Bioclimatic of mycosis among wild and endemic animals captive-bred at Tsimbazaza Park in the Madagascar

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Abstract: The Madagascar is renowned as a country with a high endemism Fauna. The island is among the hotspot biodiversity countries. In fact, some infectious diseases are harmful for its wild endemic animals but related information is lacking. This study is carry out to overcome at this deficit. The method of records' research is used to estimate the incidence of the mycosis among these animals which were captive-bred at the Tsimbazaza Park. Then, a bioclimatic study is done to appreciate the influence of climate on the development of fungal pathogens and its impact on animals. During the period of observations from year 2011 to April 2018, three types of mycosis (ringworm, aspergillosis and candidiasis) are affected twelve animals: three of them are healed and the rest died mostly by sudden death. Aspergillosis was common than the others type of infections. All classes of animals (mammals, aves, reptiles) are concerned with eleven endemic species listed on the red list of International Union for Conservation of Nature (IUCN). Females were more vulnerable than males. The optimum of diseases are located in 2016 and 2017, recorded among the global warmest years. These conditions was favorable both for generating discomfort within the living organisms and for fungus development. Infections were more significant at the two periods of offseason in the Madagascar. These outcomes will help in improving the management of the conservation program by taking into account climate-pathological risks. They may be used too, as eco epidemiology indicators on prevention of the mycosis infections in the Madagascar.

Keywords: Bioclimatic, eco epidemiology, hotspot biodiversity, mycosis, Madagascar, wild endemic animals.

1. Introduction

The Madagascar's isolation over than millions of years is an ideal condition for the development of a highest endemic biodiversity. The International Conservation has recorded among the Malagasy Fauna: i) 101 endemic primate species and subspecies, (ii) five endemic bird families which represent 51% of the diversity, iii) 370 reptile species with 90% endemic, not found nowhere else (Conservation international, 2017). In 2016, the UNEP-WCMC[1] has classified the island among the hotspot biodiversity countries (MEEF, 2016). In fact, infectious diseases such mycosis are harmful for these wild endemic animals while related information is lacking. This retrospective research aims to fill this gap by estimate the incidence of the mycosis infections among these animals captive-bred at Tsimbazaza Botanic and Zoology Park (PBZT). Then, a bioclimatic study is carried out to appreciate the relationship between climate conditions within discomfort of living organisms and the development of fungal infections. The outcomes of the study will help mainly to improve the conservation program and to prevent mycosis diseases in the Madagascar.

2. Site and Methods

2.1 Site

The PBZT is positioned at 1261m altitude in the capital of the Madagascar. It is set in the sub humid climate stage attenuated by fogs in the dry season (Cornet A., 1974). The Park is assigned for the conservation of endemic species exposed to extinction in their natural local. It participates in the implementation of the national strategies and policies on climate change and biodiversity (MeSupReS, 2015).

2.2 Methods

Investigation of the zoo stored data

A research method using zoo records is done (Holly Farmer and al., 2013). The investigation concerned the archives 'information which are stored from year 2011 to April 2018 at the Zoo. They are related to: i) scientific name, ii) sex, iii) clinical data,

[1] UNEP-WCMC: Centre de surveillance de la conservation de la nature / Agence du programme des Nations unies pour l'environnement

including details of symptoms, treatment given, iv) year of the infection, v) finality of disease: healed or death with the date, vi) the results of post-mortem examination: organs or tissues lesions after dissection observations and laboratory investigations[2] to specify the kind of mycosis.

Bioclimatic study

Climate data (temperature and rainfall) from national meteorology office is used to appreciate the relationship of climate on the fungus development and the discomfort of the living organisms. Humidity Index (HI) which measured the effects of combined heat and humidity on the body stress is used to class discomfort of living organisms according its value (Demoulin P., 1998):

- 20 <HI <29: Feeling of well-being
- 30 <HI <34: Feeling more or less uncomfortable
- 35 <HI <39: Sensation of large discomfort. Care or may extend to general feeling of discomfort.
- 40 <HI <45: Danger.

3. Results and Discussion

3.1 Mycosis, species and their IUCN status

Three kinds of fungal infections are identified to distress wild endemic animals. These are: ringworm, candidiasis and aspergillosis. Twelve (12) species in all classes of animals (reptiles, aves, primate and non-primate mammals) are affected by mycosis. Only one species, *Chrysolopus pictus* (*Chrysolopus p*.) was not an endemic animal; ten (10) of them are endemic species listed in the International Union for Conservation of Nature's red list (IUCN, 2011). The classes on the red list are following:

- **Class in "danger of extinction" (EN)**: three species (03): *Anas bernieri* (*Anas b.)*, *Circus macrosceles* (*Circus m.*) and *Lemur catta (Lemur c.*) (Tab.1).

Table 1: Animals in class of danger of extinction (IUCN)

Photo 1 PBZT
Class : Aves
Ordre : Ansériformes
Family : Anatidae,
Species: *Anas b.*

Photo 2 PBZT
Class : Aves,
Order : Falconiformes
Family : Accipitridae,
Species: *Circus m*

Photo 3 PBZT
Class : Primates,
Order : Lemuriformes,
Family : Lemuridae,
Species: *Lemur c.*

- **Class in «Vulnerable» (VU)**: four species (04): *Eulemur rubriventer* (*Eulemur r.*), *Cryptoprocta ferox* (*Cryptoprocta f.*), *Falculea palliata* (*Falculea p.*), *Uratelornis chimaera* (*Uratelornis c.*) (Tab. 2).

Table 2: Animals in class of Vulnerable (IUCN)

Photo 4 PBZT
Class : Primates
Order : Lemuriformes
Family Lémuridea,
Species : *Eulemur r.*

Photo 5 PBZT
Class : Aves,
Order : Passériformes,
Family : Vangidae,
Species: *Falculea p.*

Photo 6 PBZT
Class : Aves,
Order : Coraciiformes,
Family : Brachyptéraciidea,
Species: *Uratelornis c.*

[2] Laboratoire National de Diagnostic Vétérinaire (LNDV) and Laboratoire de l'Institut Pasteur de Madagascar (IPM)

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Photo 7 PBZT
Class : Non-primate mammals
Order : Feliformes,
Family : Eupleridae,
Species: *Cryptoprocta f.*

- **Class in "Newar Threatened" (NT)**: One species: *Lophobis cristata* (*Lophobis c.*) (number=2) (Tab.3).

Table 3: Animal in class of Newar Threatened (IUCN)

Photo 8 PBZT
Class: Aves,
Order : Pélécaniformes
Family: Threskiornithidea,
Species : *Lophobis c.*

- **Class in "Least Concern" (LC)**: two species (02): *Crocodylus niloticus madagascariensis* (*Crocodylus n. m.*) and *Anas platyrhynchos* (*Anas p.*) (Tab. 4).

Table 4: Animal in class of Newar Threatened (IUCN)

Photo 9 PBZT
Class : Reptiles,
Order : Crocodilians,
Family : Crocodylidae,
Species: *Crocodylus n. m.*

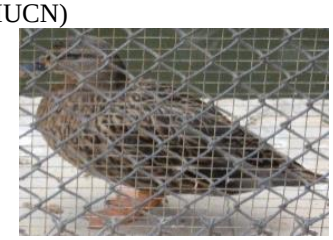


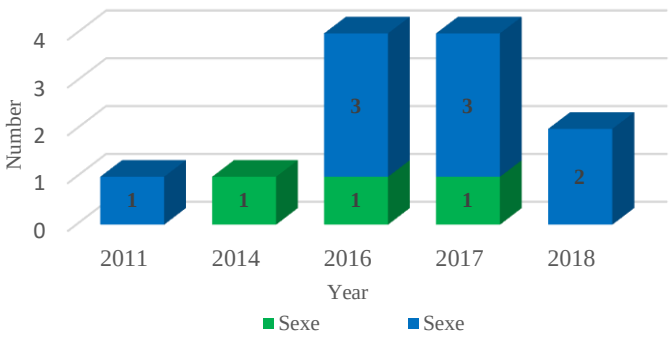
Photo 10 PBZT
Class : Aves
Ordre : Ansériformes
Family: Anatidae,
Species: *Anas p.*

If the ringworm is observed for one animal and the candidiasis disease for two, in opposite, aspergillosis was common among nine animals. Three (03) animals are recovered after treatment: *Eulemur r.* from a ringworm disease and *Lophobis c.* and *Chrysolopus p.* from a light aspergillosis. Nine (09) others was dead with five (05) sudden death.

3.2 Animals by sex and years of disease

The Figure1 reports the dispatching of animals by sex within the study years.

Figure 1: Number of animals by sex of within the study years



http://dx.doi.org/10.31364/SCIRJ/v6.i10.2018.P1118581

No disease is noticed in years: 2012, 2013 and 2015. The maxima was in the years 2016 and 2017: for 2016: *Eulemur r.*, Falculea *p.*, *Uratelornis c.*, *Circus m.*, and for 2017, *Chrysolopus p.*, *Lophobis c.* (n = 2), *Cryptoprocta f.*.

For the year 2018, two animals (02) were affected: *Anas b.* and *Anas p.*. Otherwise, two species are concerned by candidiasis: *Lemur c.* (year 2011) and *Crocodylus n. m.* (year 2014).

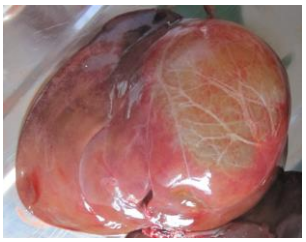
Females were more vulnerable to fungal infections with 9/12 proportion without direct relation with the breeding season.

3.3 Post mortem lesions

The following photos are shown some post mortem lesions due to deep aspergillosis and candidiasis with laboratories confirmations.

- **Lesions due to aspergillosis**

Photos 10 PBZT: Aspergillosis for *Cryptoprocta f.*. The clinical symptoms were: Skin diseases at the beginning and after a few days of healing, relapse with weakness, dyspnea and slimming

Photos 11 PBZT: Aspergillosis for *Anas b.*. No clinical signs following but sudden death


Elevation of infected sternum, bronchial bifurcation become umbilicated with granulomas in the lungs

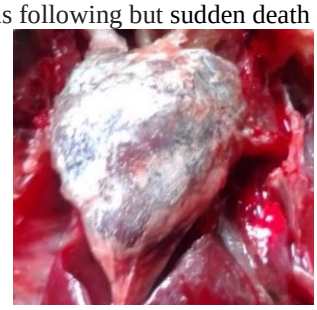
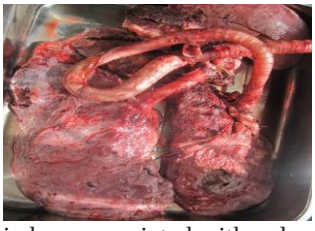
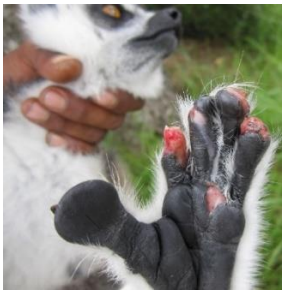

Granulomas on the tissues of the heart

Photo 12 PBZT: Candidiasis for *Crocodylus n. m..* The clinical symptoms were deep abatement followed by sudden death


Hemorrhagic lung associated with pulmonary edema

Photos 13 PBZT: Candidiasis for *Lemur c.*. The clinical symptoms were: depilation and chronic inflammatory skin lesions followed by degeneration

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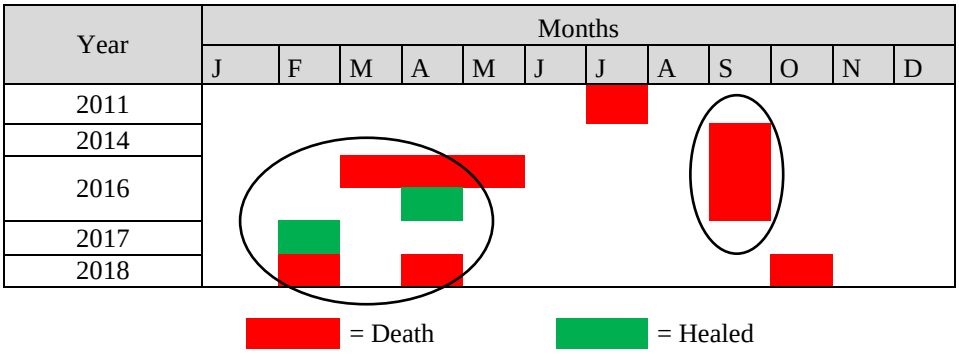
3.4 Mycosis infections and climate data

Warm temperatures with abundant rainfall are a favorable climate for the reproduction of fungal. Diseases are prevailing during the months of the two periods of offseason in the Madagascar: i) first offseason: between February to the end of April or the beginning of May and ii) second offseason: from September to beginning of October (Fig. 2).

Figure 2: Distribution of mycosis during the study period



The death on July of *Lemur c.* is an exception because it is due to a long illness.

The common characteristics of the climate (temperature, rainfall) for each months of the study period, compared to the reference period 1961/1990 in the Madagascar were: i) minima temperatures higher than the average temperature, ii) an overall increase of maxima temperatures except for July 2014, and iii) rainfall with turbulences. These situations confirmed the effectiveness of climate 'study change in 2008. In fact, it is projected that the changing would be expressed mainly in rise of the extreme temperatures (minima and maxima) and a disorder in the rainfall (DGM, 2008).

In addition, the results are reliable with the observations of the global warming about the warmer year's records from 1880 to 2017, for the years 2016, 2017 and 2014 (Global Temperature Anomalies, 2018) (Tab. 5).

Table 5: Comparison of average-differences of the temperatures at the national and global levels on the warmer years

Years	National average-deviation	Global average-deviation
2016	+1,36°C	+1,25°C
2017	+1,07°C	+1,13°C
2014	+ 0,83°C	+0,88°C

According the Global Climate Risk Index 2015, the Madagascar is ranked as the 8th most country affected by climate change with vulnerability risk (DGGFPE/MFB, 2016).

The measure of Humidity Index (IH) has confirmed the relationship between the discomforts of the living organism within the development of the fungi pathogens (Tab. 6).

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Table 6: Degree of discomfort measured by Humidity Index (IH) for each species at month corresponding on healed or death

IH value	Class of incomfort	Species Healed (H) or death (D)	Date	Type of mycosis
26	Well-being	*Falculea p.* (D)	May 2016	Aspergillosis
28		*Circus m.* (D)	September 2016	
26		*Lemur c.* (D)	July 2011	Candidias
30 à 31	More or less uncomfortable	*Crocodylus n. m.* (D)	September 2014	Aspergillosis
34		*Anas b.* (D)	April 2018	
34		*Eulemur r.* (H)	April 2016	Ringworm
35 à 36	Large discomfort extend to general feeling of discomfort.	*Cryptoprocta f.* (D)	October 2017	Aspergillosis
37 à 38	Large discomfort. Care	*Uratelornis c.* (D)	March 2016	
37 à 38	Large discomfort. Danger	*Anas p.* (D)	February 2018	Candidiasis
39 à 40	Large discomfort extend to general feeling of discomfort	*Chrysolopus p.* (H)	February 2017	Aspergillosis
39 à 40		*Lophobis c. (n=2)* (H)	February 2017	
39 à 40		*Cryptoprocta f.* (D)	October 2017	

The mycosis disease in well-being class (HI= 26 or 28) requires others considerations as habitat, food or captivity than only climate stress.

Global warming had significant impacts both on plants (Andriamalalanirina F., 2018) and on animals in the Madagascar.

4. CONCLUSIONS

Three kinds of mycosis (ringworm, aspergillosis, candidiasis) are affected all the classes of wild endemics animals captive-bred in the Tsimbazaza Park. Aspergillosis was the common fungal infections. Most species were on the IUCN red List. Females were more vulnerable than males mostly during the two periods of offseason in the Madagascar. Moreover, the maxima of the fungal infections are corresponded with the global hottest years. Climate stress had an impact both on animal's body discomfort and on the development of fungal pathogens.

The outcomes will help to improve the management of the conservation program by taking into account the climate-pathological risks. They may be used too as eco-epidemiology indicators on prevention of mycosis in the Madagascar.

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