Article

Revisiting plant conservation on wooded shrines by a transversal approach: "Core" vs. "satellite" species and anthropological knowledge in Bwaba land, Burkina Faso

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Abstract
Studies on plant conservation in sacred groves provide mixed results, with some showing their effectiveness while others do not. We argue that beyond the variety of field cases, studies usually suffer from overrating rare species and insufficient consideration of societal data. The sacred sites of Bondoukuy department in Bwaba cultural area (Burkina Faso) were geo-referenced and measured; the most abundant ligneous species were listed and their abundance recorded. Their conservation status and dynamics were assessed based on the *core* vs. *satellite* species model of Hanski. Data interpretations relied on the phytogeographical affinities of abundant species and on anthropological knowledge of the Bwaba society.

The vast majority of shrines were less than 1 ha, located in or near villages in specific landscape features, and covered with trees. The most abundant species of shrines belonged mostly to local phytochories, but were subject to rather high anthropisation. The results support the concept that wooded shrines preserve local biodiversity, but indicate threats from an invasive alien species. The location and condition of shrines appeared to be constitutive features: the Bwaba system of thought involves a series of sacred sites (with and without trees) located in remarkable features of the landscape, and their way of life has resulted in the proximity of these sites to the villages. The beliefs that promote plant cover conservation do so only to a certain extent and regardless of the species content, which raises the concern that alien species may upset the established communities. These beliefs have led the Bwaba to choose the most humid environments in which to set up their wooded shrines, which is interesting from a conservation perspective. The study advocates for a better consideration of social data to identify the key elements of the dynamics of the vegetation of sacred groves.

Keywords sacred woods; plant biodiversity conservation; *core* species; savannah vegetation; invasive species; anthropological knowledge.

1 Introduction

Conservation of biodiversity in wooded shrines is a controversial topic. To the question “does the protection of their vegetation by the inhabitants promote the maintenance of the local flora?” different responses are proposed according to the authors and the regions. Obviously, the differences arise in part from the wide variety of biological and physical environments considered, as well as from the diversity of sizes, shapes and treatments of the wooded shrines. However, we argue that beyond this variety of cases and assessments, the

data and arguments presented in this debate suffer from two main flaws that make it difficult to reach relevant conclusions. The emphasis is typically placed on rare species in the studies of plant conservation on wooded shrines, although theoretical considerations may prompt a focus on the most abundant species; this will be developed in the "ecological theoretical background" section. Besides, the link between the environmental and social aspects of shrines is generally mistaken due to a poor understanding of the rationale of human actions, as will be shown in the section "A misunderstanding regarding plant conservation on shrines" and in the discussion.

Starting from these considerations, we propose an original study of the wooded shrines of the Bwaba land in Burkina Faso, which focuses on the *core* species as defined by Hanski (1982) and on the location of shrines in relation to dwellings and landscape, two features rarely taken into consideration. The analysis and discussion are based on the phytogeographical features of plants and on anthropological knowledge of the Bwaba society. We aim to show that a new ecological theoretical approach combined with a better use of anthropological knowledge to interpret the data may significantly improve our understanding of the conservation potential of wooded shrines.

2 Ecological Theoretical Background

Whatever the part of the world, the question of the effectiveness of wooded shrines for plant biodiversity conservation arises in quite similar terms: vegetation patches that represent a small percentage of the whole territory are set apart from the landscape by ritual treatment. The landscape being usually extensively cultivated today, the groves may appear to be nature islands, a viewpoint that raises particular ecological issues. Thus, the attention of plant ecologists has been directed mainly to the crucial issue of the fragmentation of their vegetation in the wake of Garcia (2003). The latter sought to identify and assess fragmentation effects on sacred forests of India, taking the theory of island biogeography (MacArhur and Wilson, 1967) as theoretical background.

However, if we want to predict which biodiversity will be preserved in practice, other theoretical considerations have led us to focus on the most abundant species, an approach rarely adopted. Indeed, in the last few decades, much of the effort in theoretical ecology has aimed at distinguishing separate groups of species that fulfil distinct functions in ecosystems and at elaborating models linking vegetation structure, function and dynamics (Damgaard, 2011). In such attempts, the distinction between abundant and rare species is pivotal. One of the simplest models, proposed by Hanski (1982), postulates the potential existence of two classes of species in a community. The *core* species, which are "regionally common and locally abundant", can persist in the form of viable populations in the absence of immigration, whilst the *satellite* species are characterised by opposite attributes. Such a link between frequency and abundance of species has been largely verified by empirical evidence (Webb et al, 2012). The presence of *core* species would be regulated mostly by local environmental and competition constraints, which illustrates the concept of realized niche (Hutchinson, 1957), whereas *satellite* species would be linked rather to external diaspores sources and to landscape heterogeneity. Both types of species would thus show rather different dynamics and, in addition, most plant interactions in the communities must be between or with *core* species. Such a conceptual approach implies a high probability that the species which are not abundant and not frequent may become extinct (Gaston et al, 2000), and that only the more abundant plants maintain in the long term. In spite of this, studies of plant conservation on wooded shrines typically focus on rare species, overrating them.

3 A Misunderstanding Regarding Plant Conservation on Shrines

3.1 The current attempts to merge the social and biological aspects in studies of sacred groves

Diverse attempts to understand why and how wooded shrines are maintained by the societies involved have already been conducted around the world in various academic fields (e.g. Michaloud and Dury, 1998, Arora, 2006; Kokou and Sokpon, 2006; Sheridan, 2008; Ormsby and Bhagwat, 2010; Shen et al, 2012). In addition, the political and social roles of sacred groves have been pointed out in particular by Dawson (2009), Sheridan (2008, 2009) and Sheridan and Nyamweru (2008). However, it seems that the efforts to link the social logic and ecological dynamics at play on shrines have not been carried far enough to be really productive.

3.2 A flaw in the methods of biological studies

Obviously, the exclusive consideration of a part of any system cannot make it possible to understand this system in its entirety. Moreover, even focusing too strictly on this aspect can result in misunderstanding it. In ecological and conservation studies of wooded shrines, the inclusion of detailed societal data is not common and rarely accepted: it is usually considered off-topic. These studies assess the number of species present, their relative abundance, their diversity at the different levels of the ecological hierarchy, and their link to different factors. When they do not simply ignore the religious and societal aspects of shrines, they consider them to be only external factors that may affect vegetation. At most, the human actions (e.g. exploitation or protection) are included in addition to environmental parameters in the form of general and fragmentary descriptions that cannot provide an understanding of key concepts of the social system, which would require considering the entire social system. Although orthodox in ecology, this method may lead to a dead end regarding wooded shrines. Indeed, without adequate knowledge of the way of life and even of the thought system of the society that created them, some features of these shrines cannot be correctly perceived and understood. This is how a major misunderstanding regarding the treatment of grove vegetation (already underlined by Dugast, 2002) has arisen.

3.3 As a result: a misunderstanding

Even when detailed societal data are lacking on this point, ecological and conservation studies always make the assumption that the inhabitants essentially 'protect' the vegetation in wooded shrines. Indeed, when people are questioned about this, they always begin by giving this answer. However, the idea of "protecting" may be very different in their minds and in that of Occidentals. Although the protection of biodiversity is never a central topic in anthropological studies, the latter often indicate that such "protection" does not necessarily guarantee the preservation of biodiversity. This is confirmed when in-depth interviews about vegetation ritual treatment are conducted by plant ecologists (Fournier, 2011), as will be developed in the discussion. Such a finding is a key concept for conservation, but it could not have been grasped if the sacred sites and the ritual rules attached to them had not been considered in their entirety, which is to say, as a system. Thus, a minimum deciphering of the thought system associated with sacred groves appears to be a methodological requirement, but the achievement of this minimum may involve a fairly thorough knowledge of the representations of the society considered. This justifies our presentation of the Bwaba society in some length below.

4 The Case Study: the Bwaba Land and Society

4.1 Bondoukuy department: environment and land use

Bondoukuy (11°51'N, 3°45'W) department in West Burkina Faso covers about 500 km² (20 villages) in a burned savannah environment (Fig. 1). The climate is typical for the Sudan savannah zone, with both rainfall (about 850 mm per year) and temperatures peaking once a year, and 6 to 7 dry months (October to April) (Fontès and Guinko, 1995; L'Hôte and Mahé, 1996). In this region, a dramatic climate change has resulted in a

latitudinal shift of isohyets towards the South from 1950, with episodes of drought, but from 1990 some improvement has been observed (Wittig et al, 2007).

The Bwaba have always cultivated cereal crops following the 'traditional' system that includes temporary cropping and fallowing and they have always raised small ruminants, but nowadays they also produce cotton on a larger scale than in the past and raise cattle. Immigration rates have been high since the 1960's; cotton fields have progressively been extended (Serpantié, 2003: 5) and today the landscape consists of a mosaic of cultivated land (fields and fallows) and of natural 'bush' fragments mostly in State forests. Research conducted since 1990 in Bondoukuy region, mostly on fallow land (Floret and Pontanier, 2001) and conservation areas (Devineau et al, 2009), provided information on vegetation status and dynamics (Fournier et al, 2001; Devineau, 2005; Devineau and Fournier, 2007; Devineau et al, 2010) and agricultural practices (Serpantié, 2003), but the study of the vegetation of wooded shrines is just beginning (Fournier, 2011).

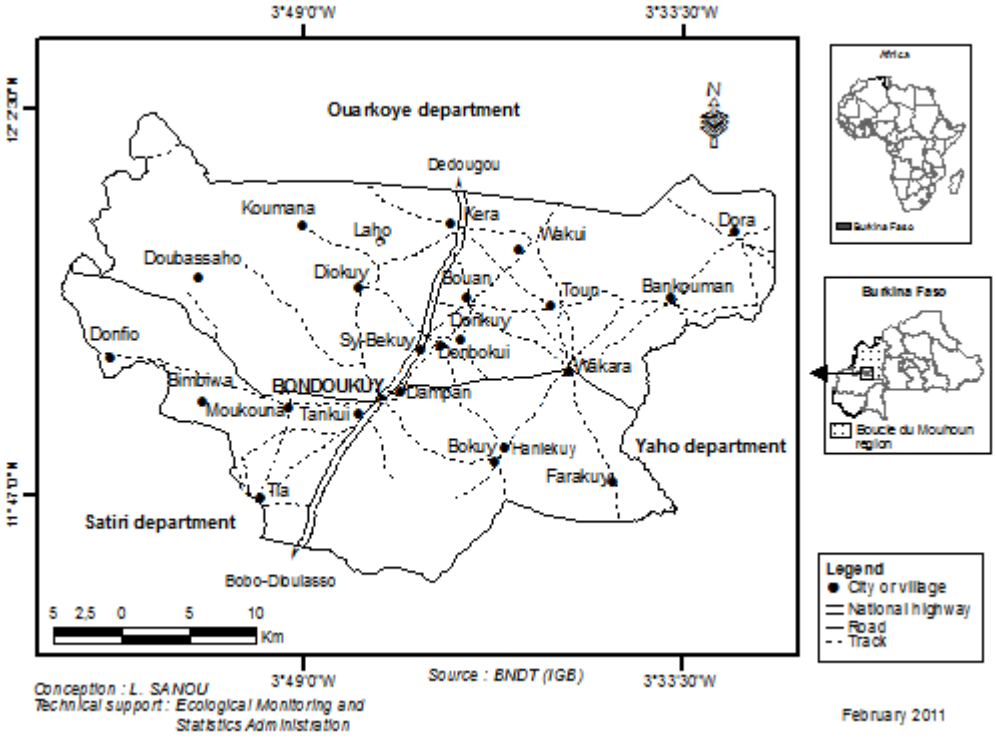

Fig. 1 Location of the Bondoukuy department and its villages

4.2 Bwaba society and villages

The Bwaba, a society of the Voltaic group, occupy an area covering western Burkina Faso and eastern Mali, forming the main body of the population in Bondoukuy region (Fig. 1). Several studies have been devoted to Bwaba society (Cremer, 1924, 1927; Capron, 1957, 1962, 1973; Capron and Traoré, 1986-1987; Coquet, 1994; Dugast, 2002, 2006, 2009). Large villages, politically and economically autonomous, are not subject to a centralized power at a higher level. These villages are today organised in grouped settlements; they have been constituted through complex processes including many displacements brought about by epidemics, famines, and frequent conflicts among villages during the pre-colonial period before 1897 (Boni, 1962; Capron, 1973;

Lemoine, 1998). The resistance to colonisation around 1915 also brought about the destruction or displacement of villages (Saül and Royer, 2001). The people affected usually abandoned their villages and re-established themselves in more stable villages.

4.3 Bwaba religion and shrines

Although Christianity and Islam are expanding, 'traditional religions' -usually described as 'animist'- remain deep-rooted in many West African societies. In Bwaba society, most economic and social activities are still bound up with traditional religion. In particular, the allocation of land among autochthonous and immigrant families is the prerogative of the *tatinibe*, the earth priest for a village or precinct. The latter conducts or supervises most collective ritual activities, while the clan and family cults are led by the elder who is the head of the group, usually the eldest male member. Rituals that usually include blood sacrifice (chickens, goats, sheep, ...) take place throughout the agricultural cycle to protect the fields and the people from harm and to ensure high yields. They are also required for funerals, to 'repair' social or ritual transgressions and, in general, to maintain the relationship with group or individual tutelary forces.

The creator is an almighty superior god called *Dombeeni*, but several other forces from the invisible interact with humans through rituals that take place on shrines: sacred objects or sacred sites. The special areas, powers, scope and domains of intervention and influence of shrines are broad and diverse, the same shrine usually playing several roles. They bring health, peace and social cohesion and also provide successful harvests; in addition they lend strength and protection to the inhabitants in the course of carrying out various activities such as farming, hunting and armed conflicts, they help in marriage and procreation, they prevent incestuous relationships and also drought and other hazards (Cremer, 1927; Capron, 1957, 1962, 1973). Bwaba shrines may or may not be covered with vegetation, and many have an altar for blood sacrifices. The most frequent prohibitions for shrines are designed to protect them from cultivation, cutting of trees and fire; this point has already been dealt with elsewhere (Fournier, 2011).

5 Methods

5.1 Interviews of elders in charge of sacred sites

In order to obtain information on all sites as exhaustively as possible and to simultaneously obtain permission to access them, semi-structured interviews were held with 75 persons, who were all elders in charge of a sacred site whom we could contact in Bondoukuy department. General information including the major prohibitions attached to each site and some elements regarding its role and significance were systematically collected.

5.2 Identification, mapping, and botanical surveys of sacred sites

Following the indications of elders in charge of rituals and usually under the supervision of one of their delegates, we identified, documented and visited all of the sacred sites in the twenty villages included in Bondoukuy department (Fig. 2). Thus, 219 sites were geo-localized, the outlines of the wooded ones (192) were recorded with a GPS system, and their topographical positions were recorded according to three classes: banks or lowland, upper or mid-slope, hills and plateaus. The results were included in a GIS, which made it possible to calculate their area and distance to villages (including former dwelling places today abandoned).

In each wooded shrine all tree species were listed following the botanical nomenclature of the International Plant Names Index and their abundance was recorded. In addition, the phytogeographical affinity of species, according to White (1986), and their conservation status according to the IUCN Red List (2011) were noted. Additional information about ecological features (including relation to fire) and local uses of species referred to in the discussion come from Arbonnier (2000), African Plant Database (version 3.4.0), and previously published work on the region (mainly Devineau and Fournier 2005, 2007; Devineau et al, 2009, 2010; Fournier, 2011) along with some personal unpublished observations.

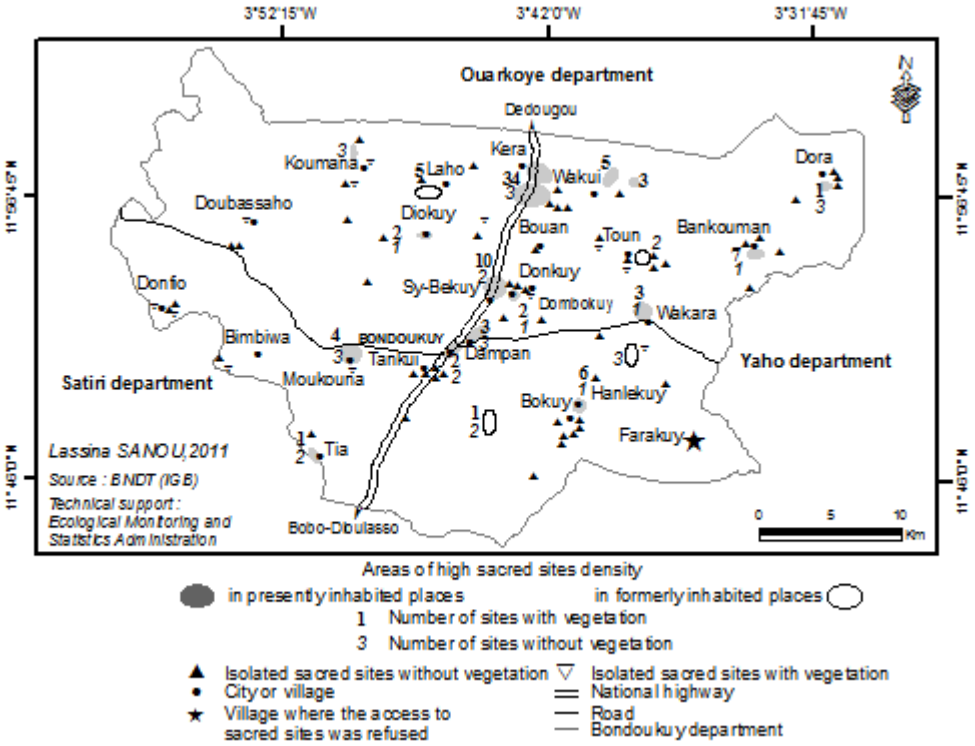

Fig. 2 Location of sacred sites in relation to the villages of Bondoukuy department

5.3 Identifying potential ligneous core and satellite species of shrines

We evaluated the abundance for each species following a geometric progression with a common ratio 2 (first class: 1 to 4 individual, second class: 5 to 8 individuals etc.). Locally abundant species were defined as showing 8 or more individuals (third and higher classes). Frequency was evaluated by counting the occurrence of species in the whole set of shrines.

We checked the Hanski (1982a) prediction that "average abundance is positively correlated with regional distribution" - in other words that locally abundant species were usually also regionally common and that species not locally abundant were regionally not common- was confirmed in our data set (Fig. 3).

The potential *core* and *satellite* species were identified by considering only the locally abundant tree species. The *core* species were equated with the species having a frequency greater than or equal to the third quartile of the overall distribution of species frequencies (24 species). The *satellite* species were equated with the species belonging to the first quartile of the overall distribution of species frequencies (also 24 species). The phytogeographical and ecological traits and the conservation status of abundant species were compared among the potential *core* species (high frequency), the potential *satellite* species (low frequency), and the medium frequency species that are found in between these two frequency distribution extremes. These traits were also compared with the results of previous work on the 'profane' environment in the region.

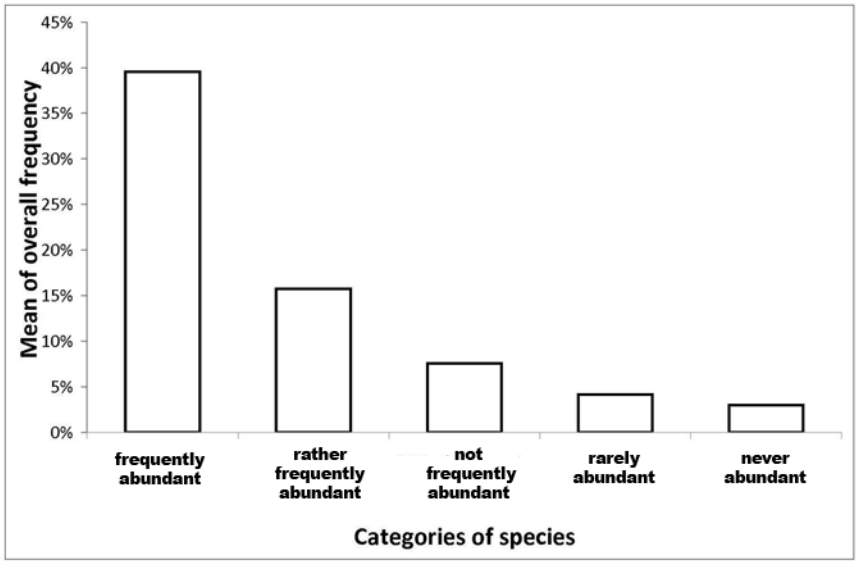

Fig. 3 Relation between abundance and regional frequency among ligneous plant species in Bondoukuy department wooded shrines. Categories defined according to the four quartiles of the frequency distribution of abundant species, plus one category for never abundant species.

6 Results

6.1 Plant cover, size and location of shrines in relation to dwelling places

Most sacred sites (88 %) had some associated vegetation, the remaining 12 % being bare soil, or stones on bare soil, and one was a pond without vegetation. The vast majority of the wooded shrines were of very small size: 63 % (including unique tree shrines) were under 0.5 ha, those with a surface area of more than 5 ha represented less than 10 %, and only a few of them had a surface area of 50 ha and more (Fig. 4). Despite their small size, the density of wooded shrines was high in the landscape, about one per 2.6 km².

In addition, the sacred sites showed a strong affinity with dwelling places: most of them (72 %) were located within villages or within a radius of 500 m around them; this affinity was mostly with presently inhabited villages (Fig. 2 and 5). Only a minority of shrines stood at more than 2 km from inhabited areas, and among them only a handful were located at more than 20 km.

Most wooded shrines (50 %) were located on river banks and in depressions, the rest distributed almost equally between the upper and mid-slope (27 %) or the hills and plateaux (23 %).

6.2 Taxonomical features and phytogeographical affinities of tree species

The 98 locally abundant ligneous species were distributed in 77 genera and 29 plant families, among which the Combretaceae (13 %) and the Fabaceae-Caesalpiniaceae (12%) were the most frequent. The majority of these species (78 %) had a Sudano-Zambezian geographical range, but 8 % were Guineo-Congolian species, other affinities being less than 4 % (supplementary material appendix 1).

The phytogeographical affinity of the potential *core* species was mostly Sudano-Zambezian (21 species out of 24); only one (*Azadirachta indica*) was a wide-ranging (pantropical) species, and one (*Flueggea virosa*) was Afro-asiatic and Australian, but no Guineo-Congolian species were observed (Fig. 6). Among the locally abundant species that were neither the most common nor the rarest, the affinity remained mostly Soudano-

Zambezian, but some (less than 10 %) were Guineo-Congolian or Asian and only a few species (under 5 %) had a broad distribution (pantropical, cosmopolitan or Tropical African range) (Fig. 6). They included in particular: *D. cinerea*, *F. virosa*, *P. thonningi*, *Bridelia ferruginea*, *T. macroptera*, *T. laxiflora*, *S. latifolius*, and *A. senegalensis*, *L. microcarpa*, *V. paradoxa*, *G. lasiodiscus*, *S. senegalensis*, *S. singueana*, *Ximenia americana*). For the 'locally abundant but less frequent' species, the affinity was still mostly Sudano-Zambezian (15 out of 24), but a larger proportion of them was Guineo-Congolian and four other affinities were encountered, among which were exotic ones (Fig. 6).

Thus, the less common the plant, the greater is its chance of belonging to a southern adjacent (Guineo-Congolian) phytochory or of showing wide-ranging affinities.

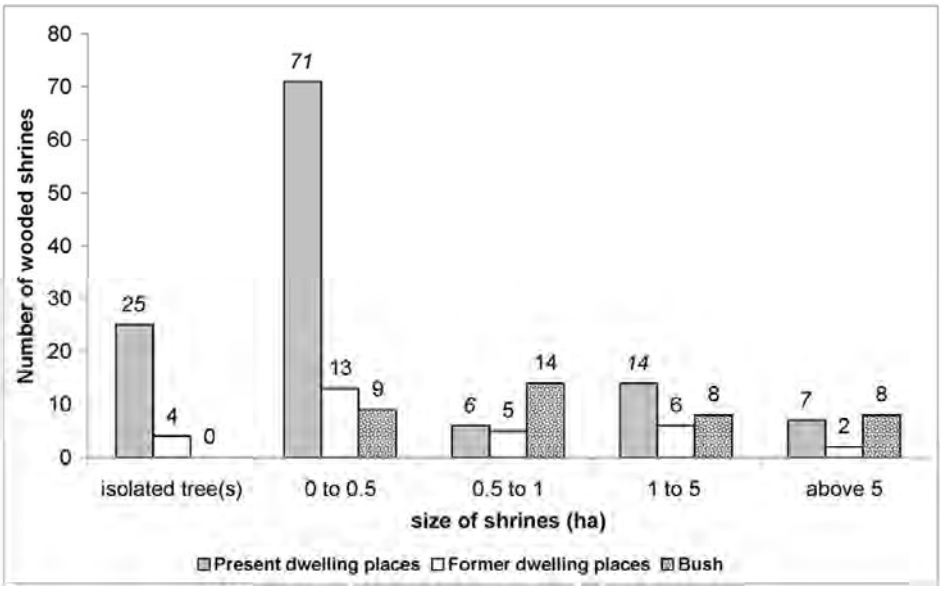

Fig. 4 Range of surface areas of wooded shrines in Bondoukuy department

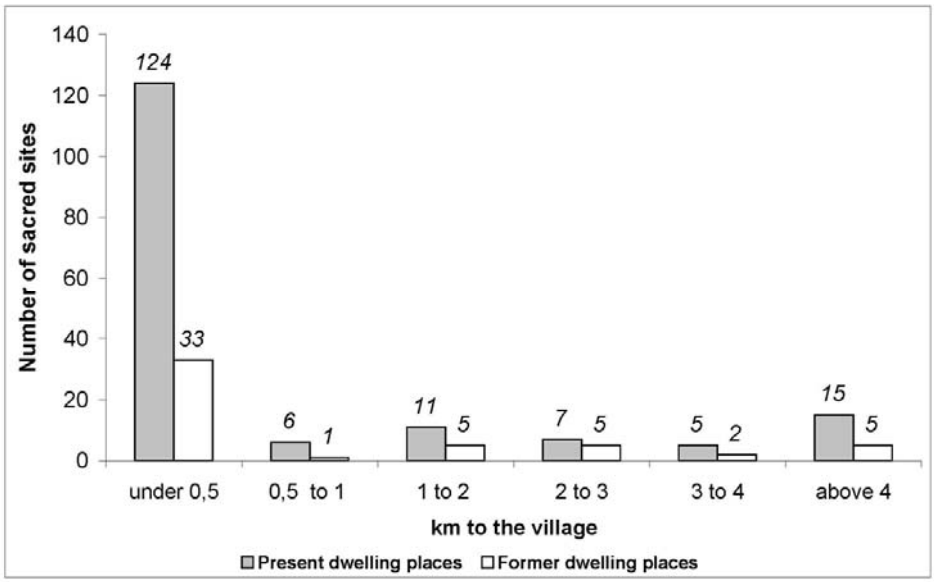

Fig. 5 Distance between former and present dwelling places and natural sacred sites in Bondoukuy department

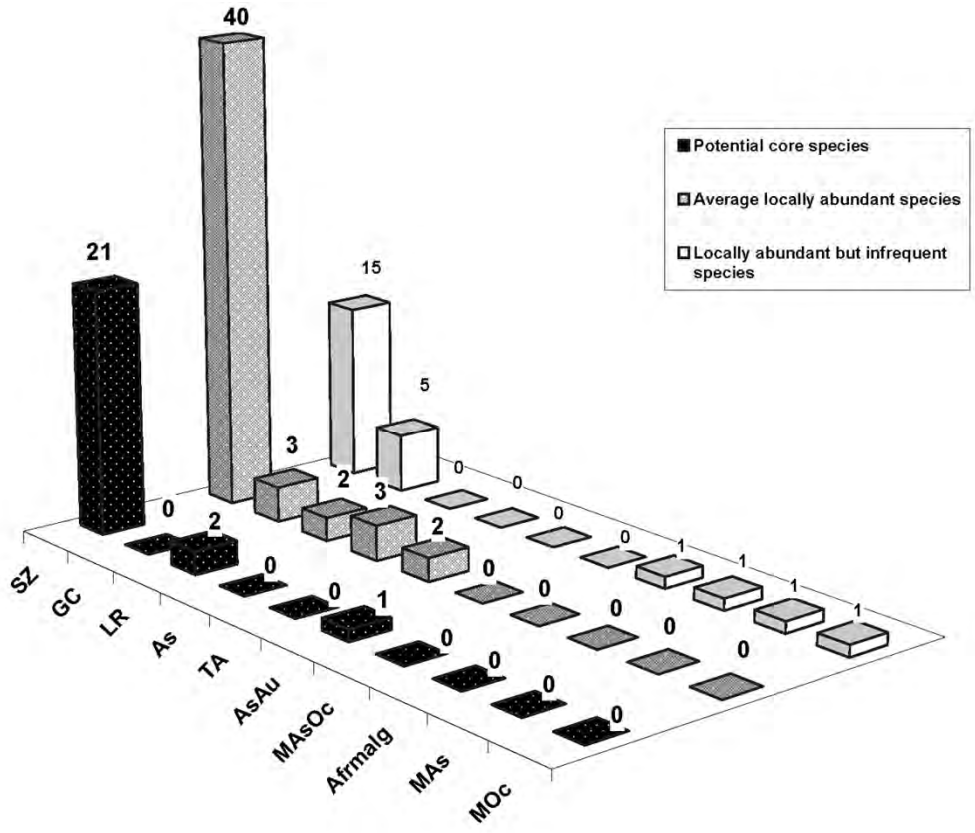

Fig. 6 Phytogeographical affinities of the locally abundant ligneous species in wooded shrines in Bondoukuy department
Affinities (with the number of species for each on the graphic) for the definition of 'abundant' and 'rarer' see text. As = Asian; AsAu = afro-asiatic and australian; GC = guineo –congolian; SZ = sudano-zambezian and sudanian; MasOc = afro-malagasy, asiatic and oceanian; Mas = afro-malagasy and asiatic; MOc = american and oceanic; Afmalg = afro-malagasy; LR = pantropical; TA = tropical Africa.

6.3 Conservation status of tree species

The conservation status of the locally abundant species was mostly 'least concern' (65 %), but a good many (23 %) were 'vulnerable' and the status was still unknown for 9 %. However, the list also included two 'near threatened' species: *Erytrophleum africanum* and *Andira inermis*. One 'endangered' tree, *Acridocarpus chevalieri* (Malpighiaceae), a Guineo-Congolian plant, was encountered on a heavily anthropized dense grove of 5 ha with a dense canopy (about 90 % cover) on hydromorphic clayey soil.

The 'frequent' (i. e.) potential *core* species all had the status of 'least concern' or 'vulnerable'. The 'abundant but infrequent' species included near threatened and endangered species as well as a good number of species the status of which is still unknown. Average locally abundant species showed intermediate characteristics (Fig. 7).

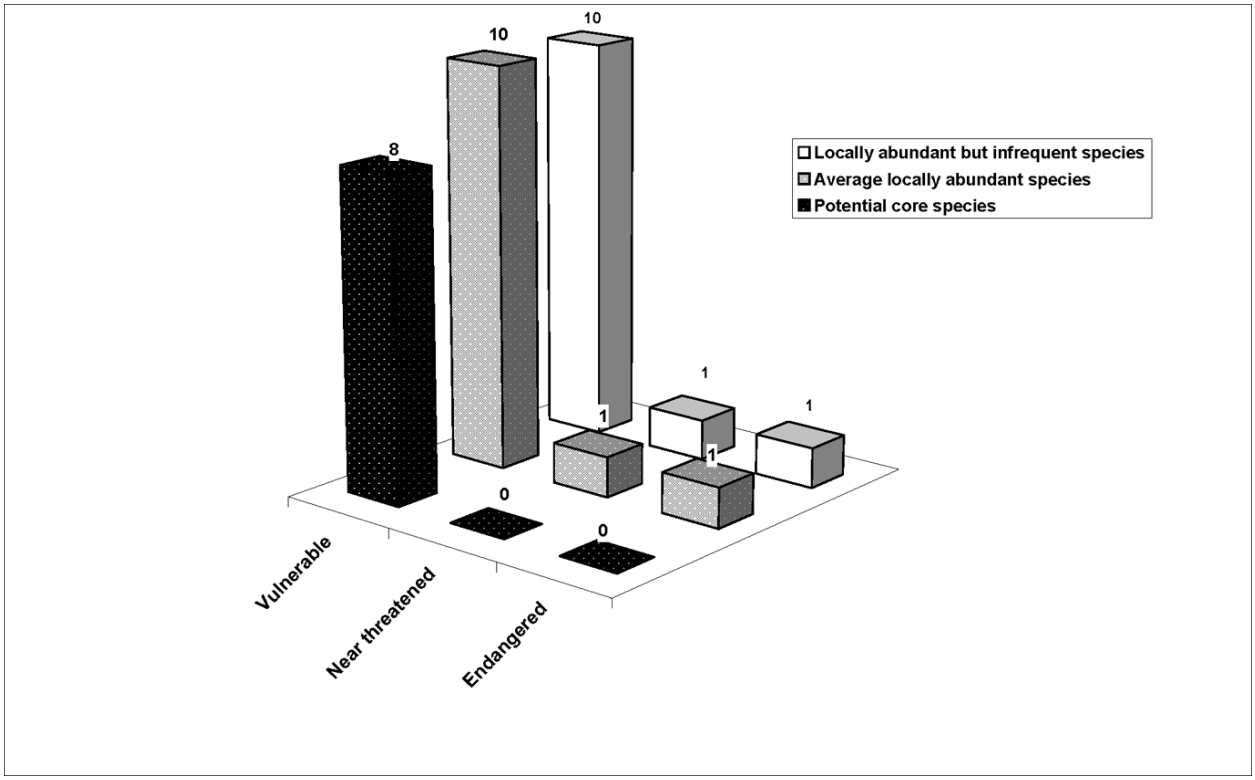

Fig. 7 Conservation status of the locally abundant species in wooded shrines in Bondoukuy department

7 Discussion

7.1 The salient biological features of the species on shrines and their link with human practices

7.1.1 The potential *core* species

Let us examine the ecological characteristics of the 6 most frequent species that we equated with potential *core* species: *A. leiocarpa, A. indica, D. mespiliformis, C. sieberiana, F. apodanthera* and *G. senegalensis* (see the full list of species in supplementary material appendix 1 and their ecological features in supplementary material appendix 2).

All these plants are Sudano-Zambesian - which means that they are species particular to the regional phytochory- except the second one which is an exotic species. The most striking features shared by potential *core* species appears to be their ability to thrive when protected from too frequent fire, the termite mounds on which some of them often grow being to a certain extent free from fire. Indeed, as a result of their location in or near villages and of their ritual treatment, Bwaba wooded shrines are usually carefully protected from fire.

7.1.2 The other species

The potential *satellite* species of grove shrines showed a much higher proportion of Guineo- Congolian -plants of the neighbouring southern phytochory)- than the potential *core* species. They preferred humid and wooded sites, mostly on riverside and bottom-slope positions (*T. macroptera, T. laxiflora, S. latifolius, A. senegalensis*. Such environments rarely cover large areas in a landscape. In addition, in the region studied, their vegetation has been almost entirely replaced by cultivated fields while there are not many in the protected areas either, since, as a rule, the state forests are established on the poorest and driest soils (Devineau et al, 2009).

The average locally abundant species included plants characteristic of fallow land and disturbed sites (*D. cinerea, F. virosa, P. thonningi, Bridelia ferruginea*) and plants that bear edible fruit (*L. microcarpa, V.*

paradoxa, *G. lasiodiscus*, *S. senegalensis*, *S. singuean*a, *Ximenia americana*) which are therefore often protected in villages, fields and fallows (Devineau et al, 2010).

Thus, these plants show a rather strong link either with humid environments or with human presence and activities. Such features may not be unique to Bwaba shrines since Insoll (2007a) for example also mentions a concentration of useful plants on the Tallensi shrines of northern Ghana.

7.2 The human logic that shapes the condition, size and location of shrines

7.2.1 Reasons for setting small shrines near villages

As already mentioned, most Bwaba sacred sites were located near the villages. This significant fact is rarely addressed in ecological studies regarding the "sacred groves", but such proximity is not surprising if we consider that regular and easy access to shrines is crucial. Indeed shrines play a major role in villagers' lives: they are involved in almost every aspect of Bwaba social life and production activities (Capron, 1973: 154-156). This location of shrines may be better understood when we examine their method of creation. As described by Capron and in our previous study, certain shrines, in particular those called Nyile, were created at the founding of the village: they relate to the dwelling of the first occupant. Other shrines were created when a *djina* (invisible being) revealed its willingness to conclude an agreement with humans through a strange event in reality or in a dream, or through a series of misfortunes. The shrine is in principle installed where the strange event occurred, but also in any other place chosen by the elected person. It follows that, for convenience, the most likely location of a shrine is near the village. In addition, shrines may be moved (Fournier, 2011).

The small size of Bwaba shrines, which makes them vulnerable to disturbance through edge-effects, seems to be in part a side-effect of their location in or near the villages and of the preference of this society for grouped housing. It is not a feature proper to Bwaba society, either: on the Asian continent Garcia disclosed almost the same size distribution for the sacred forest of Kodagu region in India, with more than 50 % of their wooded shrines being under 0.4 ha.

7.2.2 Some shrines can even be relocated near the villages

Human settlements have been very mobile in the past few centuries, as a result of conflicts, but also famines, epidemics and other crises. Armed conflicts were part of both the history of the larger region and of Bwaba traditions (Cremer, 1924: 125-147; Capron, 1962: 156-157). Groups that fled their villages of origin, for whatever reason, usually re-assembled as a separate sub-group in other villages (Lemoine, 1998), and over time found a way to relocate at least some of their sacred sites (Fournier, 2011). From the data presented in this paper, it is clear that if they were not moved, most of the sacred sites of the abandoned villages eventually disappeared or were destroyed. Thus, in Bwaba society, the proximity to dwelling places appears to be a constitutive feature of shrines. Such a location of shrines has been noticed among other societies of the Gur language group as the Nawdba of northern Togo (Laîné, 2010); it is even the usual location of shrines among the Kasena of eastern Burkina Faso (Liberski-Bagnoud, 2002; Liberski-Bagnoud et al, 2010). At least some shrines show this location among the Vore group of the Bobo society in West Burkina Faso, culturally very close to the Bwaba, but speaking a Mande language (Alfieri, 2010).

7.2.3 Why such relocation is legitimate

The exact reasons for doing so may differ among the societies since they relate to the beliefs of each of them. Moving shrines is not specific to the Bwaba, either. Le Moal (1980: 277) reports that the sacred sites related to rituals involving masks in Bobo society are commonly moved for convenience. He comments that such a process of transposition is perfectly legitimate in the eyes of those concerned and mentions similar practices of sacred sites transfer among the Dogon of Mali (Griaule, 1936: 47 note 1). Such moves of sacred sites were also reported in other societies of Burkina Faso: the Gurmantche (Kaboré, 2010: 227-233), the Bobo Vore (Alfieri, 2010:189), and the Bwaba (Fournier, 2011). Mentioning the transfer of the wooded shrines related to the

acquisition of masks among the Bobo, Le Moal recalls that myths, which take place in a dimension beyond secular time, are repeated through the rituals: the mythic narrative that describes the event is renewed and may thus sacralise a new site.

7.2.4 The choice of remarkable sites of the landscape

More than the protection of species, the system of beliefs of the Bwaba sets apart selected environments, the sites forming a system. In fact, the concept of wooded shrines is an Occidental vision that artificially isolates them from their true context: the perspective must be broadened to perceive the system in its entirety (Fournier, 2011). The latter includes a complex set of religious concepts still incompletely understood, which are based on a series of natural features that are "good to think" to borrow the famous phrase of Lévi-Strauss (1962). Regarding the selection of these sites, the presence of ligneous vegetation is not the only significant criterion. As shown by Dugast (2002), the Bwaba natural shrines are usually located in remarkable sites from which they often have derived their name: dense groves (*bani*; names according to the Bondoukuy language, one of the 17 dialects listed by Manessy (1961)), hills (*bwe*), river banks (*vuhun*), hardpans (*tini*), caves (*kani*)..., which are the really significant elements. Despite the clear-cut differences in their appearance, these various sacred sites are thought of as being elements of a same system and, as such, each of them receives its own appropriate ritual treatment. Thus, in some Bwaba villages, the sacred sites include grassy environments that must be ritually burned at a precise period of the year, while the associated wooded sacred sites must be carefully and permanently protected from fire. Their naturally opposing characteristics are thought to be associated and the ritual treatment reinforces them (Dugast, 2008).

7.2.5 The ritual treatment is not exactly a protection of plant cover

In the set of sacred sites we studied in Bwaba land, the balance tips in favour of the wooded shrines, which suggests that the standard condition of a shrine is to have vegetation. Indeed, as a rule, a sense of respect for the vegetation is attached to all of them, a view always expressed by the Bwaba and already discussed elsewhere (Fournier, 2011). Thus, the most frequent prohibitions in Bwaba wooded shrines are cultivating, cutting trees and setting fire, despite many exceptions. Fire breaks are even set up around many of them before the dry season during collective work parties which also constitute a ritual (Dugast, 2006, 2008). However, the essence of the wooded shrines seems not so much the plant cover itself as the conditions that favour its emergence and that maintain it: the observance of the rituals. Such a perception has been described in detail in another society, the Kasena of Burkina Faso (Liberski-Bagnoud et al, 2010) and it is very likely shared by many other African societies. As regards the Bwaba, the ritual rules may differ according to the sites, but in addition according to the occasions and the persons: for example in certain sites it is possible for certain persons to collect plant parts (leaves, bark, roots) for medicinal purposes or edible fruits, while it is forbidden for others (Fournier, 2011). Through a series of similarities and contrasts, the ritual rules thus define the system which is formed by the various sites, their "owners", and their treatments. In addition, they specify the position of each member of the society in this system. Indeed, the material result of the ritual treatment on vegetation is not a purpose per se.

Thus the Bwaba wooded shrines have not been created to constitute "endogenous conservatories of biodiversity" as is often accepted, at least implicitly. They are basically religious in nature, as in many other societies around the world (e.g. Juhé-Beaulaton and Roussel, 2003; Garcia et al, 2006). The ritual rules form a symbolic language, the rationale of which is to communicate with the invisible or the mythic world of origins. Ritual systems that, as those of the Bwaba, rely on natural sites in order to conceive invisible forces and to honour them through ritual treatments seem widespread in West Africa both among the peoples of the savannah (e.g. Juhé-Beaulaton and Roussel, 2003, Daugey, 2010, Fournier, 2011) and the forests (e.g. Germain, 1984: 255).

7.3 Towards a correct ecological concept of shrines

7.3.1 Endemic species threatened by an exotic invader

The phytogeographical affinity with local phytochories (Sudano-Zambesian and Sudanian) of the most abundant and frequent species of shrines in Bondoukuy department was an expected result. It advocates in favour of the often accepted idea of the efficiency of shrines as nature conservancies. However, as shown above, one of the commonest plants in shrines is a fire-sensitive exotic plant with a pantropical range. According to our informants, *A. indica* was introduced in the region as a useful plant in villages about sixty years ago. While still rare in the 'bush', it frequently grows in and around villages as an invader, and seems to meet optimal conditions on unburned shrines where it would be disseminated by birds.

7.3.2 A special treatment, if not a protection of plant biodiversity

The ritual treatment received by the Bwaba shrines regarding vegetation undeniably sets them apart in the landscape and provides them with some protection of their plant cover, despite the many exceptions and variations mentioned above and detailed in Fournier (2011). However, the Bwaba do not care about the species content of wooded shrines, but only about their plant cover; therefore, they are not much concerned about the replacement of native species by other species and do not actively prevent it.

The protection from fire requires more development regarding its conservation effect, since it seems to be a decisive factor in the proliferation of the invasive *A. indica*. In the whole area of the West African savannah, and particularly in the less anthropogenic sectors of the region studied, fire is still a regular yearly phenomenon (Laris, 2005; Devineau et al, 2010). An increasing number of authors now consider fire as a natural element that would have filtered the specific flora of the savannah environment long before the emergence of humankind (see the synthesis by Beerling and Osborne, 2006). However, viewed closely from the ground, fire does not burn uniformly in a landscape: detailed observation shows that even in the less anthropogenic environments, fire rarely burns the savannah completely. The heterogeneity of the environment was particularly emphasized by van Wilgen et al. (2003); because of it and because of the haphazard nature of fire progression (characteristics of the ground surface, dryness of the air etc. wind speed and direction) some small areas often escape the flames. The latter are especially the particularly humid, bare or rocky patches, which usually shelter different plant communities that include more species sensitive to fire (Devineau et al, 2010). As human activities result in a decrease in the quantity of combustible vegetation and an increase in the heterogeneity of the environment, they reinforce this possibility of evading fire and thus lessen the filtering role of fire. Thus, they trigger a shifting of the balance among the types of plants, and ultimately promote fire sensitive species that may be endemic to the region as well as exotic. Therefore, in today's changing environment, the protection of the vegetation of wooded shrines from fire may provide them with a certain vulnerability to exotic invasive species that are fire-sensitive.

7.3.3 Construction by humans and bias towards the most humid environments

We will not dwell upon the hypothesis of shrines as remnants of the richer environments of the past, which assumes that plant biodiversity must be higher in wooded shrines than in 'profane' areas, because the ritual treatment would have preserved a 'primeval' environment on shrines while their surroundings were changing or being altered (e.g. Guinko, 1985): it has already been discussed and refuted in most cases (Juhé-Beaulaton and Roussel, 2002; Liberski-Bagnoud et al, 2010; Fournier, 2010, etc.). In fact, quite the reverse hypothesis may be more correct as regards Bwaba shrines: due to their location in the village and to the ritual treatment from which they benefit, their initially 'natural' flora could have shifted towards a higher proportion of fire-sensitive and extraneous species. Moreover, according to the Bwaba, some wooded shrines may have been created from bare soil by human protection (Fournier, 2011), a condition known in other parts of Burkina Faso (e. g. Liberski-Bagnoud, 2002; Alfieri, 2010: 188) and of Africa (e. g. Michaloud and Dury, 1998). While data

are still rare regarding Sudanian environments, extensions of the forest at the expense of the savannah following human influence are indeed quite common in the more humid Guinean forest-savannah mosaic: following cultivation (Spichiger and Pamard, 1973; Hiernaux, 1975) and following simple protection (Monnier, 1981; Devineau et al, 1984; Louppe et al, 1995; Fairhead and Leach, 1996). On the basis of archaeological and ethnological data, Insoll (2007a) proposed that the shrines of the Tallensi in northern Ghana should be considered both natural and constructed by humans; he must be credited with having explored such ideas in greatest depth.

The active choice of sites by humans through diverse procedures is very important regarding conservation. The natural locations selected by the Bwaba are often among the most humid: they are both unusual in the landscape and highly coveted for agriculture. Very specific environmental conditions are thus created for shrines. If we compare the percentage of wooded shrines located in each of the three main recognized physiographic units with the relative surface of these units, we observe an overrepresentation of river bank and lowland positions. This type of environment represents less than 5 % of the surface in the region (Devineau, 1986: 81) but 50 % of shrines are located in on them. Thus, shrines represent a doubly biased sample: towards the more humid landscape feature and towards the species that are fire-sensitive or useful for humans.

Venerating the invisible through prominent natural features near the village and respecting their vegetation is not an oddity of the Bwaba; many other West African societies, e.g. the Kasena (Liberski-Bagnoud, 2002), the Kusasi (Mather, 2003) and the Tallensi (Insoll, 2007b) show the same predilection. However, the variations in the ritual rules have not yet been studied.

7.4 Implications for the future of plant core species

Most of the presently frequent locally abundant species can certainly be assumed to be *core* species as defined by Hanski. However, are they all good candidates? The rather wide-ranging Sudano-Zambezian plant *A. leiocarpa*, quite common in profane areas, certainly is. Other plants showing either more humid and more southern affinities (*D. mespiliformis*) or drier and more northern affinities (*F. apodanthera* and *C. sieberiana*) may also be considered to be *core* species. But should we consider the pantropical recent invader, *A. indica* as a *core* species? This plant presently threatens the F. *albida* agroforestry parkland and the village shrines in Bondoukuy department (unpublished personal observations), as already described by Ganaba (1996) in other provinces of Burkina Faso; however the dynamics of this species is still poorly understood. Denslow and Hughes (2004) have underlined that invasive exotic plant species and native dominants may have similar effects on plant communities through their influence on local diversity and ecosystem processes. Moreover, after an initial highly dynamic stage, equilibrium may be reached with time, and the invasive species may themselves become the new *core* species that will replace the eliminated species; such a process may be ongoing in Bwaba shrines.

As underlined by White et al. (2010), understanding the linkages between the spatial and temporal patterns related to the richness and the abundance of species is crucial. Thus, some of the abundant but infrequent species can certainly be thought to be the survivors of plant communities that were once thriving, and thus may be supposed to be the *core* species of the landscape of the past that were shaped under lower human pressure. In fact, many of them show affinities with more humid environments than those presently observed, which is consistent with the environmental changes of recent decades. However, after the episode of drought, the climate is improving again in West Africa since 1990 (Wittig et al, 2007). If that trend is confirmed, the 'abundant but infrequent' species may expand again in future, provided that there are still wild places or wooded shrines where they can grow. However, some of these species might also disappear in the future.

The maintenance on shrines of some *core* species of previous landscapes does in no way mean that the plant communities themselves have been preserved. As demonstrated by the case of *A. indica*, some *satellite* species

present in the highly modified vegetation of shrines may eventually introduce themselves into the established plant communities or overrun them.

8 Conclusion

In this paper we have revisited the issue of sacred groves plant cover using the *core* and *satellite* species model of Hanski through a review of almost all of the shrines in a department of Burkina Faso. We also recorded their location in relation to dwellings and physiographic units. These data were analyzed and compared with available knowledge on Bwaba society and religion in order to describe the key features of the wooded shrines and anticipate the future of their *core* species.

It was shown that shrines are very diverse in their conception and are organised in a system; the wooded ones are mostly small in size and are preferentially located in villages or near them in remarkable landscape features located in low-lying topographical positions. These features directly relate to the representations of the invisible of the Bwaba and to their day life. This implies that shrines are subject to a regime of rather high anthropisation, but also that they contain relatively rare species particular to humid or rocky sites among which are plants endemic to the neighbouring southern- most humid zone.

Thus, the shrines are inevitably influenced by human activities, but on the other hand they are biased in favour of a particular flora, which is of interest for biodiversity conservation. Both of these characteristics are integral parts of their structure, and are not the result of any degradation or change. Nevertheless, a disturbance that really affects this system is the destruction of the bush in favour of cultivated land and in the ensuing modification of the fire regime. Besides, the Bwaba concept of sacred sites makes it clear that "traditional" beliefs cannot guarantee plant conservation on shrines: respect for ritual procedures matters much more than any ecological results on vegetation: a replacement of the local flora by alien species or even the entire disappearance of any plant cover would not impede the local cults.

In today's savannah environment, wooded shrines have to face the new conditions of extensive cultivation and altered flora and landscapes, and it seems that only the *core* species may have a good chance of being preserved. In addition, one of the major ritual prescriptions, protection from fire, now seems to be paving the way for the overthrow of the established plant communities in the form of an invasion by an alien species sensitive to fire.

We hope to have demonstrated that adopting a new approach focused on the most abundant species and integrating much more of the knowledge of other disciplines may help in identifying and prioritizing the key elements regarding the system of wooded shrines. But this is only a first step in this process.

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