

Resilient Orchids: Understanding the Heat Tolerance of *Vanda tessellata* in Changing Climate in the Western Ghats, Wayanad

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Abstract— This study examines the heat resistance and adaptive strategies of *Vanda tessellata*, a resilient wild orchid species thriving in the semi-arid conditions of Wayanad, Western Ghats. Over five years (2019–2024), comprehensive field observations, physiological assessments, and environmental monitoring were conducted to evaluate its ability to withstand extreme temperatures and minimal water availability.

Our findings highlight that *Vanda tessellata* exhibits multiple survival mechanisms, including Crassulacean Acid Metabolism (CAM) photosynthesis, which allows it to minimize water loss by absorbing CO₂ at night. The orchid also develops thickened cuticles and an extensive aerial root system that enhances moisture retention and nutrient uptake from humid air. Additionally, anthocyanin pigmentation was observed to provide photoprotective benefits by reducing oxidative stress under intense solar radiation. Microhabitat selection played a crucial role in heat tolerance, with orchids growing in shaded areas demonstrating higher survival rates than those in direct sunlight. Soil and substrate analysis revealed that the species primarily thrives on host trees with high water-holding capacity, suggesting a strong dependency on specific ecological conditions.

The study underscores the importance of habitat conservation, particularly in the context of climate change, which threatens the stability of these microhabitats. Conservation strategies should focus on protecting key forest patches, promoting assisted propagation techniques, and implementing long-term monitoring programs to track climate-induced changes in orchid populations. By understanding the adaptive strategies of *Vanda tessellata*, this research contributes to broader conservation efforts aimed at preserving heat-resistant orchid species in tropical ecosystems.

Keywords— *Vanda tessellata*, heat resistance, Western Ghats, Wayanad, CAM photosynthesis, orchid adaptation, climate resilience, aerial roots, habitat conservation, anthocyanin pigmentation.

I. INTRODUCTION

1.1 Background:

Orchids are one of the most diverse and ecologically significant plant groups in the Western Ghats, playing a crucial role in maintaining ecosystem balance. They serve as bio-indicators of environmental health due to their sensitivity to climatic changes. Among them, *Vanda tessellata* is a robust, epiphytic orchid well-adapted to extreme heat conditions, making it a key species for studying plant resilience under stress. As global temperatures rise, understanding the physiological and ecological mechanisms enabling this species to endure high temperatures and moisture fluctuations becomes increasingly important.

This orchid species is known for its ability to thrive in exposed environments with limited water availability, thanks to specialized adaptations like CAM (Crassulacean Acid Metabolism) photosynthesis, aerial roots, and thickened cuticles. These features help it survive in semi-arid and dry deciduous forests where other orchids struggle. Given the increasing threat posed