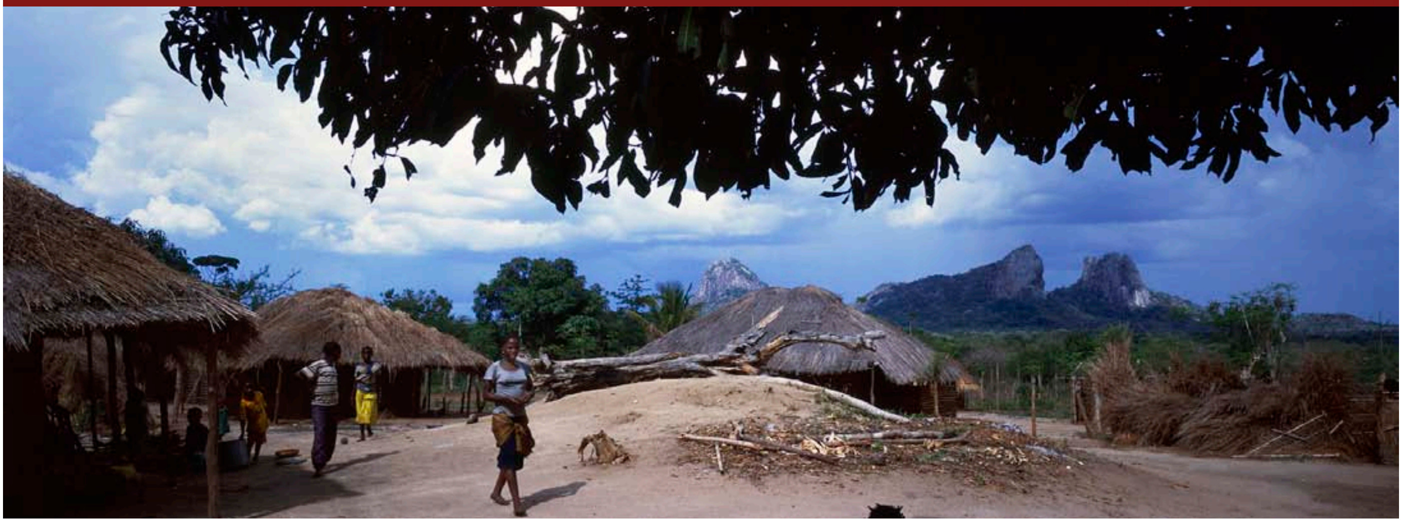
MUSÉUM NATIONAL D'HISTOIRE NATURELLE

our planet reviewed

mozambique

2008-2009



Our Planet Reviewed programme report n°1
The Coastal Forests of Northern Mozambique
2008-2009 Expeditions

In-country Partner : Instituto de Investigação Agrária de Moçambique (IIAM)

March 2011

The « Our Planet Reviewed » initiative

Current efforts to establish priorities for conservation and management are based on existing knowledge, and rarely, if ever, involve the painstaking process of acquiring adequate new information.
An unfortunate consequence of this approach is that we focus our efforts on learning more about what is already reasonably well known (e.g. charismatic mega-fauna, birds, etc.) while neglecting other equally important components of biodiversity (e.g. invertebrates, fungi, etc.), which are often excluded altogether from consideration.
« Our Planet Reviewed » is a new initiative for filling key gaps in our knowledge of the world's major biodiversity areas. The new challenge for our project teams is to apply their scientific and technical knowledge in regions of the world where the most pressing issues of Biodiversity and Conservation converge. We will thus focus on areas that are recognized as globally important for biodiversity, but where numerous knowledge gaps constitute a serious impediment to sound conservation and resource management decisions.

Filling gaps in key areas of the world

Global conservation assessments and the establishment of conservation priorities require robust and reliable information on the distribution of biodiversity across the planet. Yet this information is often mapped at a very coarse spatial resolution relative to the scale at which most land-use and management decisions are made. Furthermore, most biodiversity mapping tends to focus selectively on better-known (and often more emblematic) elements, such as larger vertebrates. Despite significant efforts made over the last several decades, the biodiversity of our planet remains largely unknown and is disappearing many times faster than we discover it.
The National Museum of Natural History (MNHN) in Paris and Pro-Natura International, are now developing a new initiative to help address this issue, aimed at significantly boosting our knowledge of the Earth's biodiversity by filling gaps through the exploration and description of a carefully selected set of key sites.
In line with a major multi-disciplinary expedition (Santo 2006, Vanuatu) and several earlier projects (New Caledonia, Panama, Philippines), we aim to sustain this effort and take full advantage of the experience we have gained by carrying out additional expeditions over the next decade that will focus on little-known sites and on neglected animal and plant groups, especially those whose study requires special organizational skills and logistical resources.

This report contains the preliminary results of the 2008-2009 « Our Planet Reviewed » expeditions in Northern Mozambique.
Downloaded from one of the following web sites :
http://www.laplaneterevisitee.org/fr/114/retour_de_mission
http://www.iiam.gov.mz/index.php?option=com_content&task=view&id=94&Itemid=161

The Botanical component of the expeditions was leaded by Jonathan Timberlake (Kew) and the report section for Botany has already been published separately as an e-report on the Kew web site:
http://www.kew.org/science/directory/projects/CoastalForestsOfNort.html
The Zoological component was leaded by Jean-Yves Rasplus (CBGP) and preliminary results are assembled in the section on zoology.

Two additional contributions by Phil Clarke, one of the members of the botanical team, focus on two areas surveyed in 2008 and 2009 and document a series of personal observations. These two separate reports provide a comprehensive baseline geo-referenced photo documentation of the region.

- Clarke, G.P. (2010) Report on a reconnaissance visit to Lupangua Hill, Quissanga District, Cabo Delgado Province, Mozambique, with notes about *Micklethwaitia carvalhoi.* 20pp.
  Downloaded from www.coastalforests.org
- Clarke, G.P. (2011) Observations on the Vegetation and Ecology of Palma and Nangade Districts, Cabo Delgado Province, Mozambique. 130pp. Downloaded from www.coastalforests.org

The 2008-2009 expeditions in Mozambique were made possible by generous contributions from the Prince Albert II of Monaco Foundation, the Stavros Niarchos Foundation and the Total Foundation.

FONDATION PRINCE ALBERT II DE MONACO

ΙΣΝ/SNf STAVROS NIARCHOS FOUNDATION

FONDATION TOTAL

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Many people helped with the preparation and execution of these expeditions, before, during and after. In particular we wish to thank the following:

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In Paris – Bertrand-Pierre Galey, Director of the Paris Natural History Museum. The Landsat images were processed by Erik Prins (Prins Engineering, Copenhagen).

In Cabo Delgado and Nampula – Prof. Oscar Monteiro of Cabo Delgado Biodiversity & Tourism (Vamizi-Quiterajo); the Governor and Provincial authorities of Cabo Delgado; the District Administrators of Palma and Macomia; Prof. Jorge Ferrão and Dr Isabel da Silva of the University of Lurio, Nampula; José Dias of the Quirimbas National Park and the WWF office in Pemba; staff of the Cabo Delgado Biodiversity & Tourism in Quiterajo, in particular Tomas Chipiri and Stanley Phiri, for field support; and the Artumas and Anadarko companies in Palma for accommodation.

In Nhica do Rovuma we thank Hunters Mozambique LDA, the concession managers, who allowed us to operate in their concession area, and the population of Nhica do Rovuma village who good-naturedly tolerated our presence for three weeks.

People who helped specifically with the botanical and zoological studies are mentioned under those sections of the report.

Excellent logistical support for the two expeditions was provided by Khangela Safaris of Bulawayo, Zimbabwe (Mike Scott, Markus Isselbacher, Mark Macadam, Tshakalisa Mpofu, Matthew Mundy, Adrian Nel, Richard Ngwenya, Russell Scott, Bernard Sibanda, Andy Trevella, David Vernon), and Charlie Mackie from Harare was the pilot during the aerial reconnaissance. The head of logistics, Roland Fourcaud, played a pivotal role in the success of the expeditions.

Oscar Simbine Monteiro, who helped from the project's start, was fundamental in organisational support in Mozambique.

Funding for the expeditions was gratefully received from the Prince Albert II of Monaco Foundation, the Stavros Niarchos Foundation, the Total Foundation and the Fondation de France.

THE 2008-2009 « OUR PLANET REVIEWED » EXPEDITIONS TO THE COASTAL FORESTS IN NORTHERN MOZAMBIQUE: PROGRAMME HISTORY AND PROCEEDINGS

Olivier Pascal

Programme History

- ### The Coastal Forests of Eastern Africa

Tropical dry forests are among the most endangered habitats in the world, a reality obscured by the omnipresence of rainforests in international campaigns to limit tropical forest degradation and destruction. Of the planet's 13 major terrestrial biomes, tropical dry forests are the most severely affected by humanity. Nearly half of these forests (48.5%) have already completely disappeared through being converted to other uses (this destruction figure corresponds to the minimum loss of this natural habitat, and does not take into account further degradation caused by selective logging or livestock grazing). A larger percentage of this biome has been destroyed than the temperate forests (46.6%) or the wet tropical forests (32.2%)[1].

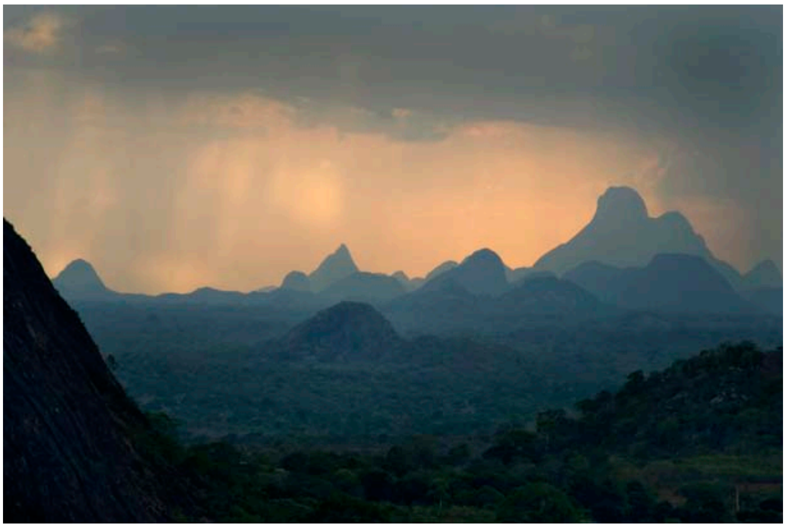
Under the joint initiative of Pro-Natura international and the Natural History Museum in Paris entitled "Our Planet Reviewed", we identified the need to study the dry forests of eastern Africa — especially those designated by conservation biologists as "The Coastal Forests of Eastern Africa". These forests are one of 34 global biodiversity 'hotspots' in the list produced by the NGO Conservation International[2], which has become the roadmap followed by the majority of the conservation community, as well as by many policymakers.

As well as being one of those 34 hotspots, the "Coastal Forests of Eastern Africa" are also part of the small group of hotspots (11 in total) that have suffered a loss of over 90% of their original natural habitat area. The remaining dry forests situated along the Eastern African coast are particularly threatened by their geographical location and by the economic context of the countries where they are found. Their urgent need for conservation is recognized by the international conservation movement. There are probably few places in the world where high biological importance, pressing conservation issues and the difficulties of achieving a realistic level of protection combine to such a large extent.

[1]. J. M. Hoekstra & Al. : « Confronting a biome crisis : global disparities of habitat loss and protection » EcologyLetters (2005) 8:23–29
[2]. Hotspots Revisited (2005) http://www.conservation.org/publications/Pages/hotspots_revisited.aspx

In Mozambique, the dry Coastal Forests offer a paradox: although they are thought to comprise the largest remaining extent of Coastal Forests in Eastern Africa, they are also the least known biologically. Most of these dry forests are located in the northern half of the country, which has seen little development due to its great distance from the capital city Maputo (up to 2000 km) and its geographical isolation, with (until recently) no road access from neighbouring countries. Forty years of conflict further discouraged biological surveys, followed by a legacy of landmines. These were finally cleared from the northernmost provinces of Mozambique in 2007, just a few months before the arrival of the first « Our Planet Reviewed » survey team.

The Mozambican Coastal Forests had been further overlooked due to their geographical position at the extreme north-eastern end of a region that is generally designated as 'Southern Africa', comprising South Africa and its neighbours, but also including Malawi and Zambia. The biological exploration and study of this area has been traditionally dominated by researchers based out of South Africa and Zimbabwe, who have specialised in the rich Cape Fynbos heathlands, the Kalahari and Namib deserts and the dryland Miombo and Mopane woodland habitats. By contrast, study of the Coastal Forests of Eastern Africa has traditionally been dominated by researchers based out of Kenya and Tanzania, which are both part of a region that is generally designated as 'East Africa'. Mozambique's Coastal Forests were not therefore associated with the Coastal Forests found further north until the 1990s, when researchers based in Tanzania decided to synthesise all known information about this forest type. They recognised the need to widen the accepted range of Coastal Forests from East Africa to Eastern Africa, in order to include Mozambique[3].

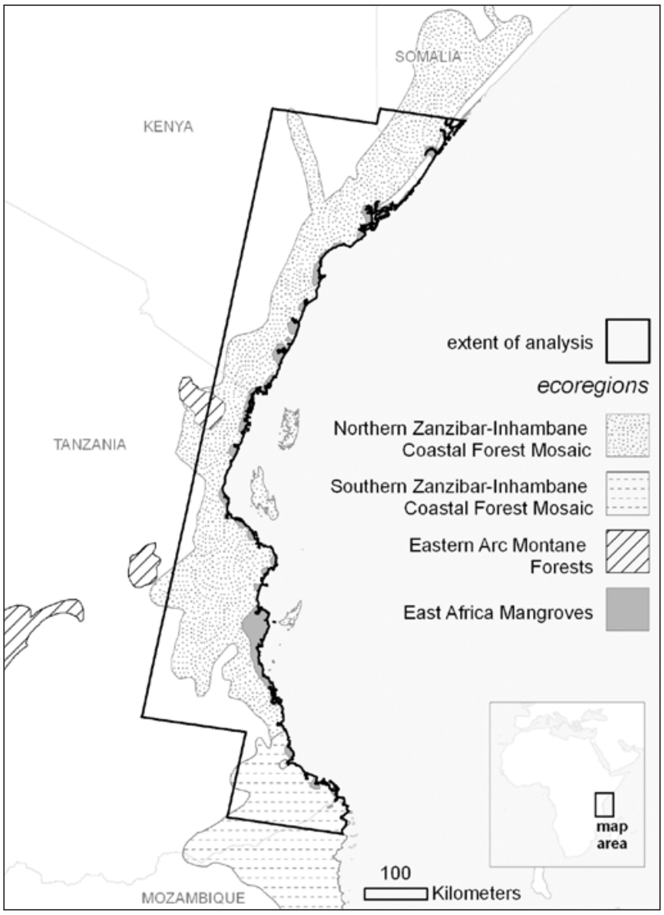


Landscape of Inselbergs in the South of the Cabo Delgado Province. Copyright : © Xavier Desmier / MNHN / PNI

[3]. Burgess, N.D. & Muir, C. (1994). *Coastal Forests of Eastern Africa: Biodiversity and Conservation.* Proceedings of a workshop held at the University of Dar es Salaam, August 9-11, 1993. Society for Environmental Exploration/ Royal Society for the Protection of Birds, UK.
- Burgess, N.D., Clarke, G.P. & Rodgers, W.A. (1998). Coastal forests of eastern Africa: status, endemism patterns and their potential causes. *Biological Journal of the Linnean Society* 64: 337-367.
- Burgess, N.D. & Clarke, G.P. (2000). *Coastal Forests of Eastern Africa.* IUCN Forest Conservation Series. 434pp. Cambridge & Gland: IUCN.

This finding was unfortunately largely disregarded by key conservationists. For although Mozambique's Coastal Forests were originally included with the Kenyan and Tanzanian Coastal Forests in WWF's Global 200 prioritisation of the worlds ecological regions in 1998[4], they were excluded in the 2001 revision[5], despite the availability of scientific evidence demonstrating the strong coherence of the northern Mozambican coastal flora with the Tanzanian and Kenyan coastal flora[6].

Figure 2 : Map of the eastern Africa Ecoregions – WWF 2001



WWF's 2001 revision split White's (1983) Zanzibar-Inhambane regional mosaic[7] into two distinct ecoregions – the 'Northern Zanzibar-Inhambane regional mosaic' and the 'Southern Zanzibar-Inhambane regional mosaic', Figure 2 — which ignored an earlier (1998) split by Clarke of the same region into an upgraded 'Swahilian regional centre of endemism' encompassing the Kenyan, Tanzanian and northern Mozambican coastal flora, together with a depauperate 'Swahilian-Maputaland transition zone' covering central and southern coastal Mozambique. Instead, WWF's two ecoregions were separated just south of the Rondo plateau in southern Tanzania, based largely on considerations of avifaunal and mammalian endemism, and the lack of data on these taxa from northern Mozambique[8].

Programmatically WWF continued to treat the Northern and Southern Zanzibar-Inhambane regional mosaic as a part of the 'Coastal Forests Ecoregion' and ran projects to conserve forests across the whole region from 2002 onwards.

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[4]. Olson, D. M. & Dinerstein, E. (1998). The Global 200: A representation approach to conserving the Earth's most biologically valuable ecoregions. *Conservation Biology* 12: 502-515.

[5]. Olson, D. M. & Dinerstein, E. (2002). The Global 200: Priority ecoregions for global conservation. *Annals of the Missouri Botanical Garden* 89: 199-224. 2002.

[6]. Clarke, G.P. (1998). A new regional centre of endemism in Africa. Chapter 4, pp. 53-65 in Huxley, C.R., Lock, J.M. & Cutler, D.F. (eds.). *Chorology, Taxonomy and Ecology of the Floras of Africa and Madagascar*. Kew: Royal Botanic Gardens.

- Clarke, G.P., Vollesen, K. & Mwasumbi, L.B. (2000). Vascular plants. Chapter 4.1 and Appendix 3 in Burgess, N.D. & Clarke, G.P. (eds.). *Coastal Forests of Eastern Africa*. IUCN Forest Conservation Series. 434pp. Cambridge & Gland: IUCN.

[7]. White, F. (1983). *Vegetation of Africa - a descriptive memoir to accompany the Unesco/AETFAT/UNSO vegetation map of Africa*; Natural Resources Research Report XX. Paris: UNESCO. 356 pp.

[8]. Burgess, N., D'Amico Hales, J., Underwood, E., Dinerstein, E., Olson, D., Itoua, I., Schipper, J., Ricketts, T., Newman, K. (2004). *Terrestrial ecoregions of Africa and Madagascar: a continental assessment.* Island Press, Washington DC. Pp. 1-501.

In northern Mozambique this largely entailed working on the establishment of the Quirimbas National Park. In an attempt to open avenues of communication between Tanzanian and Mozambican forest field biologists and conservationists, a team from the Tanzania Forest Conservation Group (TFCG) and WWF-USA was invited by WWF Mozambique to visit the Quirimbas National Park in 2002 to assess if areas of dense vegetation in that area were similar to Tanzanian coastal forests[9]. This was confirmed on this brief reconnaissance visit and again during a further visit by mammal researchers from TFCG the next year. However, this Park contains relatively small areas of coastal forest and the larger areas of coastal forest further north remained unknown, and not addressed.

Mozambican Coastal Forests were also initially excluded by Conservation International in their global analysis of terrestrial biodiversity "hotspots" in the late 1990s. This project created a hotspot that combined the Eastern Arc mountains with the Coastal Forests of Kenya and Tanzania[10] (Conservation International 1999; Myers *et. al.* 2000). Northern Mozambique was excluded because, at that time, the number of endemic plants known from that region was very small, and the boundaries of the hotspot aimed to encompass the regions of highest plant endemism[11].

Much new data has subsequently become available[12] (e.g. Burgess & Clarke 2000) which demonstrates that the Eastern African Coastal Forests contain enough species to be considered a separate hotspot in its own right, and did not need to be lumped together with the montane Eastern Arc Mountains area. Conservation International carried out this partitioning in their second major hotspots reanalysis in 2004[13], which incorporated the Mozambique coastal forests within the Coastal Forests hotspot[14].

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9. Burgess, N.D. G. Negussie, P. Bechtel, N. Oscar Moisés and N. Doggart (2003). Coastal Forests in Northern Mozambique. *The Arc Journal* 15: 1, 8-11.

10. Conservation International website http://www.biodiversityhotspots.org/xp/hotspots/hotspotsscience/Pages/hotspots_revisited.aspx Accessed February 15, 2010.

Myers, N., R. A. Mittermeier, C. G. Mittermeier, G. A. B. da Fonseca, & J. Kent. (2000). Biodiversity hotspots for conservation priorities. *Nature* 403:853-858.

Mittermeier, R.A., N. Meyers & C.G. Mittermeier (eds.) (1999). *Hotspots. Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*. Cemex, Conservation International, Mexico City.

11. Myers, N., Lovett, J.C. & Burgess, N.D. (1999). The Eastern Arc Mountains and Coastal Lowland Forests Hotspot. Pp. 204-213. In: Mittermeier, R., Myers, N. and Mittermeier, C.G. (eds.). *Hotspots: earths biologically richest and most endangered terrestrial ecoregions.* CEMEX and Conservation International, Washington.

12. Burgess, N.D., Butynski, T.M., Cordeiro, N.J., Doggart, N., Fjeldså, J., Howell, K., Kilahama, F., Loader, S.P., Lovett, J.C., Mbilinyi, B., Menegon, M., Moyer, D., Nashanda, E., Perkin, A., Stanley, W. & Stuart, S. (2007). The biological importance of the Eastern Arc mountains of Tanzania and Kenya. *Biological Conservation* 134: 209-231.

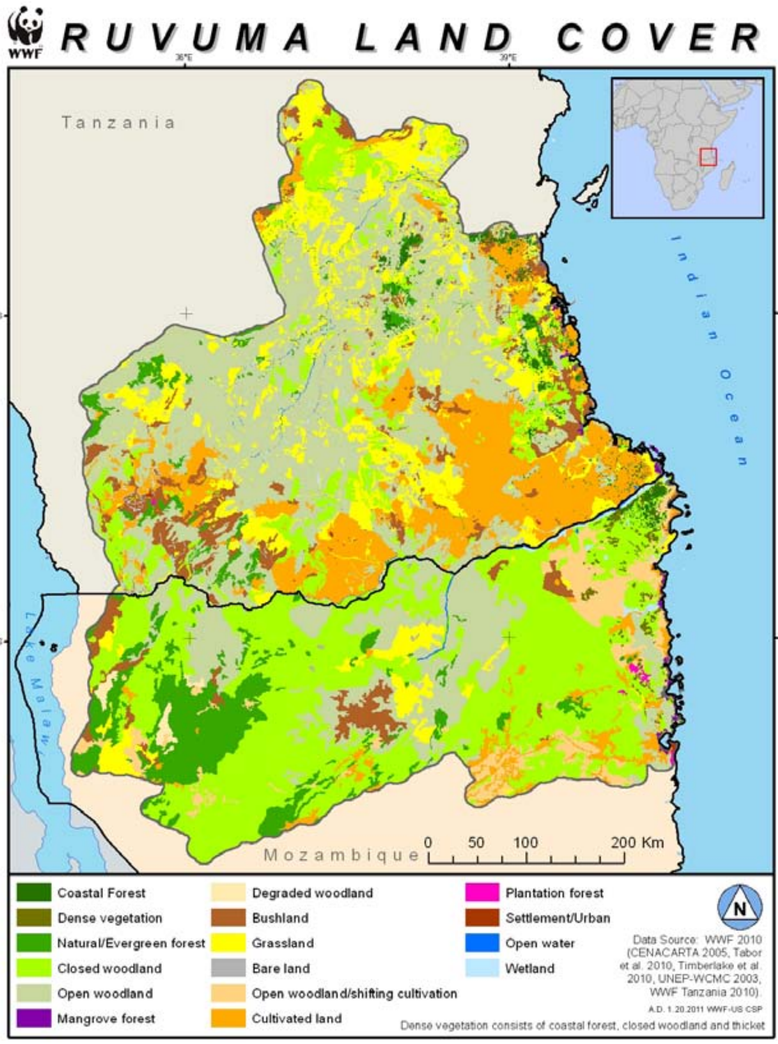
13. Mittermeier, R. A., Gil, P.R., Hoffman, M., Pilgrim, J., Brooks, T., Mittermeier, C.G., Lamoreux, J. & da Fonseca. G.A.B. (2005). *Hotspots revisited: Earth's biologically richest and most endangered terrestrial ecoregions.* Cemex, Conservation International, Washington, DC.

14. Burgess, N.D., I. Gordon, J. Salehe, P. Sumbi, N. Doggart, A. Rodgers, P. Clarke (2004). *Coastal Forests of Eastern Africa.* Pp. 231-239. In: *Hotspots Revisited: Earth's Biologically Richest and Most Endangered Ecoregions*. Eds. Mittermeier, R.A., Robles-Gil, P., Hoffmann, M., Pilgrim, J.D., Brooks, T.M., Mittermeier, C.G., Lamoreux, J.L. & Fonseca, G. Second Edition. Cemex, Mexico.

This re-assessment came too late to influence the $7 million investment by the Critical Ecosystem Partnership Fund (CEPF), the main funding mechanism for the conservation of biodiversity hotspots by Conservation International, into the 'Eastern Arc Mountains & Coastal Forests of Tanzania & Kenya Hotspot' conservation programme[15] (CEPF 2003). This investment was restricted to Kenya and Tanzania, and the coastal forests of northern Mozambique could not receive any funding.

The extensive field surveys of the 'Our Planet Reviewed' initiative during 2008 and 2009 have clearly shown that the forests in Quirimbas National Park are only a small part of a much more extensive complex of coastal forests in northern Mozambique, and that these are probably the largest remaining areas of this forest type on the eastern African coast. It has also shown that these forest areas further north are unprotected and under threat from national and international pressures.

The findings of the new research have already been incorporated within the conservation planning work for the 'Mtwara – Quirimbas Complex', one of the 9 priority places that form the core part of the WWF's Coastal East Africa Initiative in the region, and forest extent data from the present report are included in the newly produced vegetation map of the Rovuma region (cited as 'Timberlake & al. 2010 in the 'Ruvuma Land Cover' map's caption – see beside). WWF Mozambique, with assistance from others within the WWF network, has also taken on board the importance of developing conservation action in this area and funded the development of a concept funding proposal for the area in 2010, which included summarised biological, forest status, and threats data originating from the field surveys. Attempts to raise funding for conservation in this area have been ongoing since that time.



[15] Critical Ecosystem Partnership Fund (CEPF) (2003). *Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya. Ecosystem Profile (updated March 2005).* Unpublished Report, available from http://www.cepf.net/.

• The 2008-2009 Northern Mozambique Expeditions

The Mozambique 2009 expedition was the climax of a series of operations conducted in Mozambique since April 2008 by bodies responsible for the initiative entitled «Our Planet Reviewed» in partnership with the *Instituto de Investigação Agraria de Moçambique* (IIAM) and the Royal Botanical Gardens, Kew (UK).

The botanist team reviews the day's plant secimens collection. The collected plants are labelled, pressed and dried with no delay to retain the quality of the samples. From Left to right : Frances Crawford, Alice Massingue, Jonathan Timberlake, Tom Muller, Camila Souza. Quiterajo base camp, Province of Cabo Delgado. Copyright : © Xavier Desmier / MNHN / PNI

Without counting the exploratory missions, including the aerial reconnaissance mission in April 2008 we can consider the field operations in November 2008 and November 2009 as two parts of the same expedition. These two operations of different sizes brought together 25 participants for the first and 51 for the second. Moreover, a good many of the participants took part in both of these two phases, ensuring a continuity of work between 2008 and 2009. To these two phases must be added a two-week mission conducted by John Burrows and involving a total of six botanists, in September 2009.

In total, all field operations of 2008-2009 involved 60 participants, including 33 biologists who collectively provided 794 workdays of scientific expertise in Mozambique.

The Mozambican expeditions envisaged to undertake a biological survey as comprehensively as possible of «neglected» biodiversity (plants and small animals) for the coastal region of northern Mozambique, in Cabo Delgado Province, but equally to evaluate the status and changes in biodiversity of this region, especially those of the dry forests.

This report brings together the first results of the 2009 expedition but builds on and complements those of 2008. In particular, the results presented here for the study of vegetation and flora are derived from a synthesis of observations of the two operations and a compilation of work done so far to identify all the plant material collected.

Sampling in the canopy. In our expeditions, the technical team includes professional tree-climbers for collecting botanic samples in the big trees that are inaccessible from the ground. Copyright : © Xavier Desmier / MNHN / PNI

- ## Proceedings of the 2009 expedition

The programme «Dry coastal forests 2008-09» in Mozambique posed new problems in terms of organisation.
The study sites were scattered and distant from each other, their location approximate and access difficult, forcing the organisers to opt for a semi-itinerant mission, forgetting traditional expedition patterns, which usually focus resources on a single site or, conversely, are completely itinerant.

A semi-itinerant expedition meets the needs and constraints of a large group. It is indeed complicated, with an operation size involving more than ten people, to be mobile at all times. Two operation centres, or fixed bases, were identified, from which small, autonomous groups radiated in sub-camps to cover the largest possible area in the allotted time.

The operation of 2008 turned out to be an excellent test to calibrate the logistics for that of 2009. The calculation of travel time, assessment of human resources and material needs - particularly for vehicles - and the overall streamlining of all logistics could be defined precisely thanks to the experience gained in 2008.

Mike Scott, head of camp organisation, vehicles and supplies, played a key role in the success of this venture. Strengthened by his skills and the knowledge of the terrain gained in 2008, Mike was able to correctly estimate the equipment needed and mobilise an effective team, without any superfluous positions.

The presence of the head of logistics, Roland Fourcaud, well before the start of the operation also contributed considerably to the smooth running of the 2009 expedition. Roland arrived in Pemba on September 18th and departed, after rounding up the expedition, on December 12th. His long presence in the region, in addition to the 45 days in 2008, was a critical success factor of the expedition, which required a thorough knowledge of the area and its various stakeholders. This knowledge enabled reactivity to adapt quickly to hazards and to maintain the fast pace imposed by such a massive operation concentrated in a relatively short time period.

Two examples illustrate this: it is useful to know in advance that going to Tanzania to renew a tourist visa is less complicated that obtaining it in Pemba, capital of the Province. It is also valuable to know that there is no water source available for at least an hour's drive from the operation bases.

Soft tanks are used to supply water for the expedition base camp. The expedition taking place at the end of the dry season, water has to be transported by truck from water supply points that are often located hours away. Copyright : © Xavier Desmier / MNHN / PNI

The Mozambican expedition confirmed the importance of Roland's pivotal position, ungratifying because of its distance from the action, but indispensable for the management of the daily flow (of people, materials, food), for planning for contingencies and for maintaining contact with actors remote from the centre of operations.

In the background, the effectiveness of our partner, IIAM, has also greatly contributed to the success of the expedition. Responsible for administrative aspects in Mozambique - covering a wide spectrum ranging from flight clearance for the balloon, to obtaining research permits and authorisation for exporting specimens through management procedures at the level of the province, district, commune and village - the skills of the Institute in the management of such operation has been fundamental to its success.

The "Solvin-Bulle" a new flying device for canopy surveys. This motored hot air balloon was used to localise the last dry forest patches from the air.
Copyright : © Maurice Leponce / MNHN / PNI

Ultimately, this operation – in which, like every one of its kind, so many things could go wrong – was conducted without major incident and according to the predetermined scenario.

This scenario imposed a number of specific deadlines for the expedition (turnover of the teams, official visits, travel and setting up camp, etc.); the deadlines of which are always difficult to achieve in such circumstances. The management principle consisted of sticking to these key dates and actions, while adapting on a daily basis around these with the flexibility needed to resolve the many minor problems that constantly occur.

Still this success is mainly due to a gradual approach, progressively increasing the intensity and volume of field activities. Splitting the Mozambican operation into two phases over 2008 and 2009 allowed the team to make the necessary adjustments in the interim and a smooth rise in the number of participants and site visited in 2009.

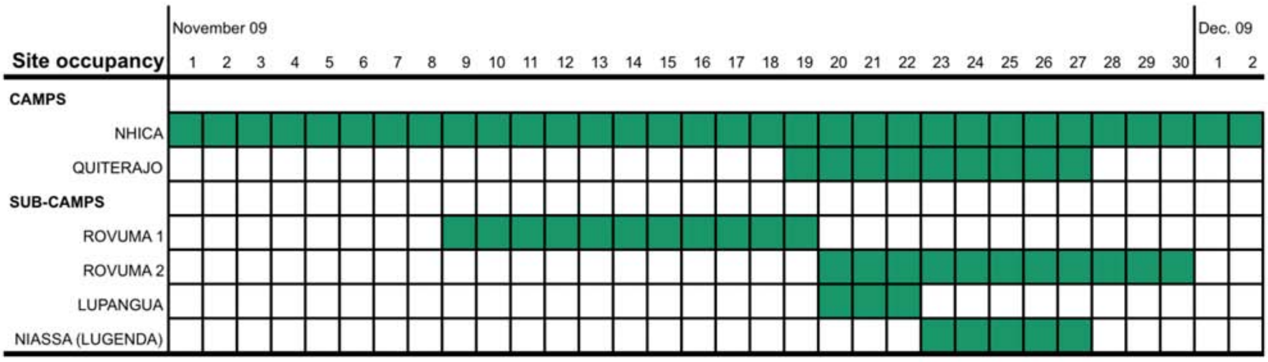
As Steinbeck noted, «all biological surveys in unknown territory should be conducted twice, the first to make mistakes and the second to correct»[16].

[16]. « The Log from the Sea of Cortez » by John Steinbeck, is the story of a scientific expedition to the Gulf of California in March 1940.

- ### Succinct description of various locations and of the 2009 expedition timing

It is difficult to describe all the movements of the teams in detail. In total, the expedition vehicles travelled nearly 100,000 km. Half of this distance is the journey to reach the north of Mozambique: the cars came by road from Zimbabwe for most of the fleet, but also from Tanzania, Kenya and South Africa.

The expedition vehicles on the main road going from Pemba, capital city of the Cabo Delgado Province, to the Tanzanian border. The twelve cars covered over 100,000 km during the six weeks expedition. Copyright : © Xavier Desmier / MNHN / PNI



The 12 vehicles in operation, to which must be added the transport of materials in an “Unimog” (4x4 truck), constantly crossed the Province to transport teams of scientists. Indeed, the fieldwork was rarely done entirely on foot since setting up the camp. Mechanised transport, over short or long distances, was required to get the teams to work sites.

Two camps were operational (Nhica do Rovuma, from 1st November to 2nd December 2009 and Quiterajo from November 19th to 27th) with a recovery period during which the camps were operating simultaneously.

The Nhica camp was by far the most used (860 workdays in total), compared to Quiterajo (120 workdays in total).

The peak occupancy of Nhica camp was reached on November 18th with 51 people, the only day when all of the expedition participants were together ; the average daily rate was 21 people per day.

The Nhica camp was also visited on the 12th and 13th of November by a delegation of the Principality of Monaco leaded by HRH Prince Albert II.

The Director of the Natural History Museum of Paris, Bertrand-Pierre Galey, the Director of IIAM, Calisto Bias and the President of the Albert II Foundation, Bernard Fautrier were also present at this occasion.

Two sub-camps along the Ruvuma River, opened in parallel, welcomed limited groups (4/5 persons) in rotation for short stays (2-3 days). These two sub-camps depended on the Nhica camp for supplies.

A 5th study site, Mount Lupangua, was visited by a small team (8 persons) on the 21st, 22nd and 23rd of November.

For the purposes of the documentary, a team also visited the Niassa Reserve from the 23rd to the 27th of November.

Two entomologists of the Museum of Natural History of Paris, the photographer and the wildlife artist of the expedition stayed on the island of Vamizi November from 27th to December 2nd (the entomologists), and from 29th November to 15th December (the photographer and artist).

1. Jonathan Timberlake explaining the expedition objectives to our honorable guests, HRH the Prince Albert II of Monaco, M. Calisto Bias, IIAM Director and M. Joaquim José Campos de Oliveira, Consul of Monaco in Mozambique.
Copyright : © Xavier Desmier / MNHN / PNI

2. Among the means of transportation used by the expedition members to travel up and down the Cabo Delgado Province, dhows allow access to coastlines that have no roads. Part of the team is trying to progress towards Lupangua Mount in the Quirimbas National Park.
Copyright : © Xavier Desmier / MNHN / PNI

3. Colin Congdon and Ivan Bampton check their catch to determine whether they can be found elsewhere or not. Butterflies belong to one of the few groups of insects that are relatively well indexed. Available guidebooks make the identification process easier in the field. These two researchers are based in Tanzania and, as others, they have driven for a whole week to join the expedition site. Ivan Bampton sadly passed away in 2010, 6 months after the end of the expedition which happened to be his last field trip.
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in partnership with

COASTAL DRY FOREST IN CABO DELGADO PROVINCE, NORTHERN MOZAMBIQUE

BOTANY & VEGETATION

November 2010

Jonathan Timberlake, David Goyder, Frances Crawford & Olivier Pascal

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INTRODUCTION

This report covers the main botanical and vegetation findings resulting from expeditions to the coastal region of Cabo Delgado Province in northern Mozambique in November–December 2008 and November 2009. It also covers findings from a reconnaissance trip in April–May 2008, which included aerial survey. Results from previous trips to the area undertaken by Quentin Luke (December 2003) and John Burrows *et al.* (2005, early 2008, mid-2009) are also incorporated. Preliminary conclusions are given on the past and present extent of the forests, their botanical composition, conservation significance and their relationship with the better-known coastal forests of southern Tanzania. The main conservation issues are outlined, along with a prioritised set of 14 proposed conservation areas or sites.

Justification for Choosing Coastal Forests

Although little-known botanically, the coastal region of north-eastern Mozambique has long been recognised as a probable area of high biological diversity and interest (Barbosa 1968, Brenan 1978, Huntley 1978, White & Moll 1978). This recognition was primarily based on the known high species diversity and high number of narrow-range endemics in the flora of coastal south-eastern Tanzania, with no apparent geographical isolation from Mozambique across the border, and also because a significant number of Mozambique narrow-range endemics were confined to the northern coastal areas (Brenan 1978). It was also recognised that the climate along the coastal strip is more moist and humid than in the continental interior (White & Moll 1978), and thus likely to be different ecologically.

The coastal forests of Eastern Africa have, over the last 20 or so years, been recognised as forming the most important part of a distinct ecoregion – the Eastern Africa Coastal Forests Ecoregion – and one with a particularly high level of species endemism. Although small, this ecoregion is often regarded as a globally important conservation priority area (Burgess & Clarke 2000, Burgess *et al.* 2004a, 2004b). The Eastern Africa Coastal Forests Ecoregion extends from southern Somalia to southern Mozambique, with the most important section being from southern Kenya through Tanzania and into northern Mozambique (Fig. 1). However, as there had been so few studies in Mozambique until recently it was not possible to confirm the distribution, extent or composition of the coastal forests there.

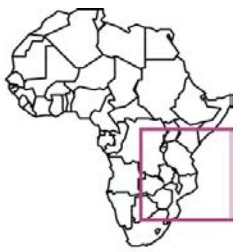
Within the whole Eastern Africa Coastal Forests Ecoregion, covering around 260,000 km² (WWF EARPO 2007), only 6260 km² (2%) is reported to be actual forest. Over 400 separate patches form a chain of relict forest and thicket patches set within savanna woodland (Burgess *et al.* 2004a). Although typically small and fragmented, these forests contain high levels of biodiversity, often varying greatly between patches.

One of the richest and most interesting parts of the Ecoregion from a biodiversity perspective is along the southern Tanzania coast from Lindi to the Rio Rovuma (Clarke 1998, 2001), the river forming the border with Mozambique. Biological surveys here in recent years have discovered a number of endemic species and forest patches with a unique species composition. Yet there are also severe threats from clearance for agriculture and settlement, cutting for charcoal or building timber, and developments associated with oil extraction, both offshore and onshore (WWF EARPO 2006, Smelror *et al.* 2006).

It is estimated that up to 80% of forest extent here has been lost over the last few hundred years (see Chapter 'Findings', Section 'Past and Present Extent of Forest' p39) and perhaps only 10% of the original coastal forest vegetation in Eastern Africa can be considered intact (Burgess *et al.* 2004a). The conservation imperative is clear. The situation is particularly severe now in Cabo Delgado, where human and agricultural settlement has increased very rapidly in recent years after a long period of insecurity. There is also renewed logging for commercial timber along with the construction of cutlines associated with oil and gas exploration.

From the above it can be seen that northern Mozambique reportedly holds not only a large and potentially significant extent of what have been termed coastal forests, forests that are now coming under increasing threat as development and exploitation of natural resources expands, but that their extent and the levels of endemism and diversity are little known.

Figure 1.
East African Coastal Forests Ecoregion (from Myers *et al.* 1999).



One of the objectives of this project was to address this lack of knowledge, and bring scientific findings on their biodiversity into the planning and decision-making processes.

What are «Coastal Forests»

The term «coastal forest» has been used widely in recent years (e.g. Hawthorne 1993, Myers, Lovett & Burgess 1999, Burgess *et al.* 2004a, Burgess & Clarke 2000, Clarke 2000, WWF EARPO 2006), but there has been inconsistency in definition. In some cases, most of the dense vegetation formations found in the coastal area (e.g. within 100–150 km of the coast) or within White's (1983) Zanzibar-Inhambane phytochorion are included, while others (e.g. WWF EARPO 2006) have included various forest or woodland formations up to 300 km inland (except mangroves), possibly as they were lowland vegetation types and contained some species with a typically East African coastal distribution.

Clarke (2000a) formally defines East African Coastal Forests as forests (i.e. a continuous stand of trees with crowns overlapping or interdigitating, usually comprising several layers and/or interlaced with lianas, often with a sparse or absent ground layer) dominated by Swahilian endemic or near-endemic tree species. He uses the term collectively to encompass both typical Eastern African coastal dry forests as well as variant and transitional formations, where they share features with forests of other phytochoria. He lists six types: (1) Eastern African Coastal Dry Forest (semi-evergreen or evergreen undifferentiated dry forest), (2) Eastern African Coastal Scrub Forest (often lower than 10 m in height), (3) Eastern African Coastal *Brachystegia* Forest (a transition woodland), (4) Eastern African Coastal Riverine/ Groundwater/ Swamp Forest (with a high watertable or poor drainage), and (5) Eastern African Coastal/ Afromontane Transition Forest (lowland forest under higher rainfall). On the other hand, Hawthorne (1993) adopts a more geological and geomorpohological definition, defining «coastal» as lying on sedimentary (or volcanic) sediments of the coastal plains and plateaux, excluding any vegetation formations on Basement Complex substrates.

However, in practice areas termed «coastal forest» shown on some regional maps cover a wide range of vegetation from dense woodland, through dry forest to true moist forest. More importantly, there appears to be no common or linking feature between these 'forest patches' in terms of species composition or ecology, which has led to confusion in determining the distribution of coastal dry forests in Mozambique, their biodiversity attributes, ecology, possible origins and conservation significance. The assumed commonality in terms of the origin and conservation importance of this group of vegetation types has masked our understanding of them, and perhaps inhibited selection of important or representative areas for conservation.

In this study we have attempted to define «coastal forest» in a more restricted way, at least as regards those in northern Mozambique. It is hoped this definition and understanding will apply equally well to forests in Tanzania south of the Rufiji River.

We define coastal dry forest here as essentially dry forest or thicket formations that are found within 50–100 km of the coast. These are generally vegetation formations with a closed or almost-closed canopy (80% cover or more when undisturbed) with a high proportion of deciduous woody species that lose their leaves during the long dry season. The definition does not include moist forest, i.e. forest dominated by species with non-drought adapted leaves, nor does it include vegetation that is dominated or characterised by what are primarily woodland species (such as *Brachystegia* or *Julbernardia*). Lower altitude moist forests of the continental interior may contain some tree species that are found in moister coastal forests, but, unless such species are dominant, this does not mean they are coastal forests. Moist forests of the continental interior, miombo and similar woodlands and mangroves are excluded, as is vegetation associated with watercourses such as rivers. Coastal dry forests are characterised as much by their species composition as by their physical structure (which can of course be modified by land uses such as logging or cultivation). Under our definition the main characteristics of coastal dry forest are:

- Dry, often early-deciduous forest (80% canopy cover or more), becoming thicket-like with disturbance. The main species are not moisture-demanding or even mesic. They occur in areas subject to a lengthy dry season (in excess of 6 months), with the majority of species responding by losing leaves.
- Contain a significant number of sclerophyllous evergreen species in the understorey.
- Have a significantly different species composition from the surrounding woodlands (mostly miombo). The overlap in species composition between the two types is often less than 30%.
- Have a very patchy distribution, and are often apparently restricted to particular soils and geomorphological positions.
- Show a marked change in species composition between patches with very few species found regularly or widely. There are a high number of species of restricted distribution, often from particular families and genera (e.g. Annonaceae, Leguminosae: Caesalpinioideae, Rubiaceae).

STUDY AREA

Area Covered

The broad study area runs the length of Cabo Delgado Province in north-eastern Mozambique from the Rovuma River, forming the border with Tanzania, south to Pemba. Its delineation is based on geology and landform, and it includes only Cretaceous and more recent deposits. Covering approximately 18,150 km² it forms a long triangle about 280 km at its longest and 100 km at its widest between Mueda and Mocimboa do Rovuma in the west, Quionga and the Rovuma estuary in the northeast, and Pemba in the south (Figs. 2–4).

The principal focus of the project was on coastal dry forest formations, known from similar studies in Tanzania to be both species-rich and contain numerous endemic species or species of restricted distribution. Associated vegetation types such as miombo (*Brachystegia*-dominated) and similar woodlands, pan grassland and riverine grasslands and formations, were only looked at in order to obtain a broader context.

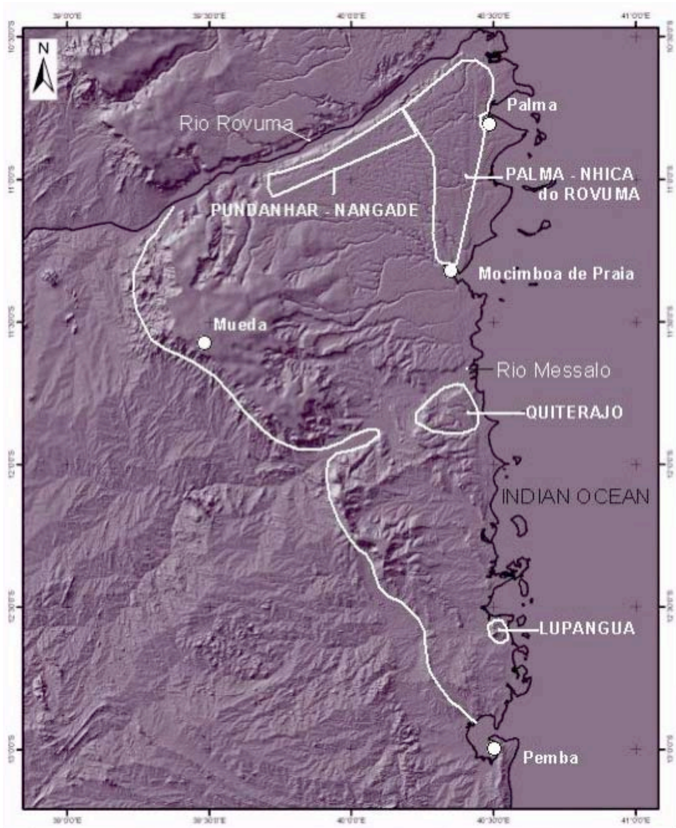


Figure 2.
Cabo Delgado study area, showing extent and the four detailed study sites.

For the two expeditions, four smaller study sites were chosen (Fig. 2), based in part on preliminary analysis of Landsat imagery (Fig. 3) and reconnaissance aerial survey in April 2007.

1. **Pundanhar–Nangade** in Palma and Nangade Districts, west of Pundanhar along the W–E higher ground associated with the Rio Rovuma, including a hunting concession (approx. 750 km²).
2. **Palma–Nhica do Rovuma** area in Palma District, along the W–E higher ground from Nhica do Rovuma associated with the lower reaches of the Rio Rovuma, and along the main road south from Palma (approx. 1400 km²).
3. **Quiterajo** in Macomia District, situated on the coast 45 km south of Mocímboa da Praia, just south of the Rio Messalo (approx. 750 km²).
4. **Lupangua** in Quissanga District, inside the Quirimbas National Park, 15 km south of Quissanga and opposite Ilha Mefunvo (approx. 25 km²) (see Clarke 2010).

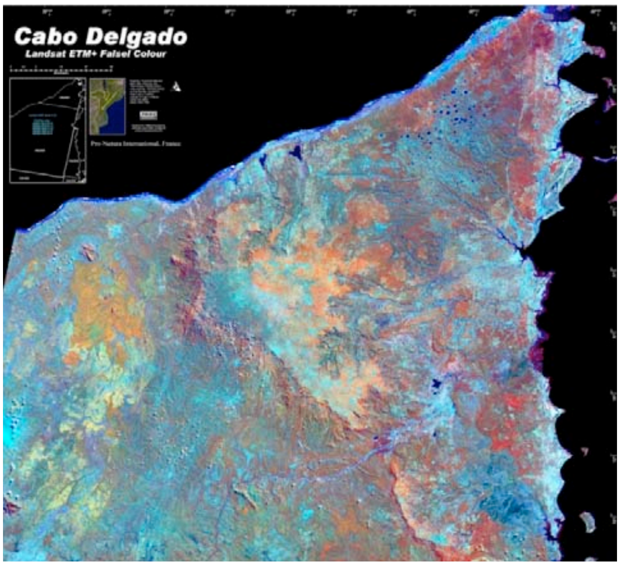


Figure 3. False colour Landsat image of north-eastern Cabo Delgado, 1999–2002.

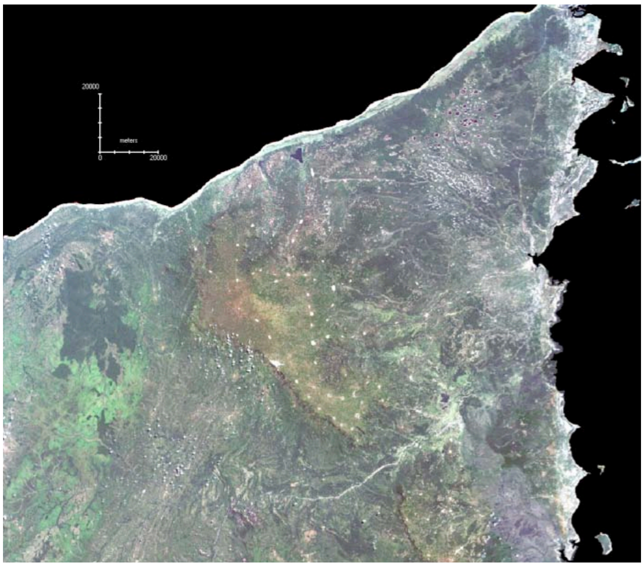


Figure 4. Natural colour Landsat image of northern part of Cabo Delgado study area (1999–2002).

These sites 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. The great majority of the study was focussed on sites 1 to 3; Lupangua was only visited briefly.

Landform

The study area comprises a gently tilting interior plateau, rising from about 100 m above sea-level along the Palma–Mocímboa road to over 600 m in the west above the Mueda escarpment. To the east of the Palma–Mocímboa road the land drops down to a narrow coastal plain consisting of recent sediments. Much of the interior plateau, as seen from Landsat imagery, acts as a 'sponge' with pans and edaphic grasslands (a result of seasonally-poor drainage) and numerous drainage lines flowing to the south-east or, in the northernmost section, to the north-east. Some of these are deeply incised where they come down to the coast. The landscape in the central portion is relatively level and not that well drained.

On the northern margin, the Rio Rovuma, which appears to be an ancient continental drainage, has cut through these plateau sediments to create a wide valley (c. 10 km wide).

Most of the study sites lie between altitudes of 80 and 180 m, but patches of dry forest were found down to an altitude of 40 m.

Geology & Soils

Most data used here are derived from the 1: 1 million scale national geological map (ING 1987). More detailed geological maps have not been located.

At a national level north-eastern Cabo Delgado is seen to have a different geological origin from the rest of the country. There is an elongated triangle (Bacia de Rovuma Moçambique) of relatively younger formations dating from the Lower Cretaceous period (145–97 Mya) up to the Neogene (23–1.6 Mya), adjacent to the much older continental block that comprises Precambrian granites and other rocks (Fig. 5). As elsewhere in the country, there is also a narrow coastal strip comprising recent Quaternary (1.6 Mya–present) deposits. The strata in these apparently marine deposits from the Cretaceous and Neogene are relatively level (60° slope, Smelror *et al.* 2006), hence the area's landform is primarily determined by differential resistance to erosion by the different strata, resulting in numerous flat-topped plateaux.

Nearly all the coastal dry forest patches encountered were located on iron-rich sandstone and conglomerates of the Mikindani Formation (mid-Neogene, ± 15–10 Mya), while associated miombo and similar woodlands were mostly found on more recent Quaternary formations (Pleistocene, ± 1.6–0.01 Mya). Mikindani Formation strata are generally found in the form of a plateau raised about 20–30 m above the surrounding woodland.

The relationship is very clear in the Quiterajo area with its forest-capped plateau, but is less clear along the Rovuma rim (Nhica do Rovuma to Nangade). In the latter area it seems possible that the coarser-scale geological map is incorrect in its depiction of the Mikindani Formation, showing the area to be underlain by undifferentiated Tertiary deposits and fossiliferous or reef limestones of the Sancul–Cogune Formation. However, red sandstone outcrops, suggesting the Mikindani Formation, were often encountered here, as well as significant areas with dry forest species.

It would appear that the soils derived from the Mikindani Formation (coarse sandy, unstructured, well-drained, red-brown in colour, presumably quite acidic) are what gives rise to the distribution of the dry forest formations studied.

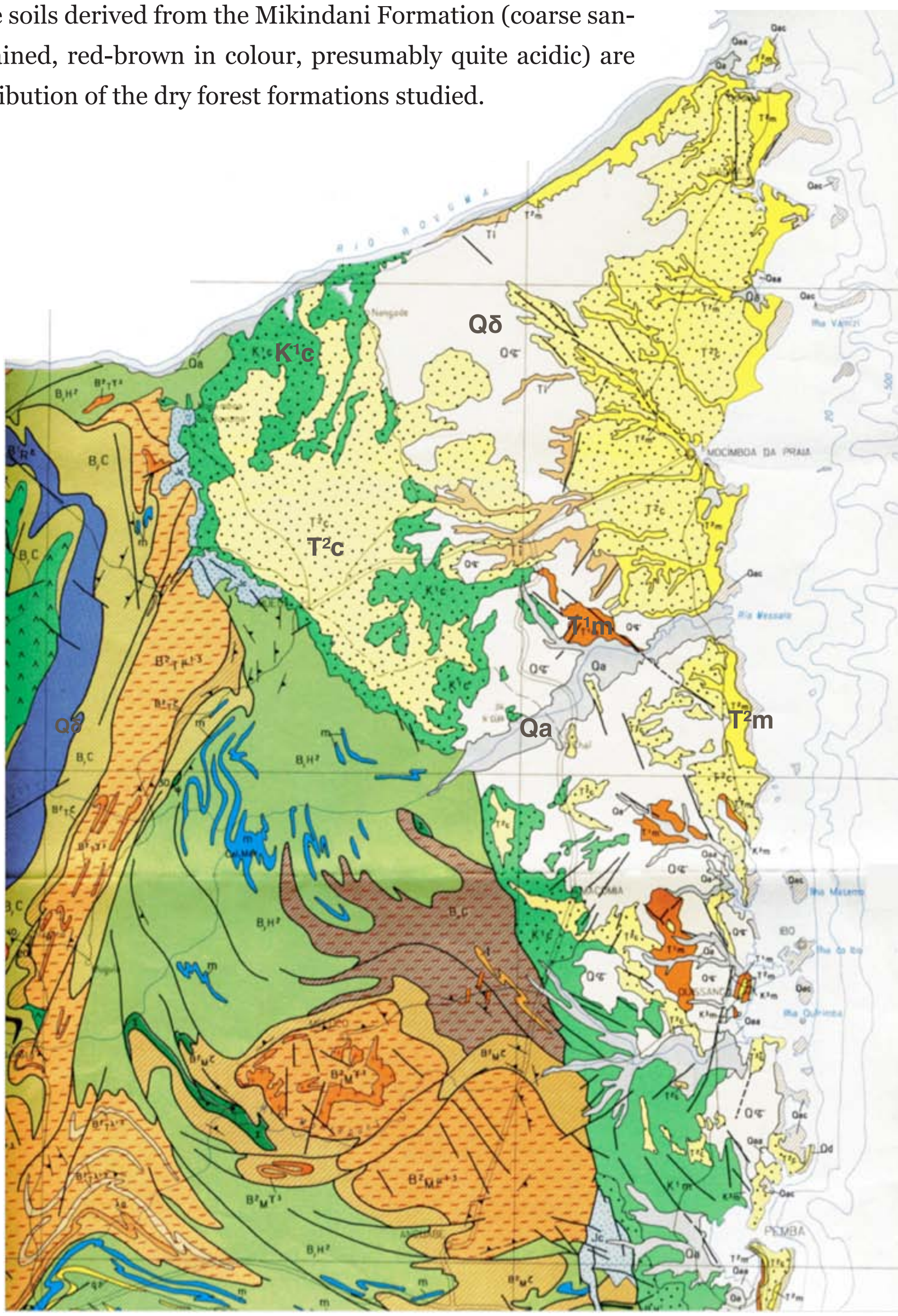


Figure 5.
Geology of Cabo Delgado study area (from I.N.G. 1987).
[Simplified legend:
Quaternary:
Qa, Recent alluvium; **Qδ**, footslope formations.
Neocene:
T²c, Mikindani Formation, iron-rich reddish sandstones & conglomerates; **T¹m**, reef limestones, marls & clays;
T²m, Sancul–Congane Formation, reef limestones.
Lower Cretaceous:
K¹c, Macondes Formation, conglomerates & arkoses.]

However, at present this link has not been specifically tested and causation has not been established. It remains an important area for future investigation (see Recommendations p77). It is this assumed relationship that was used to help determine what the original extent and distribution of dry forest formations may have been across the study area (see Chapter 'Findings', Section 'Past and Present Extent of Forest' p39).

Interestingly, along the Macomia–Mucojo road some limestone outcrops (probably nummalitic limestones or marls from the Palaeocene period, 60–65 Mya) were seen. The calcareous and clay-rich soils developed from these rocks support a very different *Acacia*-dominated vegetation from that seen elsewhere in the study area.

Climate

Detailed climatic data have not yet been located. Summary monthly data have been taken from Kassam *et al.* (1981) and are shown in Table 1 below. As can be seen, most localities had only records at that time (1980) for just under 30 years (Mueda is exceptional; other climatic data for that locality are for 27 years).

Table 1.

Summary climatic data for various stations in NE Mozambique (from Kassam *et al.* 1981).

locality	rainfall (mm/yr)	years	pET (mm/yr)	mean temp (°C)	mean of min. month (month)	mean of max. month (month)
Macomia	1198.2	28	1474.2	24.8	17.6 (Jul)	31.9 (Nov)
Mocímboa da Praia	986.1	28	1502.2	25.4	18.2 (Aug)	31.6 (Jan)
Mueda	1094.4	7	1340.8	21.4	14.3 (Jul)	28.8 (Nov)
Palma	1139.0	29	1479.1	25.0	17.5 (Jul)	32.0 (Mar)
Pemba	880.3	23	1688.6	26.3	19.5 (Jul)	31.4 (Mar)
Quissanga	998.4	24	1648.9	25.1	17.9 (Jul)	31.6 (Mar)

From these data it is assumed that rainfall in the Nhica and Quiterajo areas is around 900–1100 mm/year. Potential evapotranspiration (Penman) significantly exceeds rainfall for the period May to November–December for most sites, giving a growing season of around 4–5 months. Local wisdom suggests the rains generally start in early December, with a long hot dry period before that.

Although there is a coastal influence and some effects from the Indian Ocean monsoon, the climate across the study sites generally follows that more typical of the continental interior. There is a long hot dry season before a single clearly-defined rainy season from December to April, although the atmospheric humidity during November and early December is high.

History

The Province of Cabo Delgado, originally named after the low coral peninsula jutting into the ocean 20 km north-east of Palma, has a long and rich history stretching back to before the initial Portuguese settlements in the 16th century. The coastal area is believed to have been settled for centuries before the first European contact around 1500, and during the latter part of this period was visited repeatedly by Swahili traders, as were many places along the Indian Ocean coastline. Later on, coastal settlements were visited by traders from Oman who brought Islam.

This brief section, however, will focus on the period since 1880 and the impacts of human activities on vegetation.

Although by the mid-19th century, nearly all of what is now Mozambique was regarded as being in the Portuguese «sphere of influence» and nominally under their control, the boundaries of this sphere were not always clear or accepted. Indeed, the Portuguese authorities had unwittingly restricted their influence by the building of isolated fortifications pointing out towards the sea lanes, rather than by turning their attention inland to develop infrastructure and trade. This left the hinterland both undeveloped and more open to external influence. In the latter part of the 19th century, following on from the explorations of Livingstone across South Central Africa in the 1850s to 1860s, there appears to have been repeated pressure from the British authorities to gain a level of dominance or control across parts of northern Mozambique. In part this may have been driven by concerns on slave trading, which was still occurring in the area, but probably primarily revolved around the need to ensure unfettered access to the sea for the main British settlements in Nyasaland (now Malawi). This access had principally focussed on the Zambezi River, then the main route from the sea to Blantyre and Lake Nyassa (Malawi), but alternative land routes were being explored in case the river route became less usable, which was beginning to happen in the 1870s owing to the natural silting of the Shire River and increasing difficulties in navigation up the Zambezi. One of the principal aims of Livingstone's Zambesi Expedition (1858–1864) and subsequent mission settlements had been to promote trade in the Shire Highlands in present-day Malawi to provide economic alternatives to the slave trade (Dritsas 2010). Problems of navigation on the Zambezi (access through the delta, the Cabora Bassa [Kaborabassa] rapids, and low water levels) had prompted Livingstone to explore the Rovuma as an alternative route to the interior, and one that also avoided passing through Portuguese territory.

Meanwhile, in Cabo Delgado, there was also strong pressure from the German colonial authorities to extend German East Africa (now Tanzania) southwards. To this end, there were recorded attempts by German traders to create trading posts inland from Pemba prior to the Berlin Conference of 1884 so that the areas could be said to be important economically for Germany, with the possibility of them then being annexed from Portuguese control.

In 1882 Henry O'Neill, the then British Consul to Mozambique based at Isla de Moçambique near Nampula, walked from Menangene (now Palma) in Tunghi Bay inland to find out more about a «strangely isolated tribe» called the Mavia or Mabiha, people living up on the Mueda plateau. These people had first been mentioned by Livingstone, but it appears no European had been there before.

He was also looking for signs of continuing slave trading in the coastal area. His account and sketch map (Fig. 6) appears to be the first depiction of settlements across part of our study area. The settlement of Chimsaka (now Pundanhar) is described, as are Lakes Nangadi and Lidedi. The main items of trade, he records, were india rubber (presumably *Landolphia* latex), gum copal (*Hymenaea* resin) and ivory. Slaving had been important, but was apparently becoming less so. O'Neill also refers to the numerous «sponges» or swampy depressions in the area, many of which form large shallow lakes in the rainy season «several miles in circumference» (O'Neill 1883).

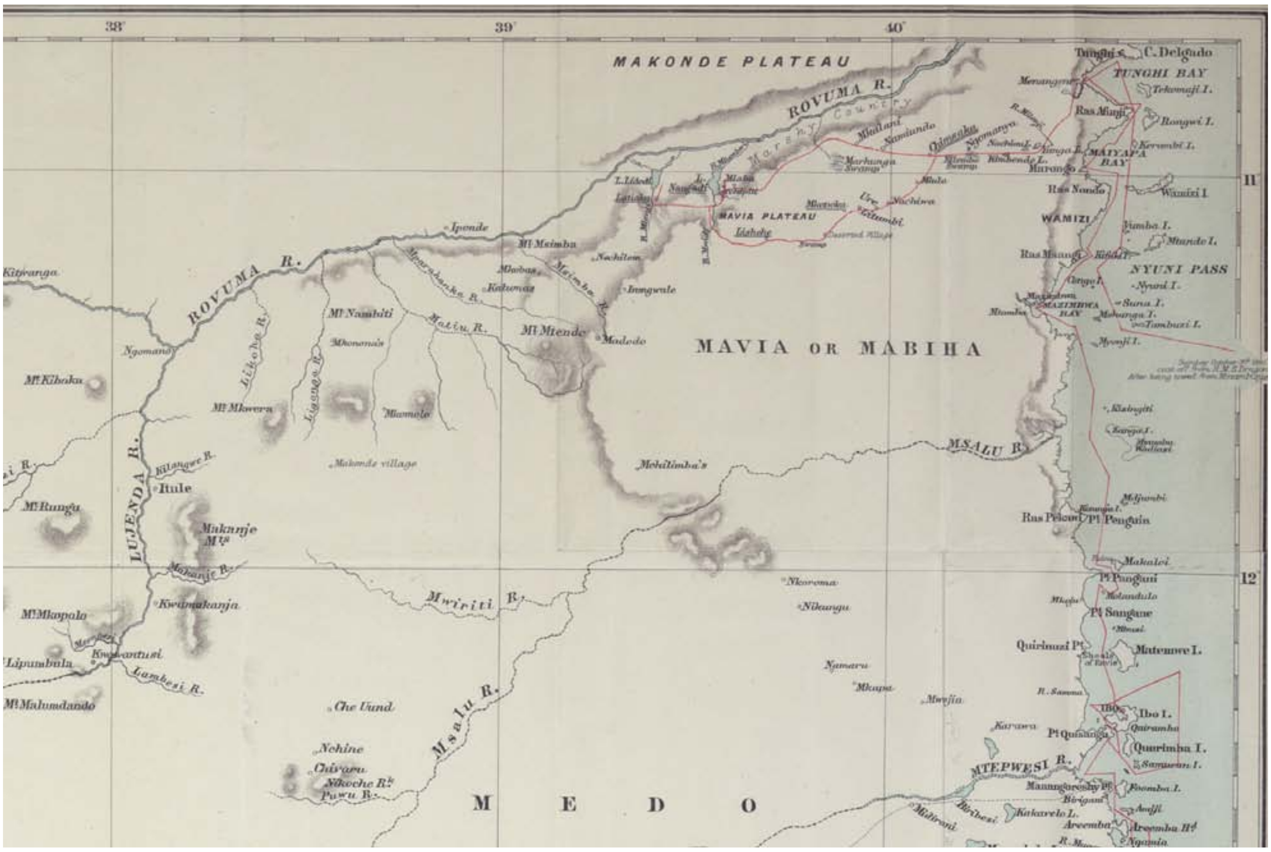


Figure 6.
Sketch map of O'Neill's 1882 trip from the coast to the Mueda plateau (from O'Neill 1883).

Joseph Last, on his epic walk to Mt Namuli from 1885–1887, initially landed at Lindi in Tanzania, just to the north of the present study area, and travelled down to the Rio Lugenda, joining it some 60 km upstream of Lake Nangadi. From here he continued upstream along the Rovuma and Lugenda rivers to Lake Chiuta and Malawi, and then on to Namuli (Last 1887). The published map based on his travels (Last 1890) also shows O'Neill's route and numerous settlements in the lower Rovuma area.

Also interesting is a map, ascribed to surveys by Last in 1885–87 (source not clear but probably also from the Proceedings of the Royal Geographical Society), showing a proposed railway line from Pemba on the coast, past what are now Montepuez and Marrupa to the Rio Lugenda, and then on to Lake Niassa/Malawi near what is now Mepondo. Potential gold, copper and coal deposits are marked. It is clear that there was a strong attempt at the time by the British to exploit economically, or possibly annex, this part of northern Mozambique.

At this time, the area to the north of the Rio Rovuma was considered German territory – German East Africa (now Tanzania) – which was confirmed politically by the Berlin Conference of 1884. However, there was also a small triangle of German territory, the Quionga Triangle, just south of the Rio Rovuma mouth, based around the small town of Quionga (see Figs. 7 & 8). This was finally occupied by the Portuguese in 1916 during the First World War, leading to the present international border with Tanzania which lies along the Rovuma River itself.

Figure 7.
British Admirality map of northern Mozambique, 1903.

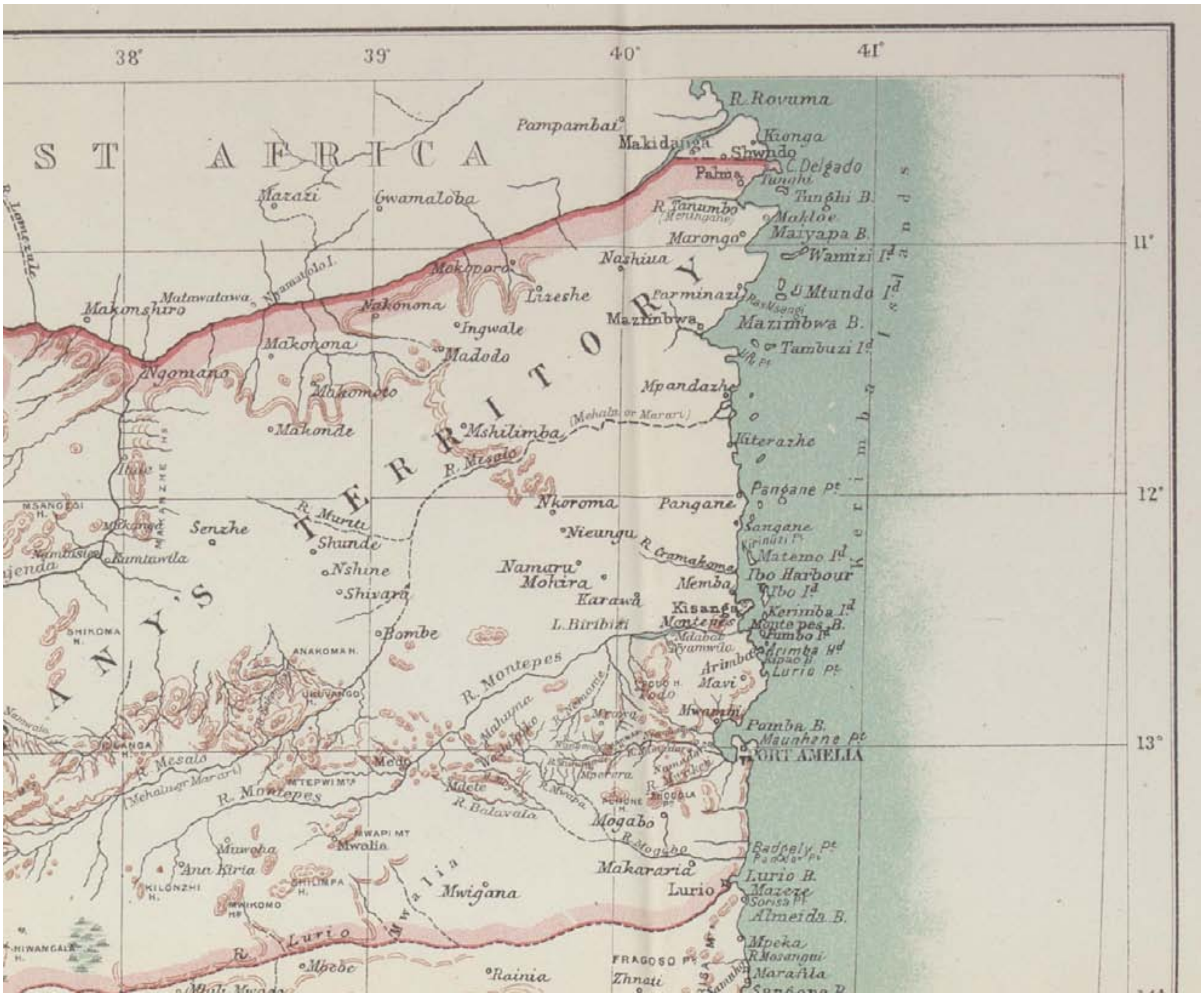


Figure 8.
Old map of Tanganyika (German East Africa) showing the Quionga enclave.

In the face of the territorial and economic ambitions of both Germany and Great Britain in the latter part of the 19th century, the Portuguese authorities did not have the resources to effectively colonise this part of northern Mozambique. Hence in 1891 a concession was granted to a private company, the Companhia do Niassa (or the Niassa Company), ironically mostly owned by British and French interests, to govern and manage what are now the provinces of Niassa and Cabo Delgado. Much of the company's agricultural activities were based on forced labour, causing much resentment. This concession – which was effectively rule – only finished in 1929 when the concession was not renewed and «control» reverted to the Portuguese crown.

During the Portuguese colonial period after the Second World War, much more emphasis was placed on economic exploitation of the natural resources of the «Overseas Province». Large parts of what are now Cabo Delgado Province were placed under cotton plantations in the 1950s, as well as being planted to cashew. It appears that there was a significant logging industry over parts of the present study area, presumably primarily for *Pterocarpus angolensis, Millettia stuhlmannii* and *Afzelia quanzensis*. During the Independence struggle in the 1960–70s, FRELIMO was based in southern Tanzania so the Rovuma border area saw much military action.

As can still be seen today, major roads were constructed (unpaved but cleared to a significant width), minefields were laid, and airstrips and military barracks built. The minefields were only finally cleared by the Halo Trust in 2007.

After Independence and during the civil war, there was little development away from the coastal strip and major settlements, but this has been changing since the early 1990s. A renewed wave of timber extraction is taking place, at least some of it illegal and uncontrolled, people are moving into what are either new agricultural areas or areas that have long been fallow, and recently there has been exploration for oil and gas which has involved the making of cutlines for geophysical exploration. These cutlines, despite attempts to close them off, are giving ready access enabling new settlements in areas that were, in practice, inaccessible before.

These changes in land ownership and management systems over the last 150 years have obviously had major effects on land use practices and settlement patterns, although this has not been adequately documented. However, it is clear that the study area has had a long and varied history of different forms of exploitation for many centuries – for ivory, slaves, gum copal, 'rubber' and timber – and this is bound to have significantly modified the present vegetation distribution and composition. What is not clear is exactly what these specific effects were, and where they have been most marked.

Previous Botanical Work

Prior to 2000 various plant collections had been made in the coastal areas of Cabo Delgado Province, in particular by L.A. Grandvaux Barbosa, F. Mendonça, Gomes e Sousa and A.R. Torre (Table 2). However, the earliest records (26 Feb–29 March 1861) are from John Kirk and Charles Meller who collected along the lower reaches of the Rovuma River during a break in Livingstone's expeditions up the Zambezi into what is now Malawi. Kirk returned to the Rovuma with Livingstone again from 7 Sept–16 Oct 1862, when they expored almost as far as Negomano, where rapids prevented further progress upstream (Foskett 1965). They collected on both the Mozambique side and in Tanzania, and the list of species indicates that they went at least some way away from the river banks. Kirk reported a local trade in copal and made perceptive comments on the branched and unbranched doum palms (*Hyphaene* species). None of these early collections appeared to have been comprehensive or focussed on dry forests in particular, but were rather to coastal areas in general.

There also appears to have been nothing published on the vegetation of the area other than in general accounts of national vegetation distribution (e.g. Pedro & Barbosa 1955, Wild & Barbosa 1967, White 1983), and nothing on the dry forests that form the focus of the present study and which have been shown to be so interesting botanically across the border in southern Tanzania.

Collector/s	Dates
Kirk, John	1861, 1862
Meller, Charles	1861
Peters, Carl	?1860s
de Carvalho, Manuel Rodriques	1884
Stocks, J.	1906
Allen, Charles E.F.	1909 – 1912
Pires de Lima, Américo	1917
Mendonça, Francisco	1942, 1948
Andrada, Eduardo Campos de	1948
Barbosa, L.A. Grandvaux	1948
Pedro, J. Gomes & J. Pedrógão	1948
Balsinhas, Aurélio	1952, 1953
Gomes e Sousa, Antonio Figueredo	1959 – 1965
Montenegro	1962
Torre, Antonio & Paiva, Jorge	1963, 1964

Table 2. Pre-Independence plant collectors in the Cabo Delgado study area.

However, in recent years there has been a resurgence of interest in the area. As part of the establishment of the Maluane Conservancy in the Quiterajo area, a rapid survey was undertaken, with some preliminary notes on the vegetation of this part of Cabo Delgado based on aerial survey and previous literature (Garnier *et al.* 1999). Although some plant specimens were collected (F. Robertson, pers. comm.) and taken to the herbarium in Harare, they were not identified.

Since 2003 there has been a series of botanical collecting trips to north-eastern Cabo Delgado, in particular focussing on coastal dry forests and associated forest vegetation types. Botanists involved in these earlier trips (Quentin Luke, John & Sandie Burrows) have also been involved in the later Pro-Natura/Paris Museum expeditions. The overall findings reported on here incorporate these earlier findings (e.g. Luke 2004). In addition, preliminary studies have been made of the flora of Vamizi Island and the newly-designated Quirimbas National Park (Silveira & Paiva 2009, Bandeira *et al.* n.d.) and of the nearby Maluane Conservancy (Bandeira & Nacamo 2007), including dry forests in the Quiterajo area.

In addition to plant collecting, some botanists earlier attempted to place the vegetation of the area in a regional or continental context. The first study describing the vegetation of Cabo Delgado was by Pedro and Barbosa (1955) for the colonial Cotton Research Board. Out of 117 vegetation types described from across the whole of Mozambique, the present study area contains perhaps 11, of which three are particularly significant (complexes 87, 90 and 94).

Complex 87 covers the coastal strip of Quiterajo sands north of Pemba between Ibo Island and the Rio Messalo. Included here are thickets/dry forests with, amongst others, *Pteleopsis myrtifolia, Guibourtia schliebenii, Androstachys johnstonii* (a species we did not encounter), *Scorodophloeus fischeri, Baphia macrocalyx, Memecylon* sp., *Pseudoprosopis euryphylla* and *Landolphia* spp. Complex 90 is confined to the Rovuma valley on sandstones, limestones of Cretaceous age or younger. Low deciduous woodland here contains *Afzelia quanzensis, Berlinia orientalis* and *Brachystegia spiciformis*, with palms in savanna areas.

Complex 94 covers the undulating area inland from Palma with medium height semi-deciduous forest and shrubland, open woodland to savanna, riparian woodland and open grassy pans. Species such as *Brachystegia spiciformis, Julbernardia globiflora, Berlinia orientalis, Pteleopsis myrtifolia* and *Parinari curatellifolia* are common.

These descriptions are rather vague and the species composition listed overlaps significantly between types. However, the boundaries depicted are similar to those picked up at a landscape level in the present study. Complex 87 represents the dry forest formations we have been focussing on, while the other two (complexes 90, 94) correspond to what we have called miombo woodlands.

The vegetation map of the Flora Zambesiaca area (Wild & Barbosa 1967, Fig. 9), which for Mozambique was primarily based on Pedro & Barbosa's earlier map, also shows 11 vegetation types in the study area (types 6, 13, 14, 14a, 14b, 28, 32, 33, 45, 53, 54), including littoral vegetation and mangroves. Much of the Mueda plateau is covered by Dry Deciduous Lowland Forest on sandstone and calcareous conglomerates (type 6) with *Adansonia digitata, Balanites maughamii, Bombax rhodognaphalon, Cordyla africana, Dialium* sp. [*D. holtzii?*], *Milicia excelsa, Millettia stuhlmannii, Sterculia appendiculata, S. quinqueloba* and *S. schliebenii*.
However, there is little sign of this forest formation remaining there now.
Deciduous Miombo Savanna Woodland–Deciduous Woodland (type 32) covers much of the undulating plateau inland from Palma and Mocímboa da Praia. Soils are mostly sandy and derived from sandstone and calcareous conglomerates, with the lower parts poorly drained. There is a well-marked mosaic of open deciduous miombo woodland with *Berlinia orientalis, Brachystegia spiciformis, Julbernardia globiflora* containing patches of 'deciduous woodland' (which we would recognise as dry forest). This type was clearly seen in the present study. In the main *Pteleopsis myrtifolia* community, *Balanites maughamii, Erythrophleum suaveolens* and *Millettia* spp. are found, along with shrubs of *Tetracera, Dichrostachys, Strychnos* spp., *Dichapetalum* spp. and *Markhamia obtusifolia*.

But in terms of species composition, this does not correspond well with what we recorded. The *Berlinia* woodland areas on grey moist sands generally also support a number of typical miombo species such as *Uapaca nitida, U. sansibarica, Parinari curatellifolia* and *Syzygium guineense*.

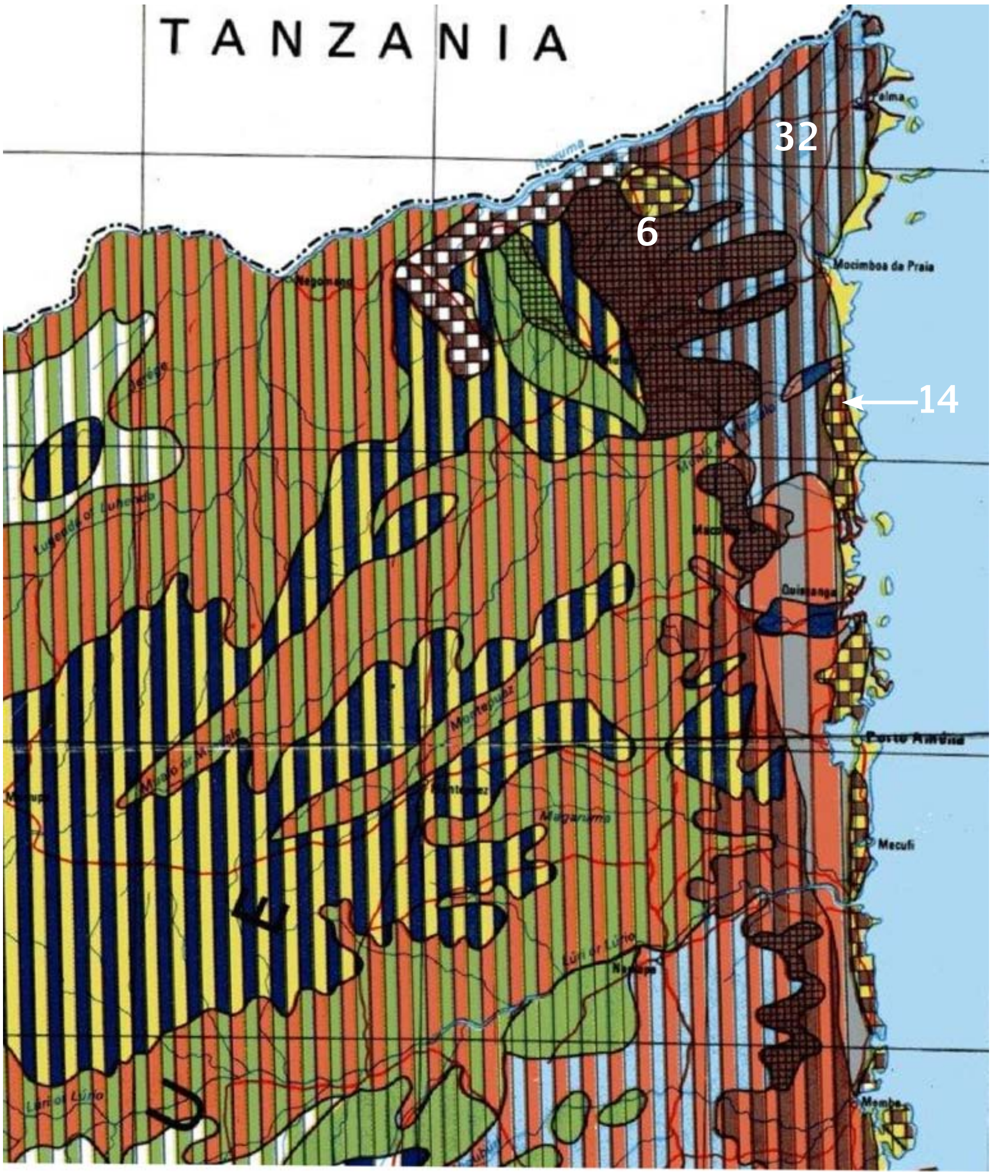


Figure 9.
Flora Zambesiaca vegetation map showing part of Cabo Delgado (Wild & Barbosa 1968).

Of particular interest to the current study is type 14, Dry Deciduous Thicket with *Guibourtia schliebenii,* which is shown as occurring south east of Lake Nangade, in the Quiterajo area and north of Pemba. This is said to occur on Quaternary sands (which is not what we found) under an annual rainfall of 800–1000 mm. The main species shown are *Guibourtia schliebenii, Pseudoprosopis euryphylla, Baphia macrocalyx, Dialium holtzii, Platysepalum inopinatum, Dichrostachys cinerea, Grewia conocarpa, Pterocarpus angolensis, Landolphia petersiana, L. kirkii, Mimosa busseana, Strophanthus* sp., *Gossypioides kirkii, Combretum pisoniifolium,* *C. xanthothyrsum, Cynometra* [=*Scorodophloeus fischeri]*, with scattered tall trees of *Bombax rhodognaphalon, B. stolzii, Sideroxylon* [=*Manilkara*?] sp., *Manilkara discolor, Afzelia quanzensis* and *Sterculia schliebenii*. This mix of species was not exactly what we recorded, but the vegetation type is clear from the description.

The main vegetation work covering the whole of Africa is Frank White's Vegetation of Africa (White 1983). In this work the whole of the East African coast from Kenya to South Africa is mapped as the Zanzibar–Inhambane regional mosaic, although this is a floristic unit, a phytochorion, not a vegetation unit. Unfortunately, White did not map any vegetation or structural units within it, other than some small patches of moist forest (not in the study area) and mangroves. However, in his accompanying descriptions (p.184–189), he briefly describes 10 broad vegetation types or groupings, of which perhaps only four (Zanzibar–Inhambane undifferentiated forest, Zanzibar–Inhambane transition woodland, Zanzibar–Inhambane woodland and scrub woodland and Zanzibar–Inhambane secondary grassland and wooded grassland) occur in northeast Mozambique. Most of the Cabo Delgado study area appears to fall under Zanzibar–Inhambane woodland and scrub woodland.
Surprisingly, White does not explicitly recognise dry coastal forest as separate type, unlike Wild & Barbosa (1967) on which much of his work for Mozambique was based. From species descriptions, though, dry coastal forest would probably fall within his Zanzibar–Inhambane undifferentiated forest.

Recently, Clarke (1998) has split White's regional mosaic into the Swahilian regional centre of endemism in the north and the Swahilian/Maputaland regional transition zone in the south. The study area lies towards the southern end of the Swahilian regional centre.

FINDINGS

This section outlines the botanical and vegetation findings resulting from the recent expeditions. Firstly the vegetation types are briefly described, followed by an analysis of previous and present extent of dry forest. Then data from the botanical collections are outlined, followed by descriptions of plant distribution patterns and some initial conservation assessments for particular species. Finally, findings from a species richness plot are described.

Main Features of Coastal Dry Forest and Associated Vegetation

The features that have characterised the coastal forests of eastern Africa, especially those in the drier southern regions, are:

- a patchy distribution across the landscape,
- a significant difference in species composition from surrounding woodland vegetation types,
- a relatively high turnover in species composition between forest patches, such that there is no single characteristic species found across large areas,
- the presence of numerous species of very restricted distribution, often only known from one or two forests.

These features have led to much of the recent conservation interest in them as many forest patches contain endemic or near-endemic species known from only a few localities, localities that are now coming under increasing threat from clearance for agriculture.

Descriptions of Dry Forest and Other Vegetation Types

Geo-referenced vegetation samples were recorded from across the study area, in both dry forest and other vegetation types such as woodland and grassland. Data recorded were species composition in various strata (>2.5 m, 0.5–2.5 m, <0.5 m), cover-abundance values, and environmental attributes such as landscape position, soil type, land use and total woody cover.

More comprehensive descriptions of the main dry forest types will be done once the vegetation survey results are analysed. However, it was clear that there are basically eight vegetation types, which are not always clearly separable:

1. **Dry forest** – various types can be described, ranging from those dominated by *Guibourtia schliebenii* to those with *Scorodophloeus fischeri*. *Dialium holtzii* and *Sterculia schliebenii* are also typical. In some areas there was dominance of *Micklethwaitia carvalhoi*. Species composition between patches is varied, with perhaps only *Manilkara sansibarensis* and *Pteleopsis myrtifolia* being commonly found across sites. [Fig. 10]

2. **Miombo and similar woodland** – Woodland, sometimes dense and almost closed-canopy, characterised by one or more of *Brachystegia spiciformis, Julbernardia globiflora, Afzelia quanzensis* and *Berlinia orientalis*. Small patches ('lenses') of dry forest are often found inside woodland areas in slightly elevated patches. The understorey in woodland is generally better developed than that under dry forest, and often characterised by grasses, which are mostly not present in dry forests. [Figs. 11, 12]

3. **Termite mound forest/woodland** – Patches of dense woodland, verging on dry forest, are commonly associated with large termite mounds, up to 20 m across. The most characteristic species here is *Hirtella zanzibarica*, with emergents of *Hymenaea verrucosa* and *Berlinia orientalis*. Lianas are also common and there is an abundance of Rubiaceae in the understorey.

4. **Palm savanna** – A wooded grassland dominated by *Borassus aethiopum* palms is commonly encountered along the upper parts of the Rovuma floodplain. Smaller areas characterised by *Hyphaene compressa* and *Phoenix reclinata* palms are commonly seen associated with pan margins and poorly-drained margins. [Fig. 11]

5. **Pan grassland** – Open grasslands associated with pans and other areas with seasonally poor drainage are very common in the Nhica–Pundanhar area in the lower parts of the gently undulating landscape. The main trees found here are *Parinari curatellifolia*, along with *Uapaca nitida* and *Pseudolachnostylis maprouneifolia*. [Fig. 13]

6. **Riparian or lakeshore woodland** – A narrow fringe of dense woodland is found along permanent drainage lines or on some lake margins. Some of the trees found here were not seen elsewhere. [Fig. 11, 14]

7. **Regenerating fallow** – Where dry forest or woodland has been cleared for agriculture, or where there has been recent extensive logging, a fallow vegetation is found comprising regenerating woody plants. Many of these are widespread, while others reflect the previous vegetation type. *Berlinia orientalis*, which is of restricted distribution along the Eastern African coast, is surprisingly common in such areas. [Fig. 11]

8. **Coral rag** – An almost impenetrable thicket to low early-deciduous dry forest on raised coral rock with minimal soil cover. This is a relatively recent formation only found close to the sea (e.g. on the Cabo Delgado peninsula) and has little relationship to the dry forests or woodlands further inland, although some species are common. [Fig. 13]

Worthy of mention here is a possible vegetation type in the area that now seems to have effectively disappeared, a somewhat moister, tall forest that was found in higher potential areas. Wild & Barbosa (1967) in their vegetation map (Fig. 9) show a significant extent (type 6) of Dry Deciduous (lowland) Forest (*Adansonia, Cordyla* or *Bombax*) on the eastern part of the Mueda plateau and south of the Rio Messalo around Chai. Such an extent of well-developed forest («dry to sub-humid, deciduous, with a closed thick and almost impenetrable layer of deciduous to semi-deciduous shrubs») does not show on recent satellite imagery; it is probable that it has been all but destroyed through agricultural expansion and logging during the pre-Independence period. Today, along the main road from Chitunda via Chai to Macomia it is possible to see a few tall remnant large-girthed trees in fields with lush secondary growth underneath, suggesting a very different vegetation previously. This is particularly noticeable on the 'shoulders' of the Messalo valley where soils are probably more fertile with a higher moisture status owing to lateral movement of both water and nutrients in the soil profile. It is possible that less-destroyed stands exist in inaccessible areas away from the main motorable tracks. If confirmed, the prior occurrence of this vegetation type shows that some areas of NE Cabo Delgado had a more mesic coastal vegetation than is generally found now, perhaps more similar to some of the coastal forests seen in northern Tanzania.

Figure 10.
Dry forest vegetation types (clockwise, from top left: dry forest in the «banana» at Quiterajo; *Micklethwaitia* forest near Quiterajo; *Micklethwaitia* forest at Lupangua [photo GPC]); dry forest near Palma [bottom]; *Scorodophloeus* forest near Hunter's concession at Pundanhar).

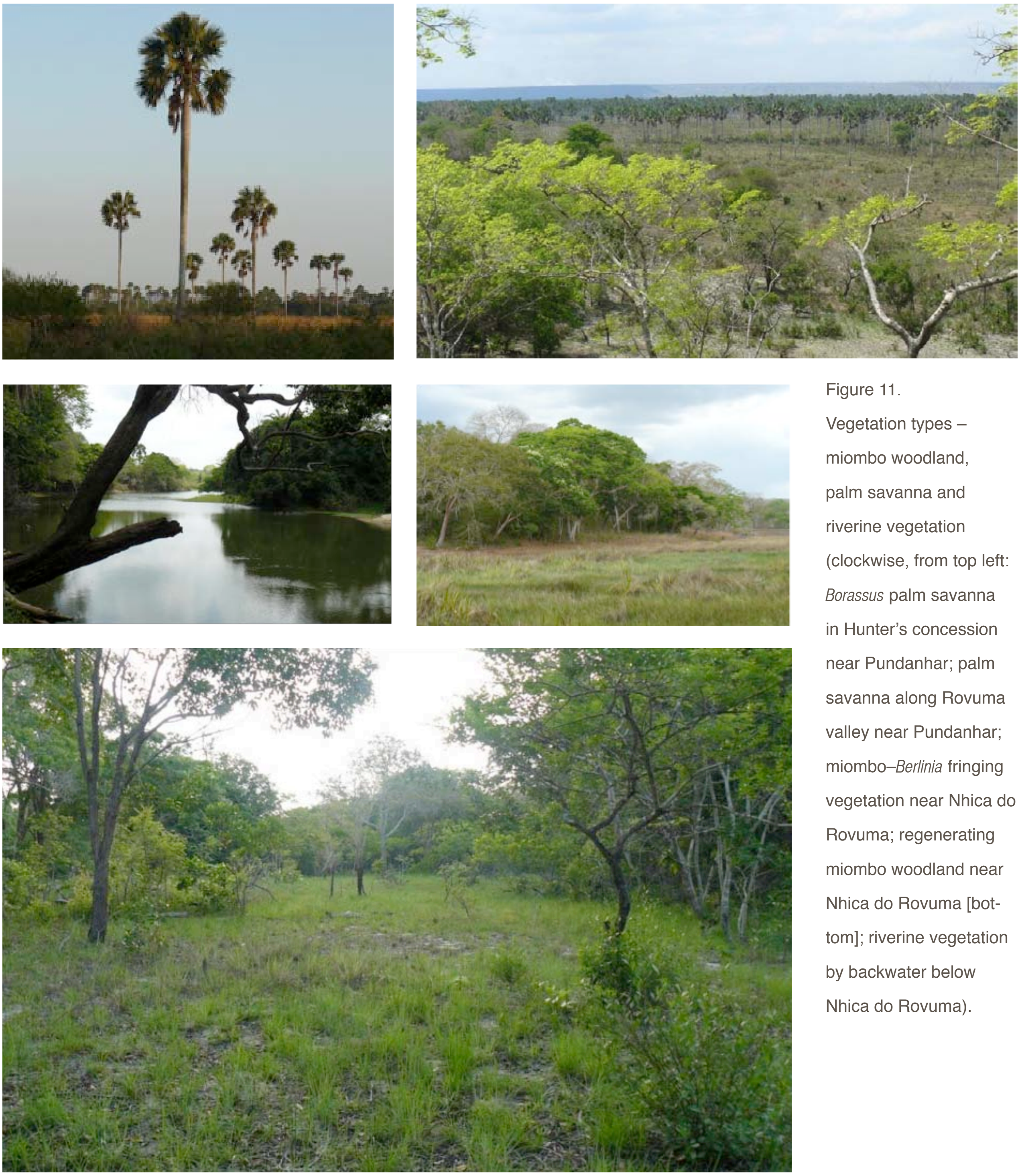


Figure 11.
Vegetation types – miombo woodland, palm savanna and riverine vegetation (clockwise, from top left: *Borassus* palm savanna in Hunter's concession near Pundanhar; palm savanna along Rovuma valley near Pundanhar; miombo–*Berlinia* fringing vegetation near Nhica do Rovuma; regenerating miombo woodland near Nhica do Rovuma [bottom]; riverine vegetation by backwater below Nhica do Rovuma).

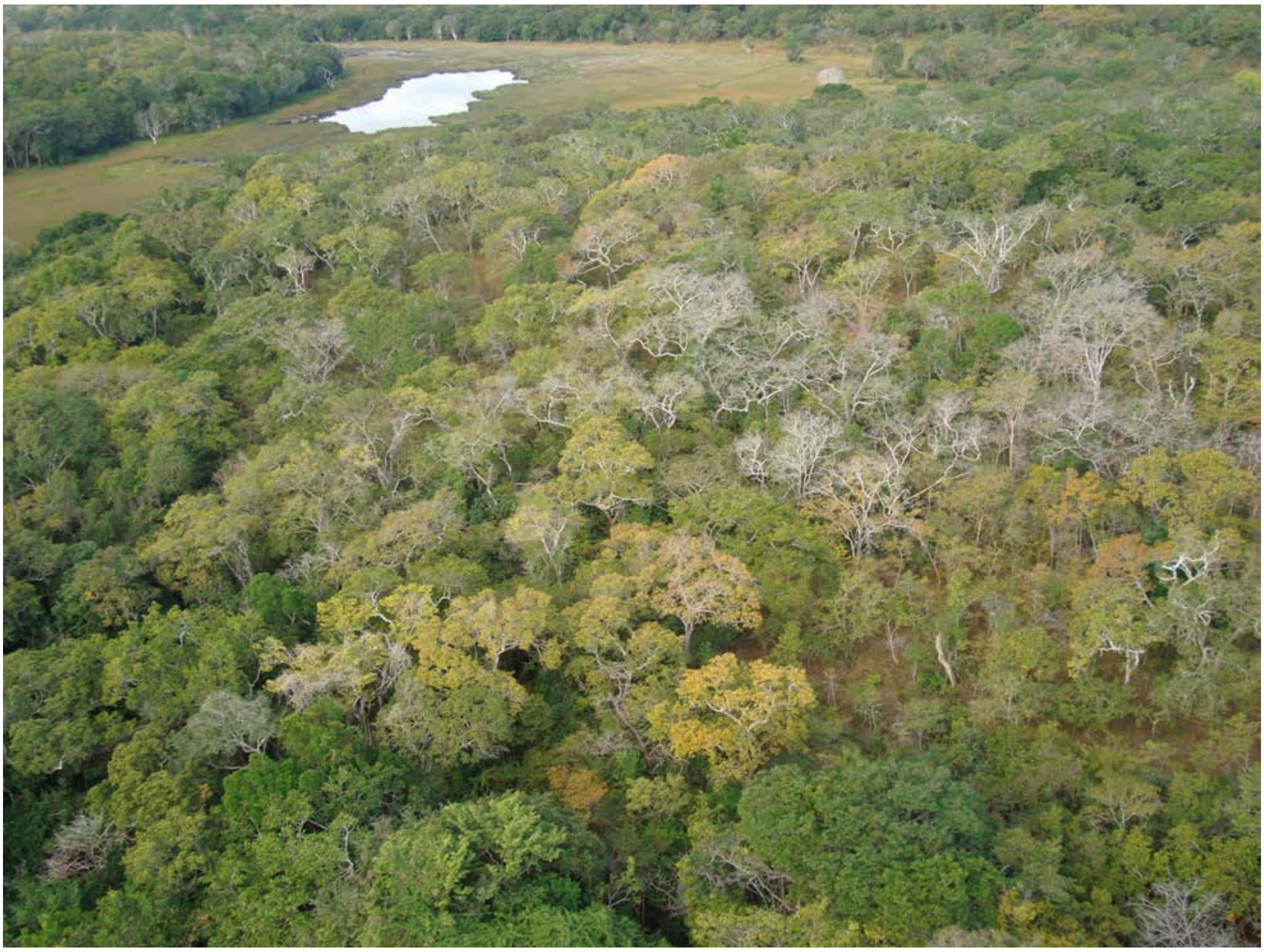


Figure 12.
Vegetation types – aerial view of miombo woodland and grassy drainage line, Nhica do Rovuma [top]; young low miombo woodland, Nhica do Rovuma [bottom]. Photos by Xavier Desmier, © X.Desmier/Pro-Natura/MNHN.

Figure 13.

Other vegetation types in survey area (clockwise, from top left: Open wooded grassland near Nhica do Rovuma; pan grassland by Nhica do Rovuma; Google Earth image of same pan; miombo woodland and edaphic grassland in northern part of Maluane concession, Quiterajo [bottom]; coral rag vegetation on Cabo Delgado peninsula).

Figure 14.
Aerial view over Palma area showing miombo woodland and flooded grasslands. Photo Martin Guard, Artumas.

Past and Present Extent of Forest

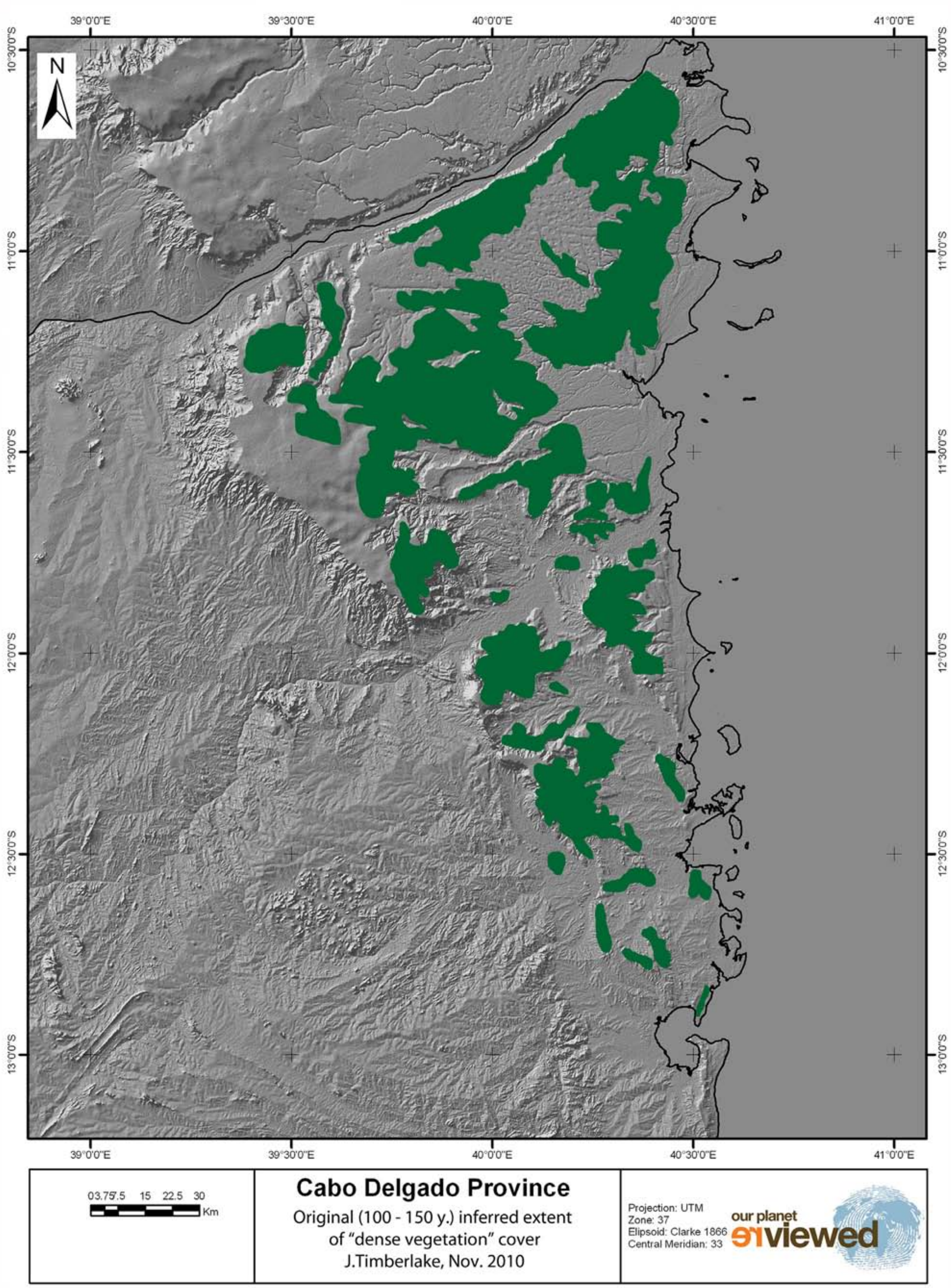
An attempt was made to estimate the remaining extent of coastal dry forest and similar formations remaining in the study area, and also to get an approximation of what the possible original extent was some 100–150 years ago, before significant changes in land use occurred.

Estimates were made using photographic copies of 1999–2002 false-colour Landsat ETM imagery at a scale of 1: 800,000 or 1: 250,000. The scenes used were:

Path/row	Date	Area
165/067	25 May 2001	far N
165/068	12 May 2002	main block
165/069	15 July 2002	far S (small)
164/068	7 Dec 1999	Pemba & coastline
164/069	31 May 2000	far SE (small)

Delineation was done by manual interpretation using a transparent mylar sheet overlay, after which a dot planimeter was used to determine area. The overlays were then scanned and put into a GIS. Results are presented by geographical block.

Figure 15. Original inferred extent of «dense vegetation cover» across study area, based on landform and Landsat imagery.



ORIGINAL EXTENT

The determination of possible original extent of dry forest was made based on a combination of (a) suitable upland landform, (b) underlying geology, and (c) reflectance (smooth reddish texture on image). A reduced image at 1: 800,000 scale was used to obtain a better synoptic view. The resulting map is shown in Fig. 15. Based on field observations of species composition and distribution, it is thought that only a small part of the area of «dense vegetation cover» would have been what we term dry forest, with the majority being miombo or similar woodland types, at least within any time scale we are concerned with here. As dry forest patches appear to be restricted to certain soils and landscape units, it was assumed that only 10% of the total extent of dense vegetation would have been dry forest rather than woodland.

Area	thick veg. cover (km^2)	dry forest (km^2)
NW, Mueda plateau & E slopes	2325	235
NE, Nangade–Pundanhar–Nhica–Quionga–Palma–Mocímboa	2173	220
EC, Rio Messalo–Quiterajo	576	60
S, Chai–Mucojo–Pemba, S of Rio Messalo	1006	100
TOTAL	6080	615

Table 3. Assumed original extent of «dense vegetation cover» (closed woodland + dry forest + thicket), based on interpretation from geology and landform on Landsat imagery.

The original extent of «dense vegetation cover» was determined as having been 6080 km^2, but incorporating the assumptions and rounding up, the extent of dry forest within that was probably only around 615 km^2 (Table 3), or 3% of the whole 18,150 km^2 study area. Even with a higher proportion of dry forest vs. woodland, the extent was unlikely to have been more than 1000 km^2. The interpretation error is probably around 20%, while the area determination has a calculation error of ± 10%. Although the assumptions used are not well substantiated, and the errors in interpretation rather high, it is probably the best that can be realistically done given our present ecological knowledge and the lack of historical data.

It can be seen from Fig. 15 that the main densely vegetated areas were probably in the north along the Rovuma margin and on the eastern slopes of the Mueda plateau. However, there were probably also some significant blocks around the lower reaches of the Rio Messalo and in the Macomia area. Most are associated with the sloping exposed sandstone strata.

PRESENT EXTENT

After this exercise, a more detailed assessment was made of the present (2002) existing extent of dense vegetation cover. For this various key assumptions were made:

a) that relatively smooth-textured non-mottled reddish areas on the imagery indicate sandy soils from the Mikindani Formation, most of which lie up on the plateau. Dark blue areas indicate woodland on Quaternary deposits, and lighter blue is grassland – both these were not included;

b) that deeper red-hued, ± homogeneous blocks are likely to be dry forest or dense woodland;

c) areas that are mottled are assumed to include significant patches of cultivation, and so are now not likely to have any conservation value and were excluded;

d) based on field evidence, the proportion of suitable substrate (deeper, vegetated sands derived from the Mikindani Formation and associated strata) likely to support homogeneous dry forest patches (as opposed to dense woodland, transitional areas or areas with just a sprinkling of dry forest species) is around one-third (33%);

e) rugged terrain, usually deep red on the imagery, along the Rovuma valley rim was included. From field experience these areas support some good patches of dry forest as well as a mix of woodland types.

Based on these assumptions, the total extent of «dense vegetation cover» was measured as 1181 km² in 2002, giving a rough estimate of 394 km² of dry forest (Fig. 16, Table 4), or 2% of the total study area. The overall loss of dense vegetation cover over the last 100–150 years appears to be around 80%, with losses ranging from 96% on the Mueda plateau to around 65% in the Nhica area. It is not clear if dry forest has been cleared preferentially over woodland, so the actual loss of forest itself may be greater.

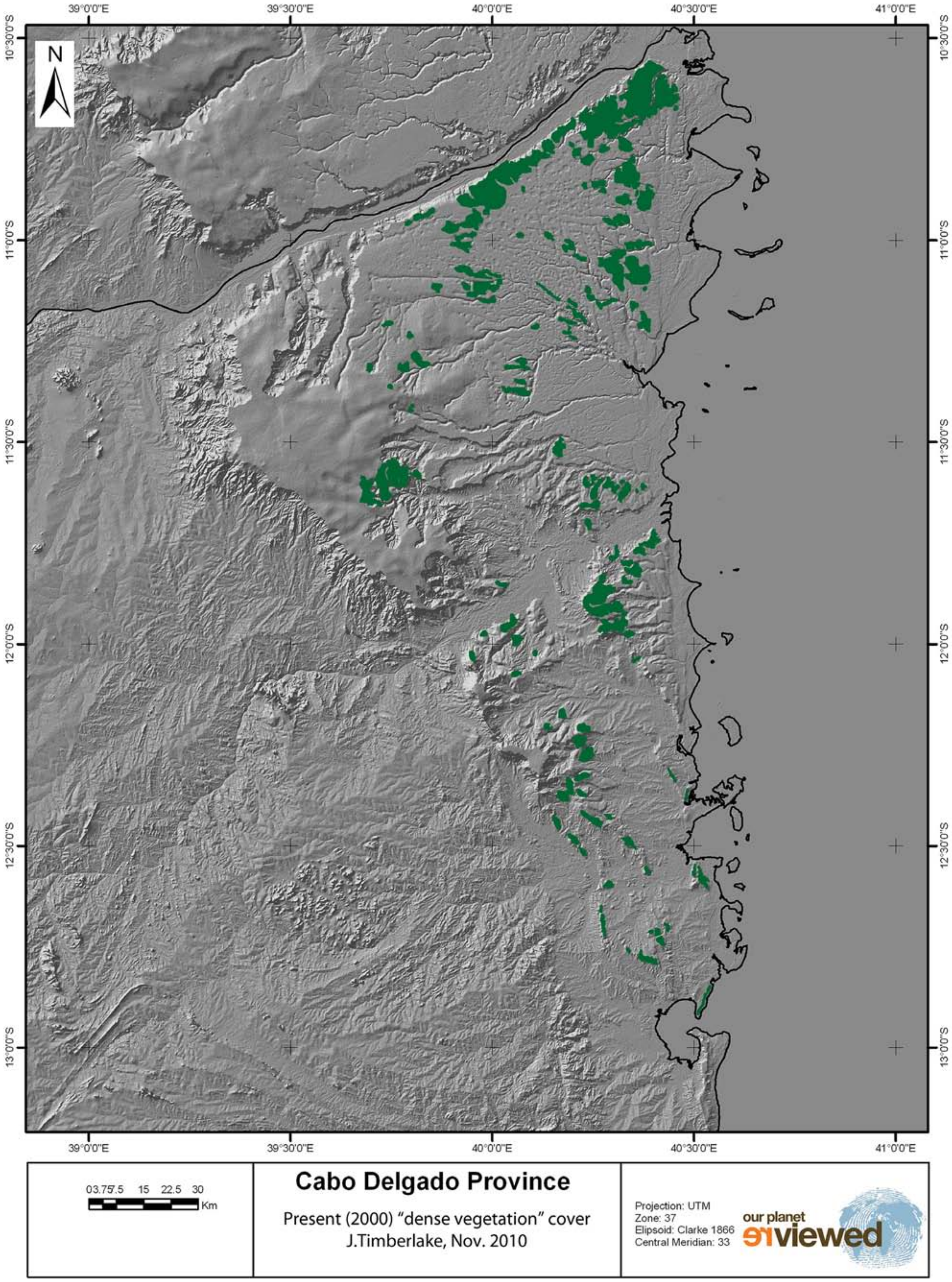
Table 4. Original and remaining extent of dense woodland and dry forest vegetation types based on interpretation of 2002 Landsat imagery and the assumptions given above.

Area	Original extent (km²)	Present extent (km²)		Loss of dense veg. cover (%)
		dense veg. cover	dry forest (est.)	
NW, Mueda plateau & E slopes	2325	89	30	96.2
NE, Nangade–Pundanhar–Nhica–Quionga–Palma–Mocímboa	2173	769	260	64.6
EC, Rio Messalo–Quiterajo	576	166	55	71.2
S, Chai–Mucojo–Pemba, S of Rio Messalo	1006	158	53	84.3
TOTAL	6080	1181	398	80.6

The main remaining areas of dry forest are found in the north-east part of the study area associated with the southern margin of the Rovuma valley from Pundahar to Nhica do Rovuma, and in the Quionga area associated with the Rio Luvumba/Macanga, which drains into the Rovuma estuary. There are also sizeable areas away from the Palma–Mocímboa da Praia road. Other significant areas of dry forest include the banana-shaped forest patch at Quiterajo («The Banana», 31 km²) and others south of this, and the patch at Lupangua (20 km²).

As can be seen from the imagery, large parts of the area have been cleared for agriculture over the last 100 years (probably most in the last 20–50 years). Yet from personal observation many additional expanses have been cleared close to population centres and main roads since 2002, when the last images were taken. It is also believed that forest habitat quality on the ground is often low owing to previous logging, old (5–50 years ago) clearance for fields, and frequent fire, none of which are readily detectable on the images. Hence the total extent of remaining dry forest (almost 400 km²) given here, from a conservation or biodiversity viewpoint is likely to be an over-estimate. It is possible that the total area is now only 300–350 km², with most of the recent loss in the Palma area.

Figure 16. Present (2000) extent of "dense vegetation cover" across study area, as determined from Landsat imagery.



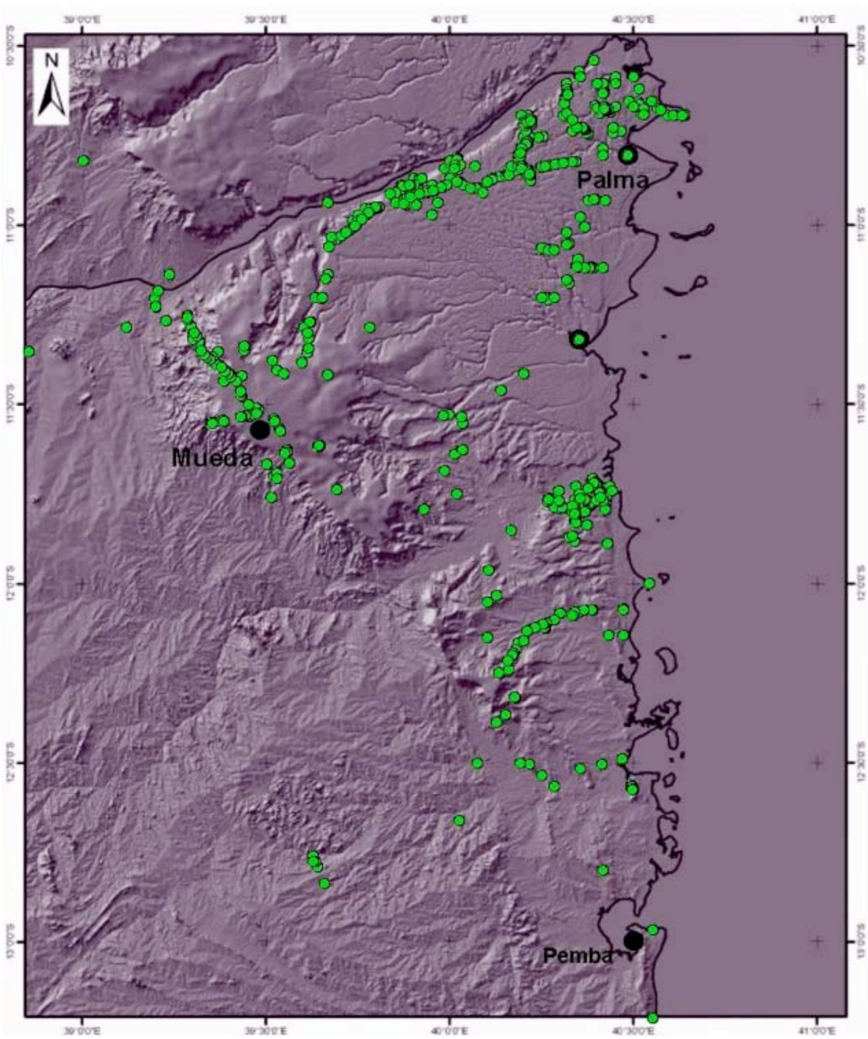
Botanical Composition

A large effort was put into stratified botanical collecting, with particular emphasis on the patches of dry forest. More open vegetation types, such as around the pans, on the coastal margins and in the Rovuma valley, were not well-collected. All species seen with flowers or fruit were collected at least once. Specimens were dried in the field, with final drying and sorting done in Maputo, from where they were sent to the herbarium at the Royal Botanic Gardens, Kew for identification. Kew has the best available collections from this part of the world.

It should be emphasised that most of the plant collecting was done in the late dry season or just after the first rains, hence many species were not found in a fertile state or with adequate vegetative material. This resulted in a marked under-representation of herbs and grasses.

Approximately 2250 collections of higher plants were made over the course of the various «Our Plant Reviewed» trips and expeditions of 2008 and 2009 (distribution shown in Fig. 17). The 2008/9 collections were duplicated in sets of four for fertile material, and sets of two for material lacking flowers or fruit. They will be distributed to herbaria in Mozambique (Instituto de Investigação Agrária de Moçambique [LMA] and Eduardo Mondlane University, Maputo [LMU]), UK (Royal Botanic Gardens Kew [K]) and France (Museum national d'Histoire naturelle, Paris [P]), with some collections also being deposited in South Africa (Buffelskloof Nature Reserve, Lydenburg [BNRH]) and in Kenya (National Museums of Kenya [EA]).

Figure 17.
Location of botanical collections in Cabo Delgado, 2003–2009.



A full list of species identified is given in Annex 2, although this is still not fully complete. A total of 738 plant taxa have been recorded from Cabo Delgado Province during project-funded expeditions (2008–2009), of which 35 taxa are either entirely new to science or were known previously from material too fragmentary to describe formally (Table 5); 23 of these were discovered during project-funded trips. The recent high quality collections will help in drawing up detailed descriptions for many of the inadequately-known species. Excluding the new species, 67 new plant species records are reported for Mozambique (Table 6), 57 of them found during the project's trips, with a further 37 species not previously recorded from Cabo Delgado Province (Annex 3). This is an exceptionally high number of new records to discover anywhere in southern and eastern Africa, and indicates not just the marked lack of previous collecting, but also the richness of the area and the number of range-restricted species.

Table 5. New species recorded from Cabo Delgado study area, 2003–2009.

Monocotyledons

Asparagaceae
Asparagus ?sp. nov.
Araceae
Stylochaeton sp., uncertain status

Dicotyledons

Annonaceae
Xylopia sp. nov.
Xylopia sp. A of FTEA
Celastraceae
Pleurostylia ?sp. nov. aff. *serrulata* Loes.
Compositae
Vernonia ?sp. nov. aff. *inhacensis* G.V.Pope
Vernonia ?sp. nov. 2
Convolvulaceae
Ipomoea ?sp. nov.
Euphorbiaceae
Euphorbia ?sp. nov. aff. *ambroseae* L.C.Leach
Flacourtiaceae
Casearia ?sp. nov.
Lamiaceae
Vitex ?sp. nov. aff. *buchananii*
Vitex cf. *mossambicensis* Gürke
Leg: Papilionoideae
Baphia ?sp. nov.
Erythrina ?sp. nov.
Melastomataceae
Warneckea sp. nov.
Meliaceae
Trichilia ?sp. nov.
Ochnaceae
Ochna ?sp. nov.
Rubiaceae
?*Chassalia* cf. *umbraticola* Vatke
Didymosalpinx callianthus J.E.& S.M.Burrows
Oxyanthus sp. A of FZ
Oxyanthus biflorus J.E.& S.M.Burrows
Polysphaeria ?sp. nov.
Psilanthus sp. nov., cf. sp. A of FTEA
Pyrostria sp. B of FZ
Pyrostria sp. D of FTEA
Pyrostria ?sp. nov. = Luke 9724
Rytigynia cf. *umbellulata* (Hiern) Robyns
= de Koning et *al.* 9759 of FZ
Tarenna sp. 53 of Degreef
Tricalysia sp. A of FZ
Tricalysia sp. B of FZ
Rutaceae
Vepris sp. nov.
Zanthoxylum lepreurii Guill.& Perr., subsp. nov.?
Sapindaceae
Deinbollia ?sp. nov.
Sterculiaceae
Cola sp. nov. 1 aff. *clavata* Mast.
Cola ?sp. nov. 2 aff. *clavata* Mast.

Two categories of range-restricted endemics can be outlined (Annex 3) – 30 species are restricted to the northernmost provinces of Mozambique, principally to the coastal dry forests of Cabo Delgado, while a further 43 species are restricted to the area either side of the border with Tanzania, demonstrating strong links between Cabo Delgado and the well documented Lindi centre of endemism in SE Tanzania.

Table 6. New records for Mozambique from Cabo Delgado study area, 2003–2009.

Amaryllidaceae
Crinum aurantiacum Lehmiller
Anthericaceae
Chlorophytum amplexicaule Baker
Araceae
Anchomanes abbreviatus Engl.
Culcasia orientalis Mayo
Stylochaeton euryphyllus Mildbr.
Arecaceae
Hyphaene petersiana Mart.
Dracaenaceae
Sansevieria cf. *metallica* Gérôme & Labroy
Orchidaceae
Eulophia acutilabra Summerh.
Eulophia guineensis Lindl.
Microcoelia megalorrhiza (Rchb.f.) Summerh.
Microcoelia physophora (Rchb.f.) Summerh.
Nervilia bicarinata (Blume) Schltr.

Acanthaceae
Lepidagathis plantaginea Mildbr.
Whitfieldia orientalis Vollesen
Anacardiaceae
Lannea schweinfurthii (Engl.) Engl.
var. *acutifolia* (Engl.) Kokwaro
Annonaceae
Artabotrys modestus Diels subsp. *macranthus Verdc.*
Letowianthus stellatus Diels
Monanthotaxis faulknerae Verdc.
Monanthotaxis trichantha (Diels) Verdc.
Monodora minor Engl.& Diels
Apocynaceae
Baissea myrtifolia (Benth.) Pichon
Cryptolepis hypoglauca K.Schum.
Balanitaceae
Balanites maughamii Sprague subsp. *acuta* Sands
Burseraceae
Commiphora fulvotomentosa Engl.
Commiphora pteleifolia Engl.
Capparaceae
Maerua bussei (Gilg & Gilg-Ben) Wilczek
Ritchiea capparoides (Andr.) Britton
var. *capparoides*
Celastraceae
Elaeodendron buchananii (Loes.) Loes.
Compositae
Vernonia zanzibarensis Less.
Connaraceae
Vismianthus punctatus Mildbr.
Cucurbitaceae
Peponium leucanthum (Gilg) Cogn.
Ebenaceae
Diospyros kabuyeana F.White
Diospyros magogoana F.White
Diospyros shimbaensis F.White
Euphorbiaceae
Croton polytrichus Pax subsp. *polytrichus*
Drypetes sclerophylla Mildbr.
Omphalea mansfieldiana Mildbr.
Labiatae
Orthosiphon scedastophyllus A.J.Paton
Premna gracillima Verdc.
Premna hans-joachimii Verdc.
Leguminosae: Caesalpiniodeae
Scorodophloeus fischeri (Taub.) J.Léonard
Senna auriculata (L.) Roxb.
Leguminosae: Mimosoideae
Newtonia paucijuga (Harms) Brenan
Leguminosae: Papilionoideae
Dalbergia lactea Vatke
Erythrina haerdii Verdc.
Erythrina sacleuxii Hua
Loganiaceae
Strychnos xylophylla Gilg
Myrtaceae
Eugenia capensis (Eckl.& Zeyh.) Sond.
subsp. *multiflora* Verdc.
Ochnaceae
Ochna ovata F.Hoffm.
Passifloraceae
Adenia kirkii (Mast.) Engl.
Rubiaceae
Coffea schliebenii Bridson (Coffea sp. D of FTEA)
Gardenia transvenulosa Verdc.
Kraussia kirkii (Hook.f.) Bullock
Leptactina papyrophloea Verdc.
Pavetta lindina Bremek.
Rhodopentas parvifolia (Hiern) Kårehed & B.Bremer
Rothmannia macrosiphon (Engl.) Bridson
Vangueria cf. *randii* S.Moore
subsp. *vollesenii* Verdc.
Rutaceae
Vepris sansibarensis (Engl.) Mziray
Zanthoxylum lindense (Engl.) Kokwaro
Sapindaceae
Haplocoelum inoploeum Radlk.
Thymelaeaceae
Synaptolepis kirkii Oliv. sensu stricto
Tiliaceae
Grewia stuhlmannii K.Schum.
Violaceae
Rinorea welwitschii (Oliv.) Kuntze
subsp. *tanzanica* Grey-Wilson
Viscaceae
Viscum gracile Polh. & Wiens
Vitaceae
Cissus phymatocarpa Masinde & L.E.Newton
Cissus sylvicola Masinde & L.E.Newton

The 738 taxa (species and subspecies) recorded come from 105 families, including 4 species of Pteridophyte and 73 monocotyledons. The largest family recorded was Rubiaceae with 83 taxa, followed by Leguminosae: Papilionoideae with 43 (Table 7), although the Leguminosae combined have the largest total at 96 taxa. [Leguminosae is treated throughout this report as three separate familes – Caesalpinioideae, Mimosoideae and Papilionoideae.] Nineteen families had more than 10 taxa. The family with the largest number of new species was Rubiaceae (13), followed by Annonaceae, Compositae, Labiatae, Papilionoideae, Rutaceae and Sterculiaceae with two each.

Family	no. taxa found	no. new species	no. new Moz records
Aracaeae	12	1	3
Orchidaceae	11		5
Acanthaceae	18		2
Annonaceae	23	2	5
Apocynaceae	28		2
Capparaceae	19		2
Celastraceae	14	1	1
Combretaceae	17		
Compositae	11	2	1
Ebenaceae	12		3
Euphorbiaceae	41	1	3
Labiatae	28	2	3
Leg.: Caesalpinioideae	24		2
Leg.: Mimosoideae	29		1
Leg.: Papilionoideae	43	2	3
Rubiaceae	83	13	8
Rutaceae	9	2	2
Sapindaceae	12	1	1
Sterculiaceae	11	2	
Tiliaceae	12		1
Vitaceae	6		2

Table 7.
Number of taxa from the main plant families found in the Cabo Delgado study.

Species Distribution Patterns

Part of the justification for this study was to see if the patterns of local endemism recorded from the Tanzania coast, especially in the Lindi region, are also found in coastal northern Mozambique. To do this properly requires the mapping of distributions of a large number of species using records both from this study and from herbaria elsewhere that have significant coastal collections, such as Kew (K), East African Herbarium (EA), Missouri (MO) and Maputo (LMA). This will take a number of months even though a number of records are available through on-line databases, and is not attempted here. Instead some preliminary observations are given on broad species distribution patterns and differences in this regard between vegetation types.

During the preliminary conservation assessments (see Chapter 'Findings', Section 'Red Data Assessments' p 51), records for seven species known to be restricted to coastal areas were collated and mapped (Fig. 18). From these it can be seen that two species appear to be endemic to coastal northern Mozambique (*Micklethwaitia carvalhoi* and *Thespesia mossambicensis*), one shows a Cabo Delgado–Lindi distribution (*Vismianthus punctatus*), and three show a somewhat broader Tanzania–Mozambique coastal distribution (*Monodora minor, Scorodophloeus fischeri* and *Guibourtia schliebenii*, although the latter is also found inland on the Eastern Arc mountains).

In the course of identification at the Kew Herbarium, it became apparent that there were 13 taxa endemic to coastal northern Mozambique (area Moz N: of Flora Zambesiaca) plus around 27 of the new species (see Annex 3). There are also 53 taxa known primarily from northern Mozambique and the adjacent areas in south-east Tanzania (area T8 of Flora of Tropical East Africa), showing the strong links between them. Most appear to be local endemics. Annex 3 also lists 11 taxa with wider distributions ranging from central to northern Mozambique to central Tanzania, and a further 46 taxa that appear to be at the southern end of their East Africa (Swahilian) distribution in Cabo Delgado.

It is also apparent that species found in miombo and similar woodland types, and in the fallows, grassland and wetlands, are far more widespread. Many are found across the Miombo Ecoregion of south central Africa (Timberlake & Chidumayo 2001) or even more widely, e.g. *Parinari curatellifolia, Afzelia quanzensis, Brachystegia spiciformis, Uapaca nitida* and *Pseudolachnostylis maprouneifolia*. This is in marked contrast to the local distribution of so many dry forest species. An interesting exception is *Berlinia orientalis*, which commonly occurs in fallows and miombo woodland (and sometimes in dry forest), but is known only from a limited area of Cabo Delgado across to southeast Tanzania.

Future work will probably confirm these distribution patterns and show the very marked East African coastal element in the overall distribution of the dry forests of the study area, with particularly strong links to that found in the Lindi–Mtwara region of southeast Tanzania, whilst also showing that the woodland and grassland flora has a much wider distribution. The Lindi area has previously been suggested as a local centre of endemism (Clarke 2001), which the present findings support.

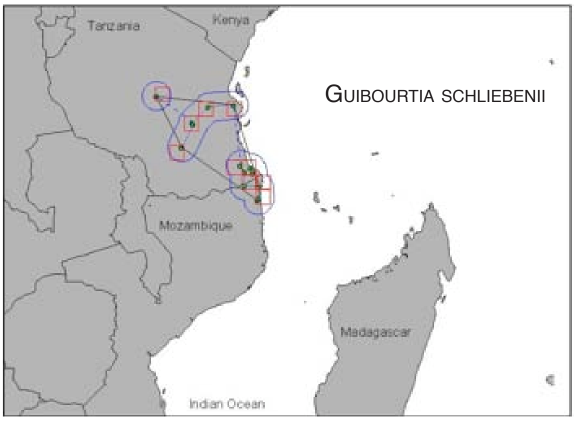
Red Data Assessments

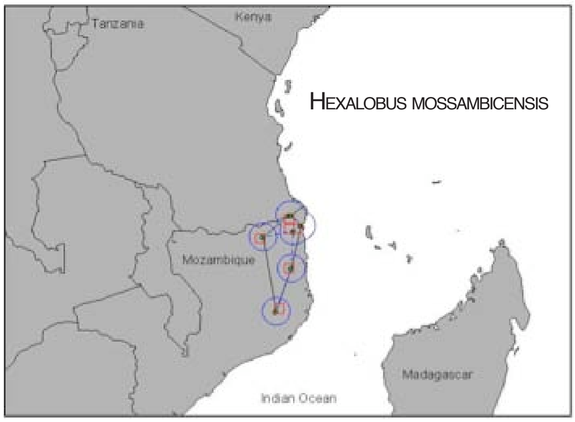
Preliminary conservation assessments to determine IUCN Red Data List categories were carried out on seven woody species known to be confined to the East African coastal region. Species were chosen primarily for their known restricted distribution patterns or their ecological importance. Later, a wider range of species from the area will be assessed and the results compared with any assessments for these species arising from the East African Red Listing process.

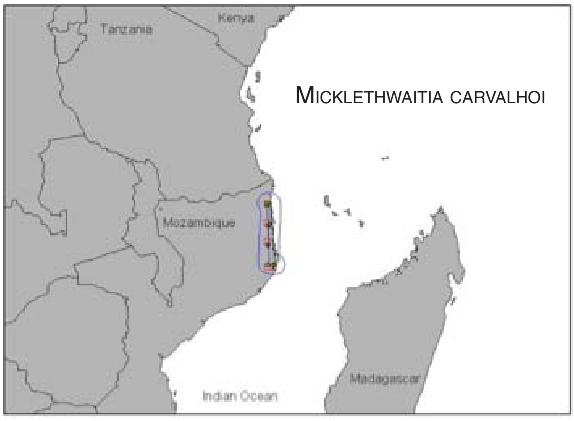
By using the Kew GIS Units extension tool, rapid conservation assessments based on IUCN categories and criteria were produced. The assessments use Extent of Occurrence (EOO), Area of Occupancy (AOO), number of sub-populations and number of locations (see www.kew.org/gis/projects/cats/catsdoc.pdf). Localities or data points were derived from collections made in the course of this study and from other specimens held in the Kew Herbarium, those available through the African Plants Initiative database (http://plants.jstor.org) and from Missouri Botanical Garden's Tropicos database (www.tropicos.org), which also includes specimens from the East African Herbarium (EA), National Herbarium of Tanzania (NHT) and the Dar es Salaam University Herbarium (DSM). The cell size used for AOO was 4 km^2 (2 × 2 km), which is that recommended by IUCN (2008) for restricted distribution species. The total number of records for each species was noted.

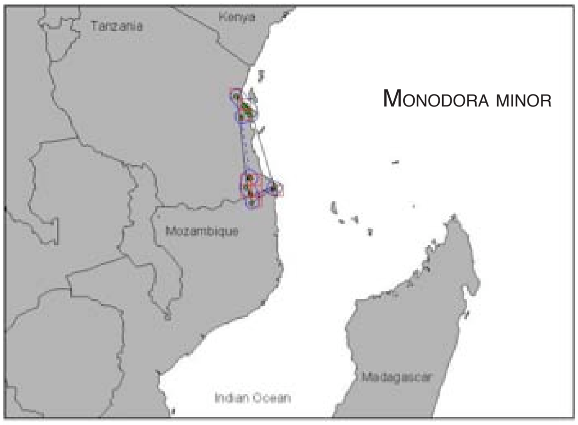
As a result of these individual species assessments, distribution maps (Fig. 18) and IUCN status were produced for each species (Table 8). By using the default 4 km^2 cell size all species were assessed as being Endangered (EN) under IUCN's Red Data categories (IUCN 2001). It should be noted that if a larger cell size was used (e.g. 35–85 km sides), the threat status decreased in most cases to Least Concern. Of the seven species, the most narrowly distributed was the Mozambique endemic *Thespesia mosambicensis*, occurring in only 5 cells, while the other Mozambique endemics *Hexalobus mossambicensis* and *Micklethwaitia carvalhoi* were recorded from only 7 cells. *Scorodophloeus fischeri*, found from N Mozambique to S Kenya, was found in 53 cells.

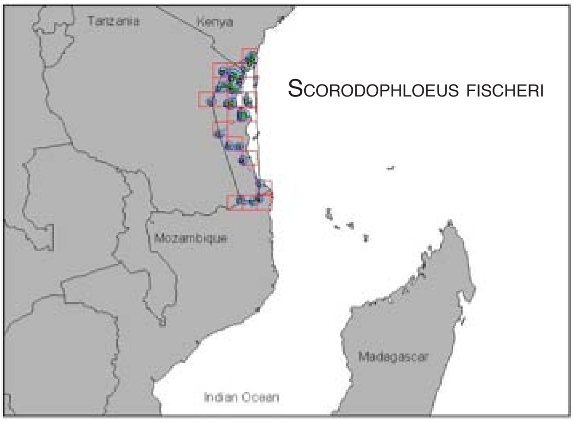
These preliminary assessments are based solely on recorded past and present distribution derived from herbarium specimens. But as we know that their habitat, at least in northern Mozambique, is under marked threat, the Endangered status seems appropriate. It is likely that a number of other dry forest species, once assessed, will have a similar threat status. The new species, at present only known from 1 or 2 localities, are likely to have a higher threat status. However, the great majority of species associated with woodland across the study area are known to have a much wider subcontinental distribution and would undoubtedly be assessed as Least Concern.

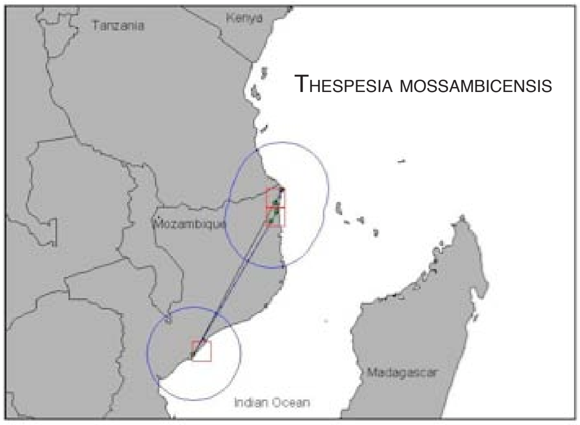












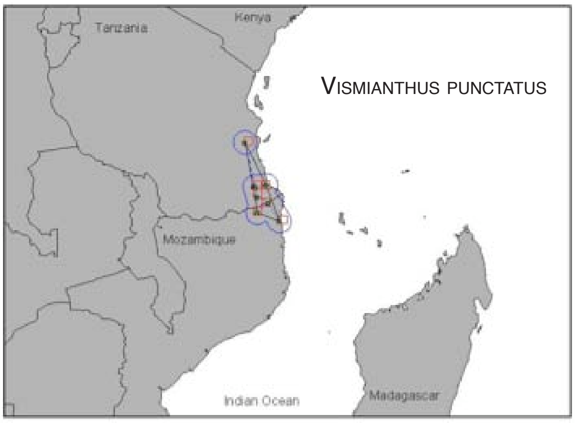


Figure 18.

Distribution records of seven selected coastal plant species for conservation assessments.

black line = extent of occurrence
red squares = area of occupancy using 4 km² grid
blue polygon = extent of subpopulations using Rapoport's mean propinquity technique

Table 8. Preliminary IUCN Red Data status for seven selected eastern African dry forest species.

Family/species	No. records	EOO (km²)	AOO (4 km² cell)	Status
Annonaceae				
Hexalobus mossambicensis *N.Robson*	11	45,043	28	EN
Monodora minor *Engl.& Diels*	23	54,062	68	EN
Connaraceae				
Vismianthus punctatus *Milbr.*	11	22,864	40	EN
Leguminosae: Caesalpinioideae				
Guibourtia schliebenii *(Harms) J.Léonard*	18	164,778	64	EN
Micklethwaitia carvalhoi *(Harms) G.P.Lewis & Schrire*	8	9,502	28	EN
Scorodophloeus fischeri *(Taub.) J.Léonard*	72	137,578	21	EN
Malvaceae				
Thespesia mossambicensis *(Exell & Hillc.) Fryxell*	5	16,416	20	EN

Plot Species Richness

It is often stated that coastal forests can have a high species diversity, yet outside of the Kaya forests of coastal Kenya there do not appear to be counts of specific areas (Quentin Luke, pers. comm.). In order to get an indication of woody species diversity, a 0.25 ha plot was recorded in the «banana» forest (Namcubi forest) at Quiterajo. A 50 × 50 m plot, recorded using four 25 × 25 m subplots, was laid out centred on 11°45'47.1" S, 40°21'42.7" E next to a track through the main forest block. The canopy, which at this semi-leafless time was around 50–60%, was dominated by *Guibourtia schliebenii*, with some emergents such as *Vitex mossambicensis* and *Lannea antiscorbutica*. Numerous sub-canopy trees and shrubs were from 1 to 5 m high. The presence of all recognisable woody species was noted by subplot, and the number of stems recorded that exceeded 6 cm dbh.

Summarised results are given in Annex 4. A total of 46 woody species were recorded from 0.25 ha, of which 35 had at least one individual greater than 6 cm dbh. Given that there were some fairly widespread species seen nearby but not in the plot, and that lianas and cryptic woody species were under-recorded, it would seem that the mean woody species diversity in this forest is probably around 50–60 species/ha. Although comparative figures for other dry forests have not been seen, this figure is thought to be within the range for dry forest, higher than for many areas of miombo woodland across the Flora Zambesiaca region, but lower than those for moist forest.

There were 332 stems greater than 6 cm dbh, suggesting a mean density of 1328 stems/ha. The main species by far was *Guibourtia schliebenii* (equivalent to 284 stems/ha), followed by the sub-canopy trees *Warneckea sansibarica* (140 stems/ha) and *Rinorea angustifolia* (128 stems/ha), *Xylopia* sp. nov. (120 stems/ha), *Memecylon natalense* / *M. flavovirens* (92 stems/ha), and *Vitex mossambicensis* (72 stems/ha).

COASTAL FORESTS ACROSS EAST AFRICA

General Comments

We do not attempt here to compare coastal forests in Cabo Delgado with those further south in Nampula and Zambezia Provinces, or those to the north in Tanzania and Kenya. It is planned to look at such similarities and differences in vegetation types, species composition and distribution at a later stage. However, here we do try to place the figure for extent of coastal forests in Mozambique in a regional perspective, particularly as it has often been stated that northern Mozambique holds the largest coastal forest extent in Eastern Africa.

In this study it became clear that the remaining coastal forests in Cabo Delgado are generally dry and often sclerophyllous, quite different from the moist coastal forests found in north-east Tanzania and south-east Kenya (see Moomaw 1960, Robertson & Luke 1993, Hawthorne 1993, Burgess & Clarke 2000). Hawthorne clearly points out the difference in composition between what he terms Dry forest and Moist forest in this northern area, and suggests that in East Africa coastal forests are in fact a mosaic of a number of structural types, and not all are «forest» using standard physiognomic definitions. He also lists the phytogeographical affiliations of a number of species from forests in Tanzania north of the Rufiji River and southern Kenya. Clarke, Vollesen & Mwasumbi (2000) list 780 endemic plant taxa recorded from the Swahilian Regional Centre of Endemism (his Appendix 3), a geographical entity that is broader than just coastal forest, but he suggests there are at least 4500 plant taxa in this phytogeographical area, with an estimated 3000 found in coastal forests. Although coastal forests south of the Rufiji are generally much drier than many in northern Tanzania (Clarke 2000b), they are still species-rich with many local endemics (e.g. Bidgood & Vollesen 1992, Clarke 2001).

Geology & Geomorphology

Hawthorne (1993) uses geology and geomorphology as much as vegetation physiognomy and composition in his definition of coastal forests. He defines «coastal» as lying on sedimentary (or volcanic) sediments of the coastal plains and plateaux, excluding any vegetation formations on exposed Basement Complex substrates. This is essentially the same as the limits used in this study. Using this definition, the possible extent of coastal forests in Mozambique north of the Zambezi River is limited, with the present study area having by far the largest suitable extent.

Comparisons of geology between the dry forests of northern Mozambique and those of Tanzania, especially in the area south of the Rufiji River, are not easy owing to difficulties for us in obtaining appropriate maps and literature. However, from the Tanzanian geological map (BRGM 2004) and the chapter on geology and geomorphology in the IUCN coastal forests book (Clarke & Burgess 2000), it is possible to make the following observations.

Whereas in northern Mozambique the remaining coastal dry forests seem confined to a particular, relatively recent and acidic strata (the Mikindani Formation of mid-Neogene age), in southern Tanzania the mapped forest patches occur on a wider range of substrates (Clarke & Burgess 2000). These range from Jurassic (208–145.6 Mya) through Cretaceous (145.6–65.0 Mya) to Neogene (23.3–1.64 Mya) in age, but with a major proportion on sediments from the more recent Neogene period. These sediments seem to be principally marine, lacustrine or fluvio-marine deposits, and are probably mostly sandstone or similar rocks. Available maps do not give a more detailed subdivision of strata or allow for location of forest patches on specific strata. However, this difference may be a result of differing definitions of what comprises coastal forest.

It would seem that along the East African coast there have also been various inundations of older sediments by the sea over the last 5–10 million years, further complicating the mineral and nutrient status of their soils (Clarke & Burgess 2000).

More careful mapping is required to determine which geological strata the dry forest patches occur or occurred on, their geomorphological position (which part of the landscape they sit in), and the depth, drainage status, pH and nutrient status of the soils on which they occur. This would be a most valuable predictive tool to indicate what the original extent of dry coastal forest might have been.

Remaining Distribution of Coastal Forests

The earliest clearly measured figure (as opposed to gross estimate) for the extent of remaining coastal forest in Mozambique is 4780 km² (Conservation International, Hotspots Revisited in Burgess *et al*. 2004a). Shortly afterwards WWF (Eastern Africa Coastal Forests Ecoregion, WWF EARPO, 2006) estimated that Mozambique had 4180 km² of closed canopy coastal forest out of 6260 km² found along the entire East African coast from southern Somalia to southern Mozambique, compared to a much lower extent of 1050 km² in Kenya and 970 km² in Tanzania (Table 9). An earlier publication from Conservation International (Hotspots, Myers *et al*. 1999) gave a much lower estimate of 3000 km² of lowland coastal forest along the whole East African coast (1400 km² in Tanzania/Kenya and suggesting around 1600 km² in Mozambique), while WWF's Terrestrial Ecoregions of Africa (Burgess *et al*. 2004b) estimated approximately 1000 km² in the northern Zanzibar–Inhambane Coastal Forest Mosaic (Somalia, Kenya, Tanzania) plus approximately 4000 km² in the Southern Zanzibar–Inhambane Coastal Forest Mosaic (Tanzania, Malawi, Mozambique), with the majority of this in Mozambique. In the Eastern Africa coastal forests book, Burgess *et al*. (2000, p.78) give a figure of 1790 km² of coastal forest in Mozambique (based on Burgess & Muir 1994). The original figure of 4583 km², on which they presumably based this estimate, came from FAO's Mapa Florestal (1980), which included many areas that are demonstrably dense woodland and not coastal or with the type of species composition that this study has been looking at.

Table 9. Extent of coastal forest (with varying definitions) along the East African coast and in Mozambique.

Extent in East Africa (km²)	Extent in Moz. (km²)	References	Notes
	4583	FAO 1980	includes dense woodland & moist forest
3000	1600	CI - Myers *et al.* 1999	
3171	1790	Burgess & Clarke 2000	Moz figure adapted from FAO
5000	?3000	WWF - Burgess *et al.* 2004b	no figure given for Moz
6259	4780	CI - Burgess *et al.* 2004a	GIS-derived?
6260	4180	WWF-EARPO 2006	GIS-derived?

However, it is not clear how most of these very varied figures were obtained. Nor has it been possible to locate a map showing in detail where this extent in Mozambique lies in order to get an indication of the proportion that might occur in the Cabo Delgado study area.

From what are really sketch maps in WWF EARPO (2006)[1] , it would appear that a third to a half of coastal forest shown for Mozambique lies within the present study area. The WWF EARPO figures above therefore suggest there should be around 1400–2400 km² of coastal forest in Cabo Delgado, whereas our figures (± 400 km², chapter 'Findings', section 'Past and present extend of forest' p40) show only a third to a sixth of this. Clearly, the extent of coastal forest in northern Mozambique has been greatly over-estimated. Our gross estimate, based on WWF EARPO's more realistic figures for Kenya and Tanzania, plus revised figures of 700 km² for Mozambique (based on 400 km² in Cabo Delgado and an assumed 300 km² further south), indicates that northern Mozambique probably supports around 15% of a total of 2600 km² of coastal forest remaining along the East African coast.

Although Cabo Delgado Province supports perhaps the main blocks of coastal forest in the country (depending on whether the moist Cheringoma woodlands/forests south of the Zambezi River are defined as coastal forests), smaller areas of what are definitely coastal dry forest occur in Nampula Province (Nacala, Mossuril), in a narrow band along the coast from Angoche to Pebane in Zambézia Province, with perhaps a similar extent along the coast in Inhambane Province.

[1] This WWF map mistakenly shows a number of forest woodland and moist forest reserves in Mozambique (e.g. Moribane, Baixa Pindo, Nangade area, Naipoto) as being «coastal forests». These are not coastal but lower altitude moist forests of the continental interior. Because of their lower altitude and not-excessive distance from the coast, they may contain some tree species that are found in moister coastal forests but, unless such species are dominant, this does not mean they are coastal forests. In addition, very little of the 7500 km² of the Quirimbas National Park is dry forest as depicted, but the Palma forest area is more extensive than shown. If these erroneous areas are excluded, about 40% of the broadly-defined coastal vegetation areas shown for Mozambique are in Cabo Delgado

CONSERVATION

Background

The First National Report on the Conservation of Biological Diversity in Mozambique (MICOA 1997) did not mention coastal forests or their biological significance, nor did the more recent national strategy produced through IUCN (Républica de Moçambique 2003). However, more recent documents coming from official sources (e.g. Fourth National Report on Implementation of the Convention on Biological Diversity in Mozambique, 2009) do refer to the coastal forests as an important conservation objective. Their importance is now gradually being recognised.

A new national conservation policy for Mozambique has been drawn up (MICOA 2008) and has recently been gazetted (Boletim da República, 1º Séries, no. 43 of 2 Nov. 2009), although the legislation is not yet in place. Hence conservation areas are still administered through the Forest and Wildlife law, which only recognises National Parks, National Reserves, Zones of Use and Sites of Historical or Cultural Value. The new strategy clearly lays out the revised scheme and categories for protected areas following the IUCN Protected Areas categories, and also the criteria required to qualify. For example, Technical Annex 5 shows the difference between Total Reserves, National Parks and Special Reserves. However, it is not clear where existing or proposed Forest Reserves (which fall under the responsibility of the Department of Forestry of the Ministry of Agriculture) fall. One fundamental point made clear in the legislation is the necessity for involvement and agreement of local communities and local government (i.e. the District and Provincial authorities) in any gazetting or management.

At present, the Ministry of Environment (MICOA) is the 'umbrella' ministry for coordination of all environmental, biodiversity and conservation issues, although responsibility for implementation and management lies with other ministries. National Parks, National Reserves and hunting areas (coutadas) are the responsibility of the Ministry of Tourism (MITUR), while management outside conservation areas falls under the National Directorate of Land and Forest in the Ministry of Agriculture, including existing Forest Reserves and wildlife ranches (fazendas do bravio). Hence any suggestions or proposals for conservation in Cabo Delgado need to be carefully thought through as to their extent and objectives before suggesting suitable categories for designation.

Existing Conservation Areas

In recent years MICOA put forward a proposal for the proclamation of the Reserva Nacional de Palma (MICOA 2006), although the justification for this was based primarily on coastal and marine conservation concerns rather than on terrestrial biodiversity. The proposed reserve of 2352 km^2 would cover the islands and immediate coastline from 11°10’ S north to the Rio Rovuma, and then inland in a broad swathe along the Rovuma valley and escarpment to Nhica do Rovuma (Fig. 19). This area would include some of the largest and best remaining coastal forest blocks northwest of Quionga (Rio Luvumba/Mavanga area), although the biodiversity descriptions given in the justification are not explicit. The mix of forest, miombo woodland and seasonally-flooded grassland in the area is, however, brought out. It is not known what has happened to this proposal, and whether it is still being pursued.

Figure 19. Map of proposed Reserva Nacional de Palma (MICOA 2006).

More attention has been given in recent years to another series of similar proposals to create a trans-frontier conservation area extending roughly from Palma to Mtwara in southern Tanzania. The main driving forces for this appear to be the protection of the rich coastal and marine biodiversity (including coral reefs and mangroves) of the Rovuma mouth and associated islands from damage due to increasing levels of oil and gas exploration, and the desire to protect and allow large mammal populations (elephant, lion, etc) to move between the two countries. This would also perhaps be able to link in with the two large protected areas of the Niassa National Reserve in Mozambique and the Selous Game Reserve in Tanzania. It is not clear at what stage such plans are, although the Artumas environmental impact statement (EIS) certainly took them into account (Impacto 2007) and WWF Mozambique is seeking funding (Rosalind Salter, pers. comm. Nov. 2010) to take this forward.

A large new national park, the Quirimbas National Park, was created in Cabo Delgado in 2002, covering 7506 km^2 including a large area on the mainland plus numerous islands and marine areas. The Park extends from just north of Pemba along the coast to the towns of Mipando and Macomia in the north, and to around 150 km inland beyond Meluco town. Management of this extensive area, within the boundaries of which at least 55,000 people live (Ministry of Tourism 2006), has been extensively supported by the French development and environmental agencies AFD and FFEM, the Danish agency DANIDA, and the World Wide Fund for Nature (WWF).

Much of the eastern part of the Quirimbas National Park lies within our study area. However, as little coastal forest was noted to lie within its boundaries (just a few small patches such as that at Lupangua), most of the project's efforts were directed towards areas further north.

Within the broad study area there are also two other protected areas – the Maluane Wildlife Conservancy and a wildlife hunting concession, along with a number of forestry concessions (Fig. 20). In both cases, although management is not primarily focussed on vegetation and plant diversity, there is some level of control and a basis on which to build future conservation initiatives, especially with Maluane.

The Maluane Conservancy is a privately-managed tourism concession in the Quiterajo area ("Game Farm" in Fig. 20) where wildlife is actively protected and tourism is considered to be a major form of land use. Game guards are employed and are active in stopping poaching and unauthorised extraction of natural resources. One of our main study sites lies in this concession.

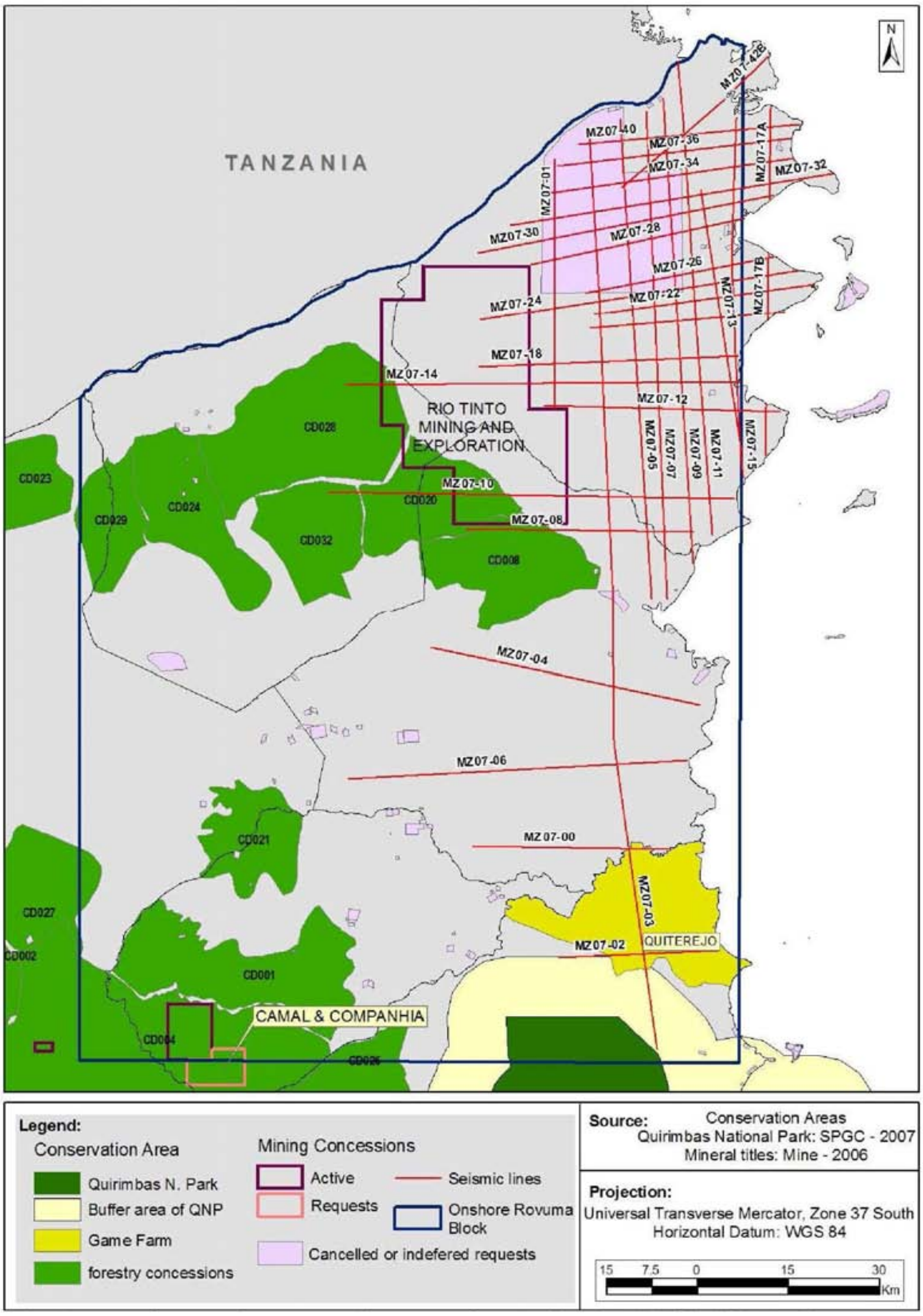


Figure 20. Conservation areas, forestry and mining concessions in north-eastern Cabo Delgado, with oil exploration cut-lines shown (source: Impacto 2007).

At least one managed hunting concession, with a semi-permanent camp, resident manager and staff, is found along the Rovuma escarpment north-west of Pundanhar (not shown in Fig. 20, but north of CD028). The concessionaire employs game scouts and tries to control poaching in the area, both of wildlife and timber.

Conservation Threats

The study area has been settled for centuries and the Rovuma valley has been a trading route, probably dating from before the Portuguese arrived on the coast in the early 1500s. Certainly from Livingstone's time up until the First World War, it was a significant route into the interior (see Last 1887), whilst slave traders used the ports during the 19th century (O'Neill 1883). In addition, both gum from *Hymenaea verrucosa* (gum copal) and latex from *Landolphia* lianas ('African rubber') were major items of trade, and collection of these products may well have had a significant local effect on vegetation. According to White & Moll (1978), by the beginning of the 20th century much of the natural vegetation of the Indian Ocean coastal regions had already been replaced by "secondary fire-maintained grassland and wooded grassland". However, it is likely that this transformation was primarily confined to the coastal strip and did not extend significantly into the densely wooded and forested interior. Cultivation and settlement further inland is likely to have been localised and confined to areas with good access to perennial water and where the vegetation was more open and soils more suited to low-input agriculture.

With increasing development by the Colonial authorities in the 1950s after the Second World War, forest exploitation through selective logging became much more widespread, particularly focussing on *Pterocarpus angolensis* (umbila), *Millettia stuhlmannii* (panga panga, jambire), *Afzelia quanzensis* (chanfuta), *Swartzia madagascariensis* (pau ferro), *Dalbergia melanoxylon* (pau preto) and *Milicia excelsa* (tule). This is likely to have had a major effect on vegetation structure across parts of the study area, effects that can still be seen now.

During the Independence war in the 1960–70s, much military infrastructure was put in along the frontier, including roads, airstrips, barracks and minefields. All these had a significant local impact on vegetation in areas along the Rovuma rim, while the roads facilitated subsequent development after Independence. The new government's policy of villagisation also created marked local impacts through radiating clearance for agriculture. Logging also underwent a resurgence at this time after the hiatus provided by the insecurity of the war years.

In recent years, since the end of the civil war in 1992, the threats have been of four main types: (a) immigration and increased settlement, resulting in extensive clearance for arable fields; (b) extensive and often uncontrolled or illegal logging for timber; (c) exploration for oil and gas; and (d) wild fires. These are elaborated upon below. The first has also resulted in increased human–wildlife conflict, primarily with elephant and lion, which compounds the current pressures on biodiversity.

EXPANDING SETTLEMENT AND AGRICULTURE

Since the end of the civil war, particularly over the last decade, local populations have been moving away from the coastal margins into the wooded and forested interior of the coastal plateau. This movement is primarily along roads and passable tracks, also including those constructed for oil and gas exploration. How much of this settlement is completely new, and how much consists of people returning to places they had been before the wars, is not clear. However, it is apparent that the present settlement is more permanent and intensive than was the case previously.

Areas of significant settlement in recent years are along both sides of the Mocimboa–Palma road down to the coast, and in the Pundanhar area (Fig. 21). What was obviously extensive woodland and forest between Mocímboa and Palma has now been mostly destroyed, with significant differences being seen by us over the 18-month period of our visits in 2008–9.

Figure 21.
Dry forest clearance and burning, Palma area (left) and Nhica do Rovuma (right).

The Mueda plateau is now almost wholly transformed, something that has probably occurred over the last 100 years. From the topography and soils, the area should have been dense miombo woodland with patches of dry forest, but it is now mostly fields and fallows. Some early plant collections from the area show dry forest species in areas that are now cleared. There are likely to be some remaining patches of good vegetation, especially on the escarpment and on the eastern slopes away from roads, but it would appear that there is now little of biodiversity conservation interest left.

Previous agriculture appears to have been somewhat itinerant, with slash & burn practices, little stumping, and extensive fallows. This does not seem to be so much the case now, with more stumping practised and more continued use of areas than previously. It is not clear to us the extent to which vegetation returns to what it was before being cleared if only slash & burn practices are used. Woodland, with its deep-rooted coppicing species, probably returns to something approaching its 'original' state in terms of composition and structure within 50–100 years. But this is unlikely to be the case with dry forest, which primarily consists of non-coppicing and more shallow-rooting species. It is also not clear to what extent the remaining dry forest patches are 'original' or have been subject to historic clearance. Certainly, the age structure of the dry forest patches, with few if any large-boled trees, suggests an age of only 50 or so years. But this may well be a natural feature.

LOGGING

There are a number of forest concessions across the study area, with some large blocks east and south-east of Lake Nangade on the headwaters of rios Uncundi and Matapata (see Fig. 20). Although these are sometimes termed 'protected areas' and the level of offtake and measures to ensure sustainability are part of the lease agreement, it is unlikely that there is any significant conservation-orientated management occurring here. In practice it is probably an area where all marketable trees are removed. Logging tracks also act as a means for illegal hunters to operate easily, and also encourage the spread of small arable fields.

Illegal logging and hunting, often emanating from or linked to Tanzania, is by its very nature unplanned and not easy to control. It also seems to be linked to Chinese companies with the timber destined for that country (see Mackenzie 2006, Chilalo 2008, Mackenzie & Ribeiro 2009).

The main targeted timbers now, at least in the area north of the Rio Messalo, are primarily woodland, not forest, species – *Pterocarpus angolensis*, *Afzelia quanzensis* and *Millettia stuhlmannii*. Over the last 50 years there appears to have been extensive and heavy exploitation of large trees in the somewhat moister forests on the slopes of the Messalo valley around Chitunda and Chai, to the point where the previous forest or woodland structure is only discernable from a few large remnant trees – these forests have effectively been destroyed, probably past any potential point of recovery.

The extent of the present logging threat into the Palma–Rovuma area is not clear; presumably it is closely linked to accessibility via motorable tracks and proximity to a point of export, whether a port or across the border in Tanzania. Certainly there was evidence of *Afzelia* and *Pterocarpus* trees being freshly cut in both the Pundanhar area and in Quiterajo (Fig. 22), and large numbers of logs were seen stacked in yards of commercial enterprises on the roads into Pemba and Mocímboa da Praia.

Figure 22.
Recently cut *Afzelia* tree, dry forest near Quiterajo.

OIL AND GAS EXPLORATION

The presence of gas and oil deposits in the Palma area has been suspected for many years but it is only since 2007 that active exploration on land has occurred, although a test well was drilled in 1986 (Smelror *et al.* 2006). In 2008 a network of cut-lines, each between 3 and 5 m wide to allow for vehicle access, was made by the exploration company Artumas across the northern part of the study area (see Figs. 20 & 23). An initial environmental impact study was made (Impacto 2007), but the recommendations made as regards coastal forests were very basic. After seismic exploration was carried out, the cut-lines were "sealed" using cut branches to stop subsequent human access, and ditches were dug across access points (Fig. 24). However, this "sealing", from what we could see, was not always adequate in areas away from the entrance points. In addition, as the dead branches rot away the tracks will become more accessible to bicycles and vehicles, although there is now also significant regeneration of woody plants from cut stumps.

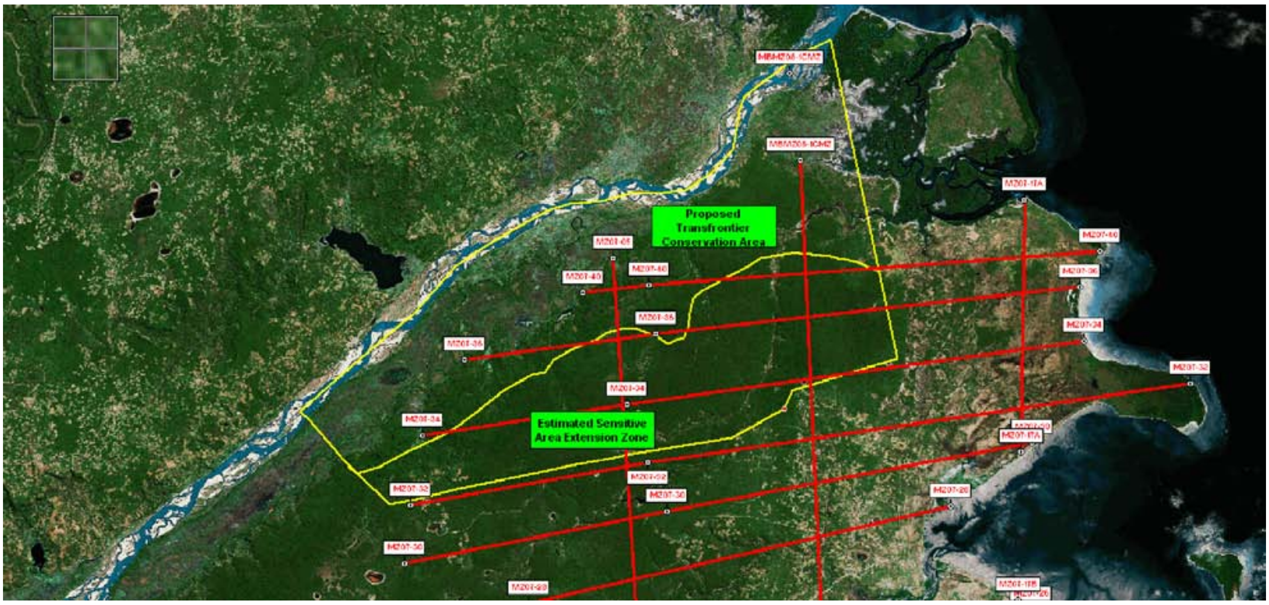


Figure 23. Prospecting cut-lines, part of proposed Transfrontier Conservation Area, and extension of Sensitive Area Zone, 2008 (source: Artumas Exploration).

The conservation threat is not from the actual area cut, which is minimal, but from the fact that a number of forest and dense woodland areas are now becoming potentially accessible to settlement and hence are under threat of being cleared for fields. In addition, some tracks that were thought locally to be mined and dangerous were cleared.

Figure 20 shows another mining concession within the northern part of the study area. This is held by Rio Tinto but we have not been able to determine what mineral they may be interested in. That concession sits across the main area of pans and grassland, and extends in the north into good dense dry forest.

Figure 24.
Prospecting cutline 'sealed off' using bulldozers and cut branches, Palma area.

Exploration operations have resulted in a small economic boom in Palma. But the associated development and population growth will put further pressure on the surrounding habitat as the need for charcoal and agricultural land increases.

WILDFIRE

Despite relatively high humidity for much of the year, there is still a significant dry season when the risk of fire and fuel loads are high. Wildfires are very extensive across the study area, more so on the periphery of newer-settled localities, and result from uncontrolled burning associated with the slash & burn of newly-cleared fields and from fires set for hunting or to make travel through grassy areas easier. Fire is used widely and indiscriminately, and there appear to be no formal sanctions applied against those responsible, although it is technically illegal to set fires away from fields.

The vegetation of the area has evolved and developed with fire, but these fires were probably much less frequent and extensive in the past. Woodlands with their well-developed grassy layer are prone to burning, but are quite resilient to most fires in terms of species composition. Dry forest is unlikely to have evolved with fire as fuel loads are generally insufficient – fires cannot enter far into a patch unless there is a good litter layer. Whether dry forest was ever regularly subjected to fire, or what the effects of fire on it might be, needs further investigation.

What is notable is that the forest/woodland and woodland/grassland boundaries are becoming increasingly "hard" and fixed in the face of more frequent burning.

Conservation Approach

The suggested approach to conservation taken here is two-fold. Firstly to try and build on existing areas that have some form of conservation or potential for conservation management, and secondarily to identify a range of sites across the study area within which a significant range of biodiversity could be protected. As mentioned earlier, there are some existing protected areas or areas where conservation management could be brought in under existing regulations. Existing protected areas are found in the Quirimbas National Park and the Maluane concession in Quiterajo, while there are various forest concessions across the area (Fig. 20) and at least one hunting concession in the Pundanhar–Nangade area. Although management of such areas is predicated on extraction or exploitation of renewable natural resources, this is meant to be sustainable and done under an approved and monitored management plan.

The second part has been done by using the model of Important Plant Areas (IPAs). IPAs (Plantlife International 2004) are based on the same concept as Important Bird Areas (IBAs), where the presence of species of global conservation significance, either due to threat status or restricted distribution, using various criteria, help select a "natural" or manageable area, e.g. an existing National Park.

Taking the idea of IPAs further, and once all zoological datas are available, it will be possible to identify Key Biodiversity Areas (KBAs, Langhammer *et al.* 2007). These are sites of global significance for biodiversity conservation and are identified using globally standard criteria and thresholds. They are based on the needs of biodiversity requiring safeguards at the site scale. The criteria are based on vulnerability and irreplacability, both concepts used widely in systematic conservation planning. Area selection is rational, based on knowledge not supposition, is global in context, and the boundaries selected have to be practical for management. The areas can be large, but could also be quite small as long as the target species can be sustained. The idea of KBAs links species-based conservation with habitat-based conservation in a pragmatic way. Although area selection is triggered by species criteria, primarily the presence of globally threatened (CR, EN or VU) or range-restricted species, of which there are many in these coastal dry forests, the actual areas are often delimited by habitat criteria. The term 'range-restricted' has been interpreted in numerous ways, and for plants it has been suggested (IUCN 2008) that these are species with a global range of less than 50,000 km^2, or even much smaller.

The study area is large, diverse, heavily impacted upon in places, and has a moderately large human population. It is also undergoing rapid development, with pressures on natural resources building up on a number of fronts. Hence any areas suggested for conservation need to be carefully selected so as to protect the widest range of biodiversity within a limited area, in particular focussing on those vegetation types or areas that are unique or rare, in particular the patches of coastal dry forest that also support most of the endemic species or species of restricted coastal distribution. However, any area selected for conservation must also be viable, capable of supporting and allowing regeneration of the priority species it contains. It also needs to have boundaries that can be acceptable to local populations and that can be managed. For example, large areas such as the Quirimbas National Park, with over 50,000 people living inside, are very difficult to manage for their biodiversity attributes.

In the southern portion of the study area, given the fairly extensive transformation of the landscape that has already occurred, the best approach to vegetation and plant conservation is thought to be a selection of viable sites containing unique vegetation types and species assemblages. For coastal forests this is often possible as they tend to be fairly restricted in extent and occupy higher parts in the landscape, so are less threatened by human activities 'upstream'. However, in the northern part of the study area, the dry forests, woodlands, termitaria and pans form a complex mosaic across a wider, gently undulating landscape, so there is both a necessity and possibility for landscape-level conservation, encompassing a range of interconnected habitats. This approach is also more appropriate for wide-ranging wildlife such as elephants, sable and roan antelope, and wild dogs. Management under such circumstances, however, is more difficult, but human use and activities – even settlement – are not necessarily precluded, as long as the ecological integrity of the landscape and habitats is not damaged. Hence our suggested approach to coastal forest conservation in Cabo Delgado is two-pronged.... site-level conservation in the southern sector, and larger area or landscape-level conservation in the north.

Below we provisionally identify a set of areas suitable for the conservation of both vegetation and plants across north-east Cabo Delgado. The selection is aimed at conserving a range of vegetation types, with particular reference to dry forests that support species of restricted distribution. Some level of prioritisation is also suggested. Area delimitation is based on available satellite imagery along with field knowledge. As we have physically not visited much of the entire study area, particularly the interior and up on the Mueda plateau, this selection must be considered preliminary. Further reconnaissance and field work may well identify better sites or additional areas.

Proposed Conservation Areas

Although this report has focussed primarily on coastal dry forests, we do not intend to suggest that conservation of any other vegetation type is of lesser importance. However, it is generally true that other vegetation types will contain fewer plant species of restricted distribution. The dry forest areas listed here should be conserved as part of a mosaic or matrix of other associated vegetation types such as woodland. A number of the conservation priority areas suggested below contain a range of vegetation types, with area 14 in particular representing a whole landscape. It is not a case of just conserving dry forests across the study area.

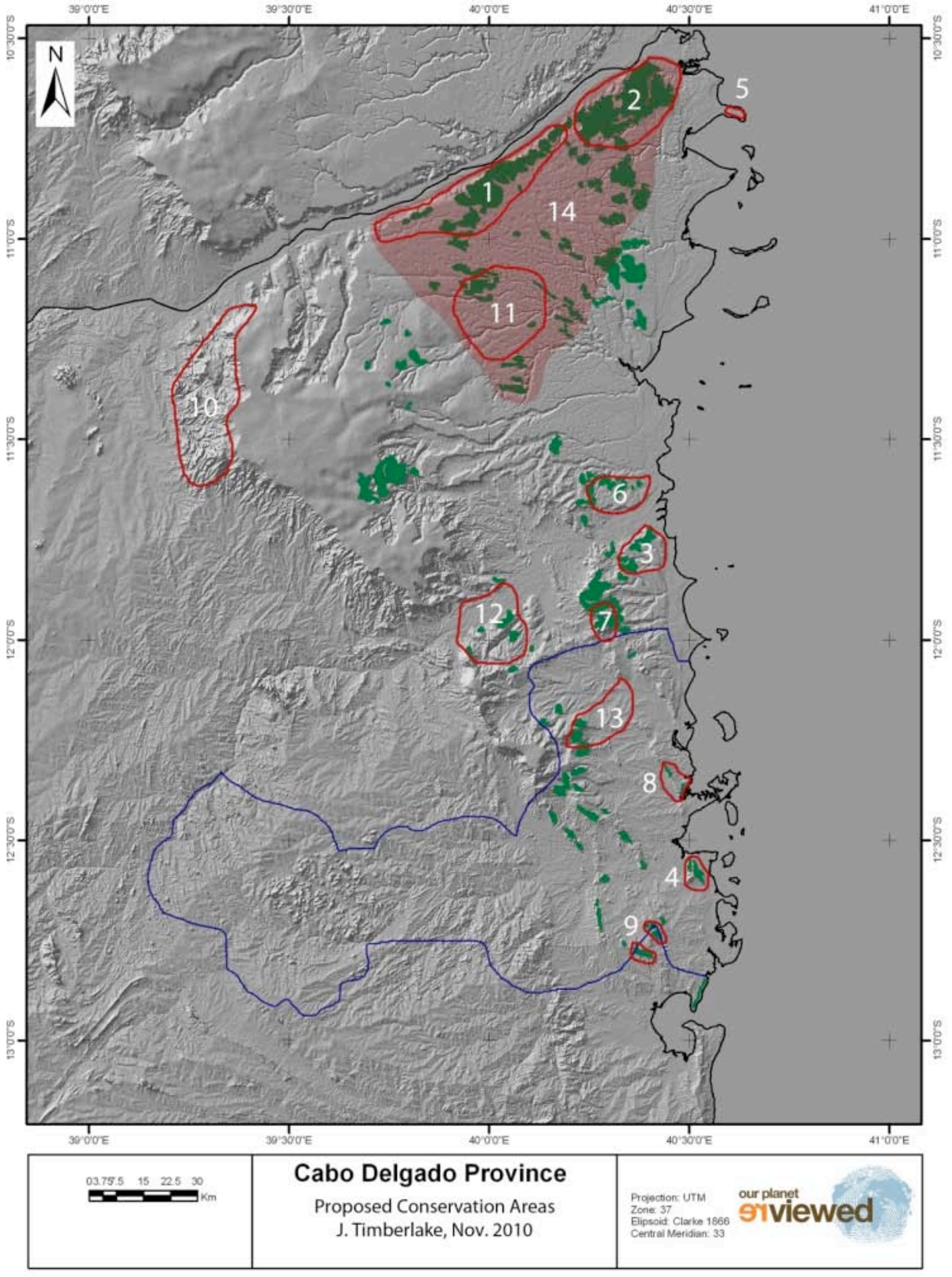


Figure 25.
Proposed areas for biodiversity conservation in NE Cabo Delgado (see text below for numbered area descriptions). Quirimbas National Park boundary is shown in blue.

Nine proposed conservation sites were identified, four of which are considered to be of high priority. In addition five larger areas were delineated that encompass a range of vegetation types, and one large area is suggested for landscape-level conservation. All areas are shown in Fig. 25 and briefly described below.

It should be stressed that the nine sites at present are just candidate areas for evaluation as IPAs. Once species mapping has been finalised it will be possible to confirm their suitablility under this designation.

HIGH PRIORITY SITES

1. **Pundanhar–Nangade**. An elongated area (c. 450 km^2) following the Rovuma rim and escarpment from 10 km east of Nangade to near Nhica do Rovuma. The area contains various types of dry forest, especially those dominated by *Scorodophloeus fischeri*, along with a number of restricted-range dry forest species. Six new species and 13 new Mozambique records were found here. It also contains a number of seasonal pans, miombo woodland, and open palm savanna on alluvium in the Rovuma valley. Part of it is included in an actively-managed hunting concession.

2. **Rio Macanga–Nhica do Rovuma**. A large (600 km^2) block along the Rovuma escarpment from Nhica do Rovuma east almost to Quionga, centred on the Rio Macanga and its tributaries. This is possibly the largest contiguous block of dense vegetation in the study area and is still relatively undisturbed, probably owing to difficulties in access. There are a number of patches of dry forest within it, along with dense woodland, grassy drainage lines and dense mixed woodland to dry forest on the steep escarpment slopes. There were 17 new species found here (6 also elsewhere in the study area) and 30 new Mozambique records. The area also includes palm savanna and alluvial vegetation on the valley floor. No part of it is protected or managed for conservation or sustainable use.

3. **Quiterajo**. An interesting area of c. 125 km^2 within the Maluane concession containing a range of vegetation types including various types of dry forest, miombo woodland, mixed woodland, floodplain grassland, small lakes and grassy drainage lines. Much of this study was carried out in this area, which contains 16 new species (13 of which have not yet been found elsewhere) and 23 new records for Mozambique. There is a large 31 km^2 block ("The Banana") of *Guibourtia schliebenii* dry forest, and a smaller area of *Micklethwaitia carvalhoi* forest near Gaza village, Lake Macungue.

4. **Lupangua**. A relatively small area (25 km^2, of which c. 20 km^2 is dry forest) of intact dry forest on a low hill close to the coast inside the Quirimbas National Park,

near the village of Mahate south of Quissanga. The area has probably been protected by inaccessibility. It contains what is probably the largest population of the Mozambique endemic tree *Micklethwaitia carvalhoi* (Clarke 2010) on the calcareous clay-rich soils. There were 2 new Mozambique records found here and 1 new species (also in Quiterajo).

SECOND PRIORITY SITES

5. **Cabo Delgado peninsula**. A small area (15 km^2) at the end of the Cabo Delgado peninsula north of Palma, including the lighthouse. The vegetation is mostly dry coastal thicket on coral rag, a fairly widespread type along the East African coastline. Here it is in particularly good condition and, given its isolated geographical position, easier to conserve.

6. **Mbau**. An area of c.150 km^2 to the north of the Rio Messalo valley, from 10 km east of Mbau village to within 5 km of the sea and covering the southern tributaries of the Rio Bundaze. Although the area was not visited it is on Mikindani sandstone and appears very similar to the better-studied Quiterajo area south of the Rio Messalo, with a significant extent of dense vegetation up to the escarpment edge, including dry forest. It is relatively undisturbed.

7. **Sakaje plateau**. A relatively small area (46 km^2) on the western and less disturbed part of the Sakaje plateau, 15 km east of Chai. Although attempts were made to reach the area this was not possible owing to lack of usable tracks, but it appears from satellite imagery and aerial survey to consist of thick vegetation with little clearance. There are likely to be patches of dry forest within it with a species composition similar to that found in Quiterajo to the north-east. The steep west-facing scarp, comprised of Mikindani sandstone or similar, protects the area from agricultural encroachment from Chai.

8. **Quissanga**. A small linear area (10 km^2) near the sea next to the Rio Sivuco, 5 km north of Quissanga and opposite Ibo Island. Although not visited on the ground, from the air it has narrow strips of good dense vegetation on two ridges, probably with dry forest species. It appears to be on the same geological formation as the Lupangua area, so is likely to have similar vegetation.

9. **Napuda**. Two relatively small areas (totalling 15 km^2) adjacent to the road leading into the Quirimbas National Park, just south of the Napuda entrance gate. Both comprise remnant dry forest and other dense vegetation on hill slopes of Mikindani sandstone. Although the hills are now being cleared, they have probably been protected by the comparatively steep terrain. In one area visited on the ground *Micklethwaitia carvalhoi* was common.

AREAS WITH A RANGE OF VEGETATION TYPES

10. **Northern Mueda plateau**. An extensive area of around 700 km^2 on the north-western margins of the Mueda plateau, covering a small part of the plateau itself, the (apparently) least-disturbed parts of the west- and north-facing scarp, gullies and some of the footslopes. The vegetation up on the plateau appears to have mostly been cleared and is now open secondary woodland to wooded grassland, but there are probably a number of unusual species on the scarps and in thicker vegetation and woodland on the footslopes. The underlying geology is Mikindani sandstone with older rocks of the Macondes Formation at the scarp base. Although the area was not visited during the current survey, it is possible that some remnants of the original, apparently more mesic dry forest vegetation mentioned in Wild & Barbosa (1968) may still remain.

11. **Rio Uncundi**. An area of around 550 km^2 along the middle reaches of the Rio Uncundi, including part of the catchment of the Rio Injoma, where the districts of Nangade and Mocímboa da Praia meet, 40 km northwest of Mocímboa da Praia town. The vegetation covers a typical cross-section of the undulating landscape on Quaternary alluvium from dense miombo woodlands (probably with small patches of dry forest) on the upper well-drained sands, through more open miombo and similar woodland types to seasonally poorly-drained grassland and drainage lines. There are also a few seasonal pans present. From satellite imagery it appears little of the area has been cleared, but recent encroachment is likely.

12. **Rio Messalo**. An area of 380 km^2 straddling the Rio Messalo where it cuts through the southern part of the Mueda plateau. It covers a range of vegetation types from footslope thicket and dense woodland on dissected terrain of the Macondes Formation through to *Borassus* palm savanna on recent alluvium along the river. The palm stands seen from the air are particularly well-developed. The broken country in the south of the area still retains much vegetation cover and it is hoped that some some remnants of the much moister tall forest once found on the slopes above the Rio Messalo around Chai and Chitunda, now logged almost to extinction, may still be found here.

13. **Mucojo flats**. An area of around 250 km^2 within the Quirimbas National Park straddling the broad valley of the Rio Muàcámula between Macomia and Mucojo. The valley comprises clay-rich Pleistocene deposits, some derived from Tertiary sediments that are particularly calcium-rich, but extends on higher ground to include outcrops of Mikindani sandstone with dense woodland (probably including patches of dry forest). The vegetation across the valley is open *Acacia* woodland to grassland, including *Acacia seyal* and the endemic *Acacia latispina*. It is the largest extent of

clay soils within the study area and is unusual in northern Mozambique.

LANDSCAPE-LEVEL CONSERVATION AREA

14. **Pundanhar–Rio Uncundi landscape**. This extensive area of approximately 4000 km^2 lies on the gently undulating plateau between Nangade, Diaca and Quionga up to the main Mocímboa–Palma road. It is underlain primarily by Quaternary deposits at an altitude of 80–140 m, but with soils derived from Mikindani sandstones to the east and south-east. Owing to the gentle undulations drainage is poor, with numerous seasonal pans present and seasonal drainage lines, together with high water-table grassland and open woodland. The vegetation consists mostly of miombo (*Brachystegia spiciformis*) and similar woodland types on slightly elevated or better-drained areas, and open *Parinari–Uapaca* woodland, grassland and pans where the water table is seasonally high with poor drainage and anaerobic conditions in the rooting zone. On better-drained and coarser-textured sandy soils derived from sandstone towards the Mocímboa–Palma road, denser woodland with patches of dry forest is found. Such areas are particularly well-developed in the north towards the Rovuma escarpment (conservation areas 1 and 2).

The area is only lightly settled, probably owing to difficulties in access, seasonal flooding and generally poor soils. It is said to be a major source of water supplies for the towns of Palma and Mocímboa, and is also known for good wildlife populations, including elephant, lion, roan and sable antelope and wild dog. Sport hunting is one form of land use practiced, while logging was common in the past but has not yet returned to previous levels.

Within this extensive area, much of the most interesting and special biodiversity in northern Cabo Delgado can be found, and it is important to retain the ecosystem functionality of the area. A particular danger is excessive drainage or rapid runoff due to agricultural expansion and extensive and regular burning, which would allow woody encroachment into the grasslands, a lowering of the water-table and hence a reduction in the ecosystem service of regular water supply to the coastal population centres.

CONCLUSIONS

The main findings are summarised below, along with some preliminary observations.

1. Most (but not all) of the coastal forest patches seen in Cabo Delgado are dry 'sand' forests. The patches are dominated by a canopy of early-deciduous and late-leafing tree species, often from the legume sub-families Caesalpinioideae and Papilionoideae, with scattered early-deciduous emergents. There is a major and significant difference in both phenology, species composition and ecological processes from the more familiar moist forests of montane areas in Eastern Africa or lowland forest of West Africa.

2. Dry forest is here defined as a vegetation formation with a relatively tall, closed or almost closed, canopy mostly comprising deciduous species, with sclerophyllous evergreen species in the sub-canopy and a poorly developed herbaceous layer. The species composition is characteristically different at both species and genus-level from the surrounding woodland and grassland. The dominant species do not appear to be deep-rooted, unlike those common in the adjacent miombo woodland. Moist forest formations from the continental interior, even if they contain a few typically coastal species, are excluded.

3. Owing to the high turnover in species composition between forest patches (looked at over a scale of some hundreds of square kilometres), it is very difficult to define coastal dry forests solely on a particular species composition, except at a sub-District scale. The closest linking or common species in this regard in Cabo Delgado is probably *Pteleopsis myrtifolia* (Combretaceae) and perhaps *Manilkara sansibarensis*.

4. There appears to be a strong linkage between the distribution of dry forest and underlying geology and soils. In Cabo Delgado that linkage is to red-brown coarse-textured sandstones of the Mikindani Formation, dating to about 15–10 Mya, which gives rise to coarse-textured, apparently acid and nutrient-poor, moderately

deep, unstructured and well-drained sandy soils. These may well be causative factors. Although some smaller forest areas, for example that at Lupangua, seem to be on a calcareous mudstone formation, not sandstone (Tom Müller, pers. comm.), it seems that the dry forest formations are mostly confined to nutrient-deficient (low P and N) sandy soils, not clays. At a landscape level it is notable that most forest patches are in the upper parts of the catena, usually on the summits of slight rises or in more elevated areas.

5. Particularly in the Palma–Nhica area, dry forests occur in an intimate matrix with miombo woodland and grassland. Forest is found on the highest parts of the catena, woodland on the slopes, becoming increasingly more open as the water table gets closer (at least seasonally) to the surface and with much finer-textured sandy soils, while high water table-dependent (edaphic) grassland is found in the depressions along with scattered trees of *Uapaca nitida* and *Parinari curatellifolia*. Along grassy drainage lines a margin of denser woodland is found, comprising *Brachystegia spiciformis, Afzelia quanzensis* and *Berlinia orientalis*. There is a marked difference in species composition, although not total exclusivity, between woodland and dry forest vegetation types.

6. Once dry forest vegetation is heavily disturbed, there is a tendency for some tree species to coppice, the shrub layer becomes thicker and the area becomes more thicket-like. This is in contrast to moist forest where coppicing does not normally occur.

7. Owing to major disturbance of forest patches in both past and recent times (logging, clearing for mine fields, cultivation), it is difficult to determine what the original distribution (or species composition) of forest might have been across Cabo Delgado. It is not clear whether dry forest was extensive across large areas of the sandstone plateau (which is not that likely), or whether it has always had a patchy distribution, being confined to specific soil/landscape conditions. There is also the issue of the possible extent and importance of secondary invasion by *Brachystegia* and other miombo woodland species into what were dry forest areas. But this is not thought to have been particularly significant.

8. In practical terms, and from the viewpoint of biodiversity values, the presence of dry forest is best determined by the presence of dry forest species assemblages, rather than by physical structure. As it is now difficult to suggest which areas were originally typical forest based on vegetation structure, it is far more useful to look for species assemblages, even if only of coppice growth, to indicate where dry forest areas were.

9. Based on landform and soils, the original extent of "dense vegetation", a combination of dry forest and dense woodland, was estimated at 6080 km^2 across the study area, with by far the greater proportion of this in the northern sector. Of this total, perhaps only 615 km^2 was ever what we now term dry forest.

10. Using satellite imagery it was calculated that only about 1180 km^2 of "dense vegetation" still remained in 2000, indicating a loss over the previous 100–150 years of over 80%. The area of greatest loss was the Mueda plateau (96%), with much lower losses in the north-eastern (Palma–Quionga) sector. The total extent of dry forest, which was only ever a small proportion of "dense vegetation", was estimated to be almost 400 km^2 in 2000, with two-thirds of this associated with the southern margin of the Rovuma valley in the Pundanhar–Quionga–Palma area. Another important block was in the Quiterajo–Messalo area. However, observation on the ground in recent years suggests that this extent of dry forest has been significantly reduced since 2000, perhaps to only 300–350 km^2.

11. Earlier estimates of the extent of coastal forest in Mozambique are confusing as broad and rather uncritical definitions were used. The best available figures are 4870 or 4180 km^2 (WWF and Conservation International). However, given that perhaps half of coastal forest in Mozambique was thought to lie within the present study area, this figure is much higher than our estimates of 400 km^2 still existing in the Cabo Delgado area would suggest.

12. A total of 738 plant taxa were been recorded from the study area by the 2008–2009 expeditions. Together with other collections from 2003 and 2005, 35 of these taxa are thought to be new or undescribed species, and a further 67 represent new records for Mozambique. The family Rubiaceae is the largest in terms of species number (83) and new species (13). The various legume families (Caesalpinioideae, Mimosoideae and Papilionoideae) are also very important.

13. A preliminary analysis of distribution patterns shows that a number of taxa are restricted to NE Mozambique and the Lindi area of SE Tanzania. There appears to be a Rovuma/ Lindi centre of plant endemism, as had been suggested earlier (Clarke 2001), but this needs to be investigated further.

14. A rapid study of forest species diversity in the Quiterajo area showed 46 woody species in 0.25 ha, with 35 species with at least one individual with a diameter greater than 6 cm. Stem density (>6 cm dbh) was 1328 stems/ha, the commonest being *Guibourtia schliebenii* with 284 stems/ha.

15. Given the dominance of forest patches by species of restricted distribution, confined globally to just hundreds or a few thousands of square kilometres, it is unlikely that the species composition of dry forest is secondary, a result of invasion by species previously not present. Dry forest species must have evolved in situ over hundreds of thousands or millions of years and in a similar environment to that found now. However, it could be that present patch dominance is a reflection of past disturbance, with the present dominant species having been present in these dry forests but not as abundant as before. It is interesting to speculate on what might be the causes of the relatively high levels of speciation in the eastern Africa coastal region, and also what might be the driving forces for the high turnover in composition between nearby areas. The substrates involved are not old (in contrast to "old landscapes" in granite areas, Chimanimani Mountains and the Cape) with long stable periods available for evolution to occur. Indeed, further south most coastal forests are on recent Quaternary deposits. To date this feature has not been satisfactorily explained.

16. The main threat to dry forest and other vegetation types of conservation interest is clearance for subsistence agriculture. This is exacerbated by improved access resulting from geophysical prospecting for oil and gas. Illegal logging is also an important threat, although in the northern sector logging was perhaps more damaging during colonial times. Frequent wild fires are a compounding factor in halting regeneration and restoration of dry forest. Once established dry forest is relatively immune to most fires.

17. Given that the major threat to these coastal dry forests is clearance for subsistence agriculture or logging, and improved access to what were hitherto almost inaccessible areas, a socio-economic study needs to be carried out to determine how extensive and strong these threats actually are and what might be the best way to overcome them. Some resource-sharing activities may be possible without destroying the ecological integrity of the selected conservation areas.

18. Fourteen areas of known or possible value for conservation of plant species, vegetation and ecological processes were identified – four high priority areas (Pundanhar–Nangade, Rio Macanga–Nhica do Rovuma, Quiterajo, Lupangua) that should qualify as Important Plant Areas, five smaller areas of second priority, four large areas covering a wide range of vegetation types and ecological processes, and a large area near the Rio Rovuma suitable for landscape-level conservation, including for wildlife populations. Although the selection focusses primarily on coastal dry forests and their species of restricted distribution, associated vegetation types and species should also form part of conservation planning.

RECOMMENDATIONS

These are divided into two categories – recommendations for conservation and similar actions, and recommendations for future studies necessary for effective management.

CONSERVATION

1. A network of areas across NE Cabo Delgado where the conservation of plant and animal diversity is of paramount importance needs to be identified. This has only been provisionally done in this study. Such areas – Important Plant Areas or Key Biodiversity Areas – need to be under Provincial or national government supervision. They must be manageable in practice and have politically-acceptable boundaries.

2. The Instituto de Investigação Agrária de Moçambique (IIAM) in Maputo should now take the initiative to identify potential conservation areas and carry out all necessary investigation and research. The mandate to do this was given in June 2009 by the Minister of Science and Technology in Mozambique.

3. Given that the major threat to these coastal dry forests is clearance for subsistence agriculture or logging, and improved access to what were hitherto almost inaccessible areas, a socio-economic study needs to be carried out to determine how extensive and strong these threats actually are and what might be the best way to overcome them. Some resource-sharing activities may be possible without destroying the ecological integrity of the selected conservation areas.

FUTURE STUDIES

4. There should be further plant collecting at other times of year, particularly in January and May when more herbs and grasses will be fertile. Most survey work that has taken place was in the late dry season and very early rains and gives an incomplete picture.

5. Determine what causes the distribution of dry forest patches and species. This is likely to be a combination of landform and soil type, including particle size distribution, subsoil texture, drainage status, acidity and mineral exchange capacity, but needs to be investigated. Soil scientists and an evaluation of soil and geology are required.

6. Determine how unique the Mozambique dry forests are in terms of composition, structure and ecology compared to coastal forests in Tanzania and Kenya, and particularly to those in the Lindi area. This will involve the GIS mapping of selected individual species using geo-referenced species data, and will be initiated by RBG Kew.

7. Explore the relationship between the coastal dry forests of the East African Coastal Forest Ecoregion and the patchy but widely distributed dry sand forests and thickets across the continental interior to W Zambia (e.g. Itigi thickets in C Tanzania, Mweru-Wantipa thickets in N Zambia, "jesse bush" of the mid-Zambezi valley, *Androstachys* thickets of W Gaza Province, *Baikiaea* thickets of W Zambia and NW Zimbabwe, *Xylia* dry forests of NC Zimbabwe). There appears to be a strong similarity in terms of their structure, ecological determinants and landscape position. From this a greater appreciation of biogeography and regional conservation understanding should emerge.

8. Other research questions that should be addressed in order to guide conservation management are: (a) has the species composition of these forests and their coppicing ability led to their continued existence as forest (rather than thicket) in the face of historical logging and clearance; (b) are they more resilient in the face of fire, or are they essentially "fire-proof"; and (c) is what we see now the "original composition" or the result of past disturbance?

9. The present type of study should be extended to dry forests further south in Mozambique down to the Zambezi River, in particular to the Nacala–Mossuril area and along the coast between Angoche and Pebane. Survey and mapping of these southern areas, where dry forests are known to exist, would provide a firmer basis for a national coastal conservation programme and enable the Mozambican authorities to play a stronger role in regional conservation initiatives (such as the Eastern Africa Coastal Ecoregion Programme of WWF). It would also provide a clearer indication to global conservation bodies such as WWF, IUCN and Conservation International of the important contribution Mozambique provides to one recognised Global Hotspot. At present much of its importance and significance is assumed and not always based on clear evidence.

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ANNEX 1.

List of persons involved in the botanical and vegetation study (fieldwork and identification). Plant identification was done by the RBG Kew Africa Drylands team and other specialists.

Tereza **Alves**, Forestry Research, IIAM, Maputo

Ana-Claudia **de Araujo**, Herbarium, RBG Kew, UK (Cyperaceae)

Aurelio **Banze**, Herbarium, IIAM, Maputo

Diane **Bridson**, Herbarium, RBG Kew, UK (Rubiaceae)

John **Burrows**, Buffelskloof Herbarium, Lydenberg, South Africa

Sandie **Burrows**, Buffelskloof Herbarium, Lydenberg, South Africa

Susan **Carter**, Herbarium, RBG Kew, UK (succulent *Euphorbia*)

Gillian **Challen**, Herbarium, RBG Kew, UK (Euphorbiaceae)

Martin **Cheek**, Herbarium, RBG Kew, UK (*Cola*)

G. Philip **Clarke**, independent botanist, Copenhagen, Denmark

Frances **Crawford**, Herbarium, RBG Kew, UK

Phillip **Cribb**, Herbarium, RBG Kew, UK (Orchidaceae)

Iain **Darbyshire**, Herbarium, RBG Kew, UK

Aaron **Davis**, Herbarium, RBG Kew, UK (Rubiaceae)

Camila **de Sousa**, Dept. Biodiversity & Conservation, IIAM, Maputo

David **Goyder**, Herbarium, RBG Kew, UK

Anna **Haigh**, Herbarium, RBG Kew, UK (Araceae)

Tim **Harris**, Herbarium, RBG Kew, UK

Mervyn **Lotter**, Mpumulanga Parks Board, Lydenberg, South Africa

Quentin **Luke**, Fairchild Botanic Garden, Nairobi, Kenya

Patricia **Luke**, Fairchild Botanic Garden, Nairobi, Kenya

Alice **Massingue**, Department of Botany, Eduardo Mondlane University, Maputo

Hermenegildo **Matimele**, Herbarium, IIAM, Maputo

Tom **Müller**, independent botanist, Harare, Zimbabwe

Olivier **Pascal**, Pro Natura International, Paris

Jonathan **Timberlake**, Herbarium, RBG Kew, UK

Barbara **Turpin**, independent botanist, Mpumulanga, South Africa

Paul **Wilkin**, Herbarium, RBG Kew, UK (monocots)

ANNEX 2.

Checklist of plants collected or recorded during Pro-Natura International Cabo Delgado project expeditions in 2008–2009.

Family	Name	Life form
PTERIDOPHYTES		
Azollaceae	*Azolla pinnata* R.Br.	Aq. fern
Blechnaceae	*Stenochlaena tenuifolia* (Desv.) T.Moore	Fern
Dennstaedtiaceae	*Blotiella natalensis* (Hook.) R.M.Tryon	Fern
Parkeriaceae	*Ceratopteris thalictroides* (L.) Brongn.	Aq. fern
MONOCOTS		
Amaryllidaceae	*Crinum aurantiacum* Lehmiller	Geophyte
Amaryllidaceae	*Crinum stuhlmannii* Baker	Geophyte
Amaryllidaceae	*Scadoxus multiflorus* (Martyn) Raf. *subsp. multiflorus*	Geophyte
Anthericaceae	*Chlorophytum amplexicaule* Baker	Herb
Anthericaceae	*Chlorophytum blepharophyllum* Baker	Herb
Araceae	*Amorphophallus maximus* (Engl.) N.E.Br *subsp. fischeri* (Engl.) Govaerts & Frodin	Geophyte
Araceae	*Anchomanes abbreviatus* Engl.	Geophyte
Araceae	*Culcasia orientalis* Mayo	Vine
Araceae	*Gonatopus angustus* N.E.Br.	Geophyte
Araceae	*Gonatopus boivinii* (Decne.) Engl.	Geophyte
Araceae	*Gonatopus clavatus* Mayo	Geophyte
Araceae	*Gonatopus petiolulatus* (Peter) Bogner	Geophyte
Araceae	*Pistia stratiotes* L.	Aquatic
Araceae	*Stylochaeton borumensis* N.E.Br.	Geophyte
Araceae	*Stylochaeton euryphyllus* Mildbr.	Geophyte
Araceae	*Stylochaeton obliquinervis* Peter	Geophyte
Araceae	*Stylochaeton puberulus* N.E.Br.	Geophyte
Asparagaceae	*Asparagus ?* sp. nov.	Shrub
Asparagaceae	*Asparagus falcatus* L.	Shrub
Asparagaceae	*Asparagus flagellaris* (Kunth) Baker *sens. lat.* *(A. pauli-guilelmii* Solms *form)*	Shrub
Asparagaceae	*Asparagus petersianus* Kunth	Shrub
Commelinaceae	*Aneilema aequinoctiale* (P.Beauv.) Loudon	Herb
Commelinaceae	*Aneilema indehiscens* Faden *subsp. lilacinum* Faden	Herb
Commelinaceae	*Aneilema pedunculosum* C.B.Clarke	Herb
Commelinaceae	*Aneilema petersii* (Hassk.) C.B.Clarke *subsp. petersii*	Herb
Commelinaceae	*Anthericosum* sp.	Herb
Commelinaceae	*Commelina* sp.	Herb

Family	Name	Life form
Commelinaceae	*Cyanotis* sp.	Herb
Commelinaceae	*Murdannia simplex* (Vahl) Brenan	Herb
Cyperaceae	*Bulbostylis* cf. *burchellii* (Ficalho & Hiern) C.B.Clarke	Herb
Cyperaceae	*Cyperus dives* Delile	Herb
Cyperaceae	*Cyperus exaltatus* Retz. *(= C. odoratus* L.*)*	Herb
Cyperaceae	*Cyperus* cf. *hemisphaericus* Boeckeler *(= C. macrocarpus)*	Herb
Cyperaceae	*Cyperus obtusiflorus* Vahl *(= C. niveus* var. *leucocephalus)*	Herb
Cyperaceae	*Cyperus prolifer* Lam.	Herb
Cyperaceae	*Cyperus vestitus* Krauss	Herb
Cyperaceae	*Cyperus zanzibarensis* C.B.Clarke	Herb
Cyperaceae	*Kyllinga* cf. *crassipes* Boeck.	Herb
Cyperaceae	*Rhynchospora candida* (Nees) Boeck.	Herb
Dioscoreaceae	*Dioscorea asteriscus* Burkill	Vine
Dioscoreaceae	*Dioscorea cochleari-apiculata* De Wild.	Vine
Dioscoreaceae	*Dioscorea sansibarensis* Pax	Vine
Dracaenaceae	*Dracaena mannii* Baker	Tree
Dracaenaceae	*Dracaena ? reflexa* Lam.	Tree
Dracaenaceae	*Sansevieria canaliculata* Carrière	Herb
Dracaenaceae	*Sansevieria hyacinthoides* (L.) Druce	Herb
Dracaenaceae	*Sansevieria* cf. *metallica* Gérôme & Labroy	Herb
Eriospermaceae	*Eriospermum abyssincum* Baker	Geophyte
Flagellariaceae	*Flagellaria guineensis* Schumach.	Vine
Hyacinthaceae	*Dipcadi longifolium* (Lindl.) Baker	Geophyte
Hyacinthaceae	*Dipcadi ? viride* (L.) Moench	Geophyte
Hyacinthaceae	*Drimia altissima* (L.f.) Ker Gawl.	Geophyte
Hyacinthaceae	*Drimiopsis burkei* Baker	Geophyte
Hyacinthaceae	*Ledebouria revoluta* (L.f.) Jessop	Geophyte
Hypoxidaceae	*Hypoxis angustifolium* Lam.	Geophyte
Hypoxidaceae	*Hypoxis nyasica* Baker	Geophyte
Iridaceae	*Gladiolus decoratus* Baker	Geophyte
Orchidaceae	*Acampe pachyglossa* Rchb.f.	Epiphyte
Orchidaceae	*Eulophia acutilabra* Sommerh.	Geophyte
Orchidaceae	*Eulophia cucullata* (Sw.) Steud.	Geophyte
Orchidaceae	*Eulophia guineensis* Lindl.	Geophyte
Orchidaceae	*Eulophia livingstoneana* (Rchb.f.) Summerh.	Geophyte
Orchidaceae	*Eulophia longisepala* Rendle	Geophyte
Orchidaceae	*Eulophia penduliflora* Kraenzl.	Geophyte
Orchidaceae	*Microcoelia exilis* Lindl.	Epiphyte
Orchidaceae	*Microcoelia megalorrhiza* (Rchb.f.) Summerh.	Epiphyte
Orchidaceae	*Microcoelia physophora* (Rchb.f.) Summerh.	Epiphyte
Orchidaceae	*Nervilia bicarinata* (Blume) Schltr.	Geophyte

Family	Name	Life form
Palmae	*Hyphaene compressa* H.Wendl.	Palm
Palmae	*Hyphaene petersiana* Mart.	Palm
Tecophilaeaceae	*Kabuyea hostifolia* (Engl.) Brummitt	Geophyte
Zingiberaceae	*Siphonochilus aethiopicus* (Schweinf.) B.L.Burtt	Geophyte
Zingiberaceae	*Siphonochilus kirkii* (Hook.f.) B.L.Burtt	Geophyte

DICOTS		
Acanthaceae	*Barleria repens* Nees	Herb
Acanthaceae	*Barleria spinulosa* Klotzsch	Herb
Acanthaceae	*Blepharis affinis* Lindau	Herb
Acanthaceae	*Brillantaisia riparia* (Vollesen & Brummitt) Sidwell	Herb
Acanthaceae	*Crossandra puberula* Klotzsch	Herb
Acanthaceae	*Dicliptera aculeata* C.B.Clarke	Herb
Acanthaceae	*Dicliptera heterostegia* Nees	Herb
Acanthaceae	*Elytraria acaulis* (L.f.) Lindau	Herb
Acanthaceae	*Hypoestes forskaolei* (Vahl) R.Br.	Herb
Acanthaceae	*Justicia anagalloides* (Nees) T.Anders.	Herb
Acanthaceae	*Justicia fittonioides* S.Moore	Herb
Acanthaceae	*Justicia stachytarphetoides* (Lindau) C.B.Clarke	Herb
Acanthaceae	*Lankesteria alba* Lindau	Herb
Acanthaceae	*Lepidagathis plantaginea* Mildbr.	Herb
Acanthaceae	*Nelsonia canescens* (Lam.) Spreng.	Herb
Acanthaceae	*Neuracanthus africanus* S.Moore subsp. *africanus*	Herb
Acanthaceae	*Ruellia prostrata* Poir.	Herb
Acanthaceae	*Whitfieldia orientalis* Vollesen	Herb
Avicenniaceae	*Avicennia marina* (Forssk.) Vierh.	Tree
Amaranthaceae	*Celosia ? nervosa* C.C.Towns.	Herb
Amaranthaceae	*Celosia* sp. aff. *nervosa* C.C.Towns.	Herb
Anacardiaceae	*Lannea antiscorbutica* (Hiern) Engl.	Tree
Anacardiaceae	*Lannea schweinfurthii* (Engl.) Engl. var. *acutifolia* (Engl.) Kokwaro	Tree
Anacardiaceae	*Ozoroa insignis* Delile subsp. *reticulata* (Baker f.) Gillett	Shrub
Anacardiaceae	*Ozoroa obovata* (Oliv.) R.Fern.& A.Fern.	Tree
Anacardiaceae	*Rhus* cf. *chirindensis* Baker f.	Shrub
Anacardiaceae	*Sorindeia madagascariensis* DC.	Tree
Annonaceae	*Artabotrys brachypetalus* Benth.	Liana
Annonaceae	*Artabotrys modestus* Diels subsp. *macranthus* Verdc.	Liana
Annonaceae	*Cleistochlamys kirkii* (Benth.) Oliv.	Shrub
Annonaceae	*Dielsiothamnus divaricatus* (Diels) R.E.Fr.	Tree
Annonaceae	*Hexalobus mossambicensis* N.Robson	Tree
Annonaceae	*Letowianthus stellatus* Diels	Tree
Annonaceae	*Monanthotaxis buchananii* (Engl.) Verdc.	Shrub

Family	Name	Life form
Annonaceae	*Monanthotaxis faulknerae* Verdc.	Suffrutex
Annonaceae	*Monanthotaxis trichantha* (Diels) Verdc.	Shrub
Annonaceae	*Monodora* cf. *grandidieri* Baill. – flowers v. small	Tree
Annonaceae	*Monodora grandidieri* Baill.	Tree
Annonaceae	*Monodora junodii* Engl.& Diels	Tree
Annonaceae	*Monodora minor* Engl.& Diels	Shrub
Annonaceae	*Ophrypetalum* cf. *odoratum* Diels	Tree
Annonaceae	*Sphaerocoryne gracilis* (Engl.& Diels) Verdc. subsp. *gracilis*	Tree
Annonaceae	*Uvaria acuminata* Oliv.	Shrub
Annonaceae	*Uvaria* cf. *angolensis* Oliv.	Shrub
Annonaceae	*Uvaria kirkii* Hook.f.	Tree
Annonaceae	*Xylopia aethiopica* (Dunal) A.Rich.	Tree
Annonaceae	*Xylopia collina* Diels	Shrub
Annonaceae	*Xylopia parviflora* (A.Rich.) Benth.	Shrub
Annonaceae	*Xylopia* sp. *A of FTEA*	Tree
Annonaceae	*Xylopia* sp. nov.	Tree
Apocynaceae	*Ancylobothrys petersiana* (Klotzsch) Pierre	Liana
Apocynaceae	*Ancylobothrys tayloris* (Stapf) Pichon	Liana
Apocynaceae	*Aspidoglossum biflorum* E.Mey.	Geophyte
Apocynaceae	*Baissea myrtifolia* (Benth.) Pichon	Liana
Apocynaceae	*Calotropis gigantea* (L.) W.T.Aiton	Shrub
Apocynaceae	*Carvalhoa campanulata* K.Schum.	Shrub
Apocynaceae	*Cryptolepis hypoglauca* K.Schum.	Vine
Apocynaceae	*Cynanchum gerrardii* (Harv.) Liede	Vine
Apocynaceae	*Cynanchum viminale* L. subsp. *suberosum* (Meve & Liede) Goyder	Vine
Apocynaceae	*Glossostelma carsonii* (N.E.Br.) Bullock	Geophyte
Apocynaceae	*Holarrhena pubescens* (Buch.-Ham.) G.Don	Tree
Apocynaceae	*Landolphia kirkii* R.A.Dyer	Liana
Apocynaceae	*Marsdenia cynanchoides* Schltr.	Vine
Apocynaceae	*Raphionacme splendens* Schltr.	Geophyte
Apocynaceae	*Rauvolfia ? caffra* Sond.	Tree
Apocynaceae	*Saba comorensis* (Bojer) Pichon	Liana
Apocynaceae	*Schizozygia coffaeoides* Baill.	Shrub
Apocynaceae	*Secamone parvifolia* (Oliv.) Bullock	Shrub
Apocynaceae	*Secamone retusa* N.E.Br.	Vine
Apocynaceae	*Stathmostelma pedunculatum* (Decne.) K.Schum.	Geophyte
Apocynaceae	*Strophanthus courmontii* Franch.	Liana
Apocynaceae	*Strophanthus kombe* Oliv.	Liana
Apocynaceae	*Strophanthus petersianus* Klotzsch	Liana
Apocynaceae	*Tabernaemontana elegans* Stapf	Tree
Apocynaceae	*Tacazzea apiculata* Oliv.	Vine

Family	Name	Life form
Apocynaceae	*Tylophora anomala* N.E.Br.	Vine
Apocynaceae	*Tylophora stenoloba* N.E.Br.	Vine
Apocynaceae	*Voacanga thouarsii* Roem.& Schult.	Tree
Araliaceae	*Cussonia zimmermannii* Harms	Tree
Balanitaceae	*Balanites maughamii* Sprague subsp. *acuta* Sands	Tree
Balanitaceae	*Balanites maughamii* Sprague subsp. *maughamii*	Tree
Balsaminaceae	*Impatiens walleriana* Hook.f.	Herb
Bignoniaceae	*Fernandoa magnifica* Seem.	Tree
Bignoniaceae	*Kigelia africana* (Lam.) Benth. subsp. *africana*	Tree
Bignoniaceae	*Markhamia obtusifolia* (Baker) Sprague	Tree
Bignoniaceae	*Markhamia zanzibarica* (DC.) Engl.	Tree
Bignoniaceae	*? Stereospermum kunthianum* Cham.	Tree
Bombacaceae	*Adansonia digitata* L.	Tree
Bombacaceae	*Bombax rhodognaphalon* K.Schum. var. *rhodognaphalon*	Tree
Bombacaceae	*Bombax rhodognaphalon* K.Schum. var. *tomentosum* A.Robyns	Tree
Boraginaceae	*Bourreria petiolaris* (Lam.) Thulin	Tree
Boraginaceae	*Coldenia procumbens* L.	Herb
Boraginaceae	*Cordia goetzei* Gürke	Tree
Boraginaceae	*Cordia subcordata* Lam.	Tree
Boraginaceae	*Ehretia amoena* Klotzsch	Tree
Boraginaceae	*Heliotropium indicum* L.	Herb
Boraginaceae	*Heliotropium ovalifolium* Forssk.	Herb
Burseraceae	*Commiphora africana* (A.Rich.) Engl. var. *africana*	Tree
Burseraceae	*Commiphora fulvotomentosa* Engl.	Tree
Burseraceae	*Commiphora karibensis* Wild	Tree
Burseraceae	*Commiphora pteleifolia* Engl.	Tree
Burseraceae	*Commiphora serrata* Engl.	Tree
Burseraceae	*Commiphora zanzibarica* (Baill.) Engl.	Tree
Capparaceae	*Boscia angustifolia* A.Rich. var. *corymbosa* (Gilg) DeWolf	Tree
Capparaceae	*Boscia mossambicensis* Klotzsch	Tree
Capparaceae	*Cadaba kirkii* Oliv.	Shrub
Capparaceae	*Capparis erythrocarpos* Isert var. *rosea* (Klotzsch) DeWolf	Vine
Capparaceae	*Capparis separia* L. var. *stuhlmannii* (Gilg) DeWolf	Vine
Capparaceae	*Capparis tomentosa* Lam.	Vine
Capparaceae	*Capparis viminea* Oliv. var. *viminea*	Vine
Capparaceae	*Cladostemon kirkii* (Oliv.) Pax & Gilg	Shrub
Capparaceae	*Maerua acuminata* Oliv.	Shrub
Capparaceae	*Maerua aethiopica* (Fenzl) Oliv.	Shrub
Capparaceae	*Maerua andradae* Wild	Suffrutex
Capparaceae	*Maerua angolensis* DC.	Tree
Capparaceae	*Maerua bussei* (Gilg & Gilg-Ben.) Wilczek	Tree

Family	Name	Life form
Capparaceae	*Maerua grantii* Oliv.	Shrub
Capparaceae	*Maerua kirkii* (Oliv.) F.White	Tree
Capparaceae	*Maerua* sp. aff. *filiformis*	Vine
Capparaceae	*Ritchiea capparoides* (Andrews) Britten var. *capparoides*	Liana
Capparaceae	*Ritchiea pygmaea* (Gilg) DeWolf	Suffrutex
Capparaceae	*? Thilachium africanum* Lour.	Shrub
Caryophyllaceae	*Polycarpon prostratum* (Forssk.) Aschers.& Schweinf.	Herb
Celastraceae	*Brexia madagascariensis* (Lam.) Ker-Gawl.	Shrub
Celastraceae	*Elaeodendron buchananii* (Loes.) Loes.	Tree
Celastraceae	*Maytenus heterophylla* (Eckl.& Zeyh.) N.Robson	Shrub
Celastraceae	*Maytenus mossambicensis* (Klotzsch) Blakelock var. *mossambicensis*	Shrub
Celastraceae	*Maytenus senegalensis* (Lam.) Exell	Shrub
Celastraceae	*Maytenus undata* (Thunb.) Blakelock	Tree
Celastraceae	*Mystroxylon aethiopicum* (Thunb.) Loes.	Tree
Celastraceae	*Pleurostylia ?* sp. nov. aff. *serrulata* Loes.	Shrub
Celastraceae	*Pristimera andongensis* (Oliv.) N.Hallé var. *volkensii* (Loes.) N.Hallé & B.Mathew	Shrub
Celastraceae	*? Reissantia indica* (Willd.) N.Hallé	Shrub
Celastraceae	*Salacia ? leptoclada* Tul.	Shrub/lian
Celastraceae	*Salacia madagascariensis* (Lam.) DC.	Shrub/lian
Celastraceae	*Salacia orientalis* N.Robson	Shrub/lian
Celastraceae	*Salacia stuhlmanniana* Loes.	Shrub/lian
Ceratophyllaceae	*Ceratophyllum demersum* L.	Aquatic
Chenopodiaceae	*Suaeda monoica* J.F.Gmel.	Shrub
Chrysobalanaceae	*Hirtella zanzibarica* Oliv. subsp. *zanzibarica*	Tree
Chrysobalanaceae	*Parinari curatellifolia* Benth.	Tree
Clusiaceae	*Garcinia acutifolia* N.Robson	Shrub
Clusiaceae	*Garcinia livingstonei* T.Anders.	Shrub
Clusiaceae	*Harungana madagascariensis* Poir.	Tree
Clusiaceae	*Psorospermum febrifugum* Spach	Shrub
Clusiaceae	*Vismia ?* sp. nov.	Tree
Clusiaceae	*Vismia orientalis* Engl.	Shrub
Clusiaceae	*Vismia pauciflora* Milne-Redh.	Shrub
Combretaceae	*Combretum andradae* Exell & J.G.Garcia	Liana
Combretaceae	*Combretum butyrosum* (Bertol.f.) Tul.	Liana
Combretaceae	*Combretum constrictum* (Benth.) M.A.Lawson	Shrub/lian
Combretaceae	*Combretum hereroense* Schinz var. *hereroense*	Shrub
Combretaceae	*Combretum holstii* Engl.	Liana
Combretaceae	*Combretum illairii* Engl.	Liana
Combretaceae	*Combretum paniculatum* Vent.	Liana
Combretaceae	*Combretum pentagonum* M.A.Lawson	Liana

Family	Name	Life form
Combretaceae	*Combretum pisoniiflorum* (Klotzsch) Engl.	Liana
Combretaceae	*Combretum stocksii* Sprague	Liana
Combretaceae	*Combretum xanthothyrsum* Engl.& Diels	Liana
Combretaceae	*Combretum zeyheri* Sond.	Tree
Combretaceae	*Pteleopsis barbosae* Exell	Tree
Combretaceae	*Pteleopsis myrtifolia* (M.A.Lawson) Engl.& Diels	Tree
Combretaceae	*Terminalia boivinii* Tul.	Shrub
Combretaceae	*Terminalia kaiserana* F.Hoffm. *?*	Tree
Combretaceae	*Terminalia sambesiaca* Engl.& Diels	Tree
Compositae	*Blumea axillaris* (Lam.) DC.	Herb
Compositae	*Dicoma* sp.	Herb
Compositae	*Eclipta prostrata* (L.) L.	Herb
Compositae	*Lactuca inermis* Forssk.	Herb
Compositae	*Nidorella auriculata* DC.	Herb
Compositae	*Sphaeranthus africanus* L.	Herb
Compositae	*Vernonia ?* sp. nov. aff. *inhacensis* G.V.Pope	Vine
Compositae	*Vernonia amygdalina* Delile	Tree
Compositae	*Vernonia colorata* (Willd.) Drake subsp. *colorata*	Shrub
Compositae	*Vernonia steetziana* Oliv.& Hiern.	Herb
Compositae	*Vernonia zanzibarensis* Less.	Shrub
Connaraceae	*Agelaea pentagyna* (Lam.) Baill.	Tree
Connaraceae	*Rourea coccinea* (Schumach.& Thonn.) Benth. subsp. *boiviniana* (Baill.) Jongkind	Tree
Connaraceae	*Rourea orientalis* Baill.	Tree
Connaraceae	*Vismianthus punctatus* Mildbr.	Shrub
Convolvulaceae	*Bonamia mossambicensis* (Klotzsch) Hall.f.	Herb
Convolvulaceae	*Hewittia malabarica* (L.) Suresh	Herb
Convolvulaceae	*Ipomoea aquatica* Forssk.	Herb
Convolvulaceae	*Ipomoea shirambensis* Baker	Vine
Convolvulaceae	*Xenostegia media* (L.) Austin & Staples	Vine
Convolvulaceae	*Xenostegia tridentata* (L.) Austin & Staples	Vine
Crassulaceae	*Kalanchoe* sp.	Herb
Cucurbitaceae	*Coccinea subglabra* C.Jeffrey	Vine
Cucurbitaceae	*Cucumis hirsutus* Sond.	Vine
Cucurbitaceae	*Eureiandra fasciculata* (Cogn.) C.Jeffrey	Vine
Cucurbitaceae	*Luffa cylindrica* (L.) M.J.Roem.	Vine
Cucurbitaceae	*Momordica trifoliolata* Hook.f.	Vine
Cucurbitaceae	*Peponium leucanthum* (Gilg) Cogn.	Vine
Cucurbitaceae	*Trochomeria macrocarpa* (Sond.) Hook.f.	Vine
Dichapetalaceae	*Dichapetalum barbosae* Torre	Shrub
Dichapetalaceae	*Dichapetalum deflexum* (Klotzsch) Engl.	Shrub

Family	Name	Life form
Dichapetalaceae	*Dichapetalum edule* Engl.	Shrub
Dichapetalaceae	*Dichapetalum macrocarpum* Engl.	Shrub
Dichapetalaceae	*Dichapetalum mossambicense* (Klotzsch) Engl.	Shrub
Dichapetalaceae	*Dichapetalum stuhlmannii* Engl.	Shrub
Dilleniaceae	*Tetracera boiviniana* Baill.	Shrub
Ebenaceae	*Diospyros abyssinica* (Hiern) F.White subsp. *abyssinica*	Tree
Ebenaceae	*Diospyros consolatae* Chiov.	Tree
Ebenaceae	*Diospyros ferrea* (Willd.) Bakh.	Tree
Ebenaceae	*Diospyros kabuyeana* F.White	Tree
Ebenaceae	*Diospyros kirkii* Hiern	Tree
Ebenaceae	*Diospyros loureiriana* G.Don subsp. *loureiriana*	Tree
Ebenaceae	*Diospyros mafiensis* F.White	Tree
Ebenaceae	*Diospyros magogoana* F.White	Tree
Ebenaceae	*Diospyros natalensis* (Harv.) Brenan	Tree
Ebenaceae	*Diospyros shimbaensis* F.White	Tree
Ebenaceae	*Diospyros verrucosa* Hiern	Tree
Ebenaceae	*Euclea natalensis* A.DC. subsp. *obovata* F.White	Tree
Erythroxylaceae	*Erythroxylum emarginatum* Thonn.	Tree
Erythroxylaceae	*Erythroxylum platyclados* Boj.	Tree
Erythroxylaceae	*Nectaropetalum ? carvalhoi* Engl.	Shrub
Euphorbiaceae	*Acalypha racemosa* Baill.	Shrub
Euphorbiaceae	*Alchornea laxiflora* (Benth.) Pax & K.Hoffm.	Shrub
Euphorbiaceae	*Antidesma venosum* Tul.	Shrub
Euphorbiaceae	*Antidesma vogelianum* Müll.Arg.	Tree
Euphorbiaceae	*Bridelia duvigneaudii* J.Léonard	Tree
Euphorbiaceae	*Caperonia stuhlmannii* Pax	Herb
Euphorbiaceae	*Cleistanthus schlechteri* (Pax) Hutch	Tree
Euphorbiaceae	*Cleistochlamys kirkii* (Benth.) Oliv.	Tree
Euphorbiaceae	*Croton kilwae* Radcl.-Sm.	Shrub
Euphorbiaceae	*Croton megalocarpus* Hutch.	Tree
Euphorbiaceae	*Croton menyarthii* Pax	Shrub
Euphorbiaceae	*Croton polytrichus* Pax subsp. *polytrichus*	Shrub
Euphorbiaceae	*Croton pseudopulchellus* Pax	Tree
Euphorbiaceae	*Drypetes arguta* (Müll.Arg.) Hutch.	Tree
Euphorbiaceae	*Drypetes natalensis* (Harv.) Hutch.	Tree
Euphorbiaceae	*Drypetes sclerophylla* Mildbr.	Tree
Euphorbiaceae	*Erythrococca menyarthii* (Pax) Prain	Shrub
Euphorbiaceae	*Euphorbia ?* sp. nov. aff. *ambroseae* L.C.Leach var. *spinosa* L.C.Leach	Succ.
Euphorbiaceae	*Euphorbia lividiflora* L.C.Leach	Succ.tree
Euphorbiaceae	*Hymenocardia ulmoides* Oliv.	Tree
Euphorbiaceae	*Maprounea africana* Müll.Arg.	Tree

Family	Name	Life form
Euphorbiaceae	*Margaritaria discoidea* (Baill.) G.L.Webster var. *nitida* (Pax) Radcl.-Sm.	Tree
Euphorbiaceae	*Margaritaria discoidea* (Baill.) G.L.Webster var. *triphosphaera* Radcl.-Sm. *forma glabra* Radcl.-Sm.	Tree
Euphorbiaceae	*Mildbraedia carpinifolia* (Pax) Hutch. var. *strigosa* Radcl.-Sm.	Shrub
Euphorbiaceae	*Oldfieldia somalensis* (Chiov.) Milne-Redh.	Tree
Euphorbiaceae	*Omphalea mansfieldiana* Mildbr.	Liana
Euphorbiaceae	*Phyllanthus engeri* Pax	Shrub
Euphorbiaceae	*Phyllanthus paxii* Hutch.	Herb
Euphorbiaceae	*Phyllanthus pinnatus* (Wight) G.L.Webster	Herb
Euphorbiaceae	*Phyllanthus reticulatus* Poir. var. *reticulatus*	Tree
Euphorbiaceae	*Pseudolachnostylis maprouneifolia* Pax	Tree
Euphorbiaceae	*Ricinodendron heudelotii* (Baill.) Hechel subsp. *africanum* (Müll.Arg.) J.Léonard var. *tomentellum* (Hutch.& E.A.Bruce) Radcl.-Sm.	Tree
Euphorbiaceae	*Schinziophyton rautanenii* (Schinz) Radcl.-Sm.	Tree
Euphorbiaceae	*? Shirakiopsis armatum* (Pax & K.Hoffm.) Esser	Tree
Euphorbiaceae	*Spirostachys africana* Sond.	Tree
Euphorbiaceae	*Suregada zanzibariensis* Baill.	Shrub
Euphorbiaceae	*Synadenium ?pereskiifolium* (Baill.) Guill.	Shrub
Euphorbiaceae	*Tannodia tenuifolia* (Pax) Prain	Herb
Euphorbiaceae	*Thecacoris spathulifolia* (Pax) Leandri var. *spathulifolia*	Shrub
Euphorbiaceae	*Uapaca nitida* Müll.Arg.	Tree
Euphorbiaceae	*Uapaca sansibarica* Pax	Tree
Flacourtiaceae	*Bivinia jalbertii* Tul.	Tree
Flacourtiaceae	*Buchnerodendron lasiocalyx* (Oliv.) Gilg	Shrub
Flacourtiaceae	*Caloncoba welwitschii* (Oliv.) Gilg	Tree
Flacourtiaceae	*Casearia gladiiformis* Mast.	Tree
Flacourtiaceae	*Casearia* sp. nov. *(*= Timberlake et al. *5665)*	Shrub
Flacourtiaceae	*Dovyalis hispidula* Wild	Tree
Flacourtiaceae	*Flacourtia indica* (Burm.f.) Merr.	Tree
Flacourtiaceae	*Homalium abdessammadii* Asch.& Schweinf.	Tree
Flacourtiaceae	*Xylotheca tettensis* (Klotzsch) Gilg	Shrub
Icacinaceae	*Leptaulus* sp.	Tree
Icacinaceae	*Pyrenacantha kaurabassana* Baill.	Vine
Ixonanthaceae	*Phyllocosmus lemaireanus* (De Wild.& T.Durand) T.& H.Durand	Tree
Labiatae	*Basilicum polystachyon* (L.) Moench.	Herb
Labiatae	*Clerodendrum cephalanthum* Oliv. subsp. *swynnertonii* (S.Moore) Verdc.	Shrub
Labiatae	*Clerodendrum lutambense* Verdc.	Suffrutex
Labiatae	*Clerodendrum robustum Klotzsch* var. *robustum*	Shrub
Labiatae	*Endostemon albus* A.J.Paton & Harley	Herb

Family	Name	Life form
Labiatae	*Hoslundia opposita* Vahl	Shrub
Labiatae	*Hyptis suaveolens* (L.) Poit.	Herb
Labiatae	*Ocimum obovatum* Benth. subsp. *obovatum* var. *obovatum*	Suffrutex
Labiatae	*Orthosiphon scedastophyllus* A.J.Paton	Herb
Labiatae	*Orthosiphon schimperi* Benth.	Herb
Labiatae	*Orthosiphon thymiflorus* (Roth) Sleesen	Herb
Labiatae	*Plectranthus gracillimus* (T.C.E.Fries) Hutch.& Dandy	Herb
Labiatae	*Premna gracillima* Verdc.	Shrub
Labiatae	*Premna hans-joachimii* Verdc.	Shrub
Labiatae	*Premna schliebenii* Werderm.	Shrub
Labiatae	*Premna serratifolia* L.	Shrub
Labiatae	*Premna velutina* Gürke	Shrub
Labiatae	*Rotheca aurantiaca* (Baker) R.Fern. forma *aurantiaca*	Herb
Labiatae	*Rotheca incisa* (Klotzsch) Steane & Mabb.	Shrub
Labiatae	*Rotheca myricoides* (Hochst.) Steane & Mabb. var. *discolor* (Klotzsch) Verdc.	Shrub
Labiatae	*Tinnea aethiopica* Hook.f. subsp. *stolzii* (Robyns & Lebrun) Vollesen	Shrub
Labiatae	*Vitex ?* sp. nov. aff. *buchananii*	Shrub
Labiatae	*Vitex carvalhi* Gürke	Tree
Labiatae	*Vitex doniana* Sweet	Tree
Labiatae	*Vitex mombassae* Vatke	Tree
Labiatae	*Vitex mossambicensis* Gürke	Tree
Labiatae	*Vitex* cf. *mossambicensis* Gürke - but corolla very large	Tree
Labiatae	*Vitex payos* (Lour.) Merrill	Tree
Lecythidaceae	*Barringtonia racemosa* (L.) Spreng.	Tree
Leg.: Caesalpinioideae	*Afzelia quanzansis* Welw.	Tree
Leg.: Caesalpinioideae	*Bauhinia tomentosa* L.	Shrub
Leg.: Caesalpinioideae	*Berlinia orientalis* Brenan	Tree
Leg.: Caesalpinioideae	*Brachystegia allenii* Hutch.& Burtt Davy	Tree
Leg.: Caesalpinioideae	*Brachystegia boehmii* Taub.	Tree
Leg.: Caesalpinioideae	*Brachystegia* cf. *manga* De Wild.	Tree
Leg.: Caesalpinioideae	*Brachystegia microphylla Harms*	Tree
Leg.: Caesalpinioideae	*Brachystegia spiciformis* Benth.	Tree
Leg.: Caesalpinioideae	*Brachystegia tamarindoides* Benth. subsp. *microphylla* (Harms) Chikuni	Tree
Leg.: Caesalpinioideae	*Brachystegia utilis* Hutch.& Burtt Davy	Tree
Leg.: Caesalpinioideae	*Burkea africana* Hook.	Tree
Leg.: Caesalpinioideae	*Cassia afrofistula* Brenan	Shrub
Leg.: Caesalpinioideae	*Cassia angolensis* Hiern	Tree
Leg.: Caesalpinioideae	*Dialium holtzii* Harms	Tree
Leg.: Caesalpinioideae	*Erythrophleum suaveolens* (Guill.& Perr.) Brenan	Tree

Family	Name	Life form
Leg.: Caesalpinioideae	*Guibourtia schliebenii* (Harms) J.Léonard	Tree
Leg.: Caesalpinioideae	*Hymenaea verrucosa* Gaertn.	Tree
Leg.: Caesalpinioideae	*Julbernardia globiflora* (Benth.) Troupin	Tree
Leg.: Caesalpinioideae	*Mezoneuron angolense* Oliv.	Liana
Leg.: Caesalpinioideae	*Micklethwaitia carvalhoi* (Harms) G.P.Lewis & Schrire	Tree
Leg.: Caesalpinioideae	*Piliostigma thonningii* (Schumach.) Milne-Redh.	Tree
Leg.: Caesalpinioideae	*Scorodophloeus fischeri* (Taub.) J.Léonard	Tree
Leg.: Caesalpinioideae	*Senna auriculata* (L.) Roxb.	Shrub
Leg.: Caesalpinioideae	*Tamarindus indica* L.	Tree
Leg.: Mimosoideae	*Acacia adenocalyx* Brenan & Exell	Shrub
Leg.: Mimosoideae	*Acacia galpinii* Burtt Davy	Tree
Leg.: Mimosoideae	*Acacia gerrardii* Benth.	Tree
Leg.: Mimosoideae	*Acacia latispina* J.E.Burrows & S.M.Burrows	Tree
Leg.: Mimosoideae	*Acacia latistipulata* Harms	Shrub
Leg.: Mimosoideae	*Acacia nigrescens* Oliv.	Tree
Leg.: Mimosoideae	*Acacia nigrescens* Oliv.	Tree
Leg.: Mimosoideae	*Acacia polyacantha* Willd. subsp. *campylacantha* (A.Rich.) Brenan	Tree
Leg.: Mimosoideae	*Acacia robusta* Burch. subsp. *usambarensis* (Taub.) Brenan	Tree
Leg.: Mimosoideae	*Acacia rovumae* Oliv.	Tree
Leg.: Mimosoideae	*Acacia senegal* (L.) Willd. var. *senegal*	Tree
Leg.: Mimosoideae	*Acacia seyal* Delile var. *fistula* (Schweinf.) Oliv.	Tree
Leg.: Mimosoideae	*Acacia sieberiana* DC. var. *sieberiana*	Tree
Leg.: Mimosoideae	*Acacia sieberiana* DC. var. *vermoesenii* (De Wild.) Keay & Brenan	Tree
Leg.: Mimosoideae	*Albizia adianthifolia* (Schumach.) W.Wight	Tree
Leg.: Mimosoideae	*Albizia forbesii* Benth.	Tree
Leg.: Mimosoideae	*Albizia isenbergiana* (A.Rich.) E.Fourn.	Tree
Leg.: Mimosoideae	*Albizia petersiana* (Bolle) Oliv. subsp. *petersiana*	Tree
Leg.: Mimosoideae	*Albizia versicolor* Welw.	Tree
Leg.: Mimosoideae	*Albizia zimmermannii* Harms	Tree
Leg.: Mimosoideae	*Amblygonocarpus andongensis* (Oliv.) Exell & Torre	Tree
Leg.: Mimosoideae	*Dichrostachys cinerea* (L.) Wight & Arn. subsp. *forbesii* (Benth.) Brenan & Brummitt	Tree
Leg.: Mimosoideae	*Elephantorrhiza goetzei* (Harms) Harms	Tree
Leg.: Mimosoideae	*Entada rheedii* Spreng.	Liana
Leg.: Mimosoideae	*Entada stuhlmannii* (Taub.) Harms	Vine
Leg.: Mimosoideae	*Mimosa busseana* Harms	Shrub
Leg.: Mimosoideae	*Mimosa pigra* L.	Shrub
Leg.: Mimosoideae	*Newtonia paucijuga* (Harms) Brenan	Tree
Leg.: Mimosoideae	*Pseudoprosopis euryphylla* Harms	Liana
Leg.: Papilionoideae	*Abrus precatorius* L. subsp. *africanus* Verdc.	Vine
Leg.: Papilionoideae	*Aeschymomene cristata* Vatke var. *cristata*	Shrub

Family	Name	Life form
Leg.: Papilionoideae	*Baphia ?* sp. nov.	Tree
Leg.: Papilionoideae	*Baphia macrocalyx* Harms	Tree
Leg.: Papilionoideae	*Cordyla africana* Lour.	Tree
Leg.: Papilionoideae	*Craibia zimmermannii* (Harms) Dunn	Tree
Leg.: Papilionoideae	*Crotalaria goodiiformis* Vatke	Herb
Leg.: Papilionoideae	*Crotalaria goreensis* Guill.& Perr.	Herb
Leg.: Papilionoideae	*Dalbergia arbutifolia* Baker subsp. *arbutifolia*	Liana
Leg.: Papilionoideae	*Dalbergia armata* E.Mey.	Liana
Leg.: Papilionoideae	*Dalbergia boehmii* Taub. subsp. *boehmii*	Tree
Leg.: Papilionoideae	*Dalbergia bracteolata* Baker	Liana
Leg.: Papilionoideae	*Dalbergia fischeri* Taub.	Liana
Leg.: Papilionoideae	*Dalbergia lactea* Vatke	Liana
Leg.: Papilionoideae	*Dalbergia melanoxylon* Guill.& Perr.	Tree
Leg.: Papilionoideae	*Derris trifoliata* Lour.	Liana
Leg.: Papilionoideae	*Eriosema parviflorum* E.Mey.	Herb
Leg.: Papilionoideae	*Eriosema pauciflorum* Klotzsch	Herb
Leg.: Papilionoideae	*Eriosema psoraleoides* (Lam.) G.Don	Herb
Leg.: Papilionoideae	*Erythrina haerdii* Verdc.	Tree
Leg.: Papilionoideae	*Erythrina livingstoneana* Baker	Tree
Leg.: Papilionoideae	*Erythrina sacleuxii* Hua	Tree
Leg.: Papilionoideae	*Erythrina* sp. not matched at K *(*=Crawford *723)*	Tree
Leg.: Papilionoideae	*Flemingia grahamiana* Wight & Arn.	Herb
Leg.: Papilionoideae	*Indigofera drepanocarpa* Taub.	Herb
Leg.: Papilionoideae	*Indigofera schimperi* Jaub.& Spach var. *schimperi*	Herb
Leg.: Papilionoideae	*Millettia eetveldiana* (Micheli) Hauman	Tree
Leg.: Papilionoideae	*Millettia impressa* Harms *subsp. goetzeana* (Harms) J.B.Gillett	Liana
Leg.: Papilionoideae	*Millettia makondensis* Harms	Suffrutex
Leg.: Papilionoideae	*Millettia stuhlmannii* Taub.	Tree
Leg.: Papilionoideae	*Millettia usaramensis* Taub. subsp. *usaramensis* var. *usaramensis*	Tree
Leg.: Papilionoideae	*Mundulea sericea* (Willd.) A.Chev.	Shrub
Leg.: Papilionoideae	*Ormocarpum kirkii* S.Moore	Tree
Leg.: Papilionoideae	*Ormocarpum schliebenii* Harms	Shrub
Leg.: Papilionoideae	*Ormocarpum sennoides* (Willd.) DC. subsp. *zanzibaricum* Brenan & J.B.Gillett	Shrub
Leg.: Papilionoideae	*Pericopsis angolensis* (Baker) Meewen	Tree
Leg.: Papilionoideae	*Philenoptera bussei* (Harms) Schrire	Tree
Leg.: Papilionoideae	*Platysepalum inopinatum* Harms	Tree
Leg.: Papilionoideae	*Pterocarpus megalocarpus* Harms	Tree
Leg.: Papilionoideae	*Swartzia madagascariensis* Desv.	Tree
Leg.: Papilionoideae	*Tephrosia noctiflora* Baker	Shrub
Leg.: Papilionoideae	*Vigna luteola* (Jacq.) Benth.	Vine

Family	Name	Life form
Leg.: Papilionoideae	*Xeroderris stuhlmannii* (Taub.) Mendonça & E.P.Sousa	Tree
Linaceae	*Hugonia busseana* Engl.	Shrub
Linaceae	*Hugonia grandiflora* N.Robson	Shrub
Linaceae	*Hugonia orientalis* Engl.	Shrub
Loganiaceae	*Mostuea brunonis* Didr.	Shrub
Loganiaceae	*Mostuea microphylla* Gilg	Shrub
Loganiaceae	*Strychnos cocculoides* Baker	Tree
Loganiaceae	*Strychnos henningsii* Gilg	Tree
Loganiaceae	*Strychnos madagascariensis* Poir.	Tree
Loganiaceae	*Strychnos myrtoides* Gilg & Busse	Shrub
Loganiaceae	*Strychnos panganensis* Gilg	Liana
Loganiaceae	*Strychnos* cf. *spinosa* Lam.	Tree
Loganiaceae	*Strychnos xylophylla* Gilg	Tree
Loranthaceae	*Agelanthus* cf. *zizyphifolius* (Engl.) Polh.& Wiens	Parasite
Loranthaceae	*Englerina inaequilatera* (Engl.) Gilli	Parasite
Loranthaceae	*Erianthemum lindense* (Sprague) Danser	Parasite
Loranthaceae	*Helixanthera kirkii* (Oliv.) Danser	Parasite
Lythraceae	*Ammannia auriculata* Willd.	Herb
Malphigiaceae	*Acridocarpus chloropterus* Oliv.	Shrub
Malphigiaceae	*Acridocarpus natalitius* A.Juss. var. *natalitius*	Shrub
Malvaceae	*Gossypioides kirkii* (Mast.) J.B.Hutch.	Shrub
Malvaceae	*Hibiscus migeodii* Exell	Herb
Malvaceae	*Hibiscus platycalyx* Mast.	Shrub
Malvaceae	*Hibiscus surattensis L.*	Herb
Malvaceae	*Hibiscus zanzibaricus* Cufod.	Herb
Malvaceae	*Pavonia leptocalyx* (Sond.) Ulbr.	Herb
Malvaceae	*Thespesia mossambicensis* (Exell & Hillc.) Fryxell	Shrub
Malvaceae	*Urena lobata* L. var. *lobata*	Shrub
Melastomataceae	*Antherotoma debilis* (Sond.) Jacq.-Fél.	Herb
Melastomataceae	*Memecylon flavovirens* Baker	Shrub
Melastomataceae	*Memecylon natalense* Markgr.	Shrub
Melastomataceae	*Memecylon torrei* A.Fern.& R.Fern.	Shrub
Melastomataceae	*Warneckea sansibarica* (Taub.) Jacq.-Fél.	Tree
Melastomataceae	*Warneckea* cf. *sessilicarpa* (A.Fern.& R.Fern.) Jacq.-Fél.	Shrub
Melastomataceae	*Warneckea sousae* (A.Fern.& R.Fern.) A.E.van Wyk	Tree
Melastomataceae	*Warneckea* sp. nov.	Shrub
Meliaceae	*Ekebergia capensis* Sparrm.	Tree
Meliaceae	*Pseudobersama mossambicensis* (Sim) Verdc.	Tree
Meliaceae	*Trichilia ?* sp. nov.	Shrub
Meliaceae	*Trichilia emetica* Vahl	Tree
Meliaceae	*Turraea robusta* Gürke	Tree

Family	Name	Life form
Meliaceae	*Turraea wakefieldii* Oliv.	Tree
Meliaceae	*Xylocarpus granatum* J.Köenig	Tree
Menispermaceae	*Jateorhiza palmata* (Lam.) Miers	Vine
Menispermaceae	*Triclisia sacleuxii* (Pierre) Diels	Vine
Molluginaceae	*Glinus lotoides* L. var. *lotoides*	Herb
Molluginaceae	*Glinus oppositifolius* (L.) DC. var. *lanatus* Hauman	Herb
Montiniaceae	*Grevea eggelingii* Milne-Redh. var. *echinocarpa* Mendes	Shrub
Moraceae	*Bosqueiopsis gilletii* De Wild.& T.Durand	Shrub
Moraceae	*Dorstenia psilurus* Welw. var. *psilurus*	Geophyte
Moraceae	*Ficus capreifolia* Delile	Tree
Moraceae	*Ficus ingens* Miq.	Tree
Moraceae	*Ficus sycomorus* L. subsp. *sycomorus*	Tree
Moraceae	*Maclura africana* (Bureau) Corner	Shrub
Myrtaceae	*Eugenia capensis* (Eckl.& Zeyh.) Sond. subsp. *multiflora* Verdc.	Shrub
Myrtaceae	*Syzygium guineense* (Willd.) DC. subsp. *guineense*	Tree
Ochnaceae	*Brackenridgea zanguebarica* Oliv.	Tree
Ochnaceae	*Ochna ?* sp. nov.	Suffrutex
Ochnaceae	*Ochna kirkii* Oliv.	Tree
Ochnaceae	*Ochna mossambicensis* Klotzsch	Shrub
Ochnaceae	*Ochna ovata* F.Hoffm.	Shrub
Ochnaceae	*Ochna polyneura* Gilg	Tree
Ochnaceae	*Ochna* cf. *puberula* N.K.B.Robson	Tree
Ochnaceae	*Ochna* cf. *rovumensis* Gilg	Tree
Olacaceae	*Olax dissitiflora* Oliv.	Shrub
Olacaceae	*Olax pentandra* Sleumer	Tree
Olacaceae	*Ximenia caffra* Sond. var. *natalensis* Sond.	Shrub
Oleaceae	*Jasminum stenolobum* Rolfe	Shrub
Oleaceae	*Schrebera trichoclada* Welw.	Tree
Onagraceae	*Ludwigia* cf. *stolonifera* (Guill.& Perr.) Raven	Herb
Onagraceae	*Ludwigia leptocarpa* (Nutt.) Hara	Herb
Opiliaceae	*Opilia amentacea* Roxb.	Liana
Opiliaceae	*Opilia celtidifolia* (Guill.& Perr.) Walp.	Liana
Opiliaceae	*Pentarhopalopilia umbellulata* (Baill.) Hiepko	Shrub
Passifloraceae	*Adenia gummifera* (Harv.) Harms var. *gummifera*	Vine
Passifloraceae	*Adenia kirkii* (Mast.) Engl.	Vine
Passifloraceae	*Adenia panduriformis* Engl.	Vine
Passifloraceae	*Paropsia braunii* Gilg	Tree
Passifloraceae	*Schlechterina mitostemmatoides* Harms	Vine
Pedaliaceae	*Dicerocaryum zanguebaricum* (Lour.) Merr.	Herb
Polygalaceae	*Carpolobia goetzei* Gürke	Shrub
Polygalaceae	*Polygala goetzei* Gürke	Herb

Family	Name	Life form
Polygalaceae	*Polygala sansibarensis* Gürke	Herb
Polygalaceae	*Polygala stenopetala* Klotzsch subsp. *stenopetala*	Herb
Polygalaceae	*Securidaca longepedunculata* Fresen.	Shrub
Polygonaceae	*Oxygonum buchananii* (Dammer) J.B.Gillett	Herb
Polygonaceae	*Persicaria madagascariensis* (Meisn.) S.Ortiz & Paiva	Herb
Portulacaceae	*Talinum tenuissimum* Dinter	Geophyte
Portulacaceae	*Talinum crispatulum* Dinter	Geophyte
Ptaeroxylaceae	*Ptaeroxylon obliquum* (Thunb.) Radlk.	Tree
Rhamnaceae	*Berchemia discolor* (Klotzsch) Hemsl.	Tree
Rhamnaceae	*Colubrina asiatica* (L.) Brongn. var. *asiatica*	Liana
Rhamnaceae	*Gouania scandens* (Gaertn.) R.B.Drumm.	Liana
Rhizophoraceae	*Bruguiera gymnorhiza* (L.) Lam.	Tree
Rhizophoraceae	*Cassipourea* cf. *euryoides* Alston	Tree
Rhizophoraceae	*Cassipourea mossambicensis (Brehmer) Alston*	Tree
Rhizophoraceae	*Ceriops tagal* (Perr.) C.B.Rob.	Tree
Rhizophoraceae	*Rhizophora mucronata* Lam.	Tree
Rubiaceae	*Afrocanthium lactescens* (Hiern) Lantz	Shrub
Rubiaceae	*Afrocanthium racemulosum* (S.Moore) Lantz	Shrub
Rubiaceae	*Afrocanthium pseudoverticillatum* (S.Moore) Lantz	Shrub
Rubiaceae	*Agathisanthemum bojeri* Klotzsch subsp. *bojeri*	Herb
Rubiaceae	*Bullockia setiflora* (Hiern) Razafin.	Shrub
Rubiaceae	*? Canthium mombazense* Baill.	Tree
Rubiaceae	*Caturanegam* cf. *stenocarpa* Bridson =Nuvunga *684*	Tree
Rubiaceae	*Catunaregam ? swynnertonii* (S.Moore) Bridson	Shrub
Rubiaceae	*Catunaregam stenocarpa* Bridson	Tree
Rubiaceae	*Chassalia umbraticola* Vatke	Shrub
Rubiaceae	*Chazaliella abrupta* (Hiern) E.M.A.Petit & Verdc.	Shrub
Rubiaceae	*Coffea (Psilanthus)* sp. *A of FTEA*	Shrub
Rubiaceae	*Coffea schliebenii* Bridson	Shrub
Rubiaceae	*Coptosperma littorale* (Hiern) Degreef	Tree
Rubiaceae	*Coptosperma nigrescens* Hook.f.	Tree
Rubiaceae	*Coptosperma supra-axillare* (Hemsl.) Degreef	Shrub
Rubiaceae	*Craterispermum schweinfurthii* Hiern	Tree
Rubiaceae	*Cremaspora triflora* (Thonn.) K.Schum. subsp. *confluens* (K.Schum.) Verdc.	Shrub
Rubiaceae	*Crossopteryx febrifuga* (G.Don) Benth.	Tree
Rubiaceae	*Cuviera semsei* Verdc.	Tree
Rubiaceae	*Didymosalpinx callianthus* J.E.Burrows & S.M.Burrows sp. nov.	Shrub
Rubiaceae	*Gardenia ternifolia* Schumach.& Thonn. subsp. *jovis-tonantis* (Welw.) Verdc. var. *jovis-tonantis* (Welw.) Aubrév.	Tree
Rubiaceae	*Gardenia transvenulosa* Verdc.	Shrub

Family	Name	Life form
Rubiaceae	*Heinsia crinita* (Afzel.) G.Taylor subsp. *parviflora* (K.Schum.& K.Krause) Verdc.	Shrub
Rubiaceae	*Heinsia zanzibarica* (Bojer) Verdc.	Shrub
Rubiaceae	*Hymenodictyon parvifolium* Oliv. subsp. *parvifolium*	Tree
Rubiaceae	*Ixora narcissodora* K.Schum.	Shrub
Rubiaceae	*Keetia gueinzii* (Sond.) Bridson	Shrub
Rubiaceae	*Keetia zanzibarica* (Klotzsch) Bridson subsp. *zanzibarica*	Tree
Rubiaceae	*Kraussia kirkii* (Hook.f.) Bullock	Tree
Rubiaceae	*Leptactina delagoensis* K.Schum. subsp. *delagoensis*	Shrub
Rubiaceae	*Leptactina papyrophloea* Verdc.	Shrub
Rubiaceae	*Multidentia exserta* Bridson subsp. *exserta*	Tree
Rubiaceae	*Mussaenda arcuata* Poir.	Tree
Rubiaceae	*Oxyanthus biflorus* J.E.Burrows & S.M.Burrows sp. nov.	Shrub
Rubiaceae	*Oxyanthus* sp. *A of FZ*	Shrub
Rubiaceae	*Oxyanthus zanguebaricus* (Hiern) Bridson	Shrub
Rubiaceae	*Pavetta decumbens* K.Schum.& K.Krause	Shrub
Rubiaceae	*Pavetta lindina* Bremek.	Shrub
Rubiaceae	*Pavetta lutambensis* Bremek.	Shrub
Rubiaceae	*Pavetta macrosepala* Hiern var. *macrosepala*	Tree
Rubiaceae	*Pavetta uniflora* Bremek.	Shrub
Rubiaceae	*Pentodon pentandrus* (Schumach.& Thonn.) Vatke var. *minor* Bremek.	Herb
Rubiaceae	*Polysphaeria* cf. *lanceolata* Hiern subsp. *lanceolata / P. multiflora* Hiern subsp. *pubescens* Verdc.	Tree
Rubiaceae	*Polysphaeria multiflora* Hiern *vel* aff.	Shrub
Rubiaceae	*Polysphaeria ?* sp. nov.	Shrub
Rubiaceae	*Psilanthus* sp. nov. cf. sp. A of FTEA (especially Luke 10197)	Shrub
Rubiaceae	*Psychotria capensis* (Eckl.) Vatke subsp. *riparia* (K.Schum.& Krause) Verdc. var. *riparia*	Tree
Rubiaceae	*Psychotria kirkii* Hiern *(*if distinct from *P. punctata)*	Shrub
Rubiaceae	*Psychotria linearisepala* Petit	Shrub
Rubiaceae	*Psychotria mahonii* C.H.Wright	Shrub
Rubiaceae	*Psychotria pumila* Hiern var. *pumila*	Shrub
Rubiaceae	*Psydrax kaessneri* (S.Moore) Bridson	Tree
Rubiaceae	*Psydrax livida* (Hiern) Bridson	Tree
Rubiaceae	*Psydrax ? martinii* (Dunkley) Bridson	Tree
Rubiaceae	*Psydrax micans* (Bullock) Bridson	Tree
Rubiaceae	*Psydrax obovata* (Eckl.& Zeyh.) Bridson	Tree
Rubiaceae	*Pyrostria bibracteata* (Baker) Cavaco	Shrub
Rubiaceae	*Pyrostria* cf. *phyllanthoidea* (Baill.) Bridson	Shrub
Rubiaceae	*Pyrostria* sp. *D of FTEA*	Shrub
Rubiaceae	*Pyrostria ?* sp. nov. = Luke 9724 (Tanzania)	Shrub

Family	Name	Life form
Rubiaceae	*Rhodopentas parvifolia* (Hiern) Kårehed & B.Bremer	Shrub
Rubiaceae	*Rothmannia macrosiphon* (Engl.) Bridson *(probably - in bud)*	Shrub
Rubiaceae	*Rothmannia manganjae* (Hiern) Keay	Tree
Rubiaceae	*Rutidea fuscescens* Hiern subsp. *fuscescens*	Shrub
Rubiaceae	*Rytigynia celastroides* (Baill.) Verdc.	Shrub
Rubiaceae	*Rytigynia* cf. *umbellulata* (Hiern) Robyns =de Koning et al. *9759 of FZ*	Tree
Rubiaceae	*Tarenna junodii* (Schinz) Bremek.	Shrub
Rubiaceae	*Tarenna pavettoides* (Harv.) Sim subsp. *affinis* (K.Schum.) Bridson	Tree
Rubiaceae	*Tarenna pembensis* J.E.Burrows	Shrub
Rubiaceae	*Tarenna* sp. *53 of Degreef* =Bidgood et al. *1357*	Tree
Rubiaceae	*Triainolepis africana* Hook.f. subsp. *africana*	Shrub
Rubiaceae	*Triainolepis africana* Hook.f. subsp. *hildebrandtii* (Vatke) Verdc.	Shrub
Rubiaceae	*Tricalysia coriacea* (Benth.) Hiern subsp. *nyassae* (Hiern) Bridson	Tree
Rubiaceae	*Tricalysia pallens* Hiern	Tree
Rubiaceae	*Tricalysia schliebenii* Robbr.	Shrub
Rubiaceae	*Tricalysia semidecidua* Bridson	Shrub
Rubiaceae	*Tricalysia* sp. *A of FZ*	Tree
Rubiaceae	*Tricalysia* sp. *B of FZ*	Shrub
Rubiaceae	*Vangueria* cf. *randii* S.Moore =Torre & Paiva *11706 (not at K)*	Tree
Rubiaceae	*Vangueria* cf. *randii* S.Moore subsp. *vollesenii* Verdc.	Tree
Rubiaceae	*Vangueria infausta* Burch. subsp. *infausta*	Tree
Rubiaceae	*Vangueriopsis lancifolia* (Hiern) Robyns	Tree
Rutaceae	*Clausena anisata* (Willd.) Benth.	Shrub
Rutaceae	*Vepris* cf. *allenii* I.Verd.	Tree
Rutaceae	*Vepris lanceolata* (Lam.) G.Don	Tree
Rutaceae	*Vepris sansibarensis* (Engl.) Mziray	Tree
Rutaceae	*Vepris* cf. *stolzii* I.Verd.	Tree
Rutaceae	*Vepris ?* sp. nov.	Tree
Rutaceae	*Zanthoxylum holtzianum* (Engl.) P.G.Waterman var. *holtzianum*	Tree
Rutaceae	*Zanthoxylum lepreurii* Guill.& Perr.	Tree
Rutaceae	*Zanthoxylum lindense* (Engl.) Kokwaro	Tree
Salvadoraceae	*Dobera loranthifolia* (Warb.) Harms	Tree
Salvadoraceae	*Salvadora persica* L. var. *persica*	Shrub
Sapindaceae	*Allophylus africanus* P.Beauv. var. *africanus*	Shrub
Sapindaceae	*Allophylus rubifolius* (A.Rich.) Engl. var. *alnifolius* (Baker) Friis & Vollesen	Shrub
Sapindaceae	*Allophylus tanzaniensis* F.G.Davies	Shrub
Sapindaceae	*Blighia unijugata* Baker	Tree
Sapindaceae	*Cardiospermum halicacabum* L.	Vine
Sapindaceae	*Deinbollia ?* sp. nov.	Shrub

Family	Name	Life form
Sapindaceae	*Glenniea africana* (Radkl.) Leenh.	Tree
Sapindaceae	*Haplocoelum inoploeum* Radlk.	Tree
Sapindaceae	*Lepisanthes senegalensis* (Poir.) Leenh.	Tree
Sapindaceae	*Macphersonia gracilis* O.Hoffm. var. *hildebrandtii* (O.Hoffm.) Capuron	Tree
Sapindaceae	*Pancovia golungensis* (Hiern) Exell & Mendonça – bijugate form	Shrub
Sapindaceae	*Pancovia holtzii* Radlk. subsp. *holtzii*	Shrub
Sapotaceae	*Inhambanella henriquesii* (Engl.& Warb.) Dubard	Tree
Sapotaceae	*Manilkara discolor* (Sond.) J.H.Hemsl.	Tree
Sapotaceae	*Manilkara mochisia* (Baker) Dubard	Tree
Sapotaceae	*Manilkara sansibarensis* (Engl.) Dubard	Tree
Sapotaceae	*Mimusops obtusifolia* Lam.	Tree
Sapotaceae	*Synsepalum brevipes* (Baker) T.D.Penn.	Tree
Sapotaceae	*Vitellariopsis kirkii* (Baker) Dubard	Tree
Scrophulariaceae	*Alectra orobanchoides* Benth. – ?aberrant form	Herb
Scrophulariaceae	*Buchnera leptostachya* Benth.	Herb
Scrophulariaceae	*Scoparia dulcis* L.	Herb
Scrophulariaceae	*Striga forbesii* Benth.	Herb
Scrophulariaceae	*Striga pubiflora* Klotzsch	Herb
Scrophulariaceae	*Torenia thouarsii* (Cham.& Schltdl.) Kuntze	Herb
Simaroubaceae	*Harrisonia abyssinica* Oliv.	Tree
Solanaceae	*Solanum catombelense* Peyr.	Herb
Solanaceae	*Solanum richardii* Dunal	Herb
Sonneratiaceae	*Sonneratia alba* Sm.	Tree
Sterculiaceae	*Cola ? discoglypremnophylla* Brenan & A.P.D.Jones	Tree
Sterculiaceae	*Cola ?* sp. nov. *1* aff. *clavata* Mast.	Tree
Sterculiaceae	*Cola ?* sp. nov. *2* aff. *clavata* Mast.	Tree
Sterculiaceae	*Dombeya acutangula* Cav.	Tree
Sterculiaceae	*Dombeya kirkii* Mast	Tree
Sterculiaceae	*Dombeya shupangae* K.Schum.	Tree
Sterculiaceae	*Hildegardia migeodii* (Exell) Kosterm.	Tree
Sterculiaceae	*Melochia corchorifolia* L.	Herb
Sterculiaceae	*Sterculia africana* (Lour.) Fiori	Tree
Sterculiaceae	*Sterculia quinqueloba* (Garcke) K.Schum.	Tree
Sterculiaceae	*Sterculia schliebenii* Mildbr.	Tree
Thymelaeaceae	*Synaptolepis alternifolia* Oliv.	Shrub
Thymelaeaceae	*Synaptolepis kirkii* Oliv.	Shrub
Thymelaeaceae	*Synaptolepis oliveriana* Gilg	Liana
Tiliaceae	*Carpodiptera africana* Mast.	Tree
Tiliaceae	*Grewia conocarpa* K.Schum.	Tree
Tiliaceae	*Grewia forbesii* K.Schum.	Shrub
Tiliaceae	*Grewia glandulosa* Vahl	Shrub

Family	Name	Life form
Tiliaceae	*Grewia holstii* Burret	Shrub
Tiliaceae	*Grewia* cf. *holtzii* Burret	Tree
Tiliaceae	*Grewia leptopus* Ulbr.	Tree
Tiliaceae	*Grewia limae* Wild	Tree
Tiliaceae	*Grewia microcarpa* K.Schum.	Shrub
Tiliaceae	*Grewia stuhlmannii* K.Schum.	Shrub
Tiliaceae	*Grewia vaughanii* Exell	Tree
Tiliaceae	*Triumfetta* cf. *rhomboidea* Jacq.	Herb
Turneraceae	*Tricliceras brevicaule* (Urb.) R.Fern. var. *rosulatum* (Urb.) R.Fern.	Herb
Turneraceae	*Tricliceras longepedunculatum* (Mast.) R.Fern.	Herb
Ulmaceae	*Trema orientalis* (L.) Blume	Tree
Umbelliferae	*Centella asiatica* (L.) Urb.	Herb
Verbenaceae	*Lippia javanica* (Burm.f.) Spreng.	Shrub
Verbenaceae	*Phyla nodiflora* (L.) Greene	Herb
Violaceae	*Hybanthus enneaspermum* (L.) F.Müll. var. cf. *caffer* (Sond) N.Robson	Herb
Violaceae	*Rinorea angustifolia* (Thouars) Baill. subsp. *ardisiiflora* (Oliv.) Grey-Wilson	Tree
Violaceae	*Rinorea arborea* (Thouars) Baill.	Tree
Violaceae	*Rinorea elliptica* (Oliv.) Kuntze	Tree
Violaceae	*Rinorea ferruginea* Engl.	Tree
Violaceae	*Rinorea ilicifolia* (Oliv.) Kuntze var. *ilicifolia*	Shrub
Violaceae	*Rinorea welwitschii* (Oliv.) Kuntze subsp. *tanzanica* Grey-Wilson	Shrub
Viscaceae	*Viscum gracile* Polh.& Wiens	Parasite
Vitaceae	*Ampelocissus obtusata* (Baker) Planch. subsp. *kirkiana* (Planch.) Wild & R.B.Drumm.	Vine
Vitaceae	*Cissus integrifolia* (Baker) Planch.	Vine
Vitaceae	*Cissus phymatocarpa* Masinde & L.E.Newton	Vine
Vitaceae	*Cissus* sp. aff. *quadrangularis* L.	Vine
Vitaceae	*Cissus sylvicola* Masinde & L.E.Newton	Vine
Vitaceae	*Rhoicissus tridentata* (L.f.) Wild & R.B.Drumm. subsp. *cuneifolia* (Eckl.& Zeyh.) Orton	Vine

ANNEX 3.

New plant species and records resulting from recent coastal forest collections, with indications of distribution pattern and endemism. Taxa that were first recorded from collections not directly associated with the "Our Planet Reviewed" project are marked with an asterisk.

Localities: HC=Hunters' Concession; Lup=Lupangua; MRov=Mocímboa do Rovuma; Nang=Nangade; Nego=Negomano; NR=Nhica do Rovuma; Pal=Palma; Pund=Pundanhar; Q=Quiterajo

NEW/UNDESCRIBED SPECIES (35)

ANNONACEAE	*Xylopia* sp. nov.	Q, Pal
ANNONACEAE	*Xylopia* sp. A of FTEA *	Pal, HC
ARACEAE	*Stylochaeton* sp. not matched (uncertain status)	Q
ASPARAGACEAE	*Asparagus* ?sp. nov.	Q
CELASTRACEAE	*Pleurostylia* ?sp. nov. aff. *serrulata* Loes.	Pal, NR
COMPOSITAE	*Vernonia* ?sp. nov. aff. *inhacensis* G.V.Pope	Pal
COMPOSITAE	*Vernonia* ?sp. nov. 2	NR
CONVOLVULACEAE	*Ipomoea* ?sp. nov.	NR
EUPHORBIACEAE	*Euphorbia* ?sp. nov. aff. *ambrosae* L.C.Leach var. *spinosa* L.C.Leach	Q
FLACOURTIACEAE	*Casearia* ?sp. nov.	NR
LABIATAE	*Vitex* ?sp. nov. aff. *buchananii*	Pal, NR, Pund
LABIATAE	*Vitex* cf. *mossambicensis* Gürke but corolla v. large	Q
LEG: PAPILION	*Baphia* ?sp. nov.	Pa
LEG: PAPILION	*Erythrina* ?sp. nov. not matched at K in FTEA/FZ regions	Q, Lup
MELASTOMATACEAE	*Warneckea* sp. nov.	Q
MELIACEAE	*Trichilia* ?sp. nov.	Nang, Pund
OCHNACEAE	*Ochna* ?sp. nov.	Pal, NR
RUBIACEAE	?*Chassalia* cf. *umbraticola* Vatke thickened inflorescence axis	Pal
RUBIACEAE	*Didymosalpinx callianthus* J.E.& S.M.Burrows, sp. nov.	NR
RUBIACEAE	*Oxyanthus* sp. A of FZ *	Q, Pal
RUBIACEAE	*Oxyanthus biflorus* J.E.& S.M.Burrows, sp. nov. * (=*Oxyanthus* cf. sp. A of FTEA)	NR
RUBIACEAE	*Polysphaeria* ?sp. nov.	NR
RUBIACEAE	*Psilanthus* ?sp. nov. cf. sp. A of FTEA, esp. Luke 10197 genus new to Moz and FZ, but to be sunk in *Coffea*	Q
RUBIACEAE	*Pyrostria* sp. B of FZ *	Q
RUBIACEAE	*Pyrostria* sp. D of FTEA *	NR, Nang
RUBIACEAE	*Pyrostria* ?sp. nov. = Luke 9724 (Tanzania) *	Nang
RUBIACEAE	*Rytigynia* cf. *umbellulata* (Hiern) Robyns * = de Koning et al. 9759 of FZ	Q

RUBIACEAE	*Tarenna* sp. 53 of Degreef * = Bidgood et al. 1357	Q
RUBIACEAE	*Tricalysia* sp. A of FZ *	Q
RUBIACEAE	*Tricalysia* sp. B of FZ *	Q
RUTACEAE	*Vepris* sp. nov. * (= Müller & Pope 1935 from Zambezia)	Q
RUTACEAE	*Zanthoxylum lepreurii* Guill. & Perr. ?var./subsp. nov.	Q
SAPINDACEAE	*Deinbollia* ?sp. nov. * (= Luke et al. 10131 from Mueda)	Q
STERCULIACEAE	*Cola* sp. nov. 1 aff. *clavata* Mast.	HC
STERCULIACEAE	*Cola* ?sp. nov. 2 aff. *clavata* Mast.	HC

NEW RECORDS: MOZAMBIQUE (67)

ACANTHACEAE	*Lepidagathis plantaginea* Mildbr.	Ngapa-Nego
ACANTHACEAE	*Whitfieldia orientalis* Vollesen	Nhica/Mueda
AMARYLLIDACEAE	*Crinum aurantiacum* Lehmiller	Q
ANACARDIACEAE	*Lannea schweinfurthii* (Engl.) Engl. var. *acutifolia* (Engl.) Kokwaro	Q
ANNONACEAE	*Artabotrys modestus* Diels subsp. *macranthus* Verdc.	Q
ANNONACEAE	*Letowianthus stellatus* Diels new genus record for Moz & FZ	Q
ANNONACEAE	*Monanthotaxis faulknerae* Verdc.	Pal
ANNONACEAE	*Monanthotaxis trichantha* (Diels) Verdc.	Pal
ANNONACEAE	*Monodora minor* Engl.& Diels *	Pal
ANTHERICACEAE	*Chlorophytum amplexicaule* Baker (if distinct from *C. blepharophyllum*)	Lup
APOCYNACEAE	*Baissea myrtifolia* (Benth.) Pichon *	Nang
APOCYNACEAE	*Cryptolepis hypoglauca* K.Schum.	Q
ARACEAE	*Anchomanes abbreviatus* Engl.	Macomia, HC
ARACEAE	*Culcasia orientalis* Mayo	NR
ARACEAE	*Stylochaeton euryphyllus* Mildbr. *	Q
ARECACEAE	*Hyphaene petersiana* Mart.	Ngapa-Nego
BALANITACEAE	*Balanites maughamii* Sprague subsp. *acuta* Sands	Pal, NR
BURSERACEAE	*Commiphora fulvotomentosa* Engl. *	Q
BURSERACEAE	*Commiphora pteleifolia* Engl.	NR
CAPPARACEAE	*Maerua bussei* (Gilg & Gilg-Ben) Wilczek *	HC
CAPPARACEAE	*Ritchiea capparoides* (Andr.) Britton var. *capparoides*	Q, Pal
CELASTRACEAE	*Elaeodendron buchananii* (Loes.) Loes.	Mucojo-Macomia
COMPOSITAE	*Vernonia zanzibarensis* Less.	Mueda
CONNARACEAE	*Vismianthus punctatus* Mildbr. *	Mueda, Q
CUCURBITACEAE	*Peponium leucanthum* (Gilg) Cogn.	Pund

DRACAENACEAE	*Sansevieria* cf. *metallica* Gérôme & Labroy	Pal
EBENACEAE	*Diospyros kabuyeana* F.White *	Pal, NR, Pund
EBENACEAE	*Diospyros magogoana* F.White	Pal
EBENACEAE	*Diospyros shimbaensis* F.White	Pal
EUPHORBIACEAE	*Croton polytrichus* Pax subsp. *polytrichus*	Pal
EUPHORBIACEAE	*Drypetes sclerophylla* Mildbr.	Q
EUPHORBIACEAE	*Omphalea mansfieldiana* Mildbr.	Q
LABIATAE	*Orthosiphon scedastophyllus* A.J.Paton	Q
LABIATAE	*Premna gracillima* Verdc.	Q
LABIATAE	*Premna hans-joachimii* Verdc. ? plot voucher 2008	HC, Nang
LEG: CAESALP	*Scorodophloeus fischeri* (Taub.) J.Léonard	HC, Nang
LEG: CAESALP	*Senna auriculata* (L.) Roxb.	Pal
LEG: MIMOSOID	*Newtonia paucijuga* (Harms) Brenan	Q
LEG: PAPILION	*Dalbergia lactea* Vatke	Pal
LEG: PAPILION	*Erythrina haerdii* Verdc.	Diaca
LEG: PAPILION	*Erythrina sacleuxii* Hua	Pal
LOGANIACEAE	*Strychnos xylophylla* Gilg	Q
MYRTACEAE	*Eugenia capensis* (Eckl.& Zeyh.) Sond. subsp. *multiflora* Verdc.	Pal, NR
OCHNACEAE	*Ochna ovata* F.Hoffm.	Lup
ORCHIDACEAE	*Eulophia acutilabra* Summerh.	Pal
ORCHIDACEAE	*Eulophia guineensis* Lindl.	Pal
ORCHIDACEAE	*Microcoelia megalorrhiza* (Rchb.f.) Summerh.	Q
ORCHIDACEAE	*Microcoelia physophora* (Rchb.f.) Summerh.	Q
ORCHIDACEAE	*Nervilia bicarinata* (Blume) Schltr.	Q
PASSIFLORACEAE	*Adenia kirkii* (Mast.) Engl.	Q
RUBIACEAE	*Coffea schliebenii* Bridson (Coffea sp. D of FTEA)	NR
RUBIACEAE	*Gardenia transvenulosa* Verdc. *	Q, Nang, NR, Pal
RUBIACEAE	*Kraussia kirkii* (Hook.f.) Bullock	Q, NR
RUBIACEAE	*Leptactina papyrophloea* Verdc. *	Pal, Q
RUBIACEAE	*Pavetta lindina* Bremek.	Q, Pal
RUBIACEAE	*Rhodopentas parvifolia* (Hiern) Kårehed & B.Bremer	Pund, Nang
RUBIACEAE	*Rothmannia macrosiphon* (Engl.) Bridson *	Pal
RUBIACEAE	*Vangueria* cf. *randii* S.Moore subsp. *vollesenii* Verdc.	NR
RUTACEAE	*Vepris sansibarensis* (Engl.) Mziray	Q
RUTACEAE	*Zanthoxylum lindense* (Engl.) Kokwaro	Pal, Q
SAPINDACEAE	*Haplocoelum inoploeum* Radlk.	Q
THYMELAEACEAE	*Synaptolepis kirkii* Oliv. sensu stricto	Q, NR
TILIACEAE	*Grewia stuhlmannii* K.Schum.	Macomia, HC
VIOLACEAE	*Rinorea welwitschii* (Oliv.) Kuntze subsp. *tanzanica* Grey-Wilson	Nang-Mueda
VISCACEAE	*Viscum gracile* Polh. & Wiens	Pal
VITACEAE	*Cissus phymatocarpa* Masinde & L.E.Newton	Mucojo-Macomia
VITACEAE	*Cissus sylvicola* Masinde & L.E.Newton	Q

NEW RECORDS: MOZAMBIQUE – CABO DELGADO (37)

ACANTHACEAE	*Justicia anagalloides* (Nees) T.Anders.	Q
ANNONACEAE	*Xylopia aethiopica* (Dunal) A.Rich.	Mueda
APOCYNACEAE	*Aspidoglossum biflorum* E.Mey.	Pal
APOCYNACEAE	*Cynanchum viminale* L. subsp. *suberosum* (Meve & Liede) Goyder	HC
APOCYNACEAE	*Marsdenia cynanchoides* Schltr.	Q, Pal
APOCYNACEAE	*Schizozygia coffaeoides* Baill.	Pund
APOCYNACEAE	*Tacazzea apiculata* Oliv.	Pal
ARACEAE	*Gonatopus petiolulatus* (Peter) Bogner *	HC
BORAGINACEAE	*Coldenia procumbens* L.	Q, Rovuma
BURSERACEAE	*Commiphora africana* (A.Rich.) Engl. var . *africana*	Q
CARYOPHYLLACEAE	*Polycarpon prostratum* (Forssk.) Aschers.& Schweinf.	Pal
CELASTRACEAE	*Brexia madagascariensis* (Lam.) Ker-Gawl.	Pal
COMBRETACEAE	*Combretum butyrosum* (Bertol.f.) Tul	Q
COMBRETACEAE	*Pteleopsis barbosae* Exell (new to CD)	Macomia-Mucojo
DENNSTAEDTIACEAE	*Blotiella natalensis* (Hook.) R.M.Tryon	Mueda
EUPHORBIACEAE	*Caperonia stuhlmannii* Pax	NR
EUPHORBIACEAE	*Croton menyarthii* Pax	Nego, Q
EUPHORBIACEAE	*Drypetes arguta* (Müll.Arg.) Hutch.	Q
EUPHORBIACEAE	*Euphorbia ambroseae* L.C.Leach var. *spinosa* L.C.Leach	Q
EUPHORBIACEAE	*Oldfieldia somalensis* (Chiov.) Milne-Redh.	Nang/HC
EUPHORBIACEAE	*Phyllanthus pinnatus* (Wight) G.L.Webster	Nego
LEG: MIMOSOID	*Albizia zimmermannii* Harms	Mueda
LEG: PAPILION	*Vigna luteola* (Jacq.) Benth.	Q
LOGANIACEAE	*Strychnos panganensis* Gilg	Q
LORANTHACEAE	*Englerina inaequilatera* (Engl.) Gilli	Pal
MALPHIGIACEAE	*Acridocarpus natalitius* A.Juss. var. *natalitius*	NR
MELIACEAE	*Pseudobersama mossambicensis* (Sim) Verdc.	Pal
MENISPERMACEAE	*Jateorhiza palmata* (Lam.) Miers	Q
POLYGALACEAE	*Polygala sansibarensis* Gürke	NR
PTAEROXYLACEAE	*Ptaeroxylon obliquum* (Thunb.) Radkl.	Pal
RUBIACEAE	*Pavetta uniflora* Bremek.	Q
RUTACEAE	*Vepris lanceolata* (Lam.) G.Don	Pal
SAPINDACEAE	*Macphersonia gracilis* O.Hoffm. var. *hildebrandtii* (O.Hoffm.) Capuron	Pal
SOLANACEAE	*Solanum catombelense* Peyr.	Q
STERCULIACEAE	*Hildegardia migeodii* (Exell) Kosterm.	Lup
VIOLACEAE	*Rinorea ferruginea* Engl. *	Mueda
VITACEAE	*Ampelocissus obtusata* (Baker) Planch. subsp. *kirkiana* (Planch.) Wild & R.B.Drumm.	Q

LOCAL ENDEMICS – MOZAMBIQUE: N ONLY (31)

ANNONACEAE	*Hexalobus mossambicensis* N.Robson	HC
ANNONACEAE	*Xylopia* sp. nov.	Q, Pal
APOCYNACEAE	*Carvalhoa campanulata* K.Schum. sensu stricto endemic local form with auriculate base to leaf	Pal
ARACEAE	*Stylochaeton* sp. not matched (uncertain status)	Q
ASPARAGACEAE	*Asparagus* ?sp. nov.	Q
CAPPARACEAE	*Maerua andradae* Wild	Diaca, Macomia
CELASTRACEAE	*Pleurostylia* ?sp. nov. aff. *serrulata* Loes.	Pal, NR
COMBRETACEAE	*Combretum stocksii* Sprague	Nang, Mueda
COMBRETACEAE	*Pteleopsis barbosae* Exell	Macomia-Mucojo
COMPOSITAE	*Vernonia* ?sp. nov. aff. *inhacensis* G.V.Pope	Pal
CONVOLVULACEAE	*Ipomoea* ?sp. nov.	NR
CUCURBITACEAE	*Coccinea subglabra* C.Jeffrey	HC
ERYTHROXYLACEAE	*Nectaropetalum ? carvalhoi* Engl. if so, then 2nd record, and fls with long style	Q
FLACOURTIACEAE	*Casearia* ?sp. nov.	NR
LABIATAE	*Vitex* ?sp. nov. aff. *buchananii*	Pal, NR, Pund
LABIATAE	*Vitex* cf. *mossambicensis* Gürke, but corolla v. large	Q
LEG: CAESALP	*Micklethwaitia carvalhoi* (Harms) G.P.Lewis & Schrire	Q
LEG: PAPILION	*Baphia* ?sp. nov.	Pal
LEG: PAPILION	*Erythrina* ?sp. nov. not matched at K	Q, Lup
MALVACEAE	*Thespesia mossambicensis* (Exell & Hillc.) Fryxell	Q
MELASTOMATACEAE	*Warneckea* sp. nov.	Q
MELIACEAE	*Trichilia* ?sp. nov.	Nang-Pund
OCHNACEAE	*Ochna* ?sp. nov.	Pal, NR
RUBIACEAE	*Psilanthus* sp. nov. cf. sp. A of FTEA (especially Luke 10197)	Q
RUBIACEAE	*Pyrostria* sp. B of FZ	Q
RUBIACEAE	*Tarenna pembensis* J.E.Burrows	Pemba, Macomia, Mossuril
RUBIACEAE	*Tricalysia* sp. A of FZ	Q (and Moz Z)
RUBIACEAE	*Tricalysia* sp. B of FZ	Q
RUTACEAE	*Zanthoxylum lepreurii* Guill.& Perr. var./subsp. nov.?	Q
SAPINDACEAE	*Deinbollia* ?sp. nov. (= Luke et al. 10131 from Mueda)	Q
TILIACEAE	*Grewia limae* Wild	Q, NR

LOCAL ENDEMICS – MOZAMBIQUE: N & TANZANIA T8 (53)

ANNONACEAE	*Dielsiothamnus divaricatus* (Diels) R.E.Fr.	Mueda (T8, SMal)
ANNONACEAE	*Monanthotaxis trichantha* (Diels) Verdc.	Pal
ANNONACEAE	*Monodora minor* Engl. & Diels	Mueda, Pal (T6,8)
ANNONACEAE	*Xylopia collina* Diels	Pal
ANNONACEAE	*Xylopia* sp. A of FTEA	Pal, HC

APOCYNACEAE	*Carvalhoa campanulata* K.Schum. (sensu stricto, but delimitation dubious)	Q, Pal (1 coll T8)
ARACEAE	*Stylochaeton euryphyllus* Mildbr.	Q
BURSERACEAE	*Commiphora fulvotomentosa* Engl.	Q (T6,8)
CAPPARACEAE	*Maerua acuminata* Oliv.	Pal, Nang, Pund
CAPPARACEAE	*Ritchiea pygmaea* (Gilg) DeWolf (also reported from Katanga)	HC
CELASTRACEAE	*Salacia orientalis* N.Robson	Mueda
CLUSIACEAE	*Garcinia acutifolia* N.Robson	Pal, NR
CLUSIACEAE	*Vismia pauciflora* Milne-Redh.	Q, Nang
COMBRETACEAE	*Combretum andradae* Exell & J.G.Garcia	MRov
CONNARACEAE	*Vismianthus punctatus* Mildbr.	Q, Pal, Mueda
CUCURBITACEAE	*Peponium leucanthum* (Gilg) Cogn.	Pund (T6,8)
DICHAPETALACEAE	*Dichapetalum edule* Engl.	Q
DICHAPETALACEAE	*Dichapetalum macrocarpum* Engl.	NR
EBENACEAE	*Diospyros magogoana* F.White	Pal
EUPHORBIACEAE	*Croton kilwae* Radcl.-Sm.	Q
EUPHORBIACEAE	*Drypetes sclerophylla* Mildbr.	Q
LABIATAE	*Clerodendrum lutambense* Verdc.	Pal
LABIATAE	*Orthosiphon scedastophyllus* A.J.Paton	Q
LABIATAE	*Premna hans-joachimii* Verdc., ? plot voucher	
LABIATAE	*Vitex mossambicensis* Gürke	Q, Pal
LEG: CAESALP	*Berlinia orientalis* Brenan	Q, Pal, NR
LEG: MIMOSOID	*Entada stuhlmannii* (Taub.) Harms	Q
LEG: MIMOSOID	*Mimosa busseana* Harms	Q
LEG: MIMOSOID	*Pseudoprosopis euryphylla* Harms	Q
LEG: PAPILION	*Baphia macrocalyx* Harms	Pal
LEG: PAPILION	*Baphia* ?sp. nov.	Pal
LEG: PAPILION	*Millettia makondensis* Harms	Pal, NR
LEG: PAPILION	*Ormocarpum schliebenii* Harms	Q
LEG: PAPILION	*Pterocarpus megalocarpus* Harms	HC (& T6)
LINACEAE	*Hugonia grandiflora* N.Robson	Mueda
LORANTHACEAE	*Erianthemum lindense* (Sprague) Danser	Pal
OLACACEAE	*Olax pentandra* Sleumer	Q, Nang, Macomia (T6,8)
RUBIACEAE	*Catunaregam stenocarpa* Bridson	Q (& Moz: Z)
RUBIACEAE	*Coffea schliebenii* Bridson	NR
RUBIACEAE	*Cuviera semsei* Verdc. (also in S Malawi)	Q
RUBIACEAE	*Didymosalpinx callianthus* J.E. & S.M.Burrows, sp. nov.	NR
RUBIACEAE	*Leptactina papyrophloea* Verdc.	Q, Pal
RUBIACEAE	*Oxyanthus* sp. A of FZ	Q, Pal
RUBIACEAE	*Oxyanthus* sp. = Bidgood et al. 1341, 1364 & Clark 29 (=*Oxyanthus* cf. sp. A of FTEA)	NR
RUBIACEAE	*Pavetta lindina* Bremek.	Q, Pal
RUBIACEAE	*Pavetta lutambensis* Bremek.	Macomia/Mucojo (T6,8)
RUBIACEAE	*Pavetta macrosepala* Hiern var. *macrosepala*	NR
RUBIACEAE	*Pyrostria* sp. D of FTEA	NR, Nang
RUBIACEAE	*Tarenna* sp. 53 of Degreef = Bidgood et al. 1357	Q

RUBIACEAE	*Tricalysia schliebenii*Robbr.	Q, NR
RUBIACEAE	*Tricalysia semidecidua* Bridson	Q, Pal, NR
RUTACEAE	*Zanthoxylum lepreurii* Guill.& Perr. var./subsp. nov.?	Q
STERCULIACEAE	*Cola* ? *discoglypremnophylla* Brenan & A.P.D.Jones	Q (T8, ?6)

REGIONAL ENDEMICS – CENTRAL/NORTHERN MOZAMBIQUE TO CENTRAL TANZANIA

ANNONACEAE	*Dielsiothamnus divaricatus* (Diels) R.E.Fr. (also in Malawi)	Q
APOCYNACEAE	*Marsdenia cynanchoides* Schltr.	Q, Pal
BURSERACEAE	*Commiphora serrata* Engl.	Q
DICHAPETALACEAE	*Dichapetalum mossambicense* (Klotzsch.) Engl.	Q
FLACOURTIACEAE	*Buchnerodendron lasiocalyx* (Oliv.) Gilg.	Q
MORACEAE	*Bosqueiopsis gilletii* De Wild.& T.Durand E African form (?subsp. nov.)	Pemba, Q
LEG: CAESALP	*Guibourtia schliebenii* (Harms) J.Léonard	Q
LEG: PAPILION	*Millettia impressa* Harms subsp. *goetzeana* (Harms) Gillett	Q, Pal
RUBIACEAE	*Pavetta decumbens* K.Schum.& K.Krause	Q
TECOPHILAEACEAE	*Kabuyea hostifolia* (Engl.) Brummitt	Q
VISCACEAE	*Viscum gracile* Polh. & Wiens	Pal

PLANTS AT SOUTHERN LIMIT OF E AFRICAN COASTAL (SWAHELIAN) DISTRIBUTION

ACANTHACEAE	*Whitfieldia orientalis* Vollesen	Nhica-Mueda
ANNONACEAE	*Artabotrys modestus* Diels subsp. *macranthus* Verdc.	Q
ANNONACEAE	*Letowianthus stellatus* Diels	Q
ANNONACEAE	*Monanthotaxis faulknerae* Verdc.	Pal
ANNONACEAE	*Uvaria acuminata* Oliv.	Q, Pal
ANNONACEAE	*Uvaria kirkii* Oliv.	Q
APOCYNACEAE	*Ancylobothrys tayloris* (Stapf) Pichon (+ 1 coll. Mulanje)	Q
ARALIACEAE	*Cussonia zimmermannii* Harms	NR
BALANITACEAE	*Balanites maughamii* Sprague subsp. *acuta* Sands	Pal, NR
CLUSIACEAE	*Vismia orientalis* Engl.	Q
CAPPARACEAE	*Maerua grantii* Oliv.	MRov
COMBRETACEAE	*Combretum constrictum* (Benth.) Laws.	Q
COMBRETACEAE	*Combretum illairii* Engl.	Q
COMBRETACEAE	*Combretum xanthothyrsum* Engl.& Diels	NR
CONNARACEAE	*Rourea coccinea* (Schumach.& Thonn.) Hook.f. subsp. *boiviniana* (Baill.) Jongkind	Q, Pal
DICHAPETALACEAE	*Dichapetalum stuhlmannii* Engl.	Macomia
EBENACEAE	*Diospyros kabuyeana* F.White	Pal, NR
EBENACEAE	*Diospyros shimbaensis* F.White	Pal

EUPHORBIACEAE	*Drypetes arguta* (Müll.Arg.) Hutch.	Q
EUPHORBIACEAE	*Oldfieldia somalensis* (Chiov.) Milne-Redh. (also Moz: Z)	Nang/HC
EUPHORBIACEAE	*Ricinodendron heudelotii* (Baill.) Hechel subsp. *africanum* (Mull.Arg.) J.Léonard var. *tomentellum* (Hutch.& E.A.Bruce) Radcl.-Sm.	NR
LABIATAE	*Endostemon albus* A.J.Paton & Harley	Pal
LABIATAE	*Premna gracillima* Verdc.	Q
LABIATAE	*Premna schliebenii* Werderm.	Q
LEG: CAESALP	*Dialium holtzii* Harms	Q, NR
LEG: PAPILION	*Dalbergia bracteolata* Baker	Q, Pal
LEG: PAPILION	*Erythrina sacleuxii* Hua	Pal
LOGANIACEAE	*Strychnos xylophylla* Gilg	Q
MYRTACEAE	*Eugenia capensis* (Eckl.& Zeyh.) Sond. subsp. *multiflora* Verdc.	NR
ORCHIDACEAE	*Microcoelia physophora* (Rchb.f.) Summerh.	Q
PASSIFLORACEAE	*Adenia kirkii* (Mast.) Engl.	Q
POLYGALACEAE	*Polygala sansibarensis* Gürke	NR
RUBIACEAE	*Chassalia umbraticola* Vatke	Q
RUBIACEAE	*Gardenia transvenulosa* Verdc.	Q, Pal
RUBIACEAE	*Heinsia zanzibarica* (Bojer) Verdc.	Pal
RUBIACEAE	*Kraussia kirkii* (Hook.f.) Bullock	Q, NR
RUBIACEAE	*Psydrax kaessneri* (S.Moore) Bridson	Q
RUBIACEAE	*Rothmannia macrosiphon* (Engl.) Bridson (probably - in bud)	Pal
RUTACEAE	*Zanthoxylum holtzianum* (Engl.) Waterm. subsp. *holtzianum*	Q, Pal, NR
SAPINDACEAE	*Haplocoelum inophloeum* Radkl.	Q
STERCULIACEAE	*Sterculia schliebenii* Mildbr.	Q, Pal
THYMELAEACEAE	*Synaptolepis kirkii* Oliv. sensu stricto	Q, NR
TILIACEAE	*Grewia holstii* Burret	Pal
TILIACEAE	*Grewia stuhlmannii* K.Schum.	Macomia, HC
VITACEAE	*Cissus sylvicola* Masinde & L.E.Newton	Q

ANNEX 4.

Summary of findings from species-richness plot, Quiterajo, 25 Nov 2009.

	subplots				
Species	**A**	**B**	**C**	**D**	**total**
Acacia adenocalyx	•	•	•	4	**4**
Caloncoba welwitschii			1		**1**
Carpolobia goetzei	2				**2**
Combretum illairii	•				
Combretum sp.				•	
?Combretum (climber, yellow flowers)		•	4		**4**
Commiphora sp.			1		**1**
Croton pseudopulchellus	•		3	•	**3**
Deinbollia sp. nov.	4	3	•	3	**10**
Dichapetalum sp.		•			
Diospyros abyssinica subsp. abyssinica	3	1	4	6	**14**
?Drypetes (tree, sclerophyllous leaves)	4	•	1	1	**6**
Euphorbia lividiflora			•		
?Flacourtiaceae (tree, to canopy)	•	1		1	**2**
Grewia sp.	•				
Guibourtia schliebenii	23	17	11	20	**71**
Holarrhena pubescens		2	3		**5**
Lannea antiscorbutica	1		1		**2**
Manilkara discolor	3				**3**
Memecylon natalense / flavovirens	5	4		14	**23**
Memecylon torrei	•		•	3	**3**
Millettia impressa subsp. goetziana	•	•	3	2	**5**
Mostuea brunonis	•	3	1	3	**7**
Ophrypetalum cf. odoratum			1	1	**2**
Oxyanthus sp. A of FZ		1			**1**
Premna gracillima			5	3	**8**
Pseudoprosopis euryphylla	•	•	4	4	**8**
Pteleopsis myrtifolia	3	2			**5**
Pyrostria ?		•			
Rinorea angustifolia subsp. ardisiiflora	10	9	5	8	**32**
Rotheca incisa			2	2	**4**
Rubiaceae 1	•				
?Rubiaceae (tree, green peeling bark)		•			
Rytigynia ?	•	2		1	**3**
Salacia cf. leptoclada	•	•		•	
Schlechterina mitostemmatoides	•				
Strophanthus petersiana	•	1	1		**2**
Strychnos henningsii		3	1		**4**
Synaptolepis kirkii		•	•		
Vismianthus punctatus	•	•		1	**1**
Vitex mossambicensis	6	5	4	3	**18**
Warneckea sansibarica	5	9	11	10	**35**
Warneckea sousae	•	4	4	3	**11**
Xeroderris stuhlmannii			1		**1**
Xylopia sp. nov.	6	8	6	10	**30**
Zanthoxylum sp.				1	**1**

Note: Numbers refer to stems 6 cm dbh or greater; dot signifies presence of smaller sizes.

in partnership with

COASTAL DRY FOREST IN CABO DELGADO PROVINCE, NORTHERN MOZAMBIQUE

ZOOLOGY

February 2011

Jean-Yves Rasplus
With the contributions by I. Bampton, C. Congdon, A. Cruaud, J.M. Duplantier, N. Madogolele, I. Ineich, J. Fuchs, M. Leponce, M. Martinez, O. Montreuil, I.V. Muratov, A.M. Ohler, J.M. Pons, T. Robillard, C. Villemant

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INTRODUCTION

Justification for choosing Coastal Forests

Lying on the north coast of Mozambique and occupying a non-negligible area, the coastal dry forests of Mozambique represent one of the largest remaining fragments of a forest mosaic that once stretched from southern Somalia to northern Mozambique. The forest habitat in this region has become fragmented, with many forest patches now more or less disturbed. The remaining natural habitats are becoming more fragmented as agriculture and other human activities spread. While the floristic composition and the vertebrate biodiversity of the Eastern African Coastal Forests Ecoregion is relatively well known (see the Botany section), the non vertebrate fauna is still under-explored with the exception of a few flagship groups (i.e. butterflies, dragonflies, dung beetles etc.). The terrestrial expeditions organized in 2008 and 2009 into the coastal dry forests of north Mozambique have partially investigated groups of vertebrates (amphibians, reptiles, birds, bats and rodents) and concentrated on several non-vertebrate taxa (including terrestrial snails and insect). The reasons for selecting these taxa are detailed here and mostly depend on the scientific questions that we expect to answer.

Main questions adressed by the zoological survey

- **Are the investigated areas more diverse than equivalent forest patches in southern Tanzania or Kenya ?**

To address this question and better evaluate the biogeographic and biodiversity values of the targetted forest fragments, we focussed on taxa that have been extensively studied in other dry coastal forest fragments in East Africa. Consequently, we proposed to include amphibians and rodents, two groups of vertebrates that are relatively well known and can reveal potential novelties, as cryptic species complexes seem to be frequent and under-investigated (see the discussion under these groups here under). The non-vertebrate fauna is largely under-investigated in the area and consequently we decided to select taxa that have been extensively studied elsewhere in the coastal dry forests of east Africa. Consequently, we proposed to study more thoroughly during the first expedition the taxa for which well-documented inventories are available for elsewhere in East Africa and that are still under investigation by active taxonomists. The taxa that best fit these characteristics are: Lepidoptera (butterflies and some groups of large moths), Coleoptera (dung beetles and Cerambycidae) and Orthoptera.

- **What is the level of endemism occurring in the northern Mozambique coastal dry forests ?**

To better address this question, we proposed to focus on :

1. Groups of non-vertebrate taxa that exhibit both relatively low vagility (low dispersion power) and strong habitat specificity. Molluscs and Apterous species of arthropods fit well, at least partially, with these characteristics. We also proposed to investigate groups that are either nocturnal or at least crepuscular so that their sampling will not overlap with the collection of the previous taxa that are either diurnal (butterlies, dung beetles) or are caught by light trapping (moths, some kadytids and crickets). The selected apterous insects belong to Hymenoptera Mutillidae and Coleoptera Tenebrionidae.

2. Groups of phytophagous arthropods that are associated with endemic plant species found by the botanists. Because that is still to be determined, we proposed to collect all the associated and accessible phytophagous fauna associated with the endemic plants (phyllophagous, xylophagous or seed-feeding insects).

- **What is the overall richness of this newly investigated area ?**

The manner we proposed to investigate this question is less specific and in some way relies on the protocols determined by the All Taxa Biodiversity Inventories (Sharkey, 2001). Consequently, we sampled a large variety of taxa through unspecific trapping and netting (Malaise, berlèse, yellow pan and pitfall traps or light trapping). To do so, we disposed of a predetermined and optimal battery of traps in the different forest fragments or forest types that were being investigated by the botanists. The material collected was sorted down to families and morphospecies and sent to a network of collaborating taxonomists.

Zoological task force

The 2008 and 2009 collecting trips have permitted 16 zoologists (see annex 1) to sample in different localities around the village of Nhica do Rovuma (Palma District, Cabo Delgado Province). They totalled altogether 142 man days of cumulative sampling. Four zoologists spent about 14 days on the site while most of the others spent less than 9 days sampling. All the zoologists have prospected the area of Nhica do Rovuma and 7 sampled at Quiterajo. Finally 2 entomologists sampled arthropods on Vamizi island during three days.

The results presented here are still preliminary and are insufficient to accurately compare the diversity and richness of insects and other groups that occur in other dry forests of East Africa. However, our first results already bring interesting novelties that highlight the value of the prospected areas for future conservation projects.

STUDIED AREAS AND SAMPLING METHODS

Prospected sites

- **Nhica do Rovuma (N) and around**

The camp (10° 45.357’ S – 40° 13.064’ E) was situated close to a pan about 2 km east of the village of Nhica do Rovuma. Due to the high quality of dry coastal forest found in 2008, this area was prospected both in 2008 and 2009. Within this area, we mostly sampled invertebrates in a well-preserved fragment of dry coastal forest along oil cutline 34. The vicinity of the lake (10° 42.684’ S – 40° 12.339’ E) as well as the forest along the Rovuma river were also intensively prospected.

- **Pundanhar (P)**

Collecting trips were organised to prospect the areas of dry forest (10° 49.428' S - 40° 0.520'E) along the Rovuma river near the village of Pundanhar, about 20km west of the campsite. Light trapping and day prospection were organised and produced interesting taxa that were not collected elsewhere, especially species associated with riverbanks.

- **Cabo Delgado (C)**

The area of coral rag limestone close to the Cabo Delgado peninsula was also visited, especially for sampling molluscs. At the time of our visits, this area hosted poor insect assemblages due to the high temperature and dryness occurring in November. However, we were able to sample interesting mollusc species that were not found elsewhere.

- **Quiterajo (Q)**

This area of dry forest hosted a large population of elephants and consequently elephant dung was intensively prospected in this area both in 2008 and 2009. The prospected area is a mosaic of savanna and dry coastal forest that is nearly undisturbed in some places.

- **Vamizi island (V)**

This island received the visit of two entomologists who prospected the rather poor assemblages of insects associated with sand and coral reefs. Two Malaise traps were set up during one week on a dry reef. Due to the isolation, the poor vegetation and the few mammals inhabiting the island, dung beetles as well as phytophagous insects were relatively rare and poorly diversified.

Sampling methods

- **Vertebrates**

Amphibian specimens were sampled from 20 to 29 November 2009 at night with help of a headlight by opportunistic collecting or by searching for calling males, or at daytime by exploring suitable hiding places (leaf litter, rotten wood, stones). Several freshwater habitats (Nhica lake, backwaters of Rovuma river, pans or 'Pantanos') and different kinds of terrestrial habitat (dry forest, forest on termite mounds, marshes near the Rovuma river, dried out pans / 'Pantanos') were prospected. Specimens were caught by hand, kept in plastic or tissue bags. Specimens were anesthetized with 1,1,1-Trichloro-2-methyl-2-propanol; tissue samples of the femoral muscle were taken from every specimen and preserved in 70° alcohol (Merck). Specimens were fixed for 24 h in 4 % formalin and transferred to 70 % alcohol for storage. Species allocation was attempted on morphological and morphometric characters using guidebooks (Channing & Howell 2006, du Preez & Carruthers 2009), specialized literature for particular species and comparative material from the MNHN collection. Barcoding using 16S and COI sequences was performed on tissue samples (analysis in progress).

Birds were captured at two primary sites: close to the main camp (Site 1: 2 kms from Nhica do Rovuma, S 10° 45.357'– E 40° 13.064') and close to the lake (Site 2: 3 kms from Nhica do Rovuma, S 10° 42.684'– E 40° 12.339'). Birds were captured using 5-10 mist nets. Nets were opened every day one hour before sunrise and left open until two hours after sunset. Ground dwelling birds (e.g. greenbuls, robins, bulbuls) were also captured using up to 10 non-invasive flat traps baited with mealworm. We also used binoculars and song/calls to identify bird species at distance and complement the inventory. We collected a representative number of specimens as standard museum skins. The specimen vouchers are presently deposited in the collections of the Muséum National d'Histoire Naturelle, Paris (France). Tissue samples, preserved in RNAlater buffer or 95% ethanol, are associated with all collected specimens. Individuals that were not collected were measured (body mass, bill length from tip to skull, bill width and depth at the distal part of the nostril, wing length, tail length and tarsus length), blood sampled and specimens photographed before being released. We also recorded any sign of molt, fat or reproductive condition (e.g. presence of a brood patch).

Terrestrial molluscs

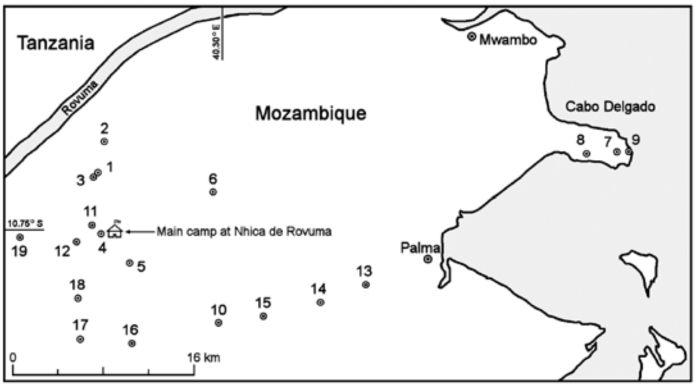

Fig. 1. Map of the prospected sites for molluscs

Living specimens and empty shells were hand-picked from under rocks and under the bark of fallen trees, on trunks and leaves, on the ground, and in leaf litter. Living specimens were photographed and were then frozen in a small amount of water and defrosted in 96% ethanol to insure the preservation of DNA and a relaxed condition for future anatomical studies. Only the empty shells, often in a very bad condition, were found for most of the species because the field work was carried out at the end of the dry season and most of the molluscs were hiding deep in the ground. All the stations were placed within the north-eastern part of Cabo Delgado province of NE Mozambique with three stations on Cabo Delgado (peninsula) itself (Fig. 1).

Arthropods

- *Opportunistic sampling (every day)*

Daily surveys were used to collect dragonflies/damselflies (Odonata) and butterflies (Rhopalocera) by net, together with the particular groups: Cicindelidae, Mutillidae and Asilidae. Woodboring insects were collected through opportunistic collecting during the day and by investigating tree stumps in the recently cleared areas at night. At the same time, we also swept 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 (17 nights)*

We used a classic light trap consisting of a white sheet of cloth, behind a UV mercury vapour lamp. A total of 17 light-trapping nights were carried out at 6 different sites, giving about 100 trapping hours. Different habitats have been collected in: a promontory looking over dry forest (Q), a landing strip near dry forest (Fig. 2A) (Q), a marshy area in the forest (N), a cleared area near a lake and dry forest (N), the vicinity of the camp (N) and in areas of savannah surrounding islands of forest (Q).

- *Barber trap (8 days)*

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. 2D). 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).

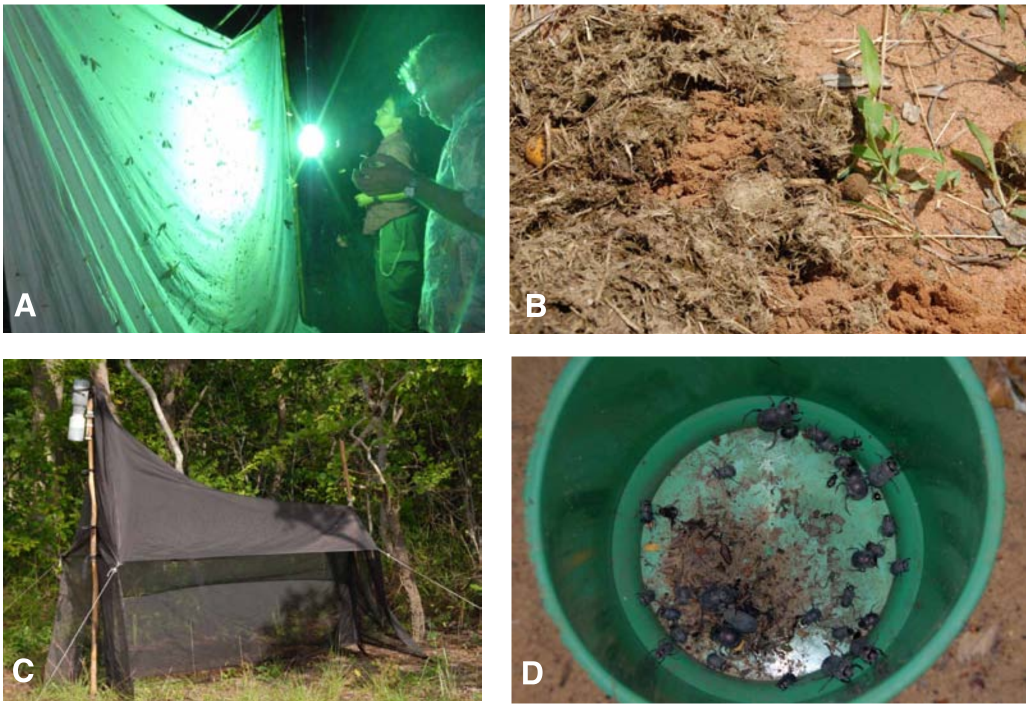

Fig 2. A. Light trap in Nhica do Rovuma, B. Fresh elephant dung showing the digging and rolling activities of dung beetles in the morning at Quiterajo, C. Malaise trap set up along the forest edge at Nhica-de-Rovuma, D. Barber trap in Quiterajo, E. Preparing insect for storage. F. Dung beetles layer.

Photos © JY Rasplus

- *Malaise traps (Nhica during 22 days)*

At the Nhica do Rovuma site, we installed two sets of 4 Malaise traps at the forest edge and line 34. These traps (Fig. 2C) remained in place throughout our stay, during both the 2008 and 2009 expeditions. They enabled the sampling of numerous Hymenoptera and Diptera living in forest habitats. This collection supplemented the sweep netting and allowed us to better estimate the richness of the insect fauna for the groups that were not targetted during the first trip, but which have been covered by entomologists during the 2009 expedition. These traps have been particularly productive and have provided several thousand specimens. This material is currently being sorted.

- *Sampling in elephant dungs*

In two localities (Nhica and Quiterajo), we looked for and collected dung beetles in elephant dung (Fig. 2B). There are large populations of these animals in the area, so it was possible to gather a large number of dung beetles associated with these faeces, especially in Quiterajo. The surveys were conducted by searching the underlying soil to a depth of 40 cm. Several thousand specimens were collected (Fig. 2F).

Sampling for DNA barcoding

For most groups studied by the zoologists (with the exception of CITES species), we also took DNA samples for sequencing and barcoding of the specimens. Specimens have been conserved in 95% alcohol, and sequencing is in process.

FINDINGS

Vertebrates

Our inventories remain largely preliminary (Table I) and cannot accurately reflect the originality and diversity of the fauna of the prospected areas. More intensive sampling throughout the whole year, and especially during the best period of the year (at the beginning of the rainy season) is needed to better evaluate the overall richness of the fauna of the remnants of dry forests of Cabo Delgado.

Taxa	Specimen N	Species N	DNA samples
Amphibians	188	38	160
Reptiles	230	43	81
Birds	236	92	236
Bats	6	3	6
TOTAL	660	176	483

Table I. Vertebrate sampling at Nhica-do-Rovuma

- **Amphibians**

Amphibians are undergoing a drastic global decline. Paradoxically, the number of amphibian species known to science is increasing with many new species discovered annually. Recent studies (Elmer *et al.*, 2008; Fouquet *et al.*, 2007; Stuart *et al.*, 2006) show that deep phylogenetic divisions among clades can be found in frogs and that these divergences strongly suggest that there is complete reproductive isolation among these clades, even when they are sympatric.

A total of 188 specimens (23 in 2008 and 165 in 2009) belonging to 32 species were collected and two further species observed and photographed. No larvae could be collected as the rainy season was just starting during the collection period. In one single species (*Phrynobatrachus accridoides*), egg laying was observed on 28 November. In most other species, males were in breeding condition, showing secondary sexual characters and calling behaviour. Several specimens of *Hyperolius* could not be allocated to species and need further study. The genus *Hyperolius* (Fig. 3A) currently holds about 130 species, which show intraspecific diversity in color pattern and little interspecific morphological variation (Veith *et al.*, 2009). Species allocation is quite difficult in this group, as for many species only old, poor descriptions are available. Probably a more thorough taxonomic study including comparison to type specimens and other collection material is needed to properly assess the identity of these species.

In the genus *Arthroleptis* (Fig. 3B), three sympatric species were collected and mating calls registered. The taxonomy of these “little brown frogs” (Schick *et al.*, 2010) is very difficult due to the absence of morphological differentiation. The genus occurs in forest areas all over sub-Saharan Africa. Recent studies on the phylogeny of this genus allowed the description of several new species. In the Mozambique lowlands currently a pigmy species (*Arthroleptis xenodactyloides*) and a small species (*A. stenodactylus*) are recognized. We found a second small sized species, which can be distinguished by morphology. Evidence from DNA and advertising calls is available for an integrative approach to this taxonomic problem.

A total of 32 anuran species, in a rather homogenous habitat, observed over a short period of poor climatic conditions is a very satisfying result. The various sites studied contain a variable number of species. These numbers must be corrected by the period of observation expressed by the number of nights of observation. The most profuse habitat was the *Kassina* pond and its surrounding forest with 17 species observed. The second richest locality was the surroundings of the Nhica lake with a total of 13 species observed in 4 nights. The temporary pond visited in 2008 held 12 species (over a 7 day period). The species diversity of the Rovuma backwaters (8 species) and Hippo pond (7 species) are under-represented due to limited exploration (only 1 night). The surroundings of the base camp (dry forest, dried out Pantanos) were explored in a single night, but observations were made casually and led to a total of 7 species. In the swamp near the Rovuma backwater, 5 species were observed.

The collection period was conducted at the beginning of the breeding season which should start with the onset of the rainy season. Breeding males were observed near their aquatic breeding site (ponds, lake) for species with free larval development (*Hyperolius*, *Ptychadena*, *Phrynobatrachus*). One particularity of the anuran fauna of the East African lowlands is the presence of species with direct development which excludes the free larval phase in water: the embryo goes through modified ontogenetic stages until eclosion as a perfect small froglet within the envelope of the egg. As anurans have no protective membranes they need high environmental humidity to complete the development of the eggs. Among the observed frogs, the species of *Arthroleptis* and *Breviceps* show such a life history. The specimens collected made their calls far from water bodies in forest areas on sandy soils.

Fig. 3.

A. *Hyperolius parkeri*

B. *Arthroleptis stenodactylus*.

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C. *Breviceps mossambicus*,

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The list of species is part of the fauna of the East African Lowlands as defined by Poynton & Broadley (Poynton & Broadley, 1991). The authors included 36 species in this group, many of them having wide distributions. We found 23 of these 36 species. The wider area has been rather intensely studied since the first half of 19th century. Despite these intense studies our knowledge of this fauna is not complete. The taxonomic problems encountered in this preliminary work might lead to the uncovering of more sibling species.

A particular interesting fact is the presence of *Arthroleptis xenodactyloides*. Poynton & Broadley (1991) found this species linked to forest cover at lower altitudes and thus has a restricted range. The presence of this species clearly indicates the biodiversity values of the forest in the Nhica region.

For three species, their known range was extended to the south: *Mertensophryne micranotis, Mertensophryne loveridgei* and *Arthroleptis brachycnemis*, which where known previously only from lowland forests of Tanzania and Kenya. These species are thus new to Mozambique.

The differences in the species present in the different localities collected might be correlated with the different vegetation types available in these habitats. The *Kassina* pond is a rather small water body surrounded by short reeds with a dry forest nearby. A large part of the shore of the Nhica lake is bordered by reeds, whereas in other parts the forest comes close to the lake edge. Nevertheless the differences among habitats are quite small and a large part of the differences between localities might be due to insufficient exploration. Even for the overall species list of the Nhica area the plateau of the species accumulation curve was not reached as new species were still being added every day until the end of study.

The presence of a sibling species of *Arthroleptis stenodactylus* confirms the interest of the fauna. And it indicates also that the exploration of amphibian biodiversity is still not closed, even in a comparatively well-studied area such as the East African lowlands.

- **Reptiles**

The reptile fauna of Mozambique was reviewed by Peters (1882; see also Bauer, 2004), when faunal studies in the region were in their infancy. Large tracts of the country were then unexplored, and this remained the situation for much of northern Mozambique until past 2000. The herpetofauna of northern Mozambique still remains one of the most poorly known in Africa. This is a consequence of the inaccessibility of the region in general and the protracted civil war in particular (1962-1992). The southern part of the country, i.e. south of the Zambezi River, has traditionally been incorporated into the southern African region and its fauna has been dealt with in numerous reviews of the subcontinent (e.g. Branch, 1998; Channing 2002). However, the region north of the Zambezi, including the provinces of Zambezia, Nampula, Niassa and Cabo Delgado, remains scientifically poorly known and many regions lack even preliminary surveys. In a zoogeographic analysis of the amphibians of the 'Zambesiaca' area (Botswana, Zambia, Malawi, Mozambique, Zimbabwe, and eastern Caprivi Strip), Poynton and Broadley (1991) noted that large tracts of northern Mozambique were poorly known or uncollected, and only 23 localities for any amphibian were known for the area 14° to 18° S and 36° to 42° E, with most restricted to the coastal region. Reptile collections from the region are similarly meagre. However, an important herpetological survey (amphibians and reptiles) was operated recently in 2003 and 2004 in the Niassa Game Reserve [NGR, Niassa Province] by Bill Branch (Report of Branch, 2004). Integration of the NGR results (Branch *et al.*, 2005) indicates that approximately 100 reptile species may occur in northern Mozambique.

Our field trip permitted the collection of reptiles east of NGR in an area and a province (Cabo Delgado) that herpetologically was not prospected previously. The area comprises a typical coastal dry forest with miombo formations and numerous termitaria. We spent 12 days in the field around the village of Nhica do Rovuma (10° 44.165'S / 40° 12.421'E), just beside the Tanzanian border constituted by the Rovuma River.

Specimens were mostly located opportunistically, during visual surveys of all habitats by up to three people (author and two villagers). Surveys were undertaken during the day and sometimes during the evening, including by other scientists during amphibian night surveys. Reptiles were mostly collected by hand but we sometimes used glue traps (without success). Species listed on the CITES appendix (turtles, cameleons and varanids) were collected but not preserved; pictures of them were made before animals were released but DNA samples were generally not taken. As access within the Nhica do Rovuma area (NDRA) is very difficult during the rainy season, the survey was undertaken at the interface between the end of the long dry season with the beginning of the summer rains, from 19 to 30 November 2010. Our survey was supplemented with additional photo records (no vouchers specimens) collected in the same area and around Palma during 2007 and 2008 by the Canadian oil exploration company ARTUMAS for an Environmental Impact Study (EIS) during the making of cut-lines for seismic studies, as well as by scientists from our team during the 2008 field survey.

A total of 230 voucher specimens were collected, and photos taken of live animals before they were anaesthetized by injecting the heart with sodium pentabarbitol. Tissue samples (ventral scales area for snakes, leg muscles or tail tips for lizards) were taken from most specimens and placed in pure ethanol before specimens were placed in 10% formalin. Once deposited at the MNHN collection all specimens were transferred to 75° ethanol. A representative collection of specimens will be lodged in the National Museum of Mozambique (Maputo) after study.

During our field trip we collected or observed a total of 35 non avian reptile species including three turtles, one crocodile (a jaw found on the lake edge), one amphisbaenid, 20 lizards [including one littoral skink collected around Pemba] and 10 snakes (See Annex 2). We also collected 81 DNA samples belonging to 28 distinct species. Numerous pictures were taken including habitats and 79 reptiles belonging to 29 distinct species. Additional collections or observations made before our field trip (pictures available to us) allows the addition of at least 5 more species for the Nhica do Rovuma area: *Rieppeleon brachyurus* (Chamaeleonidae), *Python natalensis* (Pythonidae), *Mehelya* sp. (probably *M. nyassae*) and *Scaphiophis albopunctatus* (Lamprophiidae), and *Bitis gabonica* (Viperidae). Several other species only available as pictures are on the way to being determined and will certainly add 2-3 additional species for the area. Note also that we collected 5 specimens (and DNA samples) of the littoral snake-eyed skink *Cryptoblepharus boutonii* along the rocky beach in Pemba.

Our specimens from the Nhica do Rovuma area represent about 30-35% of the reptiles that occur in Mozambique (about 170 species) but about 50% of those known for northern Mozambique (about 100 species). We collected or observed a total of 43 species (Fig. 4), a diversity similar to the 56 species obtained in the NGR (Niassa Province; Report of Branch, 2004).

Our collected amphisbaenid, that we refer to as *Chirindia swynnertoni*, is the first record for the country (species known from Malawi and Tanzania) and the most interesting species from our trip. Its identification has to be checked carefully. All our other collected species were previously known from northern Mozambique (north of Zambezi River) but most of them constitute new records at least for Cabo Delgado Province or even for the larger northern Mozambique area; several of them were not reported from the NGR survey (lacertids, *Cordylus tropidosternum*, *Gerrhosaurus nigrolineatus*, ...).

The season of our field trip also allowed us to observe and make pictures of species during their nuptial colouration (*Agama mossambica*; *Panaspis wahlbergii*, lacertids, …), which is of interest for a better knowledge of their morphological variations. Note also that a comparison of our *Panaspis wahlbergii* sample with MNHN specimens from other countries showed some significant and constant differences that require further DNA analysis to verify species allocation. That species also shows an important sexual dimorphism for scalation, colouration and body shape. Finally the numerous tissue samples that we obtained will be of considerable help to obtain a better knowledge of species boundaries for many problematic widespread southern African species.

Fig 4.
A. *Causus defilippi* is a common frog-eating night adder in the Cabo Delgado Province,
B. *Chamaeleo melleri*, the largest African chameleon and common in the studied area.
C. *Cordylus tropidosternum* is a cordylid lizard often found in dead trees or under bark,
D. *Gerrhosaurus nigrolineatus*, a large fast moving lizard,
E. *Kinixys belliana*, a common tortoise with beautiful dorsal markings,
F. *Panaspis* cf. *wahlbergii* population of the studied area are of uncertain specific attribution. Their specific status has to be checked through DNA analysis.
G. *Trachylepis maculilabris* is a widespread species but status of its different populations is not totaly confident.
H. The lacertid *Ichnotropis squamulosa* is not common in northern Mozambique.
© I. Ineich

- **Birds and bats**

In addition to birds, a small number of bats were also collected using the same mist nets and the same sampling sites as for birds. Since we mostly focussed on bird captures and owing to the very dry climate conditions that prevailed during our stay we were only able to trap three bat species (Annex 2). Such a small species number precluded the possibility to draw any conclusions about the local bat assemblage.

Bird species assemblage

Two hundred and thirty six individuals were caught in mist nets and flat traps, and all were sampled for DNA (Appendix 1). 57 specimens (42 species) were collected as standard museum skins. All together, 92 species were recorded close to Nhica do Rovuma. We caught the 236 individuals at two sites (Site 1: 143 individuals, 40 species, 6 days; Site 2: 93 individuals, 30 species, 4 days). In addition thirty three species were only identified at distance using binoculars and calls; those species were mostly waterbirds, raptors, hornbills or species that forage in the canopy (Annex 2). Four species that are endemic to the Dry Coastal Forests of Eastern Africa were recorded, namely the Eastern Green Tinkerbird (*Pogoniulus simplex*), the East Coast Nicator (*Nicator gularis*), Fischer's Greenbul (*Phyllastrephus fischeri*) and the globally Near-Threatened East Coast Akalat (*Sheppardia gunningi*). The latter constitutes a newly discovered population. We also collected one Rufous Cheeked Nightjar (*Caprimulgus rufigena*) that may represent a range extension although this record needs to be validated.

From a biogeographic point of view, the species recorded represent a typical assemblage of species adapted to open woodland and savannah but some miombo specialists were also recorded (e.g. *Lamprotornis elisabeth*). Most of the species recorded represent widespread species across Africa or represent species that are found in Eastern and Southern Africa, starting south from Northern Limpopo Province in South Africa and ending north in Kenya. We also recorded some species that breed in the Palaearctic and winter in Africa (e.g. *Caprimulgus europaeus, Merops persicus*) (Fig 5).

We still consider this first inventory for the area as very preliminary since the conditions were very dry, with no fruiting trees. Hence it is very likely that a whole guild of birds were not present at that part of the year. Additional sampling sessions would thus be necessary to better describe the avifauna characteristics of this region and assess its originality. Our preliminary results suggest nevertheless that endemism at the species level among birds, that generally exhibit high dispersal abilities, is probably low in the region of Nhica do Rovuma. Due to its geographical localization, it is worth to noting that the tissue samples collected in this poorly prospected region will provide useful information for understanding the phylogeography of several species whose ranges encompass eastern and southern Africa.

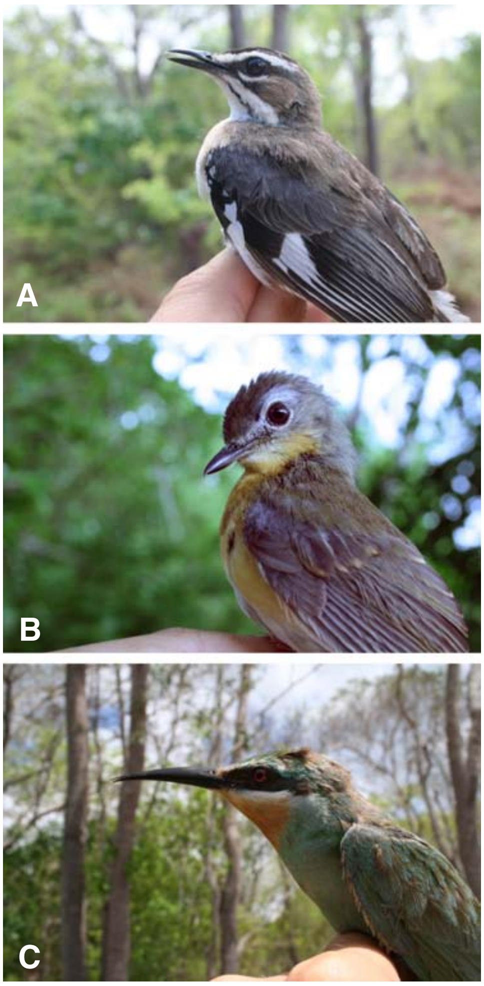

Fig 5. A. The bearded scrub-robin (*Cercotrichas quadrivirgata*) is a typical species of savanna woodland. This species has a wide geographical distribution ranging from south Somalia to South Africa. Two bearded scrub-robins were trapped near Nhica do Rovuma. B. The east coast akalat (*Sheppardia gunningi*) is a polytypic species. It occurs in eastern and southern Africa including central Mozambique but was not previously recorded in the northern region of Cabo Delgado. C. The blue-cheeked bee-eater (*Merops persicus*). *M. p. persicus* breeds across the Middle East up to India eastward and winters in East tropical Africa. It is a common winter resident in the Nhica do Rovuma area. Photos © J. Fuchs

Bat species

The three bat species recorded during the field trip are common and widely distributed across southern and eastern Africa. These bat species are found in a large variety of habitats including wooded savanna and dry forests.

- **Rodents**

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 do 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 at 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 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.

Invertebrates

- **Orthopteroids**

Despite the fact that the field trip took place at the worst season to collect orthopteroids, i.e. the end of the dry season, a good number and diversity of specimens could be collected in the least dry areas, near ponds, Nhica lake and close to the banks of the Rovuma river. Our main aim was to prospect and document diverse habitats, by day and night, in order to maximise the collection of orthopteroid insects, but also to characterise the life history traits and biology of diverse orthopteran species. About 450 specimens were collected by sight, by day and night, in the area of Nhica. The sampled specimens include a subsampling of legs placed in alcohol for future molecular work for each morphospecies identified in the field (ca. 60 morphospecies of Orthoptera). We placed special emphasis on the cricket fauna (Grylloidea) which represent about 50% of the collected material but also collected other orthoperans (115 specimens of Caelifera), blattids, mantids and phasmids.

Despite the dry season many subfamilies of crickets are represented, at least through young populations in humid and green places. Several sound recordings have been done on diverse species of Ensifera. In the prospected sites, 8 cricket subfamilies are represented: Gryllinae, Mogoplistinae, Nemobiinae, Phalangopsinae, Euscirtinae, Trigonidiinae, Eneopterinae, Brachytrupinae. Gryllinae and Mogoplisitinae are clearly in majority in terms of quantities and presumed species diversity. Although complementary studies are needed before giving a precise species list, an important fraction of the morphospecies are clearly new to science and will be described in the near future. The subfamilies Podoscirtinae and Oecanthinae, known from adjacent territories, were expected in Mozambique, but could not be found probably because of the dry season.

One species of Eneopterinae cricket was found in Nhica belonging to the genus *Xenogryllus*. Only one species of this genus is known from Western Africa (Ivory Coast, Gabon) and the genus was thought to be absent from South and Eastern Africa, and fieldwork in Tanzania by L. Desutter-Grandcolas during the nineties did not produce any *Xenogryllus*. The specimens from Mozambique differ slightly through many morphological aspects, but the greatest differences occur at the level of the calling songs which are strikingly different between Mozambique and Ivory Coast. Molecular analyses are being done to characterize these taxa, but the *Xenogryllus* from Mozambique can already be considered as a new species which will be described in the near future.

- **Beetles (Coleoptera)** (Fig. 6)

Dung beetles are considered to be a group of beetles that are highly habitat specific and sensitive to habitat change (Mico *et al.*, 1998). In eastern Africa communities of dung beetles are species-rich; they can be sampled with comparative ease and are relatively well known taxonomically (Hanski, Cambefort, 1991; Tind Nielsen, 2007). They can be disturbed by the effects of large mamals (i.e. elephant) and human activity (Botes *et al.*, 2006).

Furthermore dung beetles are important insects in the habitats where they occur. The economic value of their ecological services for the USA has recently been estimated by Losey and Vaughan (Losey, Vaughan, 2006) to be about $380 million annually. They play a critical role in the ecosystem, especially in arid areas where soils are nutrient-poor (Scholes, 1990), by accelarating nutrient recycling rates and preventing nitrogen loss. They somtimes act as secondary dispersers of seeds (Andresen, 2002), help to control mammalian intestinal parasites (Grønvold *et al.*, 1992) and their tunnelling activity increases the soil's ability to absorb and hold water (Bang *et al.*, 2006).

Some other Lamellicornia families have been the subject of large collections, mostly of the Melolonthidae, Rutelidae, Orphnidae, Trogidae, Hybosoridae and Dynastidae. We have also collected a large sample of other Coleoptera families, i.e. the Cerambycidae, Carabidae... Cetoniidae were collected by hand on flowers and by traps hung on the trees and baited with bananas.

About 80 species of Dung Beetles were collected. Some species are represented by few or single specimens. A large part of the collected sample has been identified to species level, the remaining part, about one third of the total, has been identified to genus level and sorted at the morphospecies level, and its study is still in progress. It is necessary to note that we could not determine the name of some of the collected species, as each of these species belongs to a complex of different but very similar species with a wide distribution across Africa. The study of these different complexes of species is in progress at the scale of the whole of Africa and will enable the separation and description of some new species.

Special mentions are due to the following species and genus:

- ***Onitis malleatus* Janssens, 1937**, Dung Beetle species described from Southern Tanzania, which has been rarely recorded since its description. It has been collected only once by a human dung trap.
- ***Anonychonitis freyi* Janssens, 1950**, Dung Beetle species feeding upon elephant dung, was known only from some localities in moist savanna areas in South Africa (Davis *et al.*, 2008). This species has been collected only once in the only fresh elephant dung found in Nhica.
- ***Tragiscus dimidiatus* Klug, 1855**, Dung Beetle, the single species of this genus which is widely distributed in dry savanna in south-eastern Africa. It has been collected in elephant dung in Quiterajo on some occasions. It seems to stop its breeding activity during the rainy season. The delay of the rainy season allowed us to collect this interesting species during our mission.
- Genus ***Entyposis* Kolbe**, **1894**, Melolonthidae. Two species of this special horned genus, closely related to *Schizonycha* have been collected. Only two species were known from Kenya and Tanzania until now. The study of this genus is in progress, in collaboration with Marc Lacroix, the French specialist of the Melolonthidae.

Despite of the large number of specimens collected during this mission, about 300 Cetoniidae and 1500 Dung Beetles, it is important to note that this collection is not so great, compared to what could be collected during the rainy season. As many insects emerge during the rainy season, it is the best time to produce a large and representative sample. Unfortunately, our collections were done at the end of the dry season, and too little rain fell during our expedition. The lack of rain affected not only the insect emergence, but also the flowering and the presence of the large Mammals fauna (elephant, buffalo) in Nhica and Pundanhar where the collection has been particularly limited.

The conditions were better in Quiterajo concerning elephant activity due to the presence of ponds and lakes dispersed in the area. Thus we could find in this area some fresh elephant dung during our prospection, which produced a good sample of specialized Dung Beetles. Finally, and as expected, the Scarabaeidae Dung Beetles fauna on Vamizi Island was poor in comparison with that on the continental mainland due to the small size of the island and the lack of a large mammal fauna.

27 species of Cetoniidae were collected, some of them in a large sample, while most of the species were represented in the collection by few or a single specimen. Most of them have been identified to species level by Jean-Philippe Legrand (Paris), a specialist of Afro-tropical and Oriental Cetoniidae.

About 20 species of Melolonthidae, mostly belonging to the genus *Schizonycha*, about 10 species of Rutelidae, one species of Trogidae, one of Hybosoridae, one of Orphinae, and one of Dynastidae have been collected. Most of the collected species are typically Eastern African species, occurring in the largest part of dry savanna. No new species have been singled out from the collected sample until now.

A large sample of the collected species of the different families have been kept in alcohol for DNA study.

Wood-boring beetles (Cerambycidae and Buprestidae - Fig. 9) have generally narrow trophic requirements (Farrell, Mitter, 1998) and are therefore associated with few host species. Consequently their diversity is highly correlated to the botanical diversity in most areas. 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 the 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 both sampled years (2008-2009) we collected more than 400 specimens representing about 150 species. Our list of species is still in progress and will be added soon to the results of the expedition. There are several new citations for Mozambique, a region relatively well studied for Cerambycidae.

Carabid and cicindelid beetles are frequently associated with humid area in forest or savannah (for the first group) and dry sandy areas for Cicindelidae. These groups of beetles are predatory upon large numbers of preys (mostly other insects, snails and earthworms) and are considered good bioindicators in habitats (Barraclough *et al.*, 1999; Cardoso, Vogler, 2005; Cassola, Pearson, 2000; Pearson, Cassiola, 1992; Woodcock *et al.*, 2007). In east Africa these groups are well diversified and the species associated with dry coastal forests are relatively well-known (Cassola, Bouyer, 2007). About 50 species of Carabidae and Cicindelidae have been collected during both expeditions. These samples include one possibly new species of Cicindelidae and rare species of Carabids. Their study is in progress and the list of species produced here will be implemented depending on the answer of taxonomists to whom the material has been send.

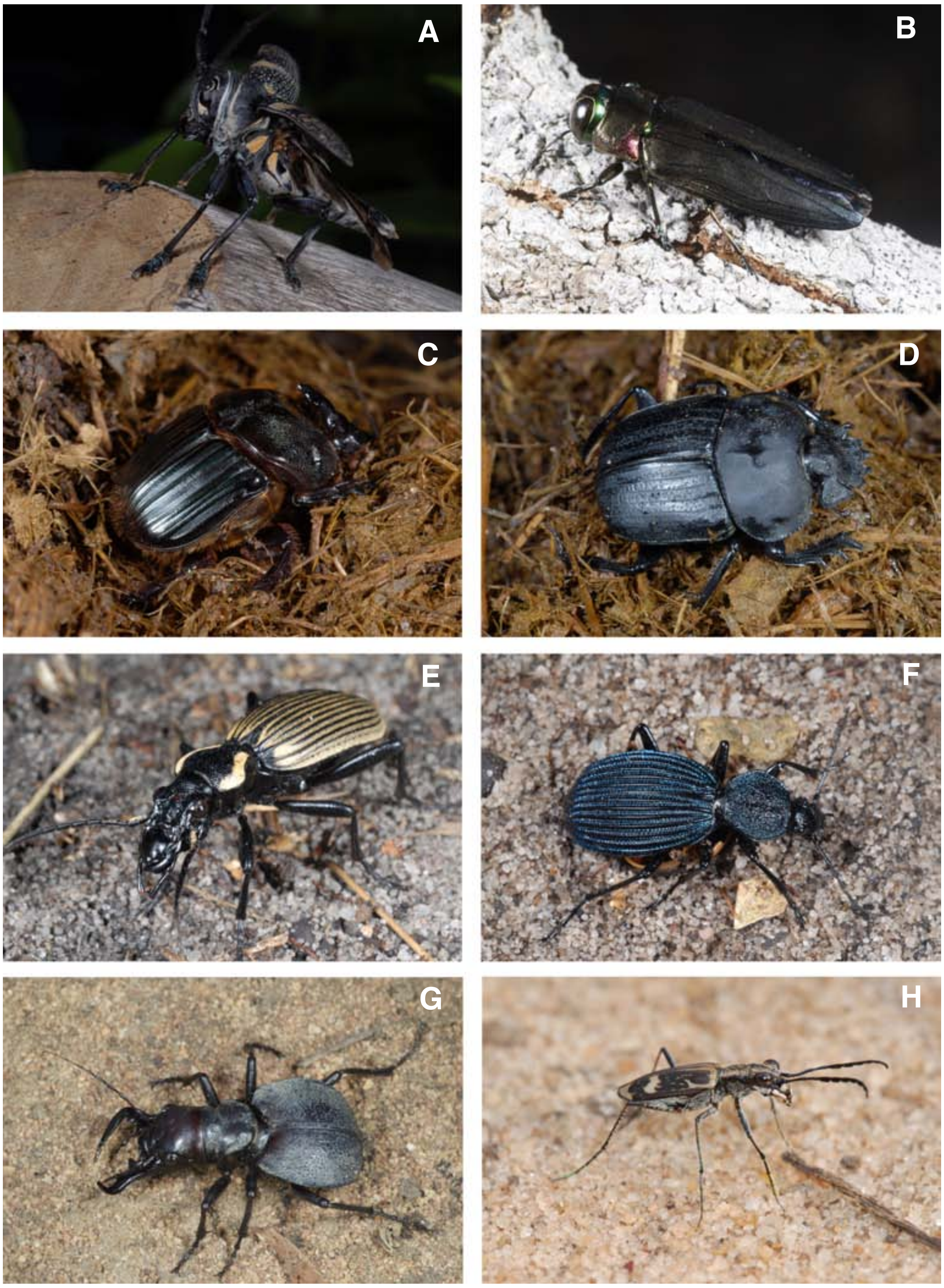

Fig 6. **Coleoptera.**
A. *Zoographus aulicus* (Cerambycidae),
B. Buprestid species.
C. *Heteronitis castenaui* (Scarabaeidae).
D. *Kheper lamarcki* (Scarabaeidae).
E. *Anthia burchelli* (Carabidae).
F. *Tefflus carinatus* (Carabidae).
G. *Manticora* scabra (Cicindelidae).
H. *Elliptica compressicornis* (Cicindelidae).
Photos © JY Rasplus

- **Butterflies (Lepidoptera)**

Most species were collected by with sweep nets. Banana-baited traps were also used, and were responsible for most of the *Charaxes* captures. Known host-plants were searched for larvae. The list for Pundanhar is of species taken on 17 and 19 November, 2009. The Nhica list is compiled from collections and observations on the other days between 12–20 Nov. The Quiterajo list is from 21–23 Nov, 2009. All the butterfly specimens collected are currently held in ABRI, Nairobi, where they were taken for identification.

From a butterfly perspective, the species collected or observed indicate an area of mixed dry forest and woodland, with some strictly coastal influences. This is very much as expected. Several of the butterfly taxa collected are new for Mozambique, and can now be added to the list of species known from the country. These are: *Acraea zonata, Baliochila sp*. (Fig. 7), *Iolaus (Epamera) ?diametra, Papilio ophidicephalus ophidicephalus* and *Euthecta cooksoni*.

Acraea zonata is a species of heavy woodland, and in Kenya and Tanzania it is strictly coastal (Kielland, 1990; Larsen, 1991). It was therefore no surprise to find it in the study area. *Iolaus diametra* is also primarily a coastal species, ranging from Ethiopia to KwaZulu-Natal (Congdon, Collins, 1998). An extended visit in March and April would undoubtedly reveal more species with similar distributions and habits. Another area that would repay study is the Niassa Game Reserve. There is reported to be forest there, and across the border in Tanzania the Rondo Plateau forest (800ñ950m) contains 11 endemic butterfly taxa (C. Congdon, unpublished). It is possible that some of these may occur in similar habitat in Mozambique.

A full checklist of the butterflies collected or observed is given in Annex 2. It is intended that a representative collection will be returned to Mozambique in due course. Species determinations are by S.C. Collins, ABRI, Nairobi. Arrangement, nomenclature and citations follow Ackery *et al.* (1995)

The area is of considerable interest and conservation value. Coastal woodland, forest and scrub in mosaic provide a variety of habitats for butterflies, and forms part of the ZanzibarñInhambane regional mosaic (White, 1983). South of the Zambezi the coastal zone has been well studied for butterflies (Pringle *et al.*, 1994), while the KenyañTanzania part has also been well collected and is known to host 35 endemic butterfly species (C. Congdon, unpublished). It is therefore very probable that the hitherto unstudied part from the Tanzania border south to the Zambezi will also be found to host species as yet unknown to science. A proper study of this area would greatly improve our understanding of the relationships between the coastal forest/woodland mosaic and neighbouring ecozones.

It was unfortunate that the expedition took place before the rains were properly established, and before the «rains butterflies» had emerged. Even so, one species new to science was found. No doubt a visit later in the rains would reveal many more forest species in particular. The collection was notably poor in Hesperiidae, most of which fly during the rainy season.

Fig 7. A new species of butterfly for science. *Baliochila* sp. Male recto, verso. Quiterajo, Mozambique, 23.xi.2009. Photos © Congdon

- **Saturniidae and Sphingidae**

About 20 species of Saturniidae (Fig 8) and 35 species of Sphingidae were collected in the different localities propected. Within these collections, there was at least one remarkable record : the capture of *Antistathmoptera rectangulata* Pinhey, l968 (front page figure), a species known from just a few localities in Tanzania (Morogoro), Malawi and Mozambique. This is the most eastern citations of this species. Several species are cited from Mozambique for the first time.

- **Wasps (Hymenoptera)**

We focused on few groups of Hymenoptera, among them the Mutillidae (Fig. 9) were chosen as they are parasitic upon nesting Hymenoptera and are good indicators of habitat degradation. About 300 specimens were collected, representing about 60 species, five of them, at least, being new to science. Despite important studies by Nonveiller and Brothers, this group is still poorly known in Africa. Our collect fills an important gap in the knowledge of the mutillid fauna of East Africa and shows that the fauna of the region of Nhica do Rovuma is extremely diverse. The study of these wasps is in progress and will take several years as most types have to be studied to ascertain the novelty of the species discovered during this study.

We also collected hundreds of specimens using malaise traps. This material has been sorted to family and sent to specialists of the relevant families. Several novelties may be expected but again the poor knowledge of these taxa and the lack of taxonomists impedes the study.

Finally, we sampled both Vespidae and Sphecidae - two groups that are relatively well known in the region and that may enable a comparison of the locality of Nhica do Rovuma to others in Tanzania and Kenya.

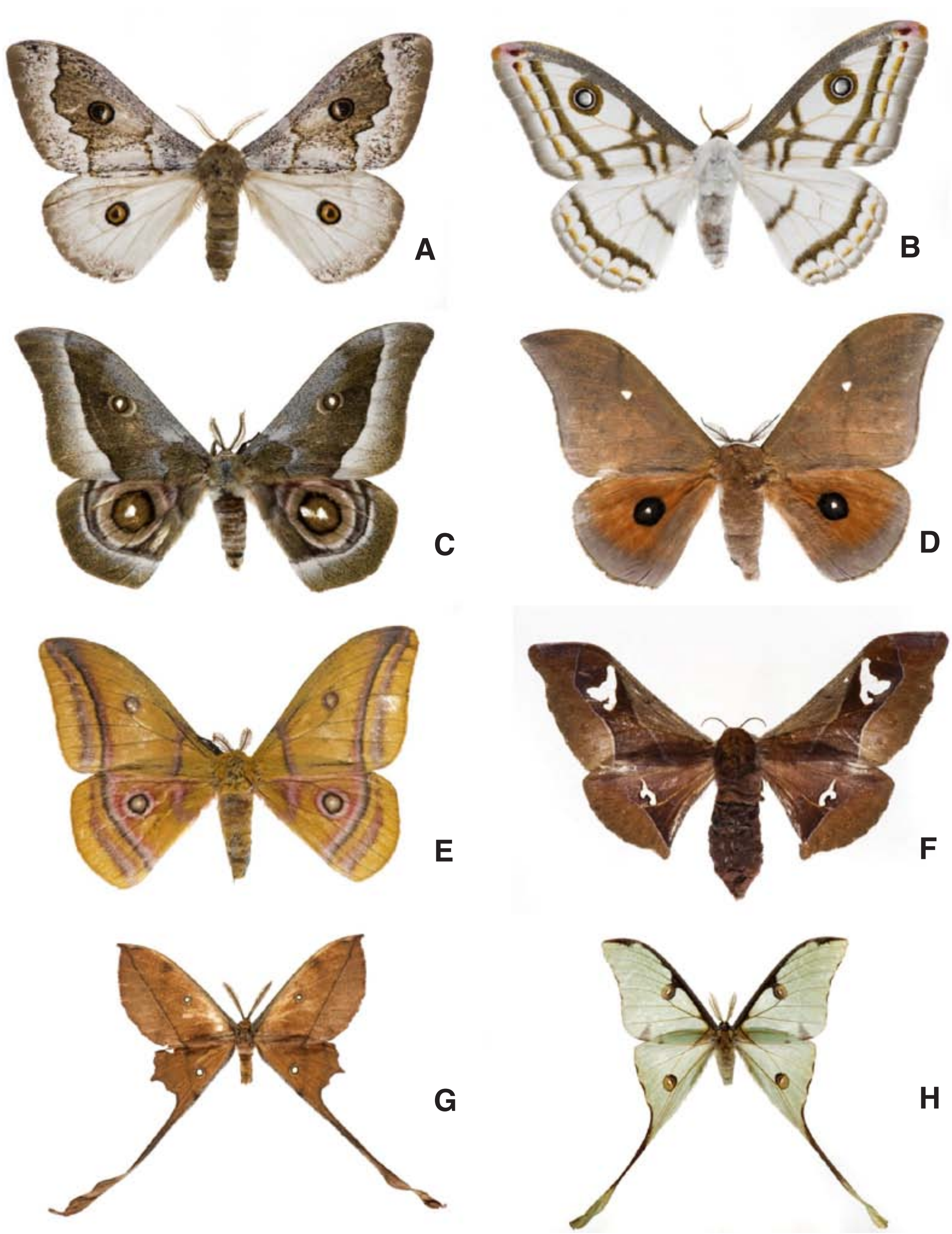

Fig 8.**Lepidoptera (Saturniidae)**. A. *Usta terpsichore*, B. *Heniocha marnois*, C. *Gonimbrasia zambesina*, D. *Pseudobunaea tyrrhena*, E. *Gonimbrasia (Nudaurelia) anna*, F. *Holocerina intermedia*, G. *Antistathmoptera daltonae rectangulata*, H. *Argema mimosae*. Photos © Xavier Desmier

Fig. 9. Mutillidae of Mozambique.
A. *Trogaspidia sp.*
B. *s.*
C-D. *Dasylabris* female and male.
Copyright © JY Rasplus.

- **Mollusca**

A total of nine days were spent in the field in November 2009 (dry season) with 19 stations surveyed by the author. Additional material was collected by I. Ineich and T. Robillard at station 4 and by A. Ohler, M. McAdam, I. Ineich and T. Robillard at station 10. All the stations were placed within the north-eastern part of Cabo Delgado province of NE Mozambique with three stations on the Cabo Delgado (peninsula) itself.

Only empty shells, often in a very bad condition, were found for most of the species because the fieldwork was carried out at the end of the dry season and most of the molluscs were hiding deep in the ground. More than 36 percent of all species (16 to be exact) were recorded from single stations. This suggests that we can still increase the total number of known species from the region. However, this increase could be achieved only with significant additional collecting effort, since only five species were added in the last twelve stations. In other words, 89 percent of species collected in the sampled area were found at the first seven stations. Stations 8M09 and 9M09 did not add any species that were not found at station 7M09, which implies exhaustive sampling on Cabo Delgado.

A total of 46 species of terrestrial molluscs that belong to 15 families were recorded from an 18×55 km area in the north-eastern corner of Mozambique. However, more than half of the species in the studied area belong to four families: Subulinidae, Streptaxidae, Helicarionidae and Urocyclidae. Three stations on Cabo Delgado (peninsula at the northern extremity of the Quirimbas Archipelago) yielded 19 species that were not found on the inland-sampled area and 18 species that occur inland were not found on Cabo Delgado, with nine species inhabiting both areas. Most noticeable (very abundant) species on Cabo Delgado – *Pupoides coenopictus* apparently does not extend its range in north-eastern Mozambique more than a few kilometres inland. On the other hand, *Rhachistia catenata* – which is quite common inland, does not occur on Cabo Delgado.

Thus, there are two clearly defined regions in the studied area from the malacological point of view: Cabo Delgado (peninsula) and inland areas. Most of terrestrial molluscs have very specific ecological preferences. The main ecological difference between Cabo Delgado and inland studied areas is the abundance of the limestone in the former and the total lack of it in the later. In fact the entire Cabo Delgado is an elevated ancient coral reef, only in its western (inland) part is it covered by sandy soil. This porous limestone accumulates rain water and slowly releases it, providing a constant humidity favourable for the snails, as well as providing calcium carbonate for shell construction and abundant shelters. Molluscs with similar ecological preferences frequently can be found living together, forming an ecological association in a particular type of habitat. This explains the major differences between the malacofauna of Cabo Delgado and inland areas.

Tha majority of the species found in northeastern Mozambique have a general eastern African distribution and only a few species from Madagascar (*Cyathopoma diegoense*), Mascarene Islands (*Nesopupa peilei* and *Microcystina minima*) and Zanzibar (*Crenatinanina crenulata*) were found on Cabo Delgado but not more than a couple of kilometres inland.

Fig. 10. Left to right – top to bottom: **Pomatiidae**: *Tropidophora ligata* (Muller, 1774), shell – 15.5×15.3 mm, stn 7; *T. zanguebarica* (Petit, 1850), shell – 10.0×9.5 mm, stn 7. **Cerastidae**: *Rhachistia catenata* (Martens, 1860), shell – 10.0×6.3 mm – sub-adult, stn 1. **Achatinidae**: *Achatina immaculata* Lamarck, 1823, shell – 102×56 mm, stn 1. **Subulinidae**: *Kempioconcha boivini* (Morelet, 1860), shell – 16.0×8.4 mm, stn 1; *K. conradti* (Martens, 1895), shell – 13.7×6.2 mm, stn 8. **Helicarionidae**: *"Sitala" jenynsi* (Pfeiffer, 1845), shell – 7.9×11.0 mm – sub-adult, stn 8. **Urocyclidae**: *Urocyclus kirki* Gray, 1864, length 75 mm, stn 10. All photographs and identifications by I.V. Muratov ©.

- **Structure of arboreal ant communities and common termites species**

The aims of the study were: (1) to study the diversity and distribution of arboreal-nesting ants; (2) to test a protocol to collect them rapidly; (3) to inventory the most common termite species. Numerically dominant arboreal-nesting ants are known to structure the distribution of other ant species and of other arthropods, such as hemiptera, providing them with energy-rich resources that sustain their large colonies. The diversity and distribution of arboreal-nesting ants are notoriously difficult to study in tropical forests due to the tall trees. Commonly used techniques (canopy fogging, pitfall trapping, baiting) involve climbing trees which is time-consuming. In collaboration with Prof. Dejean, CNRS-Guyane, we designed in Amazonia an alternative protocol. We were interested to test in dry forests the effectiveness of this new protocol which is based on baits spread every 5m along a rope. One end of the rope is tied around the trunk and, with the help of a sling-shot, the other is slung over a branch in the canopy, forming a loop that enables the baits to be easily brought back down for inspection, thereby avoiding the need for climbing. Baits were composed of a mixture of proteins, lipids and carbohydrates, and were left for 24 hours before being collected. The ant and termite inventory was mainly conducted from 14 to 26 November 2009 along a 500m transect based on line 34 near Nhica do Rovuma village. Common tree species along the transect were *Cleistanthus ?schlechteri* (Euphorbiaceae) and *Terminalia* sp. (Combretaceae). Additional termite samples were collected around the base camp.

Main results

1. Three *Crematogaster* species (subfamily Myrmicinae) were numerically dominant in the area. These species nest inside hollow branches and dead wood in the tree canopy. They mutually exclude each other and only a single species was found per tree. On-site confrontations between dominant ants colonizing baits allowed the identification of a supercolony of *Crematogaster* colonizing three-fourths of the trees along the 500 m transect. Indeed individuals collected on trees located sometimes at both end of the transect did not fight when confronted with each other. In other words, within this species colonies appear "open" and individuals can be exchanged between colonies. This behaviour is atypical since most colonies are generally "closed" i.e. that allocolonial individuals (even if from the same species) fight during encounters. This was the case of the second most common species, *Crematogaster* sp. 2.

2. Collection by hand in the canopy revealed the presence of non dominant ant species which were not attracted to the baits.

3. The two dominant *Crematogaster* species did not show any preference for host tree species. They were also observed foraging on the ground but were

little attracted by baits placed at this level. By contrast, baits placed on trunks at breast height were very attractive.

4. The most conspicuous termite species was *Macrotermes subhyalinus*, a fungus-grower termite which builds huge mounds. Another common termite is the black termite *Grallatotermes africanus* which builds an arboreal nest but, contrary to the rule, does not construct covered galleries. Their workers could be observed foraging in large columns early in the morning, before the heat of the day.

Concerning termites, *Macrotermes* huge termitaria appear as a key feature in the Miombo landscape. They cultivate fungi which decompose the cellulose of the vegetal debris they collected. Through their activity they enrich the soil and favorize the installation of the vegetation.

Concerning ants, our results suggest that *Crematogaster* ants are very common in the area since they were observed on every tree studied. In the case of *Crematogaster* sp.1 a reason for this ecological success could be the lack of aggressivity between neighbour colonies which allow them to secure large territories where the installation of incipient colonies of other species is probably very difficult. Nevertheless the polymorphic (workers of variable size) *Crematogaster* sp.2 is able to colonize part of the trees. It produces a very odorous defensive secretion but its role during inter- and intraspecific encounters is not not known yet. The dataset collected will allow to test if the two *Crematogaster* have a structuring effect on the rest of the arboreal ant community by tolerating different species on the tree that they occupy.

Fig 11. Left to right Fungi cultivating soldier termite of the genus *Macrotermes*. Maurice Leponce, specialist of social insects, excavates a gigantic termite mound in search of fungi cultivating termites (*Macrotermes*). The genus *Macrotermes* gathers the biggest species of termites in the world. Palma area, northern Mozambique
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CONCLUSIONS

Both the region of Nhica do Rovuma and Quiterajo are of strong scientific interest. In a short period of time and under dry climatic conditions, more than 10,000 specimens have been sampled by the zoologists and show that the propected regions are extremely rich and necessitate further study.

For several reasons we cannot precisely estimate the number of species collected in the prospected areas:

1) Part of the material has not been sent to specialists, simply because no specialists study these groups of arthropods. 2) Several of the groups sampled are poorly known and require type examination, and sometimes a small revision of the analysed group to better estimate their overall diversity. Most of the time, these groups have not even received attention for decades, if not more. Consequently, the last revisions – if any – are old and mostly useless. Only the well known and documented taxa have been studied extensively so far. However, these taxa, simply because they are well-known do not reveal exceptional novelties.

Nevertheless, it is noteworthy that several new species to science have been discovered in relatively well known groups: frogs, butterflies, orthoptera, dung beetles, cicindelid beetles. These flagship groups were selected to compare the fauna of the propected areas with other well preserved fragments of coastal dry forest and consequently were expected to bring only few novelties. Our first results showed that even within these well-known groups, the area propected hosts an original fauna.

All together, the number of species collected during our expeditions reached 1500, even if only half have been identified to species so far. This number may increase strongly when Malaise traps will be identified (if possible !) and show the extreme diversity of the two prospected areas.

One of the main reasons for such a diversity observed in Cabo Delgado is the diversity of the habitats propected during our study. Dry forest, but also the vicinity of the lake at Nhica do Rovuma revealed several new species. The mosaic of habitats (forests/savannas; sand/leaflitter) host an important diversity of species.

Four groups of vertebrates have been thoroughly sampled during our expeditions. The results are surprising and show that within the ca. 660 specimens sampled, these groups are representated by more than 175 species. This number is clearly underevaluated and we need more time and more sampling to better estimate the overall diversity of the Cabo Delgado dry forests. Several species of birds that are endemic to the dry forests of East Africa have been discovered (*Pogoniulus simplex*, *Nicator gularis*, *Phyllastrephus fischeri* and *Sheppardia gunningi*). One species is probably new for Mozambique and one species of frog and possibly one species of reptiles are new to science. The intensity of our propection as well as the diversity of the region is revealed by some of our results. In 9 days we collected 34 species of reptiles, while the comparatively well-studied fauna of the Niassa Game Reserve hosts only 56 reptile species. This is also the case for batracians; we discovered three species new for Mozambique and some of the discovered species were previously known only from distant localities in Tanzania or in Kenya. Consequently, the distribution range of these species is widely extended southward. The main result is the discovery of a putative new species of *Arthroleptis*. The analyses are still in progress to ascertain the novelty of this taxa.

Discovering new species of arthropods or molluscs is not surprising in such an area, despite the global fragmentation and degradation of these forests. However, the discovery of a new species of butterfly remains exceptional and needs to be emphasized. In most groups of insects, we have discovered new species and the study of our material is far from complete. Consequently, the coming months will bring several new important results showing that these areas need further study to completely understand their originality and diversity.

SYNOPSIS OF THE MAIN RESULTS

Number of specimens collected: about 10,000.

Number of species collected : about 800 but we need more time to sort out the material.

Number of families collected : 100.

Number of new records for Mozambique : more than 50.

Number of new species to science (as for Dec. 2010): about 15.

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ANNEX

ANNEX 1.

List of participants involved in the zoological survey (2008 and 2009)

Ivan Bampton. African Butterfly Research Institute (ABRI). P.O. Box 14308, Nairobi, Kenya (Butterflies)

Colin Congdon. African Butterfly Research Institute (ABRI). P.O. Box 14308, Nairobi, Kenya. Contact colin.congdon@gmail.com (Butterflies)

Astrid Cruaud. UMR CBGP « Centre de Biologie et de Gestion des Populations » Campus international de Baillarguet, Montferrier-sur-Lez, France. Contact cruaud@supagro.inra.fr (Hymenoptera and Arthropods)

Jean-Marc Duplantier. UMR CBGP « Centre de Biologie et de Gestion des Populations » Campus international de Baillarguet, Montferrier-sur-Lez, France. duplanti@mpl.ird.fr (Rodents)

Jerome Fuchs. California Academy of Sciences, 55 Music Concouse Drive, CA94118 San Francisco, USA. Email: jfuchs@calacademy.org (Birds)

Ivan Ineich. Muséum national d'Histoire naturelle, Département Evolution et Systématique, UMR OSEB 7205 CNRS Origine, Structure et Évolution de la Biodiversité. 25 rue Cuvier, CP 30, 75005 Paris. France. Contact ineich@mnhn.fr (Reptiles)

Maurice Leponce. Institut royal des Sciences naturelles de Belgique, Section d'Evaluation Biologique, 29 rue Vautier, 1000 Bruxelles, Belgique. Contact Maurice.Leponce@naturalsciences.be (Ants, termites)

Nicolau Madogolele. Ministerio da Agricultura Direccao Nacional de Agricultura Departamento de Sanidade Vegetal C.P. 3658. Maputo, Mozambique. Contact nico.fama@gmail.com (Insects)

Michel Martinez. UMR CBGP « Centre de Biologie et de Gestion des Populations » Campus international de Baillarguet, Montferrier-sur-Lez, France. Contact martinez@supagro.inra.fr (Diptères)

Olivier Montreuil. Muséum national d'Histoire naturelle, Département Evolution et Systématique, UMR OSEB 7205 CNRS Origine, Structure et Évolution de la Biodiversité. 45, rue Buffon, 75231 Paris Cedex 05, France. Contact Olivier Montreuil olivier_montreuil@hotmail.com (Beetles)

Igor V. Muratov. Department of Natural Sciences, Natal Museum, 237 Jabu Ndlovu Street, Private Bag 9070. Pietermaritzburg 3200, Kwazulu-Natal, South Africa. Contact imuratov@nmsa.org.za (Molluscs)

Anne-Marie Ohler. Muséum national d'Histoire naturelle, Département Evolution et Systématique, UMR OSEB 7205 CNRS Origine, Structure et Évolution de la Biodiversité. 25 rue Cuvier, CP 30, 75005 Paris. France. Contact ohler@mnhn.fr (Frogs)

Jean-Marc Pons. Muséum national d'Histoire naturelle, Département Evolution et Systématique, UMR OSEB 7205 CNRS Origine, Structure et Évolution de la Biodiversité. 55 rue Buffon, CP 51, 75005 Paris. France. Contact pons@mnhn.fr (Birds and Bats)

Jean-Yves Rasplus. UMR CBGP « Centre de Biologie et de Gestion des Populations » Campus international de Baillarguet, Montferrier-sur-Lez, France. Contact rasplus@supagro.inra.fr (Lepidoptera and Hymenoptera)

Tony Robillard. Muséum national d'Histoire naturelle, Département Evolution et Systématique, UMR OSEB 7205 CNRS Origine, Structure et Évolution de la Biodiversité. 45, rue Buffon, 75231 Paris Cedex 05, France. Contact robillar@mnhn.fr (Orthoptera)

Claire Villemant. Muséum national d'Histoire naturelle, Département Evolution et Systématique, UMR OSEB 7205 CNRS Origine, Structure et Évolution de la Biodiversité. 45, rue Buffon, 75231 Paris Cedex 05, France. Contact villeman@mnhn.fr (Hymenoptera)

ANNEX 2.

Preliminary list of taxa collected / observed on Pro Natura International Cabo Delgado project expeditions in 2008–2009

Amphibia	Anura	Arthroleptidae	*Afrixalus brachycnemis*
Amphibia	Anura	Arthroleptidae	*Afrixalus fornasini*
Amphibia	Anura	Arthroleptidae	*Arthroleptis* sp. 2
Amphibia	Anura	Arthroleptidae	*Arthroleptis stenodactylus*
Amphibia	Anura	Arthroleptidae	*Arthroleptis xenodactyloides*
Amphibia	Anura	Arthroleptidae	*Leptopelis argenteus*
Amphibia	Anura	Arthroleptidae	*Leptopelis mossambicus*
Amphibia	Anura	Brevicipitidae	*Breviceps mossambicus*
Amphibia	Anura	Bufonidae	*Bufo maculatus*
Amphibia	Anura	Bufonidae	*Mertensophryne loveridgei*
Amphibia	Anura	Bufonidae	*Mertensophryne micranotis*
Amphibia	Anura	Hemisotidae	*Hemisus marmoratus*
Amphibia	Anura	Hyperoliidae	*Hyperolius acuticeps*
Amphibia	Anura	Hyperoliidae	*Hyperolius parkeri*
Amphibia	Anura	Hyperoliidae	*Hyperolius* sp. 1
Amphibia	Anura	Hyperoliidae	*Hyperolius* sp. 2
Amphibia	Anura	Hyperoliidae	*Hyperolius tuberilinguis*
Amphibia	Anura	Hyperoliidae	*Hyperolius* YGD
Amphibia	Anura	Hyperoliidae	*Kassina maculata*
Amphibia	Anura	Hyperoliidae	*Kassina senegalensis*
Amphibia	Anura	Phrynobatrachidae	*Phrynobatrachus acridoides*
Amphibia	Anura	Phrynobatrachidae	*Phrynobatrachus mababiensis*
Amphibia	Anura	Ptychadenidae	*Hildebrandtia ornata*
Amphibia	Anura	Ptychadenidae	*Ptychadena anchietae*
Amphibia	Anura	Ptychadenidae	*Ptychadena guibei*
Amphibia	Anura	Ptychadenidae	*Ptychadena mascareniensis*
Amphibia	Anura	Ptychadenidae	*Ptychadena oxyrhynchus*
Amphibia	Anura	Ptychadenidae	*Ptychadena taenioscelis*
Amphibia	Anura	Pyxicephalidae	*Pyxicephalus edulis*
Amphibia	Anura	Ranidae	*Hylarana galamensis*
Amphibia	Anura	Rhacophoridae	*Chiromantis xerampelina*
Aves	Falconiformes	Accipitridae	*Accipiter badius*
Aves	Falconiformes	Accipitridae	*Accipiter tachiro*
Aves	Falconiformes	Accipitridae	*Aquila rapax*
Aves	Falconiformes	Accipitridae	*Aquila wahlbergi*
Aves	Falconiformes	Accipitridae	*Circaetus fasciolatus*
Aves	Falconiformes	Accipitridae	*Falco dickinsoni*
Aves	Falconiformes	Accipitridae	*Falco subbuteo*
Aves	Falconiformes	Accipitridae	*Gypohierax angolensis*
Aves	Falconiformes	Accipitridae	*Kaupifalco monogrammicus*
Aves	Falconiformes	Accipitridae	*Lophoaetus occipitalis*
Aves	Falconiformes	Accipitridae	*Melierax gabar*
Aves	Passeriformes	Alaudidae	*Mirafra subcinnamonea*
Aves	Coraciiformes	Alcedinidae	*Ispidina picta*

Aves	Anseriformes	Anatidae	*Dendrocygna viduata*
Aves	Apodiformes	Apodidae	*Apus apus*
Aves	Ciconiiformes	Ardeidae	*Ardea purpurea*
Aves	Ciconiiformes	Ardeidae	*Egretta garzetta*
Aves	Passeriformes	Birds	*Hedidypna collaris*
Aves	Coraciiformes	Bucerotidae	*Bycanistes buccinator*
Aves	Coraciiformes	Bucerotidae	*Tockus alboterminatus*
Aves	Passeriformes	Campephagidae	*Campephaga flava*
Aves	Caprimulgiformes	Caprimulgidae	*Caprimulgus europaeus*
Aves	Caprimulgiformes	Caprimulgidae	*Caprimulgus pectoralis*
Aves	Caprimulgiformes	Caprimulgidae	*Caprimulgus rufigena*
Aves	Coraciiformes	Cerylidae	*Ceryle rudis*
Aves	Coraciiformes	Cerylidae	*Megaceryle maxima*
Aves	Ciconiiformes	Ciconiidae	*Anastomus lamelligerus*
Aves	Passeriformes	Cisticolidae	*Apalis flavida*
Aves	Passeriformes	Cisticolidae	*Camaroptera brachyuran*
Aves	Columbiformes	Columbidae	*Streptopelia semitorquata*
Aves	Columbiformes	Columbidae	*Turtur chalcospilos*
Aves	Columbiformes	Columbidae	*Turtur tympanistria*
Aves	Columbiformes	Columbidae	*Turtur tympanistria*
Aves	Coraciiformes	Coraciidae	*Eurystomus glaucurus*
Aves	Cuculiformes	Cuculidae	*Cuculus solitarius*
Aves	Passeriformes	Dicruridae	*Dicrurus adsimilis*
Aves	Passeriformes	Estrildidae	*Estrilda astrild*
Aves	Passeriformes	Estrildidae	*Hypargos niveoguttatus*
Aves	Passeriformes	Estrildidae	*Lonchura cucullata*
Aves	Coraciiformes	Halcyonidae	*Halcyon albiventris*
Aves	Coraciiformes	Halcyonidae	*Halcyon senegalensis*
Aves	Passeriformes	Hirundinidae	*Hirundo rustica*
Aves	Piciformes	Indicatoridae	*Indicator minor*
Aves	Piciformes	Lybiidae	*Lybius torquatus*
Aves	Piciformes	Lybiidae	*Pogoniulus bilineatus*
Aves	Piciformes	Lybiidae	*Pogoniulus simplex*
Aves	Passeriformes	Malaconotidae	*Chlorophoneus sulfureopectus*
Aves	Passeriformes	Malaconotidae	*Dryoscopus cubla*
Aves	Passeriformes	Malaconotidae	*Laniarius aethiopicus*
Aves	Passeriformes	Malaconotidae	*Malaconotus blanchoti*
Aves	Passeriformes	Malaconotidae	*Tchagra australis*
Aves	Coraciiformes	Meropidae	*Merops boehmi*
Aves	Coraciiformes	Meropidae	*Merops persicus*
Aves	Coraciiformes	Meropidae	*Merops pusillus*
Aves	Passeriformes	Monarchidae	*Terpsiphone viridis*
Aves	Passeriformes	Motacillidae	*Macronyx croceus*
Aves	Passeriformes	Muscicapidae	*Cercotrichas leucophrys*
Aves	Passeriformes	Muscicapidae	*Cercotrichas quadrivirgata*
Aves	Passeriformes	Muscicapidae	*Cossypha heuglini*
Aves	Passeriformes	Muscicapidae	*Cossypha natalensis*
Aves	Passeriformes	Muscicapidae	*Sheppardia gunningi*
Aves	Cuculiformes	Musophagidae	*Tauraco livingstoni*
Aves	Passeriformes	Nectariniidae	*Chalcomitra senegalensis*

Aves	Passeriformes	Nectariniidae	*Cinnyris bifasciatus*
Aves	Passeriformes	Nectariniidae	*Cyanomitra olivacea*
Aves	Passeriformes	Nectariniidae	*Cyanomitra veroxii*
Aves	Galliformes	Numidiidae	*Guttera pucherani*
Aves	Galliformes	Numidiidae	*Numida meleagris*
Aves	Falconiformes	Pandionidae	*Haliaetus vocifer*
Aves	Galliformes	Phasianidae	*Dendroperdix sephaena*
Aves	Piciformes	Picinae	*Dendropicos fuscescens*
Aves	Passeriformes	Platysteiridae	*Batis soror*
Aves	Passeriformes	Platysteiridae	*Platysteira peltata*
Aves	Passeriformes	Ploceidae	*Euplectes axillaris*
Aves	Passeriformes	Ploceidae	*Ploceus ocularis*
Aves	Passeriformes	Ploceidae	*Ploceus subaureus*
Aves	Passeriformes	Ploceidae	*Quelea erythrops*
Aves	Passeriformes	Ploceidae	*Quelea erythrops*
Aves	Passeriformes	Ploceidae	*Quelea quelea*
Aves	Passeriformes	Prionopidae	*Prionops retzii*
Aves	Passeriformes	Pycnonotidae	*Andropadus importunus*
Aves	Passeriformes	Pycnonotidae	*Chlorocichla flaviventris*
Aves	Passeriformes	Pycnonotidae	*Nicator gularis*
Aves	Passeriformes	Pycnonotidae	*Phyllastrephus fisheri*
Aves	Passeriformes	Pycnonotidae	*Pycnonotus tricolor*
Aves	Pelecaniformes	Scopidae	*Scopus umbretta*
Aves	Strigiformes	Strigidae	*Bubo africanus*
Aves	Strigiformes	Strigidae	*Bubo lacteus*
Aves	Strigiformes	Strigidae	*Strix woodfordi*
Aves	Passeriformes	Sturnidae	*Cynniricinclus leucogaster*
Aves	Passeriformes	Sturnidae	*Lamprotornis corruscus*
Aves	Passeriformes	Sturnidae	*Lamprotornis elisabeth*
Aves	Passeriformes	Sylviidae	*Sylvietta rufescens*
Aves	Pelecaniformes	Threskiornithidae	*Bostrychia hagedash*
Mammalia	Chiroptera	Hipposideridae	*Hipposideros vittatus*
Mammalia	Chiroptera	Vespertilionidae	*Myotis bocagii*
Mammalia	Chiroptera	Vespertilionidae	*Scotophilus viridis*
Sauropsida	Squamata	Agamidae	*Agama mossambica*
Sauropsida	Squamata	Amphisbaenidae	*Chirinda swynnertoni*
Sauropsida	Squamata	Chamaeleonidae	*Chamaeleo dilepis*
Sauropsida	Squamata	Chamaeleonidae	*Chamaeleo melleri*
Sauropsida	Squamata	Colubridae	*Philothamnus hoplogaster*
Sauropsida	Squamata	Colubridae	*Philothamnus semivariegatus*
Sauropsida	Squamata	Colubridae	*Telescopus semiannulatus*
Sauropsida	Squamata	Colubridae	*Thelotornis mossambicanus*
Sauropsida	Squamata	Cordylidae	*Cordylus tropidosternum*
Sauropsida		Crocodylidae	*Crocodylus niloticus*
Sauropsida	Squamata	Gekkonidae	*Hemidactylus mabouia*
Sauropsida	Squamata	Gekkonidae	*Hemidactylus platycephalus*
Sauropsida	Squamata	Gekkonidae	*Lygodactylus capensis*
Sauropsida	Squamata	Gekkonidae	*Lygodactylus* sp.
Sauropsida	Squamata	Gerrhosauridae	*Gerrhosaurus nigrolineatus*
Sauropsida	Squamata	Lacertidae	*Ichnotropis squamulosa*
Sauropsida	Squamata	Lacertidae	*Nucras ornata*

Sauropsida	Squamata	Lamprophiidae	*Lamprophis capense*
Sauropsida	Squamata	Lamprophiidae	*Lycophidion capense*
Sauropsida	Testudines	Pelomedusidae	*Pelusios castanoides*
Sauropsida	Squamata	Psammophiidae	*Psammophis orientalis*
Sauropsida	Squamata	Psammophiidae	*Psammophis* sp.
Sauropsida	Squamata	Scincidae	*Lygosoma sundevallii*
Sauropsida	Squamata	Scincidae	*Panaspis wahlbergii*
Sauropsida	Squamata	Scincidae	*Trachylepis boulengeri*
Sauropsida	Squamata	Scincidae	*Trachylepis maculilabris*
Sauropsida	Squamata	Scincidae	*Trachylepis striata*
Sauropsida	Squamata	Scincidae	*Trachylepis varia*
Sauropsida	Testudines	Testudinidae	*Kinixys belliana*
Sauropsida	Testudines	Trionychidae	*Cycloderma frenatum*
Sauropsida	Squamata	Varanidae	*Varanus albigularis*
Sauropsida	Squamata	Varanidae	*Varanus niloticus*
Sauropsida	Squamata	Viperidae	*Bitis arietans*
Sauropsida	Squamata	Viperidae	*Causus defilippi*
Gastropoda		Achatinidae	*Achatina immaculata*
Gastropoda		Achatinidae	*Achatina randabeli*
Gastropoda		Achatinidae	*Allopeas* ? cf. *acmella*
Gastropoda		Achatinidae	*Curvella nyasana*
Gastropoda		Achatinidae	*Eonyma tugulensis*
Gastropoda		Achatinidae	*Kempioconcha boivini*
Gastropoda		Achatinidae	*Kempioconcha* cf. *obtusa auct.*
Gastropoda		Achatinidae	*Kempioconcha* cf. *subolivacea*
Gastropoda		Achatinidae	*Kempioconcha conradti*
Gastropoda		Achatinidae	*Kempioconcha kirki*
Gastropoda		Achatinidae	*Opeas hannense*
Gastropoda		Cerastidae	*Gittenedouardia metuloides*
Gastropoda		Cerastidae	*Limicena nyasana*
Gastropoda		Cerastidae	*Rachis cunctatoris*
Gastropoda		Cerastidae	*Rhachistia catenata*
Gastropoda		Cyclophoridae	*Cyathopoma diegoense*
Gastropoda		Euconulidae	*Afroguppya rumrutiensis*
Gastropoda		Euconulidae	*Microcystina minima*
Gastropoda		Gastrocoptidae	*Gastrocopta klunzingeri*
Gastropoda		Helicarionidae	*«Sitala» jenynsi*
Gastropoda		Helicarionidae	*Crenatinanina crenulata*
Gastropoda		Helicarionidae	*Trochonanina alboplicta*
Gastropoda		Helicarionidae	*Trochonanina bloyeti*
Gastropoda		Maizaniidae	*Maizania wahlbergi*
Gastropoda		Pomatiasidae	*Tropidophora insularis*
Gastropoda		Pomatiasidae	*Tropidophora ligata*
Gastropoda		Pomatiasidae	*Tropidophora nyasana*
Gastropoda		Pomatiasidae	*Tropidophora zanguebarica*
Gastropoda		Pupillidae	*Pupoides coenopictus*
Gastropoda		Streptaxidae	*Edentulina affinis*
Gastropoda		Streptaxidae	*Gonaxis* cf. *percivali*
Gastropoda		Streptaxidae	*Gonaxis denticulatus*
Gastropoda		Streptaxidae	*Gulella* aff. *browni*
Gastropoda		Streptaxidae	*Gulella perissodonta*

Gastropoda		Streptaxidae	*Gulella sexdentata* var. *liederi*
Gastropoda		Streptaxidae	*Gulella subhyalina*
Gastropoda		Streptaxidae	*Streptostele herma*
Gastropoda		Streptaxidae	*Tayloria leroyi*
Gastropoda		Succinedae	*Quickia concisa*
Gastropoda		Truncatelliade	*Truncatella marginata*
Gastropoda		Urocyclidae	*Bukobia uhehensis*
Gastropoda		Urocyclidae	*Elisolimax flavescens*
Gastropoda		Urocyclidae	*Urocyclus kirki*
Gastropoda		Vertiginidae	*Nesopupa bisulcata*
Gastropoda		Vertiginidae	*Nesopupa corrugata*
Gastropoda		Vertiginidae	*Nesopupa peilei*
Hexapoda	Neuroptera	Ascalaphidae	*Disparomitus* sp.
Hexapoda	Coleoptera	Buprestidae	*Damarsila* sp.
Hexapoda	Coleoptera	Carabidae	*Anthia (Thermophilum) burchelli* Hope 1832
Hexapoda	Coleoptera	Carabidae	*Anthia (Thermophilum) omoplata* Lequien, 1832
Hexapoda	Coleoptera	Carabidae	*Anthia thoracica* (Thunberg, 1784)
Hexapoda	Coleoptera	Carabidae	*Calosoma planicolle* Chaudoir, 1869
Hexapoda	Coleoptera	Carabidae	*Cypholoba* sp.
Hexapoda	Coleoptera	Carabidae	*Psecadius (Psecadius)* sp.
Hexapoda	Coleoptera	Carabidae	*Tefflus carinatus* Klug, 1853
Hexapoda	Coleoptera	Cerambycidae	*Ceroplesis militaris*
Hexapoda	Coleoptera	Cerambycidae	*Macrotoma* sp.
Hexapoda	Coleoptera	Cerambycidae	*Olenecamptus* sp.
Hexapoda	Coleoptera	Cerambycidae	*Phantasis* sp.
Hexapoda	Coleoptera	Cerambycidae	*Prosopocera vittata* Aurivillius, 1907
Hexapoda	Coleoptera	Cerambycidae	*Purpuricenus laetus* (Thomson, 1864)
Hexapoda	Coleoptera	Cerambycidae	*Tragocephala variegata* Bertoloni, 1849 ?
Hexapoda	Coleoptera	Cerambycidae	*Xystrocera dispar*
Hexapoda	Coleoptera	Cerambycidae	*Zographus aulicus*
Hexapoda	Coleoptera	Cetoniidae	*Amazula suavis* (Burmeister, 1847)
Hexapoda	Coleoptera	Cetoniidae	*Apocnosis striata* (Janson, 1877)
Hexapoda	Coleoptera	Cetoniidae	*Calometopus nyassae* (Westwood, 1878)
Hexapoda	Coleoptera	Cetoniidae	*Chlorocala africana* ssp. *oertzeni* (Kolbe, 1865)
Hexapoda	Coleoptera	Cetoniidae	*Dyspilophora trivittata* (Schaum, 1841)
Hexapoda	Coleoptera	Cetoniidae	*Haematonotus turbidus* (Boheman, 1860)
Hexapoda	Coleoptera	Cetoniidae	*Incala* sp.
Hexapoda	Coleoptera	Cetoniidae	*Leucocelis albomaculata* (Moser, 1904)
Hexapoda	Coleoptera	Cetoniidae	*Leucocelis lateriguttata* Moser, 1918
Hexapoda	Coleoptera	Cetoniidae	*Oplostomus* sp.
Hexapoda	Coleoptera	Cetoniidae	*Pachnoda upangwana* Moser, 1918
Hexapoda	Coleoptera	Cetoniidae	*Pachnoda vitticollis* Moser, 1914
Hexapoda	Coleoptera	Cetoniidae	*Pachnodella euparypha* (Gerstaecker, 1871)
Hexapoda	Coleoptera	Cetoniidae	*Phoxomela umbrosa* (Gory & Percheron, 1833)
Hexapoda	Coleoptera	Cetoniidae	*Pilinurgus subundatus* Westwood, 1874
Hexapoda	Coleoptera	Cetoniidae	*Plaesiorrhinella plana* ssp. *undulate* (Bates, 1881)
Hexapoda	Coleoptera	Cetoniidae	*Polystalactica conspergata* Csiki, 1909
Hexapoda	Coleoptera	Cetoniidae	*Polystalactica furfurosa* (Burmeister, 1847)
Hexapoda	Coleoptera	Cetoniidae	*Porphyronota hebraea* (Olivier, 1789)
Hexapoda	Coleoptera	Cetoniidae	*Porphyronota maculatissima* (Boheman, 1860)
Hexapoda	Coleoptera	Cetoniidae	*Pseudoclinteria infuscate* (Gory & Percheron, 1833)

Hexapoda	Coleoptera	Cetoniidae	*Rhabdotis sobrina* (Gory & Percheron, 1833)
Hexapoda	Coleoptera	Cetoniidae	*Stethodesma strachani* ssp. *servillei* White, 1856
Hexapoda	Coleoptera	Cetoniidae	*Tephraea dichroa* (Schaum, 1844)
Hexapoda	Coleoptera	Cetoniidae	*Tephraea morosa* Schaum, 1848
Hexapoda	Coleoptera	Cetoniidae	*Trymodera aterrima* (Gerstaecker, 1867)
Hexapoda	Coleoptera	Cicindelidae	*Elliptica* sp.
Hexapoda	Coleoptera	Cicindelidae	*Manticora scabra* Klug, 1849
Hexapoda	Coleoptera	Cincidelidae	*Bennigsennium insperatum*
Hexapoda	Coleoptera	Cincidelidae	*Dromica bennigseni*
Hexapoda	Coleoptera	Cincidelidae	*Dromica schaumi ?*
Hexapoda	Coleoptera	Cincidelidae	*Elliptica compressicornis*
Hexapoda	Coleoptera	Cincidelidae	*Elliptica* sp. nov.
Hexapoda	Coleoptera	Cincidelidae	*Lophyra* sp.
Hexapoda	Coleoptera	Cincidelidae	*Lophyridia fimbriata*
Hexapoda	Coleoptera	Cincidelidae	*Myriochile melancholica*
Hexapoda	Coleoptera	Elateridae	*Calais hieroglyphicus*
Hexapoda	Lepidoptera	Hesperiidae	*Borbo fatuellus fatuellus* (Hopffer, 1855)
Hexapoda	Lepidoptera	Hesperiidae	*Gomalia elma elma* (Trimen, 1862)
Hexapoda	Lepidoptera	Hesperiidae	*Netrobalane canopus* (Trimen, 1864)
Hexapoda	Lepidoptera	Hesperiidae	*Platylesches moritili* (Wallengren, 1857)
Hexapoda	Lepidoptera	Hesperiidae	*Tagiades flesus* (Fabricius, 1781)
Hexapoda	Lepidoptera	Hesperiidae	*Zophopetes dysmephila* (Trimen, 1868)
Hexapoda	Coleoptera	Lucanidae	Prosopocoilus petitclerci (Didier, 1928)
Hexapoda	Lepidoptera	Lycaenidae	*Anthene (Anthene) amarah amarah* (Guérin-Méneville, 1849)
Hexapoda	Lepidoptera	Lycaenidae	*Anthene (Anthene) lunulata* (Trimen, 1894)
Hexapoda	Lepidoptera	Lycaenidae	*Aphniolaus pallene* (Wallengren, 1857)
Hexapoda	Lepidoptera	Lycaenidae	*Axiocerses amanga amanga* (Westwood, 1881)
Hexapoda	Lepidoptera	Lycaenidae	*Axiocerses tjoane tjoane* (Wallengren, 1857)
Hexapoda	Lepidoptera	Lycaenidae	*Azanus mirza* (Plötz, 1880)
Hexapoda	Lepidoptera	Lycaenidae	*Baliochila* sp. nov.
Hexapoda	Lepidoptera	Lycaenidae	*Cigaritis apelles* (Oberthür, 1878)
Hexapoda	Lepidoptera	Lycaenidae	*Cigaritis mozambica* (Bertoloni, 1850)
Hexapoda	Lepidoptera	Lycaenidae	*Cigaritis trimeni trimeni* (Neave, 1910)
Hexapoda	Lepidoptera	Lycaenidae	*Cupidopsis jobates jobates* (Hopffer, 1855)
Hexapoda	Lepidoptera	Lycaenidae	*Euthecta cooksoni* subsp. ?nov. Bennett, 1954
Hexapoda	Lepidoptera	Lycaenidae	*Hemiolaus caeculus caeculus* (Hopffer), 1855
Hexapoda	Lepidoptera	Lycaenidae	*Hypolycaena philippus philippus* (Fabricius, 1793)
Hexapoda	Lepidoptera	Lycaenidae	*Iolaus* (*Epamera*) *?diametra* (Karsch, 1895)
Hexapoda	Lepidoptera	Lycaenidae	*Lampides boeticus* (Linnaeus, 1767)
Hexapoda	Lepidoptera	Lycaenidae	*Leptotes pirithous pirithous* (Linnaeus, 1767)
Hexapoda	Lepidoptera	Lycaenidae	*Pseudiolaus poultoni* (Riley, 1928)
Hexapoda	Lepidoptera	Lycaenidae	*Stugeta bowkeri* subsp. *tearei* (Dickson, 1980)
Hexapoda	Lepidoptera	Lycaenidae	*Zizeeria knysna* (Trimen, 1862)
Hexapoda	Neuroptera	Myrmeleontidae	*Creoleon nubifer* (Kolbe, 1914)
Hexapoda	Neuroptera	Myrmeleontidae	*Cueta cf mysteriosa* (Gerstaecker, 1893)
Hexapoda	Neuroptera	Myrmeleontidae	*Jaya dasymalla* (Gerstaecker, 1863)
Hexapoda	Neuroptera	Myrmeleontidae	*Myrmeleon obscurus* (Navas, 1912)
Hexapoda	Neuroptera	Myrmeleontidae	*Neuroleon belohensis* (Navas, 1924)
Hexapoda	Neuroptera	Myrmeleontidae	*Palpares cataractae* Péringuey, 1910
Hexapoda	Neuroptera	Myrmeleontidae	*Palpares inclemens* (Walker, 1853)
Hexapoda	Neuroptera	Myrmeleontidae	*Syngenes* cf *dolichocercus* (Navas, 1914)

Hexapoda	Lepidoptera	Nymphalidae	*Acraea (Acraea) anemosa* Hewitson, 1865
Hexapoda	Lepidoptera	Nymphalidae	*Acraea (Acraea) cuva cuva* Grose-Smith, 1889
Hexapoda	Lepidoptera	Nymphalidae	*Acraea (Acraea) egina areca* Mabille, 1889
Hexapoda	Lepidoptera	Nymphalidae	*Acraea (Acraea) natalica* de Boisduval, 1847
Hexapoda	Lepidoptera	Nymphalidae	*Acraea (Acraea) neobule neobule* Doubleday, 1847
Hexapoda	Lepidoptera	Nymphalidae	*Acraea (Acraea) oncaea* Hopffer, 1855
Hexapoda	Lepidoptera	Nymphalidae	*Acraea (Acraea) petraea* de Boisduval, 1847
Hexapoda	Lepidoptera	Nymphalidae	*Acraea (Acraea) rabbaiae rabbaiae* Ward, 1873
Hexapoda	Lepidoptera	Nymphalidae	*Acraea (Acraea) zonata* Hewitson, 1877
Hexapoda	Lepidoptera	Nymphalidae	*Acraea (Actinote) acerata* Hewitson, 1874
Hexapoda	Lepidoptera	Nymphalidae	*Acraea (Actinote) rahira rahira* de Boisduval, 1833
Hexapoda	Lepidoptera	Nymphalidae	*Bicyclus safitza safitza* (Westwood, 1850)
Hexapoda	Lepidoptera	Nymphalidae	*Byblia anvatara acheloia* (Wallengren, 1857)
Hexapoda	Lepidoptera	Nymphalidae	*Catacroptera cloanthe cloanthe* (Stoll, 1781)
Hexapoda	Lepidoptera	Nymphalidae	*Charaxes castor flavifasciatus* Butler, 1895
Hexapoda	Lepidoptera	Nymphalidae	*Charaxes cithaeron* Felder & Felder, 1859
Hexapoda	Lepidoptera	Nymphalidae	*Charaxes ethalion ethalion* (de Boisduval, 1847)
Hexapoda	Lepidoptera	Nymphalidae	*Charaxes macclounii* Butler, 1895
Hexapoda	Lepidoptera	Nymphalidae	*Charaxes protoclea* subsp. *azota* (Hewitson, 1877)
Hexapoda	Lepidoptera	Nymphalidae	*Charaxes tavetensis* Rothschild, 1894 0
Hexapoda	Lepidoptera	Nymphalidae	*Charaxes zoolina zoolina* (Westwood, 1850)
Hexapoda	Lepidoptera	Nymphalidae	*Danaus (Anosia) chrysippus aegyptius* (von Schreber, 1759)
Hexapoda	Lepidoptera	Nymphalidae	*Euphaedra (Neophronia) neophron neophron* (Hopffer, 1855)
Hexapoda	Lepidoptera	Nymphalidae	*Euryphura achlys* (Hopffer, 1855)
Hexapoda	Lepidoptera	Nymphalidae	*Hypolimnas deceptor deceptor* (Trimen, 1873)
Hexapoda	Lepidoptera	Nymphalidae	*Junonia hierta* subsp. *cebrene* Trimen, 1870
Hexapoda	Lepidoptera	Nymphalidae	*Junonia natalica natalica* (Felder & Felder, 1860)
Hexapoda	Lepidoptera	Nymphalidae	*Junonia oenone oenone* (Linnaeus, 1758)
Hexapoda	Lepidoptera	Nymphalidae	*Neptis jordani* Neave, 1910
Hexapoda	Lepidoptera	Nymphalidae	*Neptis kiriakoffi* Overlaet, 1955
Hexapoda	Lepidoptera	Nymphalidae	*Phalanta phalantha aethiopica* (Rothschild & Jordan, 1903)
Hexapoda	Lepidoptera	Nymphalidae	*Salamis anacardii* (Linnaeus, 1758)
Hexapoda	Lepidoptera	Nymphalidae	*Salamis parhassus* (Drury, 1782)
Hexapoda	Lepidoptera	Nymphalidae	*Sevenia morantii* (Trimen, 1881)
Hexapoda	Lepidoptera	Nymphalidae	*Ypthima impura* subsp. *paupera* Ungemach, 1932
Hexapoda	Lepidoptera	Papilionidae	*Graphium (Arisbe) angolanus angolanus* (Goeze, 1779)
Hexapoda	Lepidoptera	Papilionidae	*Graphium (Arisbe) antheus* (Cramer, 1779)
Hexapoda	Lepidoptera	Papilionidae	*Graphium (Arisbe) colonna* (Ward, 1873)
Hexapoda	Lepidoptera	Papilionidae	*Graphium (Arisbe) leonidas leonidas* (Fabricius, 1793
Hexapoda	Lepidoptera	Papilionidae	*Graphium (Arisbe) polistratus* (Grose-Smith, 1889)
Hexapoda	Lepidoptera	Papilionidae	*Graphium (Arisbe) porthaon porthaon* (Hewitson, 1865)
Hexapoda	Lepidoptera	Papilionidae	*Papilio (Princeps) demodocus demodocus* Esper, 1798
Hexapoda	Lepidoptera	Papilionidae	*Papilio (Princeps) nireus lyaeus* Doubleday, 1845
Hexapoda	Lepidoptera	Papilionidae	*Papilio (Princeps) ophidicephalus ophidicephalus* Oberthür, 1878
Hexapoda	Lepidoptera	Pieridae	*Belenois creona severina* (Stoll, 1781)
Hexapoda	Lepidoptera	Pieridae	*Belenois thysa thysa* (Hopffer, 1855)
Hexapoda	Lepidoptera	Pieridae	*Catopsilia florella* (Fabricius, 1775)
Hexapoda	Lepidoptera	Pieridae	*Colotis eris eris* (Klug, 1829)
Hexapoda	Lepidoptera	Pieridae	*Colotis euippe omphale* (Godart, 1819)
Hexapoda	Lepidoptera	Pieridae	*Colotis evagore antigone* (de Boisduval, 1836)

Hexapoda	Lepidoptera	Pieridae	*Colotis ione* (Godart, 1819)
Hexapoda	Lepidoptera	Pieridae	*Colotis vesta argillaceus* (Butler, 1877)
Hexapoda	Lepidoptera	Pieridae	*Eurema (Terias) hecabe solifera* (Butler, 1875)
Hexapoda	Lepidoptera	Pieridae	*Leptosia alcesta inalcesta* Bernardi, 1959
Hexapoda	Lepidoptera	Pieridae	*Mylothris agathina agathina* (Cramer, 1779)
Hexapoda	Lepidoptera	Pieridae	*Nepheronia thalassina sinalata* (Suffert, 1904)
Hexapoda	Lepidoptera	Pieridae	*Pinacopteryx eriphia eriphia* (Godart, 1819)
Hexapoda	Lepidoptera	Saturniidae	*Antistathmoptera daltonae rectangulata* Pinhey, 1968
Hexapoda	Lepidoptera	Saturniidae	*Argema mimosae* (Boisduval, 1847)
Hexapoda	Lepidoptera	Saturniidae	*Gonimbrasia (Nudaurelia) anna*
Hexapoda	Lepidoptera	Saturniidae	*Gonimbrasia zambesina zambesina*
Hexapoda	Lepidoptera	Saturniidae	*Gynanisa maja*
Hexapoda	Lepidoptera	Saturniidae	*Heniocha marnois* (Rogenhofer, 1891)
Hexapoda	Lepidoptera	Saturniidae	*Holocerina smilax* (Westwood, 1849)
Hexapoda	Lepidoptera	Saturniidae	*Orthogonioptilum* sp.
Hexapoda	Lepidoptera	Saturniidae	*Pselaphelia laclosi*
Hexapoda	Lepidoptera	Saturniidae	*Pseudimbrasia deyrollei*
Hexapoda	Lepidoptera	Saturniidae	*Pseudobunaea epithyrena* (Maassen & Weyding, 1885)
Hexapoda	Lepidoptera	Saturniidae	*Tagoropsis* sp.
Hexapoda	Lepidoptera	Saturniidae	*Urota sinope*
Hexapoda	Lepidoptera	Saturniidae	*Usta terpsichore* (Maassen & Weyding, 1885)
Hexapoda	Coleoptera	Scarabaeidae	*Afrostrandius plebejus* (Klug, 1855)
Hexapoda	Coleoptera	Scarabaeidae	*Allogymnopleurus thalassinus*
Hexapoda	Coleoptera	Scarabaeidae	*Anachalcos convexus* (Boheman, 1857)
Hexapoda	Coleoptera	Scarabaeidae	*Anachalcos procerus* Gerstäcker, 1871
Hexapoda	Coleoptera	Scarabaeidae	*Anonychonitis freyi* Janssens, 1950
Hexapoda	Coleoptera	Scarabaeidae	*Caccobius* sp. 1
Hexapoda	Coleoptera	Scarabaeidae	*Caccobius* sp. 2
Hexapoda	Coleoptera	Scarabaeidae	*Caccobius* sp. 3
Hexapoda	Coleoptera	Scarabaeidae	*Catharsius* cf. *tricornutus*
Hexapoda	Coleoptera	Scarabaeidae	*Catharsius heros* (Boheman, 1860)
Hexapoda	Coleoptera	Scarabaeidae	*Catharsius rhinoceros* Klug, 1855
Hexapoda	Coleoptera	Scarabaeidae	*Catharsius* sp. 1
Hexapoda	Coleoptera	Scarabaeidae	*Catharsius* sp. 2
Hexapoda	Coleoptera	Scarabaeidae	*Catharsius* sp. 3
Hexapoda	Coleoptera	Scarabaeidae	*Catharsius* sp. 4
Hexapoda	Coleoptera	Scarabaeidae	*Catharsius* sp. 5
Hexapoda	Coleoptera	Scarabaeidae	*Catharsius* sp. 7
Hexapoda	Coleoptera	Scarabaeidae	*Catharsius* sp. 8
Hexapoda	Coleoptera	Scarabaeidae	*Copris bootes* Klug, 1855
Hexapoda	Coleoptera	Scarabaeidae	*Copris* sp. 1
Hexapoda	Coleoptera	Scarabaeidae	*Euoniticellus kawanus* (Janssens, 1939)
Hexapoda	Coleoptera	Scarabaeidae	*Euoniticellus zumpti* Janssens, 1953
Hexapoda	Coleoptera	Scarabaeidae	*Euonthophagus* cf. *carbonarius* (Klug, 1855)
Hexapoda	Coleoptera	Scarabaeidae	*Garreta caffer* (Fahreaus, 1857)
Hexapoda	Coleoptera	Scarabaeidae	*Garreta nitens* (Olivier, 1789)
Hexapoda	Coleoptera	Scarabaeidae	*Garreta* sp. 1
Hexapoda	Coleoptera	Scarabaeidae	*Gymnopleurus ignitus* Klug, 1855
Hexapoda	Coleoptera	Scarabaeidae	*Gymnopleurus* sp. 1
Hexapoda	Coleoptera	Scarabaeidae	*Heliocopris* sp. 1

Hexapoda	Coleoptera	Scarabaeidae	*Heteronitis castelnaui* (Harold, 1862)
Hexapoda	Coleoptera	Scarabaeidae	*Hyalonthophagus alcyon* (Klug, 1855)
Hexapoda	Coleoptera	Scarabaeidae	*Kheper lamarcki* (MacLeay, 1821)
Hexapoda	Coleoptera	Scarabaeidae	*Metacatharsius* sp. 1
Hexapoda	Coleoptera	Scarabaeidae	*Oniticellus* sp. 1
Hexapoda	Coleoptera	Scarabaeidae	*Onitis malleatus* Janssens, 1937
Hexapoda	Coleoptera	Scarabaeidae	*Onitis* sp. 1
Hexapoda	Coleoptera	Scarabaeidae	*Onitis* sp. 2
Hexapoda	Coleoptera	Scarabaeidae	*Onitis viridulus* Boheman, 1857
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus aeruginosus* Roth, 1851
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus ambiguus* Péringuey, 1901
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus apiciosus* d'Orbigny, 1902(fish)
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* cf. *gazella* (Fabricius, 1787)
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* cf. *lacustris* Harold, 1877
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* cf. *vinctus* Erichson, 1843
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus crucenotatus* d'Orbigny, 1905
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus ebenus* Péringuey, 1888
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus fallax* d'Orbigny, 1913
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus fimetarius* Roth, 1851
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus flavolimbatus* Klug, 1855
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus herus* Péringuey, 1901
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus impurus* Harold, 1868 (fish)
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus nanus* Harold, 1878
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus pullus* Roth, 1851
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus signatus* Fahreus, 1857
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* sp. 1
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* sp. 10
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* sp. 11
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* sp. 2 (millipede)
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* sp. 3
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* sp. 4
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* sp. 5
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* sp. 6
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* sp. 7
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* sp. 8
Hexapoda	Coleoptera	Scarabaeidae	*Onthophagus* sp. 9
Hexapoda	Coleoptera	Scarabaeidae	*Phalops ardea* (Klug, 1855)
Hexapoda	Coleoptera	Scarabaeidae	*Phalops boschas* (Klug, 1855)
Hexapoda	Coleoptera	Scarabaeidae	*Phalops flavocinctus* (Klug, 1855)
Hexapoda	Coleoptera	Scarabaeidae	*Proagoderus aureiceps* (d'Orbigny, 1902)
Hexapoda	Coleoptera	Scarabaeidae	*Proagoderus dives* (Harold, 1877)
Hexapoda	Coleoptera	Scarabaeidae	*Proagoderus loricatus* (Klug, 1855)
Hexapoda	Coleoptera	Scarabaeidae	*Proagoderus* sp. 1
Hexapoda	Coleoptera	Scarabaeidae	*Proagoderus* sp. 2
Hexapoda	Coleoptera	Scarabaeidae	*Scarabaeus ebenus* (Klug, 1855)
Hexapoda	Coleoptera	Scarabaeidae	*Scarabaeus galenus* Westwood, 1844
Hexapoda	Coleoptera	Scarabaeidae	*Sisyphus* sp. 1
Hexapoda	Coleoptera	Scarabaeidae	*Sisyphus* sp. 2
Hexapoda	Coleoptera	Scarabaeidae	*Sisyphus* sp. 3
Hexapoda	Coleoptera	Scarabaeidae	*Tragiscus dimidiatus* Klug, 1855
Hexapoda	Coleoptera	Tenebrionidae	*Endustomus* sp.