ECOLOGICAL STUDIES

(a). Ecological studies of aeromycoflora
(b). Ecological studies of leaf surface mycoflora
ECOLOGICAL STUDIES

All the fungal species present in an area constitute the fungal community of that area. Community study is an important aspect of ecology and for this purpose we collect quantitative and synthetic data to understand the composition of the fungal community. According to Raunkiars (1934), frequency is the degree of dispersion of individual species in a particular area at a particular period and is usually expressed in percentage. Density indicates numerical strength of individual species in a community and implies number of species per unit area. Similarly contribution indicates the involvement of a species in the formation of a community by their size and number.

For ecological studies of aeromycoflora and leaf surface mycoflora, percentage frequency, density and percentage contribution of isolated fungal species was calculated.

**Percentage frequency of Aeromycoflora**

The percentage frequency of the individual species recorded from aeromycoflora was calculated (Table-V) and it was observed that *Aspergillus niger* (83.33%) was found to be most frequent species and *Curvularia lunata* (75%) to be moderately frequent species. On the contrary *Acremonium* sp. *Alternaria humicola, Arthritrinium sphaerospermum, Aspergillus carneus, A. flavus var. columnaris, A. parasiticus, A. sydowi, Chaetomella raphigera, Drechslera halodis, Penicillium citrinum, P. funiculosum, Phoma fickeli, P. fimeti, P. herbarum, Trichoderma pseudo-koningii, Trichurus spiralis, Mycelia sterilia white-(i), (ii), grey and pinkish* were least frequent (8.33%) species of the aeromycoflora.

**Density of Aeromycoflora**

The density of the fungal species was also observed, (Table-VII). Maximum density was recorded for *Cladosporium cladosporoides* (13.33) followed by *Curvularia lunata* (3.75), *Aspergillus japonicus* (3.41), *Aspergillus niger* (3.00), *Aspergillus fumigatus* (2.46),
Alternaria sp. (2.41) and Penicillium frequentans (2.33). On the contrary minimum percentage density i.e. 0.08 was observed for Acremonium sp., Aspergillus parasiticus, Chaetomella raphigera, Penicillium funiculosum, and Trichurus spiralis.

**Percentage contribution of Aeromycoflora**

Group wise, season wise, and month wise study of percentage contribution of the fungal species to the total (yearly) aeromycoflora was observed during present investigation. The percentage contribution of the fungal species varied with season and month. Results indicating that, maximum percentage contribution (86.78%) was encountered for group Anamorphic fungi followed by group Ascomycotina (5.44%), Mycelia sterilia (4.67%) and minimum percentage contribution (3.10%) was encountered for group Zygomycotina. (Table-XV, Fig-21)

The study of group wise, season wise percentage contribution of the fungal species to the total aeromycoflora (yearly) reveals that, maximum percentage contribution (51.32%) to the total aeromycoflora was recorded for winter season, moderate percentage contribution (26.90%) to the total aeromycoflora was recorded for rainy season and minimum percentage contribution (21.77%) to the total aeromycoflora was recorded for summer season. (Table-XV, Fig-19)

During summer season the percentage contribution of Zygomycotina to the total aeromycoflora was 1.43%, Ascomycotina was 5.00 percentage, Anamorphic fungi was 87.14% and Mycelia sterilia was 6.43%, (Fig-19.1). During rainy season the percentage contribution of Zygomycotina was 6.93%, Ascomycotina was 8.67%, Anamorphic fungi was 80.35% and Mycelia sterilia was 4.05%, (fig-19.2). During winter season the percentage contribution of Zygomycotina was 1.82%, Ascomycotina was 3.94%, Anamorphic fungi was 90.00% and Mycelia sterilia was 4.24%, (Table-XI, Fig-19.3)

The month wise percentage contribution of each fungal group to the total (monthly) aeromycoflora was also observed (Table-XI). The results indicating that, in the month of March, maximum percentage contribution observed for group Anamorphic (77.55%) fungi followed by Mycelia sterilia (14.29%), Zygomycotina (4.08%) and Ascomycotina (4.08%), (Fig-19.4). In the month of April, maximum percentage...
contribution observed for group Anamorphic fungi (92.59%) and minimum (7.41%) for Mycelia sterilia. (Fig-19.5). In the month of May, maximum percentage contribution observed for group Anamorphic fungi (90.48%) and minimum (9.52%) for Ascomycotina, (Fig-19.6). In the month of June, maximum % contribution observed for group Anamorphic fungi (93.03%) and minimum (6.98%) for Ascomycotina, (Fig-19.7). In the month of July, maximum percentage contribution observed for group Anamorphic fungi (75.61%) followed by Ascomycotina (9.75%), Zygomycotina and Mycelia sterilia (7.32%), (Fig-19.8). In the month of August, maximum percentage contribution observed for group Anamorphic fungi (82.69%) followed by Zygomycotina (13.47%), Ascomycotina and Mycelia sterilia (1.92%), (Fig-19.9). In the month of September, maximum percentage contribution observed for group Anamorphic fungi (87.88%), moderate for Mycelia sterilia (9.09%) and minimum for Zygomycotina (3.03%), (Fig-19.10). In the month of October, maximum percentage contribution observed for group Anamorphic fungi (76.60%), moderate for Ascomycotina (21.28%) and minimum for Zygomycotina (2.12%), (Fig-19.11). In the month of November, maximum % contribution observed for group Anamorphic fungi (84.13%) and minimum for Ascomycotina (15.87%), (Fig-19.12). In the month of December, maximum percentage contribution observed for group Anamorphic fungi (85.87%) followed by Mycelia sterilia (7.61%), Zygomycotina and Ascomycotina (73.26%), (Fig-19.13). In the month of January, maximum percentage contribution observed for group Anamorphic fungi (91.51%), moderate for Mycelia sterilia (5.66%) and minimum for Zygomycotina (2.83%), (Fig-19.14). In the month of February, maximum percentage contribution observed for group Anamorphic fungi (98.55%) and minimum for Mycelia sterilia (1.45%). (Fig-19.15)

Month wise and group wise study of percentage contribution to the total aeromycoflora (yearly) reveals that, in the month of March, out of total contribution (7.61%), Zygomycotina and Ascomycotina contribute 0.31%, Anamorphic fungi contribute 5.91% and Mycelia sterilia contribute 1.08%. In April month, out of total contribution (4.2%), Anamorphic fungi contribute 3.89% and Mycelia sterilia contribute 0.31%. In the month of May, out of total contribution (3.26%), Ascomycotina contribute 0.31% and Anamorphic fungi contribute 2.95%. In the month of June, out of total contribution (6.69%), Ascomycotina contribute 0.47% and Anamorphic fungi contribute 6.22%. In the month of July, out of total contribution (6.38%), Zygomycotina contribute 0.47%, Ascomycotina contribute 0.62%, Anamorphic fungi contribute 4.82% and Mycelia
sterilia contribute 0.42%. In the month of August, out of total contribution 8.07%, Zygomycotina contribute 1.08%, Ascomycotina contribute 0.15%, Anamorphic fungi contribute 6.69% and Mycelia sterilia contribute 0.15%. In the month of September, out of total contribution (5.13%), Zygomycotina contribute 0.15%, Anamorphic fungi contribute 4.51% and Mycelia sterilia contribute 0.47%. In the month of October, out of total contribution (7.30%), Zygomycotina contribute 0.15%, Ascomycotina contribute 1.55%, Anamorphic fungi contribute 5.60%. In the month of November, out of total contribution (9.79%), Ascomycotina contribute 1.55%, Anamorphic fungi contribute 8.24% . In the month of December, out of total contribution (14.31%), Zygomycotina and Ascomycotina contribute 0.47%, Anamorphic fungi contribute 12.19% and Mycelia sterilia contribute 1.08%. In the month of January, out of total contribution (16.48%), Zygomycotina contribute 0.47% Anamorphic fungi contribute 15.08% and Mycelia sterilia contribute 0.93%. In the month of February, out of total contribution (10.72%), Anamorphic fungi contribute 10.57% and Mycelia sterilia contribute 0.15%. (Table-XIII)

The percentage contribution of the group Zygomycotina to the total aeromycoflora in the month of March was 0.31%, in July 0.47%, in August, 1.08%, in September and October, 0.15%, in December and in the February, 0.47%, (Fig-15). In the month of April, May, June, November and February the members of the group Zygomycotina were absent. The percentage contribution of the group Ascomycotina to the total aeromycoflora in the month of March and May 0.31%, in June 0.47%, in July 0.62%, in August 0.15%, in October and November 1.15% and in December 0.47 %,( Fig-16). In the month of April, September, January and February the members of the group Zygomycotina were absent. The percentage contribution of the group Anamorphic fungi to the total aeromycoflora in the month of March was 5.91%, in April 3.89%, in May 2.95%, in June 6.22%, in July 4.82%, in August 6.69%, in September 4.51%, in October 5.60%, in November 8.24%, in December 12.29%, in January 15.08% and in February 10.57%,(Fig-17). The percentage contribution of the group Mycelia sterilia to the total aeromycoflora in the month of March was 1.08%, in April 0.31%, in July 0.47%, in August 0.15%, in September 0.47%, in December 1.08%, in January 0.93% and in February 0.15%, (Fig-18). In the month of May, June, October and November, the members of the group Mycelia sterilia were not encountered. (Table-XIII)
Maximum percentage contribution 86.78% was recorded for Anamorphic fungi, moderate 5.44% for Ascomycotina and minimum 3.10% for Mycelia sterilia. (Table-XIII)

During the present study, maximum percentage contribution was recorded for Cladosporium cladosporoides (24.88%) followed by Curvularia lunata (6.99%), Aspergillus japonicus (6.38%), A. niger (5.60%) and A. fumigatus (4.98%). The minimum percentage contribution 0.15% was recorded for Acremonium sp., Aspergillus parasiticus, Chaetomella raphigera, Penicillium funiculosum, and Trichurus spiralis. (Table-IX)

It was also evident that Aspergillus niger dominated throughout the year except in the months of May and April. Curvularia lunata was present as co-dominant species except April, May and June months. Genus wise maximum percentage contribution was recorded for Aspergillus (21.15%, with 11 species).

**Percentage frequency of Leaf Surface Mycoflora**

The percentage frequency of the individual species recorded from leaf surface mycoflora was calculated and it were noted that Aspergillus niger (75%) and Cladosporium cladosporoides (75%) was found to be most frequent species, Alternaria alternata, Aspergillus fumigatus, A. speluneus, Curvularia lunata and Penicillium frequentans was found to be moderately frequent species with the frequency of 41.66% whereas Mucor hiemalis f. silvaticus, Rhizopus oryzae, Syncephalastrum racemosum, Khukia oryzae, Acremonium strictum, Alternaria radicina, A. triticina, Arthrinium sphaerospernum, Aspergillus carneus, A. flavus var. columnaris, A. ochraceous, A. parasiticus, A. tamari, Drechslera biseptata, Fusarium equiseti, Papularia sp., Penicillium oxalicum, Pestalotiopsis gladiola, Trichoderma psuedo koningii, Trichurus spiralis, Mycelia sterilia white (iii) and black were the least frequent species of the leaf surface mycoflora with the frequency of 8.33%. (Table-VI)

**Percentage density of Leaf Surface Mycoflora:**

The density of the fungal species was also observed, Maximum density i.e., 22.91 was recorded for Cladosporium cladosporoides followed by Penicillium frequentans (4.41), Aspergillus fumigatus (3.33), Mycelia sterilia white (iii) (1.91) and Aspergillus niger (1.66). Minimum density 0.08 for Rhizopus oryzae, Syncephalastrum racemosum, Alternaria radicina, A. triticina, Arthrinium sphaerospernum, Aspergillus carneus, A. flavus var. columnaris, A.
ochraceous, *Drechslera australiensis*, *D. biseptata*, *Fusarium equiseti*, *Papularia* sp., *Trichurus spiralis*, Mycelia sterilia white (iii) reverse black. (Table-VIII)

**Percentage contribution of Leaf Surface Mycoflora:**

Group wise, Season wise and month wise percentage contribution of the fungal species recorded from leaf surface mycoflora was observed during present investigation. The percentage contribution of the fungal species varied with season and month. Results indicating that maximum percentage contribution (86.10%) was encountered for group Anamorphic fungi followed by group Mycelia sterilia (9.37%) Ascomycotina (3.85%), and minimum percentage contribution (0.67%) was encountered for group Zygomycotina. (Table-XVI, Fig-22)

The study of group wise, season wise percentage contribution of the fungal species to the total leaf surface mycoflora (yearly) reveals that, maximum percentage contribution (56.28%) to the total aeromycoflora was recorded for winter season, moderate percentage contribution (24.79%) to the total aeromycoflora was recorded for rainy season and minimum percentage contribution (18.92%) to the total aeromycoflora was recorded for summer season. (Table-XVI, Fig-20)

During summer season, the percentage contribution of Ascomycotina to the total leaf surface mycoflora was 15.93%, Anamorphic fungi was 60.18% and Mycelia sterilia was 23.89%, (Fig-20.1). During rainy season the percentage contribution of Ascomycotina was 3.38%, Anamorphic fungi was 81.76% and Mycelia sterilia was 14.86%, (Fig-20.2). During winter season the percentage contribution of Zygomycotina was 1.19%, Anamorphic fungi was 96.72% and Mycelia sterilia was 2.08%, (Fig-20.3). (Table-XII)

The month wise percentage contribution of each fungal group to the total (monthly) leaf surface mycoflora was also observed (Table-XII). The results indicating that, in the month of March, maximum percentage contribution observed for group Anamorphic (68.18%) fungi, moderate for Mycelia sterilia (25.00%) and minimum for Ascomycotina (6.82%), (Fig-20.4). In the month of April, maximum percentage contribution observed for group Anamorphic fungi (89.29%) and minimum (10.71%) for Mycelia sterilia, (Fig-20.5). In the month of May, maximum percentage contribution
observed for group Anamorphic fungi (58.33%) and minimum for Ascomycotina (41.67%), (Fig-20.6). In the month of June, maximum percentage contribution observed for group Anamorphic fungi (44.83%), moderate for Ascomycotina (34.48%), and minimum for Anamorphic fungi, (Fig-20.7). In the month of July, maximum percentage contribution observed for group Anamorphic fungi (66.67%) and minimum for Mycelia sterilia (33.33%), (Fig-20.8). In the month of August, maximum percentage contribution observed for group Mycelia sterilia (51.85%) and minimum for Anamorphic fungi (48.15%), (Fig-20.9). In the month of September, 100% contribution observed for group Anamorphic, (Fig-20.10). In the month of October, maximum percentage contribution observed for group Anamorphic fungi (88.52%), moderate for Ascomycotina (8.20%) and minimum for Mycelia sterilia (3.27%), (Fig-20.11). In the month of November, maximum percentage contribution observed for group Anamorphic fungi (95.89%) and minimum for Mycelia sterilia (4.11%), (Fig-20.12). In the month of December, maximum percentage contribution observed for group Anamorphic fungi (97.44%) and minimum for Zygomycotina (2.56%), (Fig-20.13). In the month of January, maximum percentage contribution observed for group Anamorphic fungi (96.58%), moderate for Mycelia sterilia (2.57%) and minimum for Zygomycotina (0.85%), (Fig-20.14). In the month of February, maximum percentage contribution observed for group Anamorphic fungi (97.06%), minimum for both Zygomycotina, Mycelia sterilia (1.47%). (Fig-20.15)

Month wise and group wise study of percentage contribution to the total aeromycoflora (yearly) reveals that, in the month of March, out of total contribution (7.37%), Ascomycotina 0.50%, Anamorphic fungi 5.05% and Mycelia sterilia 1.84%. In the month of April, out of total contribution (4.69%), Anamorphic fungi 4.19% and Mycelia sterilia 0.50%. In the month of May, out of total contribution (2.01%), Ascomycotina 0.84% and Anamorphic fungi 1.17%. In the month of June, out of total contribution (3.18%), Ascomycotina 1.67% and Anamorphic fungi 1.00%. In the month of July, out of total contribution (3.02%), Anamorphic fungi 2.01% and Mycelia sterilia contribute 1.01%. In the month of August, out of total contribution (4.53%), Anamorphic fungi contribute 2.18% and Mycelia sterilia 2.35%. In the month of September, out of total contribution (7.04%), Anamorphic fungi over all 7.04%. In the month of October, out of total contribution (10.23%), Ascomycotina 0.84%, Anamorphic fungi 9.05 and Mycelia sterilia contribute 0.34%. In the month of November, out of total contribution (12.23%), Anamorphic fungi 11.73% and Mycelia sterilia contribute 0.50%. In the month of
December, out of total percentage contribution (13.06%), Zygomycotina 0.33% Anamorphic fungi contribute 12.73% and Mycelia sterilia 1.08%. In the month of January, out of total contribution (19.60%), Zygomycotina 0.17%, Anamorphic fungi 18.93% and Mycelia sterilia 0.50%. In the month of February, out of total contribution (11.40%), Zygomycotina 0.17%, Anamorphic fungi 11.06% and Mycelia sterilia 0.17%. (Table-XIV)

The study of month wise percentage contribution to the total (yearly) leaf surface mycoflora was also observed. (Table-XIV)

The percentage contribution of group Zygomycotina to the total leaf surface mycoflora in the month of December was 0.33% and in January and February 0.17%, (Fig-15). In the month March to November, the members of the group Zygomycotina were absent. The percentage contribution of the group Ascomycotina to the total leaf surface mycoflora in the month of March was 0.50%, in May 0.84%, in June 1.67% and in October 0.84%, (Fig-16). In the month of April, July, August, September, and November to February the members of the Group Zygomycotina were absent. The percentage contribution of the group Anamorphic fungi to the total aeromycoflora in the month of March was 5.03%, in April 4.19%, in May 1.17%, in June 1%, in July 2.01%, in August 2.18%, in September 7.04%, in October 9.05%, in November 11.73%, in December 12.73%, in January 18.93% and in February 11.06%, (Fig-17). The percentage contribution of the group Mycelia sterilia to the total leaf surface mycoflora in the month of March was 1.84%, in April 0.50%, in June 2.18%, in July 1.01%, in August 2.35%, in October 0.34%, in November and January 0.50% and in February 0.17%, (Fig-18). The members of this group were not encountered during rest months of the year. (Table-XIV)

During summer season the percentage contribution of Ascomycotina was 15.93%, Anamorphic fungi was 60.18% and Mycelia sterilia was 23.89%. Zygomycotina was not encountered during summer season. During rainy season the percentage contribution of Ascomycotina was 3.38%, Anamorphic fungi was 81.76% and Mycelia sterilia was 14.86%. Zygomycotina was not encountered during rainy season. During winter season the percentage contribution of Zygomycotina was 1.19%, Anamorphic fungi was 96.72%
and Mycelia sterilia was 2.08%. The members of Ascomycotina were not encountered during winter season.

Month wise study of percentage contribution to the total (monthly) leaf surface mycoflora reveals that maximum percentage contribution (97.44%) was encountered for Anamorphic fungi in the month of December and minimum (0.85%) for Zygomycotina in January month. (Table-XII)

Maximum percentage contribution 86.10% was observed for Anamorphic fungi followed by Mycelia sterilia 9.37 %, Ascomycotina 3.85% and minimum 0.67% for Zygomycotina. (Table-XIV)

During the present investigation *Cladosporium cladosporoides* was found to be the most abundant species of leaf surface mycoflora (with maximum percentage contribution 46.06%). It was followed by *Penicillium frequentans* (8.88%), *Aspergillus fumigatus* (6.70%) *A. niger* (3.35%) and Mycelia sterilia white-I (3.85%), while least abundant species with minimum percentage contribution (0.17%) were *Rhizopus oryzae, Syncephalastrum racemosum, Alternaria radicina, A. triticina, Arthririnium sphaerospermum, Aspergillus carneus, A. flavus var. columnaris, A. ochraceous, Drechslera australiensis, D. biseptata, Fusarium equiseti, Papularia sp., Trichurus spiralis* and *Mycelia sterilia white (iii).* (Table-X)

The genus wise maximum percentage contribution was recorded for *Aspergillus* (22.22%, with 10 species. It was also observed that *Cladosporium cladosporoides* dominated throughout the year except in the month of May, April and July, whereas *Penicillium frequentans* was found to be as co-dominant species in the leaf surface mycoflora.