

SPATIAL DISTRIBUTION OF MARINE ANGIOSPERM AND MACROALGAE IN RELATION TO THE STRUCTURE OF THE MAHORAN REEF

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INTRODUCTION

Seagrass beds are **highly productive** and are among the most effective **carbon sinks**. They also serve as nurseries for multiple juvenile species and act as a buffer against the negative effects of eutrophication (Duffy, 2006).

Seagrass beds are also sensitive to ocean warming, which can influence their loss or promote algal overgrowth. When algae are not overly abundant, they can **coexist** with seagrass beds (Richard & Quijón, 2023).



In Mayotte :
(Pascal et al., 2013)

13 marine angiosperm species
270 algae species

In this study, we examine the **distribution of marine angiosperms and algae on the Mahoran reef of N'Gouja**, focusing on the factors shaping this distribution, including substrate type and spatial arrangement.

METHODS

Data were collected on **N'Gouja beach**, Mayotte (France), over three days, following the protocol shown in Fig.1.



Fig.1: Transect localisations and protocole on N'Gouja beach.

In each quadrat, the **type of substrate** (live coral, debris, sand) and its percentage **cover** were recorded, as well as the **coverage of seagrass beds and algae**, both identified at the **species level**. The *Halophila sp.* and *Cymodocea sp.* were only identified at the genus level. Statistical analyses were performed using **R software**. Due to **observer bias**, only stations 1B, 2B, 3B, 4, 5 and 6 were used.

DISCUSSION

Angiosperms distribution

Sand, a preferred substrate for angiosperms (Fig. 4), is **significantly dominant on the east side** (Fig. 3; Wilcoxon $p < 2.99e-16$). This would suggest higher angiosperm cover on the east.

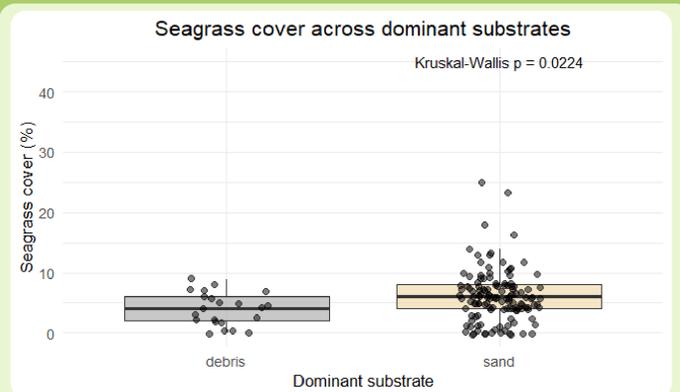


Fig.4: Angiosperms cover across substrates.

However, the results show **no significant differences along either gradient** (Fig.2 & 3). In addition, on the east side, more anthropogenic pressures are observed (boats and structures), leading to an increase in beach users and **more pressure on angiosperms through trampling**. Hypothetically, *Chelonia mydas* (green turtles) may also have a homogenising effect through regular grazing on N'Gouja.

Additionally, seagrass cover on the west side may have been underestimated due to **sampling bias** caused by poor visibility during data collection.

Angiosperms spatial distribution is fairly **homogeneous**, with substrate benefits compensating for the impacts.

Temporal perspectives



In 2017 and 2020, the seagrass beds were predominantly composed of **H. uninervis, S. isoetifolium, H. ovalis, and T. hemprichii**. In the present study, the first three species remain the most abundant in the area. Nevertheless, a substantial **decrease of 30%** in mean angiosperms abundance was observed between 2017 and 2020. Now, the data has even more decreased (Fig. 5)

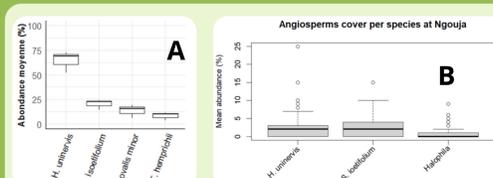


Fig.5: Mean abundance of angiosperms at Ngouja (A) in 2020 and (B) in 2025.

Several factors may have contributed to the **decline in angiosperm cover**. A plausible explanation appears to be the destructive passage of **Cyclone Chido** in December 2024, which impacted numerous coastal ecosystems on the island.

RESULTS

Algae, angiosperms, and substrates cover along a N-S gradient

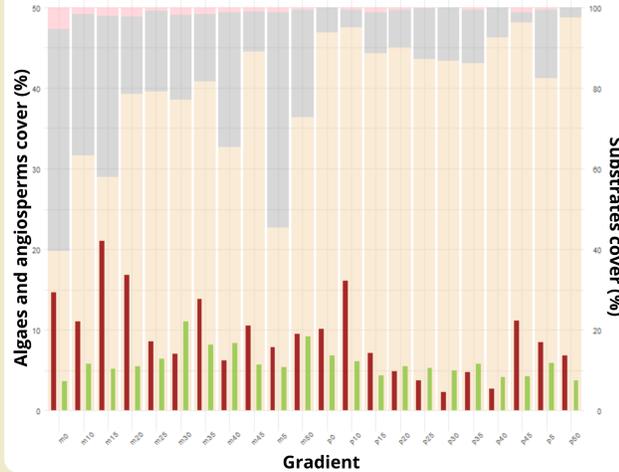


Fig.2: Algae, angiosperms and substrates cover along a south-north gradient.

North-South gradient

The spatial distribution of algae and debris cover is **significantly higher in the north (m0-m50)** compared to the south (p0-p50).

However, debris is significantly higher in the northern area, while **sand dominates the southern area**.

The Wilcoxon test shows **no significant difference in angiosperm cover** between north and south at N'Gouja.

Description: ■ Algae ■ Angiosperms ■ Sand ■ Debris ■ Live corals

West-East gradient

The spatial distribution of algae and debris coverage is **significantly higher on the west (1B; 2B & 3B)** side compared to the east (4; 5; & 6).

However, sand is **significantly lower on the west side**.

The Wilcoxon test shows **no significant difference in angiosperms cover between east and west** of N'Gouja.

Algae, angiosperms, and substrates cover along a W-E gradient

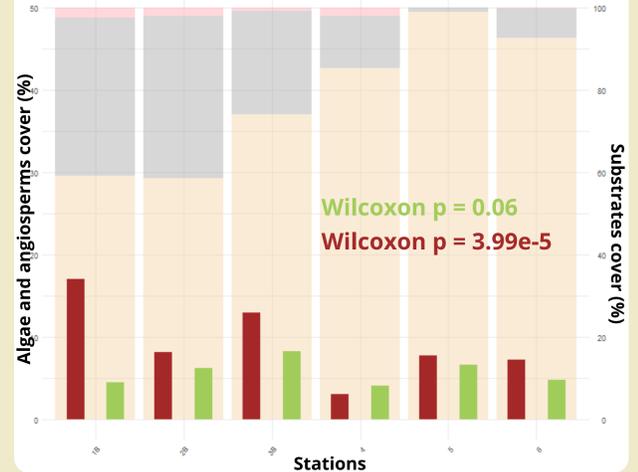


Fig.3: Algae, angiosperms and substrates cover along a west-east gradient.

Algae spatial distribution

Debris dominates the northern zone of the lagoon,, where **algal abundance is highest** (Fig. 6, 2).

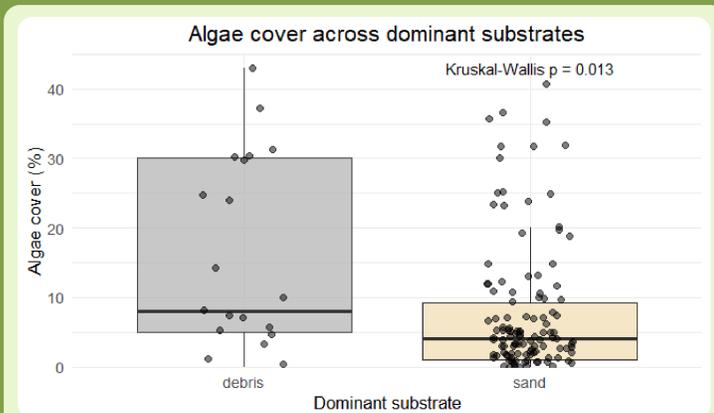


Fig.6: Algae cover across substrates.

This pattern is consistent with studies showing that stable substrates, depth, light, and nutrient availability **shape macroalgal distribution**. *Padina* is unexpectedly more abundant in the western transects, despite stricter regulations, and its presence indicates **eutrophication**. This aligns with the strong **anthropogenic pressures** at N'Gouja (tourism, trampling, pollution), which favour **opportunistic algae and degrade the ecosystem**.



CONCLUSION

The spatial distribution of angiosperms and macroalgae at N'Gouja is primarily driven by substrate heterogeneity. Algae dominate debris-rich areas in the north and west, while angiosperms preferentially occur on sandy substrates in the east. Despite these spatial contrasts, overall angiosperm cover remains relatively constant across the lagoon. This pattern may also be shaped by turtle grazing and local anthropogenic pressure.