Triplochiton scleroxylon K. Schum (Malvaceae-Sterculioideae): a key species of the *Oro* worship in Benin

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Research

Background: The African whitewood (*Triplochiton scleroxylon*), is a sacred and revered species in the tradition of the *Oro* cult in Benin. The species' natural stands are in decline and are confined to sacred forests owned by *Oro* secret societies. Information on its cultural uses and significance in the tradition of the *Oro* cult is however, poorly documented. The objective of this study is to assess the cultural keystone status of the species in the tradition of *Oro* worship in Benin.

Method: One hundred and twenty-five members of the secret society of the cult were investigated on the names and meanings of all the species used in this tradition. Six (06) identification indices of key cultural species were used for this purpose: the importance and use value of the species, their value as an additional source of income, their psycho-socio-cultural function, their ethno-taxonomic diversity and their degree of irreplaceability. Cultural keystone status scores were estimated and various statistical tests were performed to examine their variation and correlation with the calculated indices.

Results: Ten specific uses of the African whitewood were reported; of which the top three were all of spiritual and ritual importance. Key cultural species indicators showed a high value of *T. scleroxylon* for the tradition of "*Oro*" worship in Benin.

Conclusion: Triplochiton scleroxylon is a cultural keystone species for the *Oro* cult in Benin. It would be interesting to examine the potential impact of the decline of this species on the identity and stability of the *Oro* cult.

Keywords: African whitewood tree, key cultural species, bio cultural diversity, Benin.

Resumé

Contexte et objectif. Le Samba (*Triplochiton scleroxylon*), est une espèce sacrée et vénérée dans la tradition du culte *Oro* au Bénin. Les peuplements naturels de l'espèce sont en déclin et se réduisent de plus en plus aux forêts sacrées du culte *Oro*. Les informations sur ses usages et son importance culturels dans la tradition du culte *Oro* sont toutefois peu documentées. L'objectif de cette étude est d'évaluer le statut de clé de voûte cultuel de l'espèce dans la tradition du culte *Oro* au Bénin.

Méthode: Cent vingt-cinq membres de la société secrète du culte ont été enquêtés sur les noms et significations de toutes les essences utilisées dans cette tradition. Six (06) indices d'identification d'espèces culturelles clés ont été utilisés à cet effet. Il s'agit de : l'importance et la valeur d'usage des espèces, leur valeur en tant que source

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additionnelle de revenu, leur fonction psycho-socio-culturelle, leur diversité ethno-taxonomique et leur degré d'irremplaçabilité. Les scores du statut clé de voûte culturelle ont été estimés et divers tests statistiques ont été réalisés pour examiner leur variation et corrélation avec les indices calculés.

Résultats: Les indicateurs d'espèce culturelle clé ont montré dans le contexte culturel actuel et historique du Bénin, de fortes valeurs de *T. scleroxylon* pour la tradition du culte « *Oro* ».

Conclusio: Triplochiton scleroxylon est une clé de voûte culturelle du culte *Oro* au Bénin. Il serait intéressant d'examiner l'impact potentiel du déclin de cette espèce sur l'identité, la stabilité, et la perpétuité du culte *Oro*.

Mots clés: Samba, espèce culturelle clé, diversité bioculturelle, Bénin.

Background

The wide savannah corridor that reaches the coast of southern Ghana, Benin, and Togo, separates the African rainforest into two blocks: the Central African block and the West African block. This corridor is called Dahomey Gap and, in these areas, savannahs extend to the coast of the Gulf of Guinea. This area is characterized by low rainfall and while in the West African rainforest over 2000 mm of rainfall per year fall, only 1200-1000 mm per year fall in this in this corridor (Salzmann & Hoelzmann, 2005). However, the presence of isolated stands of rainforest, most of which are sacred forests (Akoègninou 1998), proves that climate is not the only factor in the existence of this corridor. The existence of the Dahomey Gap can be attributed to two main factors: climate on the one hand and anthropogenic influence on the other. In the face of continuously growing anthropogenic pressure and agricultural practices that challenge the ecosystem balance in this corridor, sacred forests constitute important remaining fragments of forests (Kokou & Sokpon 2006). Indeed, sacred forests have existed for a very long time in Africa (Koukou & Sokpon, 2006). These are patches of forest in which there are remnants of an ancient continuous forest along the entire West African coast (Fairhead & Leach, 1998). They are numerous small vegetation formations ranging from a few acres to 40 hectares in size, essentially sacred and variable in socio-cultural, political, physiognomic, ethnic, and geomantic terms (Kokou & Sokpon, 2006). The exceptional cultural diversity due to the multiplicity of ceremonies and rituals practiced in these ecosystems is fundamentally important for the cultural identity of the populations of these countries (Kokou & Sokpon, 2006). These ecosystems represent places of residence of the ancestors and protective gods of local communities. In Benin, there are sacred forests that cover a significant area. These sacred forests play a considerable socio-cultural and ecological role, sometimes sheltering species or water sources on which the existence of an entire deity or ancestral tradition depends. Local communities therefore establish rules, which vary from region to region, including a ban on the uncontrolled harvesting of firewood and plant organs for medicinal purposes (although these rules allow for the exploitation of firewood and medicinal plants). This mitigates overexploitation of natural resources and preserves sites and their biodiversity over generations (Ceperley *et al.* 2010). The work of Kokou & Sokpon, (2006) has shown that the erosion of cults or traditions could diminish the conservation value of sacred forests and thus of West African biodiversity.

Although many life forms contribute in a way to human survival, some species have more direct relevance to humans and are of prime importance in their cultures (Garibaldi & Turner 2004). These are the key cultural species. These species play special roles in communities as part of cultural support, food, shelter, fuel, and medicine suppliers; and thus, benefit from conservation efforts in traditional systems (Christancho & Vining 2004; Garibaldi & Turner 2004; McCarthy *et al.* 2014;). Culturally important species can shape the cultural identity of a particular socio-cultural group in major ways (Garibaldi & Turner 2004). Such species reunite conservation/restoration and cultural concerns and result in an upward spiral of increasing effectiveness in maintaining and restoring human and ecosystem health. So, researchers must turn their attention to the evaluation of the cultural keystone status of plant and animal species. The identification and appreciation of the complex relationships of cultural keystone species with each other and with their habitats can contribute to conservation, domestication, and ecosystem restoration efforts (Cristancho & Vining 2004; Garibaldi & Turner, 2004). Since communities that identify with cultural keystone species develop a strong desire to conserve them (Garibaldi & Turner, 2004), their identification should serve as the basis for any effort to preserve and restore biocultural or socio-ecological systems (Cristancho & Vining 2004; Garibaldi & Turner, 2004; Sujarwo *et al.* 2019; Coe & Gaoue 2020a).The identification of key species in each community's culture can therefore be very useful for conservation and domestication programs. One of the main benefits of the identification of cultural keystone species is that they provide an effective starting point for the conservation and restoration of socio-ecological systems (Cristancho & Vining 2004; Garibaldi & Turner 2004).

Several researchers have defined cultural keystone species based on qualitative data (Christancho & Vining 2004; McCarthy *et al.* 2014). As for ecological keystone species, their identification has been proved difficult. Christancho & Vining (2004), argue that a species can have the status of cultural keystone species when it fulfills most of the following criteria: the history of its origin is linked to myths, ancestors or the origin of culture, it is at the heart of the transmission of knowledge, it is essential in rituals on which the stability of the community depends, it is used to meet the basic community needs such as food, shelters, curing diseases, it has significant spiritual or religious value, it physically exists in or near the territory of the cultural group and the cultural group designates the species as one of the most important species. However, based on their qualitative and complex nature, cultural keystone species can be identified using a quantitative method based on six indicators of cultural influence: the physical presence of the species; the type, intensity and multiplicity of its use; the ethno-taxonomic diversity of the species' names in the community; the psycho-social function (i.e., the role of the species in the stories, ceremonies or symbolism of the socio-cultural group, the persistence and memory of the species' use in relation to cultural change); the level of uniqueness position of the species in the culture (difficult to substitute with other available native species) and the extent to which it provides opportunities from outside the territory (Garibaldi & Turner 2004). It is unclear what these approaches can achieve in terms of reproducibility, global syntheses, and application in Conservation Biology. Nevertheless, the work of Coe & Gaoué (2020a; 2020b) has proposed a quantitative approach that integrates all the species used by a community and ultimately identifies the cultural keystone species of that community. Still, thoughts, beliefs, myths, and institutions made manifest by the myriad of African culture and tradition are particular. A cult or deity may be intimately linked to a single species in such a way that the species becomes the essence of the deity and thus the tradition. Besides, because there is no prior study on the cultural keystone status of species in Africa, the approach developed did not consider the African ethnosphere. However, given the objectivity of the approach used by Coe & Gaoué (2020b), it can be adapted to assess the keystone status of the sacred and venerated species, in Africa. The African whitewood, Sambawawa or Samba (*Triplochiton scleroxylon*; Sterculioideae) is among the most revered sacred species in Benin (Kokou & Sokpon 2006). It is used to make monoxylean dugouts, carved objects, mortars, and drums. A sacred tree of the "*Oro*" of the Nagot-yoruba in southern Benin (Palla & Louppe 2002; Kokou & Sokpon 2006; Adomou et al. 2011), its' distribution area is increasingly being confined to the sacred forests of *Oro*. *Oro* is a god of ancestral spirits among the *Nagot-Yoruba* ethnolinguistic groups of Benin and Nigeria (Akanji & Dada 2012). They are dead spirits that wander in the air and must be appeased by certain sacrifices. *Oro* is a source of power and authority. It is an institution that performs political, judicial, and religious functions among the *Nagot-Yoruba* peoples. It is used for social purposes, and to preserve order in private and community life. Its cult is patriarchal by nature and held by male secret societies although orality mentions a major role of a woman at its origins (Akanji & Dada 2012). This organization that is not open to women and ordinary men in society (Akanji & Dada 2012). Thus, as of today, in Benin and Nigeria, females and non-members must stay indoors during its festivals as tradition forbids women and non-participants to see *Oro*. In Oro rituals and traditions, a species of the Malvaceae-Sterculioideae taxon (*Triplochiton scleroxylon*) is often mentioned: *Triplochiton scleroxylon*. *Triplochiton scleroxylon* is one of the most revered sacred species among the *Oro* in Benin. It is used in almost all ritual ceremonies of the cult. Given the seemingly real importance of *T. scleroxylon*, this piece of work aimed to assess whether it is a keystone species to the cult *Oro* or not. To this end, an approach adapted from Coe & Gaoué (2020b) was used.

Materials and Methods

Study environment

The study was conducted in Benin in the Guinean-Congolian center of endemism of plants' (Fig.1). The Guinean-Congolian region is located in the southern part of Benin (6°25'N to 7°30'N), with a sub-equatorial climate (Adomou 2005). Within that region, the Phytodistrict of Pobè and Plateau represent the main homeland of the Nagot-Yoruba sociocultural group, which is the heart of the "*Oro*" cult tradition (Fig. 1).

Sampling and data collection

An exploration phase was conducted to identify the sacred forests of the *Oro* cult in the study area as well as all the convents and members of that cult (Fig. 2).

At the end of the exploratory study, permission was sought from the village chief and the *Adjana* (chief dignitary of *Oro*) of each study site before the conduct of the surveys following in accordance with the code of ethics established by the International Society of Ethnobiology (ISE 2006). Respondents were identified and their permission was also obtained with the help of the local authorities before the administration of the interview guide designed for this purpose.

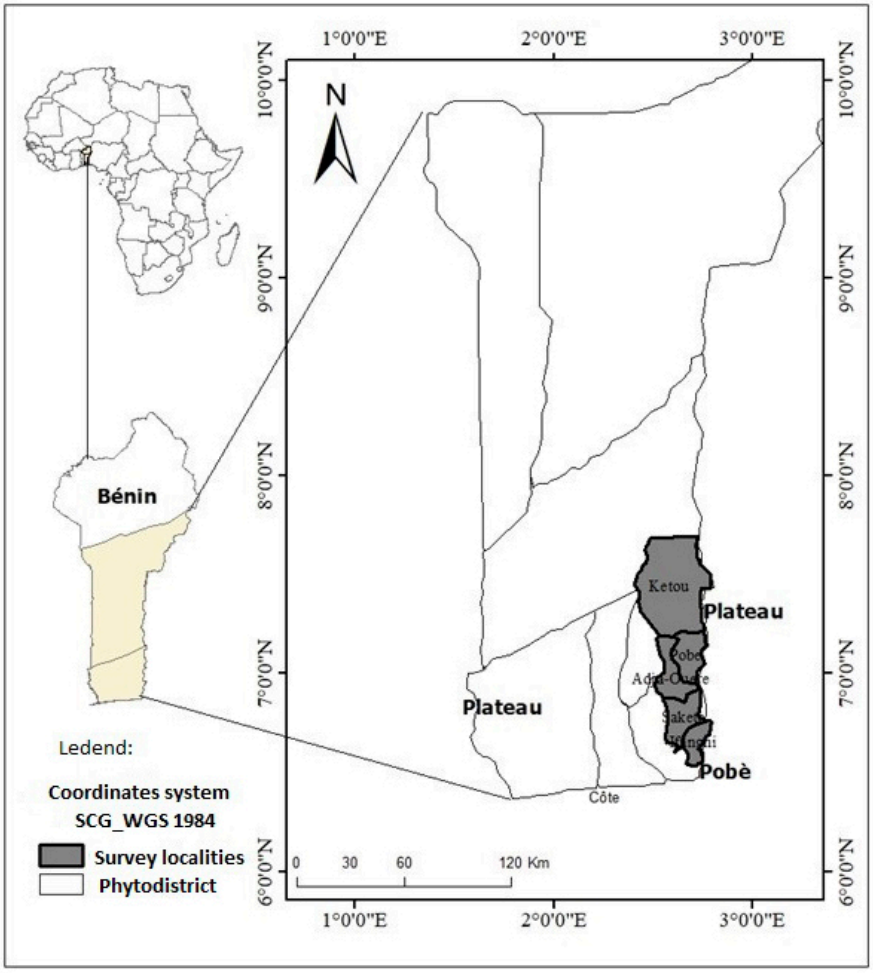

Figure 1. Distribution of the localities of the sacred forests of the *Oro* cult in Benin.

Figure 2. Some sacred forest convents of the *Oro* fetish in Benin.

Considering the distribution of *T. scleroxylon* and its sacredness in Benin, we employed a non-random sampling approach using the snowball technique (Cochran 1977) was adopted to identify key informants among the followers and dignitaries of the *Oro* cult sacred forests. This technique consists of approaching a competent informant for the study, who after being interviewed, in turn points to another competent person from the same community and the process evolves until all competent persons for the subject of study are interviewed. It allowed us to directly approach informants who are knowledgeable about *T. scleroxylon* in their community. The estimate of the number of key informants was considered representative when the saturation limit (the point at which no more informants are mentioned by the last respondent) was reached at the end of the survey (Cochran 1977). Information was recorded according to the rank and responsibility of the respondents in the cult. The baseline questionnaire was structured around knowledge of the role and use of all the species involved in different levels of the *Oro* cult ceremony.

Ethnobotanical survey

The ethnobotanical survey targeted the *Oro* cult members. Data were collected through semi-structured individual interviews and direct observations in the field. Information collected included names and meanings of all the species involved in the *Oro* cult tradition, the various usages, and the rituals related to each species, the possibilities of substitution of each species or organ of the species considered to fulfil the same cultic function, its frequency of use, its use in trade and its psycho-social functions. The basic questionnaire was structured in two parts: (i) identity of the respondent, (ii) knowledge and names of the species in the different local languages, various usages and usage forms per plant part, and the rituals related to the species. Information gathered include the level of responsibility of the informant in the worship, the different criteria for identifying the species, which are key cultural elements, i.e., the physical presence of the species, their use value and level of importance, the extent to which they are used as an income source, their psycho-socio-cultural function, the ethno-taxonomic diversity, and the unique position of each species for the success of ceremonies and rituals of the *Oro* cult.

Data processing and analysis

A total of five (05) species — *Newbouldia laevis* P. Beauv., *Uvariopsis tripetala* Baker F., *Euphorbia unispina* NE Br., *Adansonia digitata* L. and *Triplochiton scleroxylon* K. Shum — were identified for worship usages of the *Oro* cult. Relative citation frequency (RFC) of the cultural keystone species indicators (Garibaldi & Turner 2004) was calculated for each species. High values of the RFC for a specific use reflect a consensus for that use of the species in the community. Uses reported by more than 20% of respondents were considered to reflect consensus (TRAMIL 1989). Knowledge reported by less than 20% of respondents may also be important in some socio-cultural groups. However, plants with a RFC of less than 5% (Gouwakinnou et al. 2011) and which are substitutable in their role in the *Oro* cult tradition were not considered important to the tradition and were removed from the analyses. Thus, of the five (05) species identified, four (04) were removed from the analyses since they recorded only one specific usage. Indeed, *N. laevis* and *U. tripetala* are respectively used for only purification and snuff for corrections, in case of disrespect of traditional rules. As far as *A. digitata* and *E. unispina* are concerned, the only worship function they are requested for in the Oro cult can be achieved by *T. scleroxylon*. Thus, only *T. scleroxylon* was considered for analysis in the rest of the study.

Use value of the species and the level of high importance of the species

Ethnobotanical indices such as relative frequencies of citation (RFC), whole plant use value (VU_T), organ use value (VUorg) of the species according to the respondents were used for the data analysis.

Use value

The total use value of the species in the *Oro* cult tradition (VU_T) was expressed in terms of the average number of reported uses (Gomez-Beloz 2002). It was calculated by the formula:

$$VU_T = \frac{\sum_{i=1}^{N} UR_i}{N};$$

URi the number of specific uses reported by a respondent *i* in the community and N the total number of respondents in the community. The knowledge according to the levels of responsibility of the *Oro* cult actors was examined using VU_T.

The use value per organ (VUorg) expresses the average number of uses per respondent. It was calculated using the formula:

$$VU_{org} = \frac{\sum_{i=1}^{N} UR_{Org,i}}{N};$$

URorg$_i$ is the number of usages mentioned per organ by respondent *i* and N the total number of respondents in the community.

Measure of external resource acquisition.
To assess the extent to which *T. scleroxylon* is used as an additional source of income, we asked each respondent whether products from *T. scleroxylon* were sold. The responses obtained were recorded as binary data (0;1) (Coe & Gaoué 2020b).

Psycho-socio-cultural function of the species
To assess the psycho-socio-cultural function of *T. scleroxylon*, we addressed the following questions to each informant: Does *T. scleroxylon* have a story related to the *Oro* cult? Does it participate in a worship ritual? Is there a spiritual dimension associated with its use in the cult? All responses were recorded as binary data (0;1).

Measurement of ethno-taxonomic diversity of species names.
The ethno-taxonomic diversity of *T. scleroxylon* was estimated with the Pielou's equitability index:

$$R = \frac{\sum pi * log\mathbf{2}(pi)}{log\mathbf{2}(n)};$$

pi is the proportion of the number of people mentioning a given local name *i* and the total number of respondents mentioning a name for the species; n is the total number's names of the species in the tradition

Unique position of T. scleroxylon in the Oro cult tradition

We evaluated the unique position of the species using the irreplaceability index in specific uses or functions of the species. It was estimated as the average of the irreplaceability indices of all the plants' organs used. The irreplaceability index of each organ was calculated as the quotient of the total number of species of which part(s) can replace a given specific use or function of the species; and the total number of species listed divided by the total number of specific uses of the organ considered (Coe & Gaoue 2020b).

Estimating the cultural keystone status score
In order to estimate the cultural keystone status score of the species, a principal component analysis (PCA) was performed on the predictors of *T. scleroxylon* cultural keystone status and the organs of the species. Statistical analyses were performed in R software, version 4.0.3 (R Core Team 2020). The PCA was carried out with the "FactoMineR" package (Lê *et al.*, 2008). The graphical representations were made with the "factoextra" packages (Kassambara & Mundt, 2020) for the biplot. The variables used for the PCA included five indices: use value, ethno-taxonomic diversity, psycho-social function, irreplaceability, and external resource acquisition. Principal components representing a unique combination of these predictors were generated. Each principal component provides a score per species organ. The first set of principal components that explained more than 50% of the variance information in the data was retained. The cultural keystone status score of the species was the product of the retained principal component scores for each Organ (Coe & Gaoue 2020a). To identify indices that significantly predicted the cultural keystone status of *T. scleroxylon*, scatter plots of the predictor matrices were made with bivariate scatter plots below the diagonal, histograms on the diagonal and Spearman's correlations by predictor pairs above the diagonal.

Results

Assessment of the cultural keystone status of *T. scleroxylon*
Use value of the species and the high level of importance of the species
The respondents mentioned 10 specific uses of *Triplochiton scleroxylon* reveals in the *Oro* tradition. The use of the species for making spirit protection statuettes (97.35%), its leaves pruning by the *Oro* (97.35%), and its use in initiation and protection ceremonies (94.70%) are the most prominent reported uses.

Cultural/worship uses

They are overall 07 stages of *Oro* rituals or cult events, all requiring the use of *Triplochiton scleroxylon*. Knowledge about the use of the species in the different ceremonies and rituals of the *Oro* cult does not vary significantly according to the level of responsibility (rank) of the cult actors (Fig. 3).

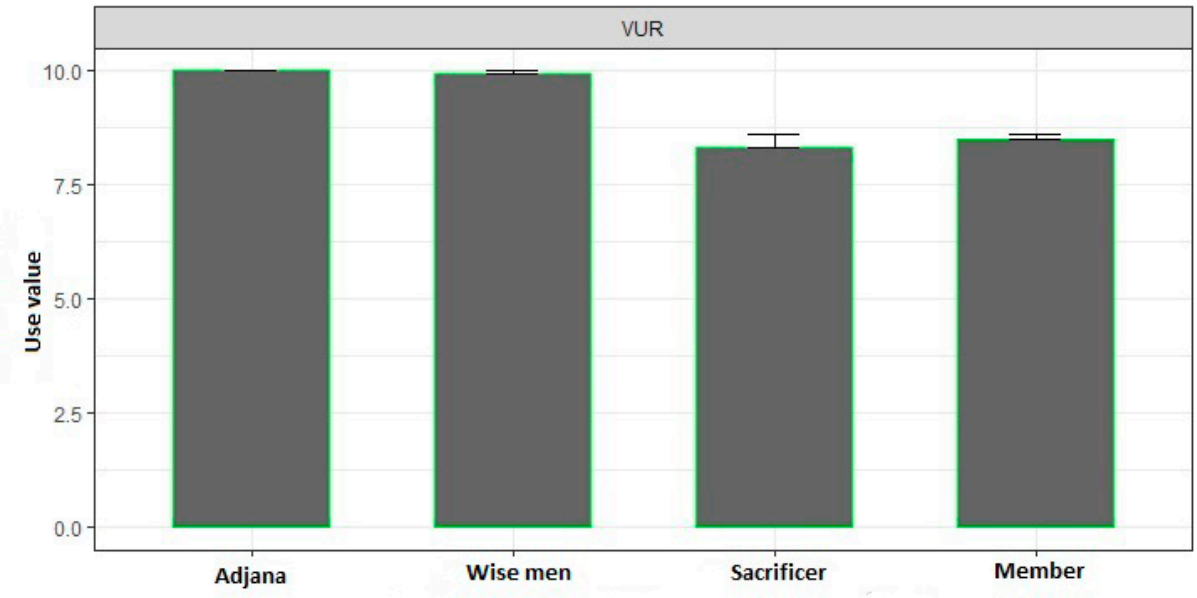

Figure 3. Cult use value of *T. scleroxylon* according to the actors of the *Oro* cult.

The uses of *T. scleroxylon* in the ceremonies and rituals of the *Oro* cult vary according to the parts of the plant (Fig. 4). The most commonly used organs are leaves (*Oro* exit ceremony and pruning), roots (*Oro* exit ceremony and making of the sacred *Oro* drums) and the trunk (sculpture of spirit protection statuettes and sacred and non-sacred drums, shelf and sawdust used to draw *Ifa* divination signs, and timber for sale).

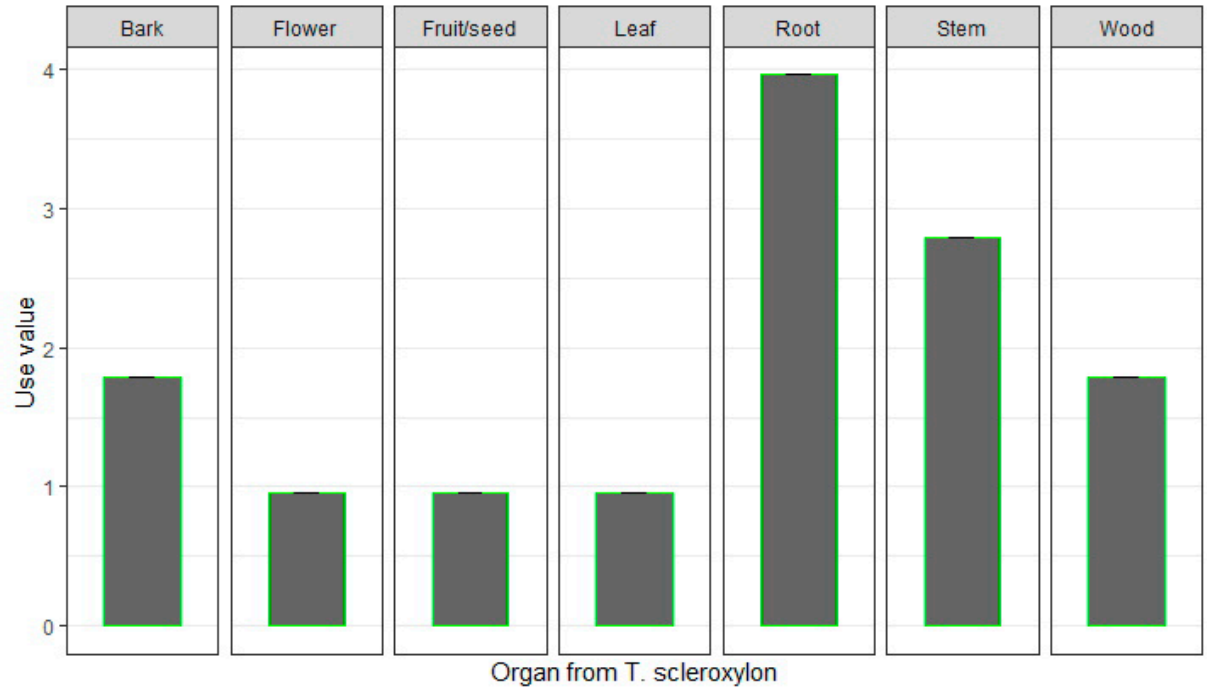

Figure 4. Cult use value of *T. scleroxylon* organs.

Ethno-taxonomic diversity of *T. scleroxylon*

In the *Oro* cult tradition, several names are used to refer to *T. scleroxylon*. These are *Aréré, Egui aréré, Egui Oro* or *Egui Ogù*. The value of the Pielou equitability computed was 0.6, suggesting a relative predominance of a few names over the other designations within the *Oro* cult community. The name "*Aréré* or *Egui aréré*" seemed to be the most used by the actors of the *Oro* cult tradition in Benin.

Psycho-socio-cultural function of the species

All the respondents claimed that *T. scleroxylon* is historically linked to the *Oro*, and that no *Oro* story can be told without mentioning it. According to the interviewees, the *Oro* was revealed to a woodcutter when he felled a *T. scleroxylon* tree. After a consultation with the *Fâ* or *Ifa* (art of divination), it was recommended to house it within the *T. scleroxylon* feet, hence the name 'Egui *Oro*'. The species is intimately and historically linked to the *Oro* cult.

Table 1. Role of the organs of *T. scleroxylon* in the *Oro* cult tradition in Benin.

Organ from *T. scleroxylon*	Role
Leaf	Leaf pruning by the *Oro* fetish, fetish exit ceremony, feeding and other ritual ceremonies.
Flower/ Fruit/seed	Leaf pruning by the *Oro* fetish
Stem	Guide, manufacture of statuette of spiritual protection and other ritual ceremonies
Wood	Habitat of the fetish, manufacture of statuette of spiritual protection, sacred tam-tam fetish *Oro* and not sacred, divinatory art and other ritual ceremonies
Root	Manufacture of the *Oro* sacred drum fetish, spiritual protection and other ritual ceremonies
Bark	Spiritual protection and other ritual ceremonies

Persistence and memory of the use of *T. scleroxylon* in relation to cultural change

All the respondents affirmed that at the origin of the *Oro* cult, *T. scleroxylon* was used in all the ritual ceremonies of the *Oro* cult. It is the tree that is used to represent the *Oro*, hence its name "Egui *Oro*" in the Nagot dialect.

Extent to which *T. scleroxylon* provides additional income sources

All the respondents claimed that *T. scleroxylon* is a species with high economic value not only to the *Oro* cult actors but also to the entire local community in its distribution area.

The trading of *T. scleroxylon* timber is reported to follow well-established rules in the convents. Periodic inventories are initiated to identify adult plants of the species. These plants are felled (Fig. 5) and cleared from the forests to be sold first to forestry operators who are followers of the *Oro* cult and then resold to non-adherents. Resources from the sale of the species are used to cover the costs of annual ceremonies and rituals and the maintenance of the *Oro* deity's shelters (Fig. 2).

Figure 5. *Triplochiton scleroxylon* felled in the sacred forest of Itchèrè-Toffo.

Unique position status of *T. scleroxylon*

The value of the irreplaceability index (I = 0) of certain plant parts in the ceremonies and rituals of the *Oro* cult illustrated the unique position of *T. scleroxylon* (Table 2).

Table 2. Irreplaceability index of the organs of *T. scleroxylon*.

Organ from *T. scleroxylon*	Leaf	Flower/Fruit/seed	Stem	Wood	Root	Bark
Irreplaceability index (I)	0.2	0.88	0	0	0	0

Reason for the irreplaceability of *T. scleroxylon* in *Oro* cult events

There are several reasons why, according to the actors of the *Oro* community, *T. scleroxylon* has a unique and irreplaceable position in *Oro* cult manifestations in Benin (Table 3).

Table 3. Reasons for the irreplaceability of *T. scleroxylon* in the ceremonies of the *Oro* cult.

Reason 1	Reason 2	Reason 3	Reason 4	Reason 5
Oro sacred fetish tree	Omnipresence in the collective consciousness	Irreplaceability of *T. scleroxylon* in stories	Irreplaceability of *T. scleroxylon* in ceremonies	Irreplaceability of *T. scleroxylon* in major emblems/symbols

The reasons for the irreplaceability of the species in cultural and/or cultic manifestations (Table 3) of the *Oro* cult, vary according to the actors of the *Oro* community. For the *Adjana* (in charge of the convents) and the wise men, *T. scleroxylon* incarnates or symbolizes in itself the *Oro*.

Perception of the *Oro* cult actors on the unique role of *T. scleroxylon* in the cult's manifestations

The Correspondence Factorial Analysis (CFA) carried out on the reasons why *T. scleroxylon* occupies a unique and irreplaceable place in the *Oro* cult manifestations according to the actors of the *Oro* community showed that the first two factorial axes synthesize all the information collected (contain 95.76% of collected information; Fig. 4). The projection of the reasons for the irreplaceability of *T. scleroxylon* in the *Oro* cult events and the actor groups of the *Oro* cult community on the two factorial axes indicates that the Adjana believe that reason 3 (Irreplaceability of *T. scleroxylon* in stories) and reason 5 (Irreplaceability of *T. scleroxylon* in major emblems/symbols) explain the irreplaceable role of *T. scleroxylon* in the *Oro* cult ceremonies. According to the community priests, Reason 1 (Oro sacred tree) explains why no other species will be able to replace *T. scleroxylon* in the ritual ceremonies of the *Oro* cult. The wise men and other community members believe that Reason 2 (Omnipresence in the collective consciousness) and Reason 4 (Irreplaceability of *T. scleroxylon* in ceremonies) explain the unique position of *T. scleroxylon* in *Oro* cult ceremonies (Fig. 6).

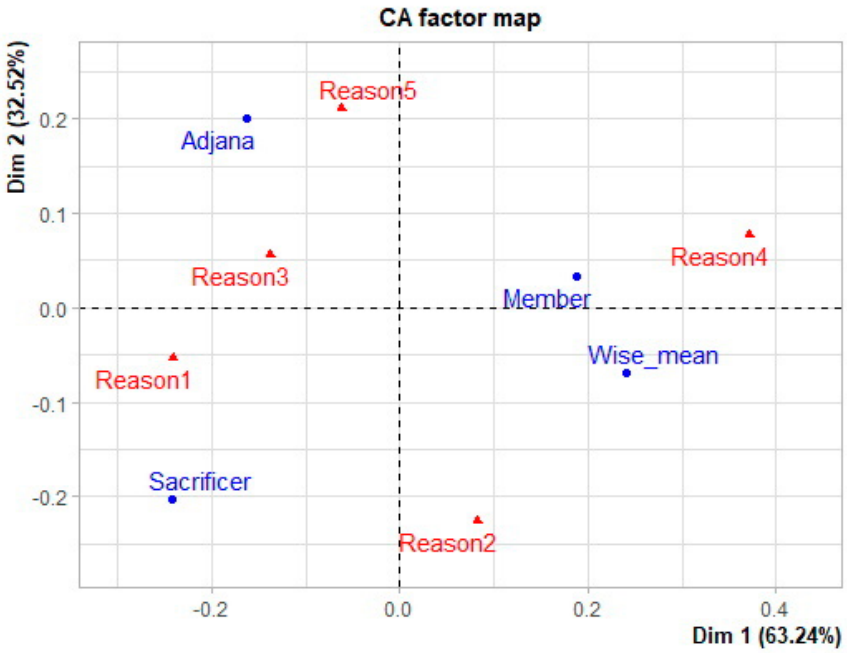

Figure 6. Projection of reasons for irreplaceability of *T. scleroxylon* in *Oro* cult ceremonies on factorial axes

Cultural keystone status score of *T. scleroxylon*

The Principal Component Analysis (PCA) performed on the predictors of the cultural keystone status of *T. scleroxylon* according to the organs of the species showed that the first two principal components synthesize almost all the information collected (92.2%; Fig. 7).

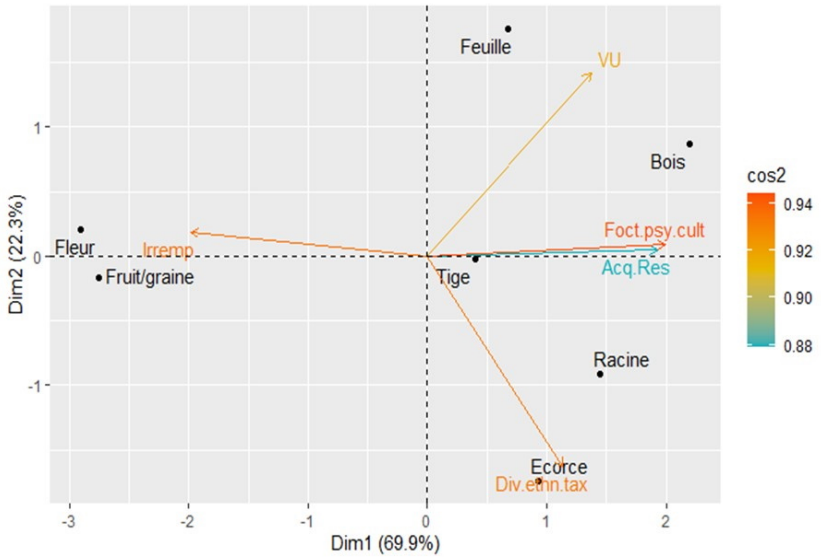

Figure 7. Projection of predictive indices of key cultural vault status and organs of *T. scleroxylon* onto principal components. Legend: VU = use value, Acq.Res = Resource acquisition, Foct.Psy.Cult = Psycho-socio-cultural function of the species, Div.Ethn.tax = Ethno-taxonomic diversity, Irremp = Irremplaçability.

Values of the cultural keystone scores of *T. scleroxylon* from the *Oro* cult in Benin ranged from 0 to 11.53 (Table 4). Bark, roots, stem and wood of *T. scleroxylon* are parts with the highest cultural keystone scores. Bark, roots, stem and wood are therefore the most important parts contributing to the status of cultural keystone species of *T. scleroxylon* to the *Oro* cult in Benin.

Table 4. Cultural keystone score of *T. scleroxylon*

Organ from T. scleroxylon	**Wood**	**Bark**	**Leaf**	**Flower**	**Fruit/seed**	**Root**	**Stem**
Cultural Keystone Score	3.92	11.53	0.24	0	0	9.99	5.05

Correlation of cultural keystone species indices with cultural keystone status scores

Fig. 8 presents the Spearman correlation of key cultural species predictors and cultural keystone scores on *T. scleroxylon* in Benin. The results show that irreplaceability and ethno-taxonomic diversity are strongly correlated with the cultural keystone score of the species. The irreplaceability index and the ethno-taxonomic diversity index are thus the indicators that significantly predict the cultural keystone status of *T. scleroxylon* in Benin.

Discussion

Results of this study highlighted *T. scleroxylon* as a cultural keystone species of the *Oro* cult in Benin

Physical presence

The first criterion considers that a key cultural species is physically present in the environment of the community under consideration. *T. scleroxylon* is a revered and sacred *Oro* tree in the Nagot cultural era in Benin. The presence of the species in a habitat is often an indicator of the sacred status of that place. In the Nagot homeland in Benin, there is no sacred forest of the *Oro* cult without the presence of at least one mature individual of *T. scleroxylon*.

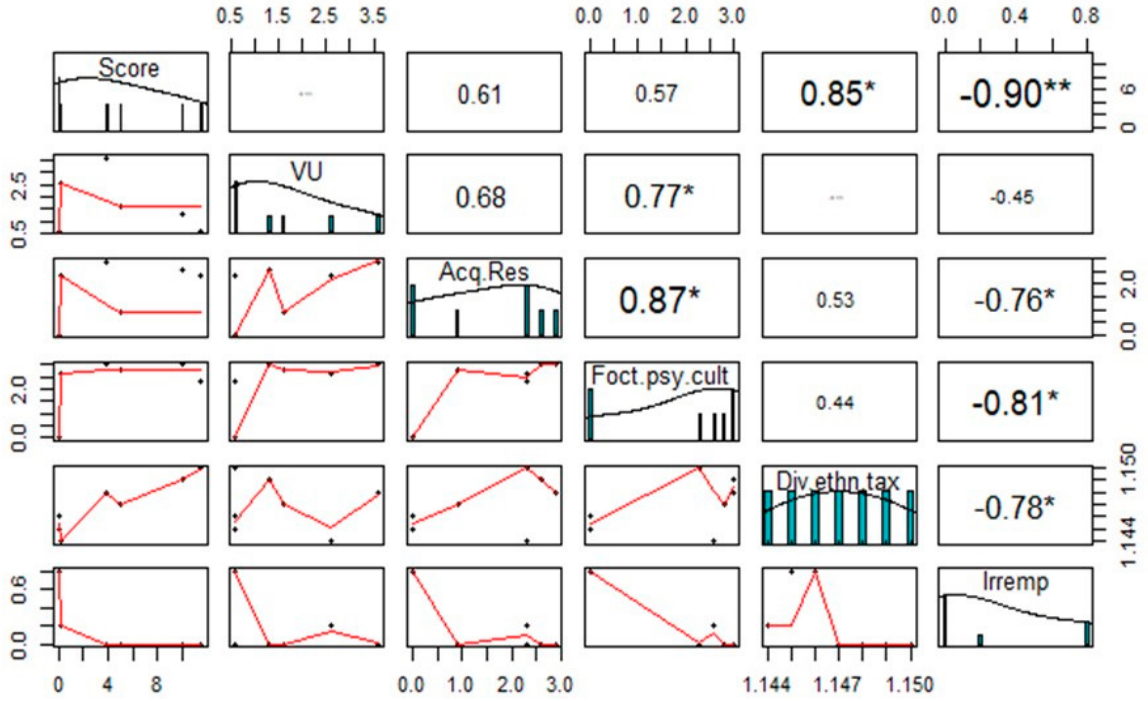

Figure 8. Scatter plot of matrices. Legend: VU = use value, Acq.Res = Resource acquisition, Foct.Psy.Cult = Psycho-socio-cultural function of the species, Div.Ethn.tax = Ethno-taxonomic diversity, Irremp = Irremplaçability.

High use value and cultural importance

The second criterion for designation as a cultural keystone is the use value and cultural importance of the species. The results showing 10 specific uses of *T. scleroxylon* in cultural and/or cultic manifestations of the *Oro* cult, illustrate the diversity of uses of *T. scleroxylon*. Beyond the cultural and cultic uses of the species, it represents an additional source of income for the community, thanks to the quality of its wood and medicinal uses. The variation in the level of knowledge obtained among informants may be related to the respondents' rank in the secret societies of *Oro*. As it is the case in most patriarchal secret societies in African traditions, the level of traditional knowledge about the cult is highly correlated with hierarchy. The knowledge and degree of knowledge about *T. scleroxylon* depends on the level of the informant in the *Oro* tradition. Use values and versatility of species are good indicators of their cultural importance. But they cannot alone help identify key cultural species especially in regions were a great number of species have high use values (eg. Africa).

Ethno-taxonomic diversity of names

The different local names given to *T. scleroxylon* by the actors of the *Oro* cult testify to the ethno-taxonomic diversity of the names of the species in the *Oro* cult tradition. The local name of a species being a revelation of a given tradition (Assogba *et al*. 2017), each of these specific names "*Aréré, Egui aréré, Egui ogù* and *Egui Oro*" and the secret names of the different organs in the convents indicate a distant contact and tradition with the *Oro*. For example, *Egui Oro* recalls not only that *T. scleroxylon* symbolizes the *Oro* but also the mechanisms of the *Oro*'s birth or its revelation to the community. *Egui aréré*, which means the tree of the dominant stage of the forest, is the tree that receives the first energy from the wind (the energy of the *Oro*). Although the ethno-taxonomic diversity of the names of a species in a community reveals a distant contact and/or tradition of the species in the history of that community, it cannot alone objectively predict the cultural vault key status of a species. Indeed, it is plausible that the ethno-taxonomic diversity of the names of a species is related to the diversity of use of the species for each group in the community.

Psycho-socio-cultural function of the species

The use of this indicator to designate a species as a keystone is however relative, as any species that is culturally important to a community can disappear without the community becoming culturally fragmented and unstable. Relying on the psycho-socio-cultural function of species in a system to define cultural keystone status may lead to biased conclusions as the memory of a culture is not static; it evolves over time and is influenced by many different factors (Olick & Robbins, 1998).

Unique position of the species

Triplochiton scleroxylon is an irreplaceable species in some important ceremonies of the *Oro* cult. This irreplaceability of the species is due to the unique role certain organs such as the root, bark, stem and wood play in the ceremonies and rituals of the *Oro* cult. The reasons for the unique role of the species in the *Oro* cult tradition vary according to the followers of this tradition. The unique position of the species in the traditional ceremonies of the *Oro* cult makes it a major species in the preservation and stability of the *Oro* cult because the sacredness associated with the *Oro* cult is historically and intimately linked to the species. For the actors of this tradition, "It is the sacred *Oro* tree". The unique position of a species could be the main index that can predict with certainty its cultural key stone status because key cultural species of a community, are culturally salient species to the extent that their disappearance can have a negatively affect the identity and cultural stability of the community considered (Garibaldi and Turner, 2004).

Additional sources of income

The sixth criterion is the ability of the species to acquire external resources. Despite its status as a revered and sacred *Oro* species, *T. scleroxylon* is traded for its timber products to generate financial resources for the *Oro* cult community. Organs of the species such as leaves, roots and bark are also harvested by the followers and sold in markets and traditional pharmacies. This criterion also provided insights into the importance of the species but does not stand alone as a reliable indicator of its keystone status. Several agroforestry species in Africa do have very high economic importance to local people.

Based on its unique position in the cultural manifestations of the *Oro* cult among the Nagot-Yoruba of Benin, *Triplochiton scleroxylon* arguably is a key cultural species of the *Oro* cult. Therefore, it will be interesting to assess the impact of the decline of *T. scleroxylon* on the identity and stability of the *Oro* cult in Benin and elsewhere. The key cultural species theory predicts that the disappearance of certain plant or animal species can have negative impacts on the identity and cultural stability of a particular community. The *Oro* cult is known to have survived in several communities of Yorouba descent brought into America during slavery. This offers a unique opportunity to compare the current practices of *Oro* cults in these communities to what has been preserved at the origin, in order to see what dimensions have been lost and test the prediction that in the absence of *T. scleroxylon,* the spiritual dimensions of the cult will be lost. It is however already evident that in some of those communities far from their original homelands, the cultural value of *Oro* is taking precedence over its spiritual backbone. In the context of climate change where many species are predicted to be displaced, it would be useful to infer the potential impact of climate change on the distribution of *T. scleroxylon* as a proxy analysis of its impact of the identity and stability of the cult *Oro*. Beyond testing for these hypotheses, species like *T. scleroxylon* urgently need initiation of conservation actions to prevent their extirpation from remnant habitats and to preserve socio-ecological systems that rely on them. Indeed, according to Gaoué & Ticktin (2007), the versatility of uses can have a severe impact on the demography of prized species. Taboos and sacralizations are to some extent made to protect key species from over-exploitation and extinction (Colding & Foke, 1997). However, some rituals when they imply heavy pressures on a given species can have the opposite effect in the long term. Studies on the impact of the prevalence of ritual ceremonies and taboos on the demographic and spatial structure of *T. scleroxylon* stands may thus unfold useful insight to inform conservation strategies.

Conclusion

This study used a multi-criteria approach to illustrate the status of *T. scleroxylon* as a cultural keystone species in the *Oro* cult tradition in Benin. The study illustrated the complexity of identifying cultural keystones. Cultures are dynamic and adaptive, the recognition of *T. scleroxylon* as a cultural keystone species may essentially remain within the current cultural and historical context. In the future, the species may no longer meet the specific criteria and thus no longer be considered as such. Although the used indices allow an objective assessment, there is no quantitative threshold for these indicators to assess the level of importance of the designation of key cultural or cult species. Despite the pertinence of the approach used, the concept of key cultural species remains subjective as the verification of the theory of key cultural vault species should be done by closely examining whether the removal of a key cultural species would lead to irreversible perpetuities and consequences for the socio-cultural identity and stability of the community or cult considered. Future prospects on this topic may consider using an experimental device that could actually examine the effect of the total extirpation of *T. scleroxylon* on the stability of the *Oro* cult. Yorouba-Nago communities that were brought out of Africa (eg. to Latin America) and still practice the Oro cult in certain forms offer a good opportunity for this test.

Declarations

Ethical approval and consent to participate: All informants gave informed consent before the interviews.
Data availability: Data are available upon reasonable request.
Conflict of interest: The authors declare that they have no competing interests.
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Authors' contributions: The two authors conceptualized the subject and designed the methodology. The first author conducted the field data collection, statistical analyses of the data and drafted the manuscript. The second authors refined the data processing approach, red and corrected the manuscript. Both authors read and approved the final version of the manuscript.

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