Socio-ecological factors favouring the presence of Erythrocebus patasschreber (Cercopithecidae) in the classified Agoua forest in central Benin

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ABSTRACT: This research aims to investigate the distribution factors of Erythrocebus patas (red monkey) in the classified Agoua forest. The data was collected from the floristic inventory, carried out within 30 30m x 30m squares. Similarly, direct observations were made to note the variables that favour the presence of the species. An Analysis of The Main Components (CPA) is done on the data collected to establish the correlation between the different types of plant formation and the characteristic elements of the environment. The results show that 70% of the red monkey's habitats are found in savannas on ferralitic and ferreginous soils and 30% of its habitats are in forest galleries, on hydromorphic soils. These habitats are generally characterized by the presence of plant species that provide them with food, serve as resting places, hiding places and predation. Water points, roads and fields are less than 5km from these habitats. However, local populations have a variety of knowledge about the use of red monkeys. All this information allows the development of an ethnobotanical repository for the conservation of the species in central Benin.

KEYWORDS: Distribution factors; Ethnozoology; Red monkey; Classified forest; Agoua.

1 INTRODUCTION

The effects of forest degradation, combined with the high hunting pressure in Africa, have led to a gradual awareness of the need to conserve critical forest habitats and the species that occupy them [1]. To this end, Benin has protected areas that are natural habitats, diversified, grouped into classified forests, and which constitute a reference and a chance for the development of terroirs. They are also a refuge for especially wildlife, which is a vital element in the lives of the various existing populations on the globe [2].

In Benin, there are about ten non-human primates [3], among them the red monkey (Erythrocebus Patas), confirmed [4], [5]. In the classified Agoua forest, populations are inefficiently exploiting natural resources, resulting in the gradual disappearance of animal species and the decline of vegetation cover [6].

Some animals are subservient to particular types of environments and their distribution depends mainly on the presence of preferential habitat [7]. Several studies have been conducted on primates in Benin. These include, for example, the studies of [8], [4], [1], [9], [10] on Colobus vellerosus, Cercopithecus mona, Procolobus verus, Cercopithecus erythrogaster erythrogaster, Chlorocebus tantalus tantalus, Cercopithecus aethiops, Cercopithecus patas, Papio anubis, Colobus bais, Colobus vellerosus, Colobus verus; Galago senegalensis.

But very few have provided information about Erythrocebus patas, the red monkey, the subject of this study in the Agoua forest. This study is particularly interested in the various elements that promote the presence of Erythrocebus patas in the

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classified Agoua forest, as its conservation is critical due to human hunting, and which has increased considerably in West Africa [11], [12].

Thus, for the conservation and sustainable management of the habitat of the Erythrocebus Patas in the classified forest of Agoua, it is necessary to know its living environment and the elements that contribute to its installation and survival.

2 MATERIALS AND METHDS

2.1 PRESENTATION OF AGOUA CLASS FOREST

The classified forest of Agoua is located in the commune of Bantè in the department of the Hills (Benin), between 8-25' and 8-50' north latitude and between 1: 40' and 2-25' of east longitude [13], (Fig. 1). It covers an area of about 75300 ha according to the classification order 8104 SE of November 4, 1953.

The classified forest of Agoua enjoys a humid Sudanese-type climate marked by two seasons. A dry season from November to March and a rainy season from April to October. The annual rainfall is 1100 mm distributed, on average over 97 days. Monthly thermal averages range from 25 to 30 degrees Celsius and daily thermal differences are small [14]. Relative humidity is no more than 31%. Total sunstroke for the year reaches 2305 hours with a maximum in March (237 hours) and a minimum in August (88 hours) [15]. The climatic context of the Agoua forest massif is therefore favourable for the development of vegetation which suffers from no limitations for its water and mineral diet. Indeed, in this massif there is a diversity of plant formations rich in PFNL that significantly contribute to the improvement of the living conditions of the coastal populations [16]. The various socio-cultural groups living around the forest engage in many activities, including agriculture, which is the main source of income for the majority of the peoples [13].
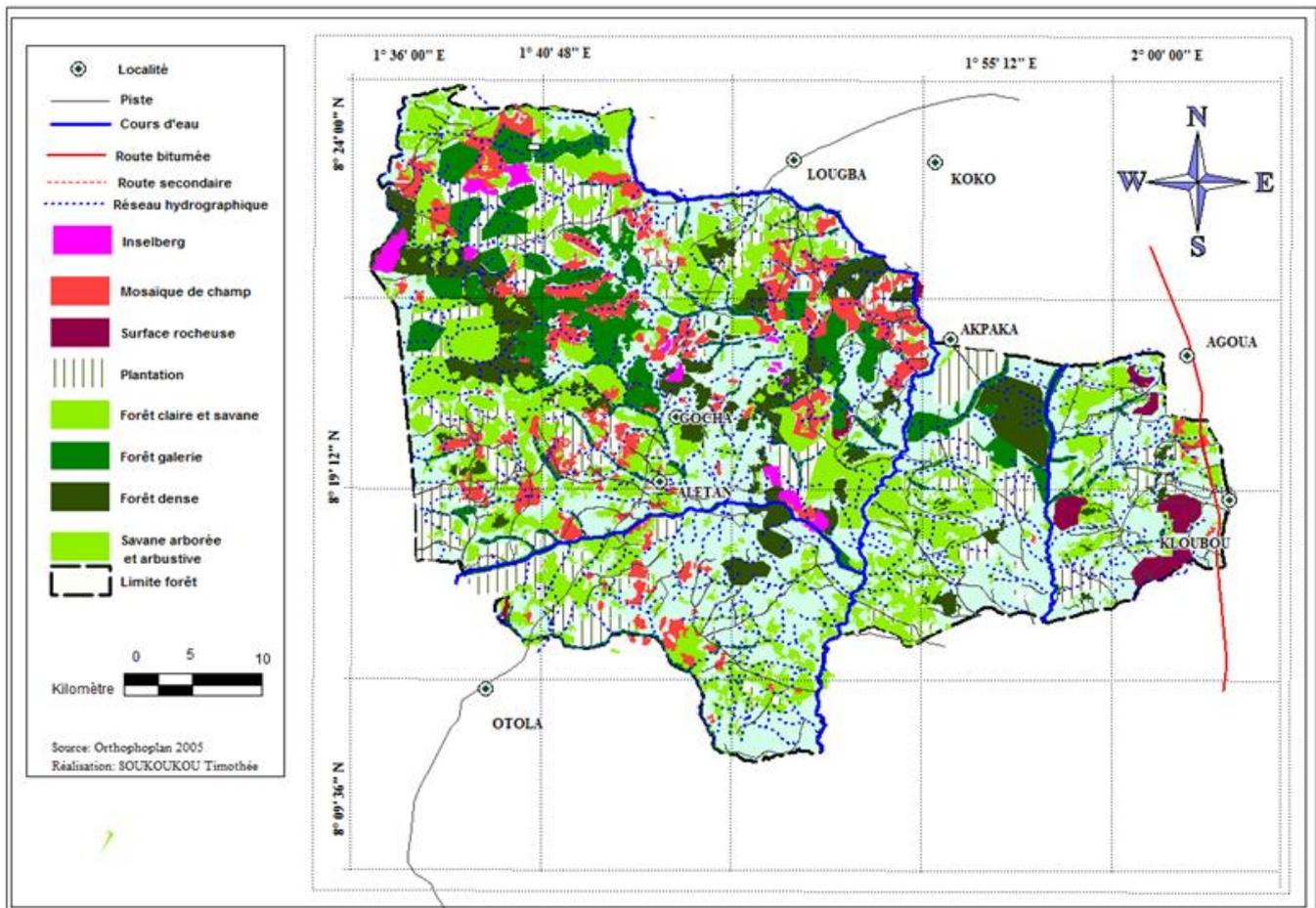

Fig. 1. Location and land-use units of the Agoua Classified Forest

2.2   ORGANIC MATERIAL

The Red Monkey (Photo 1) is from the animal kingdom, branch of vertebrates, the class of mammals, order of primates, the family of Cercopithecidae, Subfamily of Cercopithecinae and genus Erythrocebus. The red monkey is a thin species of dorsal redbrown and grey-white ventral color [10], [4]. The face can be recognized from an eyebrow arch and black nose as well as by the white area around the mouth. The coat is red in colour but the belly, limbs and feet are white. It measures between 50 and 70 cm and weighs between 7 and 13 kg [11].

Photo 1: View of a Red Monkey

2.3   DATA COLLECTION

To collect information about the red monkey's preferred habitat, the forest is traversed by north-south transects 1 km apart. Observations are made early in the morning between 7am and 10am and in the evenings between 4pm and 7pm, when the animals are supposed to move to water points or in search of food. The presence of Erythrocebus patas is notified through their cry, eye contact, paw prints, the rest of the eating. This method has been used to identify the animal's sites of occurrence and to install places. In total, thirty (30) 30m by 30m places have been set up. At the level of each square, the floristic inventory of all the species present was made as well as the vertical structure of the vegetation. In addition to this, other data such as the presence of animal species, proximity to homes, fields, roads and water points were collected.

2.4   DATA PROCESSING AND ANALYSIS

The data obtained from the collection were codified, stripped under the Excel 2010 spreadsheet and then subjected to a descriptive statistical analysis Thus, the relative frequencies are calculated according to the formula: f-n/N; with n: the number of people who answered yes and N: the total number of people surveyed and having cross-tables. Using the MINITAB software, an Analysis of the Main Components established the correlation between the different types of plant formation and the characteristic elements of the environment (Stratification, distances between habitat-first water point, habitat-fields, habitat-road).

3   RESULTS

3.1   TYPES OF PREFERRED VEGETALES FORMATIONS OF THE SPECIES

In the classified agoua forest, the red monkey prefers savannas more, especially the tree and shrub savannahs (71%) and gallery forests (29%).

Photos 2 and 3 show the tree savannahs and gallery forest in the classified forest of Agoua, respectively. This habitat is floristically diverse in which the following species are common. These are: Daniellia oliveri, Anogeissus leiocarpa, Combretum spp, Pterocarpus Erinaceus, Vitellaria paradoxa, Isoberlina tomentosa, Isoberlina doka, Aframomum saptrus, Ficus gnaphalocarpa, Afzelia africana, Terminalia spp, Parkia bigliboza, most of which give fruit.

It is composed of species of herbaceous strata (less than 2 meters) of shrub strata (2 to 5 meters) of tree strata (more than 5 meters) forming an open vault. Photo 3 shows a gallery forest, it is a preferred habitat by the species in the dry season, given its proximity to the water points.

Also, from a structural point of view, this formation presents two layers simultaneously (herbaceous and tree strates) forming a closed vault. Plant species such as Khaya senegalensis, Diospyros mespiliformis, Kigelia africana, Borasus aethiopum, Pterocarpus santalinoides, Cola gigantea, Morelia senegalensis, Syzygium guineense are commonly found here.

Photo 2. Tree savannah

Photo 3. Forest gallery

3.2   VERTICAL STRUCTURE OF VEGETATION

Fig. 2 shows the proportion of the different strata present in all the squares, sites of occurrence of the red monkey.

From the analysis in Figure 4, it appears that 60% of the red monkey habitats in the Agouaclassified forest are made up of species from the three strata simultaneously (Strate I: herbaceous, less than 2 metres in size; Strate II, shrub, size between 2 and 5 meters and Strate III, Arborescent larger than 5 meters. The denser the vegetation (Savane), the greater the chance of encountering the red monkey's habitat. It is therefore a promoting (no threat) element of the distribution of red monkeys in the classified forest of Agoua.
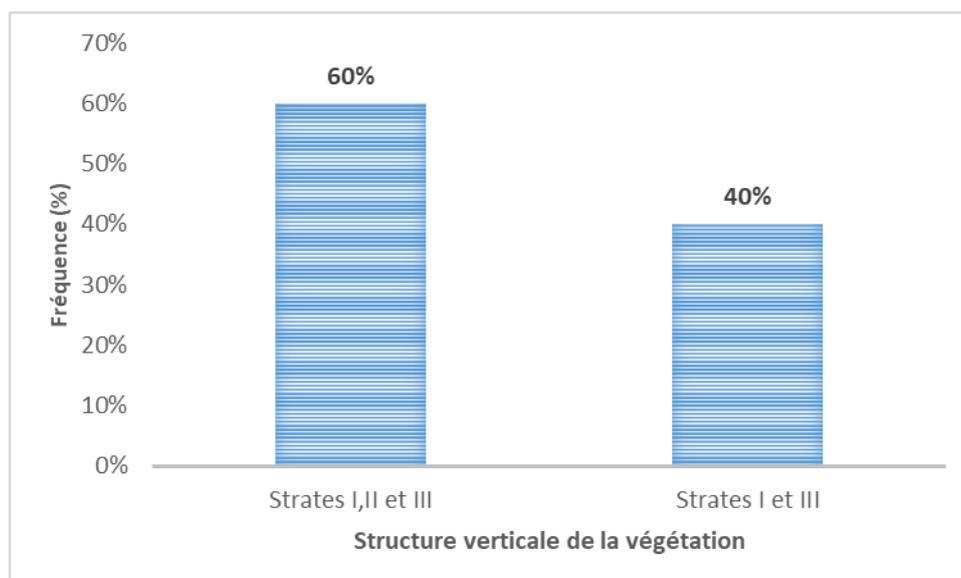
Fig. 2.   Vertical structure of vegetation

3.3   AVAILABILITY OF FOOD RESSOURCES

The availability of food resources is an indispensable factor in the distribution of all living things. Thus in the classified forest of Agoua, the presence of food is important for the presence of the red monkey. This species has a diet consisting of fruits, seeds, insects, bird eggs, lizards and tubers. The assessment of the availability of food resources identified different types of food (Fruit, Sheath, tubers, insects).

Photos 4 and 5 show some of these foods. Photos 4 and 5 show the fruit of Aframomum saptrus and the Ficus gnaphalocarpa tree whose fruits are eaten by the red monkey. In addition, in the fields, located not far from the species' preferred habitats, the remains of the species' food are found. This means that these animals also find their food in the fields. This assessment shows that food resources are available in abundance for this animal species in the forest and therefore this factor cannot in any way be a factor limiting the presence of the red monkey.

Photo 4. Fruit of Aframomum saptrus

Photo 5. Ficus gnaphalocarpa tree

3.4   DISTANCE BETWEEN HABITATS AND FIRST WATER POINTS, ROADS AND FIELDS

The distance between habitats and water points is measured during the dry season as it has been found from surveys that these animals find plenty of water in the rainy season. Below show the distances obtained during this study. Analysis of this

table shows that 30% of the red monkey's habitats in the Agoua-classified forest are between 100 metres and 1.5 kilometres from water points, while 70% of its habitats are between 2 and 5 kilometres away.

In terms of habitat-road distances, 43.33 per cent of habitats are between 0.1km and 1.5km, while 56.66 per cent of habitats are between 2 and 5km. The results also showed that 56.66% of habitats are located between 500m and 1.5km from the first fields, while 43.33% of these habitats are between 2 and 5km away.

Table 1. Distances between habitats and first water points, roads and fields

Variables	0, 1km – 1, 5km	2km - 5km
Distance Habitat-Point d'eau	30 %	70 %
Distance Habitat-Route	43, 33 %	56, 66 %
Distance Habitat-Champ	56, 66 %	43, 33 %

3.5 CORRELATION ANALYSIS BETWEEN THE DIFFERENT CHARACTERISTICS OF RED MONKEY HABITATS

The main component analysis (CPA) investigated the correlations between habitat types and the characteristics. PC1 and PC2 because already, the first axis (PC1) illustrates 100% of the information related to the initial variables. This is enough to ensure a good analysis. The correlations between these two axes and the variables characteristic of the habitat, summarized in and Fig. 3, indicate the representation of the following elements the axes.

From the analysis of Table IV and Figure 6, it appears that characteristics such as: Strate 1 (Plant species of Herbaceous strata, 2-5m and more than 5m Simultaneous; whose all the peaks form a closed or open vault in places), Food species (Presence of plant species providing food to the red monkey) Ferralitic (Ferralitic Soil), Ferrugineux (ferrginous soil), DHE2 (Distance habitat water point between 1-5km), DHC1 (Distance habitat-field between 0.5km-1.5km), DHR2 (Distance habitat-road between 2-2.5km) and Predator (Absence of predators), are negatively correlated on the PC1 axis with a correlation coefficient of 0.277 for each. If these elements are found on the same axis and negatively, it is because they characterize the same habitat (the Tree Savane and Shrub). In addition, Strate2 variables (plant species of herbaceous strata and more than 5m, whose all the peaks form a closed vault) Hydro-morph (hydro-morph soil), DHE1 (Distance habitat water point less than 1km), DHC2 (Distance habitat-field between 2 and 5km), are positively correlated on the PC1 axis, with a coefficient of 0.277 each. This shows that habitats in gallery forests are also characterized by these elements.

However, the food species variables (Presence of fruit-supplying species) and DHR1 (Distance habitat-road between 0.1 and 1.5km) are negatively correlated on the PC2 axis with the respective coefficients of -0.327 and -0.642. This means that these elements characterize both types of habitat.

Table 2. Changes in own values based on the number of Main Components

| Variables	PC1	PC2	PC3
Strate1	-0, 277	-0, 245	0, 116
Strate2	0, 277	0, 048	0, 244
Présence de nourriture	-0, 277	-0, 327	0, 082
Sol ferralitique	-0, 277	0, 267	-0, 207
Sol ferrugineux	-0, 277	0, 267	-0, 207
Sol Hydromorphe	0, 277	-0, 267	0, 207
Distance habitat- eau à moins de 1km	0, 277	0, 269	0, 451
Distance habitat- eau entre 1 et 5km	-0, 277	0, 173	0, 067
Distance habitat-champ entre 500m-1km5	-0, 277	0, 267	-0, 207
Distance habitat-champ entre 2-5km	0, 277	-0, 041	-0, 440
Distance habitat-route entre 100m-1, 5km	-0, 277	-0, 642	-0, 015
Distance habitat-route entre 2-2, 5km	-0, 277	0, 107	0, 404
Absence de prédateur	-0, 277	0, 141	0, 429
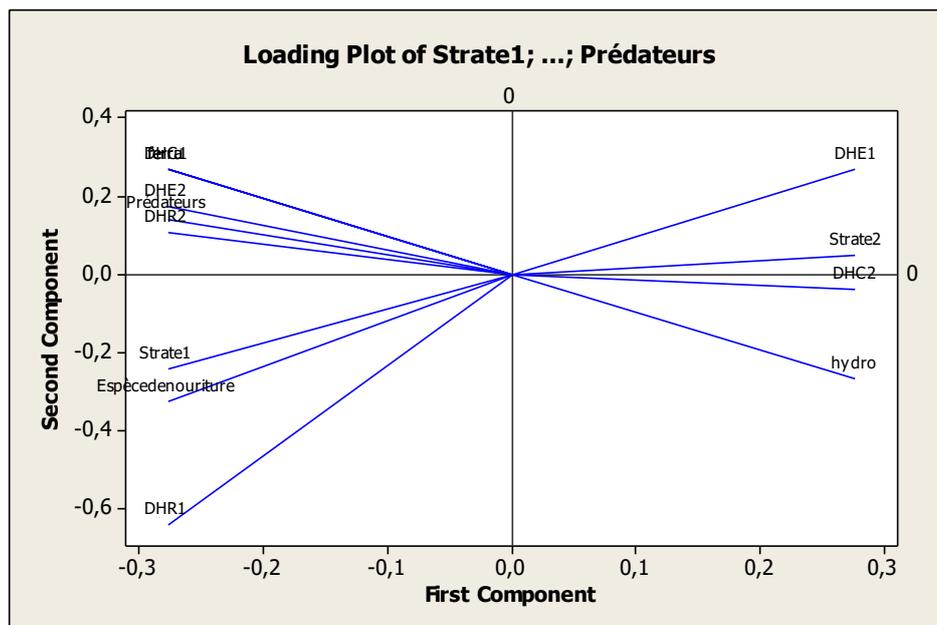
Fig. 3. *Correlation of variables with the first two Main Components*

4 DISCUSSION

From this study, it appears that the red monkey is a species that prefers to remain in the savannahs (Trees and shrubs) and in the gallery forests characterized by the presence of food, water points, strata forming closed vaults in places on ferralitic, ferruginous and hydromorphic soils. This is because the animal rests when it is hot, hides or disappears very quickly when it feels unsafe in the face of human presence. It therefore needs a safe and difficult place to access predators, shady enough to be seen or disturbed and provides food and water. In addition, the food resource is available in abundance for red monkey species in the classified Agoua forest.

This abundance is justified first by the proximity of habitats to the fields and then by the richness of food-providing species and ultimately by the diet of the species. To this end, according to [17], there is a trend towards an omnivorous diet, in relation to the product range available for tree species (leaf, seeds, insects, eggs).

Unlike [7], which has studied the identification of landscape factors affecting the distribution of wildlife in a forest concession in Gabon and who also believe from their analyses that the availability of food resources is not a determining factor in the distribution of wildlife at the landscape level, this habitat characteristic is favourable to the distribution of the red monkey in the classified forest of Agoua [18]. addressed the same idea and sees that the dispersion of food resources, water points, savannah, day or night resting sites (areas offering protection against certain types of predators) and their diversity lead the animals to a daily exploration of an area of their habitats.

The limitations of this research are based on the lack of adequate tools for data collection. Types of soil are identified through the perception of local peoples. Also, the period of collection of this data (November-January) also played on this result, because it is a period when some plants reach a critical state that does not allow to properly appreciate the floristic composition of the habitat of red monkeys.

According to the results, the availability of water resources poses a threat to the distribution of red monkeys in the classified Agoua forest. This threat could be explained by the simple reason that during the dry seasons, the streams are dry and the few rare watering points used as watering troughs for animals are often invaded by herds of oxen and also serve as hunting grounds that is to say that hunters calculate the times when the animals come to drink and wait for them to kill them.

It should also be noted that agriculture is the main threat to red monkeys. It is the main and economic activity of the local people and each season; new spaces are tangled [19]., through the study entitled: Habitat characteristics of the red-bellied monkey (Cercopithecus e. Erythrogaster) in South Benin address this same idea and believe that it is obvious that the current area of presence of this cercopithecus, which is still the object of traditional agriculture and a place of collection of firewood, keep the monkeys in precarious conditions.

The progress of this activity highlights the phenomenon of deforestation. The results of [20] on deforestation confirm this result. For this author, deforestation is usually the result of land clearing by farmers for agricultural purposes. Also, the anthropization of the environment is strengthened over time until the primary forest almost becomes depleted and the creation of the fields has contributed to the transformation of the vegetation cover. Similarly, [17] believe that deforestation is the main threat to Benin's primates and that in the village territories, itinerant agriculture results in the loss of original vegetation, hence the habitat of monkeys.

As far as poaching is concerned, in the classified forest of Agoua, it is more about hunting than fishing, although the latter exists. It is a threat that directly affects (regression and disappearance) the populations of Erythrocebus Patas, (red monkey). The work of [17], according to which hunting, because of its generally poorly supervised nature, contributes to a significant decline in wildlife populations and that the tools used are rifles and traps of various types, confirm the results of this study which are justified by hunting methods and tools [9]. also addresses this type of threat and sees that "the search for game increases the pressure on forest resources and jeopardizes the habitat of monkeys; which increases the threat of extinction hanging over these animals. »

5 CONCLUSION

The objective of this study is to study the distribution factors of the red monkey in the classified Agoua forest for conservation. From the analysis of the results, it appears that the habitats of the red monkey are characterized on the one hand by the savannahs (tree, shrubs) on ferralitic and ferrgininous soils, whose vertical structure consists of species of herbaceous, shrub and tree strata forming an open vault for the most part and on the other hand of the gallery forest where all species form a closed vault. These species provide food, serve as resting places and hiding places even if there are no predatory animal species, in case of danger. Moreover, these habitats are not as far from fields and roads. During dry seasons, water availability is a threat to this species. But in reality, human activities, in this case agriculture, are the main threat of the red monkey in the classified forest of Agoua. In addition, the man (poacher) uses traps, dogs and guns to kill them. Finally, wood cutting and transhumance are not without negative effects on their distribution. Given the importance of this species in maintaining biodiversity, it is urgent to preserve it. Prohibit the anarchic multiplication of fields and roads within the forest, involve the local population in forest management, ban trees, hunting, lighting of wildfires and other actions that could endanger wildlife, redevelop the forest.

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