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Ecological niche of *Terebralia palustris* in the mangroves of Mayotte (France, Indian Ocean)

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Introduction

The epigeal gastropod *Terebralia palustris* is widely distributed in the mangroves of the Indo-Pacific. It is an **engineering species** that contributes to **matter recycling** and **bioturbation**, and is a **resource for local populations** throughout its distribution (Dupont et al., *in prep*).

Existing knowledge on the factors explaining its **distribution** remain quite contradictory and suggests **highly context-dependent** patterns. *T. palustris* can be either limited to internal mangroves (Wells, 1980), or present on the whole mangrove (Fratini et al., 2004) depending on the location throughout its range. In Mayotte (France, Indian Ocean), *T. palustris* is **heterogeneously distributed**, being present in only 13 mangroves out of 29 on the island (Brosse et al., *in prep*).

We therefore aimed to:

- **Characterize** the extent of *T. palustris* ecological niche in Mayotte
- **Determine** what **environmental variables** are the most critical in conditioning the presence of *T. palustris* in Mayotte

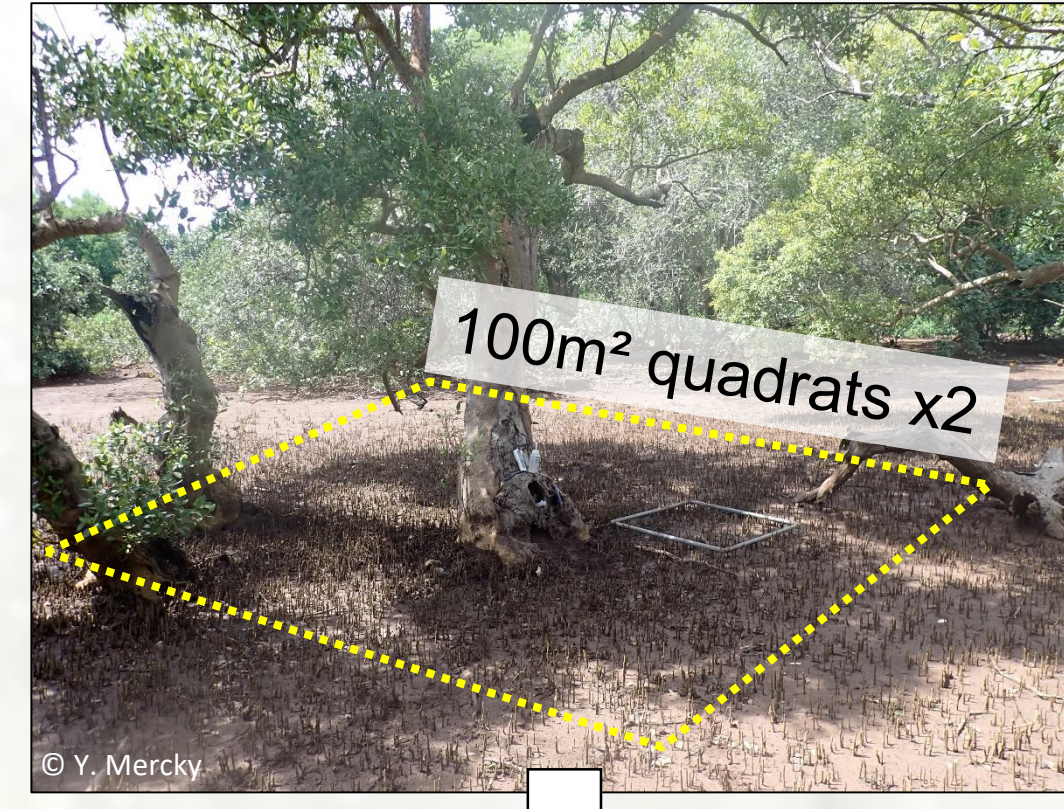
Methodology

7 mangroves:
• 5 of **presence**
• 2 of **absence**

2 stations of presence & 2 of absence

2 or 3 stations of absence

spring & neap tides of dry & wet seasons in 2022



- Tree density (tree_nb)
- Basal area (basal_area)
- Tree size (tree_size)
- Leaf litter produced during a tidal cycle (leaf_litter)

- % of stagnant water (water)
- % of litter on the ground (litter)
- Canopy cover (canopy)
- Leaf area index (LAI)
- Altitude (altitude)
- ***T. palustris* density** (terebralia)

- Sediment :
 - Median grain size (grain_size)
 - Organic matter content (OM)
 - Water content (WQ)
 - Chlorophyll a content (chl-a)

Paralleling the *T. palustris* density data with environmental characteristics

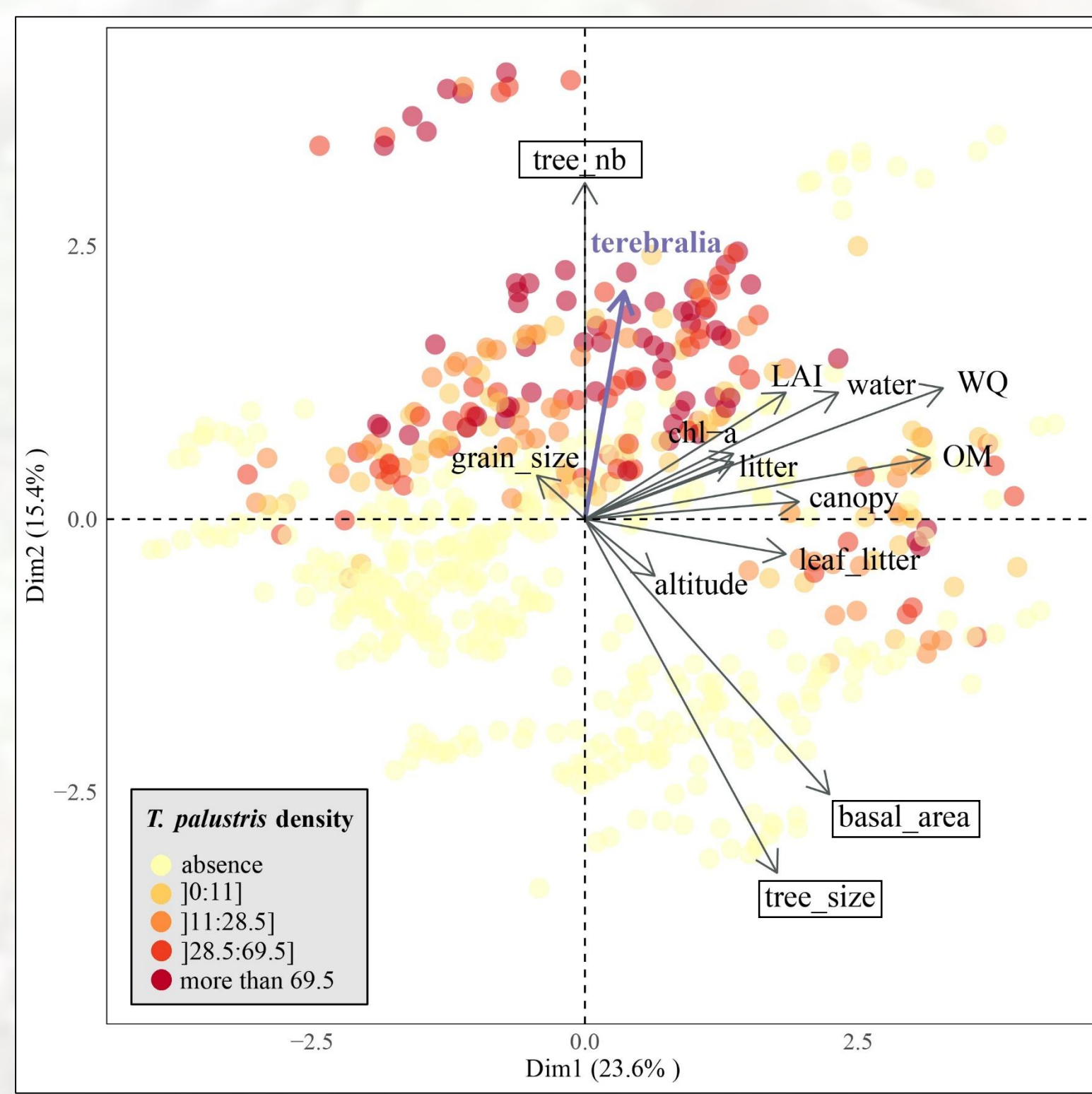


Figure 1: Principal component analysis of the environmental factors with representation of the *T. palustris* density (Abbreviations: see Methodology).

1 Characterization

- **No impact** of tidal cycle and season on *T. palustris* density (PERMANOVA: $F=0.85$, $df=2$, p -value < 0.001)
- Axis 2 of PCA (Fig. 1) **discriminates** the sites with and without *T. palustris* based on mangrove tree-related variables (nb, size, basal area)

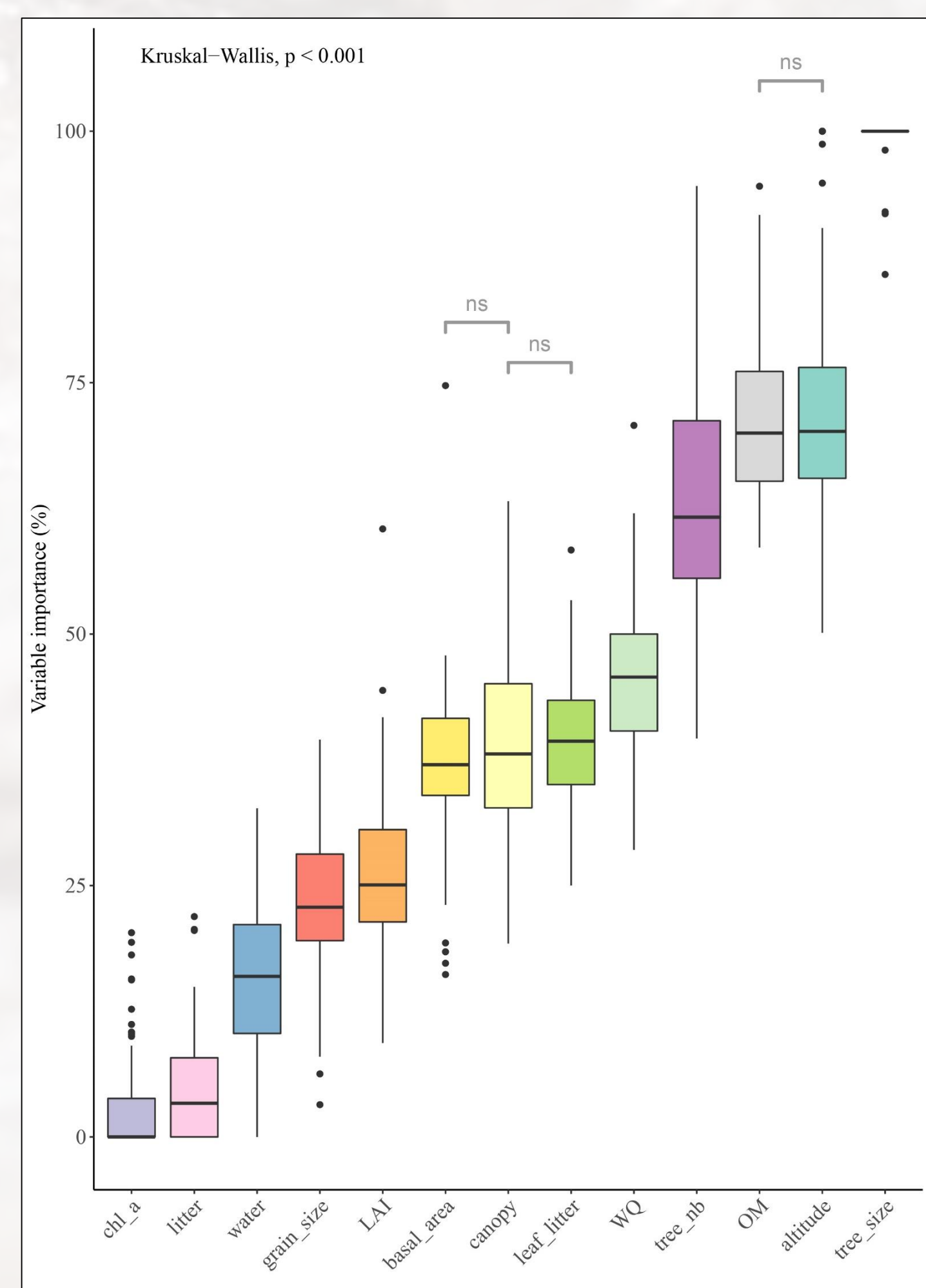


Figure 2: Boxplot with median value showing the importance of variables explaining the density of *T. palustris* by machine learning modeling (Random-forest; $n = 100$, $mtry = 4$; $ntree = 200$).

Results

3 Habitat classification

5 habitat configurations within the internal mangrove of Mayotte

- **Many** relatively **small** trees with **low** basal area & **medium** litter production
- **Lower** on the shore
- **Fine** sediment with **medium** OM, **high** WQ & **rich** in chl-a
- **Relatively closed** canopy, **high** LAI
- **Higher** % of stagnant water & ground litter



- **Numerous** relatively **small** trees, **low** basal area & **average** litter production
- **Higher** on the shore
- **Coarse** sediment, **low** in OM, WQ & chl-a
- **Closed** canopy, **high** LAI
- **Low** % of stagnant water & ground litter



- **Few** **medium-sized** trees, **large** basal area & **high** litter production
- **Higher** on the shore
- **Medium** sediment, **rich** in OM, WQ & chl-a
- **Closed** canopy, **high** LAI
- **Large** % of stagnant water & ground litter



- **Few** **medium-sized** trees with **low** basal area & **low** litter production
- **Medium** height on the shore
- **Very fine** sediment, **low** in OM, WQ & chl-a
- **Open** canopy, **low** LAI
- **Very little** % of stagnant water & ground litter

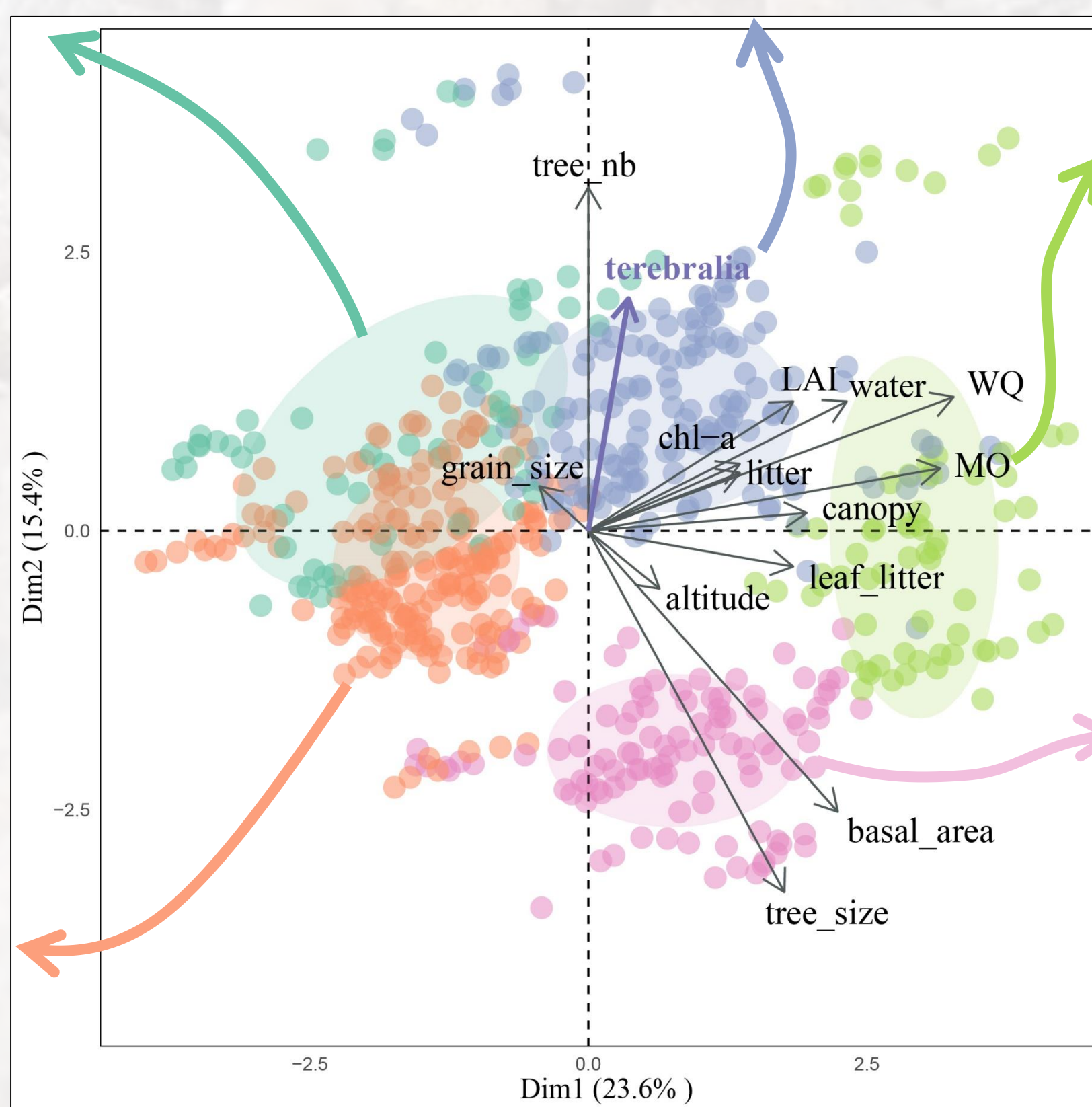


Figure 3: Principal component analysis of the environmental factors with representation of the hierarchical classification (UPGMA, $k=5$) defined by their environmental structure. Clusters 2 and 4 correspond mainly to areas where *T. palustris* is absent. (Abbreviations: see Methodology).



- **Few** **very high** trees, **large** basal area & **high** litter production
- **Medium** height on the shore
- **Rather fine** sediment, **medium** OM, WQ, chl-a
- **Rather closed** canopy, but **low** LAI
- **Low** % of stagnant water & ground litter

2 Importance of environmental variables

Random-forest models:

Tree size, altitude, organic matter and **number of trees** (Fig. 2) all play an **important role** in explaining the presence of *T. palustris* in large numbers.

Conclusion & perspectives

Unlike other areas in its range, *T. palustris* is **confined to the internal mangroves in Mayotte**, on the upper shore. Our results indicate distribution heterogeneity within the internal mangrove. **Several habitat configurations appear to be favorable** to its development. It is found where **trees** are sufficiently **numerous** (24.5 ± 22.2 trees by 100 m²) and of **medium size** (414 ± 133 cm) to provide sufficient shade to prevent desiccation, but not too much to allow biofilm production and growth of surrounding trees, where the **sediment is rich in organic matter** ($19.0 \pm 6.2\%$) for feeding. **Altitude** also plays a role and implies a bimodal response, as it is found **lower** (120 ± 40 cm) and **higher** (190 ± 30 cm) on the shore within internal mangrove. These different habitat configurations may be linked to the distribution of the animal at different life stages. A size distribution study was carried out in parallel and showed that a **differential size distribution** varies the realized niche during the species' life cycle, especially through **altitude** data. Young individuals are more likely to be found at the lower levels of the internal mangrove.

Fratini, S., Vigiani, V., Vannini, M., Cannicci S. 2004. « *Terebralia palustris* (Gastropoda: Potamididae) in a Kenyan mangal: size structure, distribution and impact on the consumption of leaf litter ». *Marine Biology* 144: 1173-82
Wells, F.E. 1980. « Comparative distributions of the mudwhelks *Terebralia sulcata* and *T. palustris* in a mangrove swamp in northwestern Australia ». *Malacological Review* 13: 1-5.