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MEDICINAL LICHENS OF INDIA

Nayaka. S., Upreti, D.K. and Khare, R.

Lichenology Laboratory, National Botanical Research Institute (CSIR)
Rana Pratap Marg, Lucknow - 226001

ABSTRACT

A total of 137 lichens having medicinal properties and occurring in India are enumerated, of which 36 species are used in traditional medicine either in India or elsewhere, 55 have been screened for antimicrobial activity, about 57 for antioxidant property while about 37 species for anti-cancer and cytotoxicity. The macrolichens (foliose and fruticose lichens) were mostly utilized for medicine value. *Cetraria islandica*, *Cladonia rangiferina*, *Evernia prunastri*, *Everniastrum cirrhatum*, *Hypogymnia physodes*, *Parmotrema chinense*, *Peltigera canina* and *Usnea longissima* are the widely exploited in different parts of the world in traditional medicine and for biological screening. A brief description of the lichen taxa, its distribution in India and its utilization is provided in the enumeration.

INTRODUCTION

Lichens, the symbiotic phenotype of nutritionally specialized fungi associated with algae, are an outstandingly successful group, exploiting a wide range of habitats throughout the world and dominating about 8% of terrestrial ecosystems. They have a varied chemistry and produce many polyketide derived phenolic compounds such as depsides and depsidones most of which are not known from other groups of plants.

Traditional uses of lichens:

Lichens have been used in traditional medicine since the time of the first Chinese and Egyptian civilizations. Their utilization in folklore as medicine has been cited in different pharmacopoeias of the world. During the middle-ages lichens figured prominently among the herbs used by medicinal practitioners (Hale 1983). The use of lichens in medicine can be traced back to antiquity. *Evernia furfuracea* has been found in an Egyptian vase belongs to 18th Dynasty (1700-1600 BC) was used as a drug (Llano 1948).

The literary review and records of medicinal plant lore of India show the word 'Shipal' is used for algae in Rigveda (6000-4000 BC), a text where the first authentic record of 'Oushadhi' (medicine) has been described. The medicinal properties attributed to Shipal as lichen are in Avkolva as mentioned in Athraveda (1500 BC). Subsequently a number of Sanskrit synonyms of lichens, for example, 'Shailaya' and 'Shilapushp' – have been described in Sushruta Samhita (1000 BC), Charaka Samhita (300-200 BC) and several Nighantu (1100-1800 AD). The Sanskrit names were later identified to several species of Parmelioid lichens, such as *P. cirrhata* and *P. perforata* (=*Parmotrema perforatum* (Jacq.) Mass.) (Kumar and Upreti 2001). The vernacular name Chharila is widely used in Ayurveda, an ancient system of Indian medicine, for different disease and disorders, for example, headache, skin diseases, urinary trouble, boils, vomiting, diarrhoea, dysentery, heart trouble, cough, fever, leprosy and as a blood purifier. *Parmelia sulcata*, which is described in medicinal plant lore of India, is also reported as medicinally useful by Hale (1983) in cranial maladies.

Doctrine of Signature:

The fame of many lichen derives from the Doctrine of Signature, which is very old in genesis and was raised to an accepted science by Paracelsus but is now discredited. The Doctrine signature relies on the concept that like affects the like. Hence plants designed by the creator for human beings may be expected to bear a sign pointing to its special use. *Lobaria pulmonaria* (L.) Hoffm., was used to treat lung disease because of its superficial resemblance to lung tissue. The long filaments of *Usnea barbata* Wigg., were used for strengthening after confinement. *Xanthoria parietina* being yellow supposed to cure jaundice, while *Peltigera apthosa* (L.) Willd., the thallus of which is dotted with small warts like tubercles, was recommended for children who suffer from 'Thrush'.

Chharila, the crude Indian drug:

Chandra and Singh (1971) provided a detailed description of crude drug 'Chharila' sold in Indian markets which comprises three species of *Parmelia*; *P. perlata* (L.) Ach. (=*Parmotrema chinense* (Osbeck) Hale & Ahti), *P. perofrata* (Wulf.) Ach. (=*Parmotrema perforatum* (Ach.) Mass.) and *P. sanacti-angelii* Lynge (=*P. sancti-angeli* (Lynge) Hale). The drug has astringent, resolvent, laxative, carminative properties and is also supposed to possess

aphrodisiac property. The drug is considered to be useful in dyspepsia, spermatorrhoea, amenorrhoea, calculi, diseases of blood and heart, stomach disorders, enlarged spleen, bronchitis, bleeding piles, scabies, leprosy, excessive salivation, soreness of throat, tooth-ache and general pain. The smoke of 'Chharila' is believed to relieve headache. The powdered drug is applied to wounds, besides a good cephalic snuff.

Lichen metabolites and their importance:

About 800 metabolites produced by lichens are identified (Huneck and Yoshimura 1996) and new ones are being identified every now and then. The secondary metabolites produced by lichens are unique with respect to those of higher plants. Biological activities of a lichen is mostly due to presence of the secondary metabolites present in them. However, their therapeutic potential not yet fully explored and thus remains pharmaceutically unexploited. This is certainly due to difficulties encountered in identification of species and collection in bulk quantity. Müller (2001) provided a list of such pharmaceutically relevant metabolites belonging to group aliphatic acids, pulvinic acid derivatives, depsides and depsidones, dibenzofurans, anthraquinones, naphthoquinones and epidithiopiperazinediones. Similarly, Boustie and Grube (2005) discussed the diversity of secondary metabolites, their evolutionary pattern, genes involved in their production, bioactive molecules and their potential use. Slow growth of lichen and in axenic culture is the major hurdle for easily obtaining desired metabolite. However, culture conditions of the mycobiont can be optimized to synthesize interesting secondary compounds and researchs are underway elsewhere in this direction.

Ethnomedicinal lichens of India:

During the last five decades of the last century, exhaustive ethnobotanical work has been carried out by several workers in different part of India, with major emphasis on higher plants where as the ethnobotanical aspects of cryptogamic groups such as algae, fungi, lichens and bryophytes have not received adequate attention. Brij Lal (1988, 1990), Brij Lal and Upreti (1995), Saklani and Upreti (1992) have collected ethnomedicinal information on a few species of lichens used by the different tribal and non-tribal communities of India. Upreti *et al.* (2005) listed 15 lichen species used by various tribes in India in their daily life either as medicine or as asthetics. Upreti and Chatterjee (2007) reviewed world wide ethnomedicinal information on

more than 50 lichen taxa. Most of the acids present in the lichens used by the tribals have been reported as antibacterial or antiviral by Asahina and Shibata (1954). The lichen acids are mainly phenolic-carboxylic acids (atranorin, lobaric, salazinic acids), fatty acids (protolichesterenic acid) and triterpenes (zeorin) derivatives.

Indian medicinal lichens:

India has a rich diversity of lichens represented by about 2450 species. The lichens are abundant in temperate and alpine regions of the Himalayas and hilly regions of Peninsular India. Several lichens are already in use in traditional medicine of the country. In the present article an attempt is made to enumerate the lichens occurring in India and known to have medicinal value either in India or elsewhere. The study revealed 137 such lichens (enumerated below and Table 1) of which at least 36 are used in traditional medicine in India and elsewhere. Most of them have been studied for their biological activity. The biological screening of lichen for active molecules can be grouped in to three main categories, antimicrobial, antioxidant and anti-cancer. About 55 lichens that also occur in India were screened for antimicrobial activity, about 57 species, including a major proportion of Graphidaceous lichens have been studied for antioxidant property while about 37 for anti-cancer, cytotoxicity and other activities. There are few lichens which have shown anti-inflamatory, immnomodulating and hepatoprotective activity.

The medicinal lichens enumerated in the present study are distributed in 25 families. Parmeliaceae with 39 species and consisting of both foliose and fruticose genera is most widely utilized. Among the growth forms foliose (64 taxa) and fruticose (36 taxa) lichens were mostly utilized for their medicinal properties, as they can be easily recognizable, pickable and yield good biomass. About 37 crustose lichens were also been utilized for their biological screening, however they mostly belongs to Graphidaceae family and experimented by a single research group of Behera *et al.* (2003, 2004, 2006). In most of the cases of ethnomedicine or biological screening crude drug or crude extract is used. The polysaccharides or usnic acid is found to be the isolated biologically active molecules in many cases.

Cetraria islandica (Fig. 1), otherwise known as ‘Iceland moss’ is the most commonly utilized lichen and has been included among the drugs listed in 50 pharmacopoeias or dispensatories of the period 1840s in Europe (Vartia 1973), also been screened for various biological activity. *C. rangiferina, Evernia prunastri, Everniastrum cirrhatum, Hypogymnia*

physodes, Parmotrema chinense, Peltigera canina and *Usnea longissima* (Fig. 2-8) are the other lichens mostly utilized for traditional medicine and biological screening.

ENUMERATION OF MEDICINALLY IMPORTANT INDIAN LICHENS

1. ***Acarospora gobiensis* H. Magn.** (Acarosporaceae) **–** A crustose lichen with grey coloured thallus with radial lobes at periphery and areolate centrally, grows firmly attached to the rocks in temperate and alpine Himalayas. Two polysubstituted brominated depsidones, acarogobien A and acarogobien B derived from this species showed inhibitory effects against *Bacillus subtilis* and *Staphylococcus aureus* (Řezanka and Guschina 1999).

2. ***Acroscyphus sphaerophoroides* Lév.** (Caliciaceae) **–** The taxon has yellowish grey to grey, irregularly thickened cylindirical to clavate fruticose thallus with apically globose sunken apothecia. It commonly grows in alpine regions of Sikkim and Nepal. Methanolic extract of the lichens showed low to moderate inhibitory activity against eleven bacteria (*Bacillus cereus, B. subtilis, Enterobacter aerogens, Escherichia coli, Klebsiella pneumoniae, Micrococcus luteus, Proteus mirabilis, Pseudomonas aeruginosa, Salmonella typhimurium, Staphylococcus aureus, Streptococcus pneumoniae*) and eight fungal strains (*Aspergillus flavus, A. nidulans, A. niger, A. sulphuricus, A. terreus, Candida albicans, Cryptococcus albidus, Trichophyton rubrum*) (Singh *et al.* unpublished data).

3. ***Alectoria ochroleuca* (Hoffm.) Massal.** (Alectoriaceae) – Fruticose lichen, grows as erect to caespitose, 5–8 cm tall threads, yellow to yellowish green in colour in alpine regions of Nepal and Himalayas. The methanolic extract of this lichen collected from Iceland exhibited cancer chemopreventive and cytotoxic activity (Ingólfsdóttir *et al*. 2000).

4. ***Arthoraphis alpina* (Schaer.) R. Sant. in D. Hawksw., P. James and Coppins** (Arthoraphidaceae) – A crustose subsquamulose lichen with bulbate thallus and disciform apothecia growing on acidic soil or mosses in Himalayas. Alcoholic extract of this lichen collected from New Zealand showed cytotoxicity against slow growing BS-C-1 cells (African green monkey kidney, ATCC CCL 26) (Perry *et al.* 1999).

5. ***Arthothelium awasthii* Patw. and Kulk.** (Arthoniaceae) – It is a crustose lichen with ecroticate thallus, with pale brown to white, granular thallus and black, unorganized ascocarp. It is reported from Maharashtra and grows on bark. The methanolic extract and barbatic acid of cultured cell aggregates of natural thallus of *A. awasthii* exhibited anti-oxidant activity including lipid peroxidation and tyrosinase enzyme activity (Verma *et al.* 2008a, 2008b).

6. ***Bulbothrix setschwanensis* (Zahlbr.) Hale** (Parmeliaceae) – A leafy lichen with wide grey lobes and bulbate cilia, found luxuriantly in tropical and temperate regions of south, central India and Himalayas. Acetone and methanolic extract of natural thalli as well as cultured tissue of this lichen exhibited inhibition of tyrosinase and xanthine oxidase activity (Behera and Makhija 2002).

7. ***Cetraria aculeata* (Schreb.) Fr.** (Parmeliaceae) – It is a fruticose lichen with olive-black branches, concave pseudocyphellae and found growing on soil. It occurs in alpine region of Uttarakhand Himalayas. Its active constituent protolichesterinic acid was tested positive against *Escherichia coli, Staphylococcus aureus, Aeromonas hydrophila, Proteus vulgaris, Streptococcus faecalis, Bacillus cereus, Bacillus subtilis, Pseudomonas aeruginosa*, and *Listeria monocytogenes* (Türk *et al.* 2003). The acetone extract of *C. aculeata* exhibited antigenotoxic significant activity against *Salmonella typhimurium,* however, it did not show any cytotoxic activity in some mammalian cancer cells (Zeytinoglu *et al*. 2008)

8. ***Cetraria islandica* (L.) Ach.** (Parmeliaceae, Fig. 1) – The taxon has suberect to erect laciniate lobes, grey brownish thallus with ridges or pits on the surface. It is a common species in western Himalayas and Nepal in temperate and alpine regions. It is popularly known as Island moss and most widely used lichen as medicine. Historically, Iceland moss has been used to manufacture antibiotic to inhibit tuberculosis, 1 kg of antibiotics yields from 40 kg of plant material. Lichen entered the Finnish Pharmacopoeia in 1915. In Finland, an antifungal cream called *USNO* is made for treating athlete's foot and ringworm. In Switzerland, Iceland moss is used for sore throat pastilles. Iceland moss is a nutritious and soothing tonic with slight laxative effect. It helps improve the appetite and digestion of the

elderly and those recovering from a debilitating illness. The bitter principles benefit the stomach in both tincture and infusion form, stimulating a poor appetite, through stimulating the production of saliva and gastric juices. It therefore can be used like Queen of the Meadow, for both hyper- and hypoacidic stomach conditions. Decoctions are used for chronic diarrhoea and respiratory problems. It increases the flow of breast milk but not with inflamed or sore breasts. Both low thyroid and anemia conditions are helped by trace levels of iodine and iron and other nutritive properties as well. (Rogers, internet). It has been mentioned in Pharmacopoeia Universalis of 1846 as a cure for pulmonary tuberculosis and cough in Finland and Europe (Vartia 1973). The lichen is taken internally as a decoction or as a herbal tonic for convalescents (Schneider 1904), in Europe as light diet for invalids and for phthisis, chronic catarrh, dyspesia, chronic diarrhoea, dysentery (Lindley 1849), in France used as pectoral and emollient (Novaretti and Lemordant 1990), in Sweden it is used to treat asthma, diabetes, nephritis, lung disease, whooping cough, cold, wasting disease (Ahmadjian and Nilsson 1963) and in northeast Italy as reconstituent after tuberculosis and anticatarrhal (Lokar and Poldini 1988). Significant amount of *C. islandica* is still sold in European pharmacies for home concoction of herbal tonic and laxatives, a number of companies produce pastilles and pills for sore throats (Richardson 1991). In Sweden and Finland *C. islandica* is sold in drug stores and natural food stores as expectorant, appetizer and roborant and to soften the guts contents (Airaksinens *et al*. 1986). It is also sold in shops for diabetes, lung diseases and catarrh in Sweden (Hale 1967). Elsewhere in folk remedy it is also used for kidney and bladder complaints as well as for poorly healed wounds (Bown, 2001). Traditionally it is used for mild inflammation of the oral and pharyngeal mucosa. It is also valued in dyspepsia and loss of appetite. In European folk medicine, it is used in cancer treatment (Chevallier, 1996). It soothes nausea from gastritis and vomiting and combines well with borage and chickweed for peptic ulcers, hiatal hernia, and esophageal reflux. In fact, for those individuals with a Yin or fluid deficiency, it would work better than a straight astringent herb. In an open clinical trial, 100 patients with pharyngitis, laryngitis or bronchial ailments were given lozenges containing 160 mg of an aqueous extract of the lichen. There was an 86% positive response with good gastric tolerance and lack of side effects. Mild infusions of Iceland moss can be used as a vaginal douche for its soothing, demulcent properties. Tincture form is best for whooping cough, asthma, TB, and kidney/bladder

complaints; especially those related to a dry, irritating condition. It may be used for night sweats or fevers, but is taken during the day to prevent recurrence. In homeopathy Iceland moss is used for acute and chronic bronchitis; asthma and pains in the chest while coughing (Rogers, internet).

Aqueous extract of *C. islandica* showed increased antioxidant activity with increased amount of the extract (Gülçin *et al.* 2002). Further, crude aqueous extract and the isolated pure compounds lichenan exhibited anti-inflamatory activity with reduced arthritis in rats (Freysdottir *et al.* 2008). The methanolic extract of *C. islandica* collected from Iceland exhibited cancer chemopreventive and cytotoxic activity (Ingólfsdóttir *et al.* 2000). The methanol extract of cultured tissue exhibited activity towards tyrosine inhibition and gram +ve bacteria such as *Bacillus subtilis, Propionibacterium acnes* and *Staphylococcus aureus* (Yamamoto *et al.* 1998). Also, various extracts exhibited antibacterial activity against *Mycobacterium aurum, M. tuberculosis huminis, M. tuberculosis bovis, Sarcina aurea, Strep. pyogenses, E. coli, P. vulgaris, B. megaterium, Staphylococcus aureus, B. subtils, C. albicans, Helicobacter pyloir* (Bustinza 1951, Ingólfsdóttir *et al*. 1985, Ingólfsdóttir *et al.* 1997, Ingólfsdóttir *et al*. 1998). In another study (+)-protolichesterinic acid isolated from this lichen also showed antibacterial activity against *M. aurum* (Ingólfsdóttir *et al.* 1998). The butyrolactone, protolichesterinic acid, isolated from *C. islandica*, was also found to inhibit HIV-RT (Pengsuparp *et al.* 1995). The (+)-protolichesterinic acid also proved to be pronounced inhibitors of platelet-type 12(S)-lipoxygenase *in vitro* system in human platelets (Bucar *et al*. 2004). Effect of l(+)-protolichesterinic acid on cultured, human cells, three malignant cell lines from breast carcinomas and erythro-leukemia (K-562) were tested. At concentrations of 20 µg/mL, significant cancer cell death was detected. In contrast, the proliferation and survival of normal skin fibroblasts and DNA synthesis was not affected (Ogmundsdottir *et al.* 1998). Stübler and Buchenauer (1996) found glucan lichenan of the lichen exhibited strong anti-viral activity. Other components, such as polysaccharides, have been found to stimulate the immune system (Ingólfsdóttir *et al*. 1994). Eight secondary compounds in *C. islandica* decreased by 52% when screened of natural UVA and UVB radiation (Bachereau and Asta 1997).

9. ***Cetrelia braunsiana* (Muell. Arg.) W. Culb. and C. Culb.** (Parmeliaceae) – A wide lobed leafy lichen with coralloid isidia greyish white to brownish tan upper surface. It is widely distributed in temperate regions of Himalayas. Methanolic extract of the lichens showed high inhibitory activity against ten bacteria (*Bacillus cereus, B. subtilis, Enterobacter aerogens, Escherichia coli, Klebsiella pneumoniae, Micrococcus luteus, Proteus mirabilis, Pseudomonas aeruginosa, Staphylococcus aureus, Streptococcus pneumoniae*) and eight fungal strains (*Aspergillus flavus, A. nidulans, A. niger, A. sulphuricus, A. terrcues, Candida albicans, Cryptococcus albidus, Trichophyton rubrum*) (Singh *et al.* unpublished data).

10. ***Cladia aggregata* (Swaerz.) Nyl.** (Cladoniaceae) – The taxon has 3–7 mm long yellow to pale brown branched vertical thallus with elliptical to oval perforations. It grows luxuriantly in temperate regions of the Himalayas. Alcoholic extract of this lichen collected from New Zealand showed antimicrobial against *Bacillus subtilis, Trichophyton mentagrophytes* and cytotoxicity against murine leukemia cells and slow growing BS-C-1 cells (African green monkey kidney, ATCC CCL 26) (Perry *et al.* 1999). The methanol extract of cultured tissue exhibited activity towards tyrosine inhibition and gram +ve bacteria such as *Bacillus subtilis, Propionibacterium acnes* and *Staphylococcus aureus* (Yamamoto *et al.* 1998). Also, methanolic extract of this lichen collected from India has shown antibacterial and antifungal activity (see *Acroscyphus sphaerophoroides*; Singh *et al.* unpublished data).

11. ***Cladonia chlorophaea* (Flörke in Sommerf.) Spreng.** (Cladoniaceae) – The taxon has 10–15 mm vertical powdery (sorediate) cup bearing secondary thallus. It is widely distributed in Himalayas both in alpine and temperate areas. The whole lichen is boiled and decoction used to wash sores which were slow to heal by people of Okanagan-Colville (part of interior Salish, British Columbia) (Turner *et al.* 1980).

12. ***Cladonia coccifera* (L.) Willd.** (Cladoniaceae) – The taxon has a vertical 5–25 mm tall secondary thallus with verruculose to squamulose surface, 3–10 mm wide cups bearing red apothecia on their margins. The species is common in temperate to alpine Himalayas. The lichen is listed in Pharmacopoeia Universalis of 1846 as one of the important medicinal plant (Vartia 1973).

13. ***Cladonia crispata* (Ach.) Flotow** (Cladoniaceae) – The taxon has dimorphic thallus, primary thallus persistent or disappearing, up to 50 mm mm tall secondary thallus, branched with open axil apices, pale to dark brown. It is reported from Eastern Himalayas in Sikkim and Arunachal Pradesh, found growing on soil. The water-soluble polysaccharides isolated from *C. crispata* has shown antitumor activity (Nishikawa *et al.* 1974).

14. ***Cladonia deformis* (L.) Hoffm.** (Cladoniaceae) – The taxon has 2–4x1–3 mm primary squamules and 10–-50 mm tall secondary thallus with farinose soredia and bear shallow cups with red apothecia at margin. In Finland the lichen is used in traditional medicine for pulmonary tuberculosis and cough (Vartia 1973).

15. ***Cladonia fimbriata* (L.) Fr.** (Cladoniaceae) – The taxon has farinose sorediate, trumpet-shaped vertical, upto 20 mm tall thallus with brown apothecia on the margin of cups. The species is widely distributed in temperate Himalayas and higher altitudes of Nilgiri Hills. Alcoholic extract of this lichen collected from New Zealand showed antimicrobial activity against *Bacillus subtilis, Candida albicans, Trichophyton mentagrophytes* and cytotoxicity against murine leukemia cells and slow growing BS-C-1 cells (African green monkey kidney, ATCC CCL 26) (Perry *et al.* 1999).

16. ***Cladonia furcata* (Huds.) Schrad.** (Cladoniaceae) – A dimorphic lichen species with 70–130 mm tall, squamulose, dichotomously branched cupless secondary thallus and upto 3 mm sized primary thallus. A widely distributed lichen in temperate Himalayas. The methanolic extract of this lichen collected from Iceland exhibited cancer chemopreventive, cytotoxic activity (Ingólfsdóttir *et al*. 2000) and antimicrobial activity else where (Ranković *et al.* 2007).

17. ***Cladonia humilis* (With.) J. Laundon** (Cladoniaceae) – The species is characterized by 1–8 mm tall, granular sorediate and peltate squamulose, cup bearing secondary thallus and brown apothecia. It is known from the temperate Himalayas. The methanol extract of cultured tissue

and natural thalli of *C. humilis* exhibited superoxide dismutase like activity (Yamamoto *et al.* 1998).

18. ***Cladonia pyxidata* (L.) Hoffm.** (Cladoniaceae) – The taxon has 10–25 mm tall secondary thallus with peltate squamules, deep goblet shaped cup. The species grows luxuriantly on decaying wood and soil in temperate Himalayas. This is one of the lichen mentioned in Pharmacopoeia Universalis of 1846 (Vartia 1973), also traditionally used to treat whooping cough and as a febrifuge in Europe (Lindley 1849, Chevallier 1996). In homeopathy *C. pyxidata* is used against symptoms that include hurried feeling, but less anxious and nervous; bloated abdomen, disorientation, uncertainty, dryness of tongue, lips, throat, skin and rectum; tired and yet sleeplessness, desire for open air; difficulty in breathing in hot room (Rogers, internet).

19. ***Cladonia rangiferina* (L.) Webber ex Wigg.** (Cladoniaceae, Fig. 2) – A dimorphic thalloid lichen with 50–110 mm tall branched secondary thallus, tomentose arachnoid on surface. The species is common in temperate and alpine regions forming aggregate tufts on soil. In India the lichen is been used by four tribal communities (Monpa, Aka, Sherdukpen and Miji) of Eastern Himalayas, Arunachal Pradesh, West Kameng district for removing kidney stones (Routh *et al.* 2005). The dried thalli powder is applied for curing eczema and other skin disease by Lepcha tribes of Sikkim and they call it as 'Anokbu Singalion' (Sinha and Singh 2005). The American Indians use this lichen as newborn baby bather after boiling this lichen (Vogel 1970).

    C. rangiferina and other similar looking *Cladonia* are also known as reindeer lichens. In northern hemisphere native people use reindeer lichen in medicinal teas to treat colds, arthritis, fevers and other problems (Perez-Llano 1944). Reindeer lichens were also used as a poultice to relieve the pain of arthritic joints. They have been known to treat fever, jaundice constipation, convulsions, coughs, and tuberculosis (Bown 2001).

    C. rangiferina also subjected to several biological activity studies. The organic extract of exhibited antibacterial activity against *Staphylococcus aureus, Bacillus subtilis* and *Candida albicans* (Bustinza 1952, Ingólfsdóttir *et al.* 1985). The methanolic extract of this lichen collected from Iceland exhibited cancer chemopreventive and cytotoxic activity (Ingólfsdóttir

et al. 2000). The water-soluble polysaccharides isolated from *C. rangiferina* has shown antitumor activity (Nishikawa *et al.* 1974). In another set of experiment the methanol extract of cultured tissue exhibited activity towards tyrosine inhibition and gram +ve bacteria such as *Bacillus subtilis*, *Propionibacterium acnes* and *Staphylococcus aureus* (Yamamoto *et al.* 1998). Recent work identified new compounds, hangokenols A and B. These and other previously identified compounds were tested for activity against methicillin resistant *Staphylococcus aureus*) and vancomycin resistant *Enterococci* spp. (Yoshikawa *et al*. 2008).

In homeopathy *C. rangiferina* has been recently proved at the 30^{th} potency by Misha Norland in 2002. It is used for treating mental symptoms include jealousy, suspicion and delusion; dreams of crime, evil, guns, murder, war, fights and robbery. It is also used for throat huskiness or loss of voice, head and eye pain; nasal congestion, burning tongue, stomach nausea, abdominal flatulence; dry cough, thick expectoration, stitching pain in chest, cold extremities and itching skin (Rogers, internet).

20. ***Coccocarpia palmicola* (Sprengel) Arvid. and Galloway** (Coccocarpiaceae) – The taxon has lead grey to brown black foliose, isidiate, upto 5 mm wide lobed thallus. It is widely distributed in subtropical to temperate regions of the Himalayas, mostly on bark of trees in moist places. Alcoholic extract of this lichen collected from New Zealand showed cytotoxicity against murine leukemia cells and slow growing BS-C-1 cells (African green monkey kidney, ATCC CCL 26) (Perry *et al.* 1999).

21. ***Collema flaccidum* (Ach.) Ach.** (Collemataceae) – It is a fliose lichen with bluish olive-green colouration, thin, smooth to folded thallus with globular to squamiform isidia, found growing on tree bark in lower temperate regions of Jammu and Kashmir, Manipur and Palni Hills of Tamil Nadu. Bianthraquinone glycosides, colleflaccinosides isolated from *C. flaccidum* collected in Israel and Russia, were reported to have antitumor activity (Řezanka and Dembitsky 2006).

22. ***Dermatocarpon miniatum* (L.) Mann** (Verrucariaceae) – It is a foliose lichen, attached to rock at centre, mono or polyphyllous, up to 5 cm across, grey in colour. It is a common lichen in temperate Himalayas, reported from Himachal Pradesh, Uttarakhand, Jammu and

Kashmir. Methanol extract of *D. miniatum* observed to be a powerful anti-oxidant and has significant antimicrobial activity (Aslan *et al.* 2006).

23. ***Diploschistes scruposus* (Schreber) Norman** (Thelotremataceae) – It is a crustose lichen, with whitish grey thallus, sunken apothecia, open, ureolate disc found growing on calcicolous rock. Acetone extract of the lichen showed antibacterial activity but at higher concentration against *Bacillus cereus, B. megaterium, Staphylococcus aureus* and *Klebsiella pneumoniae* (Saenz *et al.* 2006).

24. ***Evernia divaricatica* (L.) Ach.** (Parmeliaceae) – It is a foliose lichen found growing on twigs and hanging, yellow to light brown, flattened, wirnkled and cracked. It occurs in temperate part of Western Himalaya in Jammu and Kashmir. Methanol extract of this lichen did not have any anti-oxidant activity but has significant antimicrobial activity (Aslan *et al.* 2006).

25. ***Evernia prunastri* (L.) Ach.** (Parmeliaceae, Fig. 4) – A fruticose lichen with 10–50 mm, divaricately branched, tapering, yellowish to yellowish brown branches, pendulose, marginally and lamially sorediate. It is widely distributed in the temperate and alpine regions of Himalayas. *E. prunastri* is one of the lichen mentioned in Pharmacopoeia Universalis of 1846, called as 'Lichen quercinus virides' (Vartia 1973). The lichen has shown antibacterial (*Staphylococcus aureus, Bacillus mycoides, B. licheniformis, Mycobacterium phlei*) and antifungal (*Actinomyces sulfuroides, Tricophyton farineculatum, T. interdigitalis, Epidermophyton inguinale*) activities (Bustinza 1952) while the methanol extract of cultured tissue exhibited activity towards tyrosine inhibition and gram +ve bacteria such as *B. subtilis, Propionibacterium acnes* and *S. aureus* (Yamamoto *et al.* 1998). Also, the lichen has shown antioxidant activity (Racine *et al.* 1980). Methanol extract of this lichen exhibited significant antimicrobial activity (Aslan *et al.* 2006).

26. ***Everniastrum cirrhatum* (Fr.) Hale** (Parmeliaceae, Fig. 5) – The taxon has ash-grey to grey brown, canaliculate, leafy thallus with dark brown lower surface and rounded apothecia. The species is widely distributed in tropical and temperate regions of India. *E. cirrhatum* (earlier known as *Parmelia cirrhata* Fr.) is one of the common lichens in India and used in Ayurveda

and Unani medicine under the name 'Chharila' as carminative and aphrodisiac and considered useful in dyspepsia, spermatorrhoea, amenorrhoea, calculi, diseases of blood and heart, stomach disorders, enlarged spleen, bronchitis, bleeding piles, scabies, leprosy, excessive salivation, soreness of throat, tooth-ache and general pain (Chandra and Singh 1971). In Western Ghats of India it is also considered useful as diuretic, soporific and sedative, used in diarrohoea, dyspesia, spermatorrhoea, amenorrhoea, and dysentery, used as an incense especially to relieve headache, as a poultice, applied externally to renal and lumbar regions, which causes a copious flow of urine. As a liniment it is applied to head in cases of headaches, powder is applied to promote healing of wounds (Nadkarni 1976).

Aqueous extract of *E. cirrhatum* was found to be effective against some dermatophytic fungi such as *Epidermophyton floccosum, Microsporum audouinii, Microsporum canis, M. nanum, M. gypseum, Trichophyton mentagrophytes, T. rubrum, T. tonsurance, T. violaceum* (Shahi *et al*. 2000). Methanolic extract of this lichen has shown antibacterial and antifungal activity (Singh *et al.* unpublished data). Its ethanol extract exhibited significant antibacterial activity against virulent strain of *Mycobacterium tuberculosis* H37Rv (Gupta *et al.* 2007).

27. ***Everniastrum nepalense*** **(Taylor) Hale** (Parmeliaceae) – A canaliculated, leafy lichen with grey to grey brown thallus and rounded apothecia. The species is widely distributed in subtropical and temperate regions of India. In Nepal it is used in the treatment of toothache and sore throat (Kumar *et al* 1996). Some of the metabolites isolated from this lichen found to be potent antiproliferative agents against human keratinocyte line HaCaT and also inhibited the leukotriene B4 biosynthesis by a non-redox mechanism (Kumar and Muller 1999a,b).

28. ***Flavoparmelia caperata*** **(L.) Hale** (Parmeliaceae) – A wide lobed, yellow green, sorediate lichen with dark black lower surface. It is widely distributed in the Himalayas, Nilgiri, Palni Hills and central India. *F. caperata* is one of ingradient of chinese medicine (Hu *et al.* 1980). In Russia it is used in indigenous medicine in the form of powder to treat wounds (Moskalenko 1986). In northern Mexico it is dried, crushed and dusted upon burns (Pennington 1963), while in Woods Cree (Nihithawak) its decoction is imbibed to expel

intestinal worms and the lichen is dried and preserved as powder for same use during winter (Leighton 1985).

Early work by Burkholder and Evans (1945) reported antibiotic activity of this lichen extract against *Staphylococcus aureus*, *Diplococcus pneumoniae*, *Streptococcus hemolyticus*, *S. viridans*, *Bacillus subtilis*, *B. mycoides*, and *Sarcina lutea*. Usnic acid isolated form *F. caperata* showed highest antibacterial activity comparable with streptomycin standard. It inhibited all (*Bacillus mycoides, B. subtilis, Staphylococcus aureus, Enterobacter cloacae, Escherichia coli, Klebsiella pneumoniae*) the tested bacteria in extremely low concentrations. Acetone, methanol extract and usnic acid isolated from *F. caperata* demonstrated a significant antimicrobial activity (Ranković *et al.* 2007, 2008). In another study ethanol extract exhibited antibacterial activity against virulent strain of *Mycobacterium tuberculosis* H37Rv (Gupta *et al.* 2007).

29. ***Graphina acharii* (Fée) Müll. Arg.** (Graphidaceae) – A crustose lichen with lirellate apothecia, distributed in Western Ghats and Eastern Himalayas. The methanolic extracts of the species showed inhibitory properties of tyrosinase and xanthine oxidase with an additional superoxide scavenging capacity (Behera *et al.* 2003, 2004).

30. ***Graphina adscribens* (Nyl.) Müll. Arg.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

31. ***Graphina glaucorufa* (Vainio) Zahlbr.** (Graphidaceae)– Similar to *Graphina acharii* (Behera *et al.* 2003, 2004, 2006).

32. ***Graphina multistriata* Müll. Arg.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004, 2006).

33. ***Graphina norlabiata* Patw. and Kulk.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

34. ***Graphina nylanderi*** **Patw. and Kulk.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

35. ***Graphina perstriatula*** **(Nyl.) Zahlbr.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

36. ***Graphina salacinilabiata*** **Patw. and Kulk.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004, 2006).

37. ***Graphina simulans*** **(Leighton) Müll. Arg.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

38. ***Graphis assamensis*** **Nagar. and Patw.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004, 2006).

39. ***Graphis exalbata*** **Nyl.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

40. ***Graphis garoana*** **Nagar. and Patw.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

41. ***Graphis glauconigra*** **Vainio** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

42. ***Graphis guimarana*** **Vainio** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

43. ***Graphis hossei*** **Vainio** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

44. ***Graphis inamoena*** **Zahlbr.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

45. ***Graphis inquinata*** **(Knight and Miller) J.D. Hooker** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

46. ***Graphis nakanishiana*** **Patw. and Kulk.** (Graphidaceae)– Similar to *Graphina acharii* (Behera *et al.* 2003, 2004, 2006).

47. ***Graphis patwardhanii*** **Kulk.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

48. ***Graphis persicina*** **Mey and Flotow** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

49. ***Graphis persulcata*** **Stirton** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

50. ***Graphis pyrrhocheiloides*** **Zahlbr.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

51. ***Graphis scripta*** **(L.) Ach.** (Graphidaceae) – The taxon has grey or greyish white crustose thallus with furcated, straight to flexuose, upto 4 mm long lirellae. It is widely distributed species throughout India. The methanol extract of cultured tissue of *G. scripta* exhibited inhibition of tyrosine activity, Epstein-Barr virus activation induced teleocidin B-4 (anticancer), gram +ve bacteria (*Bacillus subtilis, Propionibacterium acnes* and *Staphyrococcus aureus*) and superoxide dismutase like activity (Yamamoto *et al.* 1998).

52. ***Graphis sikkimensis*** **Nagar. and Patw.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

53. ***Graphis sorediosa*** **Nagar. and Patw.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

54. ***Heterodermia diademata*** **(Taylor) D.D. Awasthi** (Physciaceae) – A leafy lichen with 2–3 mm wide, greyish white lacinae bearing rounded apothecia. A widely distributed lichen in subtropical to temperate parts of India, found growing on soil, rocks and bark of trees. In India Nepalese of Chaunje Basti, near Gangtok in Sikkim apply this lichen on cuts and wound as plaster to protect from water and infection. It is locally called 'Dhungo ku seto jhau' (Saklani and Upreti 1992).

55. ***Heterodermia microphylla*** **(Kurok.) Skorepa** (Physciaceae) – The taxon has greyish white, 1.5–2 mm wide lacinae with short lateral lobules and lacking lower cortex. It is known only from eastern Himalayas. The secondary metabolites isolated from *H. microphylla* and other lichens collected from Brazil exhibited immunological modulating potential as the release of hydrogen peroxide and nitric oxide in the culture of peritoneal macrophage cells from mice (Santos *et al.* 2004).

56. ***Heterodermia podocarpa*** **(Bél.) D.D. Awasthi** (Physciaceae) – It is a foliose lichen, greyish white in colour, lacking lower cortex and stalked apothecia. It is grows on bark in subtropical regions of India in Arunachal Pradesh, Maharashtra, Manipur, Nagaland, Sikkim, Uttarakhand, Tamil Nadu and West Bengal. The methanolic extract of cultured cell aggregates of natural thallus of *H. podocarpa* exhibited lipid peroxidation and tyrosinase enzyme activity (Verma *et al.* 2008a), whlile zeorin isolated from the same exhibited anti-oxidant activity (Verma *et al.* 2008b)..

57. ***Heterodermia leucomelos*** **(L.) Poelt** (Physciaceae) – It is a foliose lichen, but appears as fruticose with loosely attached, whitish grey, ribbon like thallus, marginally black ciliate, grows on bark or soil, ascending or pendulous. It is a common lichen in India reported from Karnataka, Nagaland, Sikkim, Tamil Nadu, West Bengal. Ethanol extract of this lichen exhibited significant antibacterial activity against virulent strain of *Mycobacterium tuberculosis* H37Rv (Gupta *et al.* 2007).

58. ***Hypogymnia enteromorpha*** **(Ach.) Nyl.** (Parmeliaceae) – A foliose lichen with adpressed to suberect grey brown lobes, hollow at apex. It is known from eastern Himalayas only. The methanol extract of cultured tissue of *H. enteromorpha* exhibited inhibition of tyrosine and superoxide dismutase like activity (Yamamoto *et al.* 1998).

59. ***Hypogymnia physodes*** **(L.) Nyl.** (Parmeliaceae, Fig. 3) – The taxon has flattened yellowish grey to green thallus lobes with apical labrose soralia and wrinkled lower surface. It is common in western Himalayas. *H. physodes* was one of the main ingredients of 15th century drug 'Lichen quercinus virides' in Europe tradition (Llano 1951). In Forest Potawatomi (Great Lakes) the lichen is used to cure costipation, eaten from the trees while in the woods, but usually soaked or boiled until it swelled somewhat (Smith 1933).

Burkholder and Evans (1945) first reported the antimicrobial activity of crude extract of *H. physodes* and he was followed by Mordraksi (1956). Acetone, methanol extracts of naturally growing lichen as well as cultured tissue and its gyrophoric acid exhibited antimicrobial activity against a variety of bacteria and fungus; *Bacillus mycoides, B. subtilis, Staphylococcus aureus, S. albus, Sarcina lutea, Propionibacterium acnes, Enterobacter cloacae, Escherichia coli, Klebsiella pneumoniae* and fungi *Aspergillus flavus, A. fumigatus, Botrytis cinerea, Candida albicans, Fusarium oxysporum, Mucor mucedo, Paecilomyces variotii, Penicillium purpurescens, P. verrucosum, Trichoderma harzianum* (Yamamoto *et al.* 1998, Ranković *et al.* 2007, 2008). The methanol extract of the cultured tissue of *H. physodes* also exhibited inhibition of tyrosine activity and Epstein-Barr virus activation induced teleocidin B-4.

60. ***Hypogymnia tubulosa*** **(Schaer.) Havaas** (Parmeliaceae) – A foliose lichen with tubular or flattened lobes, ashy grey to brownish in colour, apically sorediate, perforations absent and found growing on trees in temperate regions of Himachal Pradesh. 3-hydroxyphysodic acid isolated from *H. tubulosa* showed antimicrobial activity against *Aeromonas hydrophila, Bacillus cereus, B. subtilis, Escherichia coli, Klebsiella pneumoniae, Listeria monocytogenes, Proteus vulgaris, Salmonella typhimurium, Staphylococcus aureus, Streptococcus faecalis, and Candida albicans* (Yilam *et al.* 2005).

61. ***Lasallia pustulata*** **(L.) Mérat** (Umbilicariaceae) – It is foliose lichen found attached to rock at central point, margin incised, dark brown to olive brown, cylindirical isidiate and with pustules. In India it is reported from Nagaland. The acetone and methanol extracts of of this lichen manifested significant activity against Gram-positive and Gram-negative bacteria (*Bacillus mycoides, B. subtilis, Staphylococcus aureus, Enterobacter cloacae, Klebsiella pneumoniae*) with the exception of *Escherichia coli*, which was resistant. The largest zone of inhibition (22 mm in diameter) was obtained for the acetone extract against the species *Klebsiella pneumoniae*. Antifungal activity was manifested against nine of the 11 fungal species (*Aspergillus flavus, A. fumigatus, Botrytis cinerea, Candida albicans, Fusarium oxysporum, Mucor mucedo, Paecilomyces variotii, Penicillium purpurescens, P. verrucosum, Saccharomyces cerevisiae, Trichoderma harzianum*). The acetone and methanol extracts were most active in relation to the species *P. variotii*, in whose case the zones of inhibition were large (18 and 22 mm in diameter, respectively). *Lasallia pustulata* contains the lichen substances gyrophoric acid, arabitol, mannitol and umbilicarin (Ranković *et al.* 2007).

62. ***Lecanora muralis*** **(Schreb.) Rabenh.** ***em*** **Poelt** (Lecanoraceae) – It is placodioid lichen, grows on rocks in circles, yellowish to creamy colour, centrally cracked and with apothecia. It grows in temperate to alpine regions of India in Himachal Pradesh, Uttarakhand, Jammu and Kashmir. It contains usnic acid and acetone extract showed significant antibacterial activity against *Bacillus cereus, B. megaterium, Staphylococcus aureus* and *Klebsiella pneumoniae* (Saenz *et al.* 2006).

63. ***Leptogium cyanescens*** **(Rabenh.) Koerb.** (Collemataceae) – A lead grey, isidiate and lobulate lichen with smooth upper surface and tomentose lower surface. The species is widely distributed in subtropical and subtemperate regions of India. Alcoholic extract of this lichen collected from New Zealand showed cytotoxicity against murine leukemia cells (Perry *et al.* 1999).

64. ***Lethariella cashmeriana*** **Krog** (Parmeliaceae) – An orange coloured fruiticose lichen, having strongly ridged and wrinkled branches and soredia. This is a rare species in India and

reported from alpine region of Jammu & Kashmir. It is one of the ingredients of medicated teas in China (Wang *et al.* 2001).

65. ***Lobaria discolor*** **(Bory in Del.) Hue** (Lobariaceae) – The taxon has wide lobed, pale brown to dark brown, smooth thallus with dense tomentose lower surface. The species is known form temperate Himalayas and Palni Hills. Methanolic extract of this lichen has shown antibacterial and antifungal activity (see *Acroscyphus sphaerophoroides*; Singh *et al.* unpublished data).

66. ***Lobaria isidiosa*** **(Mull. Arg.) Vainio** (Lobariaceae) – The taxon has wide lobed, yellow brown to brown scrobiculate, isidiate upper surface, bullate lower surface. A widely distributed species throughout the temperate Himalayas. *L. isidiosa* is one of the lichen used in Chinese medicine (Hu *et al* 1980). The polysaccharides isolated from this lichen has been tested positive as antitumor agent (Takahashi 1974).

67. ***Lobaria japonica*** **(Zahlbr.) Asahina** (Lobariaceae) – A leafy lichen with wide yellow brown lobes and tomentose lower surface. The species is known form Nilgiri Hills in South India. The polysaccharides isolated from this lichen has been tested positive as antitumor agent (Takahashi 1974).

68. ***Lobaria pseudopulmonaria*** **Gyeln.** (Lobariaceae) – The taxon has wide lobed pale brown to brown, scrobiculate thallus with bullate lower surface. The species is known throughout temperate Himalayas. The polysaccharides isolated from this lichen has been tested positive as antitumor agent (Takahashi 1974).

69. ***Lobaria quercizans*** **Michaux** (Lobariaceae) – The taxon has pale brown, thick margin thallus with tomentose lower surface. It is known only from N.W. Himalayas. *L. qurecizans* is eaten by people of Menomini (Great Lakes) as food and medicine. It is stored after drying, put into soups. It is highly esteemed for its tonic effect on the body systems and the blood (Smith 1923).

70. ***Lobaria retigera* (Bory) Trevisan** (Lobariaceae) – The taxon has wide, pale brown to dark brown lobed thallus with scrobiculate and isidiate upper surface and bullate lower surface. A common species throughout temperate Himalayas. *L. retigera* is one of the constituents of Chinese medicine (Hu *et al.* 1980).

71. ***Mykoblastus sanguinarius* (L.) Norman** (Mykoblastaceae) – A crustose, ecorticated, lichen with black, upto 4 mm diameter apothecia. It is known from Himalayas and Nepal. The methanol extract of cultured tissue of this lichen exhibited superoxide dismutase like activity (Yamamoto *et al.* 1998).

72. ***Myelochroa entotheiochroa* (Hue) Elix and Hale** (Parmeliaceae) – A leafy lichen with mineral grey to grey, subirregular to sublinear lobes with maculate upper surface, yellow medulla and marginal cilia. A corticolous species known from Himalayas. The methanol extract of cultured tissue of this lichen exhibited inhibition of tyrosine activity (Yamamoto *et al.* 1998).

73. ***Myelochroa irrugans* (Nyl.) Elix and Hale** (Parmeliaceae) – The taxon has sublinear, loosely adnate, 4–10 cm across, mineral grey, maculate lobes with dense cilia along the margin and yellow medulla. It is widely distributed in Kerala, Nagaland, Sikkim, Tamil Nadu, Uttarakhand and West Bengal. The methanol extract of cultured tissue of this lichen exhibited inhibition of tyrosine activity (Yamamoto *et al.* 1998).

74. ***Nephroma expallidum* (Nyl.) Nyl.** (Nephromataceae) – The taxon has dull green to brownish, pubescent or scurfy upper surface of lobes. It is known from Himalayas. The methanolic extract of this lichen collected from Iceland exhibited cancer chemopreventive and cytotoxic activity (Ingólfsdóttir *et al*. 2000).

75. ***Parmelaria thomsonii* (Stirton) D.D. Awasthi** (Parmeliaceae) – A foliose lichen with loosely attached, mineral grey thallus with jet black lower surface. The Lepchas of Sikkim use the smoke of this lichen to relive eye pain (Sinha and Singh 2005).

76. *Parmelia saxatilis* (L.) Ach. (Parmeliaceae) – A foliose lichen with sublinear, mineral grey to dark grey, pseudocyphellate, isidiate upper surface and black lower surface. The species is distributed in Kumaon and Garhwal Himalayas and Sikkim. *P. saxatilis* is one of the plant in Chinese medicine (Hu *et al.* 1980). In Sweden it is applied externally to take away warts on hands (Ahmadjian and Nilsson 1963). The dried lichen was sprinkled in stockings in parts of the Highlands to prevent foot inflammation and pain from long journeys. In parts of Ireland it was applied to bad sores under the chin, as well as burns and cuts (Rogers, internet).

Various organic extract of *P. saxatilis* collected from Iceland exhibited antibacterial against *Pseudomonas aeruginosa* (Ingólfsdóttir *et al.* 1985) while the methanolic extract exhibited cancer chemopreventive, cytotoxic activity (Ingólfsdóttir *et al.* 2000) and antimicrobial activity against several bacteria and fungi (Güllüce *et al.* 2006). The salazinic acid isolated from this lichen inhibited the growth of *Mycobacterium aurum* (Ingólfsdóttir *et al.* 1998).

77. *Parmelia squarrosa* Hale (Parmeliaceae) – The taxon has sublinear, mineral grey to grey upper surface with subreticulate network of pseudocyphellate and sorediate upper surface. The taxon is common in Himachal Pradesh and Sikkim. Methanolic extract of this lichen has shown antibacterial and antifungal activity (see *Acroscyphus sphaerophoroides*; Singh *et al.* unpublished data).

78. *Parmelia sulcata* Taylor (Parmeliaceae) – A foliose lichen with sublinear, loosely adnate, whitish grey, lobed thallus, maculate, pseudocyphellate and sorediate upper surface. The taxon is distributed in Himachal Pradesh, Jammu and Kashmir, Sikkim and Garhwal Himalayas. *P. sulcata* with its sulcate markings on the surface, vaguely resembling the surface of the brain (Doctrine of signature) and was eagerly sought as remedy for cranial maladies (country not mentioned, Hale 1983).

Acetone, chloroform, diethyl ether, methanol and petroleum ether extracts of *P. sulcata* and its constituent (salazinic acid) demonstrated antibacterial and antifungal activity against *Aeromonas hydrophila, Bacillus cereus, B. mycoides B. subtilis, Enterobacter cloacae, Klebsiella pneumoniae, Listeria monocytogenes, Proteus vulgaris, Yersinia enterocolitica, Staphylococcus aureus, Streptococcus faecalis, Candida albicans, C. glabrata, Aspergillus*

niger, A. flavus, A. fumigatus, Botrytis cinerea, Fusarium oxysporum, Mucor mucedo, Paecilomyces variotii, Penicillium notatum, P. purpurescens, P. verrucosum, Saccharomyces cerevisiae and *Trichoderma harzianum* (Candan *et al*. 2007, Ranković *et al.* 2007).

79. *Parmotrema abessinicum* (Krempelh.) Hale (Parmeliaceae) – The taxon has upto 10 mm wide, rotund lobed thallus with pale grey, smooth maculate, rugose, cracked upper surface and black to light brown to mottled brown lower surface. It is known only from South India in Palni Hills and Madras. In India *P. abessinicum* is used as indigenous medicine in Andhra Pradesh and locally called as 'Rathipuvvu' (Watt and Breyer-Brandwijk 1962, Llano 1951).

80. *Parmotrema austrosinense* (Zahlbr.) Hale (Parmeliaceae) – A leafy lichen with 6–20 mm wide, rotund lobes, whitish grey, smooth, shiny upper surface, sorediate marginally. It is a widely distributed species in Assam, Himachal Pradesh, Jammu and Kashmir, Kerala, Karnataka, Madhya Pradesh, Tamil Nadu and Uttarakhand. The extract of *P. austrosinense* showed beta-glucosidase inhibitor activity (Lee and Kim 2000).

81. *Parmotrema chinense* (Osbeck) Hale and Ahti (Parmeliaceae, Fig. 6) – The taxon has foliose, membranaceous, 5–10 mm, round lobes with pale grey to mineral grey upper side, sorediate, ciliate margins. It is known from Nilgiri and Pani Hills in India. *P. chinense* (earlier known as *Parmelia perlata* (L.) Ach.) was one of the most common and widely utilized lichen in Indian system of medicine, Ayurveda and Unani under the name ‘Chharila’. However, curretly it has become rare and threatened may be due to over exploitation. The lichen is believed to be an astringent, resolvent, laxative, carminative, aphrodisiac and useful in dyspepsia, spermatorrhoea, amenorrhoea, calculi, diseases of blood and heart, stomach disorder, enlarged spleen, bronchitis, bleeding piles, scabies, leprosy, excessive salivation, soreness of throat, tooth ache and general pain (Chandra and Singh 1971). Elsewhere in India (Western Ghats) it is also used as poultice, bitter, febrifuge, astringent, relvolent, emollient and demulcent, applied to renal and lumbar regions, which causes a copious flow of urine. The powder is applied to promote healing of wounds. It is taken internally as a tonic, considered useful as diuretic, soporific and sedative, used in diarrhoea, dyspepsia, spermatorrhoea, amenorrhoea, dysentery and headache (Nadkarni 1976).

Two new terpens, parmelanostene and permelabdone isolated from *P. chinense* were also found to have antibacterial potential against *Staphylococcus aureus* and *Eschirechia coli* bacterial strains. Parmelanostene was active against *E. coli* at a concentration level 0.4 m mole but showed low inhibitory activity against *S. aureus,* where as permelabdone showed significant activity against *S. aureus* and good activity against *E. coli* (Abdulla *et al.* 2007).

82. ***Parmotrema dilatatum*** **(Vain.) Hale** (Parmeliaceae) – A foliose lichen with 6–10 mm wide, rotund, grey to yellowish grey, granular sorediate lobes, emaculate to faintly maculate upper surface and yellowish brown tan or white mottled shining lower surface. The species is distributed only in south and eastern region of India in Kerala, Manipur, Nagaland and Tamil Nadu. The secondary metabolites isolated from *P. dilatatum* and other lichens collected from Brazil exhibited immunological modulating potential as the release of hydrogen peroxide and nitric oxide in the culture of peritoneal macrophage cells from mice (Santos *et al.* 2004).

83. ***Parmotrema praesorediosum*** **(Nyl.) Hale** (Parmeliaceae) – A foliose, parmelioid lichen with yellowish grey to mineral grey upper surface, marginal soralia, slightly rugose to cracked upper surface, lower surface minutely wrinkled, black, mottled, brown with shining marginal zone. It is one of the widely distributed species in temperate and tropical regions of India. The extract of *P. praesorediosum* showed beta-glucosidase inhibitor activity (Lee and Kim 2000). Hexane, dichloromethane, ethyl acetate, acetone and methanol extracts of the thalli of *P. praesorediosum* was tested for their antimicrobial activity against eleven human pathogenic microorganisms. The potential secondary metabolite constituents of ethyl acetate and dichloromethane extracts were active against the microorganisms viz., *Bacillus cereus, Corynebacterium diptheriae, Shigella flexnerii, Staphylococcus aureus, Vibrio cholerae* and *Candida albicans.* The dichloromethane extract exhibited potential antibacterial and antifungal activity (Balaji and Hariharan 2007).

84. ***Parmotrema reticulata*** **(Taylor) M. Choisy** (Parmeliaceae) – The taxon has rotund to subrotund, 4–5 mm wide lobes with lacinae and cilia on margin. The upper surface of the lobes is mineral grey to grey green, white maculate and sorediate marginally. It is one of the most widely distributed species in tropical and temperate regions of India. In Chihuahua, the

Tepehuan use *P. reticulata* for preparing a tea to relieve discomfort from kidney disorder or venereal disease. Prepared late afternoon and set aside for one night before use (Pennington 1969). Its ethanol extract exhibited significant antibacterial activity against virulent strain of *Mycobacterium tuberculosis* H37Rv (Gupta *et al.* 2007).

85. ***Parmotrema saccatilobum*** **(Taylor) Hale** (Parmeliaceae) – A foliose lichen with rotund, 4–7 mm wide, convoluted and saccate lobes. The upper surface is mineral grey to grey, emaculate, rugose or reticulately cracked and isidiate. It is distributed in tropical and temperate regions in Andaman, Assam, Goa, Nagaland, Uttarakhand and West Bengal. The methanol extract of cultured tissue of *P. saccatilobum* exhibited inhibition of Epstein-Barr virus activation induced teleocidin B-4 and superoxide dismutase like activity (Yamamoto *et al.* 1998).

86. ***Parmotrema sancti-angelii*** **(Lynge) Hale** (Parmeliaceae) – The taxon has irregular, membranaceous, 5–15 mm wide, rotund lobes, white to dark grey on upper surface with marginal soralia. It is widely distributed in Andhra Pradesh, Assam, Kerala, Madhya Pradesh, Meghalaya, Nagaland, Rajasthan and Tamil Nadu, both in tropical and temperate areas. In Madhya Pradesh, India, Gond and Oraon tribe use this lichen by mixing the ash with mustard or linseed oil to treat ring-worm like skin disease of the neck (Brij Lal and Upreti 1995).

87. ***Parmotrema stuppeum*** **(Taylor) Hale** (Parmeliaceae) – A foliose lichen, usually grows on bark and rarely on rocks, has crenate to dentate margin, ciliate, grey and marginally sorediate. It is a common lichen occuring in lower temperate regions of Nagaland and Nilgiri and Palni Hills of Tamil Nadu. Phenolic constituents from this lichen including methyl orsenillate, orsenillic acid, atranorin and lecanoric acid showed moderate antioxidant activity (Jayapraksha and Rao 2000).

88. ***Parmotrema tinctorum*** **(Nyl.) Hale** (Parmeliaceae) – A foliose lichen with membranaceous to coriaceous, 8–30 cm wide lobed with whitish to greyish white and densely isidiate upper surface. The species is abundant in tropical and temperate regions of India. Some of the

metabolites isolated from this lichen found to be potent antiproliferaive agents against human keratinocyte line HaCaT and also inhibited the leukotriene B4 biosynthesis by a non-redox mechanism (Kumar and Muller 1999a,b). In another experiment the secondary metabolites isolated from the lichen exhibited immunological modulating potential as the release of hydrogen peroxide and nitric oxide in the culture of peritoneal macrophage cells from mice (Santos *et al.* 2004). The methanolic extract of cultured cell aggregates of natural thallus of *P. tinctorum* exhibited lipid peroxidation and tyrosinase enzyme activity (Verma *et al.* 2008a), whlile lecanoric acid isolated from the same exhibited anti-oxidant activity (Verma *et al.* 2008b).

89. *Peltigera canina* (L.) Willd. (Peltigeraceae, Fig. 7) – A foliose lichen with pale brown, wide lobed thallus, tomentose on upper surface and white veined on lower side. The apothecia are 2–6 mm diameter, revolute to reflexed. It is known from temperate to alpine Himalayas and Nilgiri Hills in South India. *P. canina* is one of the few lichens mentioned in the Pharmacopoeia Universalis of 1846 (Vartia 1973). It is also being used for liver ailments, jaundice, laxative, an imaginary remedy for hydrophobia and its high content of amino acid methionine may be the basis for its alleged curative power (Subrahmanian and Ramakrishna 1964, Lindley 1849, Biswas 1956, Hale 1974). The apothecia of *P. canina* resemble vaguely of dog teeth (doctrine of signature) and hence it is widely used for treating rabies and it is popular as dog lichen (Hale 1983). Early German settlers to North America used the lichen for strengthening a weak liver, or cooling one that was inflamed. When ground into a powder and put in white wine, it was given to little boys suffering hernia. In parts of 19^{th} century Wales, it was powdered and mixed with black pepper for dog bites. The Nitanaht of Vancouver Island used *P. canina* as an infusion for those suffering anuria, or inability to urinate. Boiled in water, and gargled, the lichen soothes the swelling of tonsils and the uvula (Rogers, internet).

The organic extracts of the lichen collected from Iceland exhibited antibacterial activity against *Bacillus subtilis, Pseudomonas aeruginosa* (Ingólfsdóttir *et al.* 1985) and cancer chemopreventive and cytotoxic activity (Ingólfsdóttir *et al.* 2000). Four polysaccharides isolated from water and alkali extracts of the lichen showed mannose and galactose as the predominating structural units. The heteroglycans were tested for *in vitro* immunomodulating

activities and showed mitogenic activity in rat spleen cell proliferation assay and stimulated IL-10 secretion. In rat peritoneal macrophages, the heteroglycans stimulated TNF- α secretion, α but not IL-10 secretion. These results indicate that the polysaccharides influence cells of the immune system both from the innate and the adaptive systems (Omarsdottir *et al.* 2005).

90. ***Peltigera dolichorhiza*** **(Nyl.) Nyl.** (Peltigeraceae) – The taxon has pale brown to brown, scrobiculate lobed thallus, brown veined lower surface, with 3–13 mm long rhizinae. The apothecia are oblong and revolute to reflexed. The species is distributed in temperate Himalayas. Alcoholic extract of this lichen collected from New Zealand showed cytotoxicity against murine leukemia cells (Perry *et al.* 1999).

91. ***Peltigera horizontalis*** **(Huds.) Raumg.** (Peltigeraceae) – A leafy lichen having thick, grey brown to brown, tomentose lobes with horizontal, submarginal apothecia and brown lower surface veins. The species is known from western Himalayas. *P. horizontalis* is mentioned in Pharmacopoeia Universalis of 1846 (Vartia 1973).

92. ***Peltigera leucophlebia*** **(Nyl.) Gyelin.** (Peltigeraceae) – A foliose lichen with yellow brown to brown lobes, bearing rounded to irregular cephalodia on the upper surface and tomentose lower surface. The species is known from temperate western Himalayas. The organic extract of this lichen collected from Iceland exhibited antibacterial activity against *Staphylococcus aureus, Escherichia coli* and *Pseudomonas aerugionosa* (Ingólfsdóttir et al. 1985), cancer chemopreventive and cytotoxic activity (Ingólfsdóttir *et al*. 2000). The tenuiorin and methyl orsellinate isolated from this lichen showed *in vitro* inhibitory activity against 15-lipoxygenase from soybeans, 5-lipoxygenase from porcine leucocytes and proliferation of cultured human breast, pancreatic and colon cancel cell lines (Ingólfsdóttir *et al.* 2002).

93. ***Peltigera membranacea*** **(Ach.) Nyl. emend. Thomson** (Peltigeraceae) – The taxon has wide lobed, thick, pale brown to brown lobes with tomentum on the upper surface and 4–8 mm diameter vertical apothecia. The lower surface has fibrillose, finely penicillate rhizinae. Hesquiat and Nitinaht Indians of Canada use this lichen as medicine (Turner and Efrat 1982,

Turner *et al.* 1983). Alcoholic extract of this lichen collected from New Zealand showed antimicrobial against *Bacillus subtilis, Trichophyton mentagrophytes,* cytotoxicity against murine leukemia cells and slow growing BS-C-1 cells (African green monkey kidney, ATCC CCL 26) (Perry *et al.* 1999).

94. *Peltigera polydactylon* (Neck.) Hoffm. (Peltigeraceae) – A foliose lichen with thick, coriaceous, grey brown to brown lobes and apothecia on extended lobules. The species is commonly distributed throughout temperate Himalayas. *P. polydactyla* is one of the lichen mentioned in Pharmacopoeia Universalis of 1846 (Vartia 1973). In India Lepchas and Nepalese of Skyong Valley, north Sikkim apply the paste of *P. polydactyla* to cuts to stop bleeding and as an antiseptic, that cure wounds and it is locally called as 'Jhau' (Saklani and Upreti 1992).

95. *Peltigera praetextata* (Flörke ex Sommerf.) Zopf (Peltigeraceae) – The taxon has pale brown tomentose, wide lobed thallus with marginally squamuliform isidia. The species is common in temperate western Himalayas. Acetone extract of *P. praetextata* tested positive against human dermatophytic fungi, *Epidermatophyton floccosum, Microsporum audounii, M. canis, M. nanum, M. gypseum, Trichophyton mentagrophytes, T. rubrum, T. tonsurance, T. violaceum* (Shahi *et al.* 2003).

96. *Peltigera rufescens* (Weiss.) Humb. (Peltigeraceae) – A foliose lichen with 2–10 mm wide, thick, dark brown, densely tomentose thallus lobes, reflexed apothecia and anastmosing veined lower surface. A common species in temperate western Himalayas. The water and methanol extract of *P. rufescens* showed highest antioxidant activity (Odabasoglu *et al.* 2005).

97. *Peltigera venosa* (L.) Hoffm. (Peltigeraceae) – A foliose lichen with small (upto 2 cm across) greenish brown thallus, horizantal apothecia and cephalodia on lower side of the lobes. It is known from few sites of north western Himalayas. *P. venosa* is one of the lichen mentioned in Pharmacopoeia Universalis of 1846 (Vartia 1973).

98. ***Pertusaria amara*** **(Ach.) Nyl.** (Pertusariaceae) – A crustose lichen with whitish grey to brownish, smooth to verrucose thallus with sorediate apothecial disc. A common lichen species in Himalayas and Western Ghats. Elsewhere *P. amara* is taken internally in cases of intermittent fever. It is implied that this use was because of its bitter taste, as a replacement for quinine (Smith 1921).

99. ***Phaeographina caesiopruinosa*** **(Fée) Müll. Arg.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

100. ***Phaeographina noralboradians*** **Patw. and Kulk.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

101. ***Phaeographiopsis indica*** **(Patw. and Nag.) Sipman and Aptroot** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004, 2006).

102. ***Phaeographis angulosa*** **Muell. Arg.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

103. ***Phaeographis submaculata*** **Zahlbr.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

104. ***Phaeographis subritigrina*** **(Vainio) Zahlbr.** (Graphidaceae) – Similar to *Graphina acharii* (Behera *et al.* 2003, 2004).

105. ***Physcia aipolia*** **(Ehrh. ex Humb.) Fürnr.** (Physciaceae) – It is a foliose lichen grows on bark, whitish grey to dark grey in colour and densely white maculate. In India it is reported from lower temperate regions of Himachal Pradesh, Jammu and Kashmir, and Nilgiri Hills of Tamil Nadu. Atranorin isolated from this lichen demonstrated an approximate and relatively strong antimicrobial activity against bacteria *Bacillus mycoides, B. subtilis, Staphylococcus aureus, Enterobacter cloacae, Escherichia coli, Klebsiella pneumoniae* and fungi *Aspergillus flavus, A. fumigatus, Botrytis cinerea, Candida albicans, Fusarium oxysporum, Mucor*

mucedo, Paecilomyces variotii, Penicillium purpurescens, P. verrucosum, Trichoderma harzianum (Ranković *et al.* 2008).

106. *Pseudocyphellaria aurata* (Ach.) Vainio (Lobariaceae) – The taxon has large leafy thallus, upto 15 mm wide, reddish brown to brown and tomentose lobes and yellow pseudocyphellae. The species is known from Western Ghats and few sites in Western Himalayas. Malagasy tribes of Ambavaniasy, Madagascar use this lichen as a tea to treat indigestion. (Sharnoff, internet).

107. *Punctelia rudecta* (Ach.) Krog. (Parmeliaceae) – A foliose lichen with rotund, 3–6 mm wide, grey to greenish grey, lobes. The upper surface bears punctiform to elongate pseudocyphellae and isidia. The species is widely distributed both in Himalayas and Western Ghats regions. The extract of this lichen exhibited antibacterial activity agains *A. faecalis* and *E. coli* (Bustinza 1952).

108. *Ramalina celastri* (Sprengel) Krog and Swinsc. (Ramalinaceae) – A fruticose lichen with strap shaped, upto 13 cm long, 10 mm wide, reticulately ridged and rugose thallus. The species is found growing in Nilgiri and Palni Hills of Western Ghats. An α-D-glucan polysaccharide isolated from *R. celastri* has shown cytotoxic effect against HeLa cells (Camerio-Leão *et al.* 1997). α-D-glucan suggested to be a biological role response modifier (BRM), which acted as antitumor agent by its macrophage activity against Sarcoma-180 tumor cells (Stuelp *et al.* 2002). Parietin isolated from *R. celastri* demonstrated antiviral activity against the arena viruses Junin and Tacaribe (Fazio *et al.* 2007).

109. *Ramalina conduplicans* Vainio (Ramalinaceae) – A fruticose lichen with 6 cm long, apically divided, sorediate, strap shaped, flattened thallus. The species is distributed in Himalayas and Western Ghats. Methanolic extract of the lichens showed high inhibitory activity against eleven bacteria (*Bacillus cereus, B. subtilis, Enterobacter aerogens, Escherichia coli, Klebsiella pneumoniae, Micrococcus luteus, Proteus mirabilis, Pseudomonas aeruginosa, Salmonella typhimurium, Staphylococcus aureus, Streptococcus pneumoniae*) and eight fungal strains (*Aspergillus flavus, A. nidulans, A. niger, A.*

sulphuricus, *A. terrcues*, *Candida albicans*, *Cryptococcus albidus*, *Trichophyton rubrum*) (Singh *et al.* unpublished data).

110. ***Ramalina farinacea*** **(L.) Ach.** (Ramalinaceae) – It is fruticose lichen, which grows on tress upto 8 cm long, erect or pendent, yellow to greyish green and sorediate. It occurs in Manipur, Uttarakhand and Palni Hills of Tamil Nadu. The acetone extract of the lichen *R. farinacea* and its (+)-usnic acid constituent showed antimicrobial activity against *Bacillus subtilis*, *Listeria monocytogenes*, *Proteus vulgaris*, *Staphylococcus aureus*, *Streptococcus faecalis* [*Enterococcus faecalis*], *Yersinia enterocolitica*, *Candida albicans* and *C. glabrata* [*Torulopsis glabrata*]. Norstictic acid was active against *Aeromonas hydrophila* as well as the above microorganisms except *Yersinia enterocolitica*. Protocetraric acid showed activity only against the tested yeasts *C. albicans* and *C. glabrata* (Tay *et al.* 2004). In another study water, ethanol, chloroform and *n*-hexane extract of *R. farinacea* exhibited antifungal, antibacterial and cytotoxicity activity against several pathogens (Esimone and Adikwu 1999). The methanol and water extract reduce HIV-I vector (lentiviral and adenoviral) infectivity in dose-dependent manner in a vector-based assay (Esimone *et al.* 2005).

111. ***Ramalina pacifica*** **Asahina** (Ramalinaceae) – The taxon has subfruticose thallus with dichotomously branched, flat, striate, sorediate lobes. It is known from Karnataka and Kerala. The methanol extract of cultured tissue of this lichen exhibited inhibition of tyrosine activity (Yamamoto *et al.* 1998).

112. ***Ramalina pollinaria*** **(Westr.) Ach.** (Ramalinaceae) – It is a fruticose lichen, brownish in colour, flattened branches with dissected apices and sorediate. It grows on bark in tropical and temperate of Andhra Pradesh, Himachal Pradesh, Uttarakhand, Jammu and Kashmir. Methanol extract of the lichen showed its activity against 11 bacteria and three bacteria (Güllüce *et al.* 2006). *R. pollinaria* collected from Turkey and its usnic acid extracted with acetone exhibited antimicrobial activities against *Escherichia coli*, *Enterococcus faecalis*, *Proteus mirabilis*, *Staphylococcus aureus*, *Bacillus subtilis* and *B. megaterium* (Cansaran *et al.* 2007).

113. ***Ramalina sinensis*** **Jatta** (Ramalinaceae) – A fruticose lichen with palmately lobed, 5–10 cm long thallus, perforated or not with apothecia upto 9 mm diameter. It is one of the most common lichen in subtemperate to temperate parts of the Himalayas and Western Ghats. Methanolic extract of the lichens showed high antibacterial and antifungal activity (see *Ramalina conduplicans*; Singh *et al.* unpublished data).

114. ***Ramalina subfarinacea*** **(Nyl.) Nyl.** (Ramalinaceae) – It is fruticose lichen, usually grows on rock, tufted, yellowish green, flattened and marginally sorediate. In India it is repored from Manipur. It contains usnic acid and acetone extract showed significant antibacterial activity against *Bacillus cereus, B. megaterium*, *Staphylococcus aureus* and *Klebsiella pneumoniae* (Saenz *et al.* 2006).

115. ***Roccella montagnei*** **Bel. em. D.D. Awasthi** (Rocellaceae) – The taxon has fruticose thallus with erect or pendulose, branched strap shaped or irregularly flattened, upto 15 cm long tapering, sorediate lobes. It is a common species of lichen in coastal regions of India. (+)-usnic acid isolated from the lichen *R. montagnei,* showed a dose-dependent anti-inflammatory activity when tested on rats, employing acute and chronic models (Vijayakumar *et al.* 2000). The antimicrobial activities of hexane, ethyl acetate, acetone, and methanol extracts of *R. montagnei* were assayed for their antimicrobial activity against six human pathogenic microorganisms (*Staphylococcus aureus, Salmonella typhi, S. para typhi-B, Proteus vulgaris, Klebsiella pneumoniae, Candida albicans*). The methanolic extract was found antimicrobial against most of the tested organisms. The drug prospecting odds of methanol extract of *R. montagnei* were better compared to other solvent extracts, as potential antibacterial and antifungal agents (Balaji *et al.* 2006).

116. ***Solorina crocea*** **(L.) Ach.** (Peltigeraceae) – A foliose lichen with brownish to reddish, upto 15 mm wide lobes and orange to saffron coloured lower surface. The apothecia are immersed and upto 10 mm in diameter. The species is known from temperate and alpine regions of the Himalayas. The methanolic extract of this lichen collected from Iceland exhibited cancer chemopreventive and cytotoxic activity (Ingólfsdóttir *et al*. 2000).

117. *Stereocaulon alpinum* Laurer (Stereocaulaceae) – It is a fruticose lichen growing on soil, pseudopodetia erect to decumbent, pale brownish or blackish, branched, caespitose, thick at base, phyllocladia crowded at apices, flattened and appressed, whitish grey, cephalodia lacking cortex having *Nostoc* inside. It is a temperate species, in India reported from Darjeeling. Methanol–water (90:10 *v*/*v*) extracts of *S. alpinum* from King George Island (Antarctica) were analyzed by Bhattarai *et al.* (2008) and Paudel *et al.* (2008) which showed a higher number (50%) of antioxidant constituents, although their activities were comparatively weak. Lobaric acid isolated from this lichen proved to be pronounced inhibitors of platelet-type 12(S)-lipoxygenase *in vitro* system in human platelets (Bucar *et al*. 2004). Effect of lobaric acid on cultured, human cells, three malignant cell lines from breast carcinomas and erythro-leukemia (K-562) were tested. At concentrations of 20 µg/mL, significant cancer cell death was detected (Ögmundsdottir *et al.* 1998). Lobaric acids and atranorin also showed activity against *Mycobacterium aurum*, a nonpathogenic organism with sensitivity similar to the *Tuberculinum bacterium* (Ingólfsdóttir *et al*. 1998).

118. Stereocaulon foliolosum var. foliolosum Nyl. (Stereocaulaceae) – A dimorphic lichen grows on rock in temperate regions, grows upto 5 cm tall, decorticated, grey to brown, phyllocladia flattened, leafy, evenly distributed upto to apex, cephalodia with *Nostoc*, brown and protosacculate. Ethanol extract of *F. caperata* exhibited significant antibacterial activity against virulent strain of *Mycobacterium tuberculosis* H37Rv (Gupta *et al.* 2007).

119. *Stereocaulon foliolosum* var. *strictum* (C. Bab.) Lamb. (Stereocaulaceae) – A dimorphic lichen with indistinct primary thallus, secondary thallus (pseudopodetia) are with foliose phyllocladia at base and granular, coralloid above. It is a widely distributed lichen in both eastern and western Himalayas. The Lepchas of Sikkim chew the raw thalli after washing to cure kidney stones and it is locally called as Longdorbi (Sinha and Singh 2005).

120. *Stereocaulon himalayense* D.D. Awasthi *et* Lamb. (Stereocaulaceae) – A lichen with dimorphic thallus, the primary thallus may be absent. The secondary thallus (pseudopodetia) are 2–5 cm tall, with granular to subcoralloid phyllocaldia. The species is widely distributed throughout temperate Himalayas. In India Lepchas of Sikkim use this lichen for urinary

trouble and blisters of tongue. The lichen is pounded and boiled in water, the decoction is prescribed twice a day after meals. The lichen is locally called as 'Dhungo-ku-Jhau' (Saklani and Upreti 1992).

121. ***Sticta nylanderiana*** **Zahlbr.** (Lobariaceae) – A foliose lichen with upto 30 mm wide, yellowish grey to dark grey lobes, saucer-shaped cyphellae on the pale brown lower surface. It is common in temperate eastern and western Himalayas. The Lepchas of Sikkim call it as Sangfon and orally take the crushed thalli for excessive cough (Sinha and Singh 2005).

122. ***Sulcaria sulcata*** **(Lev.) Bystrek ex Brodo and D. Hawks.** (Alectoriaceae) – A fruticose lichen with more or less erect, caespitose, ashy-grey to brownish thallus with sulcate pseudocyphellae. The species is known from temperate parts of Himalayas. The methanol extract of cultured tissue of *S. sulcata* exhibited inhibition of Epstein-Barr virus activation induced teleocidin B-4 and superoxide dismutase like activity (Yamamoto *et al.* 1998).

123. ***Thamnolia vermicularis*** **var.** ***subuliformis*** **(Ehrh.) W. Culb.** (Imperfect lichenes) – A fruticose lichen with erect or decumbent, branched, ashy-grey to brownish lobes. The species is common in temperate to alpine parts of the Himlayas. The organic extract of this lichen collected from Iceland exhibited antibacterial activity against *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli* and *Candida albicans* (Ingólfsdóttir et al. 1985). Heteroglycans and a beta-glucan isolated from this lichen were tested for *in vitro* immunomodulating activity and reported to have various influences on the immune system (Omarsdottir *et al.* 2007).

124. ***Thamnolia vermicularis*** **var.** ***vermicularis*** **(Swartz) Schaer** (Imperfect lichenes) – The taxon has fruticose, prostrate to erect, vermiform podetia (secondary thallus) simple to branched tapering and milky white hollow thallus. A common lichen growing on soil in alpine regions of the Himalayas. The Bhotia tribes of Garhwal Himalayas call this lichen as 'Chhai Dhoop' and use its fume for killing buttermilk-borne worms (Upreti and Negi 1995). *T. vermicularis* is used in ethnomedicine in Bolivian Andes and it commercialized and sold in marketes of La Paz and El Alto cities for cough, hoarseness (Macia *et al.* 2005). The

methanol extract of cultured tissue of the lichen exhibited inhibition of tyrosine, Epsteein-Barr virus activation induced teleocidin B-4 and superoxide dismutase like activity (Yamamoto *et al.* 1998). Bustinza (1952) reported the antibacterial activity of this lichen against *A. faecalis*.

125. ***Umbilicaria cylindrica*** **(L.) Delise ex Duby** (Umbilicariaceae) – A foliose lichen, more or less polyphyllous, umblicate, grey to white, smooth to wrinkled on upper surface with gyrodisc apothecia and ciliate margin. The lower surface lacking rhizinae. The taxon is distributed in eastern Himalayas. Alcoholic extract of this lichen collected from New Zealand showed cytotoxicity against slow growing BS-C-1 cells (African green monkey kidney, ATCC CCL 26) (Perry *et al.* 1999).

126. ***Usnea bismolliuscula*** **Zahlbr.** (Parmeliaceae) – A fruticose lichen with irregularly branched, articulate, inflated, 4–15 cm tall, tapering branches. The species is distributed in temperate Himalayas and Western Ghats. The methanol extract of cultured tissue of the lichen exhibited inhibition of tyrosine activity and gram +ve bacteria (*Bacillus subtilis, Propionibacterium acnes* and *Staphylococcus aureus*) and superoxide dismutase like activity (Yamamoto *et al.* 1998).

127. ***Usnea ghattensis*** **G. Awasthi** (Parmeliaceae) – A fruticose lichen with irregularly branched, rigid, upto 6 cm tall, brown to dark brown black branches, with dense lateral branchlets, apically black and pseudocyphellate. It is a common lichen in Western Ghats, India. Various solvent extract of natural and cultured thalli showed good antioxidant, hepatoprotective and antibacterial activity against *Bacillus licheniformis, B. megaterium, B. subtilis, Staphylococcus aureus* (Behera *et al.* 2005a. 2005b, 2006, 2009; Verma *et al.* 2008).

128. ***Usnea longissima*** **Ach.** (Parmeliaceae, Fig. 8) – A fruticose lichen with long filament, pulverulent branches, upto 30 cm long, isidiate or sorediate thallus. It is a common lichen in temperate and alpine Himalayas. The Baiga, a primitive tribe of Madhya Pradesh use this lichen along with other ingredients for treating bone fracture (Brij Lal 1988, 1990). The same lichen was employed by the Chinese, under the name ‘Sun-Lo’, as an expectorant and its

surface powder for the treatment of ulcer (Chopra *et al.* 1958, Vartia 1973). It is also main ingredient of Chinese medicine (Hu *et al.* 1980). In China it is also called as 'Lao-tzu's breard', 'pine gauze', 'female gauze', picked in 5th lunar month, dried in the shade and used for stopping sweating, dizziness, cold, pain and phlegm. It also benefits urinary tract and stops swelling in female genitalia (Sharnoff, internet). The Nitinaht Indians of Vancouver Island use the lichen for wound dressing as it has absorbent quality (Turner *et al.* 1983). *U. longissima*, a medicinal lichen of Anatolia (Turkey), is used in the treatment of gastric ulcer in local folk medicine (Odabasoglu *et al.* 2006).

The methanol extract of cultured tissue of this lichen exhibited inhibition of tyrosine activity, Epstein-Barr virus activation induced teleocidin B-4, gram +ve bacteria (*Bacillus subtilis, Propionibacterium acnes* and *Staphylococcus aureus*) and superoxide dismutase like activity (Yamamoto *et al.* 1995, 1998). *U. longissima* collected from different areas of Anatolia in Turkey and its usnic acid extracted with acetone exhibited antimicrobial activities against *Escherichia coli, Enterococcus faecalis, Proteus mirabilis, Staphylococcus aureus, Bacillus subtilis* and *B. megaterium* (Cansaran *et al.* 2006). It was shown that with increasing amount of usnic acid, the antimicrobial activity increased. Methanolic extracts of naturally occurring *U. longissima* manifested *in vitro* melanogenesis inhibitory. It was concluded that lichen extracts affected the activity of tyrosinase via the inhibition of tyrosinase glycosylation (Kim and Cho 2007). Methanol extract also showed concentration dependent inhibitory effects on ADP-induced platelet aggregation *in vitro* mouse models and produced a significant inhibition of thrombotic death or paralysis (Lee and Kim 2005). Natural product, longissiminone A isolated from this lichen found to possess potent anti-inflammatory activity in a cell-based contemporary assay (Choudhary *et al.* 2005).

Gastroprotective effect of crude extract and isolated compounds from *U. longissima* was investigated by some researchers in indomethacin-induced ulcer models in rats. The water extract exhibited significant antiulcerogenic activity and it is attributed to its antioxidant potential of the extract (Halici *et al.* 2005). Similarly, the diffractaic acid and usnic acid also significantly reduced the gastric lesions in rats and also showed antioxidant activity (Bayir *et al.* 2006, Odabasoglu *et al.* 2004, 2006).

129. ***Usnea montifuji*** **Mot.** (Parmeliaceae) – A fruticose lichen with circular, pendulous, filamentous branched, pale brown to black with dense lateral branchlets. It is known from eastern Himalayas. The methanol extract of cultured tissue of *U. montifuji* exhibited inhibition of tyrosine activity and gram +ve bacteria (*Bacillus subtilis*, *Propionibacterium acnes* and *Staphylococcus aureus*) and superoxide dismutase like activity (Yamamoto *et al.* 1998).

130. ***Usnea sikkimensis*** **Biswas** (Parmeliaceae) – A fruticose lichen reported from Sikkim but may be erroneous identification. In northeast India *U. sikkimensis* is consumed as remedy for lung troubles, haemorrhage and asthma, while powdered lichen used to strengthen hair (Biswas 1956).

131. ***Usnea subflorida*** **(Zahlbr.) Mot.** (Parmeliaceae) – It is a fruticose lichen, growing erect on bark, black near base, reddish brown upwards, sympodial branching with papillate and tuberculate pseudocyphellae. In India it is reported from Nilgiri Hills of Tamil Nadu. *U. subflorida* collected from different areas of Anatolia in Turkey and its usnic acid extracted with acetone exhibited antimicrobial activities against *Escherichia coli*, *Enterococcus faecalis*, *Proteus mirabilis*, *Staphylococcus aureus*, *Bacillus subtilis* and *B. megaterium* (Cansaran *et al.* 2006).

132. ***Xanthoparmelia conspersa*** **(Ach.) Hale** (Parmeliaceae) – A foliose lichen with subirregular, black rimmed, 2–5 mm wide, yellowish green, isidiate lobes. The lower surface is plane black with brown margins. It is known from temperate areas of the Himalayas. In Africa the Xhosa tribe take *X. conspera* internally and applied locally as a snake bite remedy while Mpondo tribes drink the decoction and powder applied locally for treatment of venereal disease, especially syphilis (Watt 1962). The extract of this lichen has exhibited antibacterial activity against *A. faecalis* (Bustinza 1952).

133. ***Xanthoparmelia coreana*** **(Gyeln.) Kurok.** (Parmeliaceae) – A foliose lichen with sublinear, flat, imbricate, 2–5 mm wide, yellowish green, shiny and moderately isidiate lobes. The species is known from temperate areas of Uttarakhand Hiamalayas.The methanol extract

of cultured tissue of *X. coreana* exhibited inhibition of tyrosine activity and gram +ve bacteria (*Bacillus subtilis, Propionibacterium acnes* and *Staphylococcus aureus*) and superoxide dismutase like activity (Yamamoto *et al.* 1998).

134. *Xanthoparmelia pulla* (Ach.) O. Blanco, A. Crespo, Elix & D. Hawksw. (Parmeliaceae) – It is foliose lichen, brown in colour found growing on rock in N.W. Himalayas. Methanol extract of this lichen did not have any anti-oxidant activity but has significant antimicrobial activity (Aslan *et al.* 2006). In another study by the same researcher efficacy of anti-genotoxicity of the lichen extract was tested against colloidal bismuth subcitrate genotoxicity and the findings showed the protective roles of the lichen (Geyikoglu *et al.* 2007).

135. *Xanthoria elegans* (Links) Th. Fr. (Teloschistaceae) – The taxon has foliose, 1 mm wide, convex, radiating, orange red to deep red brown lobes with laminal lecanorine apothecia. The species is widely distributed in alpine and temperate areas of Western Himalayas. The methanolic extract of this lichen collected from Iceland exhibited cancer chemopreventive and cytotoxic activity (Ingólfsdóttir *et al*. 2000).

136. *Xanthoria fallax* (Hepp) Arnold (Teloschistaceae) – A foliose lichen with 2 mm wide, flattened, sorediate, yellow-orange, marginally white ciliate lobes. It is known to occur in Kashmir area in India. The methanol extract of cultured tissue of this lichen-exhibited inhibition of Epstein-Barr virus activation induced teleocidin B-4 and superoxide dismutase like activity (Yamamoto *et al.* 1998).

137. *Xanthoria parietina* (L.) Th. Fr. (Teloschistaceae) – The taxon has foliose, 3 mm wide, plane or wrinkled, flabellate, orange-yellow to darker yellow lobes. It is known from Western Himalayas, Uttarakhand, Himachal Pradesh, Jammu and Kashmir. *X. parietina* is one of the lichen mentioned in Pharmacopoeia Universalis of 1846 (Vartia 1973). As the lichen appears yellow it is used in Finish folklore and other European countries for the treatment of Jaundice (Doctrine of signature) (Llano 1951), also considered substitute for quinone (Schneider 1904), used in intermittent fevers (Lindley 1849). It is also used in a preparation for washing hair (Nadkarni 1976).

The extract of the lichen has exhibited antibacterial activity against *A. faecalis* (Bustinza 1952). The methanol extract of cultured tissue of this lichen exhibited inhibition of Epstein-Barr virus activation induced teleocidin B-4 and superoxide dismutase like activity (Yamamoto *et al.* 1998). Also, the methanolic extract of this lichen collected from Iceland exhibited cancer chemopreventive and cytotoxic activity (Ingólfsdóttir *et al*. 2000).

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Note: * not seen in original

Table 1: List of medicinal lichens of India and their important uses

	Lichen taxa	Traditional medicine	Antimicrobial acticity	Anticancer/ cytotoxicity	Antioxidant/ tyrosinase ihibition	Antiinflamatory	Immunomodulating
1	*Acarospora gobiensis*	-	+	-	-	-	-
2	*Acroscyphus sphaerophoroides*	-	+	-	-	-	-
3	*Alectoria ochroleuca*	-	-	+	-	-	-
4	*Arthoraphis alpina*	-	-	+	-	-	-
5	*Arthothelium awasthii*	-	-	-	+	-	-
6	*Bulbothrix setschwanensis*	-	-	-	+	-	-
7	*Cetraria aculeata*	-	+	+	-	-	-
8	*C. islandica*	+	+	+	+	+	+
9	*Cetrelia braunsiana*	-	+	-	-	-	-
10	*Cladia aggregata*	-	+	+	+	-	-
11	*Cladonia chlorophaea*	+	-	-	-	-	-
12	*C. coccifera*	+	-	-	-	-	-
13	*C. crispata*	-	-	+	-	-	-
14	*C. deformis*	+	-	-	-	-	-
15	*C. fimbriata*	-	+	+	-	-	-
16	*C. furcata*	-	+	+	-	-	-
17	*C. humilis*	-	-	-	+	-	-
18	*C. pyxidata*	+	-	-	-	-	-
19	*C. rangiferina*	+	+	+	+	-	-
20	*Coccocarpia palmicola*	-	-	+	-	-	-
21	*Collema flaccidum*	-	-	+	-	-	-
22	*Dermatocarpon miniatum*	-	+	-	+	-	-
23	*Diploschistes scruposus*	-	+	-	-	-	-
24	*Evernia divaricatica*	-	+	-	-	-	-
25	*E. prunastri*	+	+	-	+	-	-
26	*Everniastrum cirrhatum*	+	+	-	-	-	-
27	*E. nepalense*	+	-	+	-	-	-
28	*Flavoparmelia caperata*	+	+	-	-	-	-
29	*Graphina acharii*	-	-	-	+	-	-
30	*G. adscribens*	-	-	-	+	-	-
31	*G. glaucorufa*	-	-	-	+	-	-
32	*G. multistriata*	-	-	-	+	-	-
33	*G. norlabiata*	-	-	-	+	-	-
34	*G. nylanderi*	-	-	-	+	-	-
35	*G. perstriatula*	-	-	-	+	-	-
36	*G. salacinilabiata*	-	-	-	+	-	-
37	*G. simulans*	-	-	-	+	-	-
38	*Graphis assamensis*	-	-	-	+	-	-

39	*G. exalbata*	-	-	-	+	-	-
40	*G. garoana*	-	-	-	+	-	-
41	*G. glauconigra*	-	-	-	+	-	-
42	*G. guimarana*	-	-	-	+	-	-
43	*G. hossei*	-	-	-	+	-	-
44	*G. inamoena*	-	-	-	+	-	-
45	*G. inquinata*	-	-	-	+	-	-
46	*G. nakanishiana*	-	-	-	+	-	-
47	*G. patwardhanii*	-	-	-	+	-	-
48	*G. persicina*	-	-	-	+	-	-
49	*G. persulcata*	-	-	-	+	-	-
50	*G. pyrrhocheiloides*	-	-	-	+	-	-
51	*G. scripta*	-	+	+	+	-	-
52	*G. sikkimensis*	-	-	-	+	-	-
53	*G. sorediosa*	-	-	-	+	-	-
54	*Heterodermia diademata*	+	-	-	-	-	-
55	*H. microphylla*	-	-	-	-	-	+
56	*H. podocarpa*	-	-	-	+	-	-
57	*H. leucomelos*	-	+	-	-	-	-
58	*Hypogymnia enteromorpha*	-	-	-	+	-	-
59	*H. physodes*	+	+	-	+	-	-
60	*H. tubulosa*	-	+	-	-	-	-
61	*Lasallia pustulata*	-	+	-	-	-	-
62	*Lecanora muralis*	-	+	-	-	-	-
63	*Leptogium cyanescens*	-	-	+	-	-	-
64	*Lethariella cashmeriana*	-	+	-	-	-	-
65	*Lobaria discolor*	-	+	-	-	-	-
66	*L. isidiosa*	+	-	+	-	-	-
67	*L. japonica*	-	-	+	-	-	-
68	*L. pseudopulmonaria*	-	-	+	-	-	-
69	*L. quercizans*	+	-	-	-	-	-
70	*L. retigera*	+	-	-	-	-	-
71	*Mykoblastus sanguinarius*	-	-	-	+	-	-
72	*Myelochroa entotheiochroa*	-	-	-	+	-	-
73	*M. irrugans*	-	-	-	+	-	-
74	*Nephroma expallidum*	-	-	+	-	-	-
75	*Parmelaria thomsonii*	-	+	-	-	-	-
76	*Parmelia saxatilis*	+	+	+	-	-	-
77	*P. squarrosa*	-	+	-	-	-	-
78	*P. sulcata*	+	+	-	-	-	-
79	*Parmotrema abessinicum*	+	-	-	-	-	-
80	*P. austrosinense*	-	-	+	-	-	-
81	*P. chinense*	+	+	-	-	-	-
82	*P. dilatatum*	-	-	-	-	-	+
83	*P. praesorediosum*	-	+	+	-	-	-
84	*P. reticulata*	+	+	-	-	-	-

85	*P. saccatilobum*	-	-	+	-	-	-
86	*P. sancti-angelii*	+	-	-	-	-	-
87	*P. stuppeum*	-	-	-	+	-	-
88	*P. tinctorum*	-	-	+	+	-	+
89	*Peltigera canina*	+	+	-	-	-	+
90	*P. dolichorhiza*	-	-	+	-	-	-
91	*P. horizontalis*	+	-	-	-	-	-
92	*P. leucophlebia*	-	+	+	-	-	-
93	*P. membranacea*	+	+	+	-	-	-
94	*P. polydactylon*	+	-	-	-	-	-
95	*P. praetextata*	-	+	-	-	-	-
96	*P. rufescens*	-	-	-	+	-	-
97	*P. venosa*	+	-	-	-	-	-
98	*Pertusaria amara*	+	-	-	-	-	-
99	*Phaeographina caesiopruinosa*	-	-	-	+	-	-
100	*P. noralboradians*	-	-	-	+	-	-
101	*Phaeographiopsis indica*	-	-	-	+	-	-
102	*Phaeographis angulosa*	-	-	-	+	-	-
103	*P. submaculata*	-	-	-	+	-	-
104	*P. subritigrina*	-	-	-	+	-	-
105	*Physcia aipolia*	-	+	-	-	-	-
106	*Pseudocyphellaria aurata*	+	-	-	-	-	-
107	*Punctelia rudecta*	-	+	-	-	-	-
108	*Ramalina celastri*	-	+	+	-	-	-
109	*R. conduplicans*	-	+	-	-	-	-
110	*R. farinacea*	-	+	-	-	-	-
111	*R. pacifica*	-	-	-	+	-	-
112	*R. pollinaria*	-	+	-	-	-	-
113	*R. sinensis*	-	+	-	-	-	-
114	*R. subfarinacea*	-	+	-	-	-	-
115	*Roccella montagnei*	-	+	-	-	+	-
116	*Solorina crocea*	-	-	+	-	-	-
117	*Stereocaulon alpinum*	-	+	+	+	-	+
118	*S. foliolosum* var. *foliolosum*	-	+	-	-	-	-
119	*S. foliolosum* var. *strictum*	+	-	-	-	-	-
120	*S. himalayense*	+	-	-	-	-	-
121	*Sticta nylanderiana*	+	-	-	-	-	-
122	*Sulcaria sulcata*	-	-	+	+	-	-
123	*Thamnolia vermicularis* var. *subuliformis*	-	+	-	-	-	+
124	*T. vermicularis* var. *vermicularis*	+	+	+	+	-	-
125	*Umbilicaria cylindrica*	-	-	+	-	-	-
126	*Usnea bismolliuscula*	-	+	-	+	-	-
127	*U. ghattensis*	-	+	-	+	-	-
128	*U. longissima*	+	+	+	+	+	-
129	*U. montifuji*	-	+	-	+	-	-

130	*U. sikkimensis*	+	-	-	-	-	-
131	*U. subflorida*	-	+	-	-	-	-
132	*Xanthoparmelia conspersa*	+	+	-	-	-	-
133	*X. coreana*	-	+	-	-	-	-
134	*X. pulla*	-	+	+	-	-	-
135	*Xanthoria elegans*	-	-	+	-	-	-
136	*X. fallax*	-	-	+	+	-	-
137	*X. parietina*	+	+	+	-	-	-

Figure 1 – 8. Some widely used medicinal lichens of India. 1. *Cetraria islandica,* 2. *Cladonia rangiferina,* 3. *Hypogymnia physodes,* 4. *Evernia prunastri,* 5. *Everniastrum cirrhatum,* 6. *Parmotrema chinense,* 7. *Peltigera canina,* and 8. *Usnea longissima*