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DOI
10.3897/phytokeys.175.61467

Publication date
2021

Document Version
Final published version

Published in
PhytoKeys

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Citation for published version (APA):
Houngnon, A., Adomou, A. C., Gosling, W. D., & Adeonipekun, P. A. (2021). A checklist of vascular plants of Ewe-Adakplame Relic Forest in Benin, West Africa. PhytoKeys, 175, 151-174. https://doi.org/10.3897/phytokeys.175.61467
A checklist of vascular plants of Ewe-Adakplame Relic Forest in Benin, West Africa

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Academic editor: T.L.P. Couvreur | Received 29 November 2020 | Accepted 20 January 2021 | Published 12 April 2021

Citation: Houngnon A, Adomou AC, Gosling WD, Adeonipekun PA (2021) A checklist of vascular plants of Ewe-Adakplame Relic Forest in Benin, West Africa. PhytoKeys 175: 151–174. https://doi.org/10.3897/phytokeys.175.61467

Abstract
Covering 560.14 hectares in the south-east of Benin, the Ewe-Adakplame Relic Forest (EARF) is a microrefugium that shows insular characteristics within the Dahomey Gap. It is probably one of the last remnants of tropical rain forest that would have survived the late Holocene dry period. Based on intensive field investigations through 25 plots (10 × 50 m size) and matching of herbarium specimens, a checklist of 185 species of vascular plant belonging to 54 families and 142 genera is presented for this forest. In addition to the name for each taxon, we described the life form following Raunkiaer’s definitions, chorology as well as threats to habitat. The Rubiaceae family was the richest (20 species) followed by the Fabaceae (15 species). Life forms showed the preponderance of phanerophytes (88%). The Chorological spectrum was dominated by Guineo-Congolean species (66%). Species richness estimated were 200.52 ± 9.2808 for Bootstrap; 217.62 ± 14.5972; 224.16 ± 15.3725 and 242.67 respectively for Chao, Jacknife1 and Jacknife2. Bootstrap appears to be the estimation closer to the field records. In Benin, EARF is home for Rinorea species described as West African forest bio-indicators and single location for Nesogordonia papa-verifera, Mansonia altissima, Englerophytum oblandeolatum, Octolobus spectabilis, Vitex micrantha and most of Drypeteae tribe species (Drypetes aframensis, Drypetes afzelii, Drypetes gilgiana and Drypetes leonensis) recorded in Benin. Our results provides baseline information for further in-depth analysis of vegetation history in Benin by raising the question on the past floristic connection of the Dahomey gap and community engagement in conservation.
Introduction

At the continental level, African rain forests, primarily those of the Guineo-Congolean block, are the main centres of species diversity (White 1983; Lebrun 2001; Sosef et al. 2017; Droissart et al. 2018; Couvreur et al. 2021). However, in some regions of this block, landscape changes have been so severe that particular areas would have functioned as refugia, while diversity in surrounding areas would have experienced losses. This is probably the case with forest islands within the Dahomey Gap which is the dry corridor separating the West African rain forest into the Upper Guinean and Lower Guinean blocks (White 1983; Jenik 1994; Poorter et al. 2004). During the late Holocene dry period (3000–2500 yrs BP), the once continuous rain forest belt became fragmented and was reduced to isolated patches that would have persisted and survived as “small isolated humid pockets” (Dupont and Weinelt 1996; Salzmann and Hoelzmann 2005). In addition to these historical climatic oscillations, archaeologists and ecologists highlighted several proofs of human footprint such as metallurgy (cast iron), agriculture, pottery that would have gradually caused deforestation and may explain the phytogeographic status of the Dahomey gap in West Africa (Richards 1973; Paradis 1977; Wantchecon 1983; Brand 2001; Garnier et al. 2018). Indeed, this savanna intermingled with small forest patches within the Dahomey gap, is also seen as a cultural landscape, produced by humans for subsistence, security and/or worship uses of religious traditions (Juhé-Beaulaton 2010; Cousin 2018). Consequently, the vegetation of Benin which is supposed to be luxuriant is today largely dominated by farms, fallows and grasslands (Adjanohoun 1966; Jenik 1994; Sosef et al. 2017). One fifth of the original forests remain, fragmented into isolated patches (Poorter et al. 2004). Today, Benin is home to 2807 plant species in terms of floristic composition (Akoègninou et al. 2006). It is among the best explored botany countries of sampling completeness with 2460 species theoretically estimated between 2864 and 2889 species (Sosef et al. 2017). Despite this sampling effort, some species that have not yet been collected or reported may not be listed and therefore omitted. Either because they may have disappeared, following their habitat degradation, as was the case of *Chrysobalanus icaco* L. (Syn. *C. atacoriensis* A. Chev.), which would have disappeared following earthworks (Adjanohoun et al. 1989).

However in Benin, most of these remaining forest patches, although playing the role of a high conservation priority area for heritage plants, are still experiencing severe threats due to the lack of adequate conservation strategies (Oloukoï et al. 2007; Adomou et al. 2010). This is probably the case with Ewe and Adakplame Relic Forest (EARF) in the south east of Benin. Up to now, this relic still persists on a community land while showing insular characteristics with some rare and poorly known plant species. Earlier
The botanists who worked on this refugium include Chevalier (1910), Aubréville (1937) and Adjanohoun (1966). They noted the typical feature of the Ewe-Adakplame Relict Forest (EARF) described as a Timber-refuge of the time of tribal wars, as one having a considerable number of African rain forest species of Guineo-Congolean region comparable to those of Côte d’Ivoire (Adjanohoun et al. 1989, P. 20).

In this context, floristic details on EARF may be very useful for conservation purposes through restoration and rehabilitation of degraded land with native trees. Such information is necessary for further studies in biogeography and phylogeny on the one hand, to address the main speciation models and mechanisms that may apply across tropical Africa (Demenou et al. 2016, 2018; Couvreur et al. 2021), and on the other hand to reconstruct the history of Tropical Africa vegetation.

This paper aims to provide a comprehensive checklist of vascular plants occurring in EARF that will serve as baseline for understanding the history of this vegetation over millennia. By exploring the floristic composition of EARF, we can better appreciate the biogeographic status of some species previously reported by Achoundong (1996; 2000) as bio indicators in other West African forests located on either side of the Dahomey gap. The results could help (1) to better understand how the Dahomey Gap has affected the vegetation of this area and (2) to catalyze long-lasting conservation actions toward EARF.

**Methods area**

**Study site**

The EARF covers 560.14 hectares in the Kétou District in the south-east of Benin Republic at 07°27'59.195"N, 002°34'29.395"E (Fig. 1). This part of the country belongs to the Guineo-Congolean Region (White 1983; Adomou et al. 2006). The forest relic is located at the north-east of the depression of “Co” or “Lama” on the plateaus of low altitude that evolved on the pre-Cambrian base rocks (Adjanohoun et al. 1989). In Benin, the most important national protected areas are in the north. There are several other forests (albeit small) in the southern part of the country which are within the national protected areas network (e.g. gazetted forests of Dogo-Ketou, Pobe, Lama, Pahou) which are well-managed (Adomou et al. 2006). There is also the recent Transboundary biosphere reserve of Mono which is now part of the national protected areas network. However, EARF has not yet been included in this national protected areas network.

The mean annual rainfall in the EARF is between 900–1300 mm (Adjanohoun et al. 1989; CARDER 2002; Adomou et al. 2006) which contrasts to other similar African dense semi-deciduous forests. The rainfall recorded in Upper Guinea is between 1750–1900 mm (Martin 2008) in Côte d’Ivoire (West Africa) and annual rainfall measured around the Kakamega rain forest in East Africa was approximately 2215 mm (Cords 1987) and 1956 mm (Greiner 1991). Table 1 provides parameters such as temperature, relative humidity, vegetation and soil types of the study site. The
landscape surrounding EARF is dominated by fallows, cultivation areas and housing. The vegetation is a mosaic of savanna with species of the Sudanian transition zone such as *Adansonia digitata* L., *Stereospermum kuntianum* Cham., *Trichilia emetic* Vahl, *Annona senegalensis* Pers., *Vitex doniana* Sweet, *Parkia biglobosa* (Jacq.) R.Br. ex G. Don, *Dichrostachys cinerea* (L.) Wight & Arn., *Pterocarpus erinaceus* Poir., *Pericopsis laxiflora* (Benth.) Meeuwen, *Daniellia oliveri* (Rolfe) Hutch. & Dalziel, *Vitellaria paradoxa* C.F. Gaertn., *Sarcocephalus latifolius* (Sm.) E.A. Bruce, *Uvaria chamae* P. Beauv., *Vitex grandifolia* Gürke and *Andropogon gayanus* Kunth (Biaou 2009; Armani et al. 2018).

![Figure 1. Location of the Ewe-Adakplame Relict Forest in Benin and positions of the sampling stands.](image)

| Table 1. Ecological characteristics of the study region. |
|---------------------------------------------------------|
| **Location** | 6°25–7°30N | Adjanohoun et al. (1989) |
| **Annual rainfall** | 900–1100 mm | CARDER 2002, Adomou et al. (2006) |
| **Rainfall trend** | Bimodal | Adjanohoun et al. (1989) |
| **Rainy season(s)** | March–July & September–October | Adjanohoun et al. (1989) |
| **Dry season** | August and November–February | Adomou et al. (2006) |
| **Temperature** | 24–37 °C | CARDER (2002), Bani (2006) |
| **Insolation** | 2135 h | CARDER (2002), Bani (2006) |
| **Relative humidity** | 78–95% | CARDER (2002), Bani (2006) |
| **Climate type** | Sub-equatorial | Adomou et al. (2006) |
| **Length of plant growing season** | 240 days | CARDER (2002), Bani (2006) |
| **Vegetation** | Mosaic of Savanna | Adjanohoun et al. (1989) |
| **Soil types** | Ferralic soils without concretion | Adomou et al. (1989), Bani (2006) |
| **Altitude** | 200–286 m above sea level | Bani (2006) |
The total population of the villages of Ewe and Adakplame is 13,623 individuals with 2,078 households (INSAE 2016). The main activity is agriculture, followed by hunting, livestock breeding and local commerce.

**Sampling and data collection**

The inventory of EARF plant species was conducted from February 2014 to December 2017. The forest investigation was based on a vegetation map divided into 250,000 m² (500 × 500 m) grids following 6 transects, each of 500 m width and 3000 m length. Transects were oriented south-north. The floristic sampling covered different components of the EARF (Fig. 1). At each stand, a toptometer (Chaining Buddy, Fremaco Devices, Canada) with disposable filament was used to delimit quadrats of 10 × 50 m. The observation stands were set out at intervals of 100 m along each transect line and there was one quadrat per plot of 250,000 m². In total, 25 forest quadrats of 500 m² were floristically surveyed. To set a preliminary list of EARF flora, species identification was first based on our self-background during the sampling field work with photo captures (Olympus Digital Camera SP-620 UZ Silver and Samsung Galaxy S7 Android 6.0.1). This approach was combined with description session (on field and at the National Herbarium). Voucher specimens were systematically collected for specimens whose determination is confused. They were compared with voucher specimens of the national Herbarium. To access the systematic information notes, the botanical nomenclature followed the Analytical Flora of Benin (Akoègninou et al. 2006). The list of plant species recorded was compared to online resources such as the “Catalog of life” (Hassler 2020) and the Benin National Red List (Neuenschwander et al. 2011) in order to access botanical information notes and the conservation status of species.

**Data analysis**

The Angiosperm Phylogeny Group (APG IV 2009) and the legume subfamilies currently accepted by the legume phylogeny working group (LPWG 2017) were used to update the list of the vascular plants recorded in EARF. The taxonomic plant diversity was assessed in terms of species, genus, and family richness. The species richness (S) corresponds to the number of species recorded from sampling plots (n = 25). We used the functions “specpool” and “estimateR” in R software (R-Core-Team 2016) for the main reason that S is sensitive to sample size and this may introduce bias in our estimations based on the field record. To circumvent this, we use species accumulation curve and different estimation methods in order to appreciate in the case of our field study, the best estimator which is closest to our field record (Palmer 1990; Colwell and Coddington 1994; Chiu et al. 2014). This approach also helps to assess the completeness of our sampling effort. Chao, first order jackknife, second order jackknife and bootstrap were then used to estimate the total number of species surveyed and to draw species accumulation curves (R-Core-Team 2016; Oksanen et al. 2017).
Life forms assessment followed Raunkiaer (1934); Hutchinson and Dalziel (1954–1972): Ph: phanerophytes subdivided into meg: megaphanerophyte (> 30 m tall), mes: mesophanerophyte (8–30 m), mph: microphanerophyte (2–8 m), nph: nanophanerophyte (0.5–2 m); Ch: chamaephyte, Hc: hemicryptophyte; Th: therophyte; G: geophyte (Gb: with bulb, Gr: with rhizome and Gt: with tuber); Ep: epiphyte and their climbing forms L: liana (Lmph, Lnph and Lmes, LGr, LHc).

The Chorology types were established after Hutchinson and Dalziel (1954–1972) and White (1983), as follows: GC: Guineo-Congolean, SG: Sudano/Guinean transition, GE: Lower Guinean, GO: Upper Guinean, TA: Tropical Africa, AM: Afro-Malagasy, Pan: Pantropical.

Data resources

The data underpinning the analysis reported in this paper are deposited in the Dryad Data Repository at https://doi.org/10.5061/dryad.z8w9ghxbg (Houngnon and Adomou 2021).

Results

Floristics

Fig. 2A, B shows a panoramic view around and inside of EARF. Table 2 gives an overview of the vascular plant species recorded in the EARF. A total of 185 plant species distributed over 143 genera and 54 families was recorded (Table 2). With this figure, EARF conserves 6.59% of the national flora over 560.14 hectares of a community land. Of these, Rubiaceae was the most speciose family (20 species), followed by Fabaceae (15), Malvaceae (13), Apocynaceae (12), Sapindaceae (8) and Annonaceae (7). Capparaceae, Celastraceae, Dioscoreaceae, Putranjivaceae, Violaceae

Figure 2. Panoramic view of Ewe-Adakplame Relict Forest A forest ecosystem in contact with Ewe village's (Olympus photo A. Houngnon 2014) B forest gap with Momordica charantia carpet (Samung photo A. Houngnon 2016).
Table 2. Vascular plants of Ewe-Adapklame relict forest in Benin with their binomial, family life-forms and Chorotypes [Life-forms are meg: megaphanerophyte (> 30 m tall), mes: mesophanerophyte (8–30 m), mph: microphanerophyte (2–8 m), nph: nanophanerophyte (0.5–2 m); Ch: chamaephyte, Hc: hemicryptophyte; Th: therophyte; G: geophyte (Gb: with bulb, Gr: with rhizome and Gt: with tuber); Ep: epiphyte and their climbing forms L: liana (Lmph, Lnph and Lmes, LGr, LHc) and chorotypes are GC: Guineo-Congolean, SG: Sudano/Guinean transition, GE: Lower Guinean, GO: Upper Guinean, TA: Tropical Africa, AM: Afro-Malagasy and Pan: Pantropical].

| Scientific name              | Life forms | Chorology types | Voucher specimens |
|------------------------------|------------|-----------------|-------------------|
| Acanthaceae                  |            |                 |                   |
| Rhinacanthus virens (Nees)   | Ch         | GC              | Houngnon 3860     |
| Milne. Readh. var. virens    |            |                 |                   |
| Amaranthaceae                |            |                 |                   |
| Gynandra prostrata (L.)      | Th         | Pan             | Houngnon 3538     |
| Blume                        |            |                 |                   |
| Amayllidaceae                |            |                 |                   |
| Scadoxus multiflorus (Martyn)| Gb         | TA              | Houngnon 6724     |
| Raf. subsp multiflorus       |            |                 |                   |
| Anacardiaceae                |            |                 |                   |
| Lannea nigritana (Sc. Elliot) | mes        | GO              | De Souza 1971 a   |
| Keay var. nigritana          |            |                 |                   |
| Spondias monbin L.           | mes        | Pan             | Maesen 7705       |
| Annonaceae                   |            |                 |                   |
| Artabotrys dahomensis Engl. & Diels. | Lmph | GE | Houngnon 97e |
| Artabotrys velutinus Sc. Elliot | Lmph | GC | Maesen 6612 |
| Monanthotaxis pareifolia (Oliv.) Verd. | Lmph | GE | Houngnon s.n. |
| Monodora terasunlata Benth. | mph | GC | Éq. Bot. 105d |
| Uvariodendron angustifolium (Engl. & Diels) R.E.Fr. | mph | GC | Houngnon 5571 |
| Uvariaopsis tripetala (Baker f.) G.E.Schatz Syn. | mph | GE | Akoégninou 2201 |
| Xylopia longipetala De Wild. & T. Durand | mph | GC | Houngnon 4524 |
| Apocynaceae                  |            |                 |                   |
| Alafia barteri Oliv.         | Lmph       | GC              | Chevalier 22841   |
| Ancylobotrys scandens (Schumach. & Thonn.) Pichon | Lmph | GC | Chevalier 23456 |
| Baissea zygodioides (K. Schum.) Stapf | Lmph | GC | Houngnon 118c |
| Cryptolepis nigrescens (Wennberg) L. Joubert & Bruyns Syn. | Lmph | GC | Le Têtu 297 |
| (Afreu) Bullock              |            |                 |                   |
| Holarrhena floribunda (G. Don) Dur. & Schinz | mph | TA | Houngnon 6574 |
| Hunteria umbellata (K. Schum.) Hall. f. Syn. H. eburnea Pichon | mph | GC | Aké Assi 20284 |
| Landolphia biruta (Hua) Pichon | mph | LG | Chevalier 23922 |
| Monodora latifolia (Benth.) K. Schum. | mph | TA | Akoégninou 5438 |
| Mondia whitei (Hook. f.) Skeels | mph | TA | Adjakidjé 3007 |
| Motandra guineensis (Thonn.) A. DC. | mph | TA | Adjahanhou 102 |
| Saba thompsonii (A. Chev.) Pichon | Lmes | GC | Chevalier 22967 |
| Secamone africas (Schultes) K. Schum. | Lmph | GC | Essou 3208 |
| Araceae                      |            |                 |                   |
| Anchomanes diffomnis (Blume) Engl. (Syn. A. welwitschii Rendle) | Gt | GC | Essou 1554 |
| Cercestis mirabilis (N. E. Br.) Bogner Syn. Rhekophyllum mirabile N.E.Br. | Ep | GE | Akoégninou 3299. |
| Aristolochiaceae             |            |                 |                   |
| Pararistolochia goldieana (Hook. f.) Hutch. & Dalz. | LGr | GC | Houngnon 4605 |
| Asparagaceae                 |            |                 |                   |
| Dracea arborea Bak           | mph        | GC              | Maesen 6340       |
| Asteraceae                   |            |                 |                   |
| Chromolaena odorata (L.) R. King & H. Robinson | mph | AM | Sokpon B14 |
| Gymnanthemum colonatum (Willd.) H. Rob. & B.Kahn | mph | SZ | Ayichédéhou 395 |
| Lagerra crispa (Vahl) Hepper & J. R. I. Wood. | Th | TA | Maesen 6746 |
| Bignoniaceae                 |            |                 |                   |
| Neuboldia lavisi (P. Beauv.) Seem. ex Bureau | mph | GC | Houngnon 3087 |
| Boraginaceae                 |            |                 |                   |
| Echvetia cymoou Thonn.       | mph        | GC              | Houngnon 5081     |
| Cannabaceae                  |            |                 |                   |
| Celtis mildbraedii Engl.     | mes        | GC              | Essou 1648        |
| Celtis philippensis Blanco Syn. C. brownii Rendle | mph | GC | Houngnon 2783 |
| Scientific name | Life forms | Chorology types | Voucher specimens |
|-----------------|------------|-----------------|------------------|
| *Celtis zenkeri* Engl. | meg | GC | Sokpon 852 |
| *Trema orientalis* Syn. *T. guineensis* | mph | GC | Houngnon 1714d |
| **Capparaceae** | | | |
| *Capparis brasii* DC. Syn. *C. thonningii* Schum. | Lnph | GC | Maesen 6701 |
| *Capparis erythrocarpos* Isert var. *erythrocarpos* | nph | GC | Esson 1087 |
| *Maerua duchesnei* (De Wild.) F. White Syn: *Ritchiea duchesnei* (De Wild.) Keay | mph | GC | Hougnnon 229a |
| *Ritchiea capparoides* (Andr.) Britten var. *capparoides* | nph | GE | Aki Assi 20288 |
| **Celastraceae** | | | |
| *Loeseneriella africana* (Willd.) N.Hallé var. *africana* Syn. *Hippocratea Africana* (Willd.) Loes. | Lnph | Pan | Hougnnon 6573 |
| *Ritchiea capparoides* (Andr.) Britten var. *capparoides* | nph | TA | Akoègninou 4291 |
| *Ritchiea erecta* Hook. f. Syn. *R. pentaphylla* Gilg & Bened. | nph | TA | Chevalier 22798b |
| **Connaraceae** | | | |
| *Connarhera insignis* (Vahl) Benth. f. | Lmph | Pan | Oumorou 740 |
| *Rourea coccinea* (Bak.) Jongkind syn. *Byrsocarpus coccineus* Thonn. & Schumach. | Lmph | GC | Hougnnon 453a |
| **Cucurbitaceae** | | | |
| *Calycobolus africanus* (G. Don) Heine | Lnph | GC | Adjikidjé 4111 |
| *Ipomea mauritiana* Hall. f. | Lmph | Pan | Oumorou 740 |
| **Cucurbitaceae** | | | |
| *Coccinia grandis* (L.) Voigt | Lnph | GC | De Souza & Paradis 444a |
| *Lagenaria breviflora* (Benth.) Roberty Syn. *Adenopus breviflorus* Benth. | Lmes | TA | Hougnon 443a, 1518a |
| *Luffa cylindrica* (L.) M. J. Roem | Lnph | TA | Chevalier 22798b |
| **Dichapetalaceae** | | | |
| *Dichapetalum madagascariense* Poir. Syn. *D. guineensis* (DC.) Keay | Lnph | GC | Hougnnon 1878a |
| *Tupaia fischeri* Engl. | mph | GC | Hougnnon 627b |
| **Ebenaceae** | | | |
| *Diospyros abyssinica* (Hiern) White | mes | GC | Hougnnon 627b |
| *Diospyros monbuttensis* Gürke | mph | GC | Hougnnon 629c |
| *Diospyros subrubra* F. White | nph | GC | Hougnnon 2824 |
| **Euphorbiaceae** | | | |
| *Erythrococca anomala* (Juss. ex Poir.) Prain | nph | GC | Hougnon 3345 |
| *Mallotus oppositifolius* (Geisel.) Müell. Arg. var. *oppositifolius* | nph | AM | Adjikidjé & Akoègninou 590c |
| *Tragia senegalensis* Müll. Arg. | Lnph | SG | Adjikidjé 2803 |
| **Fabaceae** | | | |
| *Caesalpinioideae* (Mimosoid clade) | | | |
| *Acacia pennata* (L.) Willd. | Lmph | TA | Essou 1672 |
| *Acacia polycantha* Willd. subsp. *Campylacantha* (Hochst. ex A. Rich.) Brenan | mes | SZ | Maesen 6703 |
| *Albizia adianthifolia* (Schum.) W. Wright var. *adianthifolia* | mes | GC | Adjikidjé 4163 |
| *Albizia glaberrima* (Schum. & Thom.) Benth. | mph | GC | Hougnon 6532 |
| *Albizia ferruginea* (Guill. & Perr.) Benth. | mes | GC | Paradis & Hougnon 933a |
| Scientific name                                      | Life forms | Chorology types | Voucher specimens |
|------------------------------------------------------|------------|-----------------|-------------------|
| Albizia zygia (DC.) J. F. Macbr.                     | mes        | GC              | Hougnon 936d      |
| Mezoneuron benthamianum (Baill.) Herend. & Zarucchi  | Lmph       | GC              | Paradis & Hougnon 277c |

**Detarioideae**

| Detarium senegalese J.F. Gmel.                      | mes        | GC              | Hougnon 268°      |

**Dialioideae**

| Dialium guineense Willd.                            | mes        | GC              | Spire 118         |

**Fabioideae/ Papilionoideae**

| Abrus precatorius L.                                | Lmph       | Pan             | Hougnon 1423g     |
| Dalbergia lactea Vatke                               | Lmph       | GE              | De Souza & Paradis 1239e |

| Dalbergia melanocylon Guill. Perr.                   | mph        | GC              | Adomou 167        |
| Desmodium salicifolium (Poir.) DC. var. salicifolium | nph        | GC              | Pauwels 57139     |
| Dolichos trilobus                                    | Lmph       | SZ              | Adomou 80         |
| Millettia thonningii (Schum. & Thonn.) Bak.         | mph        | GC              | Essou 1164        |

**Icacinaceae**

| Stachyanthus occidentalis (Keay & Miège) Boutique syn. Neostachyanthus occidentalis Keay & Miège | Lmph       | GO              | Essou 1102        |

**Lamiaceae**

| Clerodendrum capitatum (Willd.) Schum. & Thonn.      | Lmph       | GC              | Lisowski 0-929    |
| Hoslundia opposita Vahl                              | nph        | AM              | Pauwels 8286     |
| Premna quadrifolia Schum. & Thonn.                   | nph        | GO              | Sokpon 1068      |
| Vitex microantha Gürke*                               | mes        | GC              | Adomou s.n.       |

**Linaceae**

| Hugonia platygapa Welw. ex Oliv.                     | Lmph       | GO              | Paradis & Hougnon 831a |

**Loganiaceae**

| Strychnos barteri Soler.                             | Lmes       | GC              | Paradis & Hougnon 838a |
| Strychnos floribunda Gilg                            | Lmes       | GC              | Maesen 6821         |
| Strychnos nigeriana Bak.                              | Lmes       | GC              | Akoëgninou 3289     |
| Strychnos splendens Gilg                              | Lmes       | GC              | Hougnon 835b        |

**Malvaceae**

| Abutilon mauritianum (Jacq.) Medic.                  | Ch         | TA              | De Souza & Paradis 851a |
| Ceiba pentandra (L.) Gaertn.                         | meg        | Pan             | Hougnon 188a         |
| Hibiscus lamartifolius Willd.                        | Lmph       | Pan             | Adomou s.n.          |
| Hibiscus osuariensis P. Beauv.                       | nph        | GC              | Paradis et Hougnon 856a |

| Cola nilfenii K. Schum.                               | mph        | GC              | Hougnon 4399        |
| Glyphaea brevis (Spreng.) Monachino                   | mph        | GC              | Hougnon 2036°       |
| Grewia carpinifolia Juss.                             | mph        | GC              | Hougnon 1446f       |
| Mankonia altissima (A. Chev.) A. Chev. var. altissima*| mes        | GC              | Hougnon 1309a : 4322 |
| Neogordonia papaverifera (A. Chev.) syn N. kabangaensis (K.Schum.)* | mph        | GC              | Hougnon 1301a       |
| Octolobus spectabilis Welw. Syn. O. angustatus Hutch.* | nph        | GC              | Adomou s.n.         |
| Petrygoa macrocarpa K. Schum.*,                       | mph        | GC              | Hougnon 4321        |
| Sterculia tragacantha Lindl.                          | mes        | GC              | De Souza & Hougnon 188d |

| Triplochiton scleroxyylon K. Schum.                   | meg        | GC              | Chevalier 22819     |

**Melastomataceae**

| Memecylon afzelii G. Don var. afzelii                | Lmph       | GC              | Hougnon 897c        |
| Warneckea memecyloides (Benth.) Jac. Fel Syn. Memecylon memecyloides (Benth) | Lmph       | GC              | De Souza & Paradis 900a |

**Meliaceae**

| Trichilia prieureana A. Juss. subsp. prieureana       | mph        | GC              | Adomou 90           |

**Menispermaceae**

| Dioscoreophyllum cumminsi (Stapf) Diels              | Lmph       | GC              | Hougnon 919a        |
| Rhigiaora racemifera Miers                          | Lmph       | GC              | Maesen 6820        |
| Tilavera funifera (Miers) Oliv.                      | Lmph       | GC              | De Souza 92li       |
| Triclisia subcordata Oliv.                           | Lmph       | GC              | Sokpon 31          |
| Family       | Scientific name                     | Life forms | Chorology types | Voucher specimens |
|--------------|-------------------------------------|------------|-----------------|-------------------|
| **Moraceae** | *Antiaris toxicaria* Lesch.          | meg        | GC              | Essou 1547        |
|              | *Ficus recurvata* De Wild. Syn. *Ficus goliath* A. Chev. | mes        | GC              | Adomou s.n.       |
|              | *Ficus ovata* Vahl.                 | Ep         | GC              | Adomou s.n.       |
|              | *Milicia excelsa* (Welw.) Berg Syn. *Chlorophora excelsa* (Welw.) benth. | meg        | GC              | Chevalier 23169   |
| **Oleaceae** | *Olax subscorpioidea* Oliv. var. *subscorpioidea* | mph        | GC              | Hougnnon 7652     |
| **Opiliaceae** | *Opilia amentacea* Roxb. Syn. *O. celtidifolia* (Guill. & Perr) Endl. | Lmph       | SZ              | Adjakidjè 1477    |
| **Pandaceae** | *Microdenis keayana* J. Léonard, syn. *M. puberula* Hook. f. | mph        | GC              | Adomou s.n.       |
|              | *Adenia cynanchifolia* (Benth.) Harms | Lmph       | GE              | Adomou s.n.       |
|              | *Adenia lobata* (Jacq.) Engl.       | Lmph       | GC              | Essou 1637        |
| **Phytolaccaceae** | *Hilleria latifolia* (Lam.) H. Wält. | Th         | AM              | Mission ACCT/Bénin 2165 |
| **Olacaceae** | *Olax subscorpioidea* Oliv. var. *subscorpioidea* | mph        | GC              | Hougnnon 720c     |
|              | *Olyra latifolia* L.                 | nph        | GC              | Hougnnon 720c     |
|              | *Oplismenus hirtellus* (L.) P. Beauv. subsp. *Hirtellus* | Ch         | SG              | De Souza & Paradis 722a |
| **Passifloraceae** | *Streptogyna crinita* P. Beauv. | Gr         | GC              | Hougnnon 765b     |
| **Polygalaceae** | *Carpolobia lutea* G. Don | mph        | GC              | Maesen 6617       |
| **Putranjivaceae** | *Drypetes afranenuis* Hutch.* | mph        | GO              | Adomou s.n.       |
|              | *Drypetes afzelii* (Pax) Hutch.*    | mes        | GO              | Hougnnon 177 la    |
|              | *Drypetes floribunda* (Müll. Arg.) Hutch. | mph        | GC              | Hougnnon 4266     |
|              | *Drypetes gilgiana* (Pax) Pax & Hoffm.* | nph        | GC              | Akøëgninou 2196   |
|              | *Drypetes leonensis* Pax,* | mes        | GC              | Hougnnon 1771b    |
| **Rhamnaceae** | *Lasiodiscus mannii* Hook. f.       | mph        | GC              | Hougnnon 1329b    |
| **Rubiaceae** | *Aidia genipiflora* (DC.) Dandy     | mph        | GC              | Maesen 6611       |
|              | *Chandra kelly* (Schumach.) Hepper  | nph        | GC              | Maesen 6358       |
|              | *Coffea ebracteolata* (Hiern) Brenan | Lmph       | GC              | Lejoly&Ganglo 2    |
|              | *Cremaspora triflora* (Thonn.) K. Schum. | Lmph       | GC              | Maesen 6284       |
|              | *Leptactina involucrata* Hook. f.   | Lmph       | GC              | Adomou s.n.       |
|              | *Gardenia nitida* Hook.             | nph        | GC              | Adomou 73         |
|              | *Hymenodictyon floribundum* (Steuad. & Hochst.) B.L.Rob. | mes        | GC              | Sinsin 2863       |
|              | *Keetia hispida* (Benth.) Bridson   | Lmph       | GC              | Adomou s.n.       |
|              | *Morinda lucida* Benth.             | mph        | Pan             | Maesen 6651       |
|              | *Oxanthus pallidus* Hiern            | nph        | GC              | Adomou s.n.       |
|              | *Oxanthus speciosus* DC. subsp. speciosus | nph        | GC              | Essou 2496        |
|              | *Pavetta corymbosa* (DC.) F. N. Williams | mph        | SG              | Sokpon 1884       |
|              | *Poucheia africana* DC.             | nph        | GC              | Hougnnon 6659     |
|              | *Psydrax horizontalis* (K. Schwum. & Thonn.) Bridson | Lmph       | SG              | Maesen 6710       |
|              | *Psydrax parviflora* (Afzel.) Bridson | Lmph       | GO              | Maesen 6287       |
|              | *Rothmannia longiflora* Salisb       | mph        | GC              | Le Tesla 101      |
|              | *Rothmannia urcelliformis* (Hiern) Bullock ex Robyns | Lmph       | GC              | Dansi TW 50799    |
|              | *Rythygynia canthioides* (Benth.) Robyns | mph        | GC               | Adomou s.n.       |
| **Rutaceae** | *Vangueriopsis nigera* (Robyns) Verdc. Syn. *Vangueriopsis nigera* Robyns | mph        | SZ               | Maesen 6315       |
|              | *Vangueriopsis spinosa* (Schumach.&Thonn.)Verdc. Syn. *Vangueriopsis spinosa* Hepper | mph        | SZ               | Adomou 32         |
|              | *Zanthoxylum leprieurii* Guilli. & Perr. Syn. *Fagara angolensis* Engl. | mph        | GC              | Hougnnon 535a     |
|              | *Zanthoxylum zanthoxyloides* (Lam.) Zepernick & Timber | mph        | SG              | Essou 2396        |


| Scientific name                                      | Life forms | Chorology types | Voucher specimens                |
|------------------------------------------------------|------------|-----------------|----------------------------------|
| **Salicaceae**                                       |            |                 |                                  |
| Dovyalis zenkeri Gilg. (+) Syn. D. afieldii Gilg. (+) | nph        | GO              | Hougnon 1364a                    |
| Flacourtia indica (Burm. f.) Merr. Syn. Flacourtia flavecens Willd. | mph        | GC              | Hougnon 6006                     |
| **Sapindaceae**                                      |            |                 |                                  |
| Allophylus africanus P. Beauv.                       | mph        | GC              | Hougnon 4037                     |
| Allophylus spicatus (Poir.) Radlk.                   | mph        | GC              | Hougnon 4037                     |
| Blighia sapida Koenig                                | mph        | Pan             | Hougnon 5472                     |
| Blighia unijugata Bak.                               | mph        | GC              | Paradis & Hougnon 1693d          |
| Deinbollia pinnata (Poir.) Schumach. & Thonn.        | nph        | GC              | Maesen 6397                      |
| Lecaniodiscus cupanioides Planch.                    | mph        | GC              | Maesen 6310                      |
| Majidea forsteri (Sprague) Radlk.                    | meg        | GC              | Hougnon 1254a                    |
| Pancovia bijuga Willd.                               | mph        | GC              | Hougnon 4978                     |
| **Sapotaceae**                                       |            |                 |                                  |
| Chrysophyllum welwitschii Engl.* (+)                 | Lmph       | GC              | Adomou s.n.                      |
| Englerophytum oblancoelatum (S.Moore) T.D.Penn. syn. Bequaertiodendron oblancoelatum* (S.Moore) Heine & J. H. Hemsl. | mph        | TA              | Maesen 6154                      |
| Pouteria alnifolia (Baker) Roberty Syn. Malacantha alnifolia (Baker) | mph        | GC              | Sokpon 1915                      |
| **Smilacaceae**                                      |            |                 |                                  |
| Smilax anceps Willd.Syn. S. kraussiana Meissner      | LGr        | TA              | Chevalier 24225                  |
| **Solanaceae**                                       |            |                 |                                  |
| Solanum terminale Forssk. Subsp inconstans (C.H. Wright) Heine | Lmph       | GC              | Yédomonhan 173                   |
| **Ulmaceae**                                         |            |                 |                                  |
| Chaetachme aristata Planch.                         | mph        | GC              | Hougnon 1784c                    |
| **Violaceae**                                        |            |                 |                                  |
| Rinorea batesii Chipp, Kew Bull. 293 (1923).         | nph        | GC              | Adomou 83                        |
| Rinorea brachypetala (Türrcz.) Kuntze                | nph        | GC              | Adomou s.n.                      |
| Rinorea dentata (P.Beauv.) Kuntze                    | mph        | GC              | Hougnon                          |
| Rinorea ilicifolia (Welw. ex Oliv.) Kuntze *        | nph        | GC              | Adomou 109                       |
| Rinorea kibbiensis Chipp.                            | nph        | GC              | Paradis & Hougnon 1347a          |
| **Vitaceae**                                         |            |                 |                                  |
| Cissus glaucophylla Hook. f.                        | Lmph       | GC              | Adomou s.n.                      |
| Cissus petiolata Hook. f.                           | Lmph       | GC              | Adjakidjé 2976                   |
| Cissus populnea Guill. & Perr. var. populnea        | LHe        | SZ              | Hougnon 68d                      |
| Cissus quadrangularis L.                             | Lmph       | SZ              | Hougnon 5105                     |

*: Plant species restricted to Ewe Adakplame Relict Forest (+): Non recorded

were each represented by five species. Among the 185 vascular plants of EARF 12% of the families (22) were represented by one species each. The genera Dioscorea, Drypetes and Rinorea, are represented by five species followed by genera Albizia, Cissus, Strychnos (4 species each) and Celtis and Diospyros (3 species each). EARF also provides habitat for Chrysophyllum welwitschii, (Not mentioned in the Flora), Cissus glaucophylla (Not mentioned in the Flora), Drypetes aframensis, (Not mentioned in the Flora), Drypetes afzelii, Drypetes gigiana, Drypetes leonensis, Englerophytum oblancoelatum, Mansonia altissima, Nesogordonia papaverifera, Octolobus spectabilis, (Not mentioned in the Flora), Rinorea batesii, Rinorea brachypetala (Not mentioned in the Flora), Rinorea dentata, Rinorea ilicifolia, Rinorea kibbiensis, Vitex micrantha), (Not mentioned in the Flora) which appear to be confined to EARF that can be seen as the single location of their occurrence in Benin. Table 2 also describes the community data set using family, binomial, life-forms and Chorotypes. Some of these plant species are featured in Fig. 3A–K.
Figure 3. Common species of Ewe-Adakplame Relict Forest

A Drypetes gilgiana (Photo of Alfred Houngnon 2017)

B Triplochiton scleroxylon (Samsung photo A. Houngnon 2017)

C Englerophytum ob lanceolatum (Olympus photo A. Houngnon 2014)

D Mansonia altissima (Olympus photo A. Houngnon 2014)

E Uvariopsis tripetala

F Ceiba pentandra (Olympus photo A. Houngnon 2014)

G Anchomanes welwitschii (Samsung photo A. Houngnon 2015)

H Abrus precatorius (Samsung photo A. Houngnon 2016)

I Vitex micrantha (Samsung photo A. Houngnon 2016)

J Momordica charantia (Samsung photo A. Houngnon 2016)

K Dioscoreophyllum cumminssii (photo A. Adomou 2011).
Life form spectrum

The most common life forms were phanerophytes (88%), containing 3% of mega phanerophytes (meg), mesophanerophytes (mes), microphanerophytes (mph), nanophanerophytes (nph), Geophytes: Gb: with bulb, Gr: with rhizome and Gt: with tuber Ch: Chamaephytes, Th: Therophytes, Ep: Epiphytes, Hc: Hemicryptophytes. Climbing forms are L: Lianas (mph, nph and mes, Gr, Hc).

Chorology of Ewe-Adakplame relict forest

The most representative chorotypes (Fig. 5) included Guineo-Congolean species (66%), followed by 14% of wide distribution species including Tropical Africa (TA) and Pantropical (Pan) plant species. Upper Guinea species included plants such as *Uvarioptis tripetala* Syn. *Dennettia tripetala* (Annonaceae), *Drypetes aframensis* (Putranjivaceae tribe Drypeteae), *Stachyanthus occidentalis* Syn.
Neostachyanthus occidentalis (Icacinaceae), Lannea nigritana var. nigritana (Anacardiaceae), Psydrax parviflora (Rubiaceae), Premna quadrifolia (Lamiaceae), Cnestis corniculata (Connaraceae). Monanthotaxis parvifolia (Anonaceae), Artabotrys dahomensis (Anonaceae), Dalbergia lactea (Fabaceae – Faboideae), Ritchiea erecta Syn. R. pentaphylla (Capparaceae) and Cercestis mirabilis Syn. Rhektophyllum mirabile (Araceae) are among Lower Guinea species.

Species richness estimations

The counted number of plant species for the EARF was 185. This corresponds to the species richness (S) or the number of species that has been recorded from plot sampling and listed in Table 2. The species richness estimations as per Bootstrap, Chao, Jacknife1 and Jacknife2 were respectively 200.52 ± 9.2808; 217.62 ± 14.5972, 224.16 ± 15.3725 and 242.67. We can see that the species richness estimates differ strongly giving a range of 200.52–242.67 species. The species accumulation curves in Fig. 6 show that they were hardly tending towards the asymptote and are still climbing at the right-hand end signifying that the sampling effort was insufficient. This suggests that the sampling has not captured nearly all the species in EARF and that many species were missed (on average approximately 16 species (± 9.2808) for Bootstrap, 33 species (± 14.5972) for Chao, 39 species (± 15.3725) for Jacknife1 and 58 species for Jacknife2.)

Figure 5. Chorological spectrum of the Ewe-Adakplame Relict Forest. GC: Guineo-Congolean, SG: Sudano/Guinean transition, GE: Lower Guinean, GO: Upper Guinean, TA: Tropical Africa, AM: Afro-Malagasy and Pan: Pantropical.
Discussion

The Ewe-Adakplame Relict Forest corresponds to the semi-deciduous forest type, which was described in Benin as the only Drypetes aframensis-Nesogordonia papaverifera community (Adomou et al. 2009). Guineo-Congolean species are abundant (66%) although the EARF is located in a matrix of savanna-dominated vegetation. Guineo-Congolean species accounted for 33% in riparian forests of Benin (Natta 2003), 61.7% in gallery forests of the Hippopotamus Pond Biosphere Reserve at Burkina Faso (Bélem and Guinko 1998), and 70 to 75% in gallery forests at Lamto (southern Côte d’Ivoire) (Devineau 1975). The overall plant species composition makes EARF floristically comparable to the moist semi-deciduous forest of Nigeria (Lower Guinea) (Richards 1939) and the Celtis spp.-Mansonia altissima community of Côte d’Ivoire (Upper Guinea) (Guillaumet and Adjanohoun 1971). Guillaumet and Adjanohoun (1971) also pointed out that the dominance of Cannabaceae (previously Ulmaceae) and Malvaceae (previously Sterculiaceae) in the Upper and Lower Guinea forests offers evidence that West African semi-deciduous forests are at climatic climax. These indicator families were also reported as characteristics of the semi-deciduous forests in Ghana (Vooren and Sayer 1992) and Côte d’Ivoire (Swaine 1996) within the Upper Guinea zone. This high proportion of Guineo-Congolean species shows the floristic uniqueness of EARF and highlights its great importance in Benin which landscape is savanna dominated.

Unlike Palmer (1990) who showed that Jack 1 is the most precise and least biased, it is rather the Bootstrap estimator (200.52 ± 9.2808) that seems to be closer to our field results (S = 185 species). The Bootstrap value is also close to estimates of Adomou et al. (2010) who assessed the specific richness of EARF around 200 species. This is what justifies the calculation of the four estimation methods (Chao, first order jackknife, second order jackknife and bootstrap) and not only one as Palmer (1990) would have demonstrated. In our study, the species accumulation curves were calculated with estimators (Chao, Jack 1, Jack 2 and Bootstrap) and showed a change in species richness without flatten off at the right hand. The Bootstrap appears to be the best estimator which is closest to EARF plant richness estimated by Adomou et al. (2010). The Fig. 6 show that species accumulation curves were hardly tending towards the asymptote and are still climbing at the right hand end signifying that the sampling effort was insufficient. This suggests that the sampling did not capture all the species in EARF. The shape of the species accumulation curves should plateau for large numbers of sites sampled. However, the number of observed species will typically be smaller than the true number of species. Since species richness depends on sample size, we can expect that we will not have recorded all the species that occur in the survey area. So, the Species accumulation curves were used to ascertain range in values obtained with the different methods and we can expect that the correct total richness lies somewhere within that range. Many species will always remain unseen or undetected in a
collection of sample plots. It is like the case of *Chrysophyllum welwitschii* (Sapotaceae) and *Drypetes aframensis* which, although reported in EARF (Adomou 2005), has not been recorded since 2014. *Drypetes aframensis* (Salicaceae) is also not mentioned in the Benin Flora. From a physiognomic point of view, it is important to underline that it is sometimes extremely difficult to survey some areas because of the thickness of the vegetation which can be very inaccessible. Other places are severely affected by human presence leading to very sparse vegetation or gap areas in the heart of the forest with completely isolated forest tree species. This is also the case of the periphery cleared by human boundaries encroachment and so many activities often carried out illegally. These constraints have often influenced the layout and the number of sampled sites. This also proves that despite the botanical sampling effort of Benin (Sosef et al. 2017), some priority species for conservation have either not yet been collected or reported and therefore could be omitted.

The connection of EARF with the West African forests blocks located on both side of the Dahomey Gap is emphasized here by the high proportion of Guineo-Congolean species recorded (66%). The high rate of phanerophytes and their phytochories testifies to the floristic originality of EARF in a crop and savanna dominated landscape. This justifies the physiognomic and floristic links of EARF with the two Guinean and Congolia forest blocks and substantiates the hypothesis that EARF is a remnant of the

| Number of observation (N) | Richness observed (S) | Chao | Chao.se | Jack1 | Jack1.se | Jack2 | Boot | Boot.se |
|--------------------------|----------------------|------|---------|-------|----------|-------|------|---------|
| 25                       | 185                  | 217.62 | 14.5972 | 224.16 | 15.3725 | 242.67 | 200.52 | 9.2808 |

**Figure 6.** Species richness and richness estimations (Chao, first order jackknife, second order jackknife and bootstrap) (y-axis) in relation to sample size (x-axis) at the Ewe-Adakplame relict forest.
dense forests which were once a continuous block from west to central Africa as demonstrated by numerous palynological studies (Tossou 2002; Salzmann and Hoelzmann 2005) and also phylogeography (Demenou et al. 2016). The floristic link of the EARF with the West African semi-deciduous forest is also best highlighted by the high representation of many Upper Guinean endemic species belonging to the families of Cannabaceae (*Celtis mildbraedii*, *C. zenkeri* and *C. prantlii*), Malvaceae (*Triplanchton scleroxylon*, *Nesogordonia papaverifera*, *Mansonia altissima*, *Pterygota macrocarpa*, *Octobolus spectabilis* and *Sterculia tragacantha*), and Putranjivaceae (*Drypetes floribunda*, *D. gigiana* and *D. aframensis*). This record provides strong evidence for past floristic connections with the West African rain forest zone which is consistent with paleovegetation reconstructions indicating that the tropical African rain forest formed a single block during the Holocene Humid Period (c. 9000–4500 yr BP) (Tossou 2002; Salzmann and Hoelzmann 2005; Demenou et al. 2018). Furthermore, the richness of EARF in *Rinorea* species (*R. batesii*, *R. brachypetala*, *R. dentata*, *R. kibbiensis* and *R. ilicifolia*) and their abundance are unique in the country. According to Akoègninou et al. (2006), *Rinorea batesii* Chipp, *Rinorea ilicifolia* (Welw. Ex OIiv.) Kunze, *Rinorea dentata* are common in West, Central and East Africa and some of them in Madagascar. In Benin most of them are rare and are only found in EARF. *Rinorea brachypetala*, although it has been reported by Adomou (2005), was not mentioned in the National Flora (Akoègninou et al. 2006). *Rinorea* species are described as good indicators for West African semi-deciduous forests in a climax state (Achoundong 2000). The strong representation of *Rinorea* spp., the Cannabaceae (previously Ulmaceae) and the Malvaceae (previously Sterculiaceae) substantiate the view of Guillaumet and Adjanohoun (1971), who considered this forest type as the climatic climax or primeval type of semi-deciduous forest in West Africa. With this floristic composition, EARF can be seen as a unique West African rain forest refuge in a matrix of savanna-dominated vegetation in Benin.

In contrast, the surrounding vegetation at the immediate edge of EARF is composed of savanna species (Fig. 7A–J) from the Guineo-Sudanian transition zone such as: *Adansonia digitata* L. (Malvaceae), *Stereospermum kunthianum* Cham. (Bigoniaceae), *Trichilia emetica* Vahl (Meliaceae), *Annona senegalensis* Pers. (Annonaceae), *Vitex doniana* Sweet (Lamiaceae), *Parkia biglobosa* (Jacq.) R.Br. ex G. Don (Fabaceae-Caesalpinioideae (mimosoid clade)), *Dickostachys cinerea* (L.) Wight & Arn. (Fabaceae- Caesalpinioideae (mimosoid clade)), *Pterocarpus erinacea* Poir. (Fabaceae-Faboideae), *Pericopsis laxiflora* (Benth.) Meeuwen (Fabaceae-Faboideae), *Daniellia oliveri* (Rolfe) Hutch. & Dalziel (Fabaceae-Detarioideae), *Sarcocephalus latifolius* (Sm.) E.A. Bruce (Rubiaceae) and *Andropogon gayanus* Kunth (Poaceae). The landscape is characterized by two basin ecosystems with clear dissimilarity combining forest/savanna and crop areas in stable equilibrium (Figs 8A, B). This makes EARF a special site of rich biodiversity and emphasizes the vital role the forest plays as a corridor of transition conducive to resilience and the flow of genes for ecosystem equilibrium.
Figure 7. Species collected in the surrounding zone of Ewe-Adakplame Relict Forest A *Adansonia digitata* (Samsung photo A. Houngnon 2015) B *Pericopsis laxiflora* (Samsung photo A. Houngnon 2016) C *Trichilia emetic* (Samsung photo A. Houngnon 2016) D *Annona senegalensis* (Olympus photo A. Houngnon 2014) E *Vitex doniana* (Samsung photo A. Houngnon 2016) F *Parkia biglobosa* (Samsung photo A. Houngnon 2016) G *Dichrostachys cinerea* (Samsung photo A. Houngnon 2016) H *Pterocarpus erinaceus* (Samsung photo A. Houngnon 2016) I *Daniellia oliveri* (Samsung photo A. Houngnon 2016) and J *Andropogon gayanus* (Samsung photo A. Houngnon 2017).

In total, we counted thirteen species restricted to one site in EARF. This is higher than the nine species previously reported by Adomou et al. (2010) in the EARF. Our record represents 15.4% of species with high conservation priority, thus describing
EARF as being one of the richest sites in range-restricted plant species of Benin. This increase in range-restricted species can be explained by the fact that species with a high scarcity index are vulnerable and could disappear if biodiversity sanctuaries that protect them disappear (Juhé-Beaulaton 2010). Indeed, during the last three decades in Benin, some forests areas have been cleared with an annual degradation rate of 70,000 hectares per year (PNF Bénin 2004). This habitat loss has considerably narrowed the survival places where rare species were previously recorded.

Some of these species found in the single location of EARF within Benin (e.g., Acroceras gabunense, Chrysophyllum welwitschii, Dovyalis afzelii, Drypetes aframensis, Drypetes gigiana, Englerophytum ob lanceolatum, Mansonia altissima, Nesogordonia papaverifera, Octolobus spectabilis, Pterygota macrocarpa, Rinorea ilicifolia, Rinorea kibbiensis, and Vitex micrantha) may gain more attention in the National Red List (Neuenschwander et al. 2011). Among them, there are many globally threatened species as the case of Nesogordonia papaverifera and Mansonia altissima, respectively reported as vulnerable (VU) and endangered (EN) by IUCN (2002) and later, were both assessed in Benin as critically endangered (CR) by Adomou et al. (2010) who considered EARF as sites with high concentration of threatened plant species in Benin. Moreover, the impact of harvesting on the survival of the most endangered species has been long ignored while many of them are not domesticated and many species uncharacterized. The case of Mansonia altissima is of urgent concern because its population is almost completely depleted, since it is locally used for roofing poles. Englerophytum ob lanceolatum (Sapotaceae), which is not listed on the National Red List of Benin also tends to be concentrated in EARF (Houngnon 2014). Unfortunately, most of Benin Forest is still under severe threat due to expansion of towns, agricultural and fallow (Oloukoï et al. 2007) that are narrowing the natural habitat and leading to a massive loss of many of the local biodiversity taxa. To this end, since 2014, we have been trying to raise awareness among local communities from the villages of Ewe and Adakplame through participative action toward nursery establishment (Houngnon 2014) and vegetative propagation of native tree (Houngnon 2015) in order to rehabilitate the degraded lands and areas that could potentially be sensitive for the EARF durability.
Conclusion

The importance of the flora of EARF testifies to its role in conserving forest biodiversity in the Dahomey gap corridor. This justifies its peculiarity and the relevance of this baseline vegetation information that could be used as complete range taxa that may allow us to test the forest refuge hypothesis against alternative speciation models across ecological gradients. As it happens, the management of the forest of this type, also raises the question of deepening interactions linking human environment in order to better understand the actual role that humans would have played in shaping ecosystems in the Dahomey gap since millennia. So, it would be interesting to understand the interplay between locals and EARF in order to explain its persistence in this savanna dominated landscape. Therefore, the actions to be considered following this checklist of EARF must take into account the community’s engagement in rehabilitating the degraded lands inside and around EARF.

Acknowledgements

We are grateful to the Rufford Foundation for financial field assistance and the University of Amsterdam for the publication fees. We thank especially François Romazzotti and Professeur Angel Argiles for their assistance and the local communities of Ewe and Adakplame villages for their collaboration. The authors thank David Goyder, Kolawolé V. Salako and Thomas Couvreur for their contribution and their constructive comments that improved substantially the quality of this paper.

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