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Mozambique – Madagascar Expeditions 2008-10

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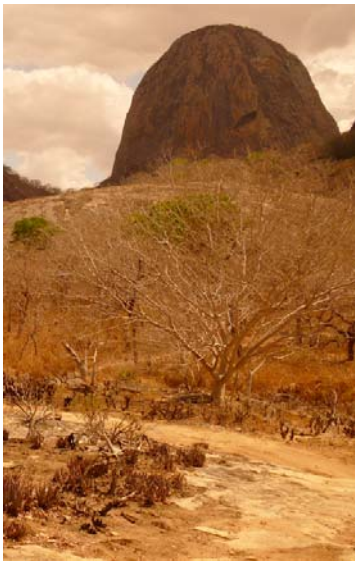
Mozambique 2008

IIAM
Instituto de Investigação Agrária de Moçambique

Expedition Report
"Reconnaissance of Coastal Forests in Cabo Delgado"
22nd November – 13th December 2008



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CONTENTS

Context and Background

The Mozambique 2008 Expedition is the first of its magnitude ever conducted in this part of the country. Even though the 2008 expedition was a preliminary reconnaissance and data acquisition phase in preparation for a more major operation in 2009, it was itself a major undertaking and has provided a base for understanding the biodiversity of woody plants and invertebrates in this region of Eastern Africa.

This is the first expedition that has involved such a high level of scientific expertise specifically dedicated to the study of Eastern African Coastal Forests in the far north of Mozambique.

The data acquired are of considerable scientific and conservation value, since no complete study of vegetation, flora and insects has ever been conducted before in this part of Mozambique.
Almost 1000 plants specimens, representing over 250 species have been collected and are being identified, together with a collection of about 750 insect species.

These collections of flora and fauna provide invaluable information for defining the program and facilitating field work for the coming main expedition phase in 2009. Furthermore, the information obtained on the various vegetation types encountered, their location and their overall status will not only guide the work of 2009 but already provide much data to guide future conservation policy for Cabo Delgado province in Mozambique.

The Mozambique 2008 Expedition provides the first detailed information on the presence and extent of different types and subtypes of vegetation that are collectively categorised as "Eastern African Coastal Forests", which constitute a biodiversity "Hotspot" according the NGO Conservation International. Previously, only Kenya and Tanzania could provide data from their countries on this "Hotspot", considered one of the 10 most important forest ecosystems for biodiversity on the African continent.

Estimated original extent (in green) of the "Eastern African Coastal Forest" Hotspot

The lack of information about the Mozambican part of this Hotspot has been a serious handicap for developing conservation policy in Mozambique; thus almost no international conservation funding for Coastal Forests has been provided to the country while Tanzania and Kenya have received several million dollars in international aid during the last 5 years. The CEPF[1], one of the few donors available for general conservation and for Hotspot funding in particular, has excluded the conservation of the Coastal Forests Hotspot in Mozambique from its financing program, "due to a lack of sufficient data." This lack is already partly addressed by the Mozambique 2008 Expedition.

[1] Critical Ecosystem Partnership Fund, www.cepf.net

Organisation of the expedition and partners involved

- The Mozambique 2008 Expedition was co-organized by Pro-Natura International and the Paris Museum of Natural History in partnership with the Instituto de Investigaçao Agraria de Moçambique (IIAM) through a series of expeditions under an initiative entitled "Our Planet Reviewed";
- This expedition was made possible thanks to the support of the Albert II Foundation of Monaco, the Total Foundation, and the Stavros Niarchos Foundation. These foundations are partners of the natural history expeditions of 2008–2010 in Mozambique and Madagascar. In addition a grant was received from the Ars-Cuttoli Foundation (*Fondation de France*) earmarked for the zoological component of the expedition;
- The flora and vegetation component of the Mozambique 2008 expedition was coordinated by Jonathan Timberlake of the Royal Botanic Gardens in Kew (UK);
- The Zoology component of the Mozambique 2008 expedition was coordinated by Jean-Yves Rasplus of the *Institut National de la Recherche Agronomique* (INRA-France);

Acknowledgements

The expedition has received the support of the following insitutions and individuals:

- The University of Lurio (Mozambique) and the management of the Maluane conservation project;
- *Chefe de Posto Administrativo de Quiterajo*, Sr. Assumane Aly;
- *Administrador do distrito de Palma*, Sr. Pedro Romão Jemusse;
- *Serviços Distritais das Actividades Económicas (SDAE) de Palma*;
- The Company Artumas.

Objectives and Methods

The virtual absence of information on the vegetation, flora and small fauna of Cabo Delgado province in Mozambique helped to define the goals of the expedition to have three main objectives:

1) To visit and characterise a number of areas that were preliminarily identified during the aerial reconnaissance survey in April 2008, and to check the status, extent and types of vegetation in these areas, targeting the least modified areas that contain dense vegetation (forest, woodland, high and low thicket);
2) To make a rapid qualitative inventory of the main woody species in these areas, supported by botanical voucher collections. These would, after identification, provide a reference collection for the 2009 expedition;
3) To make a first survey of insect diversity in the areas of study, and to select the insect groups that should be targeted for a focused collection effort in 2009.

For secondary objectives, we included:

1) The training of technicians from the Mozambiquan partner (IIAM), both in the field, at the National Herbarium in Maputo, and at the herbarium of the Royal Botanic Garden in Kew;
2) Obtaining further information for organising the technical and logistical part of the 2009 expedition;

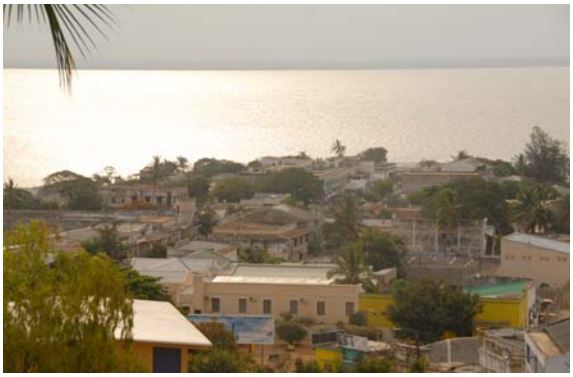
3) Acquiring media material (photos, film footage, interviews) to support communication about the project in 2009 and beyond.

The 2008 expedition was designed to cover as wide an area as possible, while maintaining enough focus to avoid a too superficial investigation of the sites visited. This necessitated a semi-itinerant expedition, although the required mobility was limited by the size of the team (25 people) and the relatively heavy logistics needed. The limited capacity for resupply and the need to access clean drinking water were also limiting factors.

Progress of the expedition

General Calendar

The operational phase of the Mozambique 2008 Expedition was conducted from the 22nd November to the 13th December 2008, giving 20 days of field research during which the full team was involved. The scientific team was divided into several groups operating in the field from 2 base camps (Quiterajo and Palma) and a secondary camp (Nhica do Rovuma). The expedition plan is detailed in Annex 1. The list of participants on the expedition, their roles and affiliated organisations is given in Annex 2.



Pemba, provincial capital of Cabo Delgado

Pemba beach

From the start to the close of the expedition, in addition to the period of research activity, a further 16 extra days should be added for organising and fact-finding in preparation for the 2009 expedition.

Roland Fourcaud, expedition logistician, arrived in Pemba on the 11th November, and was joined on the 19th by Olivier Pascal and Mike Scott, who had driven 3 days by road from Zimbabwe with 5 vehicles and the necessary camping equipment.

John and Sandie Burrows reached Pemba in their own vehicle on the 22nd November, after a 4-day trip from South Africa.

Most of the team left Pemba on the 13th December. Roland Fourcaud and Olivier Pascal did the final winding-up prior to their departure on the 16th December.

Incidents and delays

While most of the objectives of the expedition have been reached, the late arrival of part of the team had a significant impact on its progress.

The sudden cancellation of Air France flight AF8002 from Paris to Johannesburg on the 21st November 2008 led to disruptions to the program, additional costs and reduced the capacity of the "zoology" and "media"

components of the expedition. Seven participants were directly affected by this mishap, each experiencing various re-routings of their flights and consequently they arrived at different dates in Pemba. The last to arrive on the 25th November was Olivier Dubuquoy, the expedition photographer. Mathias Schmitt, journalist, was the only person who had to cancel his trip to Mozambique.

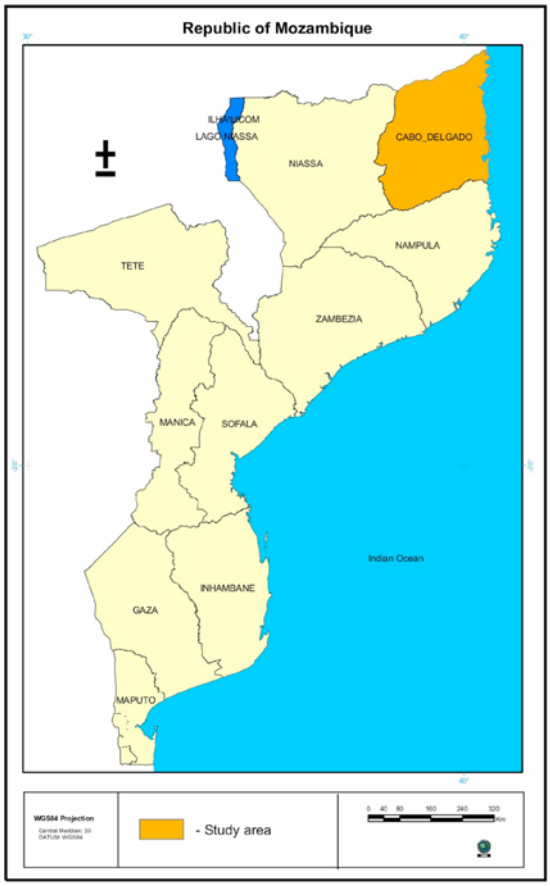
The "zoology" component of the expedition suffered the brunt of this setback. Even though the three French scientists (Jean-Yves Rasplus, Michel Martinez for entomology and Jean-Marc Duplantier for small mammals) arrived — after a chaotic trip — in Pemba on the scheduled date (22nd November) their luggage containing their scientific equipment had a different destiny. This report is not the appropriate place to go into detail about the incident, especially as it would take several dozen pages to describe this episode. It only remains to say that the zoology team had to spend 8 days without any scientific equipment. Despite this setback, their results are satisfactory, thanks to the inventiveness and adaptability of the team members.






Area of interest to the study, routes taken by the teams

The expedition took place in Cabo Delgado province in Mozambique, along a 250 km stretch of the coast from south to north (from the provincial capital of Pemba to the Tanzanian border) and in a 50 km wide band from east to west from the coast.



The program and schedule of the expedition have on the whole been adhered to. The areas around Palma and Quiterajo targetted by the expedition were both covered by the team according to plan (see Figure 1 on p. 7 for details about the areas explored).

These two areas, identified during the aerial survey in April / May 2008 as among the priority objectives for this inventory, were studied by the scientific team for 9 and 8 days respectively.

The first part of the program took place in the Maluane Reserve, a 336 km2 private concession, near village of Quiterajo which is located about 5 hours drive from Pemba (320 km). A camp was installed near this village

on the edge of a former landing strip dating back to the Portuguese period. The camp was set up on the 20th and 21st November before the arrival of the scientists in Pemba on the 22nd November.

They were transferred from Pemba to Quiterajo on the 23rd November to begin their study of the site.

Expedition vehicles on the road from Mucojo to Quiterajo, where Camp 1 was installed.

Seismic survey 'cut-line' (used as a vehicle track) in the Palma area.

The second part of the expedition took place in the northernmost region of Cabo Delgado province, with the installation of a base camp in Palma, beside the compound of the Canadian oil company Artumas. This was placed in a central and above all functional location (as required by the need for clean drinking water) from where it was possible to radiate out to other parts of the region in the far north of Mozambique.

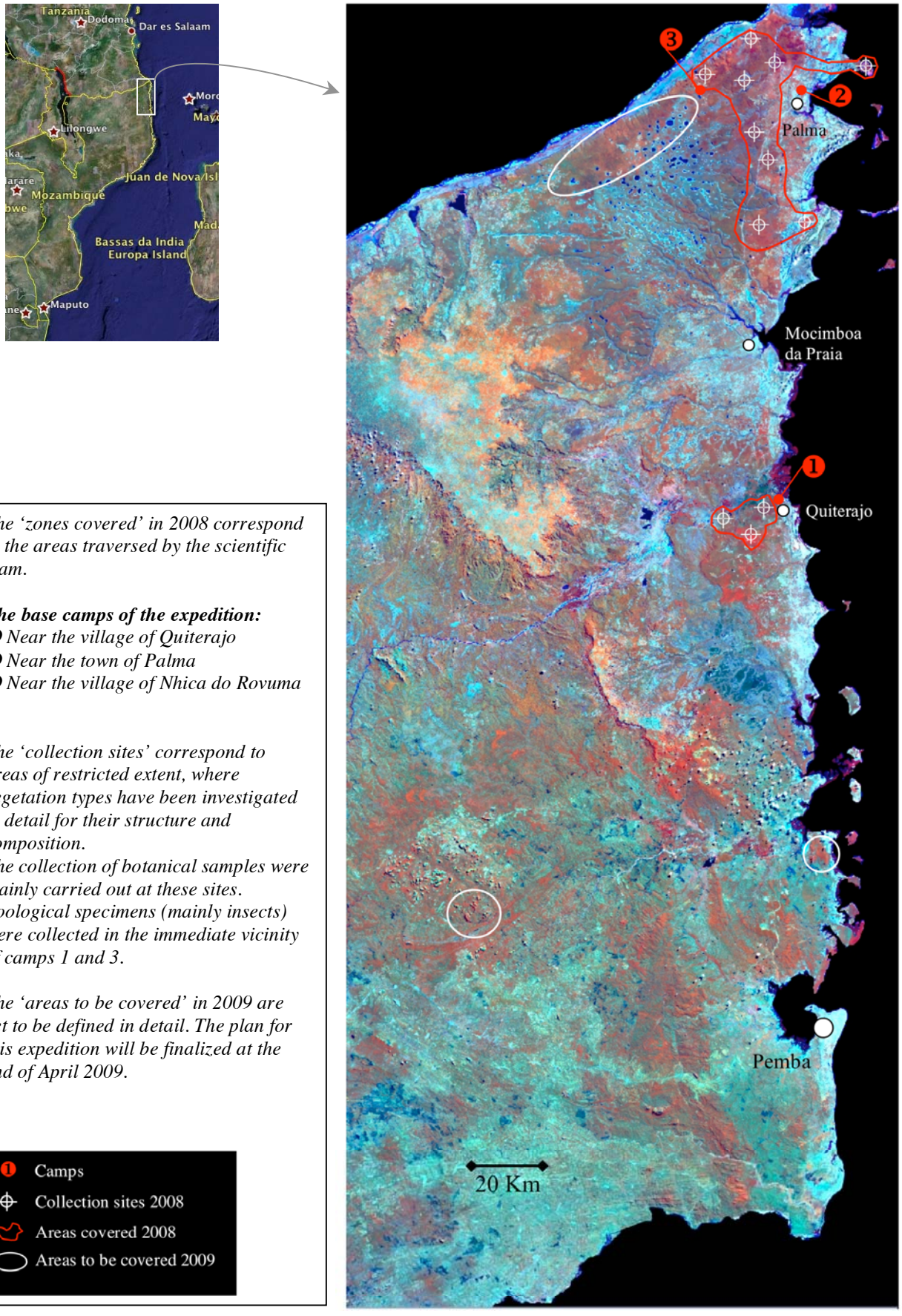
A preliminary visit to the area was made by a small team (Phil Clarke, Tom Muller and Olivier Pascal) on the 23rd and 24th November 2008, accompanied by Martin Guard (Environment Manager of Artumas) and Flip Nell (consultant with Impacto, a Mozambiquan Consulting Company entrusted with part of the Artumas environmental impact study). The visit enabled specific areas to be identified where the inventory collections should be focussed. This preliminary visit took place just before the closure of the oil cut-lines opened by Artumas for seismic surveys (all tracks, or 'cut lines' were closed by the 25th November), which provided important information on the vegetation types present and the overall state of the forests in this area, particularly through discussions with Martin Guard and Flip Nell.

The area under investigation was extensive, so a secondary camp (fly camp) was installed in one of the sites of major interest located near the village of Nhica do Rovuma, on the edge of one of a 'pantanos' (flooded depressions) that dot the plateau overlooking the alluvial plain of the Rovuma river. This camp was occupied by a reduced team throughout the stay in Palma.

'Pantanos', swampy periodically-flooded depressions. These formations are abundant on the central plateau near the Rovuma river.

'Pantanos' seen from camp 3 located on its edge.

Figure 1 : areas explored by the expedition to Mozambique in November 2008



The 'zones covered' in 2008 correspond to the areas traversed by the scientific team.

The base camps of the expedition:
❶ *Near the village of Quiterajo*
❷ *Near the town of Palma*
❸ *Near the village of Nhica do Rovuma*

The 'collection sites' correspond to areas of restricted extent, where vegetation types have been investigated in detail for their structure and composition.
The collection of botanical samples were mainly carried out at these sites. Zoological specimens (mainly insects) were collected in the immediate vicinity of camps 1 and 3.

The 'areas to be covered' in 2009 are yet to be defined in detail. The plan for this expedition will be finalized at the end of April 2009.

Summary and review of preliminary results

Detailed reports on the 'vegetation and flora' and the 'zoology' are attached as Appendix 3 and 4.

The ground covered by the expedition was a little below expectation. One of the sites included in the original program schedule, Lupangua, was not studied during this phase of the expedition, neither was Pundanhar region nor the western part of the band of forest near the Rovuma river.
Even though the extent of the planned sites to be visited and the difficult travel conditions were underestimated (we traveled over 4000 km), it was particularly the complexity of the vegetation associations encountered that account for the relative reduction in the area visited compared to that which was planned.
The interesting nature of these sites and the time needed to study them is largely responsible for the reducing the number of sites visited. That discovery is in itself a result.
However, the two priority areas have been largely covered by the expedition, according to plan.

It should be noted that the Coastal Forests of Eastern Africa are naturally limited in extent and occur only where the necessary ecological conditions are present (related to a combination of sufficient rainfall together with well-drained, nutrient-rich soils). Cabo Delgado, which receives less than 1000 mm of rainfall concentrated within six months of the year, is at the natural ecological limit for the development of forest.

The coastal forests in Cabo Delgado province are therefore present in a vegetation matrix together with coastal bushland, wooded grassland and Miombo type woodland formations. The boundary between these formation types is blurred, with transitional forms in between. This can makes it difficult to precisely distinguish between the different vegetation formation types within the landscape.

To this natural mosaic should be added the further fragmentation caused by ancient and recent human disturbance, especially cultivation and fire. This is particularly strong in coastal areas that have traditionally suffered a greater influence of human settlement than the interior.

The results of this study should therefore be interpreted by taking this context into account. And they should be compared to other parts of Eastern Africa, particularly coastal Kenya and Tanzania where very little natural vegetation now remains.

It is thus apparent that the remaining vestiges of the coastal forests in Cabo Delgado have an additional ecological importance because they persist together with a range of other natural plant communities that together provide the essential elements for understanding the original vegetation landscape of the area. It is this combination, albeit now degraded, which makes this region of northern Mozambique unique, since it is the last part of coastal East Africa where such a mosaic still exists to an appreciable extent.

1) We now have collected evidence that Cabo Delgado province is home to plant communities that are part of the 'Coastal Forests of Eastern Africa'. The results of species identifications confirm the association between the different types of forest encountered to those described in Tanzania and Kenya. This association was already predicted by other scientists although no objective evidence was available to substantiate this hypothesis.

2) The extent of forest cover, mainly concentrated along the southern rim of the Rovuma River (the natural border with Tanzania) is the largest of the entire coastal area of eastern Africa. In addition, this coverage is largely (50 to 70%) due to 'forest' and not to Miombo 'woodland', as had been widely accepted until then. The Miombo woodland formations consist of a single canopy layer over a carpet of grass. Although their ecological role is important, they are species-poor (at least for plants) and are widely distributed throughout Southern Africa and therefore of lower biodiversity value than forests, which have a multiple canopy layer together with an understorey that is often rich in rare species.

3) The general condition of the vegetation formations reveals that there has been massive human interference, both past and present:
    a. The coastal plain (5–50 m altitude) has been profoundly modified by human activity and the remaining blocks of forests are fragmented and of small extent;
    b. The plateau adjacent to the coastal plain, in the northernmost part of the province along the border with Tanzania, still has an exceptional forest cover. The northern and eastern edges of the plateau (60–100 m) still contain 2 types of dry forest, but are covered for the most part by secondary forest of varying age. The central part of the plateau (90–140 m) shows a sequence of plant communities linked to the slightly undulating topography and geomorphology, which are amazingly well preserved. The mosaic of vegetation on the plateau (swampy depressions, woodlands, and forests that are transitional between Miombo woodland and dry forest) is unique in eastern Africa.

4) The preliminary results underline the importance of protecting in its totality the mosaic of vegetation types encountered in order to ensure the integrity of the whole ecosystem, and not just the patches of forest. A practical application of this preliminary result would be to guide conservation policy to implement a type of protection that takes into account all plant associations and not only the forests proper, nor to limit conservation action to vegetation types and subtypes defined as belonging to the 'Eastern African Coastal Forests'.

5) Despite the magnitude of recent and past human disturbance, this region of northern Mozambique (covering approximately 2,000 km^2) is undoubtedly the last place on the eastern African coast with sufficient pristine sites to enable a determination of its original nature.

- Reports of experts

The contributions by experts in botany and zoology will be consolidated with a species list into an updated version of the present report that will be made public and distributed to the relevant authorities and institutions in Mozambique in June 2009. These will also be available online on the expedition website while it is active.

- Collections

2,500 specimens of plants (multiple replicates from approximately 250 plant species) were collected. These specimens will be equally distributed between the Paris National Museum of Natural History, the Royal Botanic Gardens, Kew and the National Herbarium of Mozambique.

Approximately 10,000 insect specimens will be divided up, with a reference collection going to the insect collection of IIAM in Maputo and the remainder to the Paris National Museum of Natural History and to various scientific institutions that are members of the European Distributed Institute of Taxonomy in Europe, based on their ability to identify the material.

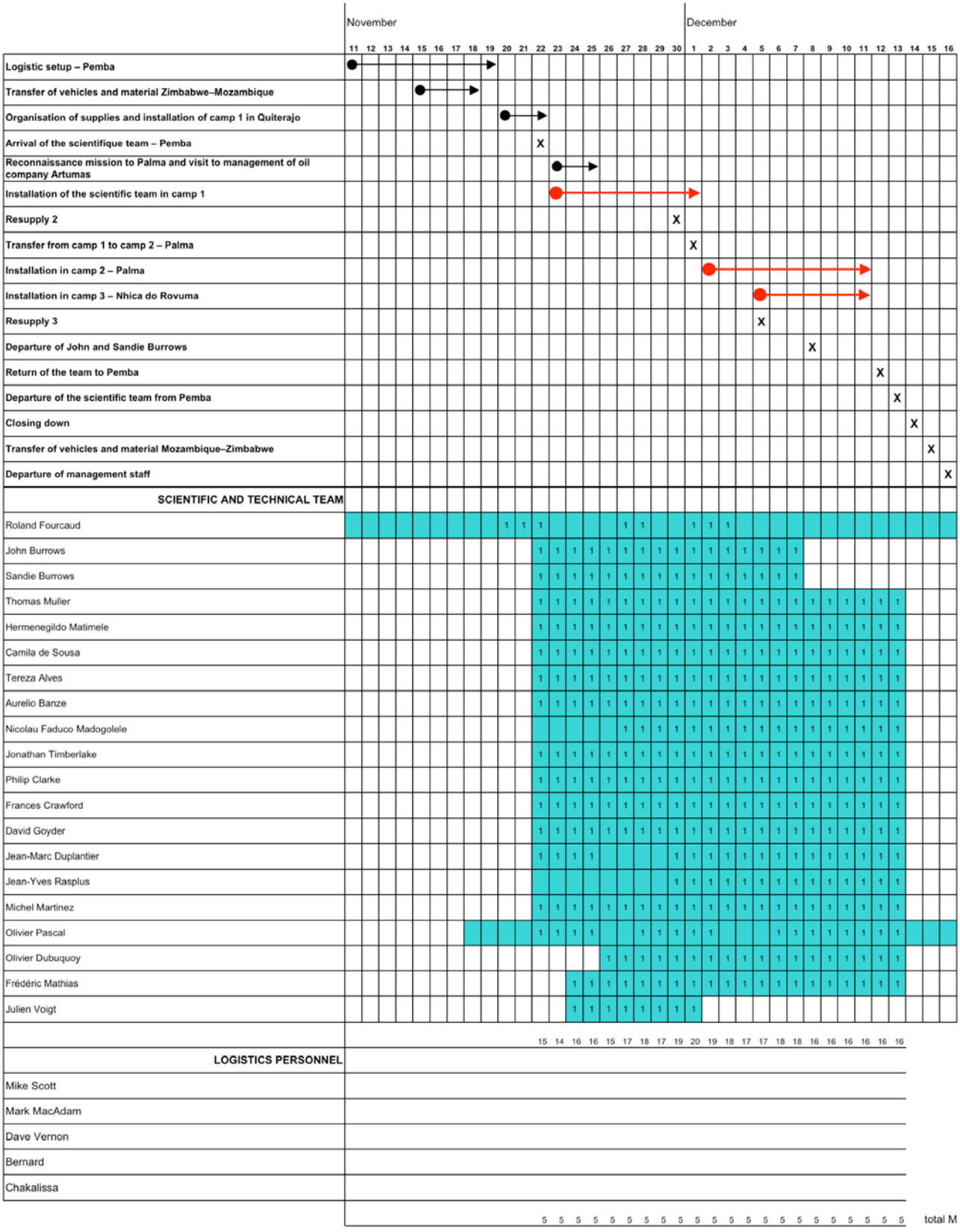
The study of this material is ongoing, but some species are without doubt new to science and at least 10 tree species were encountered for the first time in Mozambique.

- Photographic Archives

A photographic database has been established during the two reconnaissance expeditions to Mozambique. This resource will be used to illustrate the operations in Mozambique, especially to supply the expedition website that is to be launched in September 2009.

ANNEXES

Annex 1 Mission plan



Annex 2 List of participants

Name	position / role	skill	Institution	Country
John Burrows	Science team member	Botany	freelance expert in botany	RSA
Sandie Burrows	Science team member	Botany	freelance expert in botany	RSA
Thomas Muller	Science team member	Botany	freelance expert in botany	Zimbabwe
Hermenegildo Matimele	Science team member	Botany	Instituto de Investigacao Agraria de Mocambique (IIAM)	Mozambique
Camila de Sousa	Counter-part representative	Botany	Instituto de Investigacao Agraria de Mocambique (IIAM)	Mozambique
Tereza Alves	Science team member	Forest ecology	Instituto de Investigacao Agraria de Mocambique (IIAM)	Mozambique
Aurelio Banze	Tech. staff	Plant collector	Instituto de Investigacao Agraria de Mocambique (IIAM)	Mozambique
Nicolau Faduco Madogolele	Tech. staff	Insect collector	Departamento de Sanidade-Direcção Nacional de Serviços Agrários (DNSA) - MINAG	Mozambique
Jonathan Timberlake	Plant co-ordinator	Plant ecology	Royal Botanical Gardens, Kew	UK
Philip Clarke	Science team member	Botany	freelance expert in botany	UK
Frances Crawford	Science team member	Botany	Royal Botanical Gardens, Kew	UK
David Goyder	Science team member	Botany	Royal Botanical Gardens, Kew	UK
Roland Fourcaud	Logistics/admin.	Management	technical staff (Pro-Natura)	France
Olivier Pascal	Head of mission	Management	technical staff (Pro-Natura)	France
Jean-Yves Rasplus	Zool. Co-ordinator	Entomology	Institut National de la Recherche Agronomique (INRA)	France
Michel Martinez	Science team member	Entomology	Institut National de la Recherche Agronomique (INRA)	France
Frédéric Mathias	Tech. Staff	Tree climber	Technical staff (free-lance)	France
Jean-Marc Duplantier	Science team member	Rodents	Institut de Recherche pour le Développement (IRD)	France
Olivier Dubuquoy	Media / outreach	Photographer	freelance	France
Julien Voigt	Media / outreach	Photographer	freelance	France

Annex 3 Botanical component

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our planet viewed
Taking a closer look at biodiversity hotspots

Mozambique 2008

IIAM
Instituto de Investigação Agrária de Moçambique

COASTAL DRY FORESTS OF CABO DELGADO – SECOND RECONNAISSANCE TRIP
22 November – 13 December 2008

Botanical component Progess Report n°2

February 2009
Main author: Jonathan Timberlake, Kew

Summary

1. The Eastern African Coastal Forest ecosystem is considered to be among the top ten biodiversity hotspots in Africa. Coastal forests in the Quiterajo and Palma–Nhica do Rovuma area form part of this ecosystem. They are therefore important for biodiversity conservation at both the national and international levels. A major conservation priority is to preserve remaining good forest patches.

2. There is a significant difference between Tanzanian and Mozambican coastal forests – the remaining patches in Tanzania have been largely protected for a long period, while those in Mozambique, although much more extensive, have had no formal protection and most have been heavily disturbed at some time over the last 30–50 years, although they have been largely free to regenerate during the civil war period from ca. 1975–1992. This is seen through the presence of a massive tree cover containing proportionately fewer large mature trees in the Mozambique dry forests, and much of the forest extent is obviously at various stages of regeneration. Some areas of forest were however encountered that contained very large trees, though most of these were multi-stemmed, implying coppice regeneration from earlier clearance/logging. The structure and maturity of these forest patches is however unique in eastern Africa, and should therefore be a conservation priority to preserve perhaps the last surviving remnants of coastal forest with their near-original vegetation structure.

3. Less than an estimated 5% of the area within the Maluane Reserve (Quiterajo) comprises forest that is still in reasonable condition. The remaining patches of good forest are now highly fragmented and will need careful management if their biodiversity is to be maintained.

4. Although the remaining patches of good forest are the main conservation priority in the Maluane Reserve, there is a very good range and mosaic of other habitats, particularly in the northern sector from Quiterajo to the Rio Messalo. They should not be managed separately. The conservation of this range and mosaic of vegetation types, including the forests themselves, should, in our opinion, be the conservation focus for the Reserve.

5. The main threats to the forests in the Quiterajo area are:
   – clearance of good quality forest for agriculture, settlements or roads
   – reintroduction of the selective logging of large timber trees
   – excessive destruction of trees and shrubs by elephants
   – fire being allowed into the forests.

6. The forests in the Rovuma–Palma area are far more extensive than those further south, but owing to gently undulating topography, most are less well defined. Much of the area between 90–140m elevation is gently undulating and comprises a mosaic of miombo woodland, grassland and various facies of dry forest. According to Landsat imagery, the total extent is likely to have been between 250 and 350 km^2, of which perhaps 50–70% is presently under cultivation. From visits on the ground, the extent of relatively intact dry forest, that is forest still with a reasonable number of large mature trees, is perhaps only 10–20 km^2.

7. The landscape mosaic on Quaternary sediments south of Pundanhar–Nhica do Rovuma southwards to the Rio Lunique (which exits at Moçimboa da Praia) is particularly diverse owing to the various habitats found – ranging from pan grassland, through wooded grassland to miombo woodland and low dry forest, as well as thickets on termitaria. Conservation management here should be more at a landscape level, rather than site-based, and focus on retaining the numerous habitats and their inter-relationships.

8. There are two remaining blocks with moderately intact dense dry forest visited this time – along the Rovuma escarpment (particularly in the more rugged, dissected parts), and the area flanking the Rio Macanga southwest of Quionga and south of the border post at Namoto. It is thought other good forest areas are to be found west of Pundanhar.

9. Initial analysis of our plant collections suggest there are probably 10–20 species recorded for the first time in Mozambique, and 2–5 species new to science. Our collections to date, along with other recent records (John & Sandie Burrows, Quentin Luke), show there are probably over 30 new records for Mozambique or the *Flora Zambesiaca* area found in the coastal forests of Cabo Delgado. A number of these represent the southern limit of the distribution of these species.

10. The areas suggested for more detailed study on the 2009 expedition are:
    – Quiterajo / Maluane area
    – Nhica do Rovuma area
    – Pundanhar area and westwards
    – area west and southwest of Quionga.

    In addition, it is recommended that a small team look at a range of forest patches further afield, including up on the Mueda Plateau and on the plateau remnants near Macomia, to place the main studied sites into a broader context.

Survey background & context

The coastal forests of northern Mozambique are part of a wider ecosystem known as the Coastal Forests of Eastern Africa, and have been identified by biologists as an important habitat for plants and animals. This Eastern African Coastal Forest ecosystem is considered to be among the top ten biodiversity hotspots in Africa. They have been well-studied in Kenya and Tanzania, but are very poorly known in Mozambique. Initial studies in Mozambique suggest that those in the north will be very likely to contain hitherto undiscovered species.

Pro-Natura International, a French-based NGO has formed a partnership with IIAM (Instituto de Investigaçao Agronomica de Moçambique) in Maputo to carry out a survey of these forests in the northern Provinces, focussing on Cabo Delgado.

- In March 2008, Pro-Natura International employed the services of Prins Engineering http://www.prinsengineering.com/ to provide false-colour prints of the vegetation cover of coastal Cabo Delgado province in order to help identify potential areas of interesting forest, based on the results of a similar survey conducted in southeast Tanzania in 2001. From this satellite images a number of potential sites were identified ;
- In April/May 2008 Pro-Natura followed up the satellite study with an aerial survey in northern Mozambique that gave additional confirmation to the satellite analysis (see Progress Report n°1) ;
- In November & December 2008 Pro-Natura assembled a small team of botanists and entomologists to conduct a rapid assessment of the sites in Cabo Delgado that were identified by our satellite study and aerial surveys ;
- Based on the results of this rapid assessment survey, Pro-Natura will follow up in November 2009 with a larger expedition to conduct a more complete inventory of the best coastal forest sites in Cabo Delgado.

Introduction

A reconnaissance trip to Pemba, Moçimboa da Praia and Palma in northern Mozambique was carried out between 22 November and 13 December 2008. Participants on the botanical side were: Tereza Alves, Camila de Sousa, Hermenegildo Matimela and Aurelio Banze from IIAM in Maputo; Jonathan Timberlake, David Goyder and Frances Crawford from the Royal Botanic Gardens, Kew in UK; Tom Muller (Zimbabwe), Philip Clarke (Denmark), John and Sandie Burrows (South Africa).

The main objective of the reconnaissance trip was to gather biological data and information for a more detailed study planned by the end of 2009. The trip was jointly organised by IIAM, Pro-Natura International and the French Museum of Natural History.

The specific botanical objectives, which built on a previous reconnaissance trip in May 2008, were:

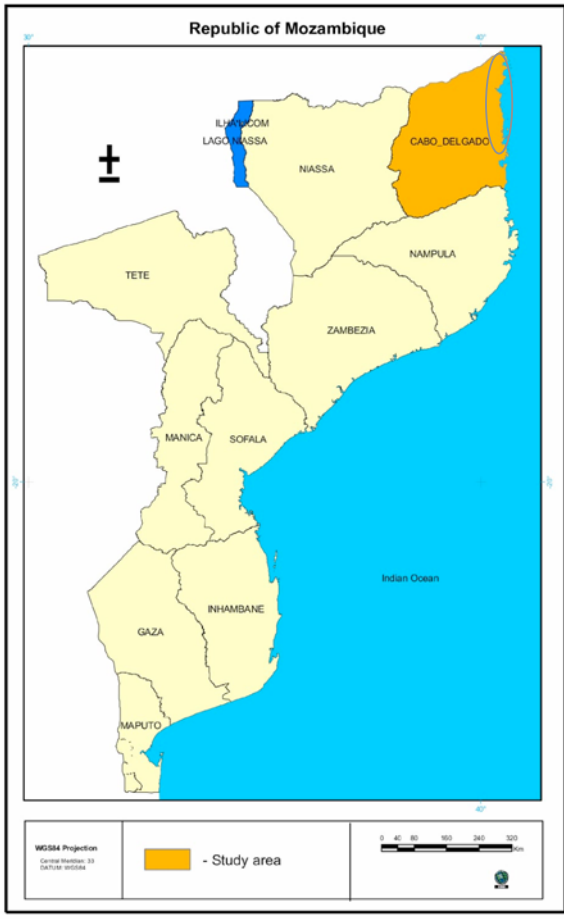
1. To categorise vegetation in the Quiterajo and Palma areas, the detailed study sites selected after the earlier trip in April/May 2008;
2. To carry out plant collections at both these sites, with particular reference to species that either characterise the vegetation or are likely to be confined to coastal forests;
3. To make a first assessment of the conservation value of the various forest patches visited, determine threats to them, and make some preliminary suggestions as to appropriate management;
4. To provide on-the-job training for Mozambican botanists.

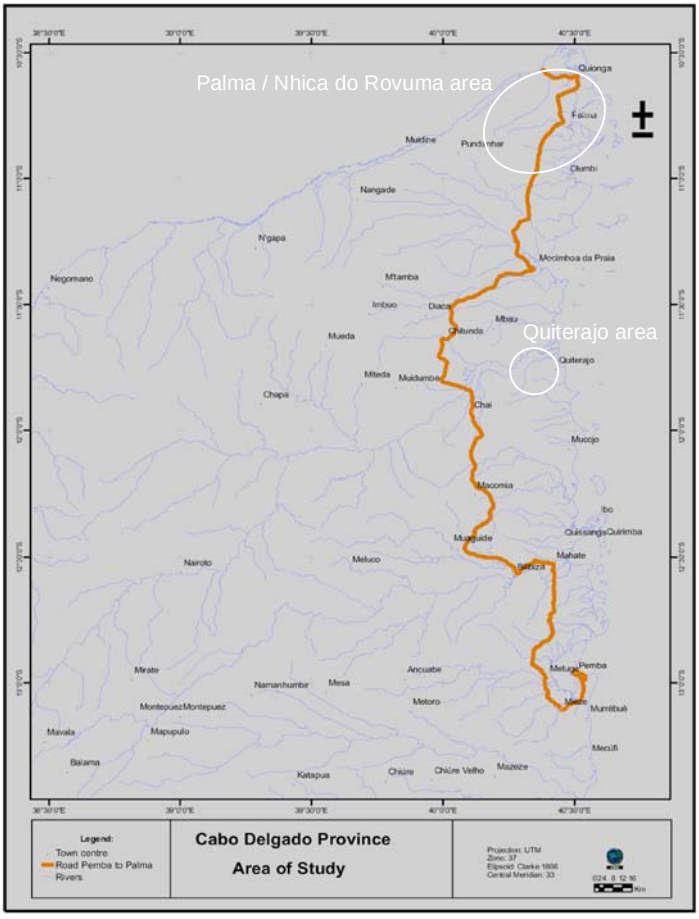
The fieldwork was followed by a one-week training session at the LMA (IIAM) Herbarium in Maputo, carried out by David Goyder. This focussed on two objectives: (a) to provide basic training in the use of plant family identification characters and how to handle larger field accessions, and (b) to carry out an initial sort of all the specimens collected on the current expedition in preparation for postage of specimens to Kew for later identification. Botanists from the University herbarium (LMU) also participated in this training.

Study Areas

The broader study area runs from Pemba in the south, up the coast to the Rovuma estuary, across to the Mueda plateau and then SSE back down to Pemba. It is about 280 km at its longest and 100 km at its widest, and covers approximately 21,000 km^2.

The principal focus of the project is dry coastal forests, known from similar studies in Tanzania to be both species-rich and to contain numerous endemics or species of restricted distribution.





For this reconnaissance trip, however, two smaller study areas were chosen based on the earlier reconnaissance – Quiterajo and the greater Palma–Nhica do Rovuma area (Figure 1). They were chosen on the basis of their apparent good condition and size, uniqueness and accessibility, and were significantly different from each other in terms of landscape and substrate.

Forest Types

Forest is considered to be a vegetation type with a closed canopy of trees, usually overlapping, a distinct shrub or understorey layer, and with no (or a very poorly developed) grass layer. Dry forest is forest dominated and characterised by species that are essentially deciduous or xerophytic in nature, although all coastal forests in this area contain some evergreen species. During the dry season dry forests can have numerous leafless trees, although evergreens are often also present. Coastal forests are broadly defined as closed canopy fire-excluded forests dominated or characterised by plant species that are confined to the eastern African coastal region. A particular type of coastal forest of interest to us is that dominated by various trees of the Leguminosae family, in particularly those in the Caesalpinioideae subfamily. It is this broad type that is known to have a number of species of restricted distribution, and to show a marked turnover in species dominance between patches. Such forests lie principally within 10–70 km of the eastern African coast.

The initial botanical and conservation findings from the November-December study trip are outlined below. However, this interim report was written before any plant specimens had been properly identified, thus results are very preliminary and further new records are likely to be found.

Areas visited during the reconnaissance trip

Landscape in the Quiterajo area

Quiterajo Area

A number of sites in the Maluane concession in the Quiterajo area were visited, but the expedition particularly focussed on northern and eastern areas.

Specimens were collected from some 250 species, of which we expect 5–20 species to be recorded for the first time in Mozambique. We may also find 1–2 new plant species to science.

The coastal forests we have primarily looked at are those on sandy soils on the plateau / escarpment edges derived from Cretaceous sandstones, as typified by the area of forest on the plateau / escarpment to the immediate north of Quiterajo centre (sede) — the Nahavara forest, sometimes termed by us "The Banana" (centred on 11º46S, 40º22'E). The soils are medium to coarse textured sands, well-drained and moderately deep, and possibly acidic. This type of forest is primarily found at 100–200m altitude and is dominated by *Guibourtia schliebenii* (a coastal forest endemic), in association with *Pteleopsis myrtifolia* and *Manilkara discolor*. Two species of *Warneckia* and two species of *Memecylon* characterise the understorey shrubs, species which are otherwise rare in Mozambique. Tree diversity in this forest type is low, with few emergents of other wide

crowned species such as *Hymenaea verrucosa, Afzelia quanzensis* and *Cordyla africana*. In many areas these large trees appear to have been removed, leaving a *Guibourtia*-dominated canopy at 10–12m with both deciduous and evergreen species, and a thick evergreen shrub layer at 3–4m. Many lianas are present, some of which appear to be very old. These contribute a significant part of the canopy cover and make passage through this type of forest difficult.

Guibourtia *dry forest, Quiterajo plateau*

Micklethwaitia *forest, Quiterajo area.*

A different type of coastal forest exists in the sacred forest area near the village of Gaza (11°46'S, 40°16'E) in the Rio Messalo floodplain on alluvial soils, where *Micklethwaitia carvalhoi* (recorded as *Cynometra fischerii* in a previous vegetation study by the Universidade Eduardo Mondlane in Maputo) is strongly dominant in a small area together with *Berlinia orientalis* and *Millettia stuhlmannii*. This is the northernmost record for *Micklethwaitia*, a monotypic genus that is endemic to Cabo Delgado. The species was only found by us at this site, and may once have been more widespread in the other areas of forest on alluvial soils.

A possible third forest type is present on the less-steep slopes leading off the escarpment edges (11°48'S, 40°20'E), and perhaps elsewhere. This type comprises tall trees up to 25m, but it was not possible to characterise it further.

Drainage line fringed by Berlinia – Afzelia *woodland, Quiterajo area*

The forests are naturally broken up in the landscape by 'baixas' (grassy drainage lines) fringed by a narrow band of *Berlinia orientalis* and *Afzelia quanzensis* woodland, and Caesalpinoid-dominated miombo (*Brachystegia*) woodland higher up the slopes. On the wider floodplains the woodland becomes more open, and in some areas is characterised by abundant *Hyphaene* doum palms. There are lots of tree species that are distributed by elephants in this vegetation type.

Human settlements were historically concentrated near areas with good access to water, such as beside the baixas and floodplain fringes. The forests on the plateaux appear to be favoured for cultivation, even where these may be at some distance from settlements. The game guards informed us that a number of settlements and cultivated areas were abandoned during the wars of 1962–1992 and more recently due to heavy elephant disturbance; which confirmed our observation that large areas of dry scrub forest on the plateaux have regenerated following clearance for agriculture.

Fires from the burning of areas cleared for farmland, or from understorey burning of mango and cashew orchards, was observed to penetrate into the forests in some areas.

The probable extent of coastal forest in the broad Quiterajo area was historically in the order of hundreds of square kilometres (300–500 km^2). But over the last 200–400 years the major part appears to have been cleared at one time or another for cultivation as part of a traditional practice of bush fallowing. This was seen in large areas of scrub forest with a very low canopy, many multi-stemmed trees that appear to have regenerated by coppicing, and in the absence or greatly reduced number of large trees.

Other significant forms of disturbance encountered were logging (apparently mainly during colonial times), the construction of access tracks and – more recently – elephant damage.

The remaining area of good quality forest in the Maluane Reserve is now highly fragmented, but contains a high diversity of species, quite a few of which are confined to the coastal area of northern Mozambique and southern Tanzania. These species are coastal, rather than originating from the continental interior. The extent of forest still in reasonable ecological condition is perhaps only 20% of what was originally present 200 years or more ago. Of this 20%, less than a quarter, i.e. less than 5%, is what we would consider to be good quality forest, even though it is disturbed.

Conservation efforts should be directed at a landscape level in order to preserve a mosaic of habitats, rather than focussing on specific sites or species. The area immediately south of the Rio Messalo, on the northern side of the concession, should be a priority.

Rovuma – Palma Area

There are basically four types of landscape in the broad area from Mueda to Palma, although we have only looked at two in any detail (Landscapes A and B).

A. "Rim" of higher ground (60–100 m elevation) underlain by Miocene sandstones, with reddish sandy soils. Comprises an E–W section of the Rovuma escarpment above the Rovuma floodplain, and a N–S section just inland of the coast following the main Palma–Moçimboa road.

B. Plateau or "sponge" of more recent Quaternary sediments, which cover most of this section of the study area, with an elevation of 90–140m. The landscape is very gently undulating, with the main drainage being through Miocene sediments to the coast to the east and fairly deeply incised.

C. Area of Mueda plateau underlain by Cretaceous sandstones, dipping W to E, and up to 700–1000 m altitude in the west.

D. Coastal plain from 5–50 m elevation, mostly comprising Quaternary deposits (alluvium and colluvium) and ancient uplifted corals on the Cabo Delgado peninsula. Vegetation mostly heavily disturbed, with many coconuts, cashew, mango, palms.

Lake Nhica and the Rovuma floodplain seen from the escarpment at Nhica do Rovuma (foreground)

The Rovuma Rim forests (looking southward from above the Rovuma River)

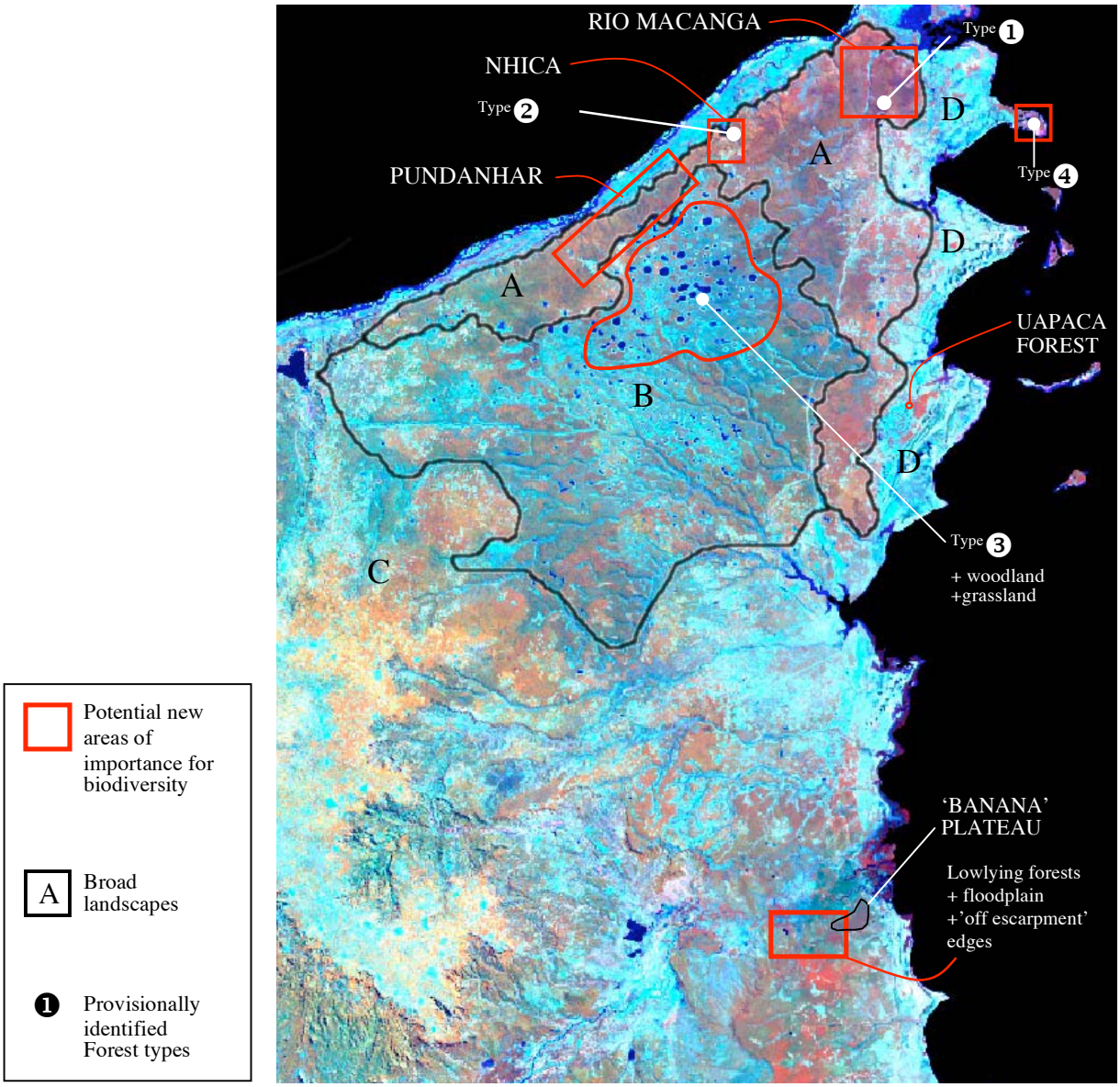
Interplay of Miombo woodland and dry coastal forest bordering a drainage line (landscape type B), Palma area

Coastal plain in the background and coral rag bushland in the right foreground, north of Pemba bay

Landscape A: Miocene sands – this area is somewhat dissected and also the most heavily settled area after the coastal plain. Vegetation probably originally comprised dry forest and fairly dense *Brachystegia* or *Berlinia* woodland/transition forest, but now most of the original vegetation has been cleared for subsistence agriculture (as well as roads and settlements), and the remainder is generally highly fragmented.

Landscape B: Quaternary sediments – this is the most extensive type and is surprisingly little disturbed (just locally). Landscape is only gently undulating and characterised by a number of grassy pans and drainage lines. Vegetation is generally *Brachystegia spiciformis–Berlinia–Uapaca nitida* woodland, but with extensive grassy areas, often fringed by *Parinari curatellifolia*. On slightly elevated areas there is often a sand cap or "lens" of coarser-textured, deeper and better-drained sand, giving rise to patches of forest-type vegetation such as closed-canopy *Berlinia* forest with an understorey of predominantly forest shrubs (especially Rubiaceae) and small

trees. It is a sort of intermediate type between typical miombo woodland and typical dry forest. Also found are numerous termitaria with "termitaria forest" and palms.



Given these different landscapes, at this stage we have provisionally identified four dry coastal forest types in this area, although not all are very distinct one from another.

1 - Dry forest on brown, medium-textured sands on higher ground, primarily on Miocene-derived soils (part of **Landscape A**). Forest 12–16 m high, lot of *Ochna* and *Diospyros verrucosa* in subcanopy, along with *Manilkara discolor* and *Berlinia*. Upper canopy often missing – remaining large trees primarily *Berlinia*, *Afzelia*, *Hymenaea* (sometimes with *Brachystegia spiciformis*). Most of this type has presumably been logged in colonial times for the larger and valued trees, and the great majority of the area

Track through disturbed dry forest, Palma area (type 1)

seems to have been cleared for cultivation at some time over the last 100 years. Many areas look to be only 10–20 years old since last cleared.

Track through good quality dry forest, Palma area (type 1)

2 - A forest type comprising larger and taller trees, more "forest-like", found on colluvial soils below the Miocene escarpment, especially in the Nhica do Rovuma area and probably elsewhere in the rugged terrain associated with the Rovuma escarpment. Soils are apparently richer in nutrients, possibly with a higher moisture status or moist for a longer-period. However, such forests are very localised, and comprise perhaps only 5% of the total dry forest area. Characterised by trees up to 30m tall of *Terminalia sansibarica*, *Dialium holtzii*, *Ricinodendron heudelotii*, *Sterculia schliebenii*, *Bivinia jalbertii*, and others. *Diospyros kabuyeana*, only recently recorded from Mozambique, is common in the understorey along cutline 34. We did not visit an adequate range of sites in this type.

Taller forest on colluvial soils (type 2), Nhica

3 - Dry forest similar to Type 1 but forming part of the Quaternary landscape catena and mosaic (**Landscape B**) between Palma and Nhica do Rovuma. Characterised by a low canopy to 10–15m of *Berlinia*, *Afzelia* and *Hymenaea* (sometimes *Brachystegia spiciformis*) with a dry forest understorey, often with unusual Rubiaceae shrubs such as *Didymosalpinx*. Appears to have been little disturbed, except close to villages, and are unique and of particular conservation interest (J. Burrows pers. comm.). More detail is given under Landscape B description.

Didymosalpinx norae, *a shrub of forest type 3*

An unusually large, 40+m tall individual of Afzelia quanzensis, *near Nhica do Rovuma*

A squat, multi-stemmed Afzelia quanzensis *which appears to have coppice-regenerated*. A. quanzensis, *like several other miombo dominant species, has the ability to coppice after being cut*

4 - Coral rag bushland. Primarily found along Cabo Delgado towards the lighthouse. It was not fully investigated, but it is believed to support a number of interesting coastal species.

Cape Delgado, itself, with coral rag bushland. The lighthouse is at the end of the track to the right

The most interesting tree species appear to be in Type 2 on colluvium, but perhaps the most species-rich is Type 1. However, this is also the most extensive both in total area and in geographical spread, so this is to be expected. Type 3 is considered to be of particular conservation interest as these forests on slightly raised "sand lenses" are an integral part of a landscape mosaic with high overall diversity.

Forest clearance (type 1) for agriculture, Nhica do Rovuma

Type 1 is the most threatened type owing to the rapid expansion of settlement and cultivation. However, it is possible that the Nhica do Rovuma and Pundanhar areas have good remaining areas of forest that are under less threat.

One specific conservation priority is in the eastern part of the study area, close to Quionga. There is a block of forest along cutlines 11 and 34 immediately north of the "hidden pan" (10º40'05"S, 40º27'52"E) NNW of Palma, flanking the incised S–N-flowing Rio Macanga that exits near Quionga. This has a particularly undisturbed canopy with emergent trees, something rarely seen elsewhere in East Africa (P. Clarke, pers. comm.). Otherwise, the main broad conservation concern would appear to be the miombo catenas on Quaternary sediments and on the Rovuma escarpment below, where the conservation focus should operate at a landscape level rather than site level.

There are still two unanswered questions:

a) Where do the Quaternary sediments end and the Miocene sediments begin? Or is the change actually transitional with no clear boundary. A boundary is clearly seen at one place on the road to Nhica on a steep gullied slope with much deeper redder consolidated sands above.

b) How can we separate out the botanical differences arising from "natural " differences, such as soil type and geomorphological position, from change arising from the last 100–200 years of human landuse. That is, to what extent are the differences in forest structure and composition seen a result of historical land use patterns rather than underlying environmental conditions?

Other Areas

Stilt-rooted Uapaca. *This tree species was only found in a tiny (1ha) patch of forest during the reconnaissance survey*

Although on this trip only the Quiterajo and Palma–Nhica areas were visited, some useful observations were made elsewhere.

A very unusual and interesting patch of swamp forest was found near Quissenge airstrip (11º03'44"S, 40º26'51"E), dominated by a stilt-rooted species of *Uapaca* (*U. lissopyrena*?) 15–20m high. Associated species were a mixture of those from miombo woodland and dry forest. This patch is apparently unique and should be a conservation priority.

There is a broad area flanking the Rio Messalo to the north and south (along the road, centred on 11º45'S, 40º00'E and 12º00'S, 40º08'E) that, although heavily disturbed and with large patches cleared for cultivation, appeared to support much larger and taller trees. The species were mostly woodland species but others are more typically associated with dry forest. The habitat appeared significantly more fertile for tree growth, and trees showed less moisture stress than those in most areas where we had been working. There was also much evidence of logging here (tracks, vehicles on road, etc), not surprising given the size of remaining trees. It is thought that the apparent higher fertility relates to both incident moisture and lateral movement of moisture and nutrients flowing towards the Messalo valley, although there may also be a difference in substrate.

Plant Specimens and Species

A team member, Frédéric Mathias, collecting samples from a Zanthoxylum

Over 890 numbered plant collections were made (Burrows 359, Crawford 132, Goyder 51, Timberlake 215, Müller 72, Matimela 80), most with 2 to 5 duplicates. These are all in Maputo at present, but will be posted to Kew very soon. Hermenegildo Matimele from IIAM came to Kew in March 2009 to lead the process of sorting and identifying with Kew staff. Assuming all goes to plan, the majority of specimens should have been named by the end of May 2009. Once identified and labelled, sets of specimens will go to Maputo (LMA and LMU), Kew and Paris.

Already nine species have been highlighted which appear to be new to Mozambique, of which two may be new to science (*Asparagus*, *Vitex*). Most of those new to Mozambique (some of which are also new records for the Flora Zambesiaca region, and one appears to be new to Africa – *Antirhea* sp. [Rubiaceae]) are known from coastal forests in southern Tanzania and were previously thought to be endemic to Tanzania, so are extensions of their known range.

John Burrows with flowers from Erythrina sacleuxii, *a new record for Mozambique*

Once our specimens are identified, and combined with records from other recent collecting trips in the area by John & Sandie Burrows (2007) and Quentin Luke (2003), there are likely to be around 20–40 new Mozambique records and range extensions, including a number new to the Flora Zambesiaca area. Among our collections there may also be 2–5 new species, with more likely to be found on subsequent trips.

Comparison with coastal forests Elsewhere

Based on experiences in coastal Tanzania (Phil Clarke), the forests we saw in Cabo Delgado have a lot of similarities to coastal forests there – in species composition, structure and ecology. There is a marked difference between the forests we visited and woodland vegetation further inland in northern Mozambique, both in structure and (particularly) in woody species composition. Miombo and similar woodland types studied in Cabo Delgado and Niassa Provinces (Reserva do Niassa) have less than 20% of woody species in common with the coastal forest areas we visited. However there was a much greater level of similarity with the miombo woodlands on Quaternary sediments in the Nhica area. The main difference in terms of characteristic and common species was the presence of *Berlinia orientalis* in coastal areas, which is absent further inland.

Berlinia has an interesting pattern of occurrence in the area. It is a coastal species that is endemic to Cabo Delgado and adjacent southern Tanzania, not found very far inland, and is not a typical component of miombo elsewhere. In the Quiterajo area it was particularly common, often dominant, fringing drainage lines, forming an edge between grassland and more typical miombo woodland. However, in the Palma area it was much more widespread, being also found extensively in areas of regenerating forest and woodland, some of which were quite recent (3–10 years old). This is probably a function of its readiness to coppice, which enables it to rapidly return after cutting during bush-cultivation. Such a feature was also not noted in S Tanzania, where it also occurs but is not common.

Comparing coastal forests in Tanzania with those in northern Mozambique, one very significant observation is that in Tanzania the forest extent is much less and is now confined primarily to Forest Reserves. These were often gazetted in German colonial times, some 100 years ago and have been broadly respected by local population, such that the boundaries are "hard" and clearly visible. The surrounding areas are now mostly cleared and cultivated, while the forests have not been cleared or excessively disturbed for a long period. In contrast, in Cabo Delgado, the coastal forests are much more extensive, but there has been very little, if any, formal protection. Hence most of the forest areas, certainly closer to the coast, have been cleared for cultivation at some time over the last 100 years, and most show signs of heavy disturbance within the last 20–50 years. This is reflected in a lack of "hard" boundaries, proportionately fewer large mature trees, and perhaps a reduced species diversity.

Although the species composition in coastal forests in Tanzania and northern Mozambique is similar, there is a high species-turnover and difference between individual patches, which is to be expected as this is a feature of coastal forests along the East African coast. Another feature of note is the genus *Cynometra*, which has a number of species present in southern Tanzania. However, it appears to be absent in northern Mozambique, the closest relatives being the Mozambique endemics *Scorodophloeus torrei* and *Micklethwaitia carvalhoi* as well as the widespread coastal forest endemic *Scorodophloeus fischeri*, known only in Mozambique from a single stand of forest near Nangade.

Annex 4 Zoological Component

MUSEUM NATIONAL
D'HISTOIRE NATURELLE

Mozambique 2008

COASTAL DRY FORESTS OF CABO DELGADO – SECOND RECONNAISSANCE TRIP

22 November – 13 December 2008

Zoological Component, Report of phase 1

February 2009

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Progress of the expedition

The biodiversity survey's 'zoology module' was centred around two localities in Cabo Delgado province (northern Mozambique), where large patches of relatively well-preserved forest are easily accessible. The two sites investigated (Quiterajo and Nhica do Rovuma) were surveyed over two relatively short periods of time (5 and 7 days respectively), as the baggage containing scientific equipment arrived almost ten days late, due to the cancellation of the flight that was to bring the staff and equipment.

A variety of trapping methods have been used at both sites, enabling the targeted collection of certain groups of interest to better understand the entomological values of the sites. We concentrated on pitfall (Barber) traps, Malaise traps, UV light traps at night and opportunistic collecting during the day. We have reduced the envisaged number of study sites, focusing on the best-preserved areas of forest and those considered to host the most interesting entomological fauna. In these habitats, we have diversified the collecting sites as far as possible, visiting different areas every day and moving the light traps in the evening. One of the team has furthermore explored and trapped at the first site without specialist equipment, using buckets as pitfall traps, while doing opportunistic collecting and preserving all the specimens collected in alcohol.

The sites explored

Quiterajo (Q)

Relatively degraded dry forest in the area around Quiterajo, targeting more specifically — but not only — the least degraded areas. This area hosts a particularly large population of elephants, as well as a relatively rich mammal fauna which ensured a large collection of dung beetles. The vegetation of this site (as well as of the following site) are described in the appendix on "vegetation and flora" by Jonathan Timberlake, leader of the botanical module of the expedition. Our surveys have focused mainly on the less disturbed fragments of forest on the edge of the escarpment.

Nhica -Do-Rovuma (N)

After a day of exploration to locate a suitable site, we moved almost 7 days (5th to 12th December 2008) to a camp near the village of Nhica do Rovuma. This area gave both a diversity of forest environments, wetlands and an escarpment edge allowing collecting to be done at night with a light trap in a open area overlooking the dry forests. In addition, areas of human activity (clearings for agriculture) enabled an effective search for wood-eating insects.

Collection methods used at both sites

Opportunistic collecting (every day)

Fig. 1. *Sorting through the result of opportunistic collecting*

Daily surveys were used to collect dragonflies/damselflies (Odonata) and butterflies (Rhopalocera) by net, together with the particular groups: Cicindelidae, Mutillidae and Asilidae. Wood-eating insects were collected through opportunistic collecting during the day and by investigating tree stumps in the recently cleared areas at night (Fig. 1). At the same time, we also brushed the vegetation with a sweep net to collect Diptera and Hymenoptera. Every available morning and late afternoon were devoted to this type of collecting.

Light traps (7 nights)

Fig. 2. *Setting up a light trap in Quiterajo*

We essentially used a classic light trap consisting of a white cloth behind a UV mercury vapor lamp. A total of 7 light-trapping nights were carried out at 6 different sites, giving about 50 trapping hours. Different habitats have been collected in: a promontory overlooking dry forest (Q), a landing strip near dry forest (Fig. 2) (Q), a marshy area in the forest (N), a cleared area near a lake and dry forest (N), and in areas of savannah surrounding islands of forest (Q).

Pit fall (Barber) traps (8 days)

Fig. 3. *Pit fall (Barber) trap in Quiterajo*

Two sets of ten Barber traps (buckets) were used as soon as we arrived at the collecting sites, and have remained in place for about 8 days at each location (Fig. 3). These buckets, arranged at a distance of 50 m apart, were placed in areas of good condition dry forest. They were not baited, and caught mainly Scarabaeidae and Carabidae beetles, and some other families (Tenebrionidae).

Malaise traps (8 days at Nhica)

Fig. 4. *Malaise trap on the forest edge at Nhica de Rovuma*

At the Nhica-do-Rovuma site, we installed two Malaise traps at the forest edge. These traps (Fig. 4) remained in place throughout our stay. They enable the collection of numerous Hymenoptera and Diptera living in forest habitats. This collection supplemented the sweep netting and allowed us to better understand the richness of the insect fauna for the groups that were not targetted during this first trip, but which will be covered by entomologists during the next phase of the expedition. These traps have been particularly productive and have provided several thousand specimens. This material is currently being sorted.

Elephant dung collection (2 locations)

In both of the locations mentioned above, we looked for and collected in elephant dung (Fig. 5). There are large populations of these animals present, so it was possible to gather a large number of dung beetles associated with these faeces. The surveys were conducted by searching the underlying soil to a depth of 40 cm. Several thousand specimens were collected (Fig. 6).

Fig. 5. *Fresh elephant dung (Q)*

Fig. 6. *Display of dung beetles, collected at Nhica*

Objectives of the 2008 survey

1. To prepare for the 2009 expedition, looking for sites to be explored while estimating the diversity and endemism of the targeted groups. The forest habitats in this region are becoming progressively more fragmented, so we think it is important to focus our exploration in 2009 on one of the two areas surveyed this year.
2. To compare the areas collected to similar fragments of forest located in Tanzania and Kenya. To better assess the biological and biogeographical importance of the forest fragments studied, we have targeted

part of our inventory collection to previously well-studied taxa in the Coastal Forests of East Africa. As a result we selected two groups of vertebrates: amphibians and rodents, as well as certain groups of well-studied insects (Scarabaeidae, Rhopalocera, Sphingidae and Saturniidae, Odonata, Cerambycidae).

3. To infer - as far as possible - the level of insect endemism in the forests of northern Mozambique. The samples taken from the groups described above will enable an answer to that question. However, in order to gain an insight into the original fauna of these forests, we studied in parallel some other taxa that characteristically have high levels of endemism: 1) groups of terrestrial arthropods with low mobility (dispersal ability) and strong trophic requirements (specialists in certain habitat types, ex Mutillidae, Tenebrionidae, Cicindelidae). 2) Groups of phytophagous (plant-eating) arthropods that are associated with the endemic plant species reported by the botanical team.

For reasons explained in the project proposal, we focused on certain groups that are important for the conservation of natural environments, without neglecting to do a holistic inventory which has been and will remain the priority of all major natural history expeditions.

Preliminary results of the 2008 survey for priority taxa

Lepidoptera

1) Butterflies (Papilionoidea and Hesperioidea)

Butterflies are by far the most studied group of insects, and their distribution is generally well known, even in Africa. Our collections at both sites amounted to about 200 butterfly specimens representing some 60 species.

2) Moths

Two families have been sampled in both collection localities: Saturniidae and Sphingidae. Nearly 150 individuals belonging to these two families were collected, representing about 60 species.

Of these, there was at least one remarkable record — the capture of *Antistathmoptera rectangulata* Pinhey, l968 (Fig. 7), a species known from just a few localities in Tanzania (Morogoro), Malawi and Mozambique.

Fig. 7. Antistathmoptera rectangulata, *Saturniidae with a localized distribution in East Africa*

Coleoptera

Scarabaeidae

Coprophage beetles generally exhibit quite strong habitat specificity and are sensitive to disturbance (Mico et al. 1998). East Africa has rich communities of these dung beetles. They are easy to sample (by means of trapping

out the feces or scats) and are relatively well known (Hanski & Cambefort 1991; Tindi Nielsen 2007). Their communities can be disturbed by the influence of large vertebrates (e.g. elephants) and human activity (Botes et al. 2006). In addition, dung beetles are particularly important insects in the habitats where they exist. The economic value of the ecological services they provide has been estimated at nearly 380 million US$ annually in USA (Losey & Vaughan 2006). They play a critical role in ecosystems, especially in nutrient-poor soils (Scholes 1990), accelerating the rate of nutrient recycling and preventing the loss of nitrogen. They may act as a secondary disperser of seeds (Andresen 2002), assist in the control of intestinal parasites in mammals (Grönvold et al. 1992), and their burrowing activity increases the soil's capacity to absorb and retain water (Bang et al. 2006).

Fig. 8. Kheper lamarcki *(Col., Scarabaeidae)*

We collected Scarabeidae associated with elephant dung in the two localities explored (Fig. 8). Over 3000 individuals were collected representing about 70 species, but the groups within the genus *Onthophagus* are not yet known with precision. Moreover, different groups of Scarabaeoidea were collected, in the pitfall traps, in the light traps (Melolonthidae) and by opportunistic collecting (i.e. the Cetoniidae), representing approximately 60 additional species.

Tenebrionidae

Tenebrionidae beetles are another important group for the conservation of natural environments. Being wingless and of poor mobility, they are poor dispersers and display radiations of species with restricted distribution and high rates of endemism (Contreras-Diaz et al. 2003). Due to time constraints, we were unable to properly collect these insects. A total of about twenty species (around 200 specimens) in this group were collected, mainly through opportunistic collecting and the UV light at night.

Cerambycidae and Buprestidae

Fig. 9. Tragocephala variegata *(Col. Cerambycidae)*

Wood-eating insects (Fig. 9) with generally narrow trophic requirements (Farrell & Mitter 1998), the Cerambycidae are among the best known groups of beetles. Being distinctive, they are regularly collected, and are well-studied in the region and are sometimes regarded as engineers of the ecosystem (Buse et al. 2008). They are often associated with rotting trees where they control the availability of woody resources for other organisms in the ecosystem, allowing the decomposition of trunks and branches. Some groups are wingless, moving little and are reminiscent of the characteristics of the Tenebrionidae.

Carabidae and Omophronidae

Fig. 10. Anthia burchelli *(Col., Carabidae)*

The Carabidae are a relatively well-known indicator group in East Africa. Dozens of species of this family were collected mainly by opportunistic collecting (several species of *Anthia*, Fig. 10), by UV light-trapping (*Calosoma*) and in pitfall traps. We believe the number of species collected to be about 40 but the material remains largely to be sorted.

Cicindelidae

Fig. 11. Manticora scabra *(Col., Cicindelidae)*

Often associated with sandy and arid environments, this group of predatory beetles has such trophic requirements that it is recognised it as an indicator taxon (Pearson & Cassiola 1992; Barraclough et al. 1999; Pearson & Cassola 2000; Cardoso & Vogler 2005 ; Woodcock et al. 2007). This is a very diverse group in East Africa (Bouyer & Cassola 2007). Approximately 15 species of Cicindelidae were collected within the explored environments, primarily by opportunistic collecting or in pitfall traps (*Manticora*, Fig. 11)

Odonata

Dragonflies are a distinctive group of insects that are relatively easy to study, including in semi-arid areas. These species show different levels of habitat specialisation and have complex life cycles that are remarkable indicators for studying freshwater ecosystems. Odonata communities are sensitive to changes in habitat (e.g. the conversion of natural forest to cultivated land) and can be easily described (Clausnitzer 2003) using both morphological and molecular methods (Rach et al. 2008). With a total of 78 species, this group is ideal for comparing diversity with other areas of dry forest in East Africa. We collected this taxon in the two areas investigated, and have preliminarily identified some thirty species. These species were collected with nets in the area around Lake Nhica but also by the UV light at night in different localities. These insects will be entrusted to Klaas-Douwe B. Dijkstra (Naturalis, Leiden), who is the Odonata specialist for the region.

Neuroptera

Having been contacted by Bruno Michel, an expert in this group, to collect these insects which are particularly abundant in the sandy areas of dry forest in Mozambique, we collected numerous specimens, mostly by light trapping. About 60 specimens (Fig. 12) representing more than 25 species have been collected and will soon be identified.

Fig. 12. *Nemopteridae (Neuroptera)*

Mantodea

Similarly, given the richness of this group, we collected praying mantids by light-trapping and through opportunistic collecting. This group is particularly diverse in the areas explored and we have been able to gather more than 60 specimens of mantids representing probably more than 25 species. The entire material will be sent to J. Roy (Muséum National d'Histoire Naturelle, Paris) for identification and possibly description.

Fig. 13. *Mantodea*

Hymenoptera

Finally, two groups of Hymenoptera were collected during this first expedition. The Chalcidians were mostly collected in Malaise traps while the Mutillidae were essentially collected opportunistically during the less hot hours of the day. The first group represented dozens of species in the collection, while the second was rarer with a more localized distribution representing about 12 species. Both groups undoubtedly include species new to science.

A few statistics

Total collection of insects: about 10,000 specimens.

Total species collected: approximately 750.

Total orders collected: 14.

Total families collected: 105 to 110.

The best represented orders: Coleoptera, with about 7,200 specimens, nearly 45 families and about 450 species collected, followed by Diptera (about 900 specimens, 140 species) and Lepidoptera (about 200 specimens, 100 species).

The best represented families: Cerambycidae (about 130 species); Scarabaeidae (70 species).

Comment on the insects

The entomological collection has been particularly successful, despite the vicissitudes of the outward flight, and we gathered close to 10,000 specimens in less than 10 days of intensive collection. The days were devoted to opportunistic collecting, sweep-netting and sifting through elephant dung, while the nights were occupied by light trapping and opportunistic collecting with a head torch. The diversity of the investigated habitats is probably one of the factors contributing to the success of these surveys. The second factor is undoubtedly the season, the first rains appearing at the start of the expedition and intensifying towards the end. The third reason is without doubt the "naturalness" of the areas explored — they are little undisturbed and we can already consider these areas to be high-quality sites for entomology, that deserve to be explored further and more intensively in 2009. Moreover, in addition to the groups cited above, we were able to note a high density and species richness of Orthoptera and Dictyoptera.

Amphibians

Amphibians are undergoing a drastic decline in the world. Paradoxically, the number of known species continues to increase every year. Indeed, recent studies (Stuart et al. 2006; Fouquet et al. 2007; Elmer et al. 2008) show that the molecular analysis of morphologically similar taxa provide evidence of cryptic and sometimes sympatric species complexes. We were unable to collect this group, that is particularly rich in East Africa, as much as we had hoped. Nevertheless, some twenty specimens were collected in the area of Nhica de Rovuma, representing a dozen species, which will be sent to Anne-Marie Ohler (MNHN).

Two new records for Mozambique — the dwarf toads *Mertensophryne micranotis* (Fig. 14) and *Mertensophryne loveridgei* (formerly *Stephopaedes loveridgei,* Fig. 15) were collected during heavy rain in the dry forest on the slopes at Nhica do Rovuma, but unfortunately escaped before they could be preserved. Good quality photographs were however taken of these specimens and their identification has been confirmed by Professor Kim Howell of the University of Dar es Salaam. *M.micranotis* is restricted to the coastal forests and was formerly known only from Kenya and Tanzania (Poynton 2000), including coastal forests near Lindi some 70 km north of the Rovuma River. *M. loveridgei* was formerly only known from SE Tanzania (Poynton 2000).

Fig. 14. *A new record for Mozamique - the tiny dwarf toad* Mertensophryne micranotis, *formerly only known from coastal forests in Kenya and Tanzania*

Fig. 15. *A new record for Mozambique - the dwarf toad* Mertensophryne loveridgei, *formerly only known from forests in SE Tanzania*

Rodents

Fig. 16. Dendromus *sp., striped arboreal mouse*

The rodents of the Coastal Forests of Eastern Africa are relatively little studied and contain many still undescribed species (Burgess et al. 2000).

In each of the localities surveyed, a battery of rodent traps was set and inspected each day, while collections were also made in the homes of the village of Nhica de Rovuma to verify the possible presence of the black rat.

The delay in the arrival of field equipment greatly reduced our ability to conduct an inventory of rodents. The first site, Quiterajo was not sampled and the results obtained are purely anecdotal. The second site has been insufficiently sampled and only the most common species were collected. Two rare species have however been caught: African dwarf mice (3 individuals). Several species are possibly present in the area and only a DNA analysis will enable an identification to species level. The specimens have been given to F. Veyrunes, an expert in this genus (CNRS / Université Montpellier).

The *Gerbilliscus* and *Dendromus* specimens will be identified through both morphology and DNA analysis performed at CBGP. The capture of a *Dendromus* sp. in a pitfall trap (Fig. 16) is amazing for a arboreal mouse, though this capture took place less than 30 meters from the edge of the forest. The ubiquitous species, *Mastomys natalensis*, was not surprisingly found in most habitats, including the village. However it should be noted that this locality is already dominated by the black rat, *Rattus rattus*, an introduced species. The presence of this rodent in a village near the coast, isolated from other urban areas by vast expanses of forest and savannah is quite worrying for the survival of endemic rodents and is also a hazard to the human population, due to its capacity as a reservoir for many diseases and the damage it causes to crops and especially food stores.

Conclusions

The collecting expedition has been particularly fruitful, especially for insects, in spite of the difficult conditions and short collecting time (less than 10 days per site). In total, we were able to collect between 750 and 1000 species, even though we decided to just target certain groups and to only use part of the collection methods available to us.

The Nhica de Rovuma site is recognised to be the richest in species numbers, the diversity of habitats contributing greatly to the diversity of species collected. However, the site of Quiterajo, which was collected for a short period of time and under poor conditions (due to a lack of collecting equipment) deserves a second investigation. The chosen period of the visit has proven to be excellent, the rains having started from our arrival and increasing throughout the expedition, favouring the emergence of insects.

The richness of the bird, amphibian and other arthropod fauna deserve special attention. It is clear that an

exploration of greater intensity for all groups of arthropods is required to inventorise these sites before they are degraded by increasing human activity. Depending on available resources, it could take place simultaneously at two sites or in a mobile manner.

We propose to cover the following groups and are currently looking for scientists who can undertake these during the collection expedition in 2009:
Orthoptera and other groups of Polyneoptera, Coleoptera, Hymenoptera, Diptera, Lepidoptera, Hemiptera and other groups.
Besides insects, the following groups deserve a more intensive exploration effort: Arthropoda (other than insects), Mollusca, Aves and Reptilia, Mammalia, Anura.

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