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Exploring the Concept of Biodiversity in Eastern Ghats Rainforests and its Evolutionary History

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Abstract: In order to effectively conserve biodiversity and understand ecological data, it is crucial to understand the spatial pattern of beta-diversity. Until recently, researchers studying biodiversity in the Amazon, the world's biggest and richest rainforest habitat, have limited their emphasis to a handful of well-known species, mostly plants and animals. There are several taxonomic group-specific patterns of biodiversity (such as richness and endemicity) that cannot be generalized. Over the course of tens of millions of years, natural processes spread out throughout the enormous South American continent gradually added to the rich biodiversity seen in the Amazon. This is one way in which the biodiversity of the Amazon is priceless. Geography, climate, and biotic interactions have always played a role in shaping evolutionary pathways, and these factors continue to do so now. Diverse taxonomic groupings exhibit substantially different speciation times. One type of Neotropical bees that is more well-known is the euglossina bee, sometimes known as the orchid bee, due to its aesthetically pleasing metallic green and blue colours.

Keywords: Biodiversity, Eastern Ghats, Rainforests, History, Ecological

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INTRODUCTION

What makes Earth's many ecosystems and ecological complexity home to such a wide variety of animals is their biological diversity. When it comes to floriculture and traditional medicine, orchids are symbols of nobility and majesty. Orchids are famous for their very beautiful blossoms, which are noted for their lengthy vase life, vibrant colours, and distinctive shapes. Because of these traits, orchid cultivation has become a lucrative business on a global scale. Numerous species are capable of interspecific and intergeneric hybridization, which has opened up enormous opportunities for creating hybrids with a wide range of floral traits, and many of these species also have beautiful flowers. Among the world's most orchid-rich regions—the Indian Ocean, the Western Ghats, and the Nicobar Islands Northeastern Himalayas—is India.

Additionally, several traditional medicinal systems have made use of Indian orchids from the beginning of time. However, only lately in our nation has there been an organized effort to collect and preserve orchids with the goal of increasing their value via selective breeding. There are an increasing number of novel hybrids being recorded on a monthly basis, and there are now over 100,000 hybrids known to exist being grown for ornamental purposes and in containers.

Even in their native environment, orchids face threats to their genetic diversity and survival posed by human activities and their unique life cycle. Many orchid species have had precipitous declines in population as a result of human activities for example, deforestation and excessive fishing. In order to

ensure that this genetic treasure is preserved for generations to come, it is imperative that different conservation measures be implemented promptly in accordance with scientific principles.

There are over 28,000 species of orchids around the globe, making it the second most numerous families of flowering plants. Their natural habitats include the steamy jungles Philippines, Australia, Ceylon, Burma, South China, Brazil, and the rest of South and Central America, Ceylon, India, and Central and South America. Orchids may be found in a wide variety of habitats, including epiphytes, lithophytes, terrestrials, and saprophytes; its name comes from the fact that their root tubers look like testicles. Orchids that grow on trees as epiphytes attach themselves externally to the tree's trunk or branches.

Roots that are epiphytic contain a unique kind of tissue called "velamen tissue" that allows them to soak up water from the air, while roots that are mycorrhizal have symbiotic relationships with certain types of fungi. There is a wide range in form, size, cooler, and posture in orchid flowers. The rear petal forms a labellum or lip, the gynostemium or column forms the formation, the pollen is united as pollinia, and non-endospermic micro seeds are inside.

LITERATURE REVIEW

Cardoso, Domingos, Särkinen, Tiina, et. al. (2017) The significance of an entity denotes its importance or relevance. The use of comprehensive floristic datasets to examine the variety and composition of the Amazon tree flora is common for deriving findings on the trends and development of plant diversity in the area. Nonetheless, it is crucial to acknowledge that these datasets exhibit considerable deficiencies they used and the substance that came out of it. The Amazon rainforest's seed plant species have been meticulously documented. This compilation includes confirmed data obtained from voucher specimens acknowledged by taxonomic specialists and is based on reliable published sources. This comprehensive list provides a starting point for discussing the ongoing controversy on the variety of flora inhabiting the Amazon. The incredible biodiversity seen in the enormous Amazonian rainforest may have its origins and functions better understood via ecological and evolutionary studies that make use of this data jungles.

M. Venkaiah et al (2020). Northern Andhra Pradesh may be found in the Eastern Ghats of the state, between the coordinates of 16°42′-18°17′ North and 81°06′ to 83°53′ East. Research on orchids in this region has been limited, but what little there is has yielded 54 species from 30 genera. Detailed information on the chapter's description, distribution, and conservation efforts are presented here.

Jalal, Jeewan, et al. (2012) There are 130 species of indigenous orchids in peninsular India, representing 38 different taxa, according to this study. Out of all these, 43 live on land, 85 in epiphytes, and 2 in holomycotrophic (saprophytic) environments. The Eastern Ghats are home to 22 species of indigenous orchids, the Deccan Plateau to 29, and the Western Ghats to 123. Due to the fast growth of taxonomic discoveries in neighbouring countries, the number of endemic species is lowered in the current research compared to past publications. This led to the discovery of widespread distributions in a number of species.

Sanjeet Kumar et al (2021). Orchid species diversity in the Indian state of Odisha [1]. Along with data pertaining to the economic and medical applications. Odisha is a state rich in flora and fauna, and its landscapes are quite varied. It is fond of almost every kind of plant life. Orchid variety is a key component of its floral riches. Their ecologically valuable and aesthetically pleasing blooms are their claim to fame.

This article proposes a list of 160 species belonging to 50 distinct genera based on a comprehensive field study conducted from 2009 to 2020 in various locations of the state. The list is backed from data found in books and archives as well as specimens kept in local herbaria. Also included are topics such as endemism, conservation, medical uses, and economic worth of a few of them.

De, L. et.al. (2019). Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Eight states make up the union: Tripura, Nagaland, Sikkim, and that make up northeast India, a focal point for mega-diversity. Approximately 31,58% (or 25,26 species) of India's flora—which makes approximately half of the country's overall flora—is native to just 7.7 percent of the country's landmass. Orchids, ferns, bamboos, rhododendrons, magnolias, and many more plant species abound in the area. It is widely thought that orchids originated in this area, and they certainly make an appearance among the local flora. Of the approximately 1,333 species of orchids (representing 186 genera) found in India, the greatest concentration (about 856) is in northeastern India.

RESEARCH METHODOLOGY

There were two approaches used to seek for patterns of orchid bee distribution. In order to establish biogeographic zones in the Neotropics that are based on faunistic similarity of locations, cluster analysis was used using data collected based on results from a study of orchid bees in the area. Countless surveys conducted by different researchers throughout the Neotropical Region provided the data used in the subsequent cluster analysis. Based on the abundance for every species in the samples we took, we determined the degree of similarity between every potential pair of locations. Using the Renkonen similarity index calculation allowed us to achieve this. Based on the literature that was found, the geographic distribution of each valid species of Euglossina was identified. The study was place on Destino Farm (1,535 m²) at coordinates 12º52’12.5" S and 52º05’8.5" W in the municipality of Ribeirão Cascalheira, in the northeastern region of Mato Grosso in central Brazil. To collect male specimens, bug nets were baited with benzoate, 1.8 cineole, eugenol, and vanillin; in bottle traps, methyl salicylate was employed (as modified by Campos et al., 1989). The bees of the genus Euglossini were caught in bottle traps and insect nets. that used pure chemicals as attractants. The frequencies, both absolute and relative, were then calculated. Specifically, we looked at whether the frequency of bee visits varied according to the kind of appealing material.

DATA ANALYSIS

Zoogeographical regions. The 28 research regions were categorized based on the similarity of their orchid bee faunas, resulting in a distinct clustering of in the realm of the Atlantic Forest, distinct from those in the Amazonian jungle. When looking at all Euglossina species or only Euglossa species, the categories were the same. Incorporating all Euglossina into the research revealed that some Central American fauna was found among Amazonian species; however, a section of Costa Rican wildlife from Parque Nacional Santa Rosa stood apart from the others areas.

When just Euglossa were analyzed, the Central American local faunas grouped together as a single separate entity. The location The Alcântara region, which is in the northeastern Brazilian state of Maranhão (MA4), varied according to the dataset used for the inquiry. When all Euglossina were considered,

Alcântara was found to cluster with the Atlantic Forest areas, although it showed very little similarity. Similarly, when just Euglossa species were considered, it was found to cluster with the Amazonian region, albeit it showed also very little similarity. After looking at every single Euglossina, the Amazonian Forest was primarily associated with a portion of Central America (Panama (Costa Rica's southernmost part), followed by the Atlantic Forest, and finally the two other places in Costa Rica. The Amazonian Forest (with its Peruvian outposts) was first included with the Atlantic Forest and then with the Central American Forest when the species of Euglossa were the only ones considered area.

Table 1. Quantification of bee populations and species, sampling techniques used, chemical attractants utilized, and prevalence of the most prevalent orchid bee species throughout 28 regions in the Neotropics.

Areas	Authors	No. bees	No. species	Method[1]	Baits[2]
Rio Grande do Sul - RS	Wittmann *et al.* (1988)	639	5	IN	C, SK, V
Faz. Santa Carlota (SS) – SP1	Rebêlo & Garófalo (1991)	892	8	IN	C, E, V
EEZ – SP2	Rebêlo & Garófalo (1997)	736	10	IN	C, E, V
Faz. Santa Carlota (SI) – SP3	Rebêlo & Garófalo (1997)	906	14	IN	C, E, V
Viçosa – SMG	Peruquetti *et al.* (1999)	893	10	BT	AB, C, E, SM, V
Belo Horizonte 1997 – BH1	Nemésio & Silveira (2007)	1,325	14	IN	AB, C, CM, E, V
Belo Horizonte 1999 – BH2	Nemésio (2004)	2,146	14	IN	AB, C, CM, E, V
Res. Serra do Caraça - RSC	Nemésio (2004)	236	10	IN	AB, C, CM, E, V
Parque Estadual Rio Doce – EMG	Nemésio & Silveira (2006)	1,183	18	IN	AB, BI, BM, BZ, C, CM, CR, DB, E, SK, SM, T, V
Rio de Janeiro – RJ	Tonhasca Jr. *et al.* (2002)	3,653	21	IN	C, CM, E, SK, SM, V
Espírito Santo – ES	Bonilla-Gómez (1999)	16,177	31	OBS	C, E, SM, SK, V
Mangrove Bahia – BA1	Neves & Viana (1997)	1,144	12	BT	C, E, SM, V
Gallery Forest – BA2	Neves & Viana (1999)	527	7	IN+BT	BB, C, CM, E, V
Paraíba – PB	Bezerra & Martins (2001)	1,082	9	BT	AA, AB, C, E, SM, V
Lowland Coast. zone – MA1	Rebêlo & Cabral (1997)	1,153	9	IN	BB, C, E, SM
Buriticupu – MA2	Silva & Rebêlo (1999)	1,740	37	IN	BB, C, E, SM, V
Cajual Island – MA3	Silva & Rebêlo (2002)	339	19	IN	C, E, SM, V
Alcântara – MA4	Brito & Rêgo (2001)	467	19	IN	BB, C, E, SM, V
Amazon 1991 – AM1	Becker *et al.* (1991)	290	16	BT	C, SK, SM
Amazon 1992 – AM2	Morato *et al.* (1992)	1,242	27	IN	AB, C, E, SM

Amazon 1996 understory – AM3	Oliveira & Campos (1996)	1,145	33	BT	AB, BB, C, CM, E, SK, SM, V
Amazon 1996 canopy – AM4	Oliveira & Campos (1996)	1,277	35	BT	AB, BB, C, CM, E, SK, SM, V
Peru – Floodplain – PE1	Pearson & Dressler (1985)	1,178	18[3]	IN	AA, AB, AC, AlB, C, CM, dC, E, EC, pC, pCy, pE, Pi, SK, SM, V
Peru – Terra Firme – PE2	Pearson & Dressler (1985)	1,661	18[3]	IN	AA, AB, AC, AlB, C, CM,CR, DC, E, EC, pCy, pE, Pi, SK, SM, V
Panama – PAN	Ackerman (1983)	21,842	44	OBS	AB, C, BB, BI, BM, BZ, CM, dC, E, G, L, SK, SM, 2pEA, 2pE, V
Costa Rica – CNP – CR1	Janzen *et al.* (1982)	961	27	IN	AB, C, CM, E, SM
Costa Rica – SNRP (300 m) – CR2	Janzen *et al.* (1982)	720	20	IN	AB, C, CM, E, SM
Costa Rica – SNRP (5 m) – CR3	Janzen *et al.* (1982)	480	12	IN	AB, C, CM, E, SM

[1]Method: OBS stands for field identification without collection; IN is for insect net; BT stands for baited traps.

[2]Baits: AA = anisyl acetate; AB = benzyl acetate, AC, cresyl acetate; AlB = benzyl BB stands for benzyl benzoate, BI for α-ionone, BM for β-myrcene, BZ for methyl benzoate, C for 1,8-cineole or eucalyptol, CM for methyl trans-cinnamate, CR for p-cresol, DB for dimethoxibenzene, DC for D-cresol methanol, dC for d-carvone, E for eugenol, EC for Ethoxy cinnamate, G for geraniol, L for linalool, pCy for p-cymere, and pE for phenyl ETOH.

The following symbols stand for compounds: vaillin, 2-phenyl ethanol, 2-phenyl ethyl acetate, p-tolyl acetate, piperonol, skatole, methyl salicylate, and 2pE.

[3] A total of the 39 species gathered, only the 18 most prevalent ones were considered for inclusion. have specimen counts, representing at least 98% of the caught bees.

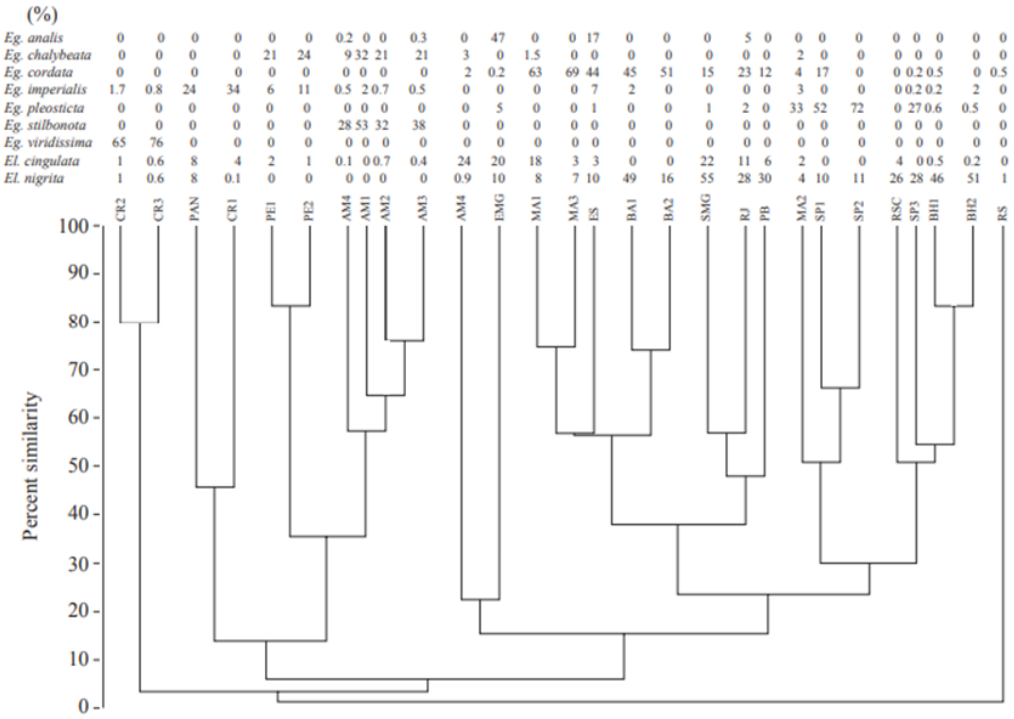

Figure 1: Grouping the 28 Neotropical Region sample locations into clusters based on the degree to which their Euglossina faunas are similar. The area codes may be found in Table 1. In the dendrograms, the numbers that appear above the acronyms of the sites represent the frequencies of the most significant species in identifying those groups.

The orchid bee fauna of Rio Grande do Sul, Brazil, had little resemblance with relation to any other area. In conclusion, three separate divisions existed in South America: The Amazon, the subtropical rain forest, which includes the Atlantic Forest and the state of São Paulo in Brazil, in Central America). Within Central America, there was a single division that included two separate but related subgroups: one for Southwest Costa Rica and Panama, as well as another one for the two locations in the northwest of the country. We shall discuss the little association among these key divisions in additional detail.

Brazil, Rio Grande do Sul. Compared to other Atlantic Forest locations, Rio Grande do Sul is unique due to the very high incidence of Eufriesea violacea (Blanchard) bees—nearly 98% of the bees in the samples. Various sites in São Paulo (SP1, SP2, and SP3), Minas Gerais (EMG, RSC, and SMG), and Espírito Santo (ES) were used to record this species. Nonetheless, its prevalence consistently remained below 5% of the overall bunch of orchids and bees in all three areas. The presence or absence of two Neotropical species, Euglossa cordata (L.) and Eulaema nigrita Lepelletier, at incredibly low frequencies (1% or less), helped to distinguish the Atlantic Forest region in southeastern Brazil from the Rio Grande do Sul. The Atlantic Forest is a domain. Three separate Atlantic Forest groups were identified by analyzing the two datasets, one of which included all Euglossina species and the other solely Euglossa species regions:

The semi-deciduous Atlantic Forest next to the Brazilian savanna is the most common habitat in first subgroup (BH1, BH2, RSC, SP1, SP2, SP3, and MA2). The primary species responsible for the concentration in these locations are El. nigrita, Euglossa fimbriata, Euglossa pleosticta, and Euglossa truncata. There are two subgroups within this group: (i) BH1, BH2, and RSC, which are characterized by

an abundance of El. nigrita and E.g. truncata; and (ii) SP1, SP2, SP3 (also located in the southern part of this group), along with MA2 (a disturbed forest area in the Amazonian region of Maranhão), where e.g. pleosticta is the most prevalent species making up at least 33% of the specimens.

For example, when only individuals of the genus Euglossa were considered, the location shifted from one cluster to another because E. pleosticta was the most common species (41%). However, when all Euglossina were included, this cluster merged with the first because e.g. fimbriata and El. nigrita appeared almost as often as E.g. decreased incidence of pleosticta in the remainder of the second cluster compared to SP3. There is a small population of E. pleosticta in the first cluster, which includes the Belo Horizonte region (Nemésio & Silveira 2007).

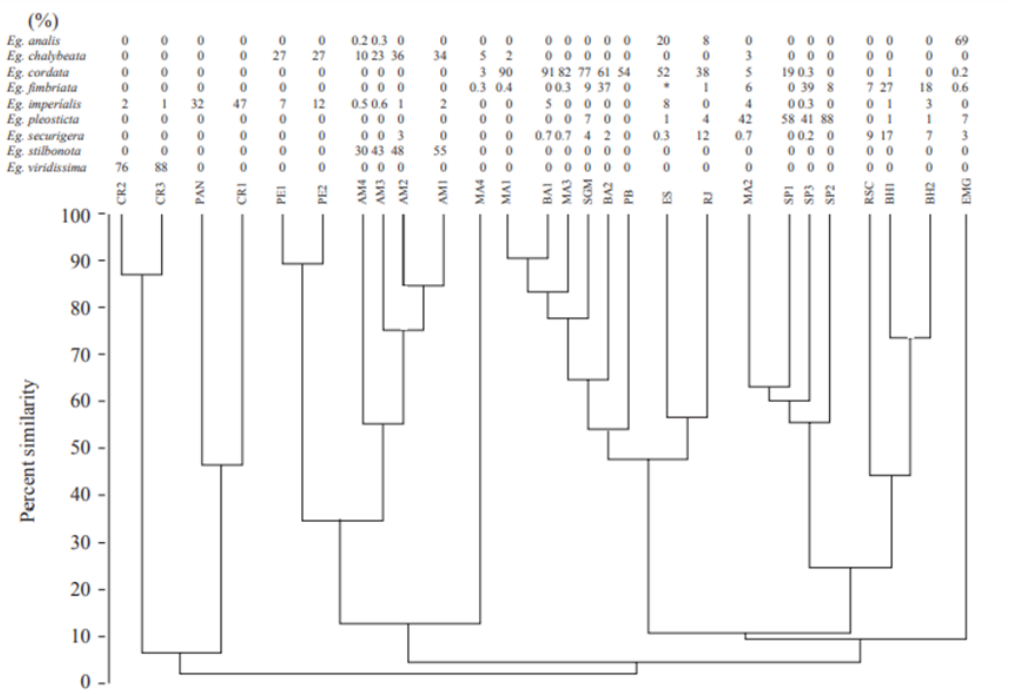

Figure 2. Grouping twenty-seven Neotropical zones into clusters defined by shared Euglossa fauna. For a list of area codes, see Table 1. The frequency of the important species is shown by the numbers above the site name that characterize the groupings shown in the dendrograms. * = frequencies under 0.05%.

Most of the members of Subgroup 2—BA1, BA2, MA1, MA2, SMG, PB, ES, and RJ—live in coastal forests. Compared to the other Minas Gerais areas in Subgroup 1 (BH1, BH2, and RSC), SMG stands out due to its proximity to the beach. e.g. Among the orchid-bee species, Euglossa cordata was the most prevalent in all six regions, with the exception of five places (BA2, ES, PB, MA1, and MA3). In certain regions, such as SMG, BA1, RJ, PB, and BA2, El. nigrita predominated. Since the internal site arrangement of this subgroup changed substantially whether all Euglossina or only Euglossa were present, it is impossible to classify it into clusters were examined, mostly owing to the varying frequencies of El. nigrita. The rarity or absence of e.g. cordata in the seven regions of Subgroup 1 seems to be the primary criterion distinguishing each of these two subsets of the Atlantic Forest.

It seems that Subgroup 3 is the result of two areas (EMG and MA4) accidentally merging. that exhibit little

resemblance to one another and to the other Atlantic Forest regions. These locations were categorized together only when examining all Euglossina, since Eulaema cingulata (Fabricius) accounted for the majority of the similarity between them. When just Euglossa species were analyzed, MA4 clustered with the Amazonian regions. The predominant species, which is uncommon in MA2, MA3, and AM3, was found in MA4 by Guérin-Méneville. Among the Atlantic Forest's remnants, EMG revealed a distinct fauna. Euglossa analis Westwood was the most common species, accounting for 47% of all Euglossina. It was also quite common in ES, with 17% of the total, but less common in RJ, with 5 percent, and even lower than 1 percent in some Amazonian zones (AM3 and AM4). After analyzing the EMG, a lot of similarities to the somewhat close-knit RJ (36%) and ES (33%). In addition, the hydrographic basin to which EMG and ES both belong is the same one. For example, cordata was essential in classifying these two areas as Subgroup 1 since it was so common there (Among all Euglossina, 44% are found in ES and 23% in RJ). But in EMG, this species made for a meagre 0.2% of the orchid population bee population.

Impact of environmental and spatial variables having influence on variation in variety of orchid bee species and their diversity The cumulative After 486 hours of sampling, The 1,673 male orchid bees that were gathered belonged to no less than 55 different species and four different genera. Only a few of the 26 species (or morphospecies) we looked at occurred on any of the plateaus in our research.

Species richness of orchid bees, including singletons, varied from fifteen to twenty-four, whereas bee abundance varied from one hundred eighty-eight to four hundred twenty-four across all plateaus. Eulaema meriana and Eu are the two species found on each of the nine plateaus.. bombiformis, were considered widespread, even though they were the only ones. Euglossa augaspis, Euglossa chalybeata, Euglossa imperialis, and Only one plateau did not have any Euglossa mocsary. Composed of these six species, the majority of the plateau species for the areas that were researched, accounting for 15% of the total. On the flip side, Only one plateau did not have any Euglossa mocsary. Composed of these six species, the known to have been collected from only one plateau for 13 species and two plateaus for 11 species. On the other hand, Euglossa decorata and Euglossa ioprosopa both slightly disjunct ranges, inhabiting plateaus about 30 km apart.

The two-dimensional NMDS (stress 0.14, variance percentage 0.70) indicated a variation in the species composition of orchid bees throughout the plateaus as a function of geography and environment. The first axis shows a temperature gradient throughout a certain length of time, while the right-hand plateaus of the ordination plot (BB) show relatively low average temperatures, elevated The first axis shows evapotranspiration and one dry month, while the second shows a gradient in the seasonality of rainfall. Axial 2 distinguished plateaus AV and SR from one another by virtue of their higher average temperatures and two or three months of dryness, resulting in reduced average precipitation.

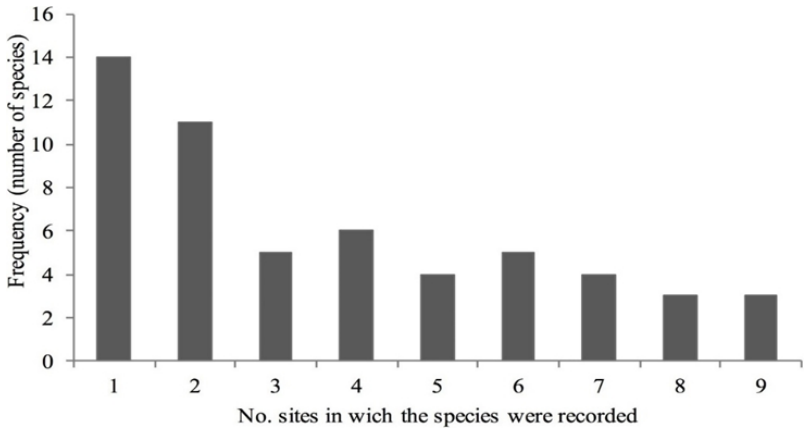

Figure 3. In FLONA Saraca'-Taquera, Brazil, 55 different species of orchid-bees were counted.

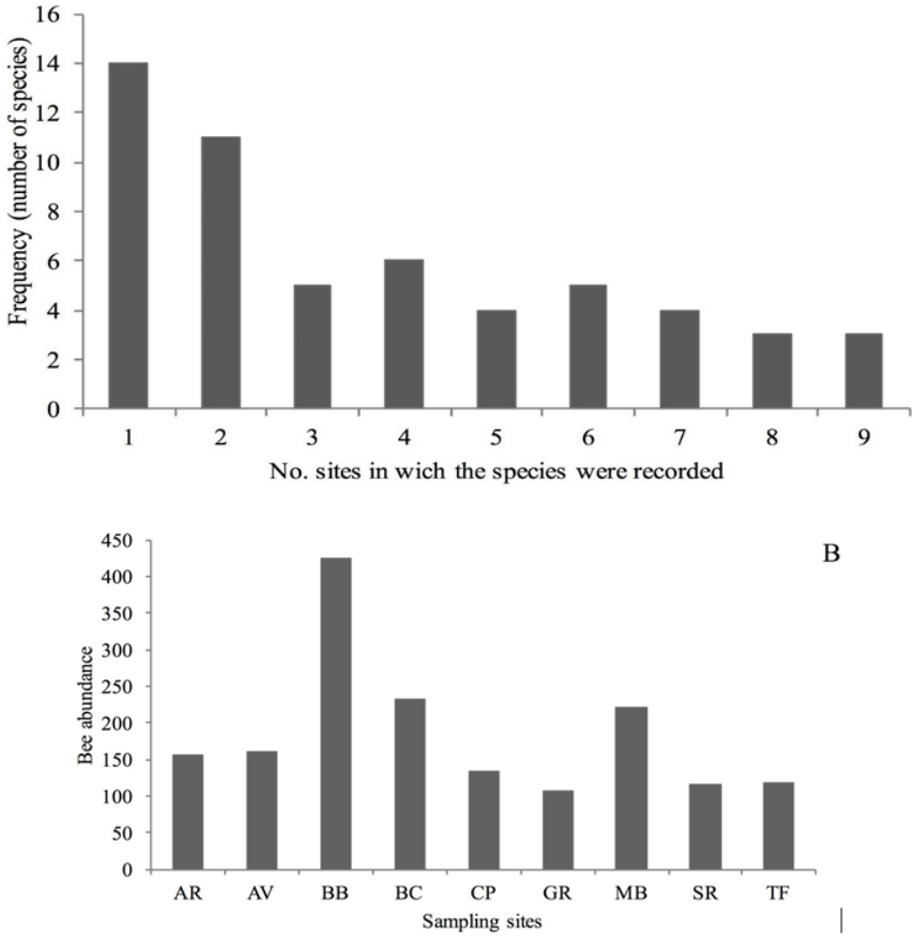

Figure 4. Richness (A) and quantity (B) of orchid bees at each sample location in Florianopolis, Taquera, Brazil. Each plateau's name is represented by a code as seen in Figure 1.

Taking into consideration Between 20.0% and 61.1% (Bray-Curtis Index, mean = 40.7%), there was a large variance in the overall abundance of the 30 most frequent species across the nine bee communities that were evaluated. We saw comparable findings (mean = 40.3%, range = 17.0-70.3%) when we tested for the presence of all 55 species that have been documented using the Jaccard index.

The degree of as the climatic and geographic factors increased, the similarity in the species composition of

orchid bees across various combinations of plateaus decreased ($R = -0.34$, $p = 0.03$) and ($R = -0.53$, $p < 0.001$), respectively. distances across sites (Fig 4A, 4B). When comparing the make-up of different bee assemblages, the most notable variations were noted.

CONCLUSION

Orchids of botanical and commercial significance need both situated and not situated conservation efforts to ensure their continued existence and the maintenance of ecological harmony in the Northern Andhra Pradesh's wet deciduous and semievergreen forests. Destruction of habitat (forests) and illicit harvesting are the main causes of biodiversity loss. The Amazon forest ecosystem is deteriorating and several species are in danger due to the precipitous decline in population in recent years (Escobar 2019). The male orchid bees may have responded to the patterns of floral scent availability in the habitats investigated by foraging less in the afternoon, which is consistent with their activity hours. That cineole was the most alluring chemical backs with the findings of previous research that has examined bait preferences in euglossines. Orchid bees in the Neotropics may be better understood with a more comprehensive sample that makes use of a variety of chemicals, which is why faunal surveys are so essential.

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