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Original Research Article

FUNGAL AND FLORAL DIVERSITY AND THREAT TO ECOLOGICAL SUCCESSION IN ZARYAN FOREST, PARACHINAR

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Abstract *Parachinar exhibits a combination of flat and hilly terrains characterized by limited vegetation, biodiversity, and resource availability. The Zaryan forest is a mountain forest that begins at the base of a mountain and extends up to but does not encompass its peak. These mountains encompassed a vast plain. In this woodland, Quercus baloot is the most prevalent plant species. The sedimentary sediments present at the beginning of this forest provide clues as to how this climax community evolved. Unbelievably, it was discovered that these species are more abundant at the base of the slope and disappear as we ascend. As the region's economy is poor, locals visit the forest more frequently to obtain wood, herbs, other bushes, and fodder to satisfy their basic needs. They have a meager income and subsist hand to mouth. Occasionally, they cut down mountains and sell them to meet their basic requirements. The region's disputed geographical and political position prohibits tourism, despite the region's incredible grandeur and breathtaking views. However, the hazard is alarming because this forest ecosystem requires protection. Pakistan Environmental Journalists and other wildlife organizations should take decisive actions and precautions to halt the deterioration and biodiversity loss.*

Keywords: Fungal diversity, floral diversity, ecological succession, Zaryan Forest, Parachinar, mycorrhizal associations, invasive species, conservation, habitat degradation

Introduction

The Zaryan Forest located in Parachinar is an obscure entity, occupied with a diverse fungal and few floral species, which play a significant role in maintaining the forest's ecological stability and ability to withstand disturbances (Fig 1A & B). Fungi fulfill crucial functions in nutrient cycling, mycorrhizal connections, and decomposition, whereas plant species exert significant influence on primary productivity and the establishment of habitats (Van Der Heijden et al., 2008; Adnan et al., 2022). A comprehensive comprehension of the interrelationships among these constituents is crucial for preserving the ecological succession dynamics within the forest (Li, 2023). Our study centered on a forest ecosystem and its associated community, specifically focusing on observing and measuring ecological succession. The Zaryan forest is located in the Upper Kurram agency (northern Pakistan), spanning from Sultan village to Teri mangle (Pewar Kotal) as its endpoint. The district is divided into three tehsils: Central Kurram, Lower Kurram, and Upper Kurram (Hussain et al., 2022). The area is-between 33º20' to 34º03' N latitude and 69º50' to 70º45' E longitude, with an approximate elevation of 6000 feet above sea level (Gilani et al., 2003). The terrain is flat, with the Rocky Mountains as its main feature (Hussain et al., 2022).The climate in Kurram varies greatly by height, from scorching heat to severe cold (Ghanim et al., 2023). The summer and spring have great weather. The climate is harsh since temperatures can drop to -10°C in winter. The moist and dry temperate living form swarm is the subject of current research (Gilaniet al., 2003). The yearly rainfall of Parachinar is 1239.96 millimeters. Morning humidity is higher than evening humidity. Low precipitation characterizes autumn and winter (Ali et al., 2023). The distribution patterns of plant species are commonly believed to predominantly correspond to their climate niches (Chauvier et al., 2021). Nevertheless, it is important to note that climate is just one aspect of the multidimensional environment that plant populations must adapt to (Gundale & Kardol 2021). Recent research has revealed significant impacts of

non-climatic elements on species distribution (Mathur & Mathur 2023). The issue became more pronounced as certain lichen species, particularly crustose lichens (Fig 1C), vanished between our initial and subsequent surveys. These lichens play a significant role in the succession process, facilitating the acceleration of rock and mineral weathering. This weathering, in turn, contributes to soil formation and prepares the terrain for subsequent vegetation growth (Krauze et al., 2021; Rahmonov et al., 2021). These animals depend on forests for their habitat and survival, as they form an ecosystem encompassing a diverse range of flora and fauna (Rathoure & Patel 2020). Temperature and precipitation are widely recognized as the two primary factors of utmost significance for forest ecosystems (Stefanidis & Alexandridis 2021). The Parachinar forest has experienced a discernible shift in temperature and rainfall patterns over-recent years (Haq & Badshah 2021). Numerous studies have been conducted in this field, focusing on the trade and conservation status of medicinal plants, the eco-taxonomic algal flora survey, ethnobotanical and phytomedicinal revisions, floristic inventory, ecological characteristics, and biological spectrums (Gilani et al., 2003; Hussain et al., 2012a; Hussain et al., 2012b; Sajida et al., 2013; Ajaib et al., 2014; Badshah et al., 2016). It is crucial to acknowledge that the available plant resources in the surrounding area are insufficient to meetthe demands, resulting in a significant influx of fuel and timber wood from North Waziristan.

Material and methods

Our study utilized a systematic sampling approach to assess fungal and floral diversity across designated zones within the Zaryan Forest from 2018 to 2020. Numerous new records of lichens have also been published from these surveys (Firdous et al., 2022; Firdous et al. 2023). Fungal samples were collected using soil and litter sampling methods (Badshah et al., 2016), while plant species data were collected through quadrat-based surveys (Kiyama & Uchida 2023). Fungal species were identified through microscopic analysis and DNA sequencing (Firdous et al., 2023), while plant species were identified using established taxonomic references (Ali & Qaisar, 1995-2009 and Nasir & Ali, 1971-2007).

Results

The investigation unveiled a diverse array of lichen species, with prominent groups including *Lecidella patavina* (A. Massal.) Knoph & Leuckert, *Lecidella tumidula* (A. Massal.) Knoph & Leuckert, *Lecidella tumidula* (A. Massal.) Knoph & Leuckert, *Lepraria lobificans* Nyl. *Calogaya biatorina* (A. Massal.) Arup, Froden & Sochting, *Dermatocarpon miniatum* (Lightf.)Th. Fr., *Xanthoria elegans* (Link) Th. Fr., *Lobothallia praeradiosa* (Nyl.) Hafellner *Acarospora* sp. and *Sarcogyne* sp. (Fig 1E). The floral diversity of the forest exhibited a limited presence of native and endemic plant species, with *Quercus baloot* being the prevailing species, accounting for 95% of the forest's total coverage (Fig 1D). Nevertheless, the fungal and floral components encounter many stressors that undermine the process of ecological succession. While invasive species were not detected in the area, the main concerns highlighted were deforestation, unsustainable land use practices, human activities, and grazing of animals. Various herbs, bryophytes, and shrubs were systematically documented and collected alongside the pioneer species in the field, providing unambiguous evidence of the ongoing succession phenomenon (Fig 2). Fruticose lichens were not observed in the study area; nevertheless, foliose lichens, particularly some species of *Physcia* and *Phaeophyscia* along with a few species of Parmeliaceae, were found to be increasing on both tree trunks and branches. Several recent publications have reported multiple new records of the Physciaceae family in this region, establishing it as the most prevalent family, with *P. vitti* identified as the dominating species of lichen (Firdous et al., 2022 and Firdous et al., 2023). Additional fungal species and their associations were also observed in the study. These included ectomycorrhizal species such as *Boletus* sp., *Agaricus* sp., *Amanita* sp., *Lepiota* sp., *Russula* sp., *Panaeolus* sp., *Chroogomphus*, *Pluteus* sp., *Clitocybe* sp., *Agrocybe* sp., *Inocybe* sp., *Termitimyces* sp., *Lactarius* sp., *Canthrallus* sp., *Parasola* sp., and *Coprinus* sp. Furthermore, wood-rotting fungi such as *Ganoderma* sp., tooth fungi, other gilled mushrooms, and polypores were also observed. Furthermore, the local fauna in this region encompassed a diverse range of wildlife species, such as primates (monkeys), large felines (tigers), suids (pigs), canids (wolves, foxes, and dogs), ursids (bears), canids (jackals), rodents (porcupines, rats, and rabbits), insectivores (hedgehogs and shrews), chiropterans (bats), and equids (mules), among others. In response to potential threats posed by these creatures, the villagers promptly resort to shooting and killing them. This action is motivated by the fact that these wild animals pose a risk to their domesticated animals, resulting in the loss of cattle and sheep. During the excursions, the skeletal remains of these creatures were discovered in the jungle. The avian species inhabiting this region encompass a variety of birds, such as sparrows, starlings, mynahs, crows, parrots, pigeons, doves, woodpeckers, quails, pheasants, vultures, owls, swallows, cuckoos, partridges, nightingales, and others. The inhabitants of this locality, particularly the proprietors of stores, were seen to possess an affinity for these avian creatures, often adorning

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their establishments by suspending or situating them within cages close to their storefronts.

Discussion

The intricate relationships between fungi and plants contribute to the Zaryan Forest's stability. Fungi assist plants through mycorrhizal associations, aiding nutrient uptake and stress tolerance (Devi et al., 2021). Moreover, fungal decomposers facilitate organic matter breakdown, enriching soil fertility (Griffiths et al., 2021). Human activities and grazing disrupt these interactions, while deforestation and habitat degradation undermine the forest's regenerative capacity (Sage, 2020; Bodo et al., 2021; Kumar et al., 2023). Such disruptions can lead to altered successional pathways, reducing the forest's resilience to disturbances (Seidl & Turner2022). The study of succession in an ecosystem is very important as it can improve our understanding of another ecological phenomenon and can help in predicting biodiversity loss,climate change, invasive species, and ecological restoration ecosystem services thus is a central concept in ecology (Malhi et al., 2020). We should conserve forests because they are essential for us as they provide oxygen, cause rainfall, and prevent soil erosion (Wang et al., 2021). Plants depend on animals and birds for pollination and seed dispersal (Genes & Dirzo, 2022). We should encourage people to live in a way that doesn't hurt the environment. We should also establish parks to protect rainforests and wildlife (Digun-Aweto et al., 2020). Support companies that operate in ways that minimize damage to the environment. Protection of this forest is especially sought by the KPK government as there are only a few forests in the whole district, and most of its plain land has very little vegetation. Although crustose lichens on dry mountains indicate ecological succession, developing a complex community will take years and years.

Conclusion

The Zaryan Forest's fungal and floral diversity underpins its ecological functions, emphasizing the need for integrated conservation efforts. Preserving mycorrhizal associations and plant-fungal interactions is vital for maintaining nutrient cycling and soil health. Urgent actions, including habitat restoration, invasive species management, and sustainable land use practices, are essential to safeguard these dynamic relationships and ensure the forest's long-termecological succession.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

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Conflict of Interest

Regarding conflicts of interest, the authors state that their research was carried out independently without any affiliations or financial ties that could raise concerns about biases.

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Figure 1. A: Parachinar Valley view; **B:** Zaryan Forest view; **C:** Disappeared crustose lichen; **D:** *Quercus baloot* trunk covered by foliose lichens; **E:** Lichen species in Zaryan forest

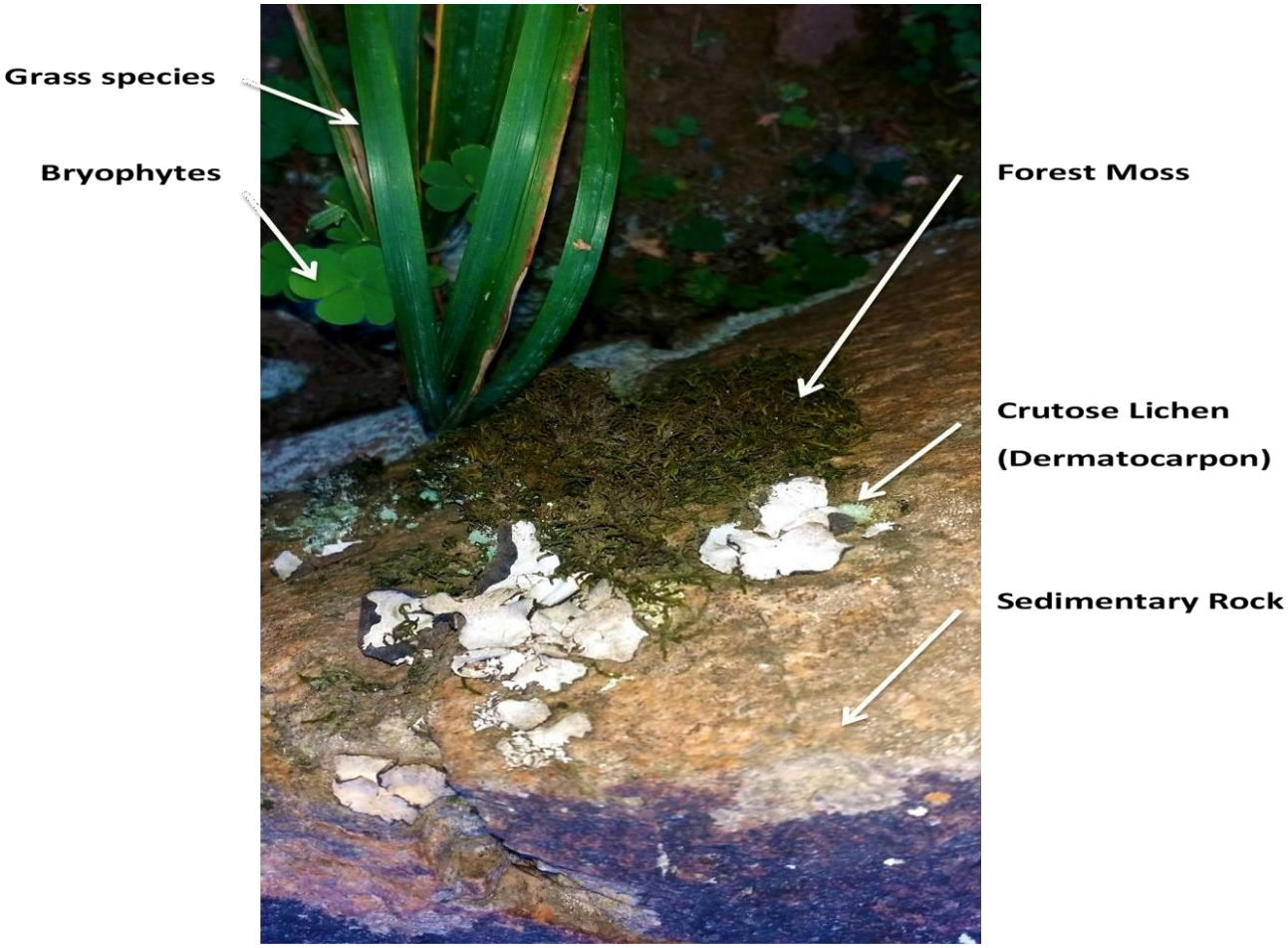

Figure 2. Ecological succession captured in Zaryan forest