

Applicant: [REDACTED]
Organisation: [REDACTED]
Funding Sought: £7,985.00
Funding Awarded: £7,985.00

EA18/1395

USING RADIOCARBON DATING TO TEST THE POPULATION STABILITY AND PERSISTENCE OF THE CENTENARIAN BAOBAB SPECIES

Baobabs (*Adansonia*, Malvaceae), iconic tree of Madagascar, Africa and Australia are known to live for thousands years. Madagascar is home to seven species, of which six are endemic to, of the nine present worldwide. Unfortunately, according to UICN (2018), three of the Malagasy baobab species (*A. grandidieri*, *A. perrieri* and *A. suarezensis*) are “endangered” and the three others (*A. madagascarensis*, *A. za* and *A. rubrostipa*) are classified “lower risk/near threatened” based on species occupancy and distribution. Moreover, some species suffer from population decline and all species present low seedling survival, with mortality rates up to 75%. In this project, I plan to perform a population viability analysis of *A. perrieri* and *A. suarezensis* to estimate population sustainability and to understand their conservation needs. I will develop a matrix population models that can predict the stability of the population and the probability of their risk of extinction. To establish the population matrix model, radiocarbon dating is used to assess the duration of life stage of baobab and to determine their age-based life history. The results of this research will be used to set up an adequate conservation system for baobab species.

PRIMARY APPLICANT DETAILS

Name [REDACTED]
Surname [REDACTED]
Tel (Work) [REDACTED]
Email (Work) [REDACTED]

CONTACT DETAILS

Role	Referee 2
Title	[REDACTED]
Name	[REDACTED]
Surname	[REDACTED]
Email (Work)	[REDACTED]

CONTACT DETAILS

Role	Referee 1
Title	[REDACTED]
Name	[REDACTED]
Surname	[REDACTED]
Email (Work)	[REDACTED]

Section 1 - Eligibility

Please answer the questions below to determine if you are eligible for this scheme

Have you previously been awarded an Ecologists in Africa grant?

No

Do you have at least an MSc or equivalent degree?

Yes

Can you answer yes to each of the following:

- Are you a citizen of a country in Africa or its associated islands that is a 'low-income economy' or 'lower-middle-income economy' according to the [World Bank categorization](#)?
- Are you working for a University or research institution in Africa (including field centres, NGOs, museums etc.) that provides basic research facilities?
- Will the proposed work be carried out in a country in Africa or its associated islands?

Yes

How much are you applying for?

Up to £8000

Please note, we do not accept re-submissions of the same project.

Applications will be rejected without being sent out for review if they are re-submissions of a proposal rejected in a previous round, or if they represent only a minor revision of such a proposal (for example, with a modified experimental design). As a guide, in order to be significantly different, at least 80% of objectives & activities should be different to the original proposal.

Using the above statement, is this project a resubmission?

No

Section 2 - Contact Details

PRIMARY APPLICANT DETAILS

Name [REDACTED]
Surname [REDACTED]
Tel (Work) [REDACTED]
Email (Work) [REDACTED]

CONTACT DETAILS

Role	Referee 2
Title	[REDACTED]
Name	[REDACTED]
Surname	[REDACTED]
Email (Work)	[REDACTED]

CONTACT DETAILS

Role	Referee 1
Title	[Redacted]
Name	[Redacted]
Surname	[Redacted]
Email (Work)	[Redacted]

GMS ORGANISATION

Type	Organisation
Name	[Redacted]
Phone	[Redacted]
Email (Work)	[Redacted]
Website (Work)	[Redacted]
Address	[Redacted]

If you do not have a current organisation (i.e. you are an independent researcher/retired), please provide your preferred contact address above and select the checkbox to the right.

Unchecked

BES Membership Number

You do not need to be a member to apply, however if you are, please provide your number below

No Response

Section 3 - CV

Education History

Please note if you do not know the exact day, select the 1st day of the month e.g. March 2005: 01/03/2005

Start Date	End Date	Qualification	Organisation	Additional Info
[Redacted]	[Redacted]	PhD Plant Sciences	[Redacted]	<i>No Response</i>
[Redacted]	[Redacted]	Master 2	[Redacted]	<i>No Response</i>
[Redacted]	[Redacted]	Master 1	[Redacted]	<i>No Response</i>

Employment History

Please note if you do not know the exact day, select the 1st day of the month e.g. March 2005: 01/03/2005

Start Date	End Date	Position	Organisation	Additional Info
[REDACTED]	No Response	Temporary teacher	[REDACTED]	No Response
[REDACTED]	[REDACTED]	Environmental Consultant	[REDACTED]	No Response
[REDACTED]	[REDACTED]	Environmental Consultant	[REDACTED]	No Response
[REDACTED]	[REDACTED]	Scientific and technical coordinator	[REDACTED]	No Response
[REDACTED]	[REDACTED]	Environmental Consultant	[REDACTED]	No Response

Research Grants/Fellowships Awarded

Date	Details	Amount Awarded (£)	Additional Info
2018	[REDACTED]	£4,970.00	[REDACTED]
2017	[REDACTED]	£1,200.00	[REDACTED]
2014	[REDACTED]	£900.00	[REDACTED]
2011-2014	[REDACTED]	£5,800.00	[REDACTED]
September-November 2013	[REDACTED]	£3,900.00	[REDACTED]
September-November 2012	[REDACTED]	£3,900.00	[REDACTED]
Aôut-Novembre 2011	[REDACTED]	£6,100.00	[REDACTED]
Septembre-Novembre 2010	[REDACTED]	£3,900.00	[REDACTED]

Septembre-Octobre 2009

[REDACTED]
[REDACTED]

£3,400.00

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

Conference Participation

Please list a maximum of 3 most relevant and recent conferences

Conference Name

Details

5e édition Forum de la recherche

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

3rd edition Journées Jeunes Chercheurs (JJC)

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

44rd International Symposium on Essential Oils (ISEO)

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

Other Awards/Achievements/Skills

[REDACTED]

[REDACTED]
[REDACTED]

[REDACTED]
[REDACTED]

Summary of Publication Record

Articles

[Redacted text block]

Professional Membership

[Redacted text block]

Additional Information

No Response

Section 4 - Project Details and Keywords

NB: The Total Project Cost and Amount Requested will be added automatically from the figures you provide on the budget page. Once you have completed your budget, you will be required to come back into this page, ensure the figures are correct, and save the page.

Summary Project Details

Total project cost: £

7,985.00

Amount requested from BES: £

7,985.00

Please read our [Bulletin article](#) for guidelines on writing an effective lay summary.

Project title:

USING RADIOCARBON DATING TO TEST THE POPULATION STABILITY AND PERSISTENCE OF THE CENTENARIAN BAOBAB SPECIES

Project lay summary:

Baobabs (Adansonia, Malvaceae), iconic tree of Madagascar, Africa and Australia are known to live for thousands years. Madagascar is home to seven species, of which six are endemic to, of the nine present worldwide. Unfortunately, according to UICN (2018), three of the Malagasy baobab species (A. grandidieri, A. perrieri and A. suarezensis) are "endangered" and the three others (A. madagascarensis, A. za and A. rubrostipa) are classified "lower risk/near threatened" based on species occupancy and distribution. Moreover, some species suffer

from population decline and all species present low seedling survival, with mortality rates up to 75%. In this project, I plan to perform a population viability analysis of *A. perrieri* and *A. suarezensis* to estimate population sustainability and to understand their conservation needs. I will develop a matrix population models that can predict the stability of the population and the probability of their risk of extinction. To establish the population matrix model, radiocarbon dating is used to assess the duration of life stage of baobab and to determine their age-based life history. The results of this research will be used to set up an adequate conservation system for baobab species.

Project start date:

10/01/2019

Project end date:

10/06/2020

Project country:

Madagascar

We have chosen a selection of keywords, which cover the breadth of the ecological research we fund. These keywords link the ecological content of an application to the most appropriate member of the BES Review College.

As your selections will determine which reviewers are asked to assess your application, please select carefully.

Please choose three words from the following:

- Conservation ecology
- Modelling
- Plant Ecology

Section 5 - Grant Specific Questions

Please provide details of the Research plan. This should include the background to the project, preliminary data, research questions, experimental approach and timetable for delivery.

Please capitalize all headings.

1- BACKGROUND TO THE PROJECT

Unlike the endemic and emblematic animals of Madagascar, little attention is given to the research and protection of plants such as baobabs. Baobabs (*Adansonia*, Malvaceae) comprises nine species distributed worldwide of which seven are present in Madagascar, six are endemics to Grande Ile (Baum 1995; Pettigrew et al. 2012). In addition to being a taxon representing a high level of biodiversity, baobabs also have a significant economic and cultural value for Madagascar. However, according to UICN (2018), three of the Malagasy baobab species (*A. grandidieri*, *A. perrieri* and *A. suarezensis*) are "endangered" and the three others (*A. madagascarensis*, *A. za* and *A. rubrostipa*) are classified "lower risk/near threatened" based on species occupancy and distribution. More than 15000 adults trees of *A. suarezensis* and only 99 adult trees of *A. perrieri* was estimated by satellite image (Vieilledent et al. 2013). In addition, numerous authors reported low survival of seedling in all species of baobabs, with mortality rate up to 75% ([REDACTED])

2- PRELIMINARY DATA

In the present project, we propose to study the effect of the baobab low regeneration rate on their long term sustainability using the Population Viability Analysis (PVA). The PVA has already been undertaken on other species to identify the threats faced by a species and an analytical modeling tool (Soulé 1986; Beissinger 2002). In this case, carbon dating is an important tool for assessing the age class of the baobab population and to determine their age-based life history. Radiocarbon dating was already used for African baobabs *A. digitata* and three Malagasy species *A. za*, *A. rubrostipa* and *A. grandidieri*.

3- RESEARCH QUESTIONS

The present work aims to evaluate the population viability analysis (PVA) of *A. perrieri* and *A. suarezensis* to better understand the species and identify these conservation needs. The research questions are (1) what is the age structure of the actual baobab population? (2) Are populations stable and viable in the long term in equilibrium? (3) Are baobabs at absolute risk of extinction in the future?

4- EXPERIMENTAL APPROACH

Baobabs occur in dry forest in all the western field of Madagascar. The study will be conducted in protected area in north of the island managed by Madagascar National Park (MNP). For *A. perrieri*, the study site is Ambondromifehy (12°52'9.05" S, 49°13'37.31" E), part of Anakarana national parc is chosen since it includes the largest number of individuals surveyed. For *A. suarezensis*, the study site is Mahory forest (12°55' 67" S, 49°14' 19.32" E).

The experimental approach will be divided in three parts:

4-1 FIELDWORK

- Tree measurements

Fieldwork will be made during the rainy season since new seedlings appear this season. For *A. perrieri*, Dbh (diameter at breast height) of all individuals recorded in Ambondromifehy will be measured. For *A. suarezensis*, tree measurement will be made for 30 trees of baobabs in Mahory forest. All individuals < 5 cm dbh and seedlings will be searched for \pm 30m around an adult tree.

- Seed production and viability: Seed production of studied species will be measured for 30 trees. We will use previous collected data for seed germination. The percentage of viable seed by soaking in water (those that flow are alive) and seedling emergence percentage from sown seeds.

- Seedling survivor: In wet weather, naturally-occurring first-year seedlings will be counted and monitored by the paracologists for one year. We will record the number of seedling attacked lethally by the snail.

4-2 RADIOCARBON DATING

Radiocarbon dating will be performed at the Beta Analytic testing laboratory. To mitigate the old wood effect, we will take the samples on twigs and the youngest stems. Several sets of wood samples will be collected from the fallen stems. Cellulose samples will be prepared by acid-basic pretreatment method. The resulting samples were combusted to CO₂, via the closed tube combustion method. Then, CO₂ was reduced to graphite on iron catalyst, under hydrogen atmosphere. The graphite samples will be analyzed by biometric analysis.

The obtained fraction modern values, corrected for isotopic fractionation with the normalized $\delta^{13}C$ and $\delta^{12}C$ will be ultimately converted to a radiocarbon date. Fraction modern values will be calibrated and converted into calendar ages. Radiocarbon dating results will include uncalibrated results, the calibration curve used, the dating method used, and any corrections applied to the result before calibration. The confidence level corresponding to calibrated ranges will also be included.

4-3 DATA ANALYSIS

- Stage based life-history

We will construct a stochastic stage-based population projection matrix model based on life history stages. Four baobab life stages will be used: (1) seed; (2) seedling (baobab less than 1 year old); (3) juvenile (dbh<30cm) [REDACTED] and (4) adult (Dbh>30cm). The following parameters are required to construct the model: P_i , the probability that an individual in life stage i will survive and remain in that life stage; G_i , the probability that an individual in life stage i will survive and grow into the next life stage and F_i , the probability of an individual's fecundity in life stage i . G_i , and P_i are determined by average duration (d_i) and survival probability (s_i) of an individual s in life stage i .

Survival rates (s_i) for each life stage will be determined as follow:

Seed production= Number of seed per trees

Seed survival rate= Number of seed/Number of seedling

Seedling survival rate= Number of seedling/Number of Juvenile.

Juvenile survival rate= Number of juvenile/Number of Adults

$F_i = (\text{seed per tree}) \times (\% \text{ fruit producing per trees}) \times (\% \text{ seed germination}) \times (\% \text{ seedling mortality})$.

All parameters will be entered into the projection matrix, and we will calculate the dominant eigenvalues (k). This k represents the relative stability of the population; if $k = 1$, the population is stable, if $k > 1$ the population is increasing and if $k < 1$ then the population is declining (Caswell, 2001).

The growth rates of trees within the juvenile and adult life stages will be determined by dating two juvenile and three adults and their corresponding tree sizes. Then, the duration of the seedling, the juvenile and adult life stage (d_i) will be determined by multiplying these growth rates by the following tree sizes: 30cm dbh was chosen for juvenile trees because this is the size at which juvenile trees become adult and 150 cm dbh was chosen for adult trees, because this size-class represents a notable number of adults in the population.

- Estimation of age-based life history parameter

Age-based parameters will be calculated from the deterministic matrix model (Nicolè et al., 2005). With the result of the radiocarbon dating, we will estimate the probability of a seed reaching maturity and the age at sexual maturity, the mean age of residence in each stage, the generation time and the mean conditional life span of the oldest adult stage.

- Sensitivity analyses

Sensitivity analyses will quantify the degree that changes in parameter values affect model outcomes and may identify the management strategies to be most effective for species recovery (Cross and Beissinger, 2000). In this project, to assess the effect of seedling recruitment on the population dynamics, a sensitivity analysis will be conducted by reducing seedling in incremental reductions by 10% from 100%. The maximum allowable reduction of seedling was reached when $k = 1$.

- Assessment of the probability of future risk

Stochastic models will be studied with Monte-Carlo simulations (Nicolè et al. 2005). For each population, we will perform several trajectories with Monte-Carlo simulations. The probability of extinction ($P_{ext}(t)$) will be calculated as the number of trajectories that were extinct after t years divided by the total number of trajectories. The mean stochastic growth rate (λ_t)

was obtained by taking the average value for all trajectories including extinct trajectories.

TIMETABLE FOR DELIVERY

January-February 2019 (rainy season): fieldwork for tree measurements and seed survival for *A. suarezensis* and *A. perrieri*. Collection of wooden samples for radiocarbon dating

January 2019-January 2020: (i) Follow up of seedling survivor and predation, (ii) seed production assessment of both species by two paraecologists. This part of the project is funded by [REDACTED]

May-June 2019: Radiocarbon dating

January 2019-January 2020:

- Field data verification;
- Remote data collection from the paraecologists;
- Drafting of a mid-term report of the project;
- Identification of possible problem and adjustment of the methodology.

February-June 2020:

- Data analysis on PVA;
- Drafting of the final project report.

Please provide details of agreed collaborations and project partners that will facilitate the proposed project.

[REDACTED]

Please provide details of the suitability of the institution where the work will be carried out and the availability of equipment and facilities required for the work.

[REDACTED]

Please provide details of necessary permits/licences obtained, if applicable.

This project requires a research authorization from MNP

Please indicate how you will assess the scientific impact of the project and the benefits for non-academic audiences.

The scientific impact of the project will be the availability of information about the sustainability of the baobab population. This is an innovative approach whose methodology can be adjusted to study the population viability of long-lived plant species.

For non-academic audiences, this study is fundamental for decision-making regarding conservation measures. We plan to share the research results with the site managers [REDACTED]

How do you intend to make your research data publically available?

We plan to publish the results in peer review journals and make oral or poster presentations in national/ international symposia.

What are the risks to the health and safety of those involved in the project and how are these risks to be minimised?

The project does not pose a risk to human health since it is based on field observations. Any chemical products to be used for collecting wood samples will not be dumped into the habitat. For radiocarbon dating, the work will be done in an accredited laboratory that has put in place all the safeguards security measures.

Please identify any ethical considerations that may arise from the project.

Authorizations for the investigation and the collection of samples will be requested from MNP. Trees are not endangered in any way by the sampling. After each coring, the increment borer will be disinfected with methyl alcohol. All persons who participated directly in the study will be listed as co-author in publications. All donors will be mentioned in all the communications we will do

Please give details of relevant scientific contacts you have already established with ecologists in your own country and details of your PhD project supervisor, if applicable.

[Redacted]

If applying for travel funds, please outline your travel plans, provide details of your overseas host institution, outline the activities planned for your visit and how these will enhance your research.

(NB: one of your Statement of Support must be provided by a contact at the host institution you intend to visit)

No Response

Please provide details of other funding applications made for this research project.

Part of this project, specifically fieldwork including seed production and viability, monitoring of seedling survival and predation by paraecologists is funded by [Redacted]. The funding requested from Ecologists in Africa concerns the radiocarbon dating and data analysis.

Have you previously applied for a grant from the BES?

No

If you would like to upload a document in support of your application please attach using the control below. Please make sure you reference these in your text.

NB: A maximum of 1 file can be uploaded. Please only upload files essential to the application. Files with additional text to supplement word limits will not be considered and may make your application ineligible.

No Response

Section 6 - Budget

Please note all budgets must be provided in Great British Pounds (GBP)

Equipment/Consumables

Item	Quantity	Description	Total Cost
Computer	1	The computer will be used for data recording and analysis	£600.00
Camera	1	he camera will be used to take pictures of all activities, especially for the fieldwork	£300.00
Supplies	<i>No Response</i>	Supplies include small field equipment, pens, booklet, printing and photocopying of the data collection sheet. The price indicated is fixed.	£100.00
<i>No Response</i>	<i>No Response</i>	<i>No Response</i>	<i>No Response</i>

Overall Equipment Cost: £
1,000.00

Local Travel/Accommodation/Subsistence

Item	Description	Total Cost
Subsistence researcher	corresponds to food and accommodation during fieldwork for a total duration of 30 days	£300.00
Fuel	The two sites are about 1000km from the central office of Antananarivo. The round trip with the on-site trip would be 2500km. For a car consuming 15l per 100, the total cost will be ((4000km X 15km)/100km)X 1£=375£	£375.00
Subsistence driver	corresponds to food and accommodation during fieldwork for a total duration of 30 days for travel inside the sites	£300.00
Permit costs	Cost of the research authorization for the entire project	£40.00
Local guide	The local guide will help us find the baobabs in the forests and assist us in the field. The price given is the 25-day guide fee (£6 per day)	£150.00
Overall Local Travel Cost: £		1,165.00

International Travel/Accommodation/Subsistence (Including multiple entry VISA)

Item	Description	Total Cost
No Response	No Response	No Response
No Response	No Response	No Response
No Response	No Response	No Response
Overall International Travel Cost: £		0.00

Literature, Documentation, Information

Item	Description	Total Cost
No Response	No Response	No Response
No Response	No Response	No Response
No Response	No Response	No Response

Overall Literature/Documentation Cost: £
0.00

Wages
(Funding is not available to cover tuition fees)

Position	Description of Role	Rate & Duration of Employment	Total Cost
Salary of researcher	The researcher coordinates all activities: fieldwork, radiocarbon dating and data analysis	As the project consumes an estimated 40% of my time, I could not take any other job than that as a temporary teacher at the University. The salary subsidy requested is 150 pounds per month, or 3060£ for 18 months	£2,700.00
No Response	No Response	No Response	No Response
No Response	No Response	No Response	No Response
Overall Wages Cost:			£ 2,700.00

Other costs not yet specified

Item	Description	Total Cost
radiocarbon dating	The price for the radiometric dating of a sample of wood is about 145£. The price indicated here corresponds to 10 samples (5 for each species).	£3,120.00
No Response	No Response	No Response
No Response	No Response	No Response
Overall Other Costs:		£ 3,120.00

Total project cost:
£
7,985.00

Amount Requested from BES
£7,985.00

Section 8 - Declaration

Applicant Declaration