subject of numerous studies. Spermaphytes have been extensively studied compared to gymnosperms and Pteridophytes, who's summarily studied. The groups less evolved (algae and bryophytes) meanwhile have been few studies, apart from sporadic surveys conducted on a very small scale, like seeks as major research can be quoted the inventory of algae [5].

Some or the component of Togolese flora, an analysis of this flora according to administrative regions even to ecological zones has not been done. The update of this flora in relation with new species finding, chorological types

and life forms have not be done yet. It's highly necessary and significant to achieve deepened analysis based document existing reference [4].

This study is a contribution which aims to summarize the information available on the Togolese flora, to focus on the background, to identify gaps and deficiencies to be addressed to have more comprehensive data. More specifically, it is an inventory of the flora with emphasis on its distribution over ecological zones of Togo. It would be an evaluation of large entities as well as the flora taxa introduced or threatened of disappearance.

2. Methodology

2.1. Study Area

West African countries, Togo is limited by Benin to the east, Ghana to the west, Burkina Faso to the north and the Atlantic Ocean to the south. With a total area of 56600 km², it extends between latitudes 6° and 11° North and longitudes 0° and 1° 4 'East. It is divided into five administrative regions, namely Maritime, Plateaus, Central, Kara and Savannah (Fig. 1A). Its population is estimated to be 6191155 people with an annual growth rate of 2.58%. The rural population is estimated at 62.6% of the total population.

2.2. Geographical Context

Togo belongs to a relatively wet and hot zone of the subequatorial littoral. Its stretched form in latitude associated with a geomorphological diversity and the various wind regimes is causing two major types of climate characterized by a few variations:

Subequatorial guinean climate ranges from ocean to latitudes 8°30 'west and 9° east. It is divided into four seasons with two variants: the guinean plain type less rainy (1000-1300 mm / year) and the guinean mountainous type more rainy with 1600 mm / year. In the guinea zone, the rainy season last from March to July with maximum rainfall in June. Low rainfall and the high number month ecologically dry represent characteristics this climate. The soils of the area in majority are qualified of bare soils, however there are some soils less evolved, hydromorphic, ferruginous tropical leached, deep and organic hydromorphic lateritic.

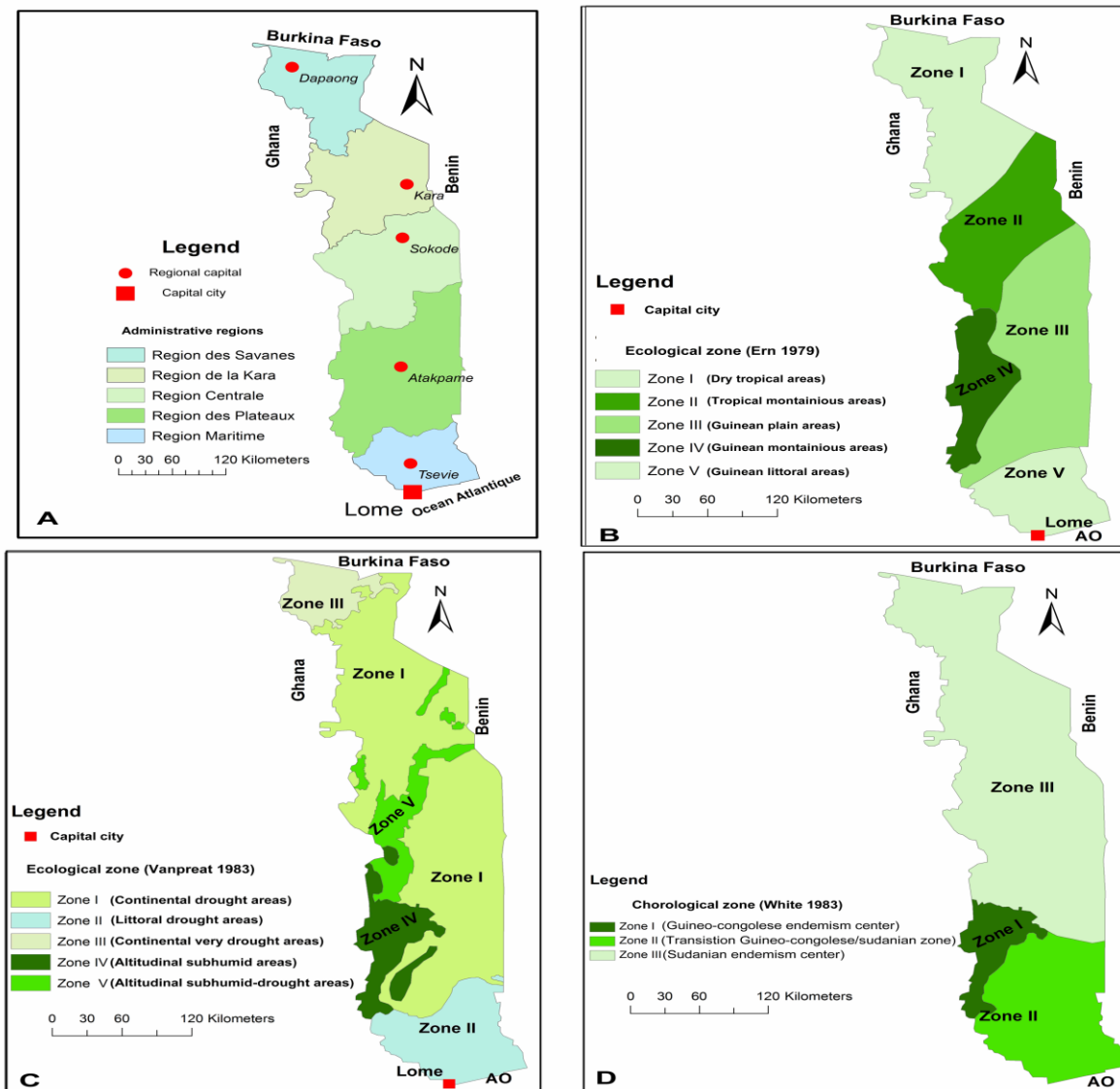


Fig-1. A- Administrative map; B- map of ecological zones [6]; C- map of ecological zones [7] and, D- map of phytogeographical subdivision [8].

The sudanian climate covers the country from 8° 30' North to the west and 9° North east up to the border with Burkina Faso. It corresponds to a subtropical mode with two seasons with three to six ecologically dry months. The period of the wet season decreases from the South towards North. Two major soil types dominate the northern landscape. It's consisted of lateritic soils (leached) without recent concretions and without crusts, and encrusted grounds associated to a lateritic carapace. To those above are added azonal soils (sands, vases and alluvial deposits).

The average temperature ranges from 26 to 28°C in the plains and goes down to 24°C in altitude. The average relative humidity ranges from 70 to 90% in the Guinean zone and 50 to 70% in the Sudanian zone [9].

2.3. Phytogeographical Context

It is a country almost dominated by savannas [10, 11]. However, it is strewn with some remarkable and massive forest patches observable in the plain environment, altitudes and along streams. Whether from the work of Ern [6] or Vanpraet [12] Togo can be divided into five ecological zones (Fig. 1B and 1C).

Subdivisions defined and proposed by Ern [6] would reflect more reality phytogeographical and would explain the reason for which they are more used. They are composed as follows:

The northern plains (zone I) correspond to the septentrional part of the country. It is a dry tropical area. Sedimentary formations or epimetamorphic of the Volta basin dominate the landscape. The main vegetation type is the Sudan savanna associated with riparian forests found along the Oti River and its affluents. The northern parts of the area are occupied by a "steppe savanna" with thorny shrubs curassic soils. This vegetation would be similar to that present in Burkina Faso and corresponds to a transition zone between the Sudanese and Sahelian training [13].

The Kabyè and the Défalé mounts which bordering the plateau of Niamtougou and the plain of Binah constitutes the zone of the northern mountains (zone II). In this zone grow dry dense forests, clear forests and grassland dominated by *Parkia biglobosa*, *Vitellaria paradoxa* and *Isobertinia* spp [14].

The central plains corresponding to Zone III and represents the large areas of plains in the country. The altitudes range between 200 and 400 meters. These undulating plains are Precambrian origin. The guinean woodland dominated the landscape [10], to which are added clear forests and galleries forests [15-17].

The ecological zone IV corresponds to Southern mounts of Togo. It covers the plains of Litimé and Ahlon, the plateau of Akébou, Akposso, Dayes and Kloto. It is the field of moist and semi-deciduous forests of Togo [18, 19]. The following species are met: *Celtis mildbraedii*, *Terminalia superba*, *Ricinodendron heudelotii*, *Parinari excelsa*. Guinean Savannas (mountain savannas) are also present [4].

The coastal plain in southern is dominated by a coastal sedimentary basin and corresponds to the zone V. The vegetation of the coastal plain shows a mosaic character [20]. Croplands, fallow, thickets, bushes, derived savannas, grassy savannas, savannas bushy mounds coexist with small islands of forest [4, 15]. The mangroves, the flooded meadows and savannas are also present in the extreme southeast [9].

Five ecological zones overlap with three phytogeographical zones (Fig. 1D), at African regional scale [8]:

Zone 1 or regional center of endemism Guineo-Congolese

Zone 2 or zone transition Guineo-congolese/Sudanian

Zone 3 or center of endemism Sudan

2.4. Method of Study

The material used within the framework this exploratory study mainly consists of available bibliographic data. Among these analytical flora of Togo [4] was the foundation on which this study is based. Complementary information from the work on of flora of western Africa neighboring countries were also used [10, 21-25].

The list species procession from the analytical Flora of Togo [4] was seized into an Excel spreadsheet; the structure included the information about classes, families, and genera, the phytogeographical area, life form type and ecological zone of identifying species.

From the data collected, a general floristic assessment of each ecological zone was calculated arithmetically. Concisely information on chorological types and biological types were used to determine the spatial distribution of diversity by ecological zone.

3. Results

Togolese flora count to date 3468 species, which belong to algae (201species), bryophytes (133species), pteridophytes (129species), gymnosperms (13 species) and angiosperms (2992 species) (Figure 2).

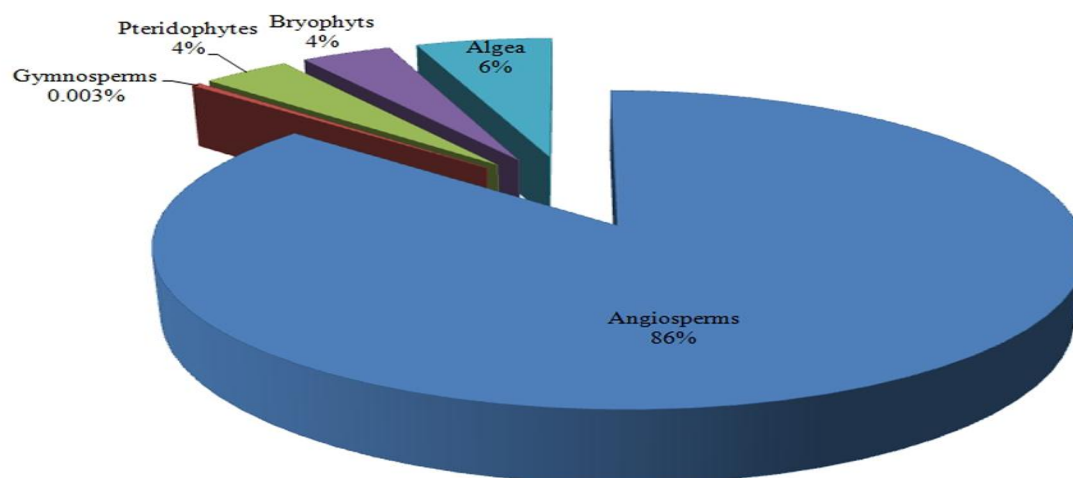


Fig-2. Distribution of plant flora

3.1. Exotic Species

For the 3468 species recorded, 520 species (14.99 %) were introduced in deliberate or uncontrolled way. Among them were reported 15 pteridophytes, 12 gymnosperms and 493 angiosperms; respectively, equal to 2.88%, 2.30% and 94.80% of introduced species.

3.2. Vascular Flora

The assembly formed of pteridophytes and spermaphytes (vascular plants) corresponds to 1080 genera belonging to 173 families. It represents 3134 species of the 3468 species. It takes into account the quasi totality of species identified to date, or 90.36% of total species (Table 1).

Pteridophytes are distributed among 22 families. The spermaphytes have 151 families. The gymnosperms are only represented by four families for 13 species while angiosperms include the large batch of families (147) and species (2992). Dicotyledons and monocotyledons each hold 2100 and 892 species and corresponding respectively to 60.55% and 25.72% of total species.

Table-1. Summary of vascular plants

	Families		Genera		Species	
	Number	(%)	Number	(%)	Number	(%)
Dicotyledons	119	68,78	846	71,69	2100	67
Monocotyledons	28	16,18	276	23,38	892	28,46
Pteridophytes	26	15,02	58	4,91	142	4,53

10 families of angiosperms are represented by more than 50 species, among them can be enumerated the Poaceae (284 species), Fabaceae (260 species), Cyperaceae (167 species), Rubiaceae (157 species), Euphorbiaceae (137 species) Asteraceae (112 species), Orchidaceae (93 species), Araceae (59species), Liliaceae (56 species) and Mimosaceae (53 species) (Table 2). The floristic composition of these ten families represents more than 39.74% of the species of flora. Based on the number of genera, graminaceous followed by leguminous plants are the most diverse tax and are respectively dominated by *Andropogon* and *Panicum* (Gramineae) and *Crotalaria*, *Indigofera*, *Desmodium*, *Cassia* and *Acacia* (Leguminosae) genera. They are followed by Rubiaceae, Asteraceae and Euphorbiaceae (Table 2).

Table-2. A list of representative families of Angiosperm

Familles	Genera	Species
Poaceae	88	284
Fabaceae	66	260
Rubiaceae	61	157
Asteraceae	53	112
Euphorbiaceae	39	137
Orchidaceae	31	93
Asclepiadaceae	31	46
Appocynaceae	28	50
Araceae	23	59
Cyperaceae	21	167
Caesalpinaceae	20	48
Lamiaceae	20	37
Liliaceae	19	57
Mimosaceae	19	53
Scrophulariaceae	19	46
Malvaceae	15	47
Commelinaceae	12	48
Verbenaceae	12	38
Convolvulaceae	11	49
Moraceae	9	49

Whether native or introduced species, four biological types dominate the taxonomic spectrum. They concern phanerophytes, therapists, lianas and hemicryptophytes. However, climbers and geophytes are diverse in their adaptability face the ecosystem process. The procession of phanerophytes is dominated by microphanerophytes and nanophanerophytes (Fig. 3A).

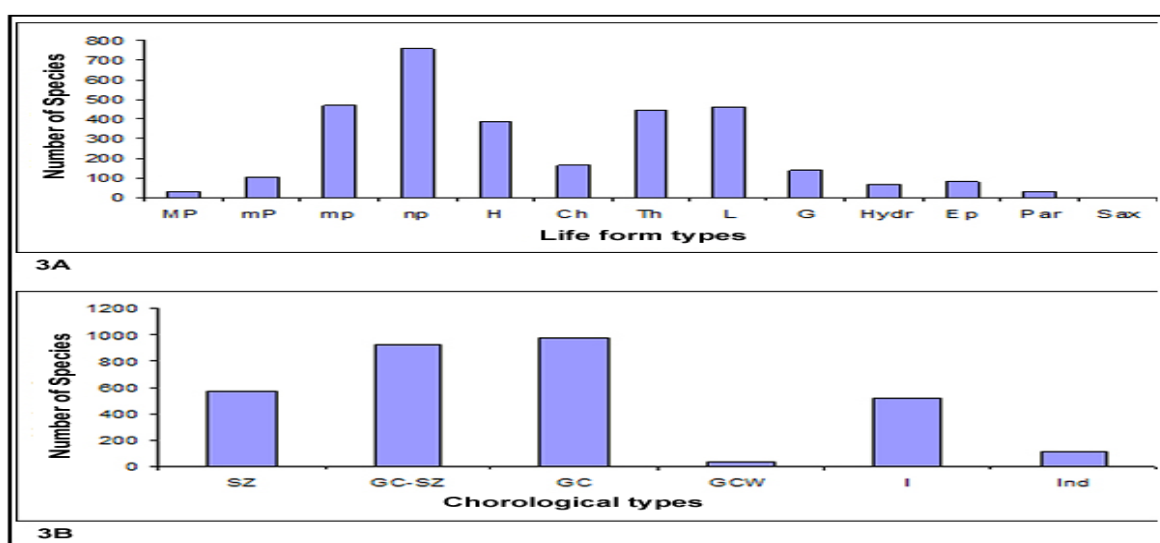


Fig-3. A-Distribution of vascular plant life form types

(MP: megaphanerophytes, Mp: mesophanerophytes, mp: microphanerophytes, Np: nanophanerophytes, L: lianas, CH: Chamephytes, G:geophytes, Th: therophytes, Hyd: hydrophyte S, Sax: Saxicolous, By: parasites, Ep: Epiphytes, H: hemicryptophytes)

B-Distribution of vascular plants chorological types

(GC: guineo-congolian species, GCW: western guineo-congolian species, SZ: sudano-zambesian species, GC-SZ: species of transition zone, I: introduced species, Ind: unspecified species)

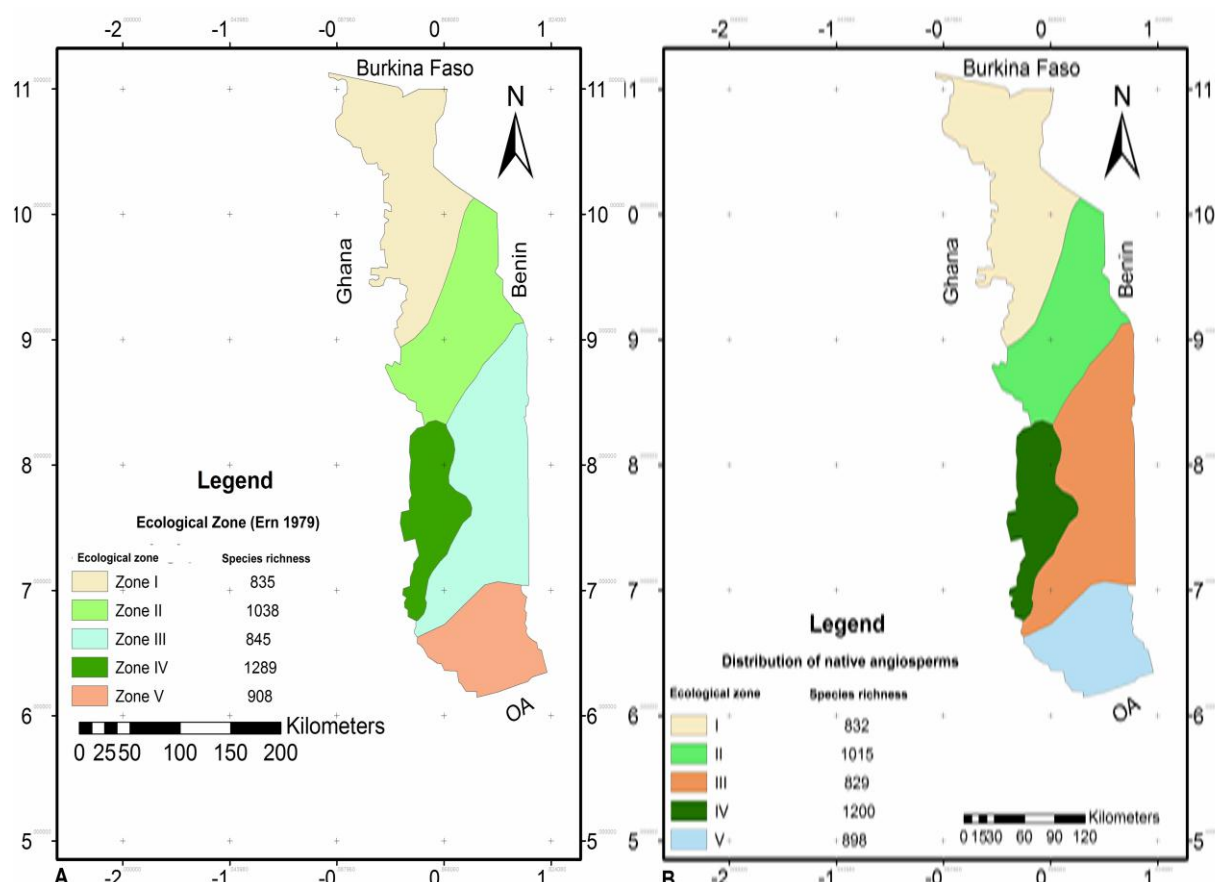


Fig-4. A-Spatial distribution of the native vascular species by ecological zone. B-Spatial distribution of the native angiosperm species by ecological zone

On chorological level the Guinea-Congolese species (GC), the western guineo-congolian species (GCW), Sudano-zambeian(SZ) and the species of the transition zone (SZ-GC) represent the main phytogeographical species native to Togo (Fig. 3B). There is also a significant number of taxa introduced, which chorological type was not determined. The Guinean-Congolese species followed transition species (GC-SZ) and Sudano-Zambeian species dominate the flora.

Based on the ecological zone units established by Ern [6], zones II and IV contain more species (Fig. 4A, B). They represent mountain ecosystem, dwellers with the relatively wet and favorable climate. They have more than 1000 species each. The other three units consisting of plains with different latitudinal positions have more than 800 species each.

The species of Sudano-Zambeian endemism center and Guinean-Congolese ones represent the essential of floristic procession. However, it should be noted the existence of introduced flora such as of pantropical, paleotropical, Afro-Malagasy, African-American, Afro-Asian species, which are adapted to the environment ecology. These species by their presence reveal the implication of human in the modification of the ecosystem biological spectrum.

At the national level the mountainous zone (Atacora chain) has a high species richness. Species richness in the three ecological zones followed more a latitudinal climatic gradient and explain why the ecological zone 5 dominated by moist savanna has more species than others. It is followed by the Guinean savanna ecosystem (zone 3), then by the highly anthropized of Sudanian area (zone 1). The overall distribution of the vascular species is concordant with that of the junctions and subjunctions of the angiosperms (Fig. 4B).

3.3. None Vascular Flora

The inferior groups such as algae and bryophytes are to know thoroughly. It is necessary to raise a notorious lack of the monographs or typical flora about their subjects. However, the synthesis work focuses on general data. Algae, aquatic exclusively relies 201 species, 170 are marine area while 31 freshwater one. Concerning bryophytes, there are 133 species, almost all subservient to the Southwest forest area.

3.4. Threatened or Disappeared Species

The most threatened and listed species are: *Ancistrophyllum secundiflorum*, *Balanites wilsoniana*, *Chrysobalanus icaco*, *Chrysophyllum welwitschii*, *Conocarpus erectus*, *Conyza aegyptiaca* var. *lineariloba*, *Cordia platythyrsa*, *Diospyros ferrea*, *Dodonea viscosa*, *Dostenia walleri*, *Ensete gillettii*, *Garcinia afzelii*, *Khaya grandifoliara*, *Milicia excelsa*, *Phyllanthus dolichofolius*, *Scaveola plumieri*, and *Shrebera arborea*. These species could be classified in several levels according to the degree of threat.

3.5. Endemicity

One species have been reported as endemic to the Togolese flora. It consists of *Phyllanthus rouxii* Brunel. It is a sub-shrub with tuberous roots and grows on the ferruginous soil of hills in northern Bassar.

4. Discussion

Most branches and taxa of flora in Togo are relatively unknown. The best known are those having species with an economic interest. The absence of a recent monograph on the entire flora or the non update of the existing flora [4] could confirm deficiencies in the accuracy of the values mentioned above. Through numerous researches on this flora new species have been reported but not considered so far. Among these works have frequently enumerated those of Akpagana [18], Kokou [15], Wala [26], Woegan [3], Péréki [27], Folega [12], mainly focus on phanerophytes, and that of Bandjé [5] on the algae. Studies on bryophytes have not been conducted to date.

On the basis of the information available on flora introduced in Togo, it is estimated that this number does not reflect much the reality for several reasons. These exotic species were almost introduced for horticultural purposes. The free movement of goods and persons within West African areas promote the contribution of Sahel taxa to sudanian and guinean wetlands by socioeconomic phenomena. The urban areas growths by appealing new practices and design of horticulture have also favored sharply the introduction of exotic species [28].

Togo is mainly covered by savanna; its vascular flora is quietly similar to the neighboring countries as Benin and Burkina Faso commonly dominated by savanna species. It appeared a strong preponderance of herbaceous and graminaceous characteristics of tropical savannas. The spermaphytes are the best known and studied. They are the largest, most significant and more diversified group. This junction is better known because their systematic would be easier to realize; the reason why more studies were devoted to them. Dominance of phanerophytes could confirm the existence of a wooded landscape, however the high rate of graminaceous also reveals the presence of open vegetation, which conferring to Togo the status Savanna country.

Some or ecological either zone, it is necessary to emphasize that variability of the climate affects the species distribution, thus explaining a relatively high species richness in wetter zones. On the national level and according to Ern [6] subdivisions, the mountainous zone (Atacora chains) has a high species richness, probably due to the fact that, it receives more rain than other parts of the country. It should be noted that the southern part of the chain is covered by semi-deciduous forests with a predominance of species of Guinean endemism area with more species than the northern which is driest. Considering that the non vascularised species have not been valorized by extensive research, it is difficult to ascertain their distribution through the five ecological zones.

A systematic inventory should be done at the national level in order to have data comparable with those obtained elsewhere in the sub-region. These results could also to allow to ensure the protection and conservation of certain sensitive species which is threatened of disappearance.

According to OIBT ITTO [29] studies, Togo lead countries where deforestation is very high. The surface many vegetation cover has strongly regressed causing the loss or threatened loss of characteristic species. However, whatever the degree, their biotopes are threatening to cause new conditions of adaptation and survival both reinforced by a climate in changing and an overexploitation of their resources for economic purposes [30].

The analytical flora of Togo [4], which is to date the only reference work devoted to the vascular flora species, only one species has been mentioned as endemic. By against certain species found in the central part of the country could be subjected to more effective checks and study about their endemism. In the current context of global warming, the update of this flora is a necessity for the purpose of flora conservation and could provide a new assessment of endemic species which depend on a typical habitat.

5. Conclusions

The flora of Togo has not been extensively studied throughout in whole. Some entities, such as seed plants (angiosperms) have been the subject to deep and extensive study compared to others who are still at an embryonic stage. Analysis of existing data, the flora is composed of 3468 species. Angiosperms are represented by 2992 species. Aside some reserves could be set on other entities in term of the number their species. The study and comprehensive analysis of all the flora remains today a strategic element in the management and conservation of biodiversity. For this purpose, specific issues of economic, environmental order in the context of sustainable management of plant resources should allow for a balance between flora components to be studied. This could also direct studies with a focus on the natural habitat and the host-parasite relationship.

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