Methodology
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Vegetation of Kolli hills varies from thorny scrub and vegetation to evergreen sholas. Other major vegetation types include deciduous formations, semi-evergreen forests and riverine forests. Keeping identification of location as objective a reconnaissance survey was carried out.

Plot establishment: After identifying the location, a plot was established. This was done with the help of plastic ropes, chains and numbered pegs. The plot was of the size 50 x 50m (2500 m²) (Pascal, 1988). These were then subdivided into quadrats of size 10 x 10 m (100 m²).

Vegetation: All plants of girth > 10 cm at breast height (1.3 m) in each quadrat were identified, species and serially numbered. Individual trees were measured for their girth and height.

Phytosociological analysis: Phytosociological analysis takes into consideration floristic richness and floristic diversity. Vegetational data were quantitatively analysed for abundance, density and frequency, important value index (IVI) of Curtis and McIntosh (1950) and Curtis (1951) was analysed. This takes into consideration the number of individuals (density) of each species, their basal area (dominance) and distribution (frequency) in the plot. IVI was calculated using the method described by Cain et al. (1956).

Density: This is an expression of numerical strength of a species.
Density $n_i = \text{number of individuals of species i.}$

Relative density $r_d = \frac{n_i}{N} \times 100$

Basal area (Dominance): This is regarded as an index of dominance of a species.

Higher the basal area greater the dominance.

$N$ is the total number of individuals in the plot.

Dominance $d_1 = \text{Sum of basal areas of individuals of same species.}$

Relative dominance $r_d = \frac{d_1}{d} \times 100$

$d$ is the basal area of the plot.

% Frequency: Refers to the degree of dispersion of an individual species in an area and is expressed in terms of percentage.

Frequency $f_i = \frac{C_1 x 100}{C}$

$C_1 = \text{number of squares where the species is present}$

$C = \text{Total number of squares studied.}$

Relative frequency $r_F = \frac{f_i}{F} \times 100$

Where $F = \sum f_i$

Important value index: A total picture of ecological status of a species with respect to a particular community structure can be obtained only by synthesising the percentage values of RF, RD and RBA. These values when added together give the IVI, based on which the association is derived. The IVI as such gives the total picture of sociological structure of a species in a community.
Thus IVI of each species = rDt + rd + rf
and the value varies from 0 to 300.

IVI of each Taxonomic family was calculated by adding the IVI of all species of the same family in the plot.

Floristic diversity: Diversity indices studies are carried out by analyzing richness and evenness indices. Since 'S' (species richness) depends on sample size, a number of indices have been proposed to measure species richness that are independent of sample size. In the present study species richness is calculated by two well known richness indices as follows.

1) Margalef (1958) index
\[ R_1 = \frac{(S-1)}{\ln(n)} \]

2) Mehinick (1964) index
\[ R = \frac{S}{\sqrt{N}} \]

Diversity indices: As the diversity index is a combined value, it has major limitation and with just the value of diversity index it is impossible to say the relative importance of species richness and evenness. Therefore the series of diversity number presented by Hill (1973), is made use of to assess the community ecologically.

Hill's family of diversity number are derived from the following formula
Hill had shown that 0th, 1st and 2nd order of these diversity (i.e., \( A = 0, 1 \) and 2) of the above equation coincides with three of the most important measures of diversity.

Hills diversity numbers are:

\[
N_0 = S \text{ where} \ 'S' \text{ is the total number of species.}
\]

\[
N_1 = e \text{ where} \ 'H' \text{ is the Shannon index.}
\]

\[
N_2 = 1/D \text{ where} \ 'D' \text{ is the Simpson index.}
\]

\[
N_0 = \text{Number of all species in the sample.}
\]

\[
N_1 = \text{Number of abundant species in each sample.}
\]

\[
N_2 = \text{Number of most abundant species in each sample.}
\]

Thus two indices are needed to analyse Hills diversity number i.e., Simpson's index (\( D \)) and Shannon - Wiener's index (\( H' \)) they are:

a) Simpson's Index

\[
D = \frac{S}{\sum_{i=1}^{S} (pi)^2}
\]

Where \( pi \) is the proportional abundance of the \( i \)th species given by

\[
pi = \frac{n_i}{N} \quad i = 1, 2, 3, \ldots, S.
\]
b) Shannon-Wiener's Index ($H'$)

$$H' = - \sum_{i=1}^{S} \left( P_i \ln(P_i) \right)$$

Where $H'$ is the average uncertainty per species in an infinite community made up of $S$ species with a non-proportional abundance $P_1, P_2, \ldots, P_S$.

Evenness indices: A number of indices have been made used to quantify evenness composition of diversity. A series of 5 indices are used here. They are expressed as a ratio of Hills no. (Alatalo 1981).

1) Evenness index I = $E_1 = H/\ln(S) = \ln(N_1)/\ln(N_0)$.  
(Pielou 1975, 1977)

2) Evenness index II = $E_2 = e^{H'/S} = N_1 / N_0$  (Sheldon 1969).

3) Evenness index III = $E_3 = e^{H' - 1/S - 1} = N_1 - 1/N_0 - 1$  
(Heip 1974)

4) Evenness index IV = $1/D/e^{H'} = N_2/N_1$  (Hill 1973).

5) Evenness index V = $1/D - 1/e^{H' - 1} = N_2 - 1/N_1 - 1$  
(Alatalo 1981)
Distribution pattern

\[ \frac{A}{F} \quad A = \text{Abundance} \]

\[ F = \text{Frequency} \]

Ratio of \( \frac{A}{F} \) < 0.025 indicates regular distribution

0.025 - 0.05 " random distribution

> 0.05 " Contiguous

Regeneration: Random selection of four sub quadrats in each quadrat was carried out in which all plants less than 10 cm girth were identified to species level, counted and tagged. Height and girth of each plant was measured and were classified into

Unestablished seedlings = < 40 cm height

Advanced growth 100 cm in height but 2-3 cm of G

Saplings - 3 - 10 cm (Basha 1987).

Biodiversity

The study area has been under regular periodic survey since March 1991. Vegetation analysis envisages the need for basic understanding of the flora. Ample field notes on the habit, habitat, phenology and lifeforms have been noted. Herbarium specimens were made following the method of Santapau (1955) and
Jain and Rao (1977). Voucher specimens are documented and deposited at the Department of Botany, Vellalar college for Women, Erode, Tamil Nadu.

Identification was carried out by using national floras like Flora of British India (Hook.f, 1872-1879) and regional floras like The Flora of Presidency of Madras (Gamble 1915) and Flora of Tamilnadu Carnatic (Matthew 1987). The identity was confirmed by matching with authentic specimens available at Madras Herbarium (MH), Botanical Survey of India, Southern Circle, Coimbatore. Nomenclature was updated with the aid of the Flora of Tamil Nadu series (Nair and Henry, 1983; Henry, Kumari and Chithra 1987; Henry, Chithra and Balakrishnan, 1989). To update nomenclature and also for confirming identity, monographs and revisions available in the Library Botanical Survey of India (BSI), Coimbatore were referred.

In addition categories like endemic, endemic and rare, rare and endangered species of Kolli Hills flora were assessed by using endemic plants of Peninsular India (Ahmedullah and Nayar 1987), Red Data Book (Nair and Sastry 1987, 88, 90). Phytogeographical distribution records were analysed.

Phenology, Biological Spectrum and phytogeography

Phenology: Flowering periods of different plant species were recorded during monthly field trips to Kollihills for a period of four years from February 1991 to March 1995. In addition phenological notes on data obtained from herbarium sheets at
I, MH(BSI), Coimbatore and materials for the Flora of Tamil Nadu Carnatic (Matthew 1981) were also used.

**Life form analysis:**

Classification of life forms and construction of a biological spectrum of Kolli hills flora is carried out. Ecological nomenclature for the various taxa has been adopted from Raunkiaer's life form (1934) and subsequently modified by Ellenberg and Büel-ler Dombois (1967).

Life forms are classified under abbreviated symbols as follows.

1. **Phanerophytes** (ph) Woody or herbaceous perennials that grow taller than 50 cm or whose shoots do not die back periodically to that height limit.
   - (a) **Megaphanerophyte** Mg. >50 m
   - (b) **Mesophanerophyte** Ms 5-30 m
   - (c) **Microphanerophyte** Mi 2-5 m
   - (d) **Nanophanerophyte** N <2 m

2. **Chamaephyte** (ch) Plants that are bunchy from ground with a sprawling habit. Their height remains within 50 cm.

3. **Hemicryptophyte** (H) Plants with vegetative buds at the level of the ground.

4. **Geophytes** (G) Plants with vegetative organs in the soil.

5. **Therophytes** (Th) Annual plants

6. **Lianes** (L) Climbing phanerogams.

7. **Epiphytes** (E) Phanerogams which are seen growing on other plants, but nutritionally independent.
8. Parasites (P) Phanerogams which are nutritionally dependent on other plants.

Exhaustive floristic survey was conducted and species were identified and related to their geographical affinity.

Litter Dynamics

Litter Quantification: Litter productivity was carried out by employing litter trap technique. 50 wicker baskets of collection area of 0.5m$^2$ were kept about 30 cm above the ground level. Traps were kept in such a way that each quadrate has two traps in it. The traps were numbered and litter collection was carried out every month for a span of one year from December 1993 to January 1995. Fallen litter was collected and brought to the laboratory in polythene bags and sorted for leaves. Small barks, twigs and reproductive parts were oven dried at 70°C for 48 h. Leaves were identified to the species level and used to estimate the leaf fall pattern and production of important tree species in the quadrate.

Litter Decomposition: Studies on the litter decomposition dynamics was based on standing ground litter and also by employing standard litter bag technique (Bocock and Gilbert 1957). The former was done by collecting litter every three months at random from 10 sampling areas of 1m$^2$ each. Litter was collected in polythene bags and brought to the laboratory and sorted into recog-
nisable leaves, floral and fruit parts, wood and bark and unidentifiable fine debris and were weighed after oven drying at 70°C for 48 hrs.

For litter bag technique, freshly fallen litter from the study areas was collected, 20 g of air dried compost was put in litter bags of dimension 25 x 20 cm of 3 mm mesh size (500 cm² surface area exposed on upper and lower surface) openings of the bags are closed by stitching. 90 such bags were placed on forest floor. Seven such bags retrieved every month for a period of one year.

\[ 7 \times 12 = 84 \quad \text{What happened to be left?} \]

From the residual mass of litter bags adhering extraneous material like roots and soil were removed by washing in running cold water. Of the seven bags retrieved oven dried weight after 48 hrs at 70°C were arrived at for four bags.

Decay constant \( k \) is arrived at. The model for constant potential weight loss (Olson 1963) represented by the equation.

\[ \frac{X}{X_0} = e^{-kt} \quad X_0 = \text{initial weight} \]
\[ X = \text{Weight remaining after time } t \]

\( K = \text{decay constant} \quad e = \text{the base of natural logarithm (decay rate coefficient)} \)
This was fitted on mass disappearance data. Half time \( t_{0.5} \) of decomposing litter were estimated from the \( K \) values using the equation
\[
t = \ln \frac{0.5}{-k} = \frac{0.693}{k} \quad \text{Bockeim et al, 1991}
\]

Steady state level (90% decay) as \( 3/k \). Value of \( k \), \( t_{0.5} \) & 90% decay for leaves and woody barks calculated.

Considering standing litter, it is considered that the site has achieved a steady state i.e., equilibrium in which gain by litter fall is equivalent to loss. (Exponential curves of accumulation and decay are mirror images of each other.)

Olson (1963) has proposed
\[
dl = (A-KL) \, dt \quad A - \text{Litter fall} \\
L - \text{Stored litter} \\
dt - \text{variation in the quantity of litter during the period } dt.
\]

In a forest at equilibrium \( dt = 0 \) \( dt = 1 \)

Therefore \( K = \frac{A}{L} \)

Time necessary for litter decay is calculated by the ratio \( L/A \) (inverse of Olson).

Rate of decomposition is not uniform and seasonal decomposition coefficient \( K' \) is established by calculated from
\[ \frac{dL}{dt} = (A - K'L) \]

\[ A - \frac{dL}{dt} \]

\[ i.e \ k' = \frac{A - (L_1 - L_0)}{L_0 + L_1} \]

\[ k' = \frac{L_1}{L(-)} \]

\[ = Initial \ value \ of \ litter \]

\[ L_1 = \text{Litter quantity after time } t. \]

Nutrient flow: Flow of nutrients through litter fall and degradation was studied by carrying out mineral analysis on the residual mass of litter. Of the seven bags retrieved, the oven dry weight of four bags were established and this was powdered in a cool blender for analysing N, P, Ca & Mg in them. Nitrogen was estimated by Kjeldhal's method (Loomis & Shull 1937), Calcium and Potassium by flame photometry, Phosphorus and Magnesium by colorimetric method.

Litter Mycoflora: Mycoflora associated with residual mass of litter was analysed for every three months. Two methods were employed.

  a. Moist chamber incubation technique

  b. Dilution plate technique

Moist chamber incubation: Ten leaves per sample were incubated in sterile moist chambers in large petriplates of diameter 15 cm. Sterilized filter paper discs moistened by sterile H₂O to maintain moisture content. Petriplates are incubated.
at 25 - 26°C in an incubator. Samples were examined from the second day onwards.

**Dilution plate technique:** Air dried litter was powdered in an ice cool blender and 10 gm were suspended in 100 ml sterile water in 250 ml conical flask. The suspensions was shaken thoroughly and further diluted to $10^{-3}$. One ml of suspension was transferred separately to 5 replicate petri dishes and 20 ml of potato dextrose agar poured in. Colonies were counted after incubation at 28°C for five days. Only the identification of fungi isolated from litter was attempted.

**Germination potential of some species in mine spoils:**

Open cast mining is underway for bauxite by Madras Aluminium Company (MALCO) and some other private parties. 250 acres of reserve forest were leased out to MALCO for carrying out mining. Mining is carried out at Ariyur, Valavanthi (1250, 1270 m above MSL) that supports shola vegetation. These shola pockets are dense forming closed canopy with different strata of plants, that are highly adapted to thrive under modified condition of light intensity, high velocity wind and humidity of high altitudes. These woodlands have a confluence of lianas, epiphytes and ferns. Gaping hole is left at Valavanthi were once such a vegetation flourished. What is left is a site with no organic matter and florisitic diversity. Ecorestoration method selected must be the one that is designed in such a way to provide primarily a green cover selecting and making use...
increasing soil organic matter and moisture content, leaving natural succession to play its part later. As a part of the present study, germination potential of some native and few exotic plants of some economic value was carried out on mine soils at laboratory conditions.

Field studies

Floristic survey and study were carried out in the mined area and the plants were duly collected, identified and herbarium specimens were prepared (Jain and Rao 1977). Identity of the specimens was confirmed by matching at MH (BSI Coimbatore). Anomalous characters shown by plants growing in mined soils were recorded.

Soil analysis

Soil samples were collected from the mined area and overburden which were about 6m deep. Samples were air dried for 48 hours. The total air dry weight of the samples was estimated and sieved using 2mm sieve.

Soil pH was estimated using pH meter.

Nutrient composition of soil

Nitrogen was estimated by micro kjedhal digestion method.

Extractable P was determined by Bray's extractant, K with flame pho-
tometer (Jackson 1973). Organic carbon was determined using Potassium dichromate method.

**Pot culture experiment**

In order to assess the germination potential, pot culture experiments were carried out ex situ. Garden soil was taken as the control, 50% mine soil and 100% mine soil were the three levels of treatment. The experiment was laid out in a randomised block design with 500 seeds of each individual species sown for each treatment. The selected parameters for the present study were germination potential, mortality rate, length of shoot, root length, leaf number, leaf area and dry weight.