Lichens: An Introduction

Brief Overview of the Lichen Forming Fungi and its biology

Lichen - (pronounced *lie'ken*, from the Greek *?e???* = tree moss)

What are lichens?

- Fungi* with an **obligate association for fulfilling nutritional requirements** with green alga or cyanobacteria (photosynthetic partner**) – not a natural taxonomic group.

- "Name of a class for all lichen – forming fungi used when these are regarded as quite separate from fungi"

  (Definition -Dictionary of Fungi – 8th ed.)

*fungal partner – mycobiont; **photosynthetic partner - photobiont

Simon Schwendener

Mycobiont – Photobiont association in a lichen

In 1868 Schwendener the first to hypothesize that lichens are dualistic in nature with fungi and alga

An association between a Master [Fungi] and Slave [Algae or Cyanobacteria]- ***Controlled Parasitism***.

Simon Schwendener analysed the structure of the lichen thallus and was awarded "Privatdozent“ (=lecturer).

In 1876 he was appointed as an "Ordinarius" in Basel, Switzerland, and in 1877 in Tübingen, Germany.

In 1877 he went to Berlin, Germany, where he worked until his death at the age of 80.

Mycobiont – Photobiont association in a lichen

Lichen symbiosis - a true mutually beneficial love story

Heinrich Anton De Bary

1831-1888 - DeBary hypothesized that lichens are ***symbiotic association (Mutualism)*** between fungi and algae

- the symbionts excrete and benefit from an exchange of metabolites, the alga receiving minerals, water and nitrogen from the fungus, the fungus receiving carbohydrates from the alga

The Mycobiont

✍Most of the lichen forming fungi are **ascomycetes** from the Class Discomycetes (apothecial forms - cup shaped fruiting bodies) and Pyrenomycetes (perithecial forms - flask shaped fruiting bodies)

✍A few are basidiomycetes related to mushrooms and Shelf fungi

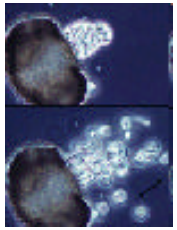
✍About 15,000 – 20, 000 Lichen species known world wide

✍About 2000 - 2200 Lichen species known from India

✍555 lichen species are known to occur in Tamil Nadu.

✍It is expected that an additional 300 to 500 lichen species are expected to add to this list by inventorying unexplored lichen rich sites.

Divisions of Kingdom Eumycota & % of Lichens



Chytridiomycota
1%

(Water molds, Allomyces, etc.)

Zygomycota
2%

(Bread molds, *Rhizopus*, Mucor, etc.)

Basidiomycota (Non lichenised)

(Mushrooms, rusts, smuts, etc.)

Ascomycota (Non lichenised)

(Sac fungi, yeast, *Penicillium*, etc.)

Basidiomycota (Lichenised)
0%

Ascomycota (Lichenised)
24%

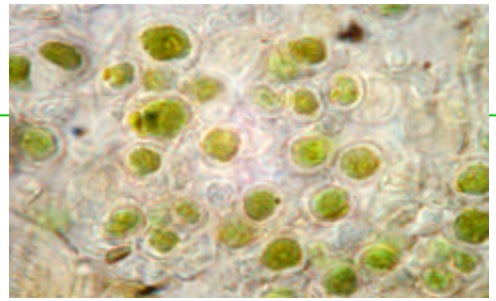
20 species of Basidiomycota are lichenised

Lichens

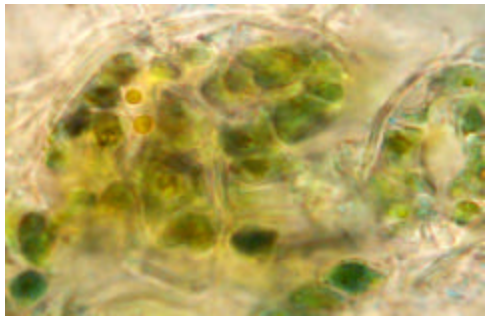
The Photobiont

- **The photobionts belong to only 24 genera of, either Chlorophyta (green algae) or Cyanobacteria (prokaryotes - blue-green algae).**
- **In 70% of lichens the alga is a sp. of *Trebouxia*.**
- **Photobiont can be free living since they are autotropic**
- **Some lichens have both Cyanobacteria and green alga as partners in same thallus.**

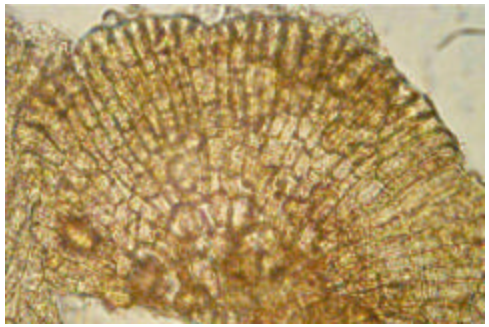
Photobionts of Lichens



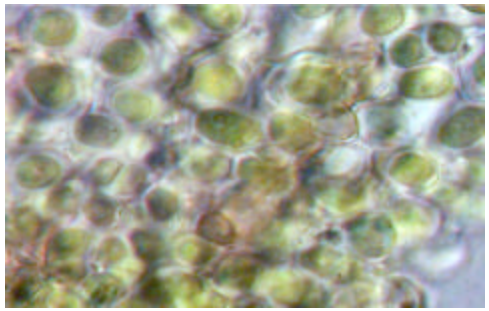
Trebouxia **– Chlorococcales**



Trentepohlia **– Chetophorales**



Phycopeltis **– Chetophorales**



Nostoc **– Nostocales**

Composite Lichen Thallus

Vary in – Appearance / Shape & Colour

Crustose lichen

↓

Crust like lichen
on the substratum

Foliose lichen

↓

leaf like lichen

Fruticose lichen

↓

Shrub like lichen

Salient features of lichens

Lichens are very slow growing organisms –Many grow only 1-2 mm/year in nature

Lichens are long living organisms - Some taxa thought to be over 1000 years old

Lichens lack protective, conductive and assimilatory tissues

Lichens are poikilohydric - Cannot self-maintain water balance as in higher plants (homiohydric)

Salient features of lichens

- **Lichens reproduce by sexual and asexual means**
- **Sexual reproduction of lichens is nothing but the reproduction of the fungal partner**
- **Lichenised fungi produce unique and abundant secondary chemical metabolites**
- **These metabolites are considered to protect the lichen thallus from excess light, drought, insect herb ivory, and microbial attack.**
- **Secondary chemistry profiles of lichens is widely used in taxonomy**
- **Some compounds are used in pharmaceuticals, and cosmetics**

Role of the partners

✍ What does the fungus gain from the alga?

Carbohydrates produced by Photobiont

Summary of movement of carbohydrate from *Trebouxia* to fungus

Sucrose is retained : Ribitol – released to the Mycobiont

Mycobiont converts ribitol in arbitol & mannitol

Mannitol cannot be used by the Photobiont

Where cyanobacteria are present, the fungus also acquires nitrogen

✍ What does the alga gain from the fungus?

A substrate and stable environment, Mineral nutrients

What else ??????

LICHEN HABITATS

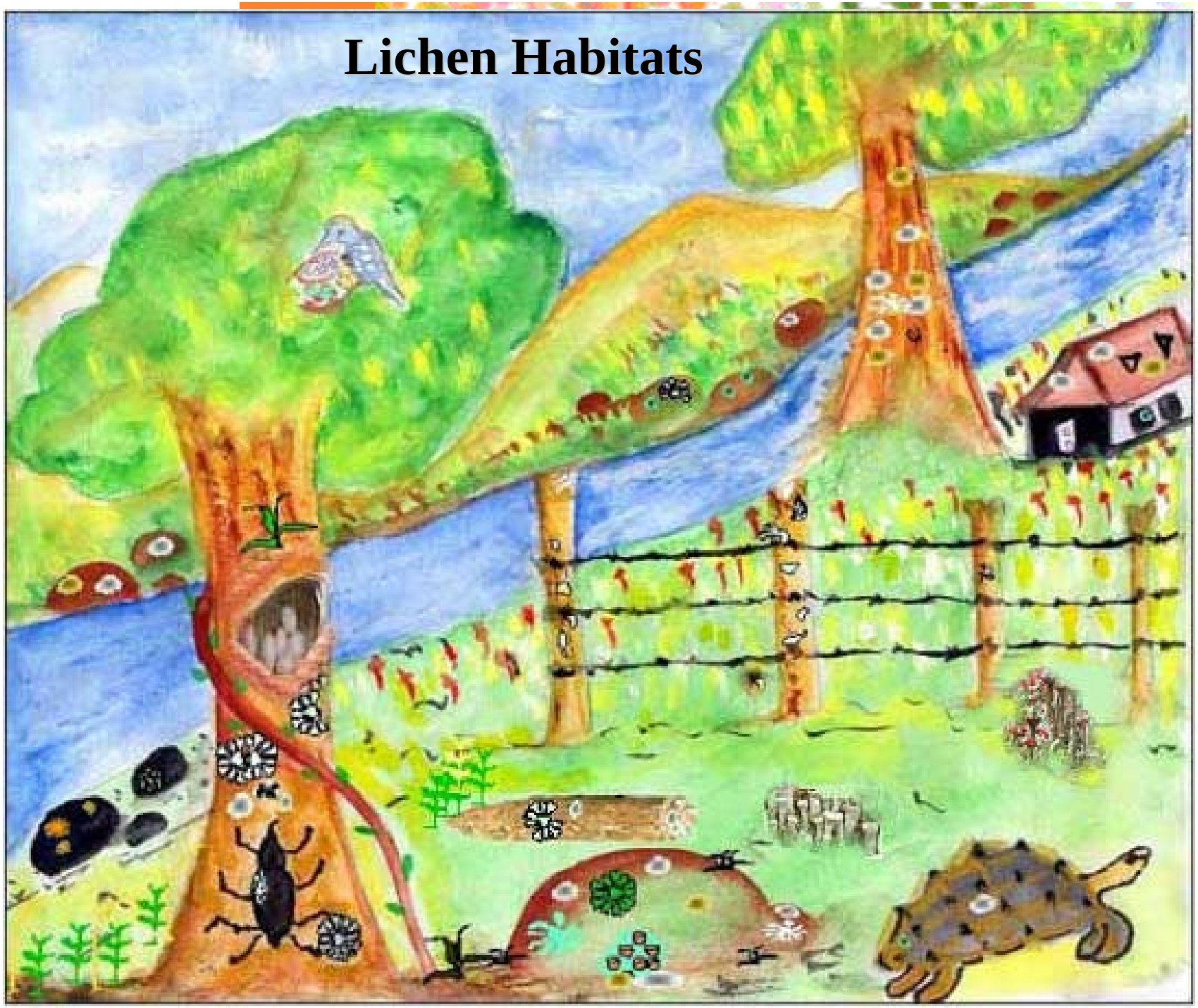
- **The symbiotic relationship enables lichens to colonize a vast spectrum of habitats and climates all over the world including extreme environments - from the Polar regions to the Equator and inter-tidal zones to mountain peaks.**

- **Within a climatically uniform region each particular substrate tends to assume eventually a characteristic and often remarkably uniform lichen community**

Distribution

- Worldwide
- Most extreme environments, from the Arctic to Antarctic, deserts to tropics, littoral zones to Mountain peaks
- Occur on or in Bark, Rock, Soil, Animal shells,and on man-made structures
- Mainly in rural areas rather than cities
  - Lichens are intolerant of atmospheric pollution, particularly sulphur dioxide & Habitat modification

Lichen Habitats



Tree bark
Rock
Soil
Leaves

Logs
Fence post
Roof top
Glass
Insect
Tortoise shell

Suggested reading…..

Text Books

Hale, M.E. (1983) *The biology of lichens* (3rd ed.). Edward Arnold. pp 1-190.

Hawksworth, DL & Hill, DJ 1984: The Lichen-Forming Fungi. - Blackie, Glasgow and London. 158 pp

Galun, M. (ed.) (1988) CRC Handbook of Lichenology. Volume I. - CRC Press, Inc., Boca Raton. 297 pp.

Galun, M. (ed.) (1988) CRC Handbook of Lichenology. Volume II. - CRC Press Inc., Boca Raton. 181 pp.

Galun, M. (ed.) (1988) CRC Handbook of Lichenology. Volume III. - CRC Press, Inc., Boca Raton. 147 pp.

Ahmadjian, V 1993: *The Lichen Symbiosis*. - John Wiley & Sons, Inc., New York. 250 pp.

Ahmadjian, V and Hale, ME 1973: *The Lichens*. - Academic Press, New York and London. xiv + 697 pp.

Awasthi, DD 2000: *A Handbook of Lichens*. - Bishen Singh Mahendra Pal Singh, Dehra Dun, India. 157 pp.

Awasthi, DD 2000: *Lichenology in Indian Subcontinent - A Supplement to "A Handbook of Lichens"*. - Bishen Singh Mahendra Pal Singh, Dehra Dun, India. 124 pp.

Indian Lichen identification keys & Field Guides:

Awasthi, D. D. (1988) A key to the macro lichens of India and Nepal. *Journ. Hattori Bot. Lab*. 65: 207-302.

Awasthi, D. D. (1991) A key to the micro lichens of India, Nepal, and Sri Lanka. *Biblioth. Lichenol*. 40: 1-336

Singh, K.P. and Sinha G.P. (1994) Lichen flora of Nagaland. Bishen Singh Mahendra Pal Singh, Dehra Dun. Pp1-498.

Upreti, D.K. and Sanjeeva, N. (2004) A field guide to the common lichens of Corbett Tiger Reserve. Bishen Singh Mahendra Pal Singh, Dehra Dun. Pp 1-41.

Indian Lichen Identification Software:

Hariharan, G.N., Balaji, P and Bharath,P. LIFKEY LIFDAT LICHENS – Interactive identification key to Lichens. (2004) Concept and Series Editor Prof. Madav Gadgil, Indian Institute of Science, Bangalore and M.S. Swaminathan Research Foundation, Chennai.

Indian Lichen laboratories…

Lichen laboratory
Agharkar Research Institute,
Agharkar Road,
Pune,
Maharastra, India

Lichen laboratory
Kerala Forest Research Institute,
Peechi,
Trissur,
Kerala, India.

Lichen laboratory
National Botanical Research Institute
Rana Prathap Marg
Lucknow 226 001
Uttar Pradesh, India

Lichen laboratory
Botanical Survey of India
Allahabad
Uttarpradesh, India

Lichen laboratory
M.S. Swaminathan Research Foundation
III Cross Street,
Taramani
Institutional area
Chennai 600 113
Tamilnadu, India