Nigerian Montane Forest Project
Montane Forest Conservation Initiative Nigeria

NIGERIAN MONTANE FOREST PROJECT
NGEL-NYAKI

UC UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Annual Report

UC SCIENCE

2019

Contents

Report design and production by Matt Walters, Univeristy of Canterbury.

Introduction

Anastasios (Tasso) Paul Leventis - Patron

Phil Hall (Chair)

John Adeyemi Adeleke

Danladi Umar

Hazel Chapman

Thanks to the unfailing support of our donors and the remarkable dedication of staff through uncertain times, 2019 has been an impressive year for the Nigerian Montane Forest Project. Major achievements are evident across all four of our objectives—conservation, research, education and community involvement. In addition we are making a significant contribution towards the Nigerian National Biodiversity Strategy and Action Plan 2016–2020 and international biodiversity goals. Examples are numerous and are found throughout this report.

Notable achievements this year include: i) that we have hosted and trained more undergraduate Industrial Training (IT) students in conservation science than ever before, highlighting the popularity of the NMFP among students. ii) The first peer reviewed international publication from the Smithsonian Plot in the journal Diversity. This is especially important because it makes available our key data and draws international attention to the Ngel Nyaki plot. iii) Beyond Bees (our honey production venture) has taken- off, with bee keeping workshops run by our collaborator Johnson Oluwaseun, held across ten communities and iv) NIMET (Nigerian Meteorological Institute) has established an automated weather station at Ngel Nyaki and is working with us to join the Project to the TAHMO-TransAfrican HydroMeterological Observatory.

A personal highlight was visiting Nigeria in May 2019 and meeting with Danladi, Elisha, Misa, Usman, Helen and others for a day long Project planning workshop. I also met with Taraba State Governor His Excellency Darius Ishaku and Retired General T.Y. Danjuma, both key supporters of the Project. While the workshop was extremely useful, I am nevertheless looking forward to my imminent visit to the field station in February 2020. Nothing substitutes for being in the field!

On a sad note, this year we lost our much-loved head patroller Saidu Isa Masabere. Saidu has been with the Project since 2008 but has worked in the montane forests as a Park ranger since the late 1960's. No one knew the Gashaka/Mambilla forests better than Saidu—he was a good friend and will be greatly missed by us all.

Again, sincere thanks to our funders who have continued to support the Project despite the uncertainties, I believe you will agree that your investment has been worthwhile. To us, it has been a life- saver, without your generous support we would not have survived the past year. Your faith in the Project is wholeheartedly appreciated.

While I am writing this as Director, the hands-on, day-to-day management of the Project has been expertly implemented by Associate Director Dr Danladi Umar (Gombe State University), Elisha Emmanuel (science coordinator) and of course, our assiduous manager Misa Zubairu and his assistant Usman Abubakar. Together this team has ensured that the Project continues to grow and fulfill its core mission. Thank you all.

Hazel Chapman
Director, Nigerian Montane Forest Project

Our values

Mission Statement

To promote national and international commitment to the conservation of Nigeria's montane forests by inspiring excellence in research by postgraduate students and empowering local communities through employment and education.

Aims

1. To combine scientific research with education at both tertiary and local community level in order to develop long term sustainable management of Nigeria's montane forests.

2. To facilitate the involvement of national and international researchers in Nigerian montane forest research.

3. To involve the community in the management of montane forest ecosystems.

4. To work with the community in other ways, such as developing small businesses and working with schools to develop conservation awareness.

Our networks

Project Partners / Collaborators

A.P. Leventis Ornithological Research Institute (APLORI), Jos, Nigeria
Chester Zoo, England
Federal University of Kashere, Gombe State, Nigeria
Gashaka Biodiversity Project, England/Nigeria
Gombe State University (GSU), Nigeria
Mayfield Community Ecology Laboratory, The University of Queensland, Australia
Nigerian Conservation Foundation (NCF), Nigeria
Nigerian National Parks (NNP), Nigeria
Prof Mike Lawes (University of KwaZulu-Natal, South Africa)
Prof Pierre-Michel Forget, Natural History Museum, Paris, France
Royal Botanic Gardens, Kew, England
Smithsonian Tropical Research Institute-ForestGEO, USA
Taraba State University (TSU), Nigeria
University of Canterbury (UC), New Zealand
University of Exeter (United Kingdom)

Project Funders

A.G. Leventis Foundation
A.P. (Tasso) Leventis
Retired General T.Y. Danjuma
Chester Zoo – North of England Zoological Society
NEXEN- a wholly owned subsidiary of CNOOC Limited
Taraba State Government
University of Canterbury, NZ

Academic Supervisors

Assoc Prof Hazel Chapman (UC)
Dr Alexander Christianini (Federal University São Carlos, Brazil)
Prof Will Creswell (University of St Andrews, UK)
Prof Ian Dickie (UC)
Prof Pierre-Michel Forget (Natural History Museum, Paris, France)
Dr Daniel Gerhard (UC)
Dr David Kenfack (Smithsonian Institute, Washington D.C. USA)
Prof Mike Lawes (University of KwaZulu-Natal, South Africa)
Dr Shiiwua Manu (APLORI)


SIMSTER

Using our research to grow a forest

Our broad-based approach to forest restoration contributes to Nigeria's biodiversity strategy.

A key focus of the project is forest conservation and restoration. By restoring forest that has been burnt, grazed and generally degraded, we can increase habitat and resources for wildlife and humans, increase carbon storage and maintain and increase pure water supplies. Our forest restoration is contributing to Nigeria's Biodiversity Strategy 2016–2020, where Nigeria commits to '15% of degraded ecosystems being under programmes for restoration and sustainable management by 2020'.

Our approach to forest restoration is broad-based. Initially we have to protect the heavily cattle-grazed grassland surrounding the forest from grazing and burning. To do this we build fences to keep cattle out of the reserve and have two look-out posts manned by patrollers to spot and put out any fires. Once the grassland is protected from these threats, forest restoration can occur through passive or active means. In passive restoration, frugivores and wind bring seeds of tree species into degraded areas so that forest can naturally regenerate. In contrast, active regeneration requires seeds and/or seedlings to be planted directly into degraded lands. Passive restoration requires only fencing and protection from fire, it is therefore the most preferable way to regenerate in remote areas such as Ngel Nyaki, with small budgets. However passive restoration doesn't necessarily work; dispersal limitation, whereby insufficient seeds are brought into the area is a common issue. In addition, factors such as competition from grasses and too much sunlight/dry conditions can also prevent seeds from germinating or establishing. If dispersal limitation is the main limiting factor, seeds can be sown directly into the degraded land – but often competition and dry conditions can limit germination, seedling growth and establishment. To avoid these bottlenecks the third, most labour intensive approach to forest restoration is to plant seedlings directly into the degraded areas.

At Ngel Nyaki our forest restoration program combines all three strategies.

Image 1 *Iveren Abiem and Biplang Yadok beside one of our long term vegetation plots. The vegetation within these plots is recorded bi-annually to monitor forest regrowth in the absence of grazing or burning. The first response is a major increases in grasses and tall herbs, many of which are totally absent in the grazed grassland.*

Image 2 *The seed trap team recording any seeds that have entered the traps. Seeds of unknown species are removed, grown in the nursery and identified when they have developed identifiable characteristics.*

Passive restoration

To predict the trajectory of forest regeneration through passive restoration we have a series of twelve 10 x 10 metre vegetation plots in grassland around the reserve which are measured every few years for species composition and height. 2019 was a census year and given the fires of 2018 it will be interesting to analyse the data and see the effects of the fires. Overall all, across the eight years since monitoring began, the data suggest that passive restoration in grassland is extremely slow. The most obvious change in vegetation is that the *Sporobolus* tussock grasses are replaced by a high number of other grass species, with *Hyparrhenia* and *Schizatarium* spp. Becoming dominant in almost all of the plots.

To understand which forest/pioneer seed species are being naturally dispersed into grassland we have established a series of seed traps in grassland sites adjacent to the forest edge. All sites are fenced–off from burning and grazing. Traps run from within the forest up to 100 metres into grassland. Every week each trap is visited by dedicated field assistants and all seeds in each trap are identified and recorded.

Once every few years we also count and measure seedlings close to the seed traps.

This year, 2019 was our 13th year of collecting seed trap data. This long-term data set is helping us understand which seeds are dispersed and which species are most likely to survive and establish at different distances from the forest edge. Over the past 13 years changes in seed community and in surviving seedlings allow us to model trajectories of passive forest regeneration. **A key finding is that passive restoration begins only very close to the forest edge or under lone trees in grassland. Without this, passive restoration seems unlikely to occur.**

In order to understand to what extent dispersal limitation and/or competition is slowing down passive restoration we have a series of long-term experimental plots. Usman Abubakar is in charge of these experiments. The experiment includes replicated treatments of i) control- no action, ii) broadcasting seeds, iii) cutting grass to remove competition. Seedlings are monitored on an annual basis. Watch this space for analysis of the data in next year's report.

Image 3 *These saplings are mostly Anthonotha, planted as seeds directly into grassland in 2017. This suggests that for Anthonotha, seed limitation, rather than habitat, is preventing forest regrowth.*

Direct seeding

Anthonotha is one of the most common forest edge tree species in Ngel Nyaki forest. It is a legume (family Fabaceae- Caesalpinioideae) and is very likely to be nitrogen-fixing, as are other species within the genus. It has large, nutrient-rich seeds, is light tolerant and relatively tolerant to fire, all attributes which make *Anthonotha* an obvious choice for planting to kick-start forest regeneration.

Previous work has shown us that the most efficient way to regenerate *Anthonotha* is by direct seeding rather than planting out seedlings established first in the nursery.

During the dry season of 2019, over 3,000 seeds of *Anthonotha noldeae* were collected for later planting into 4 hectares of fenced-off grassland during the rainy season.

Forests are also home to important pollinators of crop plants and by protecting and extending Ngel Nyaki forest we are supporting the Biodiversity and Ecosystems Network (BES-Net Phase II).

Image 4 *As one of our major aims is forest regeneration, we need a larger nursery. This year we moved the nursery back into the field station compound and increased its size considerably.*

Planting seedlings of preferred species

Throughout the year the seed collecting team collect seeds of pioneer tree species from within and around Ngel Nyaki forest for future planting. The aim is to collect seeds of each species from as many individual trees as possible to ensure we have a good genetic mix in our planting.

This year, in addition to *Anthonotha*, seeds of 26 additional tree species including *Albizia gummifera, Bridelia speciosa, Entandrophragma angolense, Milletia conraui, Parkia filicoidea, Polyscias fulva, Santeria trimera, Syzygium guineense* var. *guineense* and *Trema orientalis* were collected to regenerate in the nursery. From these, there are now 3,387 seedling ready to be planted during the 2020 rainy season. These species include other nitrogen fixing legumes and pioneer species very tolerant of fire. Once they establish, other species will naturally move–in, assisted by the shade, shelter and improved soil quality the planted trees provide.

The seed collection team collect seeds from forest trees throughout the year to plant in the nursery for forest restoration. Seeds are collected from as many individual trees of each species as possible to ensure a good genetic mix. They are sown in into polypots in the nursery and once they reach about 30 cm in height they are planted into regeneration areas during the rainy season.

In 2018 a major fire burnt a large proportion of our previous regeneration plots (2018 Annual Report). While devastating, these fires have given us an opportunity to investigate which tree species are most able to regenerate after fire. To determine this (and help us in choice of future planting), we have set up 26 transects along the forest edge running from the forest edge out into the grassland. The transects include burnt and non-burnt grassland. Every 50 metres along each transect we have recorded all woody species present (seedlings, shrubs, trees and sprouts) in a 10 x 10 metre plot.

Initial results suggest that almost all of the burnt trees are sprouting and thus recovering from the fire. The form of sprouting varies among species, but even species which look as though they would be vulnerable to fire- eg. *Polyscias fulva*, can sprout.

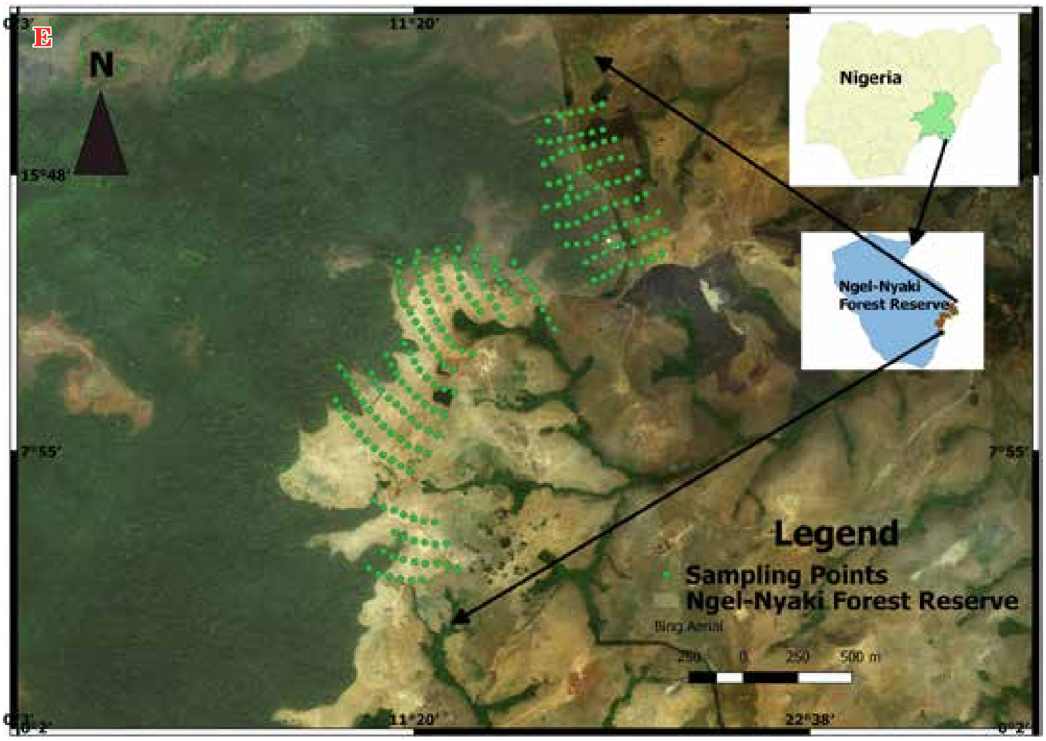


Image 5

A *Anthonotha seeds*

B *Seed collecting team L-R: Mohammed Usman, Yusuf Tongbuin, Augustine Johnson, Thomas Patrick, and Mohammed Ahmadu.*

C *The grassland tree* Bridelia speciosa *re-sprouting after appearing to be totally dead after the fire.*

D Polyscius fulva, *associated with forest or forest edge also recovers after burning.*

E *Map of the 26 transects along the forest edge running from the forest edge out into the grassland.*

Phenology

Phenology—the timing of different annual growth phases of plants such as leaf burst, flowering and fruiting—is vital to the ecology of a forest. For example, in determining food supply for animals (insects, birds, mammals), it directly impacts on forest productivity and biodiversity. Phenology is sensitive to climate change and changes in phenology are key indicators of climate change. When cycles between plants and the animals that depend on them become mis-matched, this can be disastrous. It can lead to species decline and the diminished ability of natural ecosystems to provide ecosystem services. It is therefore essential for good forest management to understand phenological cycles. Moreover, sharing phenological patterns across regions and countries will help in our understanding of climate change.

To this end, thanks to the hard work of Dr Biplang Yadok and the team on the ground at Ngel Nyaki, we now have a clean data set of 13 years (2006–present) of monthly phenological records (new leaves, flowering and fruiting), of 805 trees. These trees comprise 79 genera and 13 unknown species, along eight transects across Ngel Nyaki Reserve. These data have been collected mostly by Hammasumo Ibrahim and later Ali Bapetel, Adams Hassan and Jafaru Bapetel, who walk the transects on a monthly basis, through rain or shine, observing the phenological state of every tree.

We are currently working on these data with Dr Jennifer Wilcock from UC and preparing two publications, one on tree death, which appears to have increased in frequency over the past six years, and the other on general phenological patterns.

Image 6 *Olax fruit and seeds on the tree and being measured for the fruit/seed trait data base.*

Seed dispersal and seed traits

Understanding how seeds are moved around the forest and from the forest into surrounding grassland is key to any program of restoration of degraded forest land. Key to understanding seed dispersal is knowledge of the fruits and seeds themselves. We now have a comprehensive seed/fruit trait data base comprising over 64 species. Data include fruit dimensions, weight, colour, density, seed number, seed weight and seed dimensions.

Such data are used routinely in ecological studies and our data will contribute to a global data base of plant traits. Our contribution is unique, as many species in Ngel Nyaki forest have not been measured elsewhere or not with the accuracy we have. At Ngel Nyaki we measure 20 seeds/fruit from more than one tree, so that we have an idea of the range of trait values in any one species.

Biodiversity

Image 7 *Hammasumo Ibrahim, herbarium manager, checking specimens which have been drying in the sun.*

Woody species 'new' to Ngel Nyaki

Our science co-ordinator Elisha Emmanuel has used his passion for botany to work with the field assistants to collect and identify 31 tree species until now unrecorded from Ngel Nyaki, or at least, not in our data base. One of these species *Clerodendrum formicarum* (Gurke) Hiern [family Verbenaceae) had been collected in 1950 by Kew botanist Nigel Hepper at Ngel Nyaki, but we were unaware of it. Other species may be at Kew waiting for formal identification, or may simply have never been collected. While all of these 31 species need to be formally identified through our collaborators at the Royal Botanic Gardens, Kew, it should not now be difficult because all have been collected, annotated and photographed.

DNA barcoding of the species in the Smithsonian Plot

Thanks to the Smithsonian Institute and Dr David Kenfack all species in the 20 hectare Smithsonian Plot have been named to at least genus level. Ten of the 12 'unknown' species now have names.

Herbarium

Hammasumo Ibrahim is in charge of the Ngel Nyaki herbarium. Over 1000 plant specimens have been collected, described, and collated. In collaboration with Kew botanists Dr Martin Cheek and Xander van der Burgt, we are sending specimens to Kew for identification. Some of our specimens may be new to science—or different genetic variants. Several species in our herbarium do not quite 'fit' the description of the species we assume they must be.

Additional contributions to our knowledge of the biodiversity of Ngel Nyaki and the surrounding habitat include:

- Macro-fungi checklist
- Asteraceae checklist
- A report on the Breeding Biology of Petis's Cuckoo-shrike (*Campephaga petiti*) found in Ngel-Nyaki Forest Reserve. Being prepared for publication in a peer reviewed journal.

All three initiatives have been lead by our Science Coordinator Elisha Emmanuel.

Collaborations

2019 has seen three new collaborations between outside research organizations/researchers and the NMFP.

Image 8

A *Dr. George Nodza from the University of Lagos*

B *Dr Danladi Umar beside the new NIMET weather station*

C *Millennium Seed Bank*

D *Measuring the distance between a tree which has had its fuse blown (lightening strike) and nearest dead tree.*

E *UC Vice Chancellor Professor Cheryl de la Rey , Federal University of Kashere Vice Chancellor Professor Alhassan Mohammed Gani and NMFP Director, Dr Hazel Chapman*

Orchid collection

Dr. George Nodza from the University of Lagos (UNILAG) has established an orchid house at Ngel Nyaki with the aim of using it as a site to which orchids collections from across the montane areas of Nigeria can be housed. Collections will include orchids from across Mambilla, Cabbal Wadi and Gangirwal. These collections will serve as base collections for future studies into highland orchids by Dr George and his research group. The NMFP field assistants are working with Dr George to make and maintain the collection.

Nigerian Meteorological Agency (NIMET)

NIMET have installed a fully automatic weather station at Ngel Nyaki and we are currently developing an MOU between the Agency and the NMFP. This weather station will complement the current weather station at the field station and will be very useful in that a NIMET staff will be based at Ngel Nyaki with the Project and be on hand to maintain and collect the data.

This initiative directly addresses Nigeria's biodiversity goals; knowing weather patterns and how they are changing underpins much of biodiversity research. More than that, this new weather data will help us work more effectively with the community in planning for climate change through crop production and the planting of appropriate tree species for the future. It will also contribute to more accurate weather models and improve forecasts for Taraba State and the country as a whole.


Photo by DAVID ILIFF. License: CC BY-SA 3.0

Millennium Seed Bank Collection for Royal Botanic Gardens, Kew

To date, seeds of 21 species have been sent to Kew as part of our collaboration in the Millennium Seed Bank Partnership (details in 2018 Annual report). This work is important both for Nigeria and globally in that it is evaluating biodiversity and maintaining genetic diversity; both targets of the UN Convention on Biological Diversity.

Lightning strike research update

Drs Tim Hill and Lucy Rowland (U Exeter), Prof. Manu Haddad (U Cardiff) and Dr Ed Mitchard (Edinburgh U).

Last year we reported on the investigation into the effect of lightning strikes on tree death in tropical forests. Over 10,000 trees within the Ngel Nyaki CTFS plot have been fitted with collars designed to 'trip' when a lightning strike runs down the tree.

This year has seen two lightning strikes hitting trees and breaking fuse wires. An update on the project will be included in our 2020 Annual Report.

Research collaborations with the Federal University of Kashere, Gombe State.

In October Professor Gani, Vice Chancellor of the Federal University of Kashere, accompanied by Yakubu Adamu Malama, the Tertiary Education Trust Fund representative at Kashere visited New Zealand to meet his staff who are enrolled in PhD research at UC. During this visit we did the necessary ground-work to renew the collaboration between Federal University of Kashere and UC, and as part of this Agreement the Federal University of Kashere has agreed to financially and logistically support the NMFP- in return, we will host research and undergraduate Industrial Training students. This is a great opportunity for further research collaborations between Federal University of Kashere staff and the NMFP.

Project news

People

Saidu Isa Musabare has worked towards the protection and conservation of Taraba State forests since the 1960's. Transitioning from hunter to Park Ranger in Gashaaka Game Sanctuary (now Gashaka Gumpti National Park) in the late 1960's, Saidu worked with my father on Gangirwal in the 1970's. Saidu joined the NMFP in 2011 after retiring from the Nigeria National Park Service. He was our guide during our 2002 trek around the forests of Taraba State, the expedition which led to the NMFP. He knew every forest we visited better than anyone else and was a wonderful companion. We shall all miss Saidu greatly.

Jonathan Millard, based in Lagos and with a keen interest in sustainable development is a friend of the NMFP and is committed to helping us in our fund raising efforts. Look out for more about Jonathan in the 2020 Annual report.

When in Nigeria this year I worked with **Danladi Umar, Ridwan Jafar** and **Johnson Oluwaseun** on grant proposals for Beyond Bees.

We are proud to announce that **Dr Biplang Yadok**, past science coordinator of the Project, who later did his PhD research based at Ngel Nyaki and is currently working with the Project as a post-doctoral Fellow has been elected as a Sub-Regional Representative of the Africa Chapter of the Association for Tropical Biology and Conservation.
Further details here: https://tropicalbiology.org/blog/2019/11/14/africa-chapter-elections-results/

ASSOCIATION FOR TROPICAL BIOLOGY AND CONSERVATION

Image 9 A *Saidu Isa* **B** *Jonathan Millard* **C** *Johnson Oluwaseun, Ridwan Jafar, Hazel and Danladi Umar*

Student update

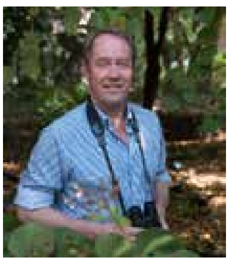
Murna Tela

The value of forest fragments in maintaining ecosystem for food security in Sub-Saharan Africa

Murna has successfully submitted her UC PhD thesis. She is now awaiting her VIVA examination. Thanks to New Zealand Ministry of Foreign Affairs and Trade for Murna's scholarship.

This year, Murna continued with her experiments on the potential roles of birds in providing pest control services to subsistence farmlands. To this end Murna's field assistants Yakubu Vugeh and Usman Bashiru did a fantastic job of running the experiments in Murna's absence. She tested whether and if so, to what extent, plasticine pest mimics on groundnut (*Arachis hypogea*) and Bambara nut (*Vigna subterranea*) crops were being attacked by insectivorous birds, and whether attack rates depended on the proximity of farmlands to forest fragments. She found (i) a strong positive correlation between the abundance of insectivorous birds and mean number of missing mimics and/or bird attack marks on mimics. (ii) The positive effect of insect-eating bird abundance on prey mimics became less strong the farther they were from a forest fragment. Together, these findings suggest that pest predation may be a key ecosystem function provided by insectivorous birds on Nigerian subsistence farmlands, and farmlands that are closer to forest fragments may experience a higher rate of pest control than those further away.

Image 10 *Murna proudly presenting her PhD frontpiece at the UC afternoon tea for all PhD submissions.*



Murna's PhD examiners are Prof Hugh Possingham, from the University of Queensland and also the Chief Scientist of The Nature Conservancy, along with Dr Mark Hulm from the University of the West Indies. Mark did his PhD research at Aplori. Murna's work is another example of the Project contributing to BES-Net.

Image 11

A *seeds of groundnuts and bambara nuts planted into polypots before being moved into the field.*

B *Plasticine Insect mimics placed on the crop plants*

C *Thanks to Murna's field assistants Yakubu Vugeh and Usman Bashiru. Yakubu with the green hat, Usman no hat brown jacket. They are being helped by IT students.*

Iveren Abiem

Investigating Conspecific Negative Density Dependence in Ngel Nyaki Forest

Understanding how diversity is maintained is essential in making informed decisions about the management of natural areas. One of the leading mechanisms for explaining the patterns of diversity and species coexistence in forests is conspecific negative density dependence (CNDD). CNDD proposes that tree seeds and seedlings often experience high mortality near conspecific adults because of host-specific natural enemies (herbivores, pathogens) or strong intraspecific competition and so, dispersal of seeds away from their maternal trees leads to increased survival and growth of offspring (Janzen, 1970, Connell, 1971). In addition, CNDD is hypothesized to promote species coexistence by giving rare species an advantage over common species because common species would have elevated mortality rates (Umaña et al., 2017).

While many studies have examined the role of NDD in plant community structuring and species coexistence in tropical forests, these studies have been concentrated in the Neotropics and Asian tropics. While African tropical forests may superficially appear similar to Asian and South American forests, their ecological structure is very different. This may reflect different processes underlying patterns in their species composition. African forests have low alpha diversity compared to their Asian and South American counterparts but have high carbon stocks, even higher than the Amazon (Sullivan et al., 2017). Moreover, African tropical montane forests are very different from African lowland tropical forests. Thus, quantifying density dependence in Afromontane forests is important in order to fill the knowledge gap of how plant species coexist.

Image 12 *Iveren and assistant Helen planting seedlings into polypots for a nursery experiment.*

My focus this year was investigating CNDD in Ngel Nyaki forest. I monitored the survival of 10,741 seedlings of 93 species for two years in the long-term forest study plot. Seedlings were recorded from 8,430 one metre squared quadrats throughout the 20.28 hectare plot. For every seedling, we calculated conspecific and heterospecific seedling neighbour densities from within 1 m^2 quadrats and conspecific and heterospecific adult densities within a 20 metre radius of the focal seedling. At the community level, neighbour density significantly affected seedling survival. Seedling neighbours negatively affected survival while adult neighbours positively influenced survival. The relationship between seedling survival and neighbourhood densities varied across growth forms and shade tolerance guilds. Conspecific densities had a negative effect on the survival of canopy and light-demanding species while total adult densities had a significant positive effect on survival of emergent, understory and liana species, and total seedling

Image 13 *During the seedling re-census all seedlings recorded and measured in the first census (tagged) we recorded if present and measured for height growth.*

densities had a significant negative and marginally significant negative effect on the survival of understorey tree and liana species respectively. Survival of large seedlings was most likely to be significantly affected negatively by conspecific adult density and total seedling density while survival of small seedlings was affected negatively by conspecific seedling density and positively by total adult density. Survival for newly recruited seedlings was not significantly affected by the biotic neighbourhood but was significantly affected by the season when the seedling recruited into the community. Seedlings that recruited in the dry season had significantly higher survival rates than those that recruited in the wet season. We conclude that conspecific negative density dependence may not be a key factor explaining species composition and coexistence patterns in the Afromontane plant community and the drivers of community coexistence in the unique environment will need to be investigated using detailed experiments.

Ted Guimfang Gabuin

Ted, a lecturer in biology at Taraba State University is about to begin his PhD research at Ngel Nyaki, based with the NMFP. Ted's thesis is entitled 'Woody plant status of protected montane forest and unprotected fragment in relation to primate diversity and abundance on the Mambilla plateau, Nigeria'. Ted's supervisors in this research are Professors G. B. Ogunjemite, A. Taiga and W. S. Japhet.

Image 14 *Usman Abubakar with field assistants and IT students on an expedition round the reserve.*

MSc students

NMFP hosted three MSc students from Gombe State and one from Taraba State Universities for Masters Research:

- Suwange Maurice Pauro (GS) –Avian - mediated seed dispersal of the mistletoes *Agelanthus brunneus* and *Globimetula braunii*. Supervisor Dr Charles Nsor
- Abubakar Mohammed Lamido (GS) The impact of floral resources on insect visitation of three common tree species within Ngel Nyaki reserve. Supervisor Dr Charles Nsor
- Abdullahi Abubakar Garba (GS) Influence of floral resources on avian visitation: An assessment of avaian visitation on *Maesa lanceolata*, *Psychotria succulenta* and *Anthocleista vogelii*. Supervisor Dr Charles Nsor

Industrial Training (I.T.) Students

An important part of the NMFP is hosting and training 300 level Nigerian undergraduate students during their six month placement under the students industrial work experience scheme (SIWES). This year the Project hosted 19 students from Ahmadu Tafawa Belewa Univerity Bauchi, Gombe State University and Taraba State University. The students lived at Ngel Nyaki for six months during which time they worked with Elisha Emmanuel (science coordinator) and the field assistants on science projects. Each student also carried out their own research project. This year the overall attitude and work ethic of the students was exceptional, and in recognition of this each student received a certificate of merit from the NMFP.

Image 15

A *Third year university I.T. (industrial training) students from Gombe State University. L-R: Monica Ishaya, Jennifer Alimpter Pey, Yusuf Hadi, Christopher Lazarus, Emeka C. Duru, Bodie S. Abraham, Jemimah Caleb, Laiche Tibins, Fatima Abdullahi, Vasty Moses, Magret M. Rubeun, Mahmud Adamu.*

B *Third year university I.T. (industrial training) students from Ahmadu Tafawa Belewa Univerity L-R: Kamalludeen Abdullahi and Ali Umar. Ali Umar worked with Ndozi George on orchid diversity within and around Ngel-Nyaki Forest Reserve and Kamal investigated the soil seed bank of selected sites within the Reserve. Kamul has a draft manuscript of his work for submission in a local journal.*

C *Third year university I.T. (industrial training) students from Taraba State University L-R: Amola Augustine, Firdausi G. Yakubu, Sanusi Hadiza Mafindi, Yaasah Joshua, Martins Linus.*

D *This year (2019) the quality of the IT students was so high that every student received a certificate of excellence. Thank you all!*

Community

Contribution to community mobilization and capacity building – aligned with the National Biodiversity Strategies and Action Plan (NBSAP) stakeholders responsibilities

Image 16 A *Pupils of the GDSS in Yelwa ask questions of Elisha Emmanuel as he talks to them about the Project and conservation.* **B** *Learning how best to plant trees.*

Conservation Club

The conservation club continues to be active and work with schools and in the community more generally. This year for example, Elisha Emmanuel led a visit to meet with the students of the Government Day Secondary School (G.D.S.S.) in Yelwa to help increase their awareness of the need for forest conservation and good land management. Elisha gave a talk and answered questions, and seedlings from the Project nursery were donated to the school as a means of encouraging afforestation. The school principal expressed his heart-filled gratitude to the Project for taking time to create this awareness.

Teaching at the local secondary school

The undergraduate I.T. students also interacted with the school students of G.D.S.S. Yelwa. For an entire term (4 months) they contributed to teaching English language, mathematics, physics, chemistry, biology, agricultural Science, and basic science and technology. This is an example of how the Project interacts with the community to benefit youth.

"Ngel-Nyaki is a blessing! I.T students from Nigeria Montane Forest Project (NMFP) Ngel Nyaki, came to assist with teaching at the Government Day Secondary School YELWA." Quote from school student on Facebook

Nursery School

The NMFP continue to support the nursery school. Misa Zubairu leads this initiative and 2019 has seen special attention paid to the girls (see photo). The TY Danjuma Foundation, who support the school financially, paid a visit and were obviously impressed with what they saw.

Image 17

Visits by the NMFP to the school students of Government Day Secondary School (GDSS) Yelwa.

A *Elisha Emmanuel talks about the Nigerian Montane Forest Project and conservation.*

B *Students on the school campus*

C *Staff of the NMFP (Elisha, Elijah and Usman) with staff of the GDSS.*

D *Team TY Danjuma Foundation representatives who came to see what their 2018 funding had done for NMFP Esso Mobile Primary School Yelwa. Dr Danladi Umar and Misa Zubairu in the picture too.*

Image 18 *Johnson training the bee keepers in new, more productive techniques to make honey.*

Honey production (Beyond Bees)

We have tried very hard to find external funding for our bee keeping operation, but so far have been unsuccessful. Part of the problem is that we are based in Taraba State and some potential funders are concerned they may not easily be able to visit the project and assess progress.

Regardless, following on from Ridwan Jafar's meetings with apiculturists at the APIEXPO AFRICA in Abuja last year (see 2018 Annual Report), this year we worked with Mr. Johnson Oluwaseun, an apiculturist based in Abuja, to develop a strategy that would allow us to continue on with Beyond Bees. To this end Johnson ran two three day workshops at Ngel Nyaki on basic bee keeping, to which bee keepers from local communities were invited. At the workshops, aimed at empowering local communities around the forest reserve through bee keeping, Mr Johnson taught basic bee keeping techniques and discussed honey, bees wax and propolis processing for Apis- therapy.

The model we are using is based on the premise that the honey produced from local communities will be bought and processed by the Project. We will then sell-on the honey to Abuja and Lagos, allowing us to become increasingly self-sustainable. With guidance and introduction to markets from our Board member John Adeleke, we hope to begin honey production on a relatively large commercial scale.

Without doubt Johnson's workshops have led to an increasing awareness by the local community of the ecosystem services provided by their forest reserve and an increasing intent to conserve the forest for future generations.

One of the Chinese produced wooded beehives we are now using at Ngel Nyaki. The hives are small enough to be moved from the forest into more secure areas once honey has been made. They are light weight and strong.

A comment by one attendee on our Facebook page:

"I have learned a lot from that program. How I wish everyone would understand the importance of the forest as I do!! I just hope one day everybody would see the forest as his own and be willing to protect it with his life."

Zubairu Mohammed Shekarau, Yelwa

Ndombo Ngishi School

Ndombo Ngishi is a small hamlet neighbouring the lower slopes of Ngel Nyaki forest reserve. There is very little room for farming in the area, with slash and burn having already depleted most of the resources outside of the reserve. The NMFP is linking with the Ndombo Ngishi community through employment of staff but also by providing some basic education to those in the village who need it. It is a three hour trek up-hill to the nearest school in Yelwa; to help, we have provided resources for a basic nursery school. Pictured, Usman teaching the children at Ndombo Ngishi.

Floristic survey

PLATE 1: *A. Adenostemma caffrum; B. Ageratum conyzoides. H Aspilia africana; D. Aspilia ciliata; E. Aspilia kotschyi; F. Aspilia sp1;. C Baccharis nebularis; J. Bidens oligophora G. Bidens pilosa; J. Bidens sp1; K. Bidens sp2*

PLATE 2: *A. Chondrilla juncea; B. Chromolaena odaorata; C. Chrysanthellum indicum ssp. afroamericanum. D. Cicerbita bourgaei E. Conyza canadensis; F. Conyza sp; G. Conyza sumarensis; H. Cosmos sulphureus; I. Crassocephalum bauchiense; J. Crassocephalum crepidioides K. Crassocephalum rubens L. Crassocephalum sp1*

Nine field expeditions specifically to collect Asteraceae were carried out between January of 2018 and November of 2019. Timing of collections was scheduled taking into account the main seasonal variations in the region.

A total of 70 species were recorded, 65, from 36 genera were identified with an additional five species unidentified. Below are the images- while many are named we are making sure the names are all correct before publishing them. Nicholas Hind, an Asteraceae expert at the Royal Botanical Gardens Kew is very kindly helping us with the identification.

A check list: Diversity and abundance of Macro-fungi of Ngel-Nyaki Forest Reserve, Mambilla Plateau

Emmanuel Barde Elisha [1,2*], Laiche Danladi Tibins[3] and Hazel Chapman[2]

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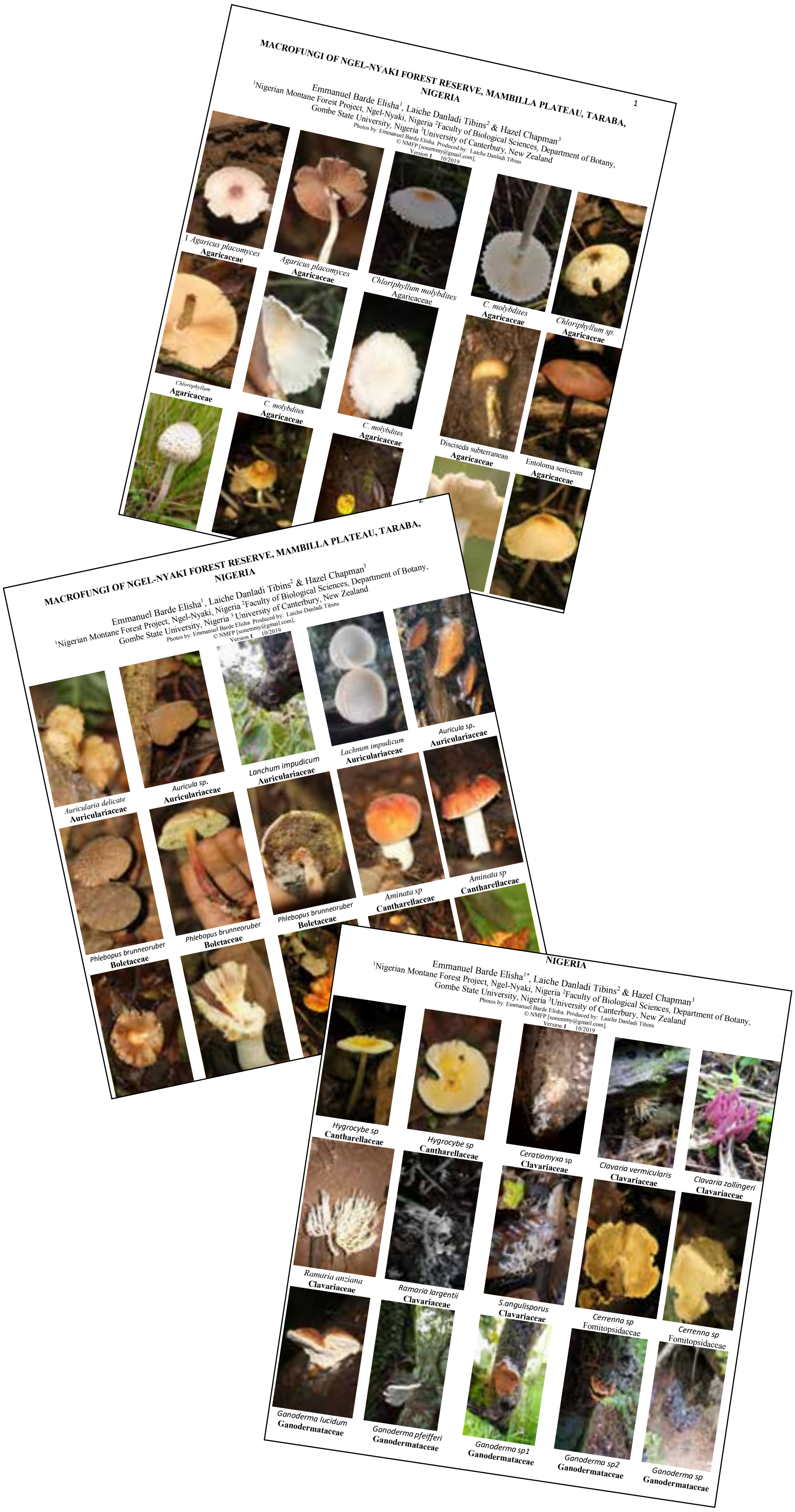

Outputs

Peer reviewed articles

- Abiem, I., Arellano G., Kenfack, D., Chapman, H. (2020). Afromontane Forest Diversity and the Role of Grassland- forest Transition in tree Species Distribution. Diversity Diversity DOI: 10.3390/d12010030
- Yadok, B. G., Pech, R., & Chapman, H. (2019). Perception of predation risk by African giant pouched rats (Cricetomys sp. nov) is higher in forest-edge microhabitats. Behavioural Processes, 168. doi:10.1016/j.beproc.2019.103953
- Yadok, B. G., Forget, P. M., Gerhard, D., & Chapman, H. (2019). Low fruit-crop years of Carapa oreophila drive increased seed removal and predation by scatterhoarding rodents in a West African forest. Acta Oecologica, 99. doi:10.1016/j.actao.2019.103448
- Nsor, C. A., Godsoe, W., & Chapman, H. M. (2019). Promiscuous pollinators—Evidence from an Afromontane sunbird–plant pollen transport network. Biotropica, 51(4), 538-548. doi:10.1111/btp.12669
- Charles, L. S., Dwyer, J. M., Chapman, H. M., Yadok, B. G., & Mayfield, M. M. (2019). Landscape structure mediates zoochorous-dispersed seed rain under isolated pasture trees across distinct tropical regions. Landscape Ecology, 34(6), 1347-1362. doi:10.1007/s10980-019-00846-3
- Ezukanma I. O., Ogundipe O. T. & Glime J. (2019). Bryophytes associated with termite mounds on the northeastern Nigerian highlands. Cryptogamie, Bryologie 40 (5): 31-39. https://doi.org/10.5252/cryptogamie-bryologie2019v40a5. http://cryptogamie.com/bryologie/40/5

Under review

- Agaldo J, Christianini A, Chapman H.M. Interactions between Ants and Non-myrmecochorous Diaspores in a West African Montane Landscape. Tropical Ecology. Currently addressing reviewers comments for Journal of Tropical Ecology
- Yadok, B. G., Forget P.M., Gerhard D.G, Aliyu B. and Chapman H.M. Seed nutrient content rather than seed size influences seed dispersal by scatterhoarding rodents in a West African montane forest. Currently awaiting reviewers comments for Journal of Tropical Ecology.
- Abiem, I, Dickie, I, Kenfack, D, Chapman H. Facilitation and density effects explain coexistence in a tropical Afromontane forest habitat. Currently addressing reviewers comments for Oikos.

Workshops attended

- Murna Tella and Ivern Ibiem, attended the 20th Student Conference on Conservation Science (SCCS) March 26th–28th 2019 – Cambridge, UK. The Student Conference on Conservation Science series in Cambridge, Australia, Beijing, Bangalore, New York and Hungary is the only international series of conservation conferences aimed entirely at students. Murna and Iveren were fully funded to attend the conference where they both presented a poster (see following pages) on their PhD research.

Posters

Do insectivorous birds provide pest control?

Murna Tela [a, b*], Will Cresswell [c] and Hazel Chapman [a]

[a] Department of Biological Sciences, University of Canterbury, New Zealand
[b] Department of Biological Sciences, Gombe State University, Nigeria
[c] School of Biology, University of St Andrews, St Andrews Fife KY16 9TS, UK

Introduction

Forest-agricultural mosaics are common ecosystems in Nigeria. In montane habitats, forest fragments support a rich diversity of bird species. However, these forest fragments are being lost due to anthropogenic land use change. This raises concern because these forests potentially harbour bird species which may provide pest control services to subsistence farmlands. Here we test the hypothesis that the insectivorous bird community, through pest control, support crop production

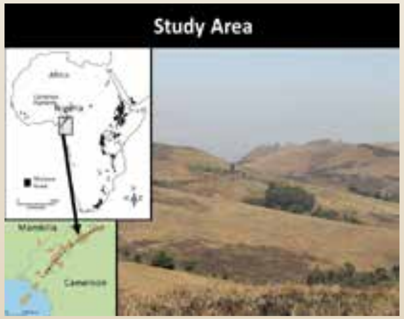

Figure 1: A map of this study area showing Mambilla Plateau, in North-eastern Nigeria. The plateau is predominantly grassland with subsistence farmland at varying distances from forest fragments.

Research Questions

Do bird provide ecosystem service to farmers through pest control in *Zea mays*?

Does increase in distance of farmlands from forest fragments result in;

(i) reduced insectivores abundance?

(ii) reduced crop yield?

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Methods

We surveyed birds using the point count method (Bibby et al., 2000) in farmlands and forest fragments on the Mambilla Plateau in NE Nigeria.

We used exclosure experiments (Classen et al., 2014) to determine whether excluding insectivorous birds from crops led to a reduction in crop yield

Crop yield increased when birds were present

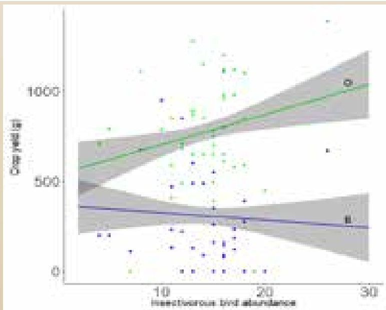

Figure 2: Crop yield increased with an increase in insectivorous species in the control treatment, but decreased when birds were excluded

References

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Zhang, W., Kato, E., Bianchi, F., Bhandary, P., Gort, G. and van der Werf, W., 2018. Farmers' perceptions of crop pest severity in Nigeria are associated with landscape, agronomic and socio-economic factors. *Agriculture, ecosystems & environment*, *259*, pp.159-167.

Results

We recorded 3,135 birds belonging to 46 different species across farmlands

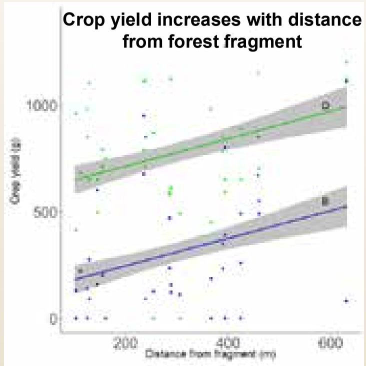

Figure 3: Crop yield increased with increase in distance of farmlands from forest fragments for both treatments

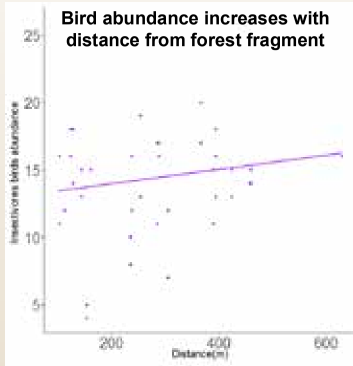

Figure 4: Insectivorous bird abundance increased with increase in distance of farmlands from forest fragments

Conclusions

Crop yield was significantly higher in the presence of insectivorous birds.

Bird abundance was highest further away from forest fragments and consequently crop yield was highest away from forest fragments. This is contrary to expectation that farmlands closest to forest fragments will have higher bird abundance and higher crop yield. This may imply that land sparing - where land conservation is held separate, and away from crop production may be the best overall strategy towards biodiversity conservation in Nigeria.

On the other hand, this pattern observed may be because farmlands further from fragments had higher insect density thus attracted more birds. It has been reported that the presence of non-crop areas in a landscape may manage pests (Zhang et al., 2018)

Acknowledgement

Field Assistants; Yakubu, Usman and Ahmadu

Gombe State University Nigeria

Nigerian Montane forest Project

Does neighbourhood crowding drive seedling survival in Afromontane forests?

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[2]Department of Plant Science and Biotechnology, University of Jos, Jos, Nigeria
[3]Nigerian Montane Forest Project, Taraba State, Nigeria

Introduction

- Understanding the mechanisms that generate and maintain diversity in forests is important because forests influence ecosystem functioning.
- One of these mechanisms is **Conspecific negative density dependence (CNDD)** e.g. see Janzen-Connell hypothesis (Janzen 1970; Connell 1971)

CNDD= lower survival around neighbours of same species (conspecifics)

- In Afromontane forests however, many species show a high degree of clumping which does not support CNDD

Figure 1: The CNDD model of regeneration and a hypothetical model for regeneration in Afromontane forest

- We propose that species establishing near conspecifics (i.e. species that clump) experience weak CNDD which allows them to increase their relative abundance.
- Using large stem and seedling data for woody plants from a 20 hectare (ha) large plot in a montane forest in Nigeria, we try to answer the following:-

Does :

- **seedling composition reflect patterns in adults?**
- **CNDD drive tree seedling survival?**

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Methods

In 2015, a 20 ha large permanent plot was established in the Ngel Nyaki (NN) forest reserve in the North East of Nigeria and all trees having a diameter at breast height (dbh) of ≥ 1 cm were mapped, measured and recorded.

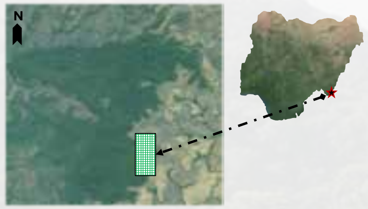

Figure 2: A google map showing the aerial view of the NN forest and the position of the large plot

Seedling census

- We conducted a census of seedlings in 2017 in 8,112 1 m^2 quadrats distributed uniformly throughout the plot.
- We recorded every woody plant seedling encountered, mapped their positions and measured their height
- We carried out a recensus of these seedling plots in 2018 to monitor seedling growth and survival and also record new recruits into the community.

We then modeled individual seedling survival as a function of conspecific and heterospecific neighbor densities.

Results

Table 1: Abundance and diversity of seedlings (≥ 20cm tall and <1cm dbh) and saplings and trees ≥1 cm dbh in Ngel Nyaki Forest Dynamics plot

Life history stage	Number of individuals	Number of species	Species richness (Chao)	Shannon-Weiner's index
Seedlings	11918	84	90.74	1.7195
Adults	41031	106	118.98	2.1641

Seedling abundance increases with abundance of adults

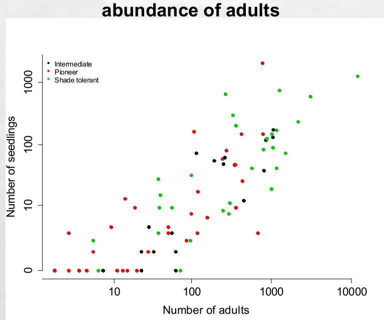

Figure 3: The relationship between seedling abundance and adult abundance for 106 species in the NN Forest plot. NB: Both axes have been log-transformed

Neighbourhood crowding drives survival?

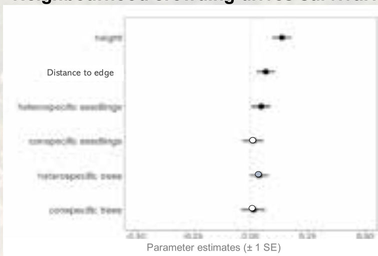

Figure 4: Community-wide estimates of relative influence of biotic variables on the survival of seedlings. Error bars represent 2 s.e. around the mean estimate. Black points indicate parameter estimates significantly different from zero at the 0.05 level of significance;

Conclusions

We found that diversity was higher in adults than in seedlings. Species in the seedling layer were a subgroup of the species found in the larger stemmed classes.
Our results also showed that seedling abundance was a function of adult abundance. A species with a high number of adults had a high number of seedlings.
Finally, our results show that individual seedling survival was significantly higher when surrounded by heterospecific seedlings. A most interesting observation was that seedlings had a higher probability of survival when surrounded by neighbours of the same or different species. In other words, seedlings preferred crowded neighbourhoods.

Acknowledgements

- The Forest GEO field team (Ngel-Nyaki)- Helen, Dahiru, Enoch, Auwal, Ahmadu, Faith, Comfort, Ali, Abubakar, Joel, Ali and Helen
- The University of Jos and the A. P. Leventis Ornithological Research Institute, Jos
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- British Ecological Society

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