

New assessment reveals extraordinary plant diversity at risk in Ngezi–Vumawimbi Forest Reserve, Pemba Island, Zanzibar, Tanzania

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Abstract The Ngezi–Vumawimbi Forest Reserve is the largest remaining patch of natural vegetation on Pemba Island, Zanzibar, Tanzania. In 2024, in collaboration with the Department of Forestry, Ministry of Agriculture, Zanzibar, we conducted a baseline biodiversity survey of animal and plant communities. Preliminary results reveal previously unrecognized plant diversity, including species likely new to science that are currently under study. We confirmed the presence of endemic and threatened plant species, and recorded populations of species not previously reported on Pemba Island. We also confirmed the presence of a small population of blue duiker *Philantomba monticola*, currently under threat from poaching. One of the areas richest in plant diversity is designated for development of a new tourist resort. This would replace most of the Vumawimbi evergreen coastal forest, home to a unique forest type in continental Africa dominated by *Intsia bijuga*.

Keywords Biodiversity, coastal forest, deforestation, Eastern Africa hotspot, Ngezi–Vumawimbi Forest Reserve, Pemba, Tanzania, vascular plants

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The coastal forests of Eastern Africa are recognized as a biodiversity hotspot (Burgess & Clarke, 2000) and a high priority area for conservation (Mittermeier et al., 2004). Considered the hotspot most at risk of plant and vertebrate extinctions as a result of habitat loss, it is included among the 11 so-called hyperhot priorities for conservation investment (Brooks et al., 2002). East African coastal forests are highly fragmented and isolated, with an average area of only 12 km², and rarely > 20 km². Despite their small size, these forests support many endemic genera and species of plants and animals (Burgess et al., 1993) and have the highest number of endemic plant and vertebrate species per km² of any biodiversity hotspot (Myers et al., 2000). Within the coastal

forests of Eastern Africa, the importance of the offshore islands of Mafia, Unguja and Pemba has long been recognized. Each of these large islands off the coast of Tanzania harbours endemic species, many of which are confined to forest (Burgess & Clarke, 2000). Pemba Island exhibits the highest levels of animal endemism, including an endemic bat (*Pteropus voeltzkowi*), four endemic birds (*Nectarinia pembae*, *Zosterops vaughani*, *Otus pembaensis*, *Treron pembaensis*) and four endemic reptiles (*Phelsuma parkeri*, *Trachylepis albotaeniata*, *Mochlus pembanum*, *Dispholidus pembae*). This high level of endemism is partly a result of the isolation of Pemba from the Africa mainland since the Late Miocene–Pliocene (Stockley, 1942). Unlike Unguja and Mafia, Pemba is a true oceanic island (Greenway et al., 1988; Burgess & Clarke, 2000).

The forests of Mafia and Pemba Islands receive an annual average of nearly 2,000 mm of rainfall, supporting the development of tropical rainforest, yet Pemba hosts relatively few endemic plant species compared to coastal forests on the mainland (Burgess & Clarke, 2000). This could, however, be a reflection of the limited study of the island's plant diversity. Additionally, the vegetation on Pemba, as elsewhere in the Zanzibar Archipelago, has been modified by human activities for at least 2,000 years, and especially over the last 2 centuries, during which much of the natural vegetation was cleared for timber and plantations (Burgess & Clarke, 2000). The most comprehensive study of the vegetation is that of Beentje (1990a,b), who described vegetation types, assessed their conservation values both locally and globally, evaluated the impacts of exploitation and the introduction of exotic species, produced plant lists and vegetation maps, and identified areas of concern for future management and conservation. However, Beentje's work mainly focused on forestry species and was limited to Ngezi moist forest and Tondooni coastal forest, excluding the Vumawimbi evergreen coastal forest. Another biodiversity inventory was conducted by Nahonyo et al. (2005), adding vegetation sampling, new plant records for the Forest Reserve, and a faunal checklist based on both historical data and new surveys.

The largest forest remnant on Pemba Island is the c. 20 km² Ngezi–Vumawimbi Forest Reserve (Rodgers et al., 1986; Beentje, 1990a; Fig. 1), gazetted in 1959. It includes c. 550 ha of moist forest and 220 ha of giant heath vegetation dominated by *Erica mafiensis*. Other vegetation types include

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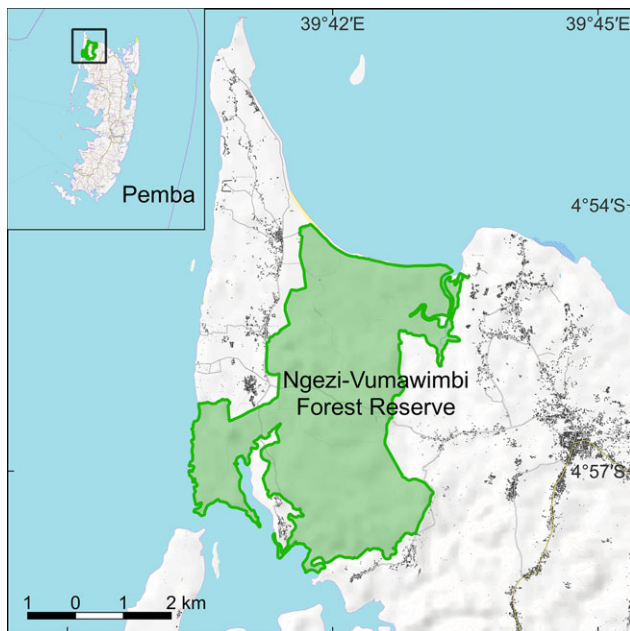


FIG. 1 Location of the Ngezi-Vumawimbi Forest Reserve in the north of Pemba Island, Tanzania.

coastal evergreen thicket, dry coastal forest, mangroves, wetlands and secondary bush that is a result of overharvesting. Additional forest remnants, such as Ras Kiuyu (c. 2.7 km²) and Msitu Mkuu (c. 3.5 km²), c. 15 km from Ngezi, in the north-east of Pemba, remain largely unexplored. Ngezi Forest is globally unique as it hosts a species assemblage unparalleled in other East African forests (Beentje, 1990a), and is the only forest in East Africa where species restricted to coastal East African forests (e.g. *Rhodognaphalon mossambicense*), Afromontane elements (*Erica*, *Cassipourea gummiflua*), eastern Indian species (e.g. *Samadera indica*, *Donella lanceolata*), Guineo-Congolian forest species (*Uapaca guineensis* and *Anthocleista* cf. *vogelii*, found in this survey) and Mascarene and Madagascar species (e.g. *Chrysalidocarpus*, *Typhonodorum lindleyanum*) coexist. A systematic plant inventory of these forests is nevertheless required as previous surveys have been either incidental (herbarium specimens collected by Vaughan and Greenway in the 1920–1930s), or short-term (Rodgers et al., 1986; Beentje, 1990a).

During 4–12 December 2024, we had the opportunity to conduct a baseline survey to assess plant and animal diversity in the Ngezi-Vumawimbi Forest Reserve. This work was carried out within the framework of the GREEN Project (Generating Resilience through Ecological Enhancement in Ngezi-Vumawimbi Forest) led by the conservation organization Istituto Oikos and implemented in collaboration with the Department of Forestry of Zanzibar. The project supports the protection of the Forest Reserve through initiatives to improve knowledge of the forest's status, preserve its globally important biodiversity,

address threats such as deforestation and illegal resource extraction, and train forest guards in ecological, botanical and wildlife survey and monitoring techniques.

Botanical surveys were conducted across all the main habitats of Ngezi-Vumawimbi Forest Reserve: moist forest, evergreen coastal forest, *Erica* heathland, swamp forest, swamp open areas and coastal thicket on coral rag. Only mangrove stands were not surveyed systematically, but a comprehensive species checklist is already available (Hamad et al., 2014). Plants were identified in the field, and in many cases herbarium specimens were collected. These specimens have been deposited at NHT, with duplicates in some cases sent to PAV for further study (herbarium acronyms follow Thiers, 2025). Some species have been identified only to genus or family and await further taxonomic study of the collected material.

We recorded at least 350 plant species, of which c. 20% represent species not previously reported for Pemba Island (Supplementary Table 1), at least nine of which are categorized as threatened or Near Threatened on the IUCN Red List (Table 1). We collected 264 herbarium specimens, which have been deposited at NHT. We confirmed the presence of species known from only a few localities in East Africa (e.g. *Allophylus vestitus*, *Strophanthus zimmermannianus*, both categorized as Endangered on the IUCN Red List) as well as species endemic to Pemba (e.g. *Chrysalidocarpus pembanus*, categorized as Vulnerable). We confirmed the occurrence of *Intsia bijuga*, an important timber tree primarily distributed in Southeast Asia and Madagascar and categorized as Near Threatened. This species had only been known from Pemba Island based on a herbarium specimen collected by Greenway in 1929. We found *Intsia bijuga* widely distributed in the Vumawimbi evergreen coastal forest, where trees up to 25 m tall dominate the canopy. To our knowledge, this is the only coastal forest in East Africa dominated by *I. bijuga*.

Other noteworthy records include the presence of three carnivorous plant species (*Drosera indica*, *Utricularia benjaminiana*, *Utricularia subulata*) in the open swamp areas, and orchids (*Acampe pachyglossa*, *Eulophia maculata*) in the Vumawimbi evergreen coastal forest, none of which had previously been reported from Pemba Island. A small population of *Disperis* may represent a new species and is currently under study. Several species new to the Forest Reserve were also found in the Tondooni coastal evergreen thicket and coastal forest on coral rag (e.g. *Antidesma vogelianum*, *Cissus quinquangularis*, *Commiphora africana*, *Ficus bubu*). We also recorded new occurrences of alien species in the flora of Pemba, such as *Alternanthera sessilis* and *Acanthospermum hispidum*.

Despite the conservation efforts by the Department of Forestry and these discoveries, the conservation status of the Forest Reserve is critical. The small population of blue duiker

TABLE 1 Threatened and Near Threatened plant species recorded and collected in Ngezi-Vumawimbi Forest Reserve, with their IUCN Red List status (IUCN, 2025) and habitat.

Family	Species	IUCN Red List status ¹	Habitat
Sapindaceae	<i>Allophylus vestitus</i> F.G.Davies	EN	Moist forest
Apocynaceae	<i>Strophanthus zimmermannianus</i> Monach.	EN	Moist forest
Arecaceae	<i>Chrysalidocarpus pambanus</i> H.E.Moore	VU	Moist forest, Vumawimbi evergreen coastal forest
Ericaceae	<i>Erica mafiensis</i> (Engl.) Dorr	VU	<i>Erica</i> heathland
Rubiaceae	<i>Vangueria pallidiflora</i> (Bullock) Lantz	VU	Moist forest
Fabaceae	<i>Intsia bijuga</i> (Colebr.) Kuntze	NT	Vumawimbi evergreen coastal forest
Moraceae	<i>Milicia excelsa</i> (Welw.) C.C.Berg	NT	Moist forest
Rubiaceae	<i>Psydrax recurvifolius</i> (Bullock) Bridson	NT	Vumawimbi evergreen coastal forest, Tondooni coastal thicket
Vitaceae	<i>Cissus quinquangularis</i> Chiov.	NT	Tondooni coastal rag

¹NT, Near Threatened; VU, Vulnerable; EN, Endangered.

Philantomba monticola, whose presence in Ngezi we confirmed after more than 25 years, is under significant pressure from poaching and habitat alteration. The Pemba Island population is recognized by some authors (Wilson, 2001) as *Philantomba monticola sundevalli*, which also occurs on other islands and Eastern Africa coastal forests. This classification is based on morphological traits and geographical distribution. Genetic studies are needed to clarify the taxonomic placement of the Pemba population. For this purpose, bone fragments from the remains of a trapped specimen were collected and will undergo genetic analysis. Timber species such as *Erythrophloeum suaveolens*, *Intsia bijuga* and *Milicia excelsa* are overexploited through illegal logging. These forests face severe degradation as a result of illegal timber harvesting, firewood and charcoal production, agricultural expansion and urbanization (Burgess et al., 2017). During our survey, we documented numerous signs of illegal logging. For example, the moist forest reported by Beentje in this area 35 years ago, which had about 80% canopy cover and was recommended as one of the two core areas of the Reserve, has now been reduced to a disturbed, open secondary forest, crossed by paths and motorbikes trails. The unique heathland dominated by *Erica mafiensis* is subjected to annual fires that threaten its integrity.

Another finding of concern is the status of the Vumawimbi evergreen coastal forest in the north of the Reserve. This entire c. 3 × 1 km area, with high biodiversity and dominated by *I. bijuga*, has been designated for the development of a tourist resort. A billboard at the entrance to the construction site indicates the project will include a complex of villas and swimming pools (Caro et al., 2025). The construction site, already visible on satellite imagery, will also impact the adjacent wetland, where we observed the Vulnerable, endemic Pemba scops owl *Otus pumbaensis* and the Endangered frog *Phrynobatrachus pakenhami*.

Illegal logging in the Ngezi–Vumawimbi Forest Reserve needs to be prevented, and any expansion of tourist infrastructure should be carefully planned in a manner that is fully aligned with the existing protection framework of the Forest Reserve. This forest harbours globally significant natural values, many of which are as yet undescribed, and potentially undiscovered, and has potential for sustainable ecotourism that could generate funding for its conservation while supporting the sustainable development of surrounding communities.

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Conflicts of interest None.

Ethical standards All activities were conducted within the framework of a memorandum of understanding between Istituto Oikos and the Department of Forestry, Ministry of Agriculture, Irrigation, Natural Resources and Livestock, Zanzibar, of 23 of October 2024, which includes the provision of international technical expertise in conservation and research, biodiversity baseline surveys, and monitoring. Herbarium specimens and tissue samples have been deposited in NHT and in the University of Dar es Salaam, in accordance with Tanzania and Zanzibar legislation, by members of the Department of Forestry and the University of Dar es Salaam. Plant material was collected without damaging natural or threatened populations and

wherever possible only parts of plants were collected. Mammal specimens were collected as bones or fur found in the field. For reptiles and amphibians, capture and handling techniques conformed to the highest standards of animal welfare. Young rangers hired within the Green Project have been trained in plant and animal surveys and identification. This research abided by the *Oryx* guidelines on ethical standards.

Data availability The data that support the findings of this study are available from the corresponding author upon reasonable request. Herbarium specimens are deposited in the National Herbarium of Tanzania (NHT) and are freely available for consultation.

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