DAVIS EXPEDITION FUND

REPORT ON EXPEDITION / PROJECT

Expedition/Project Title: A study of the boundaries between monodominant *Gilbertiodendron dewevrei* forest and mixed forest in the Nouabalé-Ndoki National Park, Republic of Congo.

Location: Nouabalé-Ndoki National Park, Republic of Congo.

Group Members: Ellen Heimpel, Moundoungas Lettycia, Alimbabouya Henri, Bakumbi Kuru, Dr David Harris.

Aims: To establish transects across the boundary between monodominant *G. dewevrei* forest and mixed terra firme forest to investigate how species composition changes across the boundary, and ask whether *G. dewevrei* is expanding into mixed forest.

A study of the boundaries between monodominant Gilbertiodendron dewevrei forest and mixed forest in the Nouabalé-Ndoki National Park, Republic of Congo.

Ellen Heimpel

January – March 2024

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Summary

This research activity consisted of a 6-week field trip to the Nouabalé-Ndoki National Park, Republic of Congo. The aim of the research was to establish transects across the boundary between monodominant *Gilbertiodendron dewevrei* forest and mixed *terre firme* forest, characterising the boundary between the two forest types, and investigating whether *G. dewevrei* is expanding into mixed species forest. The team spent 3.5 weeks at Mondika research camp, and 2 weeks at Mbeli research camp, during which we set up 14 transects, measured and identified 2,766 trees, measured 1679 seedlings of *G. dewevrei,* collected 126 herbarium specimens, and collected soil samples from 14 different locations. This work is a continuation of a previous trip I undertook from November 2022 to January 2024, with the support of the Davis Fund.

Background

Large areas of the Congo Basin are dominated by the tree *Gilbertiodendron dewevrei* (Gérard 1960, Letouzey 1985, Connell and Lowman 1989, Hart et al. 1989, Hart 1990). Such dominance is exceptional in tropical forests, which contain the Earth's highest level of biodiversity. Overturning every stereotype of plant diversity in the tropics, *Gilbertiodendron dewevrei* forms stands in which up to 90% of the tree stems belong to just this one species (Hart 1995, Torti et al. 2001, Makana et al. 2011, Djuikouo et al. 2014, Van der Burgt et al. 2021). For the past 60 years, scientists have been trying to determine how *G. dewevrei* achieves this dominance. The most recent research suggests a suite of traits of *G. dewevrei* combine to create an environment where it can dominate in stands and achieve a stable monodominant state (Torti et al. 2001, Peh et al. 2011). These include EM fungi, large shade-tolerant seedlings, mast fruiting, and light plasticity of seedlings (Peh et al. 2011, Tovar et al. 2019, Hall et al. 2020).

Three recent publications on *G. dewevrei* monodominant forests have further increased our understanding of this forest type. These publications were based on research carried out in the Sangha Trinational, where this study took place. Tovar et al., (2019) used a pollen core from a yanga in the Goualougo Triangle to show that a small patch of *G. dewevrei* has been in continuous existence for at least 3000 years with low levels of forest disturbance and almost no change in species composition. Hall et al., (2020) showed that in the Sangha Trinational *G. dewevrei* is associated with moist and infertile soils and competes well under a variety of light conditions. In addition, Heimpel et al. (2024) recently showed that *G. dewevrei* forest in the Sangha Trinational is distinct from mixed forest in both forest structure and species composition, and should be considered separately in both conservation planning and carbon stock calculations. However little research has been done into the distribution of these monodominant forest patches, and whether they are expanding, contracting or remaining stable.

This research aimed to study the boundaries between monodominant and mixed forest and investigate whether or not *G. dewevrei* is expanding into mixed forest. This was also the first study looking at detail at the boundaries of *G. dewevrei* forest, characterising them in terms of woody plant species and forest structure.

Aims of research trip.

The aims of this research trip were:

1. To set up transects across the boundary between monodominant *Gilbertiodendron dewevrei* forest and adjacent mixed terra firme forest, as well as in the centre of *G. dewevrei* forest, in the vicinity of both Mondika and Mbeli research camps.
2. To investigate whether *G. dewevrei* forest is expanding into mixed species forest.
3. To investigate how the species composition changes across the boundary from monodominant to mixed species forest.

Data collection

Zone of study

The research was carried out in the Nouabalé - Ndoki National Park, in *Gilbertiodendron dewevrei* forest within 10km of the two research camps: Mondika and Mbeli (Figure 1).

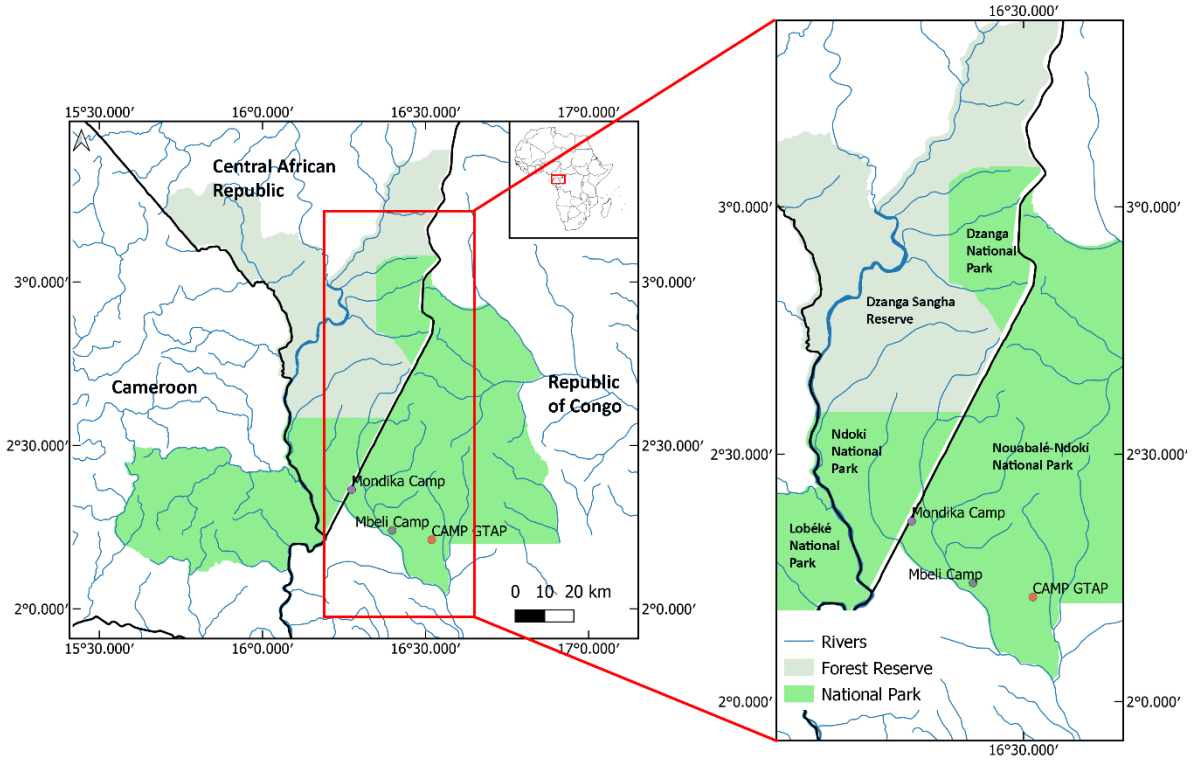

Figure 1. Map showing the Sangha Trinational, and the locations of the research camps within the Nouabalé-Ndoki National Park. Mondika and Mbeli Camp were visited during this trip.

Period of study

This research took place from the 26th January – 4th March 2024.

Participants

The team consisted of myself, Ellen Heimpel, a research assistant employed through the Wildlife Conservation Society (WCS), Moundoungas Lettycia, and two local trackers: Alimbabouya Henri, Bakumbi Kuru. We were also accompanied for part of the trip by Dr David Harris.

Activities

Methodology

We set up transects across the boundaries between monodominant *G. dewevrei* and mixed terre firme forest in the vicinity of Mondika and Mbeli research camps. GPS points were randomly selected along boundaries between monodominant and mixed forest, using satellite imagery. In the field the boundary point was determined as the last seedling of *G. dewevrei* along the transect line. The transects were laid out at a 90° angle from the boundary: 120m in length (100m in *G. dewevrei* forest and 20m in mixed forest), and 40m in total width. Trees were then measured in four different categories, with different transect widths for each category (Fig. 4):

- All trees ≥ 70cm dbh. Transect 40 m wide - 20 m either side of the main transect line.
- All trees ≥ 10cm dbh. Transect 20 m wide - 10m either side of the transect line
- All trees 1–10 cm dbh. Transect 4m wide. 2 m either side of the transect line
- Seedlings of *G. dewevrei* with dbh < 1 cm. Transect 4 m wide. 2 m either side of the transect line.

Each stem was identified, DBH measured, and position recorded by measuring the length and width along/from the transect in metres. For *Gilbertiodendron* seedlings, the height was measured, as well as the position. For unidentified trees, voucher specimens were taken for identification at Royal Botanic Garden Edinburgh (RBGE). Two vouchers of each specimen were made, one for export back to RBGE, and one to leave at the National Herbarium of the Republic of Congo in Brazzaville.

In addition, transects were set up in the centre of *G. dewevrei* forest patches, to provide a comparison to test whether different patterns are observed at the boundaries. These were set up following the same procedure, except they were only 100 m in length, as they did not have the 20m section in mixed forest.

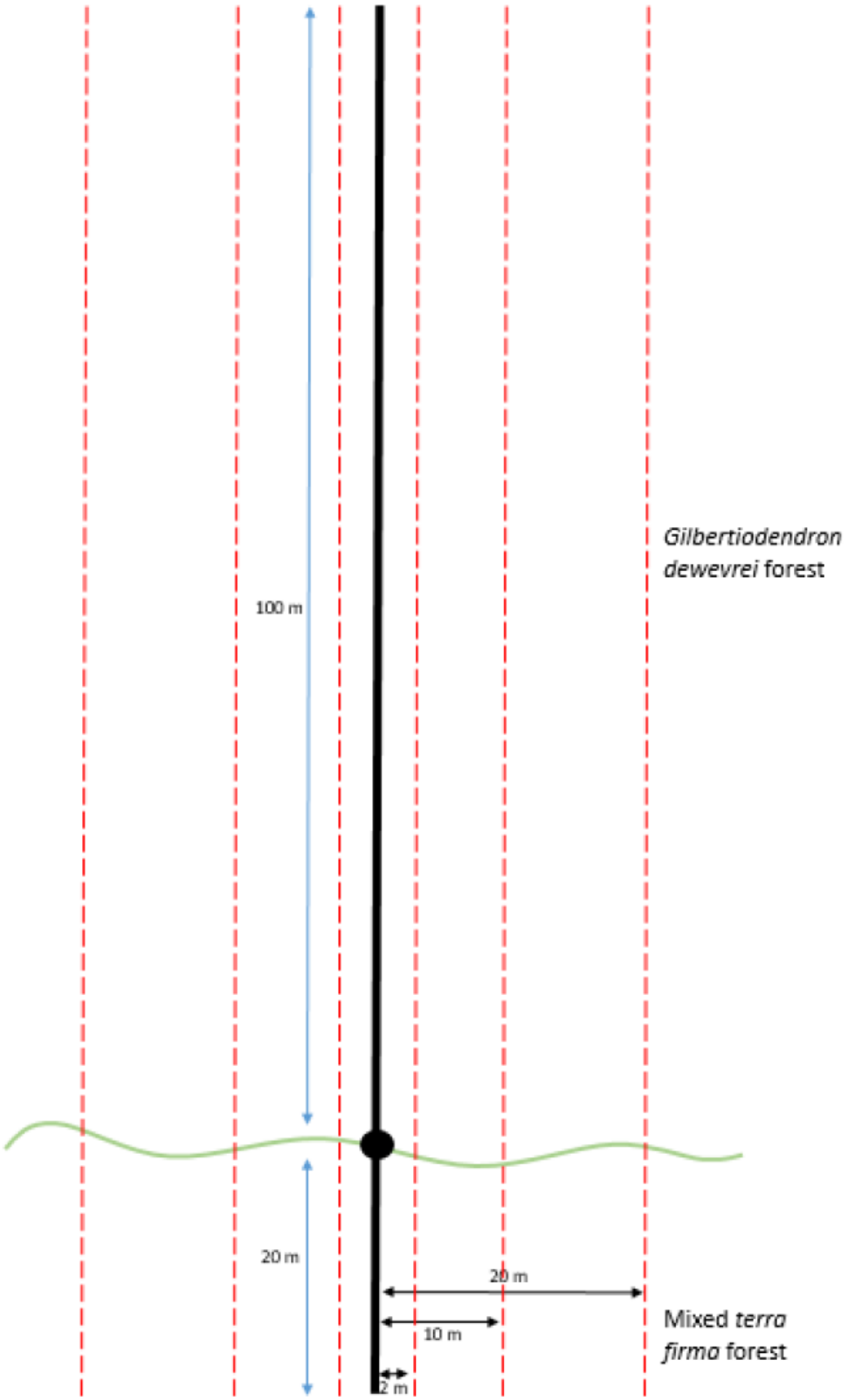

Figure 4. Layout of transects across the boundaries between monodominant and mixed forest. Black line is the transect, the green line represents the boundary, the black circle is the last *G. dewevrei* seedling, and the red dotted line represents the different transect widths for different sizes of trees.

Soil samples were also taken along the transect, in *Gilbertiodendron* forest, at the boundary and in mixed forest. At each sampling point, 5 samples were taken and bulked (Fig 5). Soil was dried in the field, and taken back to Edinburgh to be analysed at the University of Edinburgh. Parameters tested will be carbon and nitrogen contents, particle size, phosphorous content, and exchangeable cations. This is to investigate if there are any changes in soil across the boundary.

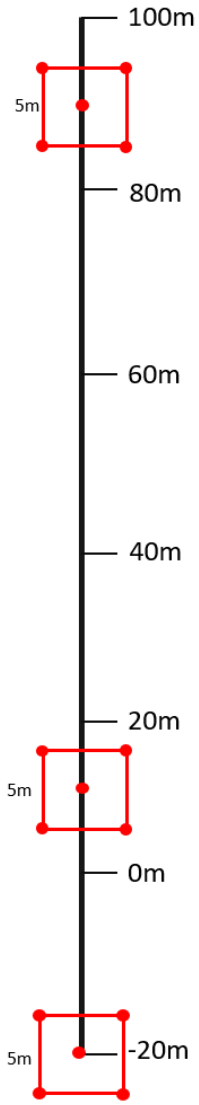

Figure 5. Soil sampling procedure. Soil samples were taken at 3 locations at each transect, represented by the red square. Each red circle represents a soil core, which will then be bulked for each sample.

Figure 6. Photos of the measurement of small seedlings of *Gilbertiodendron dewevrei* (left), and dbh of juvenile trees of all species 1-10 cm dbh (right). These trees were measured 2m either side of the main transect line. Photos show Moundoungas Lettycia carrying out the measurements.

Figure 7. Measurement and identification of all trees >10cm dbh 10m either side of each transect line. A and C show trees measured with a DBH tape, and B shows leaves being collected using clipper poles for identification of the tree species.

Figure 8. Collection of soil samples. Soils were sampled to 20cm deep using a soil corer. At each location 5 cores were taken and combined.

Figure 9. Making herbarium specimens in the field.

Outcomes

We completed 14 transects. 10 transects across the boundary between monodominant *G. dewevrei* forest and mixed terre firme forest and 4 in central patches of *Gilbertiodendron dewevrei* forest.

2,766 trees were measured and identified, as well as 1,679 seedlings of *G. dewevrei.*

Herbarium Specimens

We made herbarium specimens for 126 plants (Table 1). Two specimens were made for each plant. One specimen was deposited at the National Herbarium of Brazzaville, and the other taken to the herbarium at RBGE for identification purposes.

Collector	**Number**	**Species**
Heimpel, E.	73	*Tricalysia palles*
Heimpel, E.	74	*Massularia acuminata*
Heimpel, E.	75	*Rothmannia lateriflora*
Heimpel, E.	76	*Drypetes laciniata*
Heimpel, E.	77	*Drypetes polyantha*
Heimpel, E.	78	*Diospyros dendo*
Heimpel, E.	79	*Homalium*
Heimpel, E.	80	*Pancovia harmsiana*
Heimpel, E.	81	*Garcinia smeathmannii*
Heimpel, E.	82	*Angylocalyx pynaertii*
Heimpel, E.	83	*Drypetes urophylla*
Heimpel, E.	84	*Drypetes angustifolia*
Heimpel, E.	85	*Leptactina arborescens*
Heimpel, E.	86	*Cola chlamydantha*
Heimpel, E.	87	*Hannoa klaineana*
Heimpel, E.	88	*Uvariopsis soldheidii*
Heimpel, E.	89	*Garcinia smeathmannii*
Heimpel, E.	90	*Dialium pachyphyllum*
Heimpel, E.	91	*Psilanthus mannii*
Heimpel, E.	92	*Massularia acuminata*
Heimpel, E.	93	*Drypetes polyantha*
Heimpel, E.	94	*Bertiera iturensis*
Heimpel, E.	95	*Drypetes angustifolia*
Heimpel, E.	96	*Chytranthus gilletii*
Heimpel, E.	97	*Ongokea gore*
Heimpel, E.	98	*Anthonotha macrophylla*
Heimpel, E.	99	*Tarenna funebris*
Heimpel, E.	100	*Drypetes umbricola*
Heimpel, E.	101	*Dialium pachyphyllum*
Heimpel, E.	102	*Pteleopsis hylodendron*
Heimpel, E.	103	*Picralima nitida*
Heimpel, E.	104	*Dasylepis seretii*
Heimpel, E.	105	*Diospyros canaliculata*

Heimpel, E.	106	*Garcinia kola*
Heimpel, E.	107	*Belonophora coriacea*
Heimpel, E.	108	*Rothmannia*
Heimpel, E.	109	*Ongokea gore*
Heimpel, E.	110	*Dialium pachyphyllum*
Heimpel, E.	111	*Psilanthus mannii*
Heimpel, E.	112	*Amphimas pterocarpoides*
Heimpel, E.	113	*Dasylepis seretii*
Heimpel, E.	114	*Psilanthus mannii*
Heimpel, E.	115	*Millettia sanagana*
Heimpel, E.	116	*Diospyros dendo*
Heimpel, E.	117	*Bertiera iturensis*
Heimpel, E.	118	*Cuviera*
Heimpel, E.	119	*Zanthoxylum gilletii*
Heimpel, E.	120	*Trichilia rubescens*
Heimpel, E.	121	*Dialium pachyphyllum*
Heimpel, E.	122	*Tessmannia africana*
Heimpel, E.	123	*Drypetes polyantha*
Heimpel, E.	124	*Tricalysia filiformi-stipulata*
Heimpel, E.	125	*Rothmannia*
Heimpel, E.	126	*Aidia micrantha*
Heimpel, E.	127	*Tessmannia Africana*
Heimpel, E.	128	*Crotonogyne poggei*
Heimpel, E.	129	*Tessmannia africana*
Heimpel, E.	130	*Tessmannia africana*
Heimpel, E.	131	*Drypetes polyantha*
Heimpel, E.	132	*Drypetes fallax*
Heimpel, E.	133	*Rinorea dentata*
Heimpel, E.	134	*Baphia*
Heimpel, E.	135	*Lychnodiscus grandifolius*
Heimpel, E.	136	*Monodora*
Heimpel, E.	137	*Dialium pachyphyllum*
Heimpel, E.	138	*Dialium pachyphyllum*
Heimpel, E.	139	*Dialium pachyphyllum*
Heimpel, E.	140	*Tessmannia Africana*
Heimpel, E.	141	*Dialium pachyphyllum*
Heimpel, E.	142	*Dialium pachyphyllum*
Heimpel, E.	143	*Baphia*
Heimpel, E.	144	*Tabernanthe iboga*
Heimpel, E.	145	*Chytranthus*
Heimpel, E.	146	*Ceiba pentandra*
Heimpel, E.	147	*Tarenna pallidula*
Heimpel, E.	148	*Diospyros crassiflora*
Heimpel, E.	149	*Rothmannia lateriflora*

Heimpel, E.	150	*Pavetta calothyrsa*
Heimpel, E.	151	*Homalium*
Heimpel, E.	152	*Nesogordonia kabingaensis*
Heimpel, E.	153	*Drypetes urophylla*
Heimpel, E.	154	*Dialium pachyphyllum*
Heimpel, E.	155	*Tarenna funebris*
Heimpel, E.	156	*Belonophora coriacea*
Heimpel, E.	157	*Rothmannia hispida*
Heimpel, E.	158	*Tricalysia filiformi-stipulata*
Heimpel, E.	159	*Dialium pachyphyllum*
Heimpel, E.	160	*Dialium pachyphyllum*
Heimpel, E.	161	*Scottellia klaineana*
Heimpel, E.	162	*Erythrophleum suaveolens*
Heimpel, E.	163	*Dialium pachyphyllum*
Heimpel, E.	164	*Dialium pachyphyllum*
Heimpel, E.	165	*Ongokea gore*
Heimpel, E.	166	*Cola acuminata*
Heimpel, E.	167	*Microdesmis puberula*
Heimpel, E.	168	*Laccodiscus pseudostipularis*
Heimpel, E.	169	*Lovoa trichilioides*
Heimpel, E.	170	*Rothmannia libisa*
Heimpel, E.	171	*Tricalysia pallens*
Heimpel, E.	172	*Pteleopsis hylodendron*
Heimpel, E.	173	*Dialium bipindense*
Heimpel, E.	174	*Klainedoxa gabonensis*
Heimpel, E.	175	*Dialium pachyphyllum*
Heimpel, E.	176	*Dialium pachyphyllum*
Heimpel, E.	177	*Tessmannia Africana*
Heimpel, E.	178	*Chytranthus*
Heimpel, E.	179	*Baphia*
Heimpel, E.	180	*Chytranthus*
Heimpel, E.	181	*Drypetes umbricola*
Heimpel, E.	182	*Drypetes umbricola*
Heimpel, E.	183	*Dialium pachyphyllum*
Heimpel, E.	184	*Tessmannia africana*
Heimpel, E.	185	*Tetrorchidium didymostemon*
Heimpel, E.	186	*Drypetes gossweileri*
Heimpel, E.	187	*Rothmannia*
Heimpel, E.	188	*Drypetes urophylla*
Heimpel, E.	189	*Baphia*
Heimpel, E.	190	*Tricalysia filiformi-stipulata*
Heimpel, E.	191	*Pauridiantha dewevrei*
Heimpel, E.	192	*Tessmannia Africana*
Heimpel, E.	193	*Dialium pachyphyllum*

Heimpel, E.	194	*Dialium pachyphyllum*
Heimpel, E.	195	*Leptonychia*
Heimpel, E.	196	*Fernandoa adolfi-friderici*
Heimpel, E.	197	*Dracaena arborea*
Heimpel, E.	198	*Pteleopsis hylodendron*

Table 1: List of plant specimens collected during this field excursion. Table lists collector, collector number and species identification.

Soil Samples

Soil samples were taken at 14 different locations (Table 2), at every transect.

Transect Number	**Latitude**	**Longitude**	**Amount**
1	2.375121	16.2595	3 x 200g samples
2	2.344746	16.29746	3 x 200g samples
3	2.4042	16.28471	3 x 200g samples
4	2.352051	16.28774	2 x 200g samples
5	2.313865	16.29808	3 x 200g samples
6	2.360015	16.30421	3 x 200g samples
7	2.39951	16.27485	3 x 200g samples
8	2.304967	16.30205	2 x 200g samples
9	2.248504	16.4083	3 x 200g samples
10	2.223945	16.40225	3 x 200g samples
11	2.249266	16.40531	2 x 200g samples
12	2.241	16.41639	3 x 200g samples
13	2.255705	16.41894	2 x 200g samples
14	2.254584	16.4203	3 x 200g samples

Table 2: List of soil samples that were collected during this field excursion. Table lists transect number, location in latitude and longitude, and number and weight of samples that were taken.

Soil will be analysed at the School of Geosciences, University of Edinburgh. Parameters tested will be carbon and nitrogen contents, particle size, phosphorous content, and exchangeable cations. This is to investigate if there are any changes in soil across the boundary.

Next steps

Currently I am in the process of identifying the herbarium specimens at the Royal Botanic Garden Edinburgh, and analysing the soil samples at the University of Edinburgh School of Geosciences. I will then analyse this data to investigate whether *G. dewevrei* is expanding into mixed species forest, and how tree species composition changes across the boundary.

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