LICHENS OF UTTAR PRADESH

SANJEEVA NAYAKA
D. K. UPRETI

Uttar Pradesh State Biodiversity Board

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Foreword

Lichens represent a symbiotic relationship between a fungus and a phosynthetic partner. These organisms are the most ubiquitous on the planet, being one of the few forms of life able to tolerate both the ice wastes of the Antarctic and arid deserts.

The Lichenology lab of the National Botanical Research Institute is a distinguished lab. Dr. Sanjeev Nayaka and Dr. D. K. Upreti have written this book based on critical observation of more than 2250 lichen specimens available at the herbarium of NBRI and also based on field studies in 35 districts of Uttar Pradesh. This book has original taxonomic description and colour pictures of 135 well identified lichen taxa belonging to 46 genera and 25 families.

The study is unique and has been extremely useful as 11 new records for India have been added for the State of Uttar Pradesh too. This study is of immense use as 61 new species have been added to the earlier list of species.

I sincerely hope that this book will put the subject on a firm fooling in the state of Uttar Pradesh and lead to the appreciation of the important role that lichens could play as biological indicators of atmospheric pollution. I am confident that, this book will meet a real need and will be of considerable use to researchers, students, policy makers, educators, especially those interested in lichenology.

I also sincerely hope that the wonderful 135 coloured photographs that enrich this book will help to convey the beauty of these wonderful organisms and stimulate greater interest in these extraordinary "Fungi".

I wish the authors all success!

(Pawan Kumar)

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निदेशक

Dr. C. S. Nautiyal
Director

Date : 20th May, 2013

Foreword

The diversity of higher group of plants in the state of Uttar Pradesh is well worked out. However, the lower group of plants in general and lichens in particular are poorly known from the state. Before the creation of new state of Uttarakhand in the year 1994, the state of Uttar Pradesh was represented by rich diversity of lichens as most of the temperate and alpine regions known for luxuriant growth of lichens are under its boundaries. As a consequence of division most of the lichen rich sites are now located in Uttarakhand and no authentic record of lichen diversity from Uttar Pradesh is presently available so far.

The work embodied in this book entitled "Lichens of Uttar Pradesh" is the outcome of extensive collection, critical observation of large number of specimens available in the herbarium of this institute. The book covers detailed taxonomic description and coloured photographs of 135 well identified lichen taxa, with 11 new records for India and 61 new additions to the state of Uttar Pradesh.

Being the first attempt of inventorization of lichens of the state of Uttar Pradesh it is hoped that this book will be immense help to common people, scientists, teachers, students and others interested in the study of lichens. The identification keys both for different genera and species together with excellent photographs of each species will enable the user of the book to identify the taxa more easily.

I congratulate the authors for their endeavour and bringing out this comprehensive and qualitatively important contribution to Indian Lichenology.

(C. S. Nautiyal)

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Preface

Among the different group of plants the cryptogams in general and lichens in particular are poorly known in the country. Except few rich lichen sites in the temperate and alpine regions, most of the localities situated in tropical regions of the country are poorly known for their lichen wealth. The regional and local floristic accounts of lichens for most parts of the country are either poorly known or lacking. As per latest information from the Gangetic Plains only a total of 247 species are know while the state Uttar Pradesh records only 43 species. On the contrary the state Uttar Pradesh records about 21,720 km^2 of forest area and includes one National Park and 24 Wildlife Sanctuaries. Further, the state being capital of rich cultural heritage includes several historical buildings and monuments that would possibly harbour rich diversity of lichens. The ecological interesting habitats but poor record of lichens in Uttar Pradesh persuaded us to initiate a detailed study on the lichens in the state. To begin with the specimens that were already available at herbarium LWG were studied and then fresh samples were collected from eastern parts of the Uttar Pradesh in a span of two years. The study resulted in several interesting specimens; however we present here only 135 well identified taxa. The study added 61 new records to Uttar Pradesh and 11 new records for India.

The present book being the first attempt of inventorization of lichens of the state of Uttar Pradesh not only generate an awareness about lichens among common people but also will be of immense help to scientist, teachers, students, conservators and environmentalist in their studies. We hope that the book will also play a great role not only in preparation of databases of plants of the state but also know the status of plant diversity in the region.

S. Nayaka
D. K. Upreti

Acknowledgments

We thank The Secretary, Uttar Pradesh State Biodiversity Board (UPSBB), Lucknow, for the financial assistance provided under the project entitled 'Enumeration of lichens from Uttar Pradesh'. We are grateful to Director, CSIR-National Botanical Research Institute, Lucknow for his encouragement and for providing necessary infrastructural facilities at the institute. We duly thank Dr. P. B. Khare, Coordinator, Plant Diversity, Systematics and Herbarium Division, CSIR-NBRI for his support. We would especially thank Mrs. Pratibha Singh, IFS, Dy. Conservator of Forests, UPSBB for her unconditional support and encouragement for the publication of the book. Dr. Ramjee Srivastava, Senior Scientist, UPSBB is thanked for his persistent encouragement throughout the study.

Dr. P. K. Divakar, Associate Professor at Madrid, Spain was of great help in providing literature and technical advice at regular intervals. All the Research Scholars of the Lichenology Laboratory, CSIR-NBRI are appreciated for their cooperation during the study. Among them it is worth mentioning few names who were of great help while the book was under publicatn; Dr. Rajesh Bajpai, Mr. Himanshu Rai, Ms. Roshni Khare, Mr. Komal Kumar Ingle, and Mr. Logesh Acharya. Finally, we thank Mr. Piyush Dwivedi, Shivam Arts, Lucknow for beautifully designing the book.

Contents

Introduction

Lichens are the unique group of organisms made of symbiotic association between a photosynthetic partner (alga or cyanobacteria) and a heterotrophic fungus. The fungal partner is called as mycobiont which in most of the cases belong to phylum Ascomycota and rarely to Bacidiomycota. The photosynthetic partner is called as photobiont. When the fungal and photosynthetic partners form an association they loose their original identity and start behaving as a single organism, i.e. lichens. The association is also termed as 'lichenization' and fungus is then referred as 'lichenized fungus'. Hence, lichens are called as dual organism and their body is known as 'composite thallus'. In most of the cases one mycobiont and a photobiont would make a successful association while few lichens would have more than one photobionts usually belonging to both green algal and cyanobacterial group, such association is called as tripartite lichens. Hence, at a given time lichen can have members from two to three Kingdoms altogether, Fungi, Protists and Monera (sensu Cavalier-Smith 2004). The lichen thallus is dominated by fungal component (about 90%) and it provides shape, structure and even colour to the organism. The lichens are classified under fungal Kingdom of which about $1/5^{th}$ of species are lichenized. Lichens are the most widely distributed group of organism in the world and about 20,000 species are known so far.

Since ancient times, lichens have been a household item in India, used as spice and as traditional medicine. Lichens are an important ingredient in the powdered spice, Garam Masala, Sambhar Masala and Meat Masala. The raw lichen spices sold in Indian markets are actually the mixture of several species and a total of 35 were identified from them (Upreti *et al.* 2005). Reports on more than 70 lichen species used in ethnic medicine throughout the world are available, of which at least 25 are recorded from India. Lichens in the name 'Chharilla', 'Shailya' or 'Ushna' are used in Ayurvedic and Unani system of medicine. The Gaddi tribes in Kangra valley use some lichen species as 'hawan samagri' (sacrificial fire). Apart from these ethnic inhabitants in remote places use lichen for ailments such as headache, skin diseases, urinary trouble, boils, vomiting, diarrhoea, dysentery, heart trouble, cough, fever, leprosy and as a blood purifier. The Bhotia tribes in Nanda Devi Biosphere Reserve, Uttarkhand, burn lichen *Thamnolia vermicularis* and use the smoke as vermicide to kill the germs in the milk storage containers. At Kannauj a town in Uttar Pradesh traditional perfume named 'Otto' (Hena Attar) is prepared using

lichens since 800 years. Large quantities of lichens are being collected from Himalayas for their commercial use. Lichens are also known for their colouring properties as they produce yellow, pink, violet, brown and orange dyes when boiled with cotton, wool and silk cloth. Further, the lichen species produce brilliant colour when treated with ammonia. Before the advent of synthetic dyes lichens were used as a major textile dye in hilly and forest areas and are also the source for famous litmus dyes.

The lichens produce >1000 secondary metabolites, of which only 50–60 are known in other group of organism and rest all unique to themselves (Elix & Stocker-Wörgötter 2008). Most of the secondary metabolite extracts showed a wide variety of biological actions including antimicrobial (against fungus, bacteria, virus, protozoa), anti-inflammatory, analgesic, antipyretic, anticancer and antioxidant activities. Nayaka *et al.* (2010) enumerated a total of 137 medicinally important lichens from India.

Lichens are sensitive to microclimatic conditions and are considered as indicators of air pollution, anthropogenic disturbance, forest health and continuity, and they constitute an important component of biodiversity. Lichens are very slow growing organisms and attain just few millimeter or centimeter of growth in a year. However, they grow on variety of substrates in all the phytogeographical regions of the world. Adequate moisture, light and altitude, unpolluted air and undisturbed substratum often favours luxuriant growth of lichens.

Lichens are popular organisms known by different common names in different regions of the world such as Oak Moss, Iceland Moss, Reindeer Moss, Rock Moss and Stone Flower in English. In Indian languages lichens are known by different local names such as; Sanskrit - Shilapushp, Shailya, Siphal; Hindi - Shaik, Pattar ka Phool; Uttarakhand - Chharilla, Chadilo, Jhoola Ghaas; Marathi and Konkani - Dhagad Phool; Kannada - Kalluhuvu, Shilavalka; Tamil and Malayalam - Kal Paasi, Kal Jadai, Kal Tamara; Bengali -Shailja; Himachali - Mehendi; Kashmir - Pum Rose; Panjabi - Chal Chabila; Assam and Sikkim - Jhau.

Geography of Uttar Pradesh

The state of Uttar Pradesh is situated between the coordinates 23° 52' - 30° 24' N latitude and 77° 05' - 84° 34' E longitude. It is the fifth largest state of India comprising an area of 2,40,928 km^2 which is 7.3% of the total area of the country. The state shares its boundaries with Uttarakhand and Nepal in the north, Bihar in east, Jharkhand and Chhattisgarh in south-east and Madhya Pradesh in south, and Rajasthan, Haryana and Delhi in west. The state is divided in to 71 districts (see map in page 15) and it is the highly populous state of India with 19,95,81,477 people.

The state of Uttar Pradesh represented three distinct hysographical regions. The transitional belt running along the entire length of the state of Uttarkhand and country of Nepal is called the 'terai' and 'bhabhar' area. These areas have thick forest interspersed with tall elephant grass, marshes and swamps. The Gangetic Plains which stretches across the entire length of the state from east to west is the most fertile land and utilized from the ancient time for agricultural cultivation. The southern fringe of the Gangetic Plains is demarcated by the Vindhya Hills and Plateau. The area exhibit a unique topography with strong ground and low hills.

The annual rainfall of Uttar Pradesh ranges from 1,000 - 1,200 mm and the temperature varies between 5° C during winter to 45° C in summer. The state has three seasons, i.e. winter - during November to February; summer - during March to June, and monsoon - during July to September. The state is well drained by a number of rivers originating from the Himalayas in north or Vindhya Hills in south. The river Ganges and its main tributaries - Yamuna, Ram Ganga, Gomti, Ghagra and Gandak are fed by the perpetual snows of the Himalayas. The Chambal, Betwa and Ken rivers have their origin form Vindhya Hills and drain the south-western part of the state before joining Yamuna. The Son River also originates from Vindhya Hills and drain the south-eastern part of the state.

The state has a total forest cover of 21,720 km^2, which is about 9% of the state's geographical area. The state has 70.3% of Reserve Forest, followed by 21% of Un-Classified forest, and 8.6% of Protected Forests. It can be noted that Uttar Pradesh has one National Park (Dudhwa) and 24 Wildlife Sanctuaries. The districts Sonbhadra (36.79%), Pilibhit (19.55%), Lakhimpur Kheri (19.05%) and Chandauli (18.63%) are the few districts with maximum forest cover in the state.

The forest of the state is of typical northern dry deciduous type and can be broadly divided in to dry deciduous forest, mixed forest, saal forest, scrub forest, grass land and aquatic vegetation. Based on the Champion and Seth classification the state has 27 forest types which belongs to the following forest type groups;

1. Tropical semi-evergreen - 0.21%
2. Tropical moist deciduous - 19.68%
3. Littoral swamp - 2.35%
4. Tropical dry deciduous - 59.66%
5. Tropical swamp forest - 4.61%

Trees out side the forest areas (TOF) account for 22.49% of the green cover. Within the forested area of Uttar Pradesh the flowering plants are fairly well studied and so far 1,442 species are reported. The common forest tree vegetation belongs to *Acacia nilotica, A. catechu, Adina cordifolia, Aegle marmelos, Albizia lebbeck, Bauhinia variegata, Bombax ceiba, Butea monosperma, Cassia fistula, Dalbergia sissoo, Diospyros melanoxylon, Ficus benghalensis, Ficus religiosa, Holarrhena antidysenterica, Mallotus philippensis, Mangifera indica, Phyllanthus emblica, Pterocarpus marsupium, Shorea robusta,* and *Tectona grandis*. About 10 taxa of angiosperm are endemic to the state while more than 150 invasive alien species are reported which belongs to 109 genera and 44 families. The state is represented by the occurrence of 300 species of algae, 985 fungi, 135 species of lichens, 77 bryophytes, 44 pteridophytes and 1442 species of angiosperms.

Status of lichen diversity in India

Lichens of India are being studied since 1753 A.D. with Carl Linnaeus mentioning *Lichen fuciformis* (L.) DC (= *Roccella montagneii* Bél.) from India in his monumental work 'Species Plantarum'. Later on E. Acharius (1810, 1814), and Fries (1825) added four and five species respectively to Indian lichen mycota. However, the first ever record of lichen collection from India is known to be by Bélanger (1834-38) from Pondichery and Coromandal Coast. After Bélanger for nearly 100 years and until 1930s several European naturalist explored Indian subcontinent and collected a large number of lichens. Awasthi (1965, 2000) and Singh (1964) catalogued and provided a detailed historical review of Lichenological studies in Indian subcontinent. Quraishi (1928) and Chopra (1934) are probably the pioneer Indian nationals who studied lichens of the country. However, it was Dr. D.D. Awasthi who systematically initiated lichenological studies in India and established a School of Lichenology in Botany Department of Lucknow University, Lucknow. By the year 1965 total number of lichens known from whole Indian subcontinent was 1310 species (Awasthi 1965) and this number increased to 1995 species by the year 1977 (Singh 1980). Both the micro and macrolichens of Indian subcontinent (1850 spp. under 23 genera and 80 families) were keyed out by Awasthi (1988, 1991). Singh and Sinha (1997) estimated 2021 species of lichens within 248 genera for India. Recently, Singh and Sinha (2010) enumerated a total of 2305 lichen species under 305 genera and 74 families from India. Exhaustive exploration and increased taxonomic studies resulted in constant rise in the number of lichen species and at present India is represented by 2368 species under 305 genera and 67 families of which 557 (23%) are endemic. It can be noted that since the year 1991 about 500 species are added to Indian lichen mycota at the rate of 25 species per year.

Among the different lichen families Graphidaceae emerges as the most dominant family in India with 431 taxa followed by Parmeliaceae (347 spp.) and Physciaceae (213 spp.). Among the different genera *Graphis* has the maximum number of species (115) followed by *Pyrenula* (91), *Lecanora* (89) and *Caloplaca* (71). More than 60% of Indian lichen mycota is dominated by crustose lichens with 1518 taxa, followed by foliose (705) and fruticose (205) lichens. Tropical regions of the country exhibit more crustose lichens while temperate region have dominance of foliose and fruticose lichens. Among the substratum most of the lichens (1768) prefer to grow on bark. The rocks and soil are other important substratum represented by 605 and 222 taxa respectively. As many as 26 lichens, especially belonging to genus *Calicium* and *Cladonia* grow on dead wood. A total of 54 lichens also grow on moss while four species grow on other

lichens. The foliicolous lichens are also well represented in India with 140 species of which at least 130 are grow exclusively (obligate) on leaves. The foliicolous lichens grow in shady understory of the forest and in light gaps, and are the indicator of forest health microclimate, anthropogenic disturbance (Lücking 1999, Lücking and Matzer 2001).

Singh and Sinha (1997) divided India in to eight Lichenogeographic Regions based on the 10 dominant families and genera in the region. Among the eight Lichenogeographic Regions, Eastern Himalaya and North-east India, and Western Ghats represented maximum diversity of lichens with 1144 and 1138 species respectively. The Western Ghats also harbours maximum number of 266 endemic taxa. Western Himalayas ranks third in the diversity of lichens with 781 species. Andaman and Nicobar Islands though represent lesser number of species (364) the percentage of endemic taxa is very high (27%). The region Gangetic Plains to which the state Uttar Pradesh belongs represents a total of 247 species under 78 genus and 34 families. Among different states of India Tamil Nadu records the maximum numbers of lichens with 785 taxa followed by Uttarakhand (581), West Bengal (531) and Sikkim (503). However, there are several states and ecologically interesting sites within India that are under explored for lichenological investigation and Uttar Pradesh is one such state.

Lichen study in Uttar Pradesh

Before the creation of new state Uttarakhand from Uttar Pradesh in the year 1994, the state Uttar Pradesh was represented by 471 species of lichens belonging to 88 genera and 46 families. As a consequence of division most of the lichen rich sites are now located in Uttarakhand. From Uttar Pradesh no authentic chronological lichen exploration records are available. A specimen of *Heppia* collected by Dudgeon from Allahabad during the year 1926 is the oldest record available so far for the the state. Upreti & Büdel (1990) identified this specimen as *Heppia lutosa* (Ach.) Nyl., and the species has not been recollected anywhere from state or entire India.

After the year 1926 though the collections of lichens from few localities in the state were available but the specimens remained undescribed or included under the monographic studies such as; *Pyxine* (Awasthi 1980), *Collema* (Akhtar & Awasthi 1980), *Brigantiaea* (Awasthi & Srivastava 1989), *Caloplaca* (Joshi & Upreti 2007, 2008), *Arthopyrenia* (Upreti & Pant 1993), *Endocapron* (Singh & Upreti 1984), *Phylliscum* (Upreti 1988), *Lecanora* (Uprtei 1997), *Heppia* (Upreti & Büdel 1990). Upreti *et al.* (2002) reported *Arthopyrenia ceuthocarpoides* Müll. Arg. and *Phylliscum macrosporum* A. Henssen from Lucknow and as new record for India. Later on it is observed that the identification of both the species are erroneous. It can be noted that *P. macrosporum* was repeatedly cited by several authors till recently (Singh & Upreti 1991; Chatterjee *et al.* 1996; Saxena 2004; Saxena *et al.* 2004; Ayub 2005).

During the last two decade lichen biodeterioration studies attracted several workers and lichens growing over monuments of Uttar Pradesh were collected (Ayub 2005; Chatterjee *et al.*, 1996; Saxena *et al.* 2004; Singh & Upreti 1991). Apart from biodeterioration studies for carrying out air pollution monitoring several specimens of lichens were also collected from different parts of Uttar Pradesh including Faizabad (Dubey *et al.* 1999), Kanpur (Satya & Upreti 2009; Satya *et al.* 2011), Lucknow (Bajpai *et al.* 2004; Mishra *et al.* 2003; Saxena 2004; Saxena *et al.* 2007; Upreti & Bajpai 2001), and Rae Bareli (Bajpai *et al.* 2010a, b).

Srivastava (2004) attempted compile some of the above studies and mentioned the occurrence of 42 lichen species belonging to 17 genera and 15 species in Uttar Pradesh. Singh & Sinha (2010) in the annotated checklist of Indian lichens enumerated 43 species from Uttar Pradesh. However, the correct distributions of some of the species such as *Bulbothrix isidiza* (Nyl.) Hale, *Dirinaria picta* (Sw.) Clem. & Shaer, *Pyrenula immissa* (Stirt.) Zahlbr., *P. introducta* (Stirt.) Zahlbr., and *P. pinguis* Fée., was not mentioned in the checklist.

A number of lichen taxa such as Parmelioid lichens (Divakar & Upreti 2005), *Lecanora* (Nayaka 2004), Pyrenocarpous lichens (Gauniyal 2005), Teloschistaceae (Joshi 2008) monographed at CSIR-National Botanical Research Institute, Lucknow mentioned the occurrence of many taxa in the state of Uttar Pradesh. Joshi (2008) described in his thesis a total 83 Teloschistacaen taxa from India and included seven species form Uttar Pradesh. Recently, while studying the specimens collected from monuments of Faizabad, Upreti & Nayaka (2006) described a new species of *Anisomeridium calcicolum* Upreti & Nayaka. Further, Nayaka *et al.* (2011) listed a total of 42 species from 11 localities within Katarniaghat Wildlife Sanctuary.

Most of the lichenological studies in Uttar Pradesh were carried out in Lucknow districts due to its easy accessibility by researchers at CSIR-National Botanical Research Institute situated in Lucknow. The district has less of forest area (129 km^2, 5.1%), but has a number of mango orchards all around which provide suitable habitat for some epiphytic lichens. The district also has rich cultural heritage and hence includes several old historical buildings and monuments. The lime plaster of the monuments and some old buildings provides suitable habitats for luxuriant growth of calcicolous lichens. Lucknow is also one of the fast growing cities of north India with increasing urbanization and vehicular traffic. The lichens being sensitive to air pollution their utilization in biomonitoring is another interesting aspect of the lichenological investigation in the area. Singh & Upreti (1991) studied the lichen flora of Lucknow with reference to historical monuments, while Saxena (2004) studied lichens in Lucknow in relation to air pollution. Saxena (2004) intensively surveyed a large number of localities (51 nos.) within the district and recorded 33 species under 15 genera. Upreti *et al.* (2002), Saxena *et al.* (2003), and Upreti (2005) made a few notes on changed environment of Lucknow with respect to lichen mycota. Ayub (2005) studied the lichens growing on some major monuments of Uttar Pradesh, especially of Lucknow and listed 14 lichen species. Asafi Imambara, Asafi Mosque, Residency complex, Sadat Ali Khan Maqbara, Sikander Bagh Building and Dilkusha Palace are some of the monuments studied for lichen biodeterioration in Lucknow.

Nayaka & Upreti (2011) compiled all the available literature as discussed above on lichens of Uttar Pradesh which resulted in 90 species under 24 families and 33 genera. The list of 90 species served as base line information for the work presented in this book.

Current status of lichen diversity in Uttar Pradesh

The accounts of lichens provided in this book is based on the critical observation of more than 2250 specimens either readily available at herbarium LWG or freshly collected from eastern part of Uttar Pradesh. The study also involved the re-examination of several taxa earlier listed from the state by Nayaka & Upreti (2011). Though there were several interesting taxa discovered during the study in this book we presented only well identified species along with their illustrations.

At present Uttar Pradesh is represented by 135 taxa (132 species and two varieties) belonging to 46 genera and 25 families. The study added a total of 11 new records for India and 61 new additions to Uttar Pradesh. At the same time in the present book 15 species of lichens were excluded due to their erroneous identification or doubtful occurrence.

The lichen mycota of Uttar Pradesh is dominated by crustose lichens with 90 species. The foliose lichens are well represented in the state with 20 species and it is followed by squamulose lichens with 18 species. The squamulose lichens mostly belong to genera *Endocarpon* and *Peltula*, and occur on rocks, lime and cement plasters of monuments and old buildings. The true fruticose lichens are absent in Uttar Pradesh, however *Lichinella flexa* and *Peltula tortuosa* are subfruticose or minutely fruticose growth forms occur in the state. The species *Peltula placodizans* and *Dimelaena tenuis* are the only two placodioid forms represented in Uttar Pradesh. Together with *Chrysothrix* other leprose lichen collected from the state is *Lecanora coriensis*.

The lichens in Uttar Pradesh preferred to grow on tree bark with 95 species and rest of them (37) grew on rocky substratum (including lime/cement plaster); *Dirinaria aegialita* and *Parmotrema praesorediosum* found growing both on bark as well as on rock. *Strigula smaragdula* is the only species found growing on leaves. It is interesting to note that Uttar Pradesh represented by a good number of Pyrenocarpous lichens with 21 species, followed by Graphidaceous (15, including *Opegrapha*) and Cyanolichens (14).

Among the 25 lichen families, Physciaceae, Graphidaceae and Lichinaceae are most diverse families with 10, 5 and 4 genera respectively. Similarly, among different genera *Lecanora* is the most dominant genus with 17 species, followed by *Bacidia* and *Caloplaca* with 11 and 9 species respectively. *Arthopyrenia nidulans, Arthothelium abnorme, Caloplaca bassiae, Peltula euploca, Pyxine cocoes,* and *Rinodina sophodes* are some of the most common lichens in Uttar Pradesh.

Out of the 71 districts as per the current study lichens representation is available only for 35 districts of the state of which Behraich and Lucknow represent 50 species each followed by Sonbhadra district with 39 species.

Among the 90 species of lichens listed by Nayaka & Upreti (2011) a total of 15 lichen species are excluded from Uttar Pradesh after following the modern concept of different taxa. The major changes were observed regarding the members of Graphidaceae after following nomenclature studies carried out by Lücking 2009; Lücking *et al.* 2009; Mangold *et al.* 2009; Sharma *et al.* 2012; Staiger 2012. Similar changes were also found in the genus *Opegrapha* while following Ertz 2009.

List of lichen taxa excluded from Uttar Pradesh

1. *Arthopyrenia terminata* (Nyl.) Müll. Arg. (Arthopyreniaceae) - reported from Lucknow (Saxena 2004; Gauniyal 2005).
2. *Bacidia medialis* (Tuck.) Zahlbr. (Ramalinaceae) - reported from Lucknow (Saxena 2004; Srivastava 2004)
3. *Caloplaca conciliascens* (Nyl.) Zahlbr. (Teloschistaceae) - reported from Mirzapur (Joshi 2008)
4. *Caloplaca pyracea* (Ach.) Th. Fr. (Teloschistaceae) - reported from Bahraich (Nayaka *et al.* 2011)
5. *Drinaria papillulifera* (Nyl.) D. D. Awasthi (Physciaceae) - reported from Faizabad (Dubey *et al.* 1999; Srivastava 2004; Singh & Sinha 2010)
6. *Fissurina incrustans* Fée (Graphidaceae) - reported from Bahraich (Nayaka *et al.* 2011)
7. *Graphis guimarana* Vaino (Graphidaceae) - reported from Bahraich (Nayaka *et al.* 2011)
8. *Graphis nigroglauca* Leighton (Graphidaceae) - reported from Bahraich (Nayaka *et al.* 2011)
9. *Graphis subasahinae* Nagarkar & Patw. (Graphidaceae) - reported from Bahraich (Nayaka *et al.* 2011)
10. *Graphis subserpentina* Nyl. (Graphidaceae) - reported from Bahraich (Nayaka *et al.* 2011)
11. *Maronea constans* (Nyl.) Hepp. (Fuscideaceae) - reported from Bahraich (Nayaka *et al.* 2011)
12. *Opegrapha herpetica* (Ach.) Ach. (Roccellaceae) - reported from Lucknow (Saxena 2004; Srivastava, 2004)
13. *Opegrapha* cfr. *heterospora* Vainio (Roccellaceae) - reported from Bahraich (Nayaka *et al.* 2011)
14. *Opegrapha leptoterodes* Nyl. (Roccellaceae) - reported from Lucknow (Saxena 2004)
15. *Pertusaria pallidula* Stirton (Pertusariaceae) - reported from Lucknow (Saxena 2004)
16. *Thelotrema pachysporum* Nyl. - reported from Bahraich (Nayaka *et al.* 2011)

List of all the lichen taxa treated in the book (Note: New to Uttar Pradesh are marked with * sign and new to India are presented in **bold** letter)

1. *Anisomeridium calicicolum* Upreti & Nayaka
2. *Arthopyrenia grisea* (Schleich. ex Schaer.) Körber*
3. *A. minor* R.C. Harris*
4. *A. nidulans* Müll. Arg.
5. *Arthothelium abnorme* (Ach.) Müll. Arg.*
6. *Bacidia alutacea* (Krempelh) Zahlbr.
7. *B. arnoldiana* Körber*
8. *B. convexula* (Müll. Arg.) Zahlbr.*
9. *B. incongruens* (Stirton) Zahlbr.*
10. *B. inundata* (Fr.) Körber
11. *B. laurocerasi* (Delise ex Duby) Ozenda & Clauz.
12. *B. millegrana* (Taylor) Müll. Arg.
13. *B. rubella* (Hoffm.) Massal.*
14. *B. rufescens* (Müll. Arg.) Zahlbr.*
15. *B. spadicea* (Ach.) Zahlbr.*
16. *B. submedialis* (Nyl.) Zahlbr.
17. *Bacidiospora psorina* (Nyl. ex Hue) Kalb*
18. *Baculifera remensa* (Stirton) Marbach*
19. *Buellia alboatrior* (Nyl.) Zahlbr.*
20. *B. almorensis* S. Singh & D.D. Awasthi
21. *Caloplaca bassiae* (Willd. ex Ach.) Zahlbr.
22. *C. cinnabarina* (Ach.) Zahlbr.*
23. *C. cupulifera* (Vainio) Zahlbr.
24. *C. granularis* (Müll. Arg.) Zahlbr.*
25. *C. phlogina* (Ach.) Flagey*
26. *C. poliotera* (Nyl.) Steiner*
27. *C. subpoliotera* Y. Joshi & Upreti
28. *C. tropica* Joshi, Y. & Upreti
29. *C. vitellinula* (Nyl.) H. Olivier
30. *Chapsa alborosella* (Nyl.) A. Frisch
31. *Chrysothrix candelaris* (L.) J.R. Laundon
32. *C. chlorina* (Ach.) J.R. Laundon*
33. *Collema pulcellum* var. *subnigrescens* (Müll. Arg.) Degel.
34. *Cryptothecia scripta* G. Thor
35. *Dimelaena tenius* (Müll. Arg) H. Mayrhofer & Wippel*
36. *Diorygma junghuhnii* (Montn. & Bosch) Kalb, Staiger & Elix
37. *Dirinaria aegialita* (Afz.) Moore
38. *D. applanata* (Fée) D.D. Awasthi*
39. *D. confluens* (Fr.) D.D. Awasthi
40. *D. consimilis* (Stirton) D.D. Awasthi
41. *Endocarpon nanum* A. Singh & Upreti
42. *E. nigrozonatum* A. Singh & Upreti
43. *E. pallidum* Ach.
44. *E. pusillum* Hedwigia
45. *E. rosettum* A. Singh & Upreti
46. *E. subrosettum* A. Singh & Upreti
47. *Fissurina comparimuralis* Staiger*
48. *Graphis ajarekarii* Patw. & C.R. Kulk.*
49. *G. capillacea* Stirt.*
50. *G. chlorotica* A. Massal & Kremp.*
51. *G. cincta* (Pers.) Aptroot*
52. ***G. japonica* (Müll. Arg.) A.W. Archer & Lücking***
53. ***G. pseudoserpens* Chaves & Lücking***
54. *G. striatula* (Ach.) Spreng.
55. *G. subducta* Vainio*
56. *Haematomma puniceum* (Sm. ex Ach.) Massal.*
57. *Hafellia disciformis* (Fr.) Marbach & H. Mayrhofer
58. *Heppia lutosa* (Ach.) Nyl.
59. *Hyperphyscia adglutinata* var. *adglutinata* (Flörke) Mayerli & Poelt*

60. *H. adglutinata* var. *pyrithrocardia* (Müll. Arg.) D.D. Awasthi*
61. *H. minor* (Fée) D.D. Awasthi
62. *H. syncolla* (Tuck ex Nyl.) Kalb.
63. *Lecanora achroa* Nyl.
64. *L. alba* Lumbsch*
65. *L. argentata* (Ach.) Degel.
66. *L. austrointumescens* Lumbsch & Elix
67. *L. cenisia* Ach.*
68. *L. chlarotera* Nyl.*
69. *L. cinereofusca* H. Magn.
70. *L. concilians* Nyl.
71. *L. coriensis* (Hue) J.R. Laundon
72. *L. coronulans* Nyl.*
73. *L. flavidomarginata* B. de Lesd.
74. *L. helva* Stizenb.
75. *L. inerjecta* Müll. Arg.
76. *L. leprosa* Fée
77. *L. perplexa* Brodo
78. *L. pseudistera* Nyl.*
79. *L. rugosella* Zahlbr.
80. *L. tropica* Zahlbr.
81. *Lecidea granifera* (Ach.) Vainio
82. *Letrouitia leprolyta* (Nyl.) Hafellner
83. *L. transgressa* (Malme) Hafellner & Bellem.
84. ***Lichenella flexa* Henssen, Büdel & Nash***
85. ***Opgerapha agelaeotera* Vainio***
86. ***O. astraea* Tuck.***
87. ***O. maldiveana* Ertz***
88. *O. subvulgata* Nyl.
89. *O. varia* Pers.*
90. *Parmotrema mesotropum* (Müll. Arg.) Hale
91. *P. praesorediosum* (Nyl.) Hale
92. *P. saccatilobum* (Taylor) Hale
93. ***Peltula corticola* Büdel & R. Sant.***
94. *P. euploca* (Ach.) Poelt
95. *P. obscurans* (Nyl.) Gyeln.
96. *P. patellata* (Bagl.) Swinsc. & Krog.
97. *P. placodizans* (Zahlbr.) Wetmore*
98. *P. tortuosa* (Nees) Wetmore
99. *P. zahlbrucknerii* (Hasse) Wetmore
100. *Pertusaria albidella* Nyl.*
101. *P. leucosora* Nyl.*
102. *P. leucostoma* (Bernh.) Massal.
103. *P. punctata* Nyl.*
104. *P. quassiae* (Fée) Nyl.
105. *Phaeophyscia hispidula* (Ach.) Moberg
106. *P. orbicularis* (Neck.) Moberg
107. *Phylliscum indicum* Upreti
108. *P. testudineum* Henssen*
109. ***Phyllopeltula steppae* Kalb***
110. *Physcia dimidata* (Arn.) Nyl.
111. *Porina aenea* (Wallr.) Zahlbr.*
112. ***Pyrenopsis triptococca* Nyl.***
113. *Pyrenula brunnea* Fée
114. *P. comirana* Vainio
115. *P. mamillana* (Ach.) Trevisan
116. *P. melaleuca* Müll. Arg.*
117. *P. subacutalis* Upreti
118. *P. subglabriuscula* Vainio
119. *Pyxine cocoes* (Swartz) Nyl.
120. *P. himalayensis* D.D. Awasthi*
121. *P. meissnerina* Nyl.
122. *P. petricola* Nyl.*
123. *P. subcinerea* Stirton*
124. ***Ramonia microspora* Vězda***
125. *Rinodina exigua* (Ach.) Gray*
126. *R. oxydata* (Massal.) Massal.*
127. *R. sophodes* (Ach.) Massal.
128. *Sphinctrina anglica* Nyl.
129. *S. tubaeformis* Massal.
130. *Strigula smaragdula* Fr.*
131. *Thelenella luridella* (Nyl.) Mayrh.*
132. *Thelotrema pachysporum* Nyl.
133. ***Thyrea plectospora* A. Massal.***
134. *Verrucaria margacea* (Wahlenb.) Wahlenb.*
135. *V. pinguicula* (Nyl.) Massal.*

Methodology

The present investigation initiated with more than 500 lichen specimens earlier collected and preserved in the herbarium LWG representing 15 districts of Uttar Pradesh. Fresh samples of lichens were collected from orchards and forested areas in 22 districts in eastern parts of Uttar Pradesh (Allahabad, Ambedkar Nagar, Azamgarh, Baliya, Balrampur, Chandauli, Deoria, Gazipur, Gorakhpur, Hardoi, Jaunpur, Kushinagar, Maharajganj, Mau, Mirzapur, Pratapgarh, Sant Kabir Nagar, Sant Ravidas Nagar, Sitapur, Sonbhadra, Sultanpur, Varanasi). The lichen samples were dried, labeled with details of localities and preserved in the herbarium LWG for further study.

The lichens specimens were identified following the standard procedure by studying their morphology, anatomy and chemistry. The external morphology was studied using the Leica S8APO and Leica EZ4 stereozoom microscopes. The anatomical structures, especially of ascomata were studied using Leica DM500 and Nikkon Eclipse compound microscope. The microscopes were attached with camera and photographic accessories. The thin hand cut sections of the apothecia were initially mounted in plain water to record the colour and measurements of various structures. The sections were then treated with aqueous KOH solution and Lugol's solution (for iodine reaction) and reactions were recorded. The colour spot tests were performed on the cortex and medulla by using routine reagents; aqueous solution of KOH (K), calcium hypochlorite (C) and para-phenalene-diamine (P). The positive reactions were marked as + and negative as -. Thin Layer Chromatography (TLC) was performed in solvent system A (Toluene 180 ml : 1-4 Dioxane 60 ml : Acetic acid 8 m) following Walker & James (1980) for identification of secondary metabolites. In case of lichen genus *Dirinaria* microcrystalography was performed for identification of divaricatic and sekikaic acids through their shape and structures of crystal.

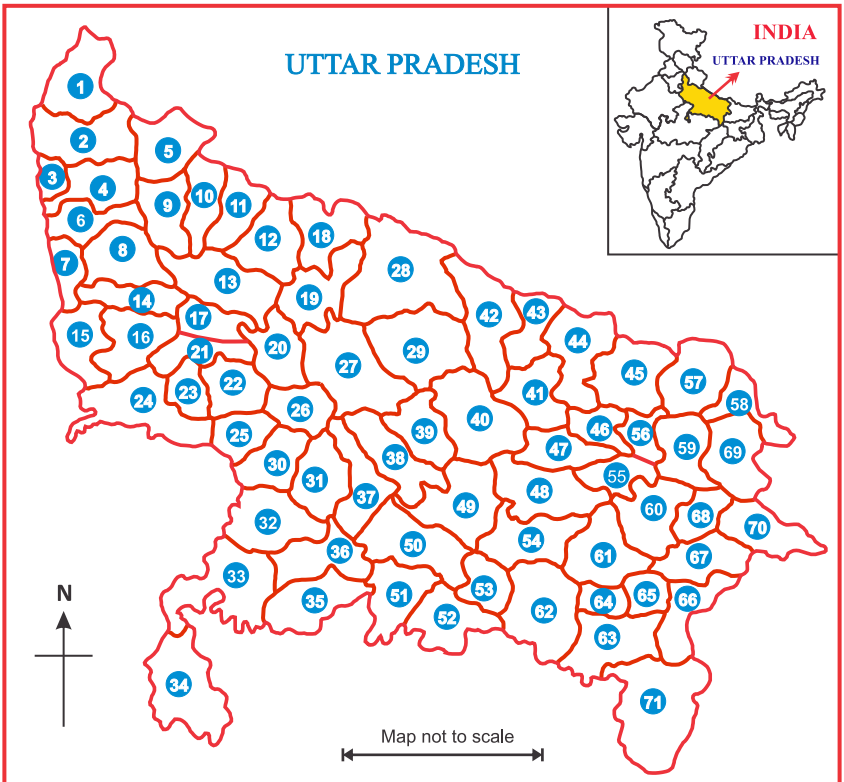
Identified taxa are confirmed by matching them with the original protologue, type material or well identified specimens available at LWG herbarium. Following the recent classification proposed by Lumbsch & Huhndorf (2007) the nomenclature of the taxa are updated.

The book is provided with the artificial key for identification of all lichen genera represented; brief description to the genus and key for identification of the species within the genus. A statistics of total number of species known under the genus in the world and from India are provided next to the genus character along with the relevant literature consulted. For all the taxa treated in the book only basionym is provided (whenever available). The description and photo-

graphs of each taxa included in the book is entirely based on the observation of specimens from Uttar Pradesh, except for *Collema pulcellum* var. *subnigrescens*, where the specimen was untraceable. An attempt is made to provide the detailed description including morphology, anatomy and chemistry. Please note that the thickness of exciple, epihymenium, hymenium, hypothecium do not carry any taxonomic significance as they likely to vary from specimen to specimen.

Under the subheading 'comments' ecology and diagnostic characters of the species is discussed. The status of lichen is species mentioned as rare, common and very common based on the number of specimens available and different localities or districts to which they represent. The world distribution is mentioned whenever the species is new to India. Further, the distributions of all the taxa included are marked individually on the map of Uttar Pradesh.

Map of Uttar Pradesh



1. Saharanpur
2. Muzaffarnagar
3. Baghpat
4. Meerut
5. Bijnor
6. Ghaziabad
7. Gautam Buddha Nagar
8. Bulandshahar
9. Jyotiba Phule Nagar
10. Moradabad
11. Rampur
12. Bareilly
13. Budaun
14. Aligarh
15. Mathura
16. Mahamaya Nagar
17. Kanshiram Nagar
18. Pilibhit
19. Shahjahanpur
20. Farrukhabad
21. Etah
22. Mainpuri
23. Firozabad
24. Agra
25. Etawah
26. Kannauj
27. Hardoi
28. Lakhimpur Kheri
29. Sitapur
30. Auraiya
31. Ramabai Nagar
32. Jalaun
33. Jhansi
34. Lalitpur
35. Mahoba
36. Hamirpur
37. Kanpur Nagar
38. Unnao
39. Lucknow
40. Barabanki
41. Gonda
42. Bahraich
43. Shrawasti
44. Balrampur
45. Siddharth Nagar
46. Basti
47. Faizabad
48. Sultanpur
49. Rae Bareli
50. Fatehpur
51. Banda
52. Chitrakoot
53. Kaushambi
54. Pratapgarh
55. Ambedkar Nagar
56. Sant Kabir Nagar
57. Maharajganj
58. Kushinagar
59. Gorakhpur
60. Azamgarh
61. Jaunpur
62. Allahabad
63. Mirzapur
64. Sant Ravidas Nagar
65. Varanasi
66. Chandauli
67. Ghazipur
68. Mau
69. Deoria
70. Ballia
71. Sonbhadra

Mixed deciduous forest in Hatinalla (Sonbhadra dist.)

Rocky outcrop at Markundi Hills (Sonbhadra dist.) which harboured many interesting lichens

Shorea robusta forest in Nichlol Forest Range of Sohagibarwa Wildlife Sanctuary (Maharajganj dist.)

Mango orchard in Tulsipur village (Jaunpur dist.)

Luxuriant growth of foliose lichens on *Shorea robusta* tree trunk in Shaktinagar (Sonbhadra dist.)

Luxuriant growth of some crustose lichen in Nichlol Forest Range of Sohagibarwa Wildlife Sanctuary (Maharajganj dist.)

Key for identification of lichen genera of Uttar Pradesh

1a. Thallus distinctly foliose, ± orbicular, continuous, margin ± free 2

1b. Thallus otherwise (minute fruticose, placodioid, squamulose, leprose, crustose) 8

2a. Thallus dark olive green to brownish, thin, plicate, photobiont cyanobacteria . . . *Collema* (*C. pulcellum* var. *subnigrescens*)

2b. Thallus otherwise (whitish grey, brownish to greenish grey) 3

3a. Marginal lobes broader, lower surface lacking rhizines, smooth, brown and shinning . . . . . *Parmotrema*

3b. Marginal lobes narrow, lower surface rhizinate or not 4

4a. Thallus whitish grey, lobes ± pruinose, K+ yellow 5

4b. Thallus greenish grey to brownish, K- 7

5a. Thallus densely pruinose, delicate, sorediate . . . . . *Physcia* (*P. dimidiata*)

5b. Thallus otherwise, lobes ± pruinose 6

6a. Thallus closely adnate, lower surface lacking rhizines . . . . . *Dirinaria*

6b. Thallus ± free at margin, lower surface with rhizines . . . . . *Pyxine*

7a. Lower surface with dense rhizines projecting beyond the lobes . . . . . *Phaeophyscia*

7b. Lower surface with moderate rhizines, not projecting beyond the lobes, lobes ± closely adpressed . . . . . *Hyperphyscia*

8a. Thallus leprose, sorediate, granular or minute isidiate, usually sterile 9

8b. Thallus otherwise 11

9a. Thallus K+ purple, isidiate or sorediate . . . . . *Caloplaca* (*C. bassiae, C. phlogina*)

9b. Thallus K+ yellow or K-, leprose 10

10a. Thallus yellow orange or lemon yellow, calycin present . . . . . *Chrysothrix*

10b. Thallus whitish to bluish grey, usnic acid present . . . . . *Lecanora* (*L. coriensis*)

11a. Thallus minutely sub-fruticose to fruticose 12

11b. Thallus squamulose, placodioid, crustose 13

12a. Thallus with cylindrical lobes, black, dark bluish black, saxicolous . . . . . *Lichinella* (*L. flexa*)

12b. Thallus sub-fruticose, with upright lobes, olive green to brownish, saxicolous . . . . . *Peltula* (*P. tortuosa*)

13a. Thallus squamulose to placodioid, lobate at margin, saxicolous 14

13b. Thallus squamulose or crustose 15

14a. Thallus greenish brown, orbicular, gyrophoric acid present, saxicolous . . . . . *Dimelaena* (*D. tenius*)

14b. Thallus olive brown to brown, effigurate, with long radiating lobes, saxicolous . . . . . *Peltula* (*P. placodizans*)

15a. Thallus squamulose 16

15b. Thallus crustose 24

16a. Thallus minute, squamulose to granular, apothecia orange-pink to brown, ascospores hyaline, transversely septate . . . . *Bacidiospora* (*B. psorina*)

16b. Thallus squamulose, subfoliose to minutely foliose, ascomata otherwise 17

17a. Thallus corticolous, photobiont cyanobacteria 18

17b. Thallus saxicolous, growing on rocks or lime/cement plaster, photobiont green alga or cyanobacteria 19

18a. Thallus greenish brown, sorediate . . . . . *Peltula* (*P. corticola*)

18b. Thallus olive brown, esorediate . . . . . *Phyllopeltula* (*P. steppae*)

19a. Thallus with green algae, yellow brown to greenish brown, ascomata perithecia . . . . . *Endocarpon*

19b. Thallus with cyanobacteria, ascomata otherwise 20

20a. Thallus dark brown, reddish brown to black 21

20b. Thallus greenish brown to pale brown 23

21a. Thallus in rosettes, ascomata pycnoascocarp, ascospores simple, hyaline, globose to broadly ellipsoid . . . . . *Thyrea* (*T. plectospora*)

21b. Ascomata apothecia 22

22a. Upper surface of the squamules granular, marginal squamules sometimes elongate to effigurate . . . . . *Pyrenopsis* (*P. triptococca*)

22b. Squamules smooth, circular and closely aggregated . . . . . *Phylliscum*

23a. Apothecial disc wide open, orange to red brown, asci 8 spored . . . . . *Heppia* (*H. lutosa*)

23b. Apothecial disc wide open or closed, asci multi spored ..... *Peltula*

24a. Ascomata unorganized 25

24b. Ascomata organized (mazaedium, perithecia, apothecia or modified apothecia) 26

25a. Ascomata round to irregular, dark grey to black, asci 8 spored ..... *Arthothelium* (*A. abnorme*)

25b. Ascomata granular or verrucose, white to creamish, asci 1 spored ..... *Cryptothecia* (*C. scripta*)

26a. Ascomata mazaedium, stalked or subsessile ..... *Sphinctrina*

26b. Ascomata otherwise 27

27a. Ascomata perithecia 28

27b. Ascomata apothecia or modified apothecia 34

28a. Thallus epiphyllous, whitish grey ..... *Strigula* (*S. smaragdula*)

28b. Thallus corticolous or saxicolous 29

29a. Ascospores brown, mostly 3 septate, perithecia black, thallus corticolous ..... *Pyrenula*

29b. Ascospores hyaline, thallus corticolous or saxicolous 30

30a. Ascospores simple, thallus saxicolous, greenish brown to grayish brown, rimose areolate ..... *Verrucaria*

30b. Ascospores transversely septate or muriform 31

31a. Ascospores muriform, thallus saxicolous, olive brown to brown, areolate, smooth ..... *Thelenella* (*T. luridella*)

31b. Ascospores transversely septate 32

32a. Perithecia covered by thallus, with involucrellum, ascospores up to 3 septate, thallus corticolous ..... *Porina* (*P. aenea*)

32b. Perithecia naked, small, black, ascospores 1 - 3 septate 33

33a. Paraphyses long celled, branched and anastomosing above the asci, thallus saxicolous ..... *Anisomeridium* (*A. calcicolum*)

33b. Paraphyses ± moniliform, branched and anastomosing, thallus corticolous ..... *Arthopyrenia*

34a. Apothecia lirellate 35

34b. Apothecia otherwise 38

35a. Lirellae white, emergent, sunken or fissure like 36

35b. Lirellae black to dark grey, emergent, immersed to completely naked . 37

36a. Disc white, covered with brownish puina, exciple non-carbonized, ascospores hyaline, muriform ..... *Diorygma* (*D. junghuhnii*)

36b. Disc slit or fissure like, mostly sunken, lirellate area white, delicate, ascospores transversely septate to submuriform .... *Fissurina* (*F. comparimuralis*)

37a. Lirellae completely naked, simple, ascospores hyaline, transversely septate, locules mostly rectangular ..... *Opegrapha*

37b. Lirellae partially or completely covered by thallus, ascospores hyaline, transversely septate or muriform, locules otherwise ..... *Graphis*

38a. Ascomata perithecioid, opening with pore, chroodiscoid, emergent or sunken 39

38b. Ascomata rounded, cup like 42

39a. Ascomata perithecioid, sunken in verrucae, thallus verrucose ..... *Pertusaria*

39b. Ascomata otherwise 40

40a. Ascomata chroodiscoid, round to elongated, sunken to the level of thallus, ascospores transversely septate ..... *Chapsa* (*C. alborosella*)

40b. Ascomata opening with pore 41

41a. Asci 8 spored, ascospores transversely septate, thallus whitish grey ..... *Thelotrema* (*T. subtile*)

41b. Asci multi spored, ascospores simple, thallus greenish ..... *Ramonia* (*R. microspora*)

42a. Apothecial margin and disc black, ascospores brown 43

42b. Apothecia otherwise 45

43a. Hymenium inspersed with oil globules, ascospores 1-septate ..... *Hafellia* (*H. disciformis*)

43b. Hymenium lacking oil globules, ascospores transversely 1 or more septate or submuriform 44

44a. Ascospores with transversely 1 septate, norstitic acid present ..... *Baculifera* (*B. remensa*)

44b. Ascospores submuriform or appearing as 3 septate with two pseudolocules on either side of middle septa ..... *Buellia*

45a. Apothecia margin concolours to thallus, smooth to verrucose, lecanorine, disc variously coloured 46

45b. Apothecial margin otherwise, coloured to pale 49

46a. Proper exciple brown, continuous with the hypothecium, ascospores simple, thallus verrucose to granular . . . . . *Lecidea* (*L. granifera*)

46b. Proper exciple hyaline, distinct or indistinct 47

47a. Apothecial disc orange red to brick red, ascospores transversely septate . . . . . *Haematomma* (*H. puniceum*)

47b. Apothecial disc otherwise, variously coloured 48

48a. Ascospores hyaline, simple, ellipsoid . . . . . *Lecanora*

48b. Ascospores brown, 1 septate . . . . . *Rinodina*

49a. Ascospores polaribilocular, hyaline, epihymenium K+ purple . . . . . *Caloplaca*

49b. Ascospores transversely 3 to many septate, submuriform, hyaline 50

50a. Ascospore locules lentiform, apothecial margin yellow-orange . . . . . *Letrouitia*

50b. Ascospore locules otherwise 51

51a. Thallus minutely squamulose, apothecial disc orange pink, ascospores acicular, transversely 4 - 12 septate . . . . . *Bacidiospora* (*B. psorina*)

51b. Thallus crustose, granular, scurfy to furfuraceous, ascospores 3 - 15 septate . . . . . *Bacidia*

Description of the Taxa

Anisomeridium (Müll. Arg.) M. Choisy (Family: Monoblastiaceae)

Icon. Lich. Univ.: 3. 1928.

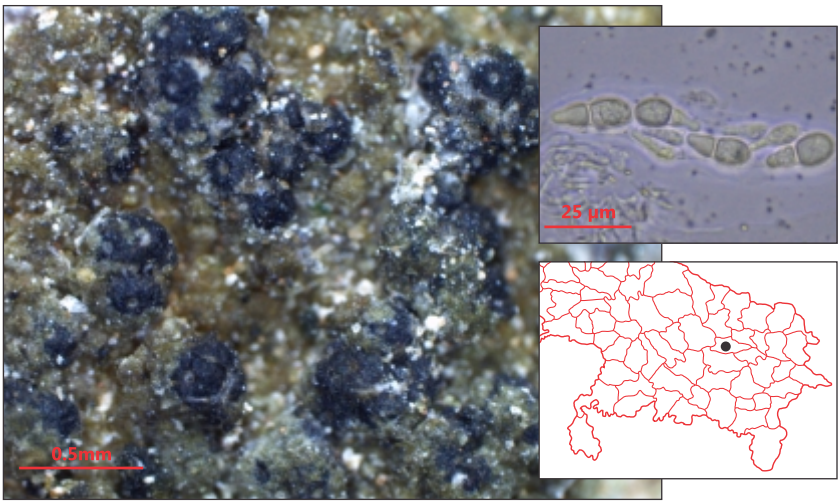
Thallus crustose, epi or endophloeodal, whitish, pale grey to greenish; photobiont *Trentepohlia*. Ascomata perithecia, hemispherical to globose, simple to compound. Paraphyses slender, branched and anastomosed above; periphyses absent. Asci cylindrical to clavate, 8 spored; ascospores 1 – 3 septate, ovoid to clavate-fusiform, hyaline, smooth, uni to biseriate. Pycnidia immersed to sessile, black, ± globose or conical.

World wide 100 species; India 17 species; Literature: Upreti & Nayaka 2006.

Anisomeridium calcicolum Upreti & Nayaka

Lichenologist 38(3): 231. 2006.

Thallus saxicolous (lime plaster), crustose, green to olivaceous, thin, filmy or somewhat granular in part, continuous, cracked when dry. Perithecia 0.25 – 0.50 mm diam., solitary or sometimes 2 or 3 confluent, hemispherical, black, glossy, shining, usually naked, sometimes covered by a thalline layer almost up to the ostiole; ostiole apical. Exciple complete, black, up to 50 µm thick around ostiole, paler in lower parts, 35 – 40 µm thick; hamathecium 180 – 250 µm, hyaline, oil droplets absent; paraphyses unbranched near the base, branching and anastomosing above. Asci 8 spored, cylindrical to clavate,



60 – 70 × 12 – 16 µm, apical dome with distinct, broad ocular chamber; ascospores hyaline, transversely 1 septate, spindle shaped, one cell larger than the other, 15 – 19 × 5 – 8 µm. Pycnidia black, hemispherical, superficial to submerged, 0.01 – 0.3 mm diam.; micro conidia globose, rarely slightly elongated, 1.0 – 1.5 µm diam.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Anisomeridium calcicolum* has a unique habitat as it is found growing on lime plaster of more than 200 years old monument Gulab Bari in Faizabad district. It grows on moist, vertical surface near the base of the monument, in association with some species of Lichinaceae. Though it is luxuriantly growing on the monuments, but rare in occurrence as it is collected from single locality.

Arthopyrenia A. Massal. (Family: Arthopyreniaceae)

Ric. Auton. Lich. Crost: 165. 1852.

Thallus crustose, thin, epi or usually endophloeodal; photobiont green alga, *Tretepohlia*. Ascomata perithecia, simple, sunken or adnate, somewhat confluent, globular to hemispherical. Exciple brown or blackish brown, complete or lacking at base; ostiole apical; paraphyses thick, free, gelatinized, branched and anastomosed. Asci with or without ocular chamber, usually 8 spored; ascospores hyaline, oval-ellipsoid, with blunt ends, transversely 1-5 septate, constricted at septa.

World wide 120 species; India 15 species; Literature: Upreti & Pant 1993.

Key to the species of *Arthopyrenia*

1a. Ascospores spindle shaped, 1 septate, 20 – 42 × 6 – 16 µm . . . . . *A. nidulans*

1b. Ascospores oblong-ellipsoid, up to 20 µm long 2

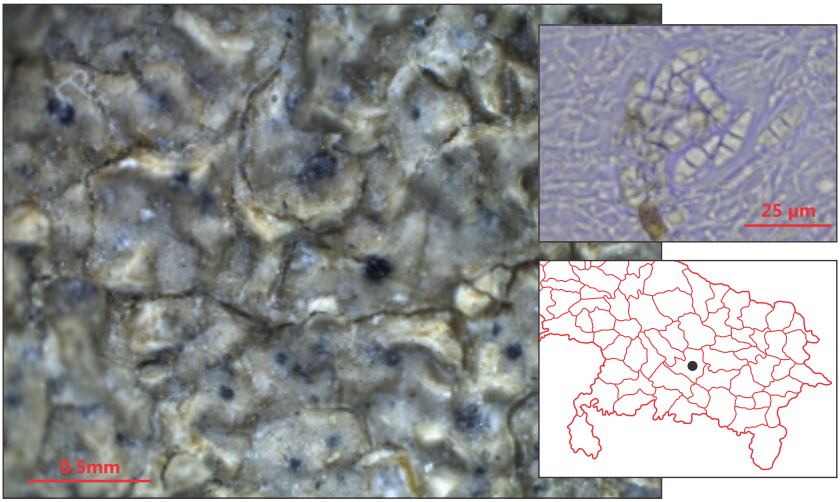
2a. Ascospores 1 – 3 septate . . . . . *A. grisea*

2b. Ascospores always 1 septate, mature spores sometimes pale brown . . . . . *A. minor*

Arthopyrenia grisea (Schleich. ex Schaer.) Körber

Syst. Lich. Germ.: 369. 1855. – *Verrucaria epidermidis* var. *grisea* Schleich. ex Schaer., *Lich. Helv. Spicil.* 2: 56. 1826.

Thallus corticolous, crustose, smooth to rough, shining, yellowish grey, endophloeodal. Perithecia black, solitary or 2 – 3 in groups, sunken to slightly emergent, flat to slightly conical, covered by corticiform layer, 0.06 – 0.12 mm diam.; ostiole apical, ostiolar region black, naked. Exciple ± laterally spreading, brown above, pale, thinning or indistinct at base, 10 – 27 µm thick; hamathecium conical to globose, hyaline, I-, 205 – 228 × 175 – 190 µm across;



paraphyses branched and anastamosing. Asci 8 spored, clavate to cylindrical, 60 – 80 × 16 – 18 µm; ascospores hyaline, 1 – 2(–3) septate, oblong-ellipsoid, 15 – 20 × 5 – 7 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Arthopyrenia grisea* is a rare species in Uttar Pradesh was found growing on *Mangifera indica* tree trunks along road side, near by Thermal Power Plant (NTPC) in Rae Bareli district. The specimen of this species appears as sterile crust due to its smaller size of the perithecia which is mostly covered by corticiform layer.

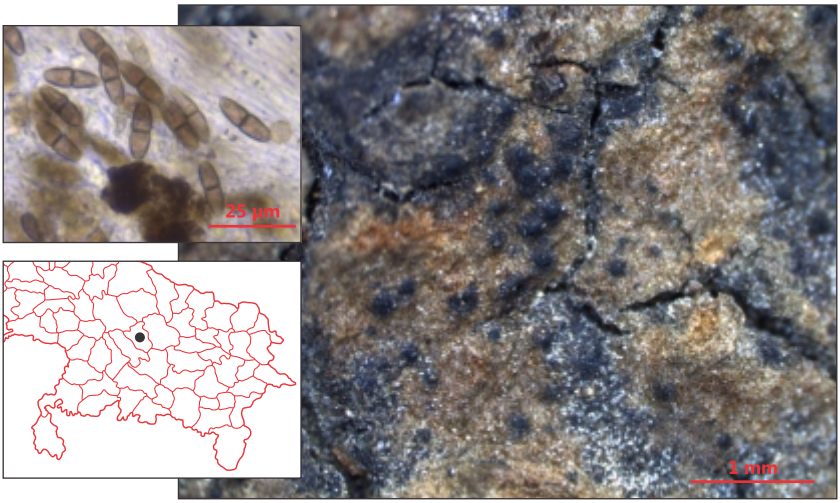
Arthopyrenia minor R.C. Harris, in Tucker & Harris

Bryologist 83(1): 7. 1980.

Thallus corticolous, crustose, brownish grey, smooth, cracked areolate, endophloeodal. Perithecia black, solitary or rarely 2 – 3 in groups, conical to semiglobose, sunken to semi-emergent, 0.17 – 0.45 mm diam., ostiolar region naked; ostiole apical, indistinct. Exciple brown above, pale, thinning and indistinct below, 31 – 55 µm thick; hamathecium hyaline, I-, 291 × 395 µm across; paraphyses branched and anastomosing. Asci 8 spored, cylindrical to clavate, 45 – 73 × 10 – 15 µm; ascospores hyaline (sometimes pale brown at maturity), transversely 1 septate, oblong to ellipsoid, 16 – 19 × 5 – 7 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Arthopyrenia minor* is a rare species in Uttar Pradesh found growing on a tree at garden of CSIR-National Botanical Research Institute,



Lucknow. The studied specimen was quite old and has an appearance of fungus, in addition some of the mature ascospores were brown in colour. However, presence of algal cells in thallus, structure of perithecia and paraphyses confirms it to be *Arthopyrenia*.

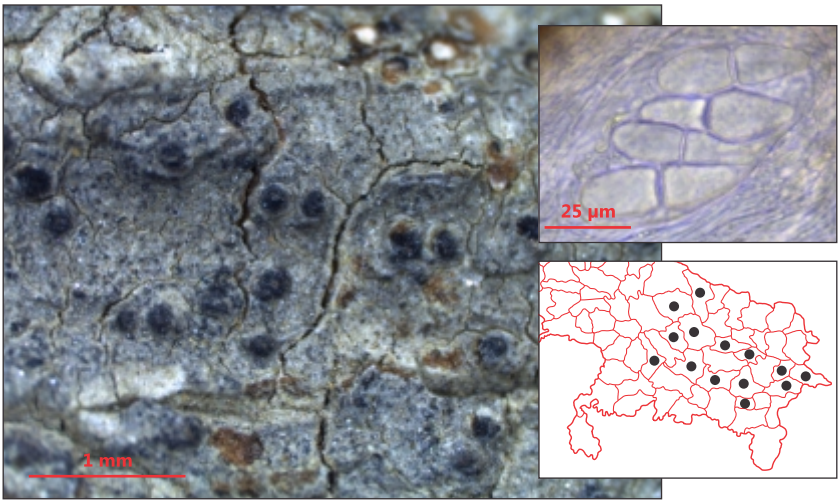
Arthopyrenia nidulans Müll. Arg.

Flora 68: 326. 1885.

Thallus corticolous, crustose, epi to endophloeodal, whitish grey, smooth, continuous to cracked areolate; prothallus indistinct or blackish. Perithecia, black, semi-immersed, shiny, solitary, rarely in groups, hemspherical, 0.2 – 0.3 mm in diam.; ostiole apical, naked, black, plane to depressed. Exciple brown above, thinning and incomplete at base, slightly or not spreading at base, 15 – 20 µm thick; hamathecium globose, 140 – 150 × 150 – 170 µm across; paraphyses branched and anastomosing. Asci clavate to broadly ovate, 8 spored, 70 – 90 × 35 – 45 µm; ascospores hyaline, transeversely 1 septate, spindle shaped, one of the cell larger and rounded, other cell smaller and triangular, constricted at septa, 20 – 30(42) × 6(12) – 13(16) µm; perispore distinct, thickened up to 2 µm. Pycnidia black to brown, superficial to sunken, 0.02 – 0.05 µm; conidia semiglobose to globose, 1.5 – 2.0 µm diam.

Chemistry: Thallus K- or K± yellow, C-, KC-, P-. TLC: Unknown triterpenes at Rf class 6.

Comments: *Arthopyrenia nidulans* is one of most common species of *Arthopyrenia* in Uttar Pradesh. It grows on variety of host plants such as *Artocarpus heterophyllus, Azadirachta indica, Citrus* sp., *Madhuca indica* and



Mangifera indica in orchards and along road sides. Earlier some of the specimens from Uttar Pradesh belonging to *A. nidulans* were erroneously identified as *Anisomeridium ambiguam* (Müll. Arg.) Aproot, *A. anisolobum* (Müll. Arg.) Aproot, *A. biforme* (Borrer) R.C. Harris, and *A. terminatum* (Nyl.) R.C. Harris. However, *A. nidulans* can be easily differentiated from other species by its large ascospores which can range from 20 to 50 µm in length and 6 to 18 µm in width. Though the ascus is of 8 spores, but at maturity it contains only one or two large spores. The spindle shaped ascospores with upper large and lower small locules and thick perispore are the other prominent characters of the species.

Arthothelium A. Massal. (Family: Arthoniaceae)

Ric. Auton. Lich. Crost: 54. 1852.

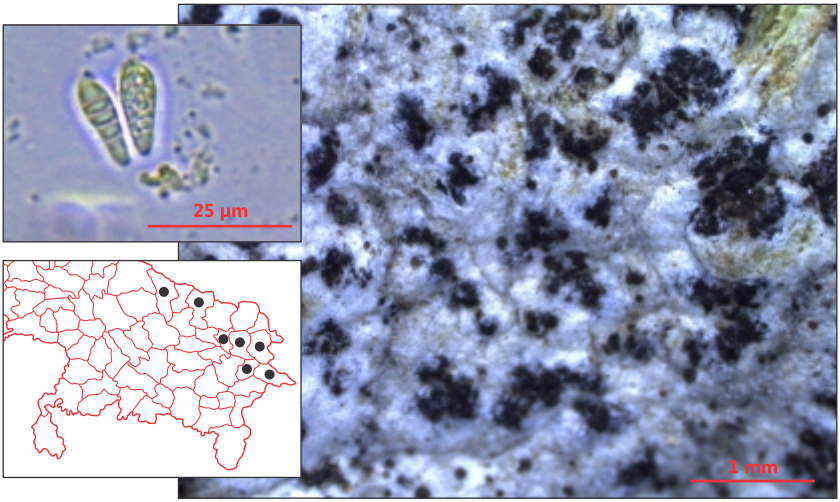
Thallus crustose, effuse, ecorticate, corticolous; photobiont green alga, *Tretepohlia*. Ascomata unorganized, innate or adnate, round or irregular in outline. Excipuloid tissue absent; paraphyses branched or anastomosing. Asci bitunicate, thick walled, 8 spored; ascospores hyaline, multicelled-muriform.

World wide 120 species; India 42 species; Literature: Awasthi 1991.

Arthothelium abnorme (Ach.) Müll. Arg.

Flora 63: 287. 1880. – *Opegrapha abnormis* Ach., *Lich. univ.*: 1-696. 1810.

Thallus corticolous, crustose, ecorticate, white to whitish grey. Ascomata unorganized, round to irregular in shape, epruinose to slightly pruinose,



smooth to rough, dark grey to black, small 0.2 – 0.4 mm, mostly coalescing to form large ascomata of size 0.8 – 1.5 mm. Pseudoexciple dark brown, continuous below hymenium, 14 – 23 µm thick, epihymenium dark brown to greenish brown, 16 – 21 µm thick; hymenium hyaline, 28 – 33 µm thick; hypothecium hyaline to pale brown, 15 – 28 µm thick; paraphysoids branched and anastamosing. Asus 8 spored, clavate to globose, 54 – 57 × 17 – 22 µm; ascospores muriform, transversely 7 – 9 septate, 2 – 3 vertical septa, hyaline, oblong to ovate, 18.8 – 19.7 × 5.4 – 8.0 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Arthothelium abnorme* is one of the most common species in Uttar Pradesh found growing on variety of trees such as *Azadirachta indica*, *Ficus* sp., *Litchi chinensis*, *Madhuca indica*, *Mangifera indica*, palm, *Shorea robusta* and *Syzygium cumini*, in mango orchards, mixed and saal forests. It can be easily identifiable due from its whitish grey thallus, unorganized apothecia and hyaline, muriform ascospores.

Bacidia De Not. (Family: Ramalinaceae)

Giorn. Bot. Ital. 2: 189. 1846.

Thallus crustose, effuse, ecorticate, corticolous or saxicolous; photobiont green alga, member of Chlorococcaceae. Ascomata apothecia, sessile, rounded, biatorine. Proper exciple para or prosoplectenchymatous; paraphyses sparingly branched with hyaline or pigmented apices, or branched and anastomosing. Asci 8 spored, tholus I+ blue; ascospores hyaline, acicular, ellipsoid or bacillar. Pycnoconidia simple or septate, variously shaped.

World wide 230 species; India 29 species; Literature: Awasthi & Mathur 1987; Awasthi 1991.

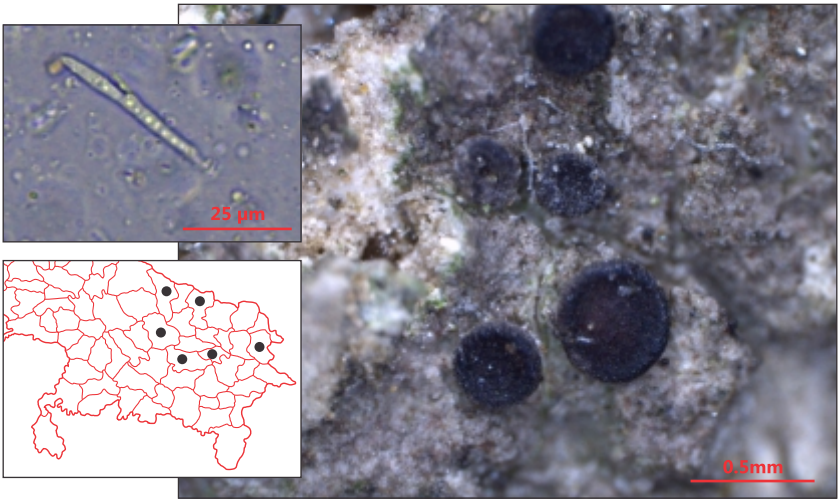
Key to the species of *Bacidia*

1a. Thallus saxicolous 2
1b. Thallus corticolous 3
2a. Hypothecium K+ violet, brown, ascospores 3 septate . . . . . *B. inundata*
2b. Hypothecium K-, dark brown, ascospores 3 – 5 septate . . . . *B. arnoldiana*
3a. Apothecia yellow orange, ascospores rod shaped 3 – 5 septate . . . . . *B. incongruens*
3b. Apothecia pale, pinkish, brown to dark brown 4
4a. Ascospores rod shaped, 3 – 5 septate, apothecia red brown . . *B. rufescens*
4b. Ascospores fusiform to acicular, 3 – 15 septate 5
5a. Epihymenium K+ violet, ascospores 7 – 12 septate. . . . . *B. alutacea*
5b. Epihymenium K+ violet 6
6a. Ascospores 3 – 5 septate, apothecia reddish brown . . . . . *B. convexula*
6b. Ascospores 3 – 15 septate. 7
7a. Thallus granulose verrucose 8
7b. Thallus scurf-furfuraceous 9
8a. Ascospores 3 – 9 septate, apothecia brown to dark brown, margin excluded . . . . . *B. submedialis*
8b. Ascospores 10 – 15 septate, apothecia pinkish brown to brown, margin persistent . . . . . *B. millegrana*
9a. Thallus scurfy, greenish grey, ascospores 6 – 12 septate . . . . . *B. rubella*
9b. Thallus granular-furfuraceous 10
10a. Epihymenium brown to dark brown, ascospores 8 – 12 septate, 38 – 64 × 2 – 3 µm . . . . . *B. laurocerasi*
10b. Epihymenium pale brown to brown, ascospores 7 – 15 septate, 45 -72 × 3 – 4 µm . . . . . *B. spadicea*

Bacidia alutacea (Krempelh.) Zahlbr.

Cat. Lich. Univers. 4: 174. 1926. – *Lecidea alutacea* Kremp., *Flora* 61: 519. 1878.

Thallus corticolous, crustose, grey brown to olivaceous brown, smooth. Apothecia frequent, round, sessile, 0.2 – 0.9 mm diam.; margin prominent at least when young, ay be excluded in older apothecia, biatorine, darker than the disc; disc red brown to dark brown, plane to convex. Exciple biotorine, with radiating hyphae, continuous below hymenium, 43 – 64 µm thick;



epihymenium red brown, K+ violet, up to 17 µm thick; hymenium hyaline, up to 47 µm thick; hypothecium slightly yellow, up to 35 µm thick; paraphyses branched and anastamosing. Ascus 8 spored, cylindrical, 42 – 44 × 8 – 9 µm; ascospores hyaline, transversely 7 – 12 septate, acicular, 20.3 – 45.3 × 3.1 – 5.3 µm.

Chemistry: Thallus K-, C-, KC-, P-. Epihymenium K+ violet. TLC: Triterpene like spots at Rf class 6 and 7.

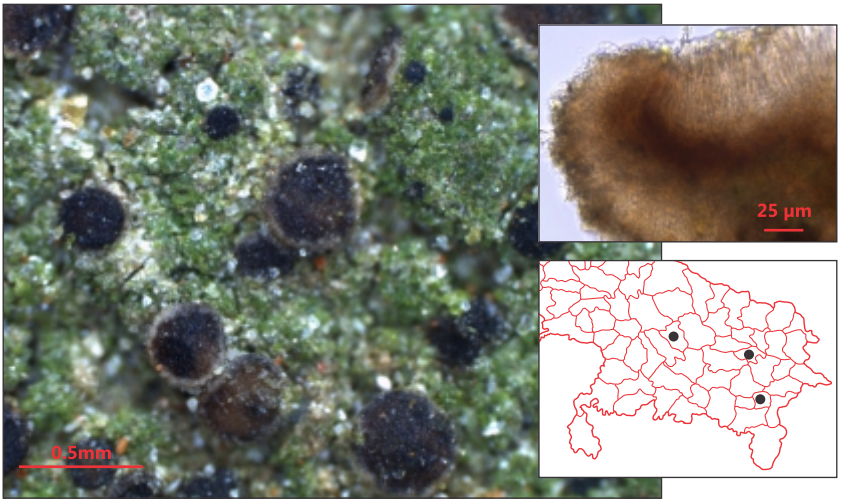
Comments: *Bacidia alutacea* is a common species in Uttar Pradesh and found growing on various trees including *Mangifera indica* and *Syzygium cumini* in moist deciduous forests and mango orchards. It differs from other species of *Bacidia* known from the region with K+ violet epihymenium.

Bacidia arnoldiana Körber

Parerga Lichenol.: 134. 1860.

Thallus saxicolous, crustose, rough, irregular, cracked areolate, greenish to greenish grey. Apothecia numerous, round, sessile, 0.1 – 0.4 mm diam.; margin prominent, thinning at maturity, biatorine, paler than the disc; disc dark brown to black, plane to convex, epruinose. Exciple pale brown to brown, 50 – 75 µm thick; epihymenium greenish brown to brown, K-, 10 – 15 µm thick; hymenium hyaline to pale yellow, I+ blue changing to orange red, 36 – 54 µm thick; hypothecium dark brown, 30 – 48 µm thick; paraphyses simple to sparingly branched, apical cell swollen and pigmented. Asci 8 spored, clavate, 35 – 50 × 10 – 15 µm; ascospores hyaline, acicular, transversely 3 – 5 septate, 30 – 46 × 0.8 – 1.6 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

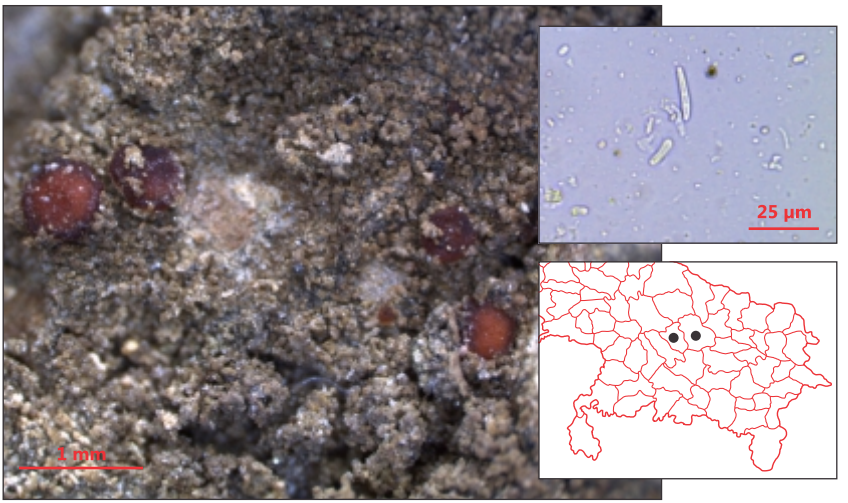


Comments: *Bacidia arnoldiana* is a common species of *Bacidia* occurring on rocks in exposed areas. One of the specimens was found growing on the cement plasters of boundary wall of CSIR-National Botanical Research Institute, Lucknow.

Bacidia convexula (Müll. Arg.) Zahlbr.

Cat. Lich. Univers. 4: 188. 1926. – *Patellaria convexula* Müll. *Arg., J. Linn. Soc., Bot.* 29: 222. 1892.

Thallus corticolous, crustose, granular to furfuraceous, greyish green.



Apothecia frequent, sessile, biatorine, 0.1 – 0.6 mm in diam.; margin thin, excluded when mature, reddish brown, biatorine, darker than the disc; disc reddish brown, plane to convex. Exciple hyaline to yellowish, 85 – 128 µm thick; epihymenium yellowish, K-, 11 – 20 µm thick; hymenium hyaline, 86 – 118 µm thick; hypothecium hyaline, 42 – 86 µm thick; paraphyses simple to branched, apical cell swollen. Asci 8 spored, cylindrical to clavate, 45 – 53 × 9 – 11 µm; ascospores hyaline, fusiform to acicular, transversely 3 – 5 septate, 18.1 – 30.9 × 1.9 – 4.9 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

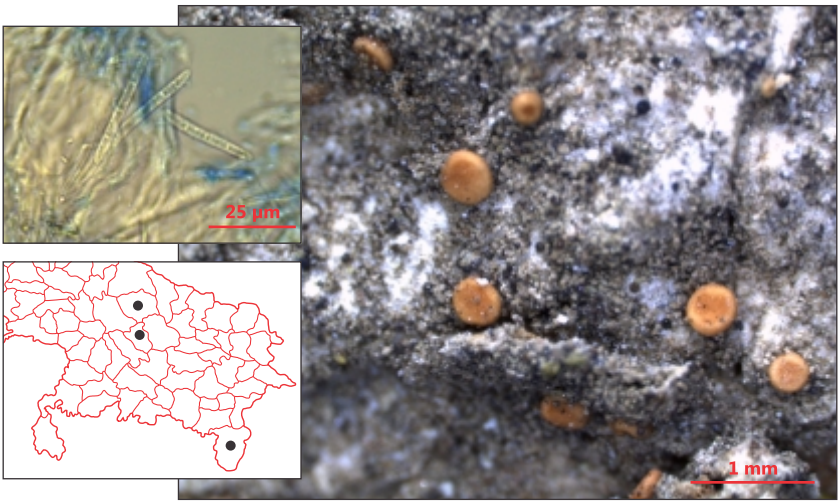
Comments: *Bacidia convexula* is a common species in Uttar Pradesh mostly found growing on the *Mangifera indica* tree trunks in mango orchards. It can be identified by its powdery thallus and reddish brown apothecia.

Bacidia incongruens (Stirton) Zahlbr.

Cat. Lich. Univ. 4: 208. 1926. –*Lecidea incongruens Stirton, Proc. Roy. Soc. Glasgow* 2: 314. 1879.

Thallus corticolous, crustose, whitish grey to greenish grey, scurfy to granular. Apothecia frequent, 2 – 5 mm diam.; margin prominent, smooth, biatorine, paler than the disc; disc yellow orange, plane to concave, rarely convex, epruinose. Exciple biatorine, hyaline, hyphae radiating, 44 – 64 µm thick; epihymenium K-, KI+ blue, I+ blue, 14 – 18 µm thick; hymenium hyaline, KI+ blue, I+ blue, 55 – 89 µm thick; paraphyses simple to branched, apical cell slightly thickened. Ascus 8 spored, cylindrical to clavate, 42 – 56 × 10 – 13 µm; ascospores hyaline, rod shaped to fusiform, transversely 2 – 3(-5) septate, 19.9 – 35.4 × 2.4 – 3.9 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.



Comments: *Bacidia incongruens* is a common species and easily identifiable due to its small, yellow-orange apothecia and 3 – 5 septate ascospores. However, the ascospores size of the Uttar Pradesh samples are slightly larger than the other Indian specimens as denoted in microlichen key of Awasthi (1991). It is found growing mostly on variety of trees such as such as *Artocarpus heterophyllus, Azadirachta indica, Madhuca indica, Mangifera indica,* and palm trees in orchard areas and along road side.

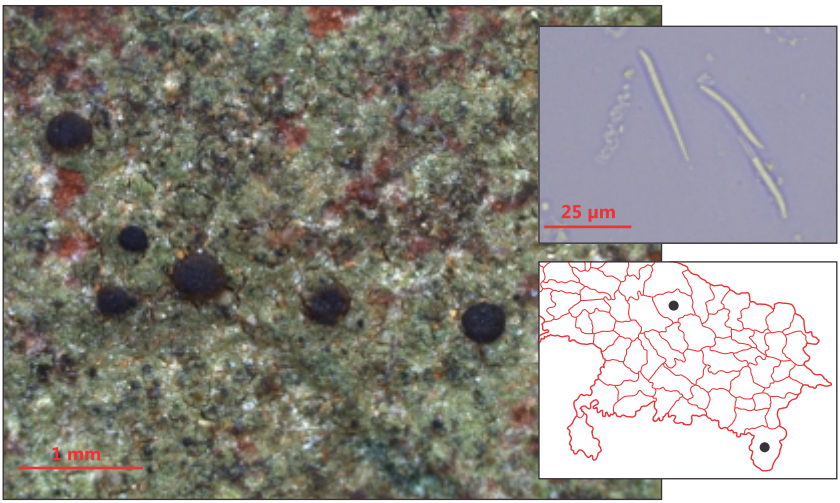
A large number of samples of *B. incogruens* are earlier identified as *B. medialis* (Tuck. in Nyl.) Zahblr., based on the septation of the ascospores (3 – 5) and yellowish tinge in apothecia. However, *B. medialis* clearly differs from *B. incongruens* with yellow brown to reddish brown apothecia.

Bacidia inundata (Fr.) Körber

Syst. Lich. Germ.: 187. 1855. – *Biatora inundata* Fr., *Kongl. Vetensk-Acad. Nya Handl.*: 270. 1822.

Thallus saxicolous, crustose, slightly granular, yellowish green. Apothecia round, sessile, 0.1 – 0.4 mm diam.; margin entire, thinning and excluded at maturity, biatorine, paler than the disc; disc brown, dark brown to blackish, plane to convex, epruinose. Exciple pale to dark brown, 30 – 50 µm, K+ greenish to violet; epihymenium pale brown to brown, 6 – 12 µm thick, K-; hymenium hyaline, 40 – 48 µm thick; hypothecium brown to dark brown, K+ violet, 40 – 48 µm thick; paraphyses simple to branched, apical cell swollen and pigmented. Asci 8 spored, clavate, 40 – 44 × 8 – 10 µm; ascospores hyaline, acicular, transeversely 3 septate, 27 – 45 × 1.6 – 2.4 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.



Comments: *Bacidia inundata* is a rare lichen species in Uttar Pradesh found growing on exposed rocks. One of the specimens was encountered on the bricks of an old monument Raja Sahib's fort in Sitapur district.

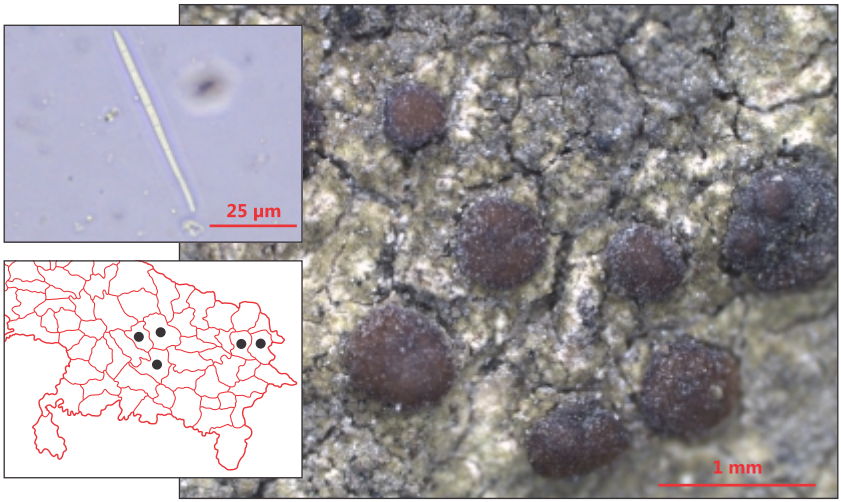
Bacidia laurocerasi (Delise ex Duby) Ozenda & Clauz. In Zahlbr.

Cat. Lich. Univers. 4: 213. 1926. – *Patellaria laurocerasi* Delise ex Duby, *Bot. Gall.* 2: 653. 1830.

Thallus corticolous, crustose, rough to cracked areolate, yellowish green to greenish grey, thin. Apothecia frequent, sessile, 0.3 – 1.0 mm in diam.; margin thick and prominent when young, thinning and excluded at maturity, biatorine, pinkish, paler than the disc; disc pinkish brown, later reddish brown and dark brown, concave, plane to convex, epruinose. Exciple hyaline to pale yellow, 46 – 72 µm thick; epihymenium brown to dark brown, 10 – 16 µm thick, K-; hymenium hyaline, 58 – 84 µm thick; hypothecium yellowish to brown, 52 – 78 µm thick; paraphyses simple to branched, apical cell swollen. Asci 8 spored, clavate, 50 – 65 × 14 – 20 µm; ascospores hyaline, acicular, transversely 8 – 12 septate, 38 – 62 × 2.4 – 3.2 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: Unknown triterpenes at Rf. Class 6 – 7.

Comments: *Bacidia laurocerasi* is a common lichen species in Uttar Pradesh found growing on various trees like *Artocarpus heterophyllus, Mangifera indica* and *Syzygium cumini* in mango orchards. The species can identifiable from its pinkish tinged apothecia, with thick margin especially when young.



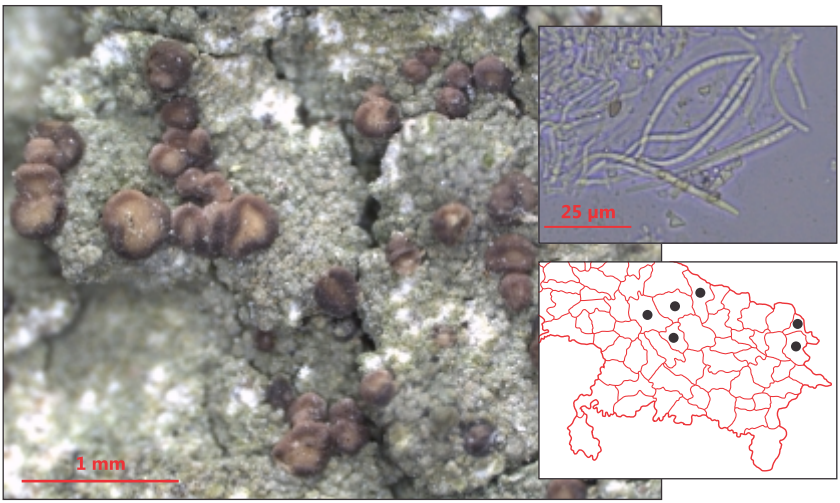
Bacidia millegrana (Taylor) Zahlbr. in Wawra & Beck

Itin. Princip. Coburg. 2: 152. 1888. – *Lecanora millegrana* Taylor in Hook., *London J. Bot.* 6: 159. 1847.

Thallus corticolous, crustose, rough, verruculose to granulose, greenish to whitish grey, prothallus whitish to brown. Apothecia frequent, mostly round, sessile, 0.2 – 1.0 mm diam.; margin persistent, initially thick and then thinning at maturity, biatorine, darker than the disc, pinkish brown to brown and sometimes dark brown; disc pale orange to brownish, plane to slightly convex, epruinose. Exciple pale yellow to brownish, 60 – 80 µm thick; epihymenium pale brown to brown, K-, 10 – 15 µm thick; hymenium hyaline, 72 – 88 µm thick; hypothecium pale yellow, 40 – 64 µm thick; paraphyses simple to branched, apical cell slightly swollen. Asci 8 spored, clavate, 65 – 77 × 15 – 20 µm; ascospores hyaline, acicular, transversely 10 – 15 septate, 42.2 – 68.5 × 3.2 – 4.1 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P± yellow. TLC: Atranorin, triterpene at Rf class 5.

Comments: *Bacidia millegrana* is a common species in Uttar Pradesh found growing on variety of trees including *Litchi chinensis, Mangifera indica, Polyalthia* sp., *Prosopis* sp., and *Shorea robusta* in orchard areas and saal forest. *B. millegrana* can be distinguishable from other species with its paler apothecia, verrucose and K+ yellow thallus.

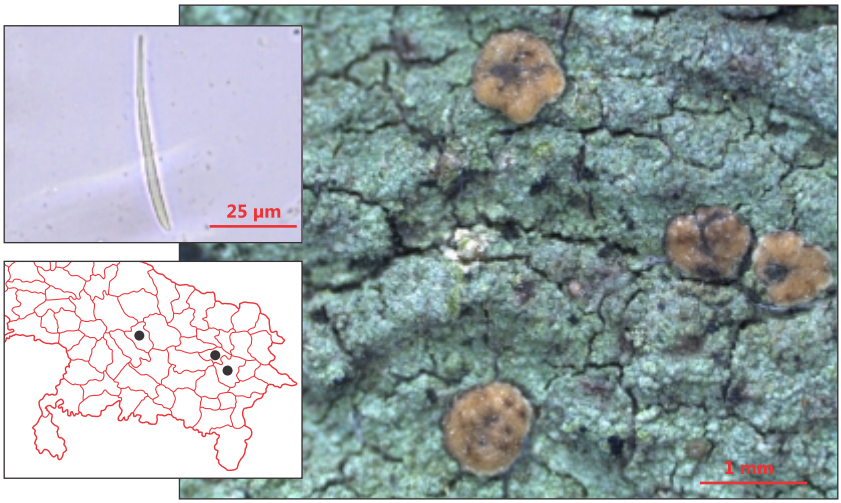


Bacidia rubella (Hoffm.) A. Massal.

Ric. Auton. Lich. Crost.: 118. 1852. – *Verrucaria rubella* Hoffm., *Deutschl. Fl.* 2: 174. 1796.

Thallus corticolous, crustose, thin, rough, verruculose to scurfy, cracked areolate, greenish grey. Apothecia frequent, sessile, mostly round, 0.2 – 1.3 mm diam.; margin biatorine, brown, moderately thick and darker when young, thinning and excluded at maturity; disc yellow to orange brown, plane to slightly convex. Exciple pale brown, 40 – 85 µm thick; epihymenium pale brown, 9 – 16 µm thick, K-; hymenium hyaline to yellowish, 50 – 70 µm thick; hypothecium yellowish to pale brown, 30 – 45 µm thick; paraphyses simple to branched, apical cell swollen and pigmented. Asci 8 spored, clavate 45 – 55 × 16 – 18 µm; ascospores hyaline, acicular, transversely 6 – 12 septate, 38.8 – 64.3 × 2.4 – 3.2 µm.

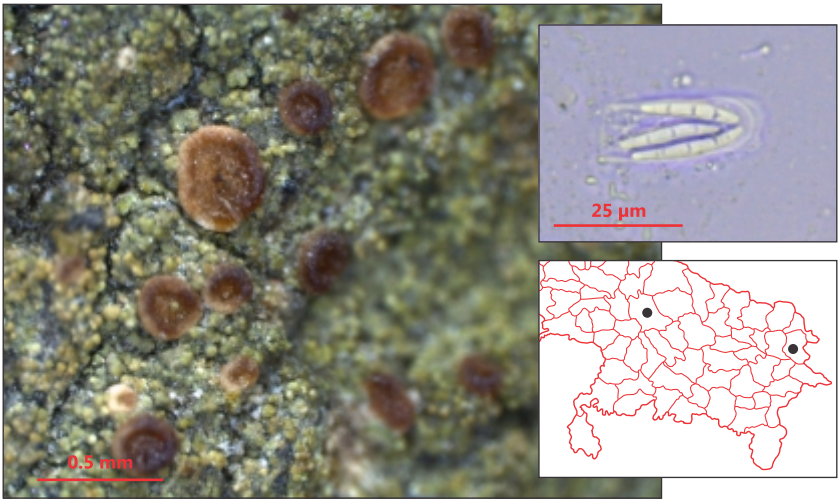
Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.



Comments: *Bacidia rubell*a is a common lichen species in Uttar Pradesh, found growing on *Mangifera indica* and *Shorea robust*a tree trunks in orchard and saal forest. The species is characterized by its yellow to orange brown apothecia and greenish grey, cracked areolate thallus.

Bacidia rufescens (Müll. Arg.) Zahlbr.

Cat. Lich. Univers. 4: 239. 1926. – *Patellaria rufescens* Müll. Arg., *Flora* 67: 467. 1884.



Thallus corticolous, crustose, rough, verruculose to granular, uneven, cracked, greenish grey. Apothecia frequent, sessile, round, 0.1 – 0.5 mm diam.; margin prominent, initially thick, thinning and indistinct at maturity, biatorine, concolours with the disc or slightly darker, yellow brown; disc yellow brown to reddish brown, epruinose, plane to slightly convex. Exciple hyaline or pale yellow, 64 – 75 µm thick; epihymenium pale brown, 8 – 10 µm thick, K-; hymenium hyaline, 54 – 72 µm thick; hypothecium pale yellow, 40 – 46 µm thick; paraphyses simple to branched, apical cell swollen. Asci 8 spored, clavate, 45 – 65 × 10 – 15 µm; ascospores hyaline, rod shaped, transversely 3 – 5 septate, 20.2 – 24.4 × 3.1 – 3.4 µm.

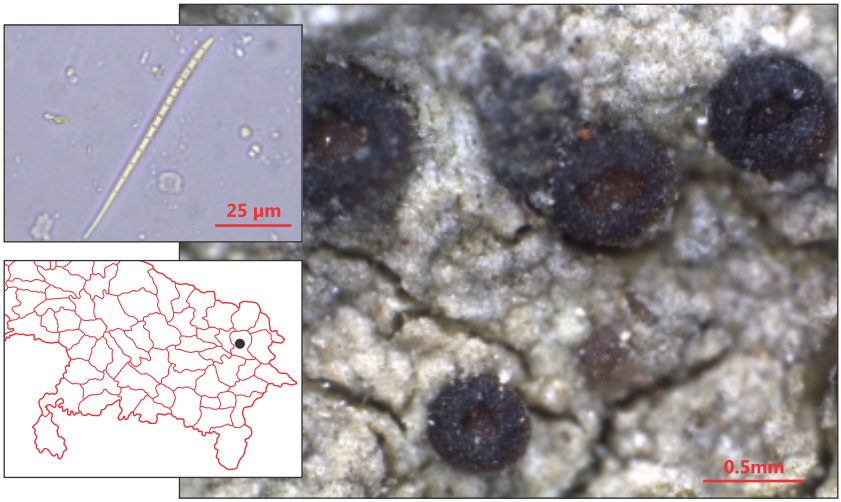
Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Bacidia rufescens* showed its rare occurrence in Uttar Pradesh found growing on *Mangifera indica* trees in mango orchard. It is characterized by yellowish brown to reddish brown apothecia, verruculose thallus and rod shaped, 3 – 5 septate ascospores.

Bacidia spadicea (Ach.) Zahlbr.

Denkschr. Kaiserl. Akad. Wiss., Wien. Math. Naturwiss. Kl. 83: 128. 1909. – *Lecidea spadicea* Ach., *Syn. Meth. Lich.*: 34. 1814.

Thallus corticolous, crustose, rough, verruculose to granular, cracked, yellowish or greenish grey. Apothecia mostly round, some mature apothecia dilated to irregular, sessile, 0.2 – 0.8(-1.0) mm diam.; margin smooth,



sometimes wavy, biatorine to lecidine, concolours with disc or much darker, brown to dark brown, mostly above the level of disc, thinning and excluded at maturity; disc plane to concave, mature apothecia slightly convex, epruinose, brown, dark brown to blackish. Epihymenium pale brown to brown, 8–10 µm thick; hymenium hyaline, 55–75 µm thick; hypothecium pale brown to brown, 30–54 µm thick; paraphyses simple to branched, apical cell swollen. Asci 8 spored, clavate, 44–65 × 13–17 µm; ascospores hyaline, acicular, transversely 7–15 septate, 45.1–65.4(–72.0) × 3.5–4.2 µm.

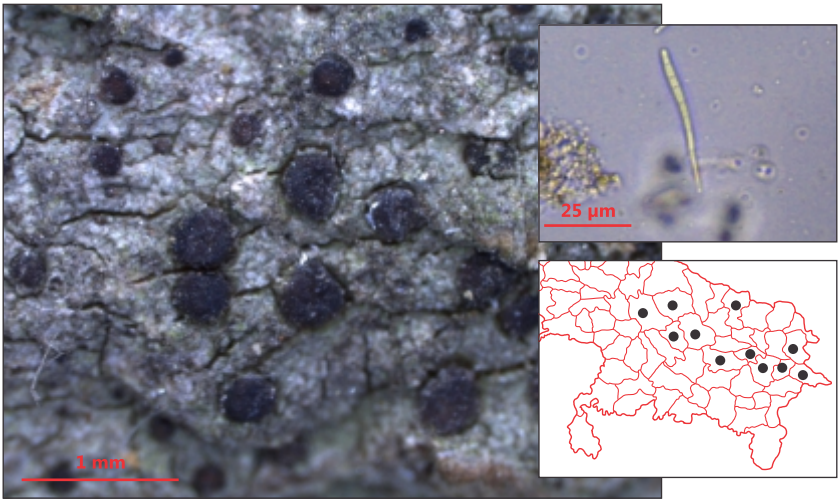
Chemistry: Thallus K+, C-, KC-, P-. TLC: Atranorin.

Comments: *Bacidia spadicea* is a rare species in Uttar Pradesh found growing on *Mangifera indica* and *Syzygium cumini* trees in mango orchard and saal forest. The species has prominently dark brown apothecia, verruculose, K+ yellow thallus.

Bacidia submedialis (Nyl.) Zahlbr.

Cat. Lich. Univers. 4: 243. 1926. – *Lecidea submedialis* Nyl., *Acta Soc. Sci. Fenn.* 26(10): 14. 1900.

Thallus corticolous, crustose, granulose to verruculose, whitish grey to grey. Apothecia numerous, sessile, round, 0.2–0.8 mm diam.; margin thin, biatorine, darker than disc, excluded in mature apothecia; disc pale brown when young, becoming darker with age, plane to slightly convex. Exciple brown, continuous below hymenium, 58–78 µm thick when young;



epihymenium pale brown, K-, 10 – 16 µm thick; hymenium hyaline, 50 – 56 µm thick; hypothecium slightly yellowish, up to 55 µm thick; paraphyses branched and anastamosing. Ascus 8 – spored, cylindrical to clavate, 44 – 54 × 9 – 11 µm; ascospores hyaline, acicular, transversely (–3)6 – (–7)9 septate, 31.4 – 40.9 × 3.0 – 3.8 µm.

Chemistry: Thallus K± yellow, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Bacidia submedialis* is one of the common species in Uttar Pradesh. It is found growing on various trees including *Artocarpus heterophyllus, Madhuca indica*, *Mangifera indica,* and *Syzygium cumini* in orchard and deciduous forest. It is characterized by whitish grey, rough thallus, brown apothecia and up to 9 septate, acicular ascospores.

Bacidiospora Kalb (Family: Ramalinaceae)

Lich. Neotr. Fascl. 10: 4. 1988.

Thallus squamulose, corticolous or saxicolous; photobiont green alga, a member of Chlorococcaceae. Ascomata apothecia, sessile, rounded, biatorine. Exciple para or prosoplectenchymatous; paraphyses sparingly branched with hyaline or pigmented apices, or branched and anastomosing. Asci 8 spored, tholus I+ blue; ascospores hyaline, acicular, ellipsoid or bacillary. Pycnoconidia filiform and curved. Homosekikaik and hyperhomosekikaik acids are present in thallus.

World wide 5 species; India 1 species; Literature: Kalb 1988; Awasthi 1991.

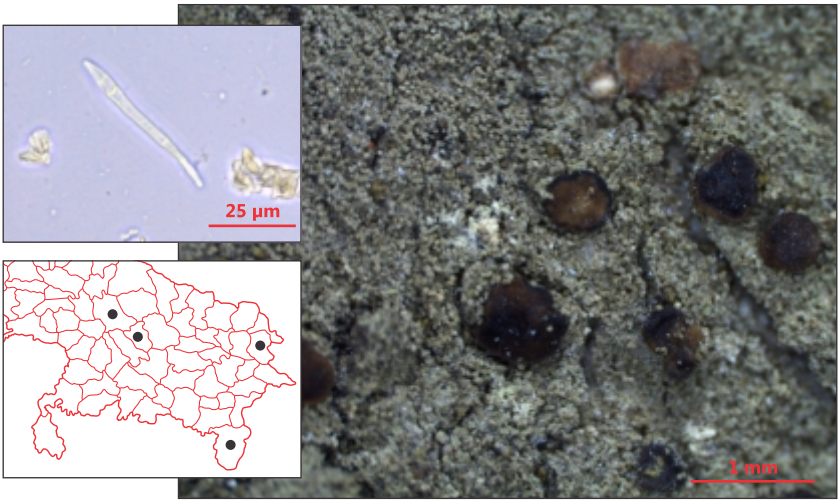
Bacidiospora psorina (Nyl. in Hue) Kalb

Biblioth. Lichenol. 88: 305. 2004. – *Lecidea psorina* Nyl. ex Hue, *Nouv. Arch. Mus. Hist. Nat., ser.* 3(3): 120. 1891.

Thallus corticolous, crustose, granular to minute squamulose, greenish grey, continuous, ecorticate. Apothecia numerous, round, sessile, 0.4 – 0.7 mm diam.; margin prominent, thick when young, thinning and excluding at maturity, smooth to flexuouse, biatorine, concolours with disc or darker, brown; disc pale orange-pinkish, brown and turning dark brown at maturing, plane to convex, epruinose. Exciple hyaline to pale brown, continuous below hypothecium, K-, 50 – 72 µm thick; epihymenium hyaline to pale brown, K-, KI+ blue, 9 – 12 µm thick; hymenium hyaline to pale brown at maturity, K-, KI+ blue, 69 – 84 µm; hypothecium hyaline to pale brown, K-, KI-; paraphyses branched, anastamosing, conglutinated, slightly swollen at tips. Ascus 8 spored, clavate, KI+ blue, 44 – 74 × 12 – 19 µm; ascospores hyaline, acicular, transversely 4 – 12 septate, not easily dischargeable from asci, 40.8 – 64.5 × 2.9 – 6.5 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Bacidiospora psorina* is a common lichen species in Uttar Pradesh found growing on *Mangifera indica* and other trees in mango orchard and deciduous forest. It is characterized by granular to minute squamulose thallus, brown apothecia and up to 12 septate, acicular ascospores.



Baculifera Marbach & Kalb (Family: Physciaceae)

Biblioth. Lichenol. 74: 113. 2000.

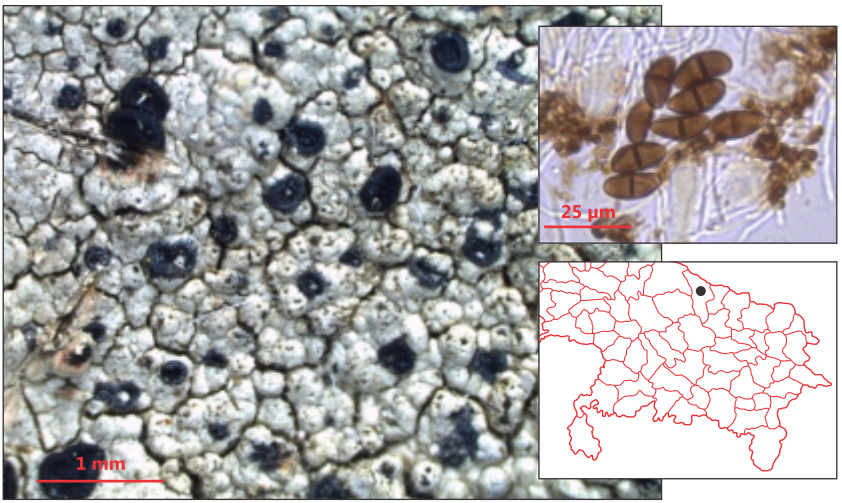
Thallus crustose, smooth to granulose-verrucose, rimose areolate or truly areolate, thick and well developed, saxicolous or corticolous; photobiont green alga, *Trebouxia*. Ascomata apothecia, dark brown to black, round, rarely irregular in outline, sessile, adnate to immersed, lecideine. Exciple indistinctly or distinctly cellular; epihymenium brown to olive-brown; hymenium lacking oil inspersion; hypothecium hyaline to brown; paraphyses septate, simple to apically branched, capitate, brownish-black at apices, conglutinated. Asci usually 8 spored rarely 16 spored; ascospores pale brown to dark-brown, 1 septate, wall uniformly thickened or unevenly thickened (mischoblastio-morphic or placodiomorphic), surface smooth or ornamented. Conidia elongate bacilliform. Norstictic acid present.

World wide 14 species; India 2 species; Literature: Marbach 2000; Awasthi 1991.

Baculifera remensa (Stirton) Marbach

Biblioth. Lichenol. 74: 144. 2000. – *Lecidea remensa* Stirt., *Trans. Glasgow Soc. Field Naturalist* 4: 166. 1876.

Thallus corticolous, crustose, rough to verrucose, cracked areolate, whitish grey. Apothecia innate to sessile, round to irregular; margin lecidine, black, prominent; disc black, mostly concave, epruinose. Exciple dark brown, 45 – 70 µm thick; epihymenium brown, 10 – 14 µm thick; hymenium pale yellow, lacking oil globules, 48 – 62 µm thick; hypothecium brown to dark brown, 45 – 70 µm thick; paraphyses simple, apical cell swollen and brown pigmented.



Asci 8 spored, cylindrical to clavate, 36 -48 × 10 – 15 µm; ascospores brown, transversely 1 septate, oblong, 14.2 – 18.1 × 5.8 – 8.3 µm.

Chemistry: Thallus and medulla K+ red, C-, KC-, P+ yellow. TLC: Norstictic acid present.

Comments: *Baculifera remensa* is a rare species in Uttar Pradesh, found growing on bark of trees in deciduous forests. It is characterized by verruculose, whitish grey, K+ red, P+ yellow thallus, and black apothecia.

Buellia de Not. (Family: Physciaceae)

Giorn. Bot. Ital. 2(1,1): 195. 1846

Thallus crustose, smooth to granulase-verrucose, rimose-areolate or truly areolate, hypothallus rarely present, saxicolous or corticolous; photobiont green alga, *Trebouxia*. Ascomata apothecia, dark brown to black, round, rarely irregular in outline, sessile, adnate to immersed, lecideine. Exciple indistinctly or distinctly cellular; epihymenium brown to olive-brown; hymenium with or without oil globules; hypothecium brown; paraphyses septate, simple to apically branched, capitate, brownish-black at apices, conglutinated. Asci usually 8 spored; ascospores pale brown to dark-brown, 1 septate to submuriform, wall uniformly thickened or unevenly thickened (mischoblastiomorphic or placodiomorphic type), surface smooth or ornamented.

World wide 455 species; India 41 species; Literature: Marbarch 2000; Singh & Awasthi 1981.

Key to the species of *Buellia*

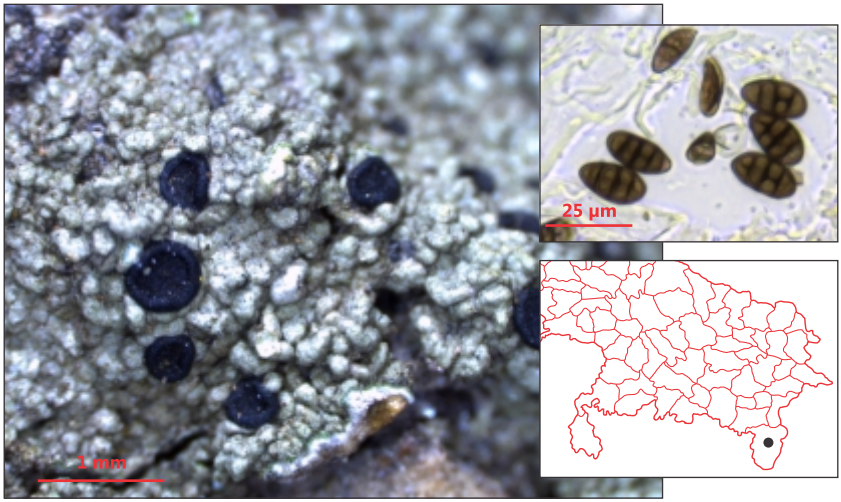
1a. Ascospores submuriform, transversely 3 – 5 septate, vertically up to 2 septate, atranorin present . . . . . *B. alboatrior*

1b. Ascospores transversely 1 septate, with 2 – 3 pseudo-locules on either side of septa, norstictic acid present . . . . *B. almorensis*

Buellia alboatrior (Nyl.) Zahlbr.

Cat. Lich. Univers. 7: 441. 1931. – *Lecidea alboatrior* Nyl., *Flora* 52: 71. 1869.

Thallus corticolous, crustose, rough, verrucose, whitish grey. Apothecia frequent, sessile, 0.7 – 6.7 mm diam.; margin lecidine, black; disc black, rough, epruinose, flat to concave. Exciple brown, 54 – 72 µm thick; epihymenium brown, 8 – 12 µm thick; hymenium hyaline, clear, 52 – 68 µm thick; hypothecium brown to dark brown; 16 – 30 µm thick. Ascus 8 spored, cylindrical to clavate, 55 – 63 × 14 – 20 µm; ascospores brown, ellipsoid to ovate, submuriform, transversely 3 – 5 septate, vertically 0 – 2 septa per cell, surface ornamented, 18.5 – 24.2 × 7.7 – 10.2 µm.



Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin present.

Comments: *Buellia alboatrior* is a rare lichen species in Uttar Pradesh, found growing in association with *Lecanora* spp. on *Acacia nilotica* tree trunk along road side plantation.

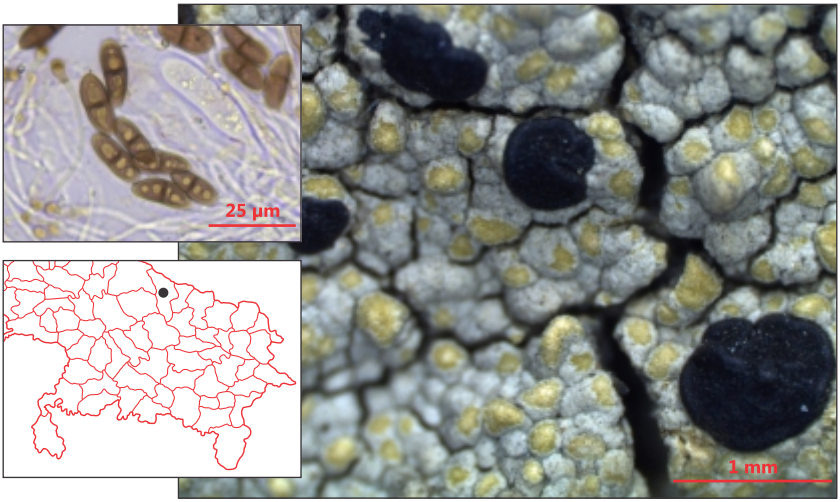
Buellia almorensis S. Singh & D.D. Awasthi

Biol. Mem. 6(2): 173. 1981.

Thallus corticolous, crustose, rough to verruculose, cracked areolate, decorticated areas yellowish. Apothecia round, innate, 03 – 0.8 mm diam.; margin lecidine, black, thin; disc black, rough, plane to concave. Exciple brown, much darker inwards, 71 – 80 µm thick; epihymenium brown, 6 – 14 µm thick; hymenium clear, pale yellow, 55 – 74 µm; hypothecium pale brown to brown, 39 – 58 µm thick, paraphyses simple to branched, apical cells swollen and brown pigmented. Asci 8 spored, cylindrical to clavate, 41 – 64 × 11 – 16 µm; ascospores brown, ellipsoid to oblong, transversely 1 septate, with 2 – 3 pseudo-locules on either side of septa, surface ornamentation indistinct, 15.5 – 20.2 × 6.1 – 8.5 µm.

Chemistry: Thallus K+ yellow turning red, C-, KC-, P+ yellow. TLC: Norstictic acid present.

Comments: *Buellia almorensis* is a rare species in Uttar Pradesh, found growing on *Shorea robusta* tree trunk in saal forest. The species is characterized by from its black apothecia, whitish grey, rough, K+ red thallus, greenish yellow



decorticated portion, and peculiar ascospores that have 2 – 3 locules on either side of the middle septum.

Caloplaca Th. Fr. (Family: Teloschistaceae)

Lich. Arct.: 218. 1860.

Thallus crustose to squamulose, placodioid or crustose-effigurate at margins, yellowish-orange, red, brown-red to blackened, K+ purple or K-; photobiont green alga, *Trebouxia*. Ascomata apothecia, lecanorine or biatorine, round, orange, orange-red, rust-brown to black. Exciple biatorine or lecidine, sometime lecanorine; hypothecium usually hyaline; paraphyses simple, septate, capitates. Asci 8 spored; ascospores hyaline, thick walled, polaribilocular or rarely 3 loculed. Pycnoconidia short or long.

World wide 510 species; India 71 species; Literature: Joshi 2008.

Key to the species of *Caloplaca*

1a. Thallus isidiate or sorediate 2

1b. Isidia and soredia absent 6

2a. Thallus isidiate; isidia minute, simple, small to granular . . . . . *C. bassiae*

2b. Thallus sorediate 3

3a. Thallus saxicolous 4

3b. Thallus corticolous 5

4a. Soralia crateriform, thallus lemon yellow to orange yellow , K+ purple . . . . . *C. cupulifera*

4b. Soralia postulate, thallus whitish grey to grey, K+ yellow . . *C. subpoliotera*

5a. Thallus greenish-grey to greenish yellow, apothecia absent . . *C. phlogina*

5b. Thallus yellowish grey or creamish, soredia dense, apothecia present, orange brown . . . . . *C. granularis*

6a. Thallus rimose areolate, subeffigurate, orange to orange-red, saxicolous . . . . . *C. cinnabarina*

6b. Thallus otherwise 7

7a. Thallus squamulose to subsquamulose, K+ yellow, apothecia orange to olivaceous brown. . . . . *C. poliotera*

7b. Thallus indistinct, reduced 8

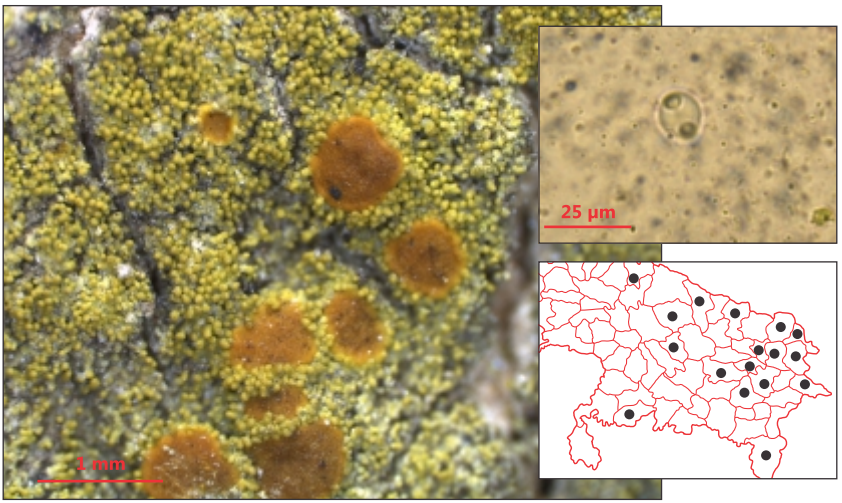
8a. Apothecia orange to orange brown with dark brown to black margin, thallus reduced, whitish grey. . . . . *C. tropica*

8b. Apothecia yellow to orange or reddish orange, thallus present around apothecia, yellowish . . . . . *C. vitellinula*

Caloplaca bassiae (Willd. ex Ach.) Zahlbr.

Cat. Lich. Univers. 7: 78. 1930. – *Lepraria bassiae* Willd. ex Ach., *Methodus*: 5. 1803.

Thallus corticolous, crustose, thin, yellowish to greenish yellow, isidiate; isidia simple, rarely branched and coralloid, sometimes thallus appears completely granular due to minute isidia. Apothecia rare, most of the time thallus sterile, apothecia when present round, sessile, 0.3 – 0.5 mm diam.; margin thick, biatorine, paler than the disc, yellow, isidiate; disc yellow-orange, plane to



concave. Exciple biatorine, sometimes with algal cells, 55 – 73 µm thick; epihymenium yellowish to golden, K+ pink, 21 – 28 µm thick; hymenium hyaline, inspersed with oil globules, 51 – 64 µm thick; hypothecium hyaline, inspersed, 53 – 92 µm thick; paraphyses, simple to sparingly branched. Ascus 8 spored, clavate; ascospores hyaline, ellipsoid to oblong, transversely 1 septate, locules polaribilocular, 14.5 – 16.5 × 10.6 – 11.0 µm.

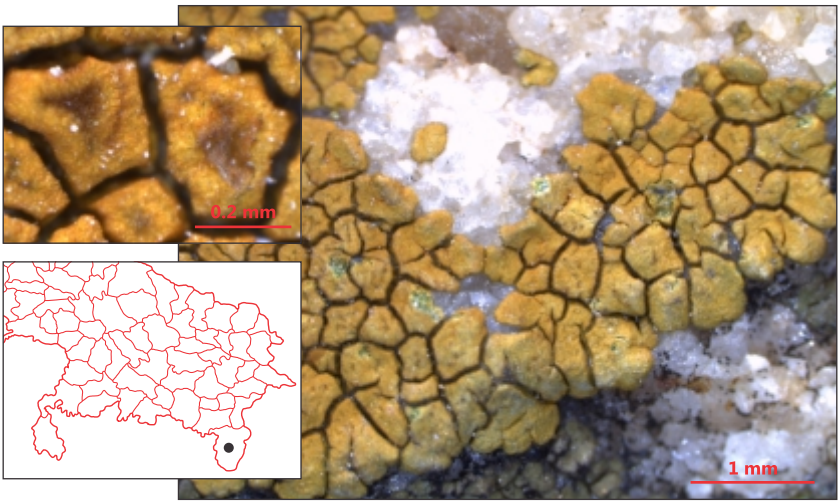
Chemistry: Thallus K+ yellow purple, C-, KC-, P-. TLC: Parietin present.

Note: *Caloplaca bassiae* is a most common and widely distributed species in Uttar Pradesh; found growing on variety of trees including *Artocarpus heterophyllus, Azadirachta indica, Litchi chinensis, Madhuca indica, Mangifera indica, Shorea robusta* and *Syzygium cumini*, in orchards as well as forest areas. In rare cases the species also occurs on rocks in shady and moist places. The species can be easily identifiable from its yellow to orange isidiate, K+ purple thallus. The species is mostly sterile and rarely produce yellow-orange apothecia. The exciple is biatorine, however sometimes it becomes lecanorine with algal cells.

Caloplaca cinnabarina (Ach.) Zahlbr. in Engl. & Prantl

Nat. Pflanzenfam. 1(1): 228. 1908. – *Lecanora cinnabarina* Ach., *Lichenogr. Universalis*: 402. 1810.

Thallus saxicolous, crustose, rimose areolate, subeffigurate, yellow-orange to orange-red, K+ purple. Apothecia numerous, at the centre of areole, sunken, solitary, rarely 2 – 3 confluent; margin slightly rising above the areole, biatorine, concolours with the thallus; disc darker than the thallus. Exciple with algal cells, 35 – 43 µm thick; epihymenium golden brown, K+ purple, 11 – 19 µm



thick; hymenium hyaline, 28 – 42 µm thick, hypothecium hyaline, 27 – 48 µm thick; paraphyses articulate, swollen to moniliform. Ascus 8 spored, clavate, 25 – 40 × 10 – 15 µm; ascospores hyaline, polaribilocular, ellipsoid to oblong, 8.2 – 12.4 × 3.4 – 6.3 µm.

Chemistry: Thallus and apothecia K+ purple, C-, KC-, P-. TLC: Parietin present.

Comments: *Caloplaca cinnabarina* is a common lichen species in Uttar Pradesh, however recorded from a single locality, Markundi Hills in Sonbhadra district. It is found growing on exposed rocks and readily identifiable with its yellow – orange colour, rimose areolate subeffigurate thallus that turns purple with K. Though apothecia are seen in most of the specimens, but the ascospores are rarely produced.

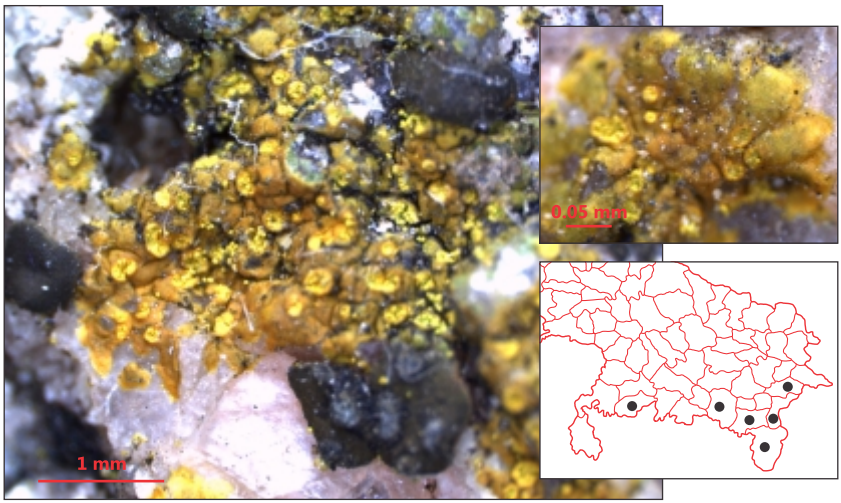
Caloplaca cupulifera (Vainio) Zahlbr.

Cat. Lich. Univers. 7: 226. 1931; – *Placodium cupuliferum* Vain., *Ann. Acad. Sci. Fenn., Ser.* A 6*(7)*: 44. 1915.

Thallus saxicolous, crustose, continuous to areolate, thin, lemon yellow to orange yellow, 2.0 – 10.0 mm across or neighbouring thallus coalescing to form large thallus; margin lobate, thinner; sorediate, soralia crateriform, forming cup like depression. Apothecia absent.

Chemistry: Thallus K+ purple, C-, KC-, P-. TLC: Parietin present.

Comments: *Caloplaca cupilifera* is a common species in Uttar Pradesh found growing on exposed rocks in association with other species of *Caloplaca* and



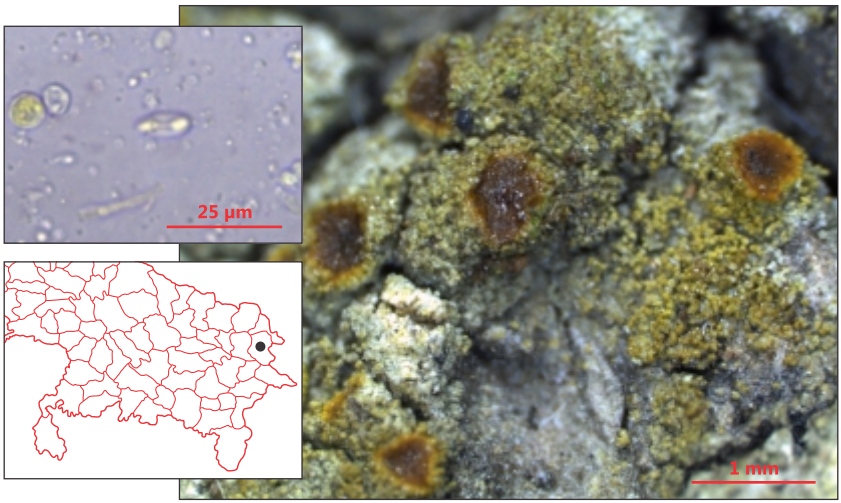
Peltula. It is a sterile lichen with striking yellow colouration and unique, crateriform or cup like soralia.

Caloplaca granularis (Müll. Arg.) Zahlbr.

Cat. Lich. Univers. 7: 41. 1930. – *Callopisma aurantiacum* var. *granulare* Müll. Arg., *Rev. Mycol. (Toulouse)* 10: 63. 1888.

Thallus corticolous, crustose, yellowish grey or creamish, occasionally with yellow tinge, especially around ascomata, sorediate; soredia granular, in advance stages thallus is completely sorediate and appearing leprose. Apothecia, rare to frequent, closely adnate to thallus, ± constricted at base, round to irregular, 0.3 – 0.8 mm diam.; margin thin to excluded, yellowish, granular; disc plane to concave, orange to brown, epruinose. Proper exciple 11 – 20 µm thick, hyaline, thalline exciple ±present, algal cell present below hypothecium; epihymenium golden brown, K+ pink to purple, KI+ blue, 24 – 31 µm thick; hymenium with abundant oil globules, hyaline, KI+ blue, 63 – 81 µm thick; hypothecium hyaline, 54 – 65 µm thick; paraphyses thin, septate, branched, articulate. Ascus 8 spored, clavate, 50 – 58 × 11 – 15 µm; ascospores hyaline, broadly ellipsoid to oblong, transversely 1 septate, polaribilocular, 12.2 – 17.1 × 6.0 – 8.8 µm.

Chemistry: Thallus K± pink, C-, KC-, P-. TLC – No chemicals or pale yellow spot at Rf class 6 – 7.



Comments: *Caloplaca granularis* is a rare lichen species in Uttar Pradesh, found growing on *Mangifera indica* trees in mango orchards. The species may be confused for leprose lichen (*Lepraria* sp.) due to its yellowish grey, granular sorediate thallus. It may also be confused for *Caloplaca bassiae*, as the small, granular isidia resembles soredia. However, isidia has smooth, shining surface. Joshi (2008) studied this species from Chakrata Hills of Uttarkhand where the material did not have any apothecia (sterile). Specimen from Uttar Pradesh is fertile and matches well with the description of *C. granularis*.

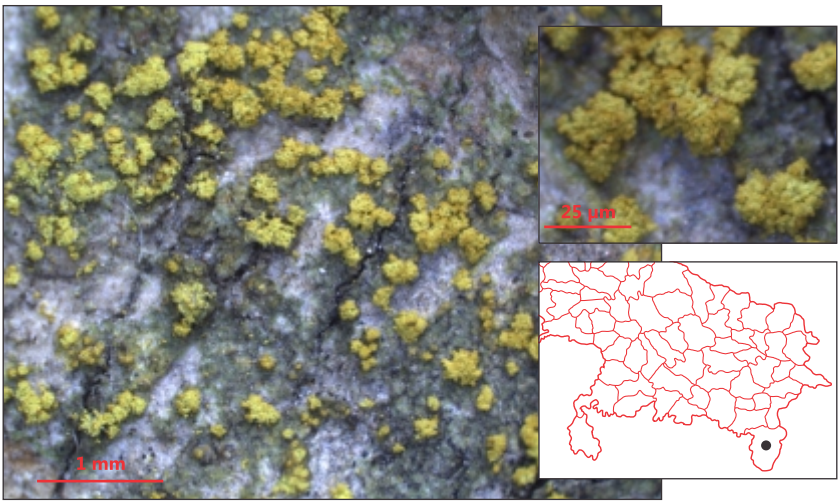
Caloplaca phlogina (Ach.) Flagey

Mem. Soc. D.Emulat. Doubs: 250. 1886. –*Parmelia citrina* var. *phlogina* Ach., *Methodus* 180. 1803.

Thallus corticolous, crustose, thin, greenish-grey to greenish yellow, continuous to patchy, sometimes neighbouring thallus coalescing, sorediate; soralia marginal to laminal, yellow to orange yellow, capitate, formed by breaking of thallus, projecting above the thallus. Apothecia absent.

Chemistry: Thallus K+ purple, C-, KC-, P-. TLC: Parietin present.

Comments: *Caloplaca phlogina* is a rare lichen species in Uttar Pradesh, found growing on the *Acacia nilotica* tree trunk along road side. It is characterized by greenish yellow, smaller, K+ purple thallus. The soralia initially develops from margin and at later stage spreads all over the thallus.



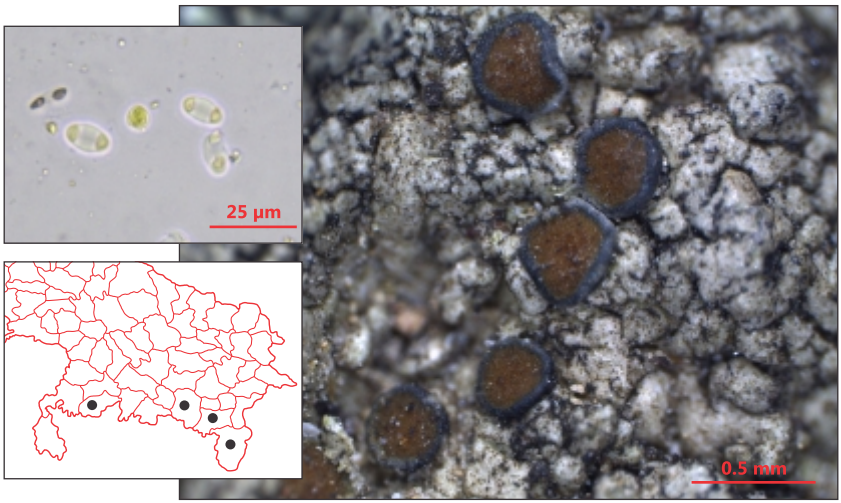
Caloplaca poliotera (Nyl.) Steiner

Sitzungsber Kaiserl Akad. Wiss., Wien, Math. Naturwiss. Cl. Abt. 1, 106: 219. 1897. – *Lecanora poliotera* Nyl., *Flora* 52: 70. 1869.

Thallus saxicolous, crustose, areolate, squamulose to subsquamulose, grey brown, K+ yellow, 13 – 3.0 cm across; areole or squamules plane to slightly convex, round to angular, 0.2 – 0.5 mm across; medulla white. Apothecia subimmersed to sessile, rare to numerous, scattered, sessile, 0.2 – 0.3 mm diam.; margin persistent, brown to black, occasionally lecanorine; disc orange brown to olivaceous brown. Exciple biotrine to lecidine, sometimes thalline with algal cells, K-, 37 – 61 µm thck; epihymenium golden brown, K+ purple, 18 – 20 µm thick; hymenium hyaline, inspersed with oil globules, I-, 44 – 52 µm; hypothecium hyaline; paraphyses articulate to moniliform, 48 – 51 µm. Ascus 8 spored, clavate, 25 – 34 × 7 – 10 µm; ascospores hyaline, ellipsoid, transversely 1 septate, polaribilocular, 11.4 – 12.3 × 6.7 – 7.3 µm. Pycnidia black, immersed, numerous, 1 – 3 per areole, 0.05 – 0.08 mm, round to flask shaped; conidia bacilliform, 3.4 – 4.3 × 0.7 – 0.9 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin and Parietin present.

Comments: *Caloplca poliotera* is a common species in Uttar Pradesh, found growing on rocks, both in exposed areas and shady, moist places. This species shows much variation in thallus and apothecial characters. The margin of apothecia is lecidine in most of the cases, however lecanorine margin with algal cell in the exciple are also may present in the same or different thallus. Pycnidia may be present or absent. Lichens with pycnidia reproduce with conidia and



hence mostly lack apothecia. The thallus can range from simple rimose, areolate condition to thick, subsquamulose to squamulose condition. Apothecia are usually sessile and constricted at base, but sometimes they may be subimmersed.

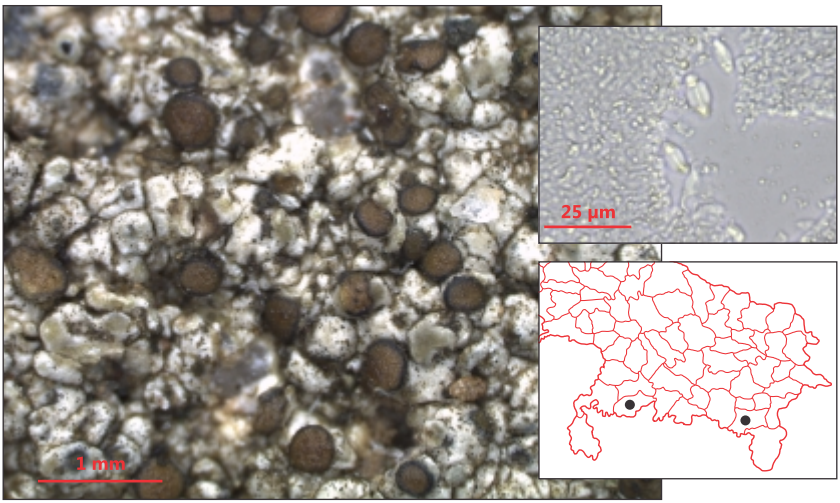
Caloplaca subpoliotera Y. Joshi & Upreti

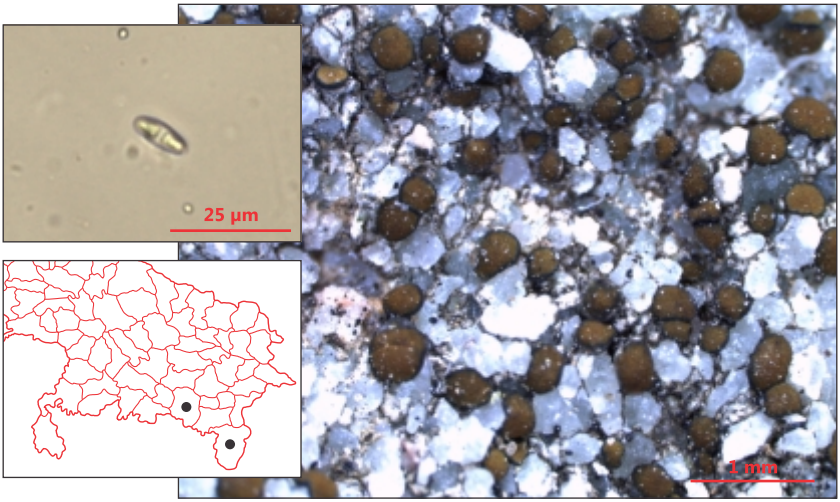
Nova Hedwigia 86(1-2): 269. 2008.

Thallus saxicolous, crustose, thin, rimose areolate, whitish grey to grey, coalescing with neighbouring thallus and spreading in to large area, sorediate; soralia pustulate, mostly laminal, white, fine granular. Apothecia few, scattered, sessile, round, 0.2 – 0.5 mm diam.; margin smooth, lecidine, dark brown to black; disc orange to orange brown, plane to slightly convex. Exciple darker towards cortex, hyaline or paler towards inwards, algal cell absent, 35 – 50 µm thick; epihymenium yellow brown to brown, 7 – 15 µm thick, K+ purple; hymenium hyaline, 28 – 42 µm thick; hypothecium hyaline, 25 – 35 µm thick; paraphyses simple to furcated, apical cells swollen. Asci 8 spored, clavate, 33 – 42 × 12 – 17 µm; ascospores hyaline, polaribilocular, narrowly ellipsoid, 6.1 – 12.3 × 4.2 – 5.1 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin present.

Comments: *Caloplaca subpoliotera* is a rare species in Uttar Pradesh found growing on exposed rocks. It is characterized by sorediate thallus and few apothecia with lecidine margin and orange brown disc. Lack of apothecia and presence of sorediate condition makes it appear mostly like a sterile lichen and hence probably only few specimens were being collected.





Caloplaca tropica Y. Joshi & Upreti

Lichenologist 39(6): 505. 2007.

Thallus saxicolous, crustose, indistinct, mostly present below apothecia or in crevices, whitish. Apothecia numerous, scattered, sessile, 0.3 – 0.4 mm diam.; margin lecidine, dark brown to black, persistent; disc orange to orange brown, plane to convex. Exciple brown outwards, hyaline inwards, algal cells absent, 17 – 25 µm thick; epihymenium yellow to golden brown, K+ pink, 9 – 14 µm; hymenium hyaline, 32 – 45 µm thick; hypothecium hyaline, 18 – 22 µm thick. Ascus 8 spored, clavate, 41 – 49 × 9 – 13 µm; ascospores hyaline, transversely 1 septate, narrowly ellipsoid, polaribilocular, 11.6 – 13.0 × 5.9 – 6.4 µm.

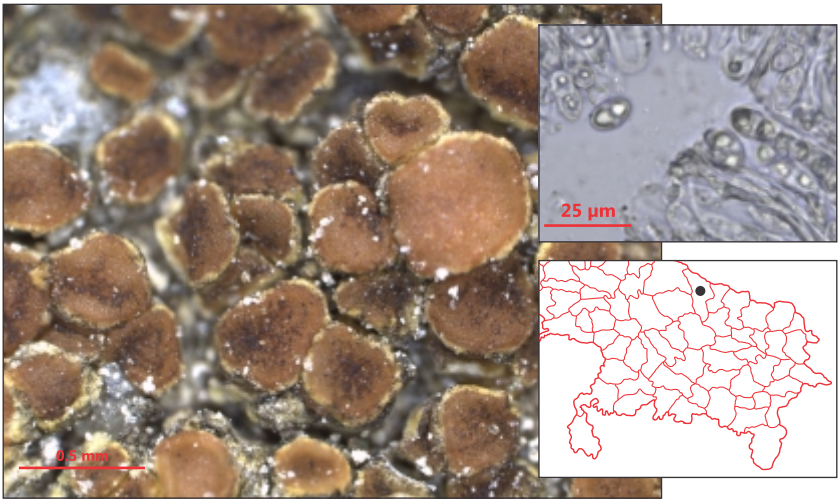
Chemistry: Thallus K-, C-, KC-, P-. TLC: Parietin present.

Comments: *Caloplaca tropica* is a common lichen species in Uttar Pradesh, found growing mostly on exposed, shining quartzite rocks. It can be readily identifiable due to its habitat and beautiful, small, dark brown margined, orange brown apothecia.

Caloplaca vitellinula (Nyl.) H. Olivier

Expos. Lich. Quest Fr. 1: 232. 1897. – *Lecanora vitellinula* Nyl. *Flora* 46: 305. 1863.

Thallus saxicolous, crustose, poorly developed, present around ascomata, yellow to yellowish orange. Apothecia numerous, clustered or closely placed, round to angular, 0.2 – 0.8 mm diam.; margin thin, biatorine, entire, pale or concolours to thallus; disc yellow to orange or reddish orange, plane to slightly



convex. Exciple hyaline, with algal cells, 25 – 30 µm thick; epihymenium golden brown, 11 – 14 µm thick, K+ purple; hymenium hyaline, 44 – 64 µm thick; hypothecium hyaline, 55 – 60 µm thick; paraphyses simple to furcated, apical cells swollen to capitate and wit oil globules. Asci 8 spored, clavate, 48 – 68 × 10 – 20 µm; ascospores hyaline, polaribilocular, ellipsoid, 11.8 – 15.2 × 6.5 – 8.2 µm.

Chemistry: Thallus K± purple, C-, KC-, P-. TLC: Parietin present.

Comments: *Caloplaca vitellinula* is a rare lichen species in Uttar Pradesh, found growing on cement plaster near river bridge in Katarniaghat Wildlife Sanctuary. It is characterized by crowded, yellow to orange apothecia and reduced thallus. Originally, the specimen of Uttar Pradesh was annotated as *Caloplaca lithophila* H. Magn. Regarding the nomenclature of *C. lithophila* there exists doubts and Arup (2009) treated this species as synonym of *C. vitellinula*, but with a '?' mark. However, he ascertained that *C. lithophila* is not a species of its own.

Chapsa A. Massal. (Family: Graphidaceae)

Atti I. R. Ist. Veneto Sci. Lett. Arti, ser. 3, 5: 256. 1860.

Thallus corticolous, continuous, fissured, endo or epiphloeodal, white, greenish grey, fawn, ecorticate or corticated, smooth, with a matt to glossy, mealy, compact or cartilaginous surface; prothallus line thin, brownish; photobiont green alga, often within the substrate; sometimes distinct layer of calcium oxalate crystals developed basal to photobiont layer; phenocortex present. Ascomata apothecia, *Chroodiscus* type, dispersed or in loosely

aggregated groups, rounded, angular or reniform, margin fissured to lobed. Proper exciple fused or free from thalline margin; periphysoids always free, perpendicular to proper exciple; paraphyses rigid or strongly conglutinated. Asci narrowly to broadly clavate, 1 – 8 spored; ascospores, hyaline or brown, transversely septate.

World wide 15 species; India 7 species; Literature: Mangold *et al.* 2009; Joshi *et al.* 2012.

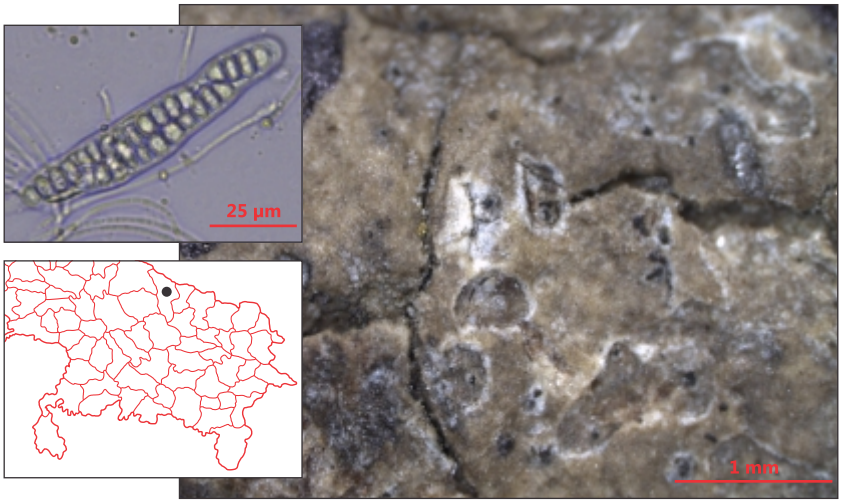
Chapsa alborosella (Nyl.) A. Frisch

Biblioth. Lichenol. 92: 90. 2006. – *Graphis alborosella* Nyl., *Ann. Sci. Nat., Bot., ser.* 4, 19: 372. 1863.

Thallus corticolous, crustose, ecorticate, epiphloeodal, olive green to grey. Apothecia to chroodiscoid, sunken or at the level of thallus, rounded to oblong or irregular, solitary to fused, 0.3 – 0.6 mm diam.; ascomatal disc ± exposed, pruinose. Proper exciple fused with thalline rim, hyaline; epihymenium hyaline to pale brown; hymenium clear, hyaline, 75 – 90 µm thick; paraphyses simple, straight, slightly thickened apically; lateral paraphyses inconspicuous. Asci 8 spored, 50 – 65 × 9 – 14 µm; ascospores hyaline, transversely 3 – 6 septate, oblong, ± rounded ends, I-, 19 – 23 × 6 – 7.8 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemical detected.

Comments: *Chapsa alborosella* is a rare species in Uttar Pradesh, found growing on tree bark in deciduous forest. It is characterized by chroodiscoid, oblong to irregular apothecia, transversely septate ascospores. On the contrary



to the description provided by Mangold *et al.* (2009) specimen of Uttar Pradesh has smooth thallus (not protruding) and ascospores were mostly 3 septate.

Chrysothrix Mont. (Family: Chrysotrichaceae)

Ann. Sci. Nat., Bot. ser. 3, 18: 312. 1852.

Thallus generally leprose, either byssaceous or crustose-leprose, thin or thick, ecorticate, yellow to yellowish-green, orange, composed of pulverulent, convex or spherical granules or anastomosing filaments, corticolous, lignicolous or saxicolous; photoblont a green alga. Ascomata apothecia, rare, innate or superficial with a thin non-corticate margin or immarginate. Exciple poorly developed; paraphyses septate, anastomosing above. Asci arrested bitunicate, 8 spored; ascospores hyaline, 1 – 3 septate, obovate to ellipsoid.

World wide 11 species; India 4 species; Literature: Awasthi 1991.

Key to the species of *Chrysothrix*

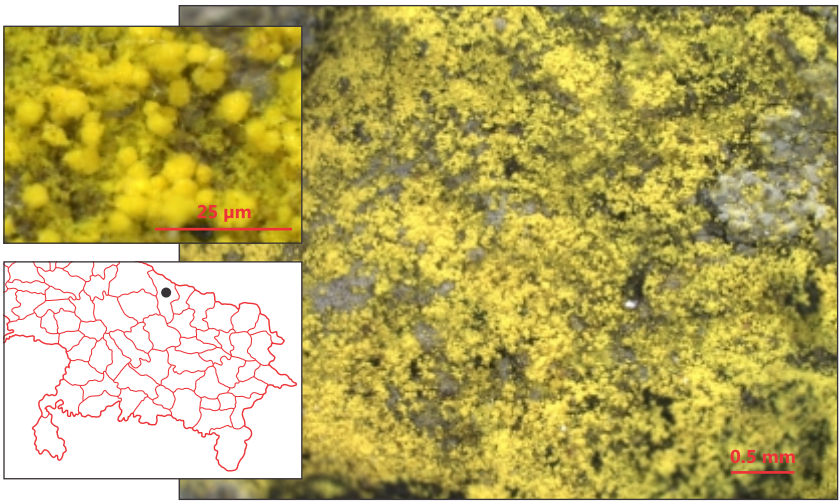
1a. Thallus yellow orange, calycin present . . . . . *C. candelaris*

1b. Thallus lemon yellow or greenish yellow, calycin and vulpinic acid present . . . . . *C. chlorina*

Chrysothrix candelaris (L.) J.R. Laundon

Lichenologist 13(2): 110. 1981. – *Byssus candelaris* L., *Sp. Pl.* 2: 1169. 1753.

Thallus corticolous, leprose, yellow orange; granules minute, 0.02 – 0.06 mm diam., with scarce hyphal filaments. Ascomata absent.



Chemistry: Thallus K-, C-, KC-, P-. TLC: Calycin present.

Comments: *Chrysothrix candelaris* is a rare lichen species in Uttar Pradesh, found growing on tree trunk in deciduous forest. It can be easily identifiable due to its yellow orange, powdery thallus.

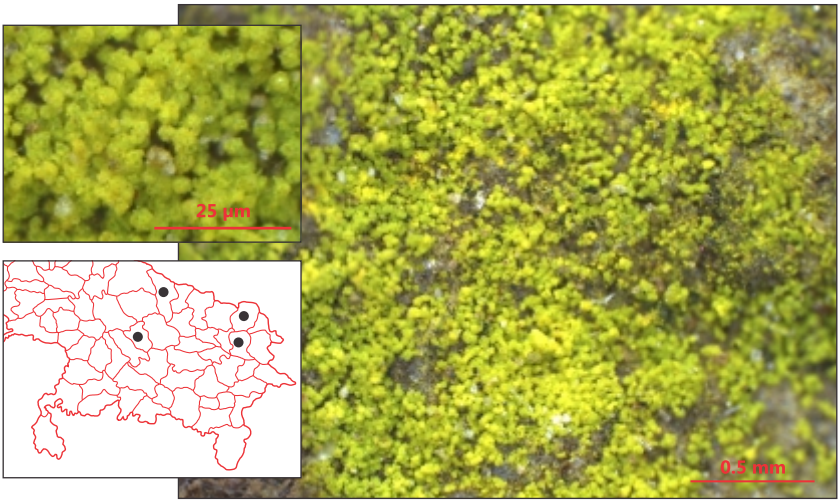
Chrysothrix chlorina (Ach.) J.R. Laundon

Lichenologist 13(2): 106. 1981. – *Lichen chlorinus* Ach., *Lichenogr. Suec. Prodr.*: 6. 1798.

Thallus corticolous, leprose, forming pulverulent mass, lemon yellow or greenish yellow; granules 0.02 – 0.05 mm diam, with few hyphal filaments. Ascomata absent.

Chemistry: Thallus K± pale orange, C-, KC-, P-. TLC: Calycin and vulpinic acid present.

Comments: *Chrysothrix chlorina* is a common lichen species in Uttar Pradesh, however few specimens have been collected, found growing on *Mangifera indica* and *Shorea robusta* tree trunks in orchard and saal forest. The species can be easily distinguishable from *C. candelaris* due to its lemon yellow colouration.



Collema F.H. Wigg. (Family: Collemataceae)

Prim. Fl. Holsat.: 89. 1780.

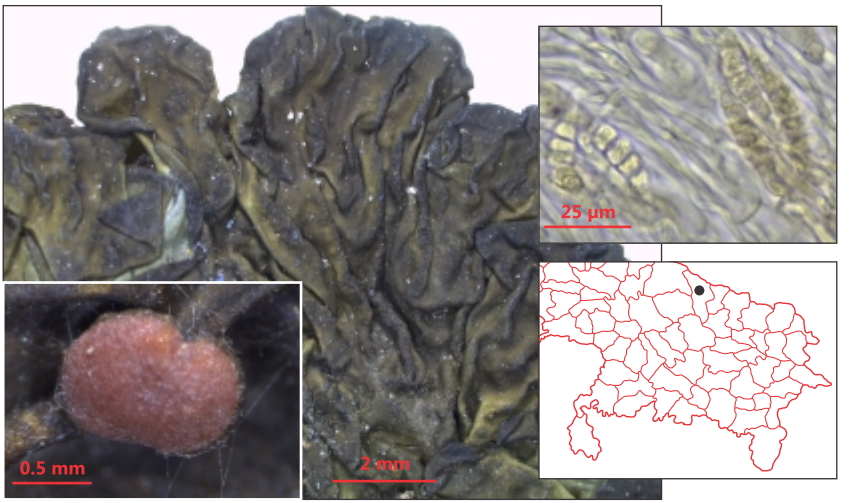
Thallus foliose, subfoliose, lobate, gelatinous and swollen when wet; homoiomerous, pale olivaceous green, bluish or blackish, smooth or ridged, isidiate or not, regularly longitudinally ridged and pustulate, or irregular coarse ridged condition; isidia granular, globular, teretiform, simple, coralloid branched or squamuliform; lower surface with depressions corresponding to ridges and pustules, with or without rhizines; photobiont a cyanobacterium, *Nostoc*, dispersed throughout thallus. Ascomata apothecia, laminal, sessile, substipitate to pedicellate; disc pale red, red brown to darker. Exciple lecanorine; hymenium I + blue; hypothecium pale. Asci unitunicate, apically thickened, usually 8 spored; ascospores hyaline, transversely septate, submuriform or muriform; paraphyses simple to branched.

World wide 82 species; India 35 species; Literature: Akhtar & Awasthi 1980; Awasthi 2007.

Collema pulcellum* var. *subnigrescens (Müll. Arg.) Degel.

Symb. Bot. Upsal. 20(2): 173. 1974. – *Synechoblastus flaccidus* var. *subnigrescens* Müll. Arg., *Proc. Roy. Soc. Edinburgh* 4: 456. 1882.

Thallus corticolous, foliose, up to 10 cm across, dark olive green to brownish; lobes rotund to irregular, 2.5 – 5.0 mm wide, plicate rugose to deeply ridged;



lower side slightly paler than the upper, attached by haptera; thallus up to 63 µm thick, homoiomerous. Apothecia rare, up to 1.2 mm diam.; margin thalline, concolours with the thallus, thin, smooth; disc pinkish orange, convex, epruinose. Thalline exciple with algal cells, 27 – 78 µm thick, lacking psudocortex; proper exciple euparaplectenchymatous, continuing below hypothecium; epihymenium pale yellow, up to 25 µm thick; hymenium hyaline, up to 105 µm thick; hypothecium hyaline to pale yellow, up to 151 µm thick; paraphyses branching. Asci 8 spored, clavate, up to 52 × 14 µm; ascospores hyaline, fusiform, transversely 3 – 6 septate, 41.7 – 48.8 × 7.6 – 9.7 µm.

Chemistry: Thallus K± pale orange, C-, KC-, P-. TLC: Calycin and vulpinic acid present.

Comments: *Collema pulcellum* var. *subnigrescens* a rare foliose cyanolichen species in Uttar Pradesh, found growing on tree bark in forested areas. It is reported form Katarniaghat area in Behraich district by Akthtar & Awasthi (1980); however the specimen is untraceable in the herbarium LWG.

Crypthothecia Stirton (Family: Arthoniaceae)

Proc. Roy. Soc. Glasgow 10: 164. 1876.

Thallus crustose, effuse, ecorticated, white, yellow to yellowish-green, usually corticolous; photoblont a green alga; hypothallus well developed. No organized ascomata. Asci ± evenly dispersed in thallus, loose non-coherent hyphal tissue between asci, globose, spheroid, or ovoid, bitunicate, 1 – 8 spored; ascospores hyaline, submuriform to multicelled muriform.

World wide 75 species; India 31 species; Literature: Awasthi 1991.

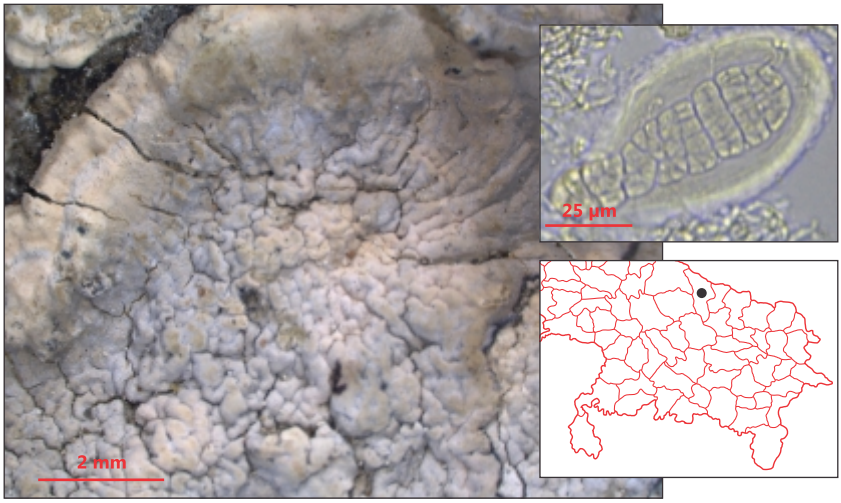
Cryptothecia scripta G. Thor

Symb. Bot. Upsal. 32(1): 285. 1997.

Thallus corticolous, crustose, thick, pale, creamish to pinkish white; hypothallus fimbriate. Fertile area forming granular or verrucose structures; fertile granules few to numerous and grouped. Asci 1 spored, clavate, ovoid to globose, 62 – 97 × 41 – 54 µm; ascospores hyaline, muriform, oblong to ovoid, transversely 7 – 12 septate, vertically 2 – 8 septate, 45.7 – 75.3 × 18.6 – 27.6 µm.

Chemistry: Thallus K-, C+ pink, KC+ pink, P-. TLC: Gyrophoric acid present.

Comments: *Cryptothecia scripta* (= *C. subnidulans* Stirton) is a common species in Uttar Pradesh. However, only one specimen has been collected from deciduous forest of Katarniaghat Wildlife Sanctuary. In the sanctuary several trees bear large, white patches of *C. scripta*, which is mostly mistaken for sterile,



crustose lichen species. The closer observation of the patch reveals the fertile granules and a typical fimbriate, whitish hypothallus at the margin of the patch.

Dimelaena Normam (Family: Physciaceae)

Nyt Mag. Naturvidensk. 7(3): 231. 1852.

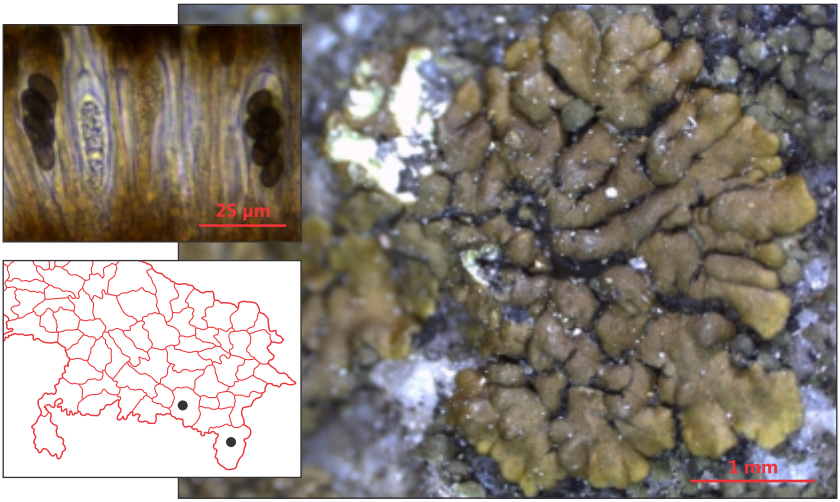
Thallus crustose, thin to thick, placodioid, with radiate-plicate marginal lobes; prothallus present or absent; white, yellow-white, yellow, pale grey to grey, grey-brown, pale or dark brown, dull or glossy; photobiont a unicellular green alga. Ascomata apothecia, immersed to sessile or adnate, ± round; disc black, usually epruinose. Exciple lecanorine to lecidine; hymenium hyaline; hypothecium hyaline to pale or dark brown; paraphyses simple or sparingly branched, expanded and pigmented at the apices. Asci clavate to cylindrical, *Bacidia* type, 8 spored; ascospores 1 septate, of the *Beltraminia* type, olive-brown, then grey-brown or dark brown at maturity, broadly ellipsoidal, ± constricted at the septum, surface smooth or finely ornamented.

World wide 8 species; India 3 species; Literature: Upreti *et al.* 2010.

Dimelaena tenuis (Müll. Arg.) H. Mayhofer & Wipple in Mayrhofer, Matzer, Wippel & Elix

Mycotaxon 58: 304. 1996.

Thallus saxicolous, placodioid, orbicular, greenish brown, 0.5 – 3.0 cm across,



often coalescing with neighbouring thallus and covering large area; lobes linear, angular to slightly rotund, ± convex, 0.3 – 0.7 mm wide; areoles towards centre are convex to bulged, 0.2 – 04 mm across. Apothecia frequent, distributed towards centre of the thallus, 0.2 – 0.4 mm diam.; margin lecidine, black; disc black, plane to convex, epruinose. Exciple brown, 20 – 37 µm thick; epihymenium brown, 13 – 21 µm thick; hymenium hyaline, 45 – 55 µm thick; hypothecium brown to dark brown to dark brown, 51 – 96 µm thick; paraphyses simple to weakly branched, apical cell swollen and brown pigmented. Ascus 8 spored, 46 – 53 × 8 – 14 µm; ascospores brown, transversely 1 septate, rarely simple, ellipsoid, 10.3 – 13.3 × 5.6 – 7.0 µm.

Chemistry: Thallus K-, C+ pink, KC+ pink, P-. TLC: Gyrophoric acid present.

Comments: *Dimelaena tenuis* is a common lichen species in Uttar Pradesh, found growing on exposed rocks. It is characterized by circular, olive brown thallus with lobate margin and black apothecia. Sometimes, the thallus also grow as scattered squamulose over rock.

Diorygma Eschw. (Family: Graphidaceae)

Syst. Lich.: 13. 1824.

Thallus off-white to pale olive-green, smooth, dull to somewhat glossy. Ascomata lirelliform apothecia, linear and branched, irregularly rounded and ± discoid, immersed or subimmersed. Labia open; proper exciple non-

carbonized or thin and carbonized, or absent; hymenium not inspersed, I- or I+ blue. Ascospores hyaline, transversely septate to muriform, I+ pale blue, medium blue or blue-violet.

World wide 25 species; India 24 species; Literature: Sharma & Khadilkar 2012; Kalb *et al.* 2004.

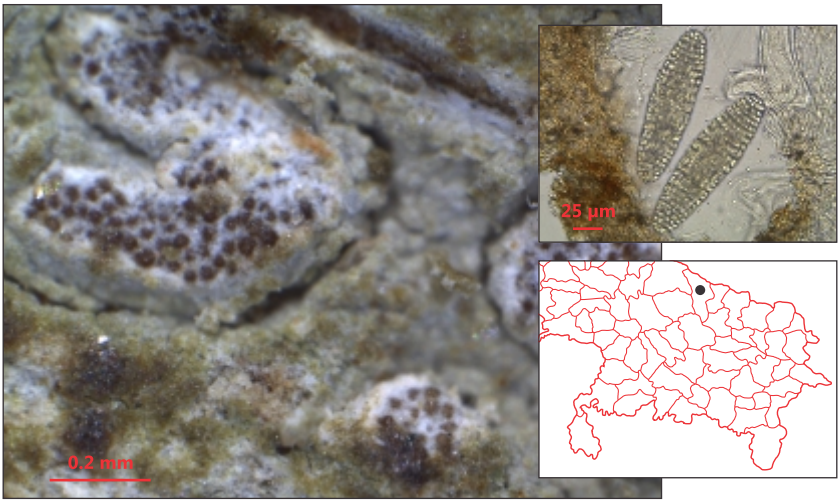
Diorygma junghuhnii (Mont. & Bosch) Kalb, Staiger & Elix

Symb. Bot. Upsal. 34(1): 157. 2004. – *Ustalia junghuhnii* Mont. & Bosch. in *Jungh., Pl. Jungh.* 4: 477. 1855.

Thallus corticolous, crustose, whitish grey to grey, thick, rough. Lirellae mostly emergent, paler than the thallus, frequent, simple to furcated, curved, 0.3 – 0.6 mm long, 0.1 – 0.3 mm broad; disc white, covered with brownish puina. Exciple divergent, non-carbonized, 50 – 63 µm thick; epihymenium yellowish brown, 10 – 18 µm thick; hymenium hyaline to yellowish, 65 – 86 µm thick, I+ blue; hypothecium hyaline to yellowish; paraphyses simple to branched, anastomosing. Asci 1 – 2 spored, clavate, 73 – 144 × 34 – 53 µm; ascospores hyaline, muriform, broadly ellipsoid, 73.3 – 143.4 × 34.5 – 52.4 µm.

Chemistry: Thallus K+ red, C-, KC-, P+ orange. TLC: Norstictic and consticitic acid present.

Comments: *Diorygma junghuhnii* is a rare lichen species in Uttar Pradesh, found growing on tree bark in moist deciduous forest. It is characterized by whitish grey thallus and whitish or much paler lirellae.



Dirinaria (Tuck.) Clem. (Family: Physciaceae)

Clement, Gen. Fungi: 84. 1909.

Thallus foliose, adnate, lobes dichotomously to pinnately divided, usually flabellate-plicate, confluent in centre, grey to darker grey, with or without isidia and soredia; heteromerous; corticated on both sides; lacking rhizines; photobiont a green alga, *Trebouxia*; medulla white or pigmented. Ascomata apothecia, laminal, thalline, usually black, pruinose or not. Exciple lecanorine; epihymenium pale brownish, K-; hypothecium brown to brown-black. Asci 8 spored; ascospores brown, 1 septate, thick walled. Atranorin present in upper cortex.

World wide 35 species; India 11 species; Literature: Awasthi 1975, 2007.

Key to the species of *Dirinaria*

1a. Thallus lacking soredia and isidia, saxicolous . . . . . *D. confluens*

1b. Thallus sorediate 2

2a. Soredia developing from thick isidioid outgrowths, later becoming crateriform, divaricatic acid present . . . . . *D. aegialita*

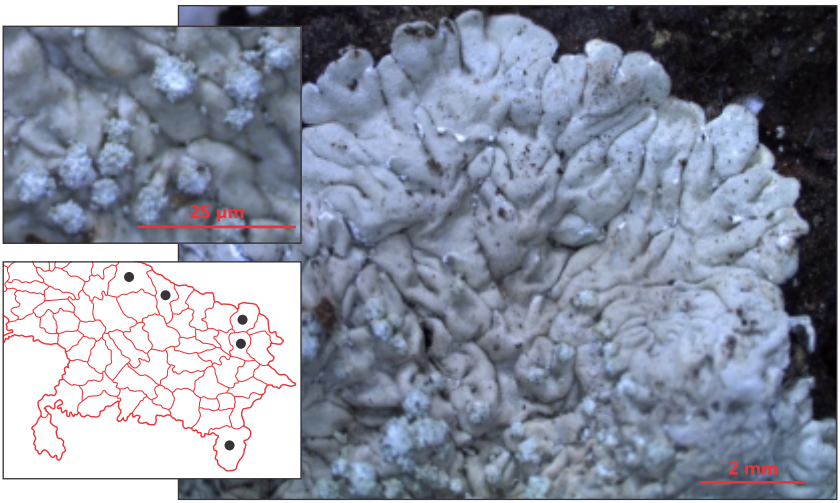
2b. Soredia developing directly on the thallus 3

3a. Thallus with sekikaic acid . . . . . *D. consimilis*

3b. Thallus with divaricatic acid . . . . . *D. applanata*

Dirinaria aegialita (Afzel.) Moore

Bryologist 71: 248. 1968. – *Parmelia aegialita* Afzel. in Ach., *Methodus*: 191. 1803.



Thallus corticolous and saxicolous, foliose to placodioid, orbicular, 0.8 – 7.5 mm across, whitish grey, sorediate; lobes rotund, plicate to imbricate, slightly convex, slightly pruinose, 0.6 – 1.8 mm wide; soredia arising from isidioid outgrowths, later becoming crateriform; lower surface of lobes pale to greyish, lacking rhizines; medulla white. Ascomata absent.

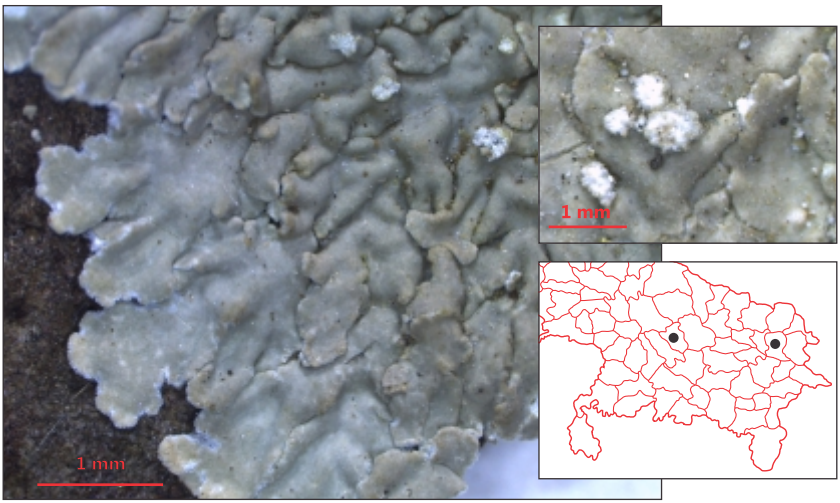
Chemistry: Thallus and medulla K-, C-, KC-, P-. TLC: Divaricatic acid present.

Comments: *Dirinaria aegilita* is a common lichen species in Uttar Pradesh, found growing mostly in forested areas on variety of trees, such as *Acacia nilotica, Shorea robusta* and *Syzygium cumini*. It can be identified by its whitish grey, circlar thallus having small lobes and isidioid growth becoming sorediate. The isidioid growth can be seen towards younger portion (margin) of the thallus. The isidioid growth and divaricatic acid differentiates it from other species within the genus.

Dirinaria applanata (Fée) D. D. Awasthi in D. D. Awasthi & M. R. Agarwal

J. Indian Bot. Soc. 49: 135. 1970. – *Parmelia applanata* Fée, *Essai Crypt. Ecorc.:* 126. 1824.

Thallus corticolous, foliose to placodioid, orbicular, up to 5 cm across, whitish grey, sorediate; lobes plicate to imbricate, 1.0 – 1.5 mm wide, slightly pruinose; lower side pale to grayish, lacking rhizines; soralia capitate; soredia fine granular. Ascomata absent.



Chemistry: Thallus and medulla K-, C-, KC-, P-. TLC: Divaricatic acid present.

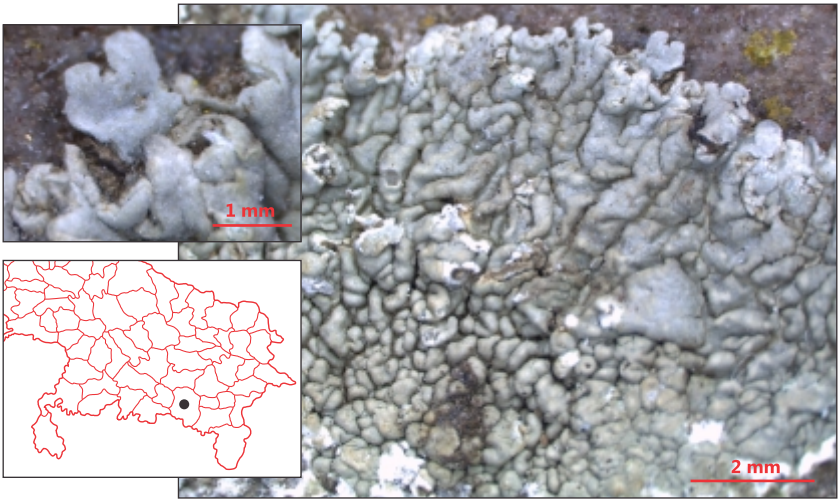
Comments: *Dirinaria applanata* is a rare lichen species in Uttar Pradesh, found growing on *Mangifera indica* and *Shorea robusta* in orchard and forest areas. It is characterized by whitish grey thallus, smaller lobes, the soralia that develops directly on lamina, and divaricatic acid in chemistry.

Dirinaria confluens (Fr.) D.D. Awasthi

Biblioth. Lichenol. 2: 28. 1975. – *Parmelia confluens* Fr., *Syst. Orb. Veg.* 1: 284. 1825.

Thalllus saxicolous, foliose to placodioid, closely adpressed to rock, whitish grey, up to 4 cm across, lacking soredia and isidia; lobes plicate and imbricate, slightly pruinose, 0.4 – 1.5 mm wide; lower side grey to brownish, lacking isidia and soredia. Ascomata absent.

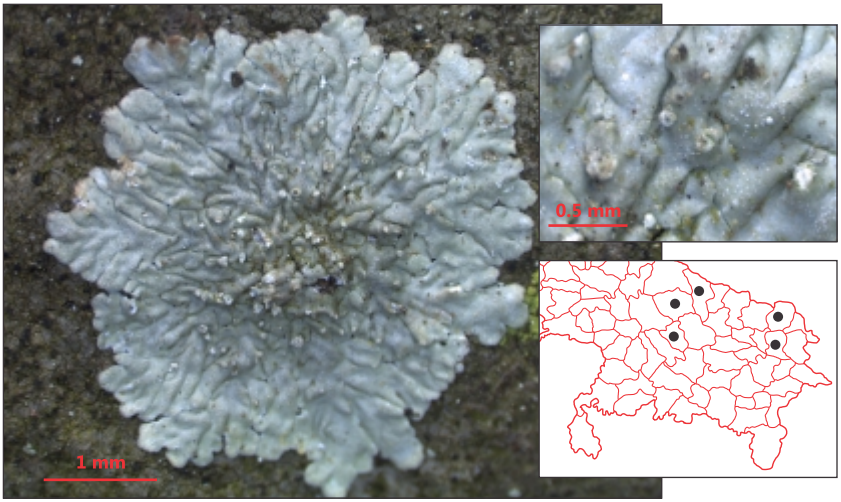
Chemistry: Thallus and medulla K-, C-, KC-, P-. TLC: Divaricatic acid present.



Comments: *Dirinaria confluens* is a common lichen species in Uttar Pradesh, found growing on exposed rocks. It is characterized by whitish grey thallus that lacks vegetative propagules, but having divaricatic acid in medulla.

Dirinaria consimilis (Stirt.) D.D. Awasthi in D.D. Awasthi & M.R. Agarwal

J. Indian Bot. Soc. 49: 135. 1970. – *Physcia consimilis* Stirt., *Proc. Roy. Soc. Glasgow* 11: 310. 1879.



Thallus corticolous, foliose to placodioid, whitish grey, up to 7 cm across, sorediate; lobes plicate–imbricate, 0.5–2.1 mm wide, slightly pruinose, rotund, plane to convex; soralia capitate; soredia granular; lower surface grey to brownish. Ascomata abscent.

Chemistry: Thallus and medulla K-, C-, KC-, P-. TLC: Sekikaic acid present.

Comments: *Dirinaria consimilis* is a common lichen in Uttar Pradesh, found growing on bark of variety of trees such as *Ficus* sp., *Mangifera indica, Shorea robusta* and *Syzygium cumini*. The species is characterized by plicate, imbricate, ± pruinose lobes and presence of sekikaic acid.

Endocarpon Hedw. (Family: Verrucariaceae)

Descr. Adumbr. Muscor. Frond. 2: 56. 1789.

Thallus minutely foliose, squamulose or occasionally crustose, both surfaces or only upper surface paraplectenchymatously corticated; photobiont green alga, layer composed of compactly arranged hyphae as well as algal cells; medulla consists of lax hyphae. Ascomata perithecia generally immersed; ostioles indistinct or prominent, like a protuberance. Exciple paraplectenchymatous, blackish; hamathecium with hymenial photobiont; periphyses present, simple; paraphyses gelatinized. Asci 1–16 spored; ascospores brown, muriform.

World wide 50 species; India 7 species; Literature: Singh & Upreti 1984; Awasthi 2007.

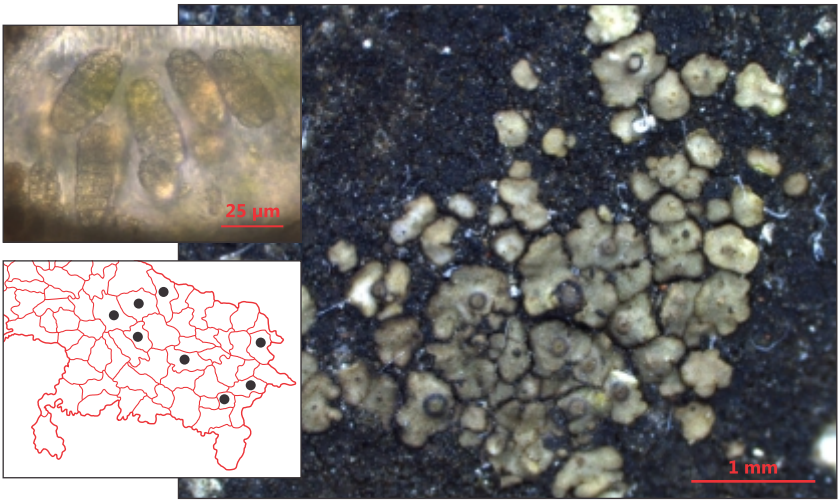
Key to the species of *Endocarpon*

1a. Squamules larger, 2 – 7 mm across to subfoliose 2
1b. Squamules smaller, up to 1 mm across 3
2a. Lower side pale . . . . . *E. rosettum*
2b. Lower side black . . . . . *E. subrosettum*
3a. Lower side of the squamules pale . . . . . *E. nanum*
3b. Lower side of the squamules black 4
4a. Hypothallus present, black . . . . . *E. nigro-zonatum*
4b. Hypothallus absent 5
5a. Squamules loosely adnate, imbricate, ascending . . . . . *E. pallidum*
5b. Squamules closely adnate, not imbricate, not ascending . . . . . *E. pusillum*

Endocarpon nanum Ajay Singh & Upreti

Candollea 39: 541. 1984.

Thallus saxicolous, squamulose, yellowish brown to greenish brown, greenish when wet, closely adnate to substratum; squamules circular to angular, 0.3 – 1.0 mm across; lower surface pale. Perithecia 1 per squamule, semi-emergent, 0.10 – 0.26 mm diam.; ostiole protruding, dark brown to black rimmed. Exciple brown, 26 – 36 µm thick; hamathecium hyaline, rarely with algal cells, conical to globose, 80 – 94 µm across. Asci 1 – 2 spored; ascospores pale brown to brown, oblong, muriform, transversely 9 – 10 septate, vertically 2 – 4 septate, 30.5 – 44.2 × 12.6 – 19.8 µm.



Chemistry: Thallus and medulla K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Endocarpon nanum* is a common lichen species in Uttar Pradesh, found growing on rocks, cement and or lime plasters of compound wall, building and monuments. Sometimes it grows on soil over rock and in association with cyanobaterial mat which gives the appearance of hypothallus. It can be easily identifiable due to its smaller squamules and paler lower surface.

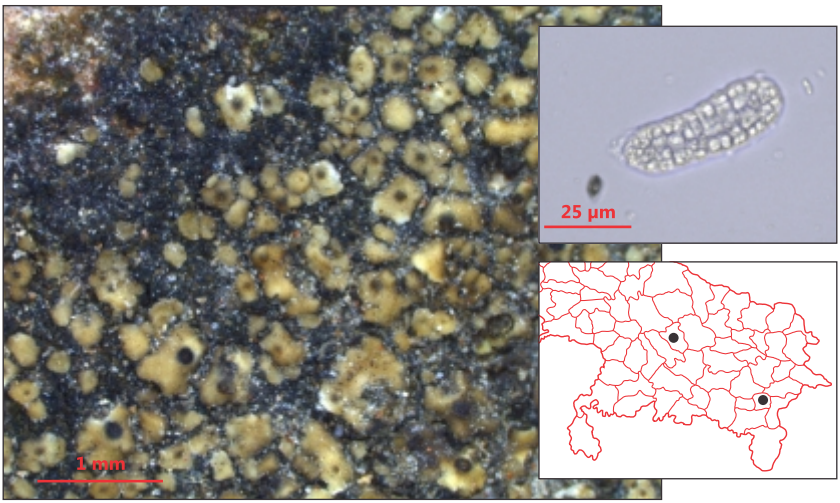
Endocarpon nigro-zonatum Ajay Singh & Upreti

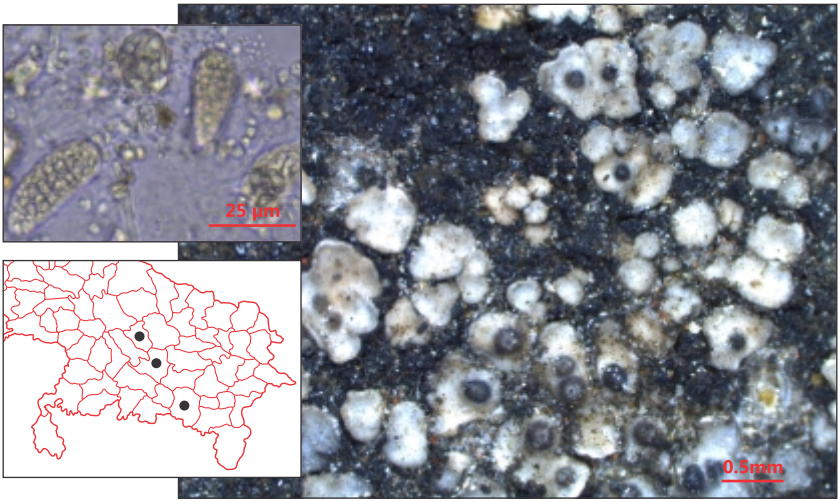
Candollea 39: 542. 1984.

Thallus saxicolous, squamulose, greenish brown to dark brown, dark green when wet; squamules 0.7 – 1.2 mm wide, closely adnate to substratum; lower surface of squamules black; hypothallus black, prominent. Perithecia semi-emergent, 1 – 2 per squamule, 0.07 – 0.2 mm diam.; ostiolar region black. Exciple brown to dark brown, 35 – 48 µm thick; hamathecium hyaline, conical to globose, 162 – 182 µm across. Asci 1 – 2 spored, clavate, 82 – 99 × 22 – 27 µm; ascospores pale brown to brown, oblong to broadly ellipsoid, muriform, transversely 9 – 14 septate, vertically 2 – 5 septate, 34.6 – 58.3 × 16.1 – 20.3 µm.

Chemistry: Thallus and medulla K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Endocarpon nigrozonatum* is a common species in Uttar Pradesh, found growing mostly on lime plaster of monuments, old building, compound walls and rarely on exposed rocks. It is distinguishable by its squamulose thallus, black, prominent hypothallus and darker under surface.





Endocarpon pallidum Ach.

Lichenogr. Universalis: 301. 1810.

Thallus saxicolous, squamulose, yellowish brown to greenish brown, greenish when wet; squamules 0.4 – 1.2 mm across, loosely attached, imbricate, ascending; lower surface black. Perithecia 1 – 3 per squamule, semi-emergent, 0.13 – 0.25 mm diam.; ostiole papillate. Exciple brown, 14 – 18 µm thick; hamathecium hyaline, 54 – 69 µm. Ascospores muriform, oblong, pale brown, transversely 7 – 12 septate, vertically 1 – 2 septate, 28.8 – 42.5 × 13.2 – 20.6 µm.

Chemistry: Thallus and medulla K-, C-, KC-, P-. TLC: No chemicals detected.

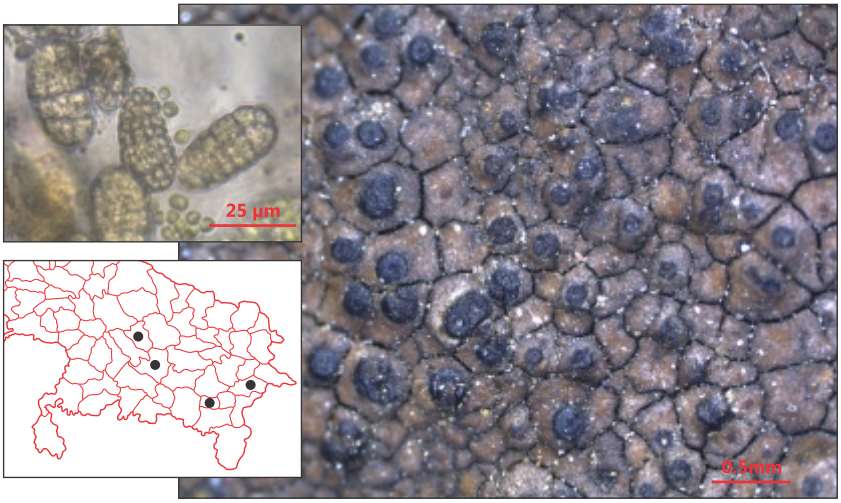
Comments: *Endocarpon pallidum* is a common lichen species in Uttar Pradesh, found growing both on exposed rocks and man made substrates like cement/lime plasters of old buildings. It is characterized by overlapping, minute squamules with blackish lower surface.

Endocarpon pusillum Hedw.

Descr. Adumbr. Muscor. Frond. 2: 56. 1789.

Thallus saxicolous, squamulose, brownish to greenish brown, greenish when wet; squamules 0.2 – 0.8 mm diam., closely adnate to substratum; lower surface black. Perithecia 1 – 2 per squamule, 0.11 – 0.31 mm diam.; ostiolar region black. Exciple dark brown to brown black, 43 – 54 µm thick; hamathecium hyaline, conical to globose, 128 – 174 µm across. Ascospores pale brown, oblong to broadly ellipsoid, muriform, transversely 6 – 9 septate, vertically 2 – 4 septate, 22.5 – 42.8 × 16.1 – 21.4 µm.

Chemistry: Thallus and medulla K-, C-, KC-, P-. TLC: No chemicals detected.

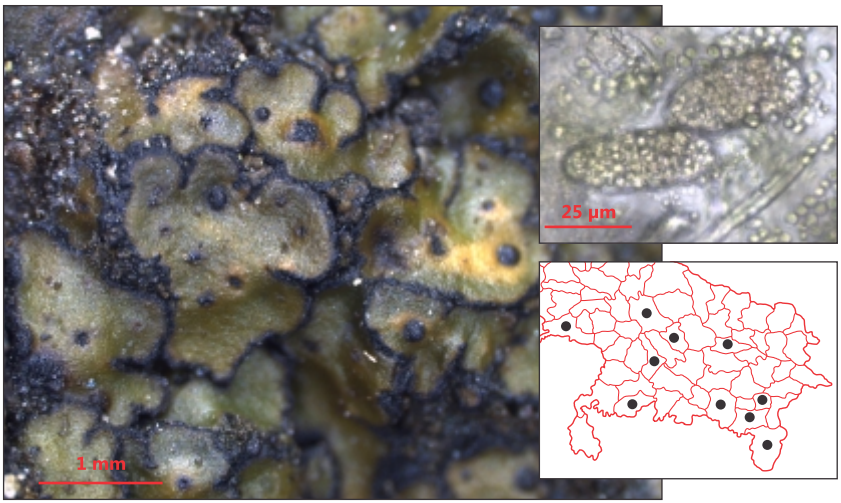


Comments: *Endocarpon pusillum* is a common lichen species in Uttar Pradesh, found growing on exposed rocks as well as on the plaster of old building and compound walls. It can be differentiated from *E. pallidum* with closely adnate squamules that are non-imbricate and non-ascending.

Endocarpon rosettum Ajay Singh & Upreti

Candollea 39: 543. 1984.

Thallus saxicolous, squamulose to subfoliose, brownish to greenish brown, greenish when wet; squamules 1.0 – 3.5 mm across, overlapping and forming rosettes; lower surface pale. Perithecia 5 – 10 per squamule, sunken,0.13 – 0. 2



mm diam.; ostiole punctuate. Exciple dark brown, 26 – 52 µm thick; hamathecium hyaline, conical to globose, 225 – 242 µm across. Ascospores muriform, pale brown, oblong, transversely 7 – 10 septate, vertically 1 – 2 septate, 36.2 – 48.1 × 17.3 – 22.1 µm.

Chemistry: Thallus and medulla K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Endocarpon rosettum* is a common species in Uttar Pradesh, found growing on rock as well as lime/cement plaster of buildings. It is characterized by large squamules that form rosettes on the substratum.

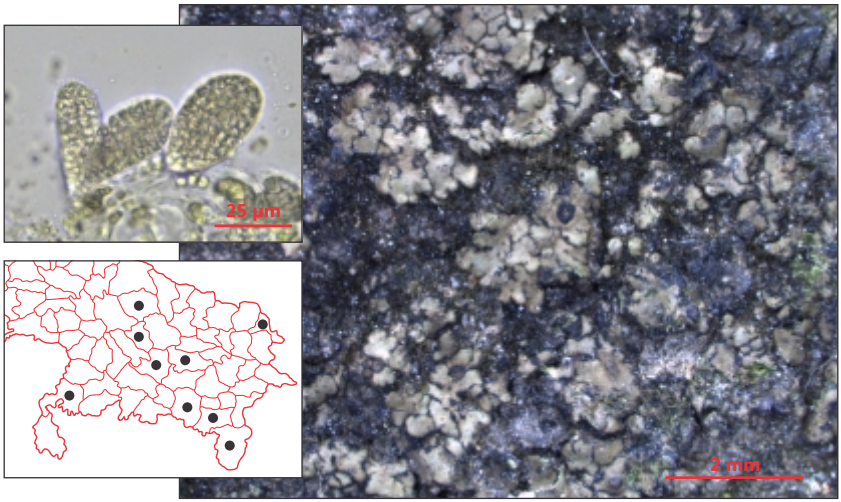
Endocarpon subrosettum A. Singh & Upreti

Candollea 39: 547. 1984.

Thallus saxicolous, squamulose to subfoliose, scattered, rosette forming, 0.1 – 2.5 mm diam.; upper surface olive brown, yellow to greenish brown, much greener when wet; squamules orbicular to suborbicular, 0.2 – 0.3 mm; lower surface black. Perithecia 1 – 2 per squamule, laminal, prominent, brown to black, 0.15 – 0.35 mm diam.; ostiole white or pale. Exciple pale brown to brown; involucrellum present, brown, broad at tip, tapering down; hymenium hyaline, with algal cells. Ascus 2 spored; ascospores pale brown, muriform, globose to ellipsoidal, 35.1 – 43.5 × 16.3 – 23.4 µm.

Chemistry: Thallus and medulla K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Endocarpon subrosettum* is a common lichen in Uttar Pradesh, found growing over exposed rock, bricks, lime and cement plasters of old building and monuments. It is easily distinguishable by its large squamules with darker lower surface.



Fissurina Fée (Family: Graphidaceae)

Meth. Lich. Gen.: 35. 1824.

Thallus corticolous, crustaceous, epiphloeodal, greenish grey to greyish or yellow brown, smooth, shiny. Ascomata lirellate apothecia, visible as thalline cracks or slits. Thalline margin generally in from of roof just over the disc, exciple uncarbonized or slightly carbonized, exciple and proper margin poorly developed. Ascospores hyaline, generally smaller, ovoid or ellipsoid, usually transversely 3 septate or muriform, with thick jelly like wall or halonate, I- or weakly bluish or rarely I+ blue violet.

World wide 30 species; India 20 species; Literature: Sharma *et al.* 2012; Staiger 2002.

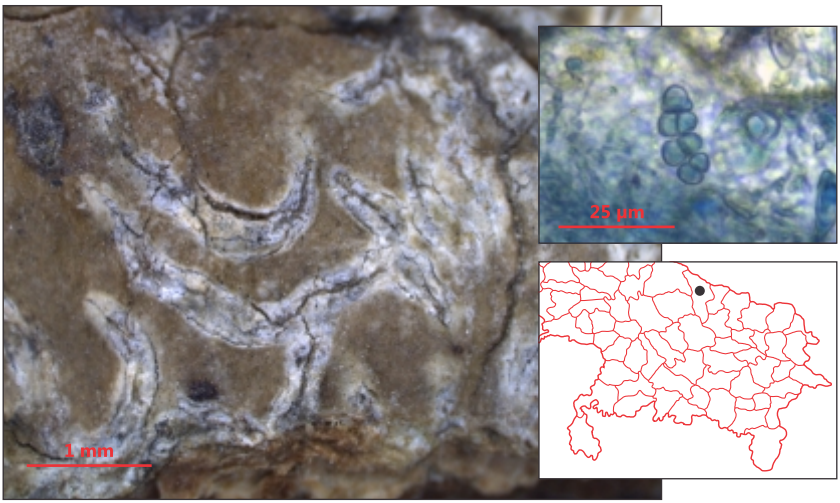
Fissurina comparimuralis Staiger

Biblthca. Lichenol. 85: 143. 2002.

Thallus corticolous, crustose, yellowish brown to grey brown, smooth. Lirellae irregularly scattered, immersed to superficial, delicate, simple to branching, curved to flexuouse, 1.7 – 2.5 mm long; margin white, plane, broad, covering the disc; disc slit like. Exciple pale, apically brownish, non-carbonized, 13 – 21 µm thick; hymenium hyaline, 93 – 126 µm thick; hypothecium hyaline, 14 – 26 µm thick. Asci 8 spored, clavate; ascospores submuriform, broadly ellipsoid to ovate, transversely 3 septate, vertically 0 – 1 septate, 21.3 – 23.4 ×8.6 – 11.2 µm.

Chemistry: Thallus and medulla K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Fissurina comparimuralis* is a rare lichen species in Uttar Pradesh found growing on the bark of *Shorea robusta* in saal forest. It is characterized by whitish, fissured lirellae, hyaline, submuriform ascospores.



Graphis Adans (Family: Graphidaceae)

Fam. Pl. 2: 11. 1763.

Thallus crustose, usually epi or endophloeodal, rarely saxicolous or epiphyllous; photobiont a *Trentepohlia*. Ascomata lirellate apothecia, usually elongate, simple or variously branched rarely short oryzaeform, immersed in thallus or emergent, sessile; margin connivent or not. Exciple complete or dimidiate, totally or partially carbonized, brown, yellow or hyaline; labia of exciple entire or striate; hypothecium thin; paraphyses, simple, not thickened at apices. Asci clavate to sub-cylindrical, (1–) 2–4–8 spored; ascospores hyaline transversely 3 to many septate to muriform, oblong-ellipsoid to fusiform, locules lentiform.

World wide 320 species; India 115 species; Literature: Lücking 2009; Lücking *et al.* 2009.

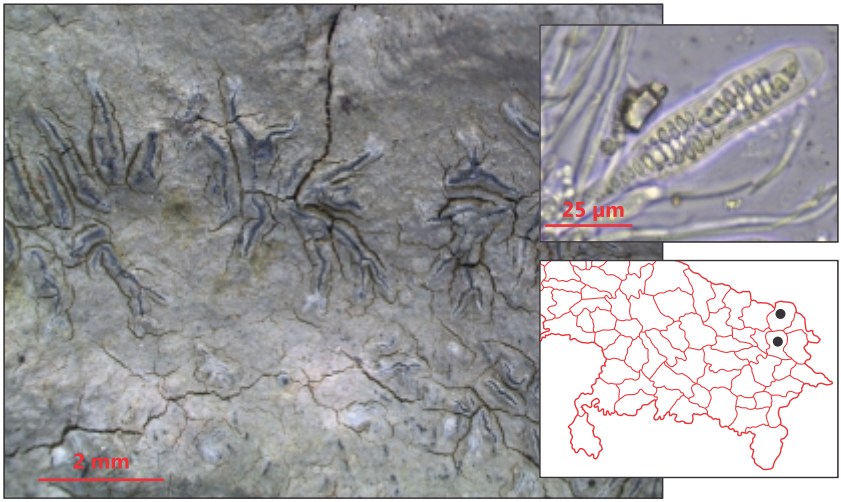
Key to the species of *Graphis*

1a. Labia entire 2
1b. Labia striate 5
2a. Hymenium inspersed with abundant oil globules, exciple laterally carbonized, ascospores transversely 5 – 10 septate . . . . . *G. cincta*
2b. Hymenium lacking oil globules - 3
3a. Ascospores muriform, exciple apically carbonized . . . . . *G. japonica*
3b. Ascospores transversely septate, exciple laterally carbonized 4
4a. Thallus with norstictic and stictic acid . . . . . *G. ajarekarii*
4b. Thallus with norstictic and salazinic acid . . . . . *G. capillacea*
5a. Ascospores transversely septate 6
5b. Ascospores muriform 7
6a. Exciple apically carbonized, ascospores 5 – 12 septate . . . . . *G. chlorotica*
6b. Exciple laterally carbonized, ascospores 4 – 19 . . . . . *G. striatula*
7a. Exciple apically carbonized, stictic acid present . . . . . *G. subducta*
7b. Exciple laterally carbonized, secondary metabolites absent . . . . . *G. pseudoserpens*

Graphis ajarekarii Patw. & C.R. Kulk.

Norweg. J. Bot. 26(1): 45. 1979.

Thallus corticolous, crustose, grayish, smooth to rough. Lirellate apothecia



scattered or mostly in radiating groups, dichotomously branched, flexuouse, apices acute, 0.5 – 1.7 mm long, thalline margin present; disc narrow, slit like, epruinose or slightly pruinose. Exciple incomplete, laterally carbonized, convergent, covered by thalline tissue up to the top; labia entire; epihymenium hyaline to pale yellow; hymenium hyaline, 78 – 95 µm thick; hypothecium hyaline, 25 – 32 µm thick. Asci 8 spored, cylindrical to clavate, 55 – 88 × 12 – 18 µm; ascospores hyaline, ellipsoid, transversely 7 – 10 septate, 31.3 – 35.7 × 12.3 – 17.4 µm.

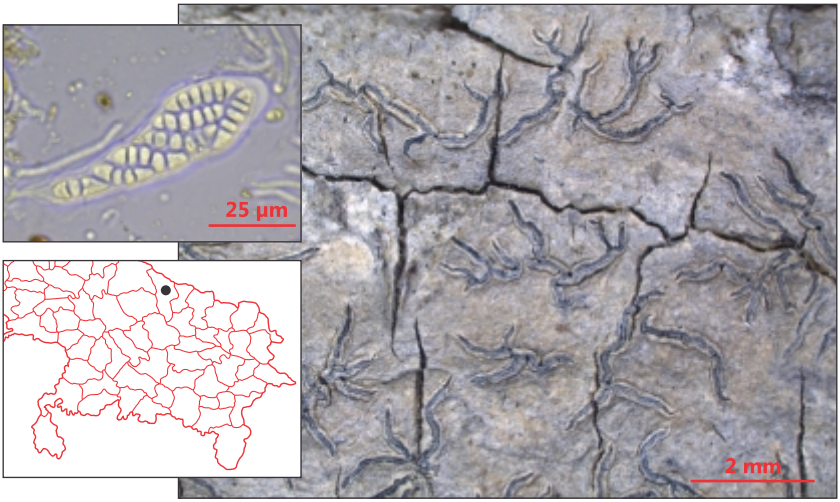
Chemistry: Thallus K+ red, C-, KC-, P+ yellow. TLC: Norstictic, stictic, constictic acid present.

Comments: *Graphis ajarekarii* is a common lichen species in Uttar Pradesh, found growing on *Mallotus philippensis*, *Shorea robusta* and *Syzygium cumini* trees mostly in forested area. It is characterized by stellately aggregated lirellae, entire labia, laterally carbonized exciple, transversely septate ascospores and norstictic acid complex in chemistry.

Graphis capillacea Stirt.

Proc. Roy. Soc. Glasgow 11: 315. 1879.

Thallus corticolous, crustose, grey to brownish grey, smooth. Lirellate apothecia emergent to semi-emergent, dense, stellately arranged, branched, flexuouse, ends tapering, 0.9 – 2.3 mm long, thalline margin prominent, covering the exciple up top; disc narrow, slit like, black, pruinose. Exciple incomplete at base, laterally carbonized, slightly broadening at base,



convergent, 18 – 34 µm thick; labia entire; epihymenium brown to dark brown, 11 – 18 µm thick; hymenium hyaline, 74 – 95 µm thick; hypothecium hyaline 16 – 20 µm thick. Asci 8 spored, clavate, 67 – 83 × 16 – 18 µm; ascospores hyaline, fusiform to ellipsoid, transversely 3 – 7 septate, 19.2 – 25.0 × 5.5 – 6.7 µm.

Chemistry: Thallus K+ red, C-, KC-, P+ yellow. TLC: Salazinic, stictic, norstictic (sometimes protocetraric) acid present.

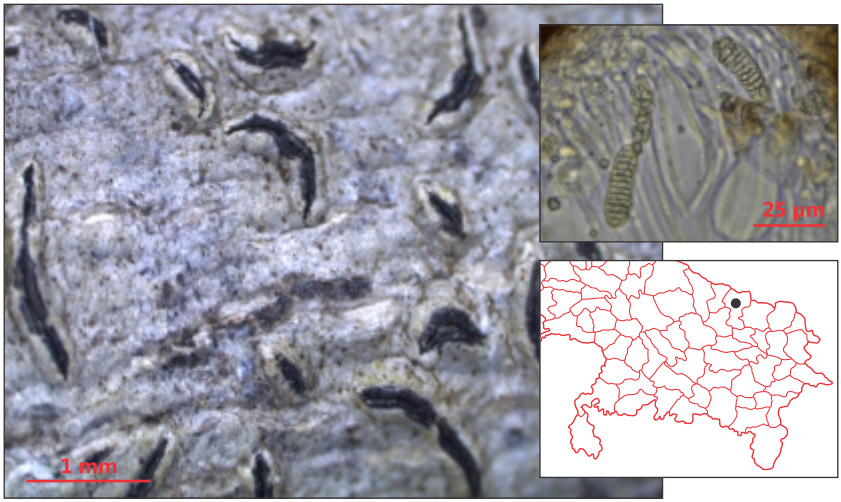
Comments: *Graphis capillacea* is a common lichen species in Uttar Pradesh, found growing on variety of trees including *Ficus* spp. and *Syzygium cumini* trees in deciduous forest. It is characterized by grey thallus, stellately arranged lirellae, laterally carbonized exciple, entire labia, transversely septate ascospores and salazinic acid along with norstictic acid complex in chemistry.

Graphis chlorotica A. Massal & Kremp.

Verh. K. K. Zool. -Bot. Ges. Wein. 21: 865. 1871.

Thallus corticolous, crustose, whitish grey, smooth. Lirellate apothecia emergent, simple, rarely branching, straight to flexuose, externally covered by thallus tissue, 0.4 – 1.9 mm long; disc black, slit like, epruinose. Exciple apically carbonized, 16 – 30 µm thick; labia striate; epihymenium pale yellow; hymenium hyaline, 60 – 95 µm thick; hypothecium hyaline to pale brown, 28 – 35 µm thick. Asci clavate 8 spored, up to 85 × 16 µm; ascospores hyaline, transversely 5 – 12 septate, 18.1 – 30.4 × 7.5 – 9.9 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.



Comments: *Graphis chlorotica* shows its rare occurrence in Uttar Pradesh found growing on bark in forst areas. It is characterized by apically carbonized exciple, striate labia, transversely septate ascospores.

Graphis cincta (Pers.) Aptroot in A.W. Archer

Fl. Australia 57: 651. 2009. – *Opegrapha cincta* Pers., *Ann. Wetter. Ges.* 2: 15. 1811.

Thallus corticolous, crustose, smooth, whitish grey. Lirellate apothecia emergent, black, simple to furcated or irregularly branching, uniformly scattered or few in groups, 0.3 – 2.5 mm long; thalline margin prominent; disc black, epruinose, slit like or rarely open. Exciple dark brown, laterally carbonized, discontinuous below, convergent, broadening towards base, 22 – 49 µm thick; labia entire; epihymenium brown, granular, 8 – 14 µm thick; hymenium hyaline, abundant oil globules present, up to 92 µm thick; hypothecium hyaline to pale brown, up to 50 µm thick; paraphyses simple, straight, apical cell swollen and pigmented. Ascus 8 spored at immaturity, ultimately 2 – 4 spored, cylindrical to clavate, I+ yellow orange, 51 – 73 × 7 – 9 µm; ascospores hyaline, broadly ellipsoid to oblong, ends obtuse, transversely 5 – 10 septate, locules lens shaped, 23.8 – 36.7 × 6.7 – 9.1 µm.

Chemistry: Thallus K+ yellow turning red, C-, KC-, P+ yellow. TLC: Norstictic acid.

Comments: *Graphis cincta* is a common lichen species in Uttar Pradesh, found growing on twigs and trunks of various trees in moist deciduous forest. It is characterized by K+ red thallus, black, simple to furcated lirellae,

discontinuous exciple, oil globule inspersed hymenium, transversely 5 – 10 septate ascospores.

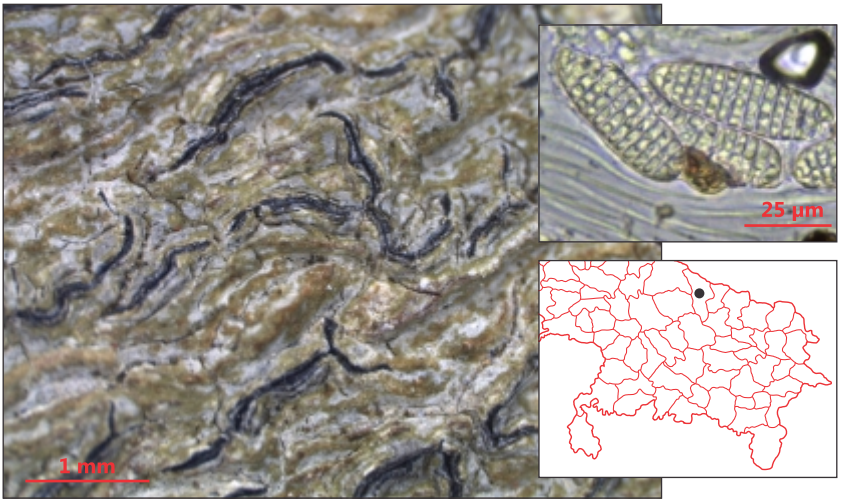
Graphis japonica (Müll. Arg.) A.W. Archer & Lücking, in Lüking, Archer & Aptroot

Lichenologist 41(4): 431. 2009. *Graphina japonica* Müll. Arg., *Flora* 74: 113. 1981.

Thallus corticolous, crustose, epiphloeodal, greenish grey, smooth. Lirellate apothecia immersed to erumpent, simple to irregularly branched, flexuose to curved, ends tapering, 0.5 – 2.0 mm long; externally covered by thalline margin; disc slit like, epruinose. Exciple convergent, U-shaped from base, carbonized at apex, 21 – 28 µm thick; labia entire; hymenium clear, hyaline, 107 – 118 µm thick; epihymenium pale brown; hypothecium hyaline, 17 – 20 µm high, paraphyses simple, straight. Asci 4 – 6 spored, clavate, up to 114 × 33 µm; ascospores hyaline, muriform, oblong to broadly ellipsoid, 36.1 – 68.9 × 11.9 – 29.9 µm.

Chemistry: Thallus and medulla K+ yellow, C-, KC-, P+ yellow. TLC: Stictic acid complex present.

Comments: *Graphis japonica* is a rare species in Uttar Pradesh, found growing on bark in deciduous forest. It is characterized by irregularly branched lirellae, carbonized labia and large, muriform ascospores. The specimens of this species was annotated as *Graphis subserpentina*, however detailed study revealed it to be *G. japonica*. It is a new record for India, earlier it is reported from Eastern Paleotropics (China, Indonesia, Japan and Taiwan). We strongly feel that there may be several specimens in various herbaria of India belonging to this species, but erroneously identified. The recent compilation of the genus *Graphis* by

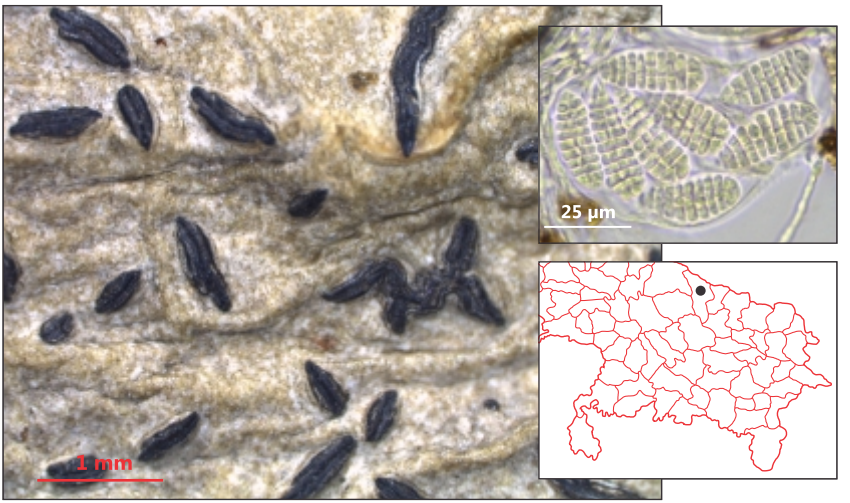


Lücking *et al.* (2009) is a valuable literature for identification of this group of lichen.

Graphis pseudoserpens Chaves, Lücking & Umaña

Fieldiana, Bot. 38(1549): 101. 2008.

Thallus corticolous, crustose, yellowish to whitish grey. Lirellate apothecia emergent, simple, straight, thalline margin prominent, 0.3–1.9 µm long; disc black, epruinose. Exciple apically to laterally carbonized, convergent, 19–35 µm thick; labia 3–4 striate; epihymenium pale brown; hymenium clear,



hyaline, 39 – 94 µm thick; hypothecium clear, 19 – 32 µm thick. Asci clavate, 68 – 98 × 27 – 43 µm; ascospores hyaline, muriform, 20.4 – 44.0 × 12.9 – 24.2 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Graphis pseudoserpens* is a rare lichen species in Uttar Pradesh, found growing on the bark of *Jatropha* tree in forested area. It is characterized by striate labia, laterally carbonized exciple, muriform ascospores and lacking secondary metabolites. It is a new record for India, earlier reported from Costa Rica (Lücking *et al.* 2009).

Graphis striatula (Ach.) Spreng.

Syst. Veg., Edn. 16 4(1): 250. 1827. –*Opegrapha striatula* Ach., *Syn. Meth. Lich. (Lund)*: 74. 1814.

Thallus corticolous, crustose, off-white to pale grey, thin, smooth, dull. Ascomata lirellate apothecia, semi-emergent, black, straight to curved, unbranched, without or a thin thalline margin, 0.4 – 1.5 mm long, 0.1 – 0.3 mm wide. Exciple laterally carbonized, incomplete at base, convergent, 24 – 52 µm thick; labia 1 – 3 striate; epihymenium pale brown; hymenium hyaline, 100 – 130 µm thick, not inspersed; paraphyses simple. Asci 8 spored, clavate, up to 68 × 16 µm; ascospores hyaline, fusiform, transversely 4 – 17 (19) septate, 24 – 50 × 5 –9 µm.

Chemistry: Thallus K -, C -, KC -, Pd -. TLC: No chemicals detected.

Comments: *Graphis striatula* is rare lichen species in Uttar Pradesh, found growing on trunk of cultivated trees near forest area. It is characterized by laterally carbonized exciple, striate labia, transversely septate ascospores.

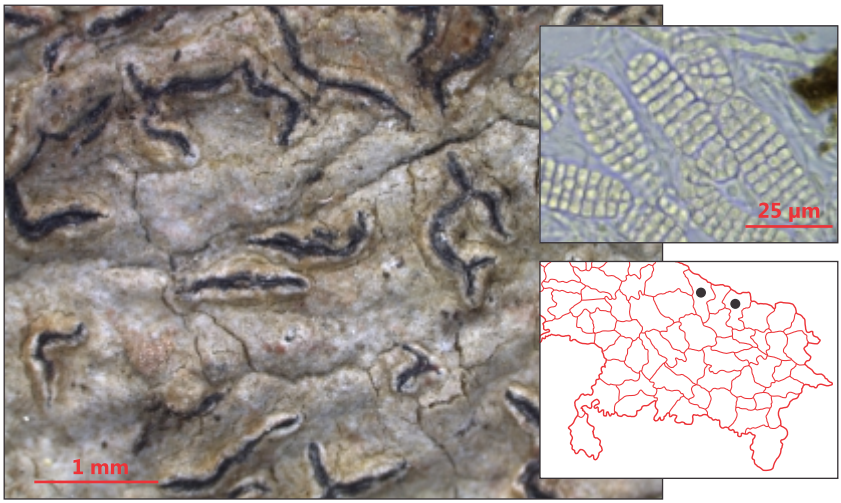
Graphis subducta Vainio

Ann. Acad. Sci. Fenn., ser. A 15(6): 203. 1921.

Thallus corticolous, crustose, yellowish grey to whitish grey. Ascomata lirellate apothecia, erumpent, simple to irregularly branched, straight to slightly curved, externally covered by thalline tissue, 0.4 – 1.75 mm long; disc black, epruinose, slit like. Exciple dark brown, apically carbonized, convergent, 15 – 31 µm thick; labia striate; epihymenium pale brown; hymenium clear, hyaline, 81 – 93 µm thick; hypothecium hyaline, 21 – 42 µm thick. Asci clavate, 97 – 141 × 40 – 61 µm; ascospores muriform, hyaline, 35.3 – 55.4 × 12.3 – 20.8 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P+ orange. TLC: Stictic acid complex present.

Comments: *Graphis subducta* is a less frequent lichen species in Uttar Pradesh, found growing on *Mangifera indica* and other trees in orchards and forested areas. It is characterized by black lirellae, apically carbonized, striate labia, muriform ascospores and stictic acid complex in chemistry.



Haematomma Massal. (Family: Haematommataceae)

Ric. Auton. Lich. Crost.: 32. 1852.

Thallus crustose, effuse, ecorticated, corticolous; photobiont a protococcoid green alga. Ascomata apothecia sessile, adnate to immersed, lecanorine, rounded, disc red, pinkish-red to red brown, thalline margin persistent, well developed or less developed. Exciple lecanorine; paraphyses branched and

anastomosing, not thickened at apices. Asci *Lecanora* type, 8 spored; ascospores hyaline, transversely 3 – 25 (–28) septate, rarely submuriform, fusiform or acicular, straight or apically curved within the ascus. Pycnidial ostiole red, K+ magenta or hyaline, never green; pycnoconidia cylindrical, straight or curved.

World wide 53 species; India 4 species; Literature: Awasthi 1991.

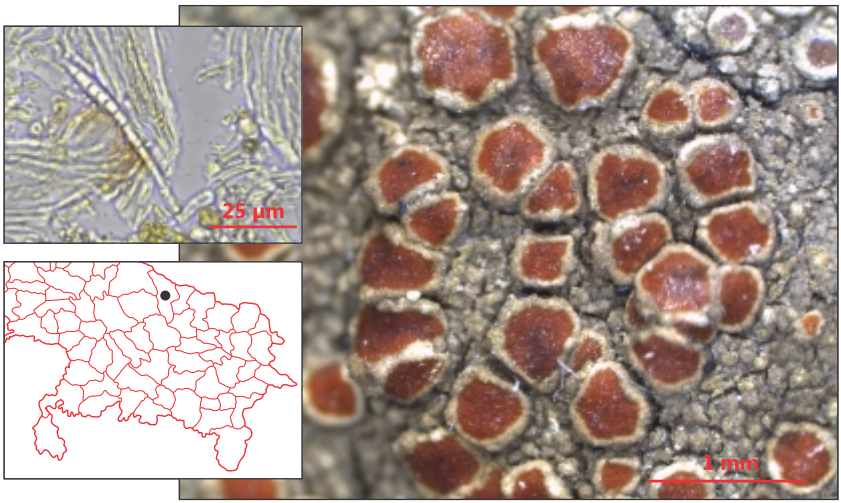
Haematomma puniceum (Sw.) A. Massal.

Atti Reale Ist. Veneto Sci. Lett. Arti, ser. 3, 5: 253. 1860. – *Lichen punicens* Sw. *in Ach., Methodus*: 167. 1803.

Thallus corticolous, crustose, rough to verruculose, cracked areolate, greenish grey. Ascomata apothecia, numerous, round to angular or irregular, sessile, constricted at base, 0.2 – 0.8 mm diam.; margin thick, smooth to verrucose, thalline, concolours with thallus; disc orange red to brick red, epruinose, plane to slightly convex. Exciple with algal cell and large crystals, 39 – 75 µm thick; epihymenium granular, golden brown, K+ pink/purple, 19 – 27 µm; hymenium hyaline to yellowish, with abundant oil globules, 78 – 85 µm thick; hypothecium yellowish, up to 110 µm thick; paraphyses simple to rarely furcated. Asci 8 spored, clavate, 61 – 76 × 13 – 18 µm; ascospores hyaline, acicular, transversely 11 – 15 septate.

Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Parietin present.

Comments: *Haematomma puniceum* is a rare lichen species in Uttar Pradesh, found growing on *Shorea robusta* tree trunk in saal forest. It has strikingly red apothecia, epihymenium turning K+ pink, and hyaline, acicular, up to 15 septate ascospores.



Hafellia Kalb & H. Mayrhofer & Scheid. (Family: Physciaceae)

Lichenes Neotropici Fasc. 9: 9. 1986.

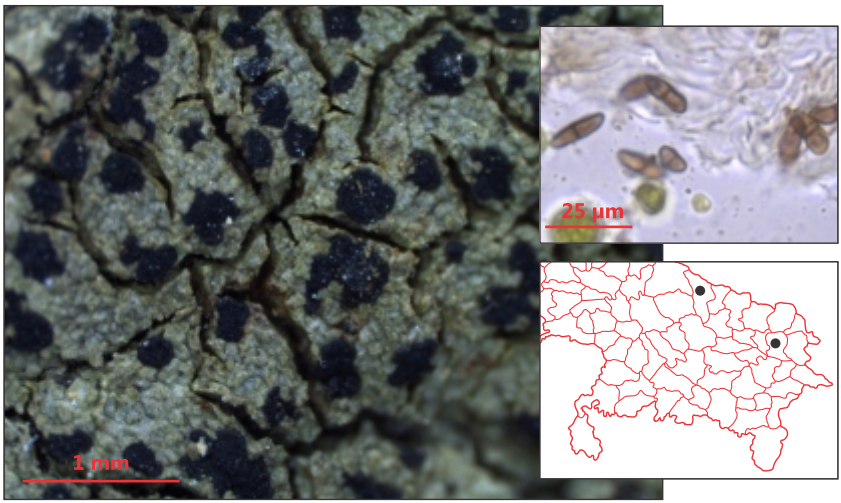
Thallus crustose. smooth to granulose-verrucose, rimose areolate or truly areolate, thick and well developed, hypothallus rarely present, saxicolous or corticolous; photobiont *Trebouxia*. Ascomata apothecia, dark brown to black, round, rarely irregular in outline, sessile, adnate to immersed, lecidine. Exciple indistinctly or distinctly cellular; epihymenium brown to olive-brown; hymenium strongly interspersed by oil; hypothecium hyaline; paraphyses septate, simple to apically branched, capitate, brownish-black at apices, conglutinated. Asci usually 8 spored rarely 16 spored; ascospores pale brown to dark brown, 1 septate, wall uniformly thickened or unevenly thickened (mischoblastiomorphic or placodiomorphic), surface smooth or ornamented. Conidia bacilliform. Norstictic acid and other unusual secondary metabolites such as Diploicin or Pacodiolic acid present in the thallus.

World wide 5 species; India 3 species; Literature: Marbach 2000.

Hafellia disciformis (Fr.) Marbach & H. Mayrhofer in Marbach

Biblioth. Lichenol. 74: 264. 2000.

Thallus corticolous, crustose, cracked areolate, smooth to verruculose, greenish grey, in small patches of 0.7 – 2.5 cm; prothallus dark brown to black. Apothecia round, closely adnate to the thallus, 0.2 – 0.5 mm diam.; margin thin, black, smooth, mostly persistent; disc black, epruinose, plane to concave, smooth to granular. Exciple lecidine, brown, 14 – 26 µm thick; epihymenium



brown, K-, KI+ blue, 10 – 14 µm thick; hymenium hyaline, oil globules present, 61 – 75 µm thick; hypothecium brown to dark brown, up to 40 µm thick; paraphyses branching and anastamosing, apical cell swollen and pigmented. Ascus 8 spored, clavate, 43 – 58 × 9 – 11 µm; ascospores brown, transversely 1 septate, oblong to ellipsoid, spore wall uniformly thickened, smooth, 13.9 – 16.9 × 4.2 – 5.9 µm.

Chemistry: K+ yellow, C-, KC-, P-. TLC: Atranorin present.

Comments: *Hafellia disciformis* is less frequent lichen species in Uttar Pradesh, found growing mostly on *Shorea robusta* trees in deciduous forest. It is characterized by verruculose, K+ thallus, dark brown prothallus, black, closely adnate apothecia, and brown, 1 septate ascospores.

Heppia Naeg. (Family: Heppiaceae)

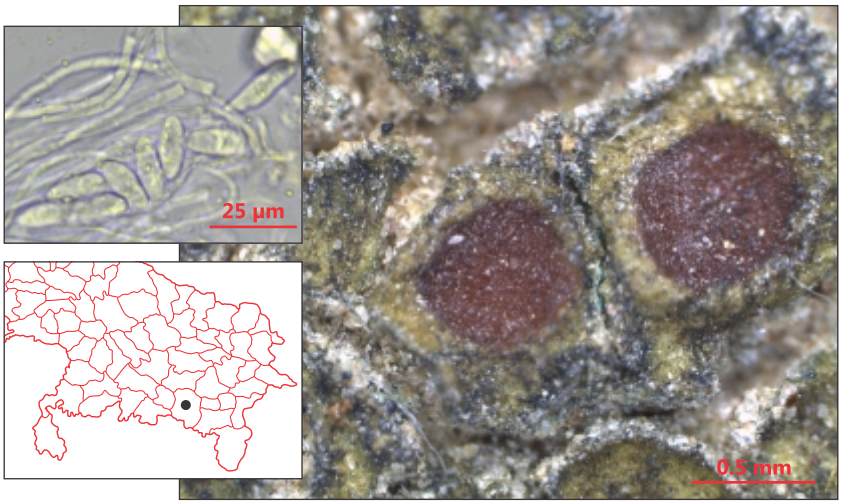
Naegeli in Hepp, Flecht. Europ. 49: 1853.

Thallus crustose to squamulose-foliose or fruticose with small tuberculate lobes, umbilicate or rhizinate; photobiont a cyanobacteria, *Scytonema*, either enclosed with in paraplectenchymatous tissue of mycobiont or in a layer. Ascomata apothecia initially immersed, then sessile with distinct disc. Exciple thalline; paraphyses simple. Asci 4 – 8 spored; ascospores hyaline, simple. Pycnoconidia ellipsoid, straight.

World wide 7 species; India 2 species; Literature: Upreti & Büdel 1990; Awasthi 1991.

Heppia lutosa (Ach.) Nyl.

Syn. Lich. 2: 45. 1863. –*Collema lutosum* Ach., *Syn. Meth. Lich.*: 309. 1814.



Thallus terricolous, squamulose; squamules closely adnate to substratum, orbicular, greenish, bluish green to brownish, 1.1 – 2.2 mm across. Ascomata apothecia, cirucular, depressed to semi-emergent, 0.2 – 1.0 mm diam.; margin indistinct to slightly rsised when young, prominent, thick at maturity, thalline, concolours with the thallus; disc orange red to reddish brown, plane to concave, epruionose. Exciple with cyanobacterial cells, 100 – 146 µm thick; epihymenium golden brown, 17 – 28 µm thick; hymenium hyaline to yellowish, 103 – 115 µm; hypothecium yellowish, 52 – 70 µm thick; paraphyses simple, apical cells swollen and yellow brown pigmented. Asci 8 spored, clavate, 63 – 96 × 15 – 17 µm; ascospores hyaline, broadly ellipsoid, simple, 14.7 – 17.9 × 6.8 – 8.0 µm.

Chemistry: K+ yellow, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Heppia lutosa* is a rare lichen species in Uttar Pradesh, found growing on soil. It is characterized by circular, yellow brown squamulose thallus, red-brown apothecia and hyalaine, ellipsoid 8 ascospres in asci. It is the oldest lichen specimen collected during 1926 from Allahabad area of Uttar Pradesh by W. Dudgeon. There after it has not been collected any where from India. The preserved sample is very delicate and hence its lower surface was not studied.

Hyperphyscia Müll. Arg. (Family: Physciaceae)

Bull. Herb. Boiss. 2 Apt. 1: 10. 1894.

Thallus foliose, closely adnate, usually small and narrowly lobate; lobes grey-brown; lower side often agglutinated to substratum, with short rhizines or rhizines absent. Thallus heteromerous, usually corticated on both sides; photobiont a green alga, *Trebouxia*. Ascomata apothecia, laminal, margin thalline, disc dark brown. Exciple lecanorine; hypothecium hyaline; paraphyses branched. Asci with amyloid tholus, 8 spored; ascospores brown, 1 septate, *Pachysporaria* or *Physcia* type. Pycnoconidia filiform, more than 10 µm long.

World wide 9 species; India 5 species; Literature: Awasthi 2007.

Key to the species of *Hyperphyscia*

1a. Thalllus sorediate 2

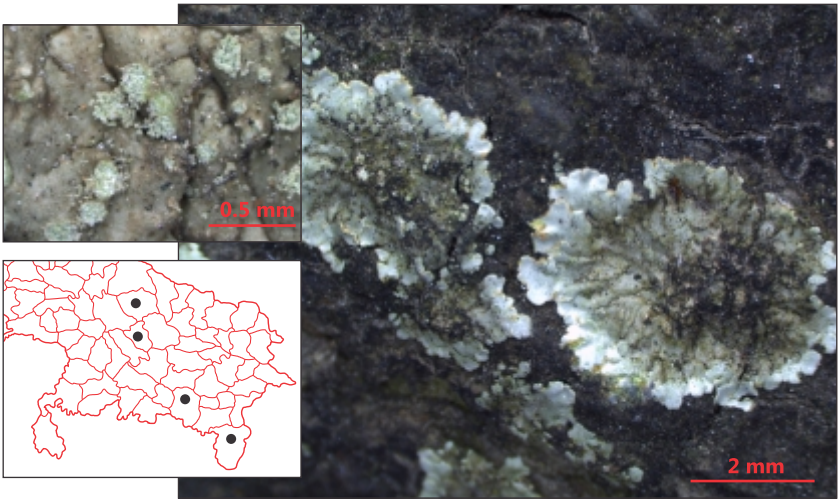
1b. Thallus lacking soredia and isidia, firmly attached, greyish brown . . . . . *H. syncolla*

2a. Thallus with hypothallus at visible at lobe margin . . . . . *H. minor*

2b. Thallus lacking hypothallus 3

3a. Medulla intermittently orange red . . . *H. adglutinata* var. *pyrithrocardia*

3b. Medulla white . . . . . *H. adglutinata* var. *adglutinata*



Hyperphyscia adglutinata* var. *adglutinata (Flörke) H. Mayrhofer & Poelt

Herzogia 5: 62. 1979. – *Lecanora aduglutinata* Flörke, *Deutschl. Lich. Gessam. Anmerk. 4, Lief Rostoch.*: 7. 1819.

Thallus corticolous, foliose, orbicular, small, 0.6 – 2.4 cm across, greenish grey to brownish, sorediate; lobes minute, 0.2 – 0.4 mm wide, slightly pruinose, free from the substratum; lower surface pale, yellowish white to grey white, rhizinate; rhizines dark grey with white tips; sorelia capitate; soredia granular, greenish; medulla white to greenish. Apothecia absent.

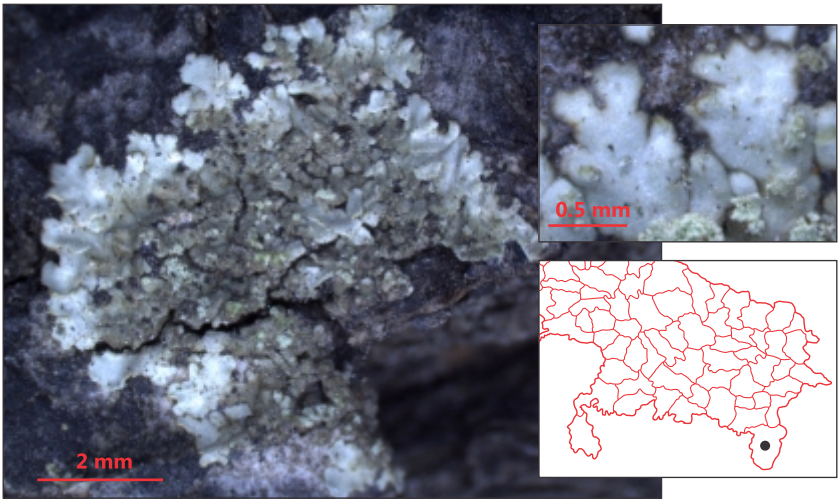
Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Hyperphyscia adglutinata* var. *adglutinata* is common lichen species in Uttar Pradesh, found growing mostly on *Mangifera indica* trees in orchard areas. It can be easily identified due to its smaller thallus size and greenish grey thallus. It grows along with *Pyxine* spp., which has prominent whitish grey, larger thallus. Sometimes *H. adglutinata* var. *adglutinata* get darker colouration and camouflage with the substratum.

Hyperphyscia adglutinata* var. *pyrithrocardia (Müll. Arg.) D.D. Awasthi

Comp. Macrolich. India, Nepal & Sri Lanka: 197. 2007. –*Physcia adglutinata* var. *pyrithrocardia* Müll. Arg., *Flora* 63: 278. 1880.

Thallus corticolous, foliose, 1.0 – 3.0 cm diam., often coalescing with neighbouring thallus; upper surface whitish grey to brownish, darkening at



margin; lobes free from substratum, 0.2 – 0.4 mm wide; sorelia capitate to irregular, laminal; soredia farinose; lower surface pale at margin, rhizinate; medulla white, sometimes orange and K+ purple. Apothecia absent.

Chemistry: K-, C-, KC-, P-. TLC: Skyrin present.

Comments: *Hyperphyscia adglutinata* var. *pyrithrocardia* is a rare lichen species in Uttar Pradesh, found growing on tree bark in deciduous forest. It is a minute lichen and hardly visible by naked eye as it camouflaged with the bark. It is characterized by greenish brown, sorediate thallus, patchy orange medulla that turns of K+ purple.

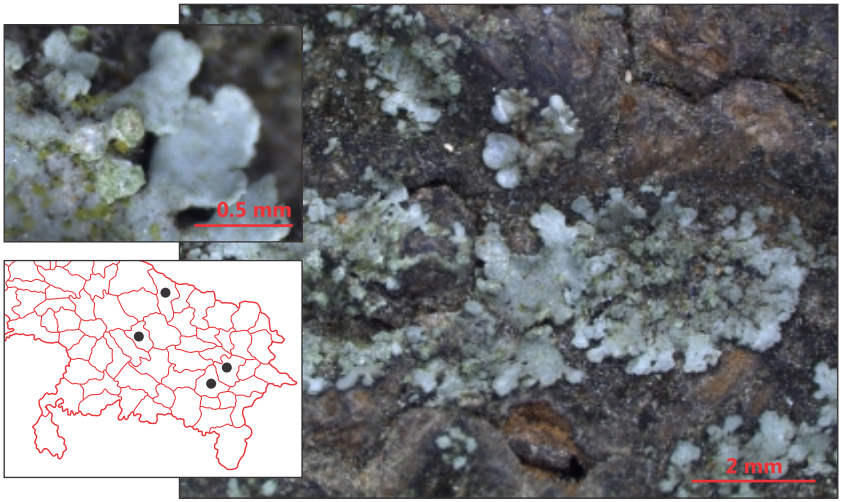
Hyperphyscia minor (Fée) D.D. Awasthi

J. Hattori Bot. Lab. 65: 208. 1988. – *Parmelia minor* Fée, *Essai Crypt. Exot. (Paris)*: 125. 1924.

Thallus corticolous, foliose, orbicular, 0.7 – 3.5 cm across, greenish grey to darker; lobes minute, 0.1 – 0.4 mm wide, ± pruinose; lower surface pale, rhizinate; hypothallus black, loose; medulla white; sorelia capicate; soredia farinose. Apothecia absent.

Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

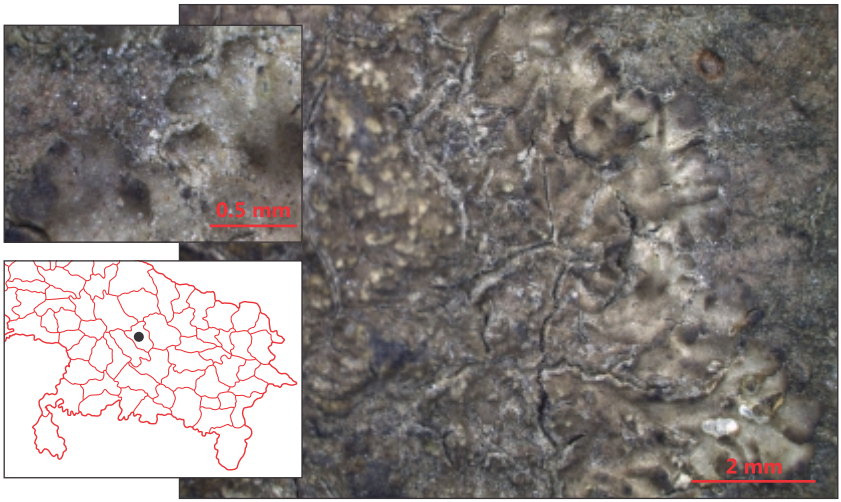
Comments: *Hyperphyscia minor* is a common species in Uttar Pradesh, found growing mostly on *Mangifera indica* trees in orchards and rarely in forests. It is characterized by minute greenish grey to brownish thallus and blackish, loose



hypothallus. It is a common species in India, cosmopolitan in distribution; frequently encountered in tropical region, however not included in the checklist of Indian lichens by Singh & Sinha (2010).

Hyperphyscia syncolla (Tuck. ex Nyl.) Kalb

Lich. Neotrop. Fasc. 6, no. 230. 1983. – *Physcia syncolla* Tuck. ex Nyl., *Acta Soc. Sci. Fenn.* 7: 441. 1863.



Thallus corticolous, placodioid-foliose, orbicular, closely adpressed to substratum, grayish brown to brown, up to 4 cm across; lobes flat, 0.2 – 0.6 mm wide, epruinose, much darker; lower surface brownish, lacking rhizines; medulla white. Apothecia absent.

Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Hyperphyscia syncolla* is a rare species in Uttar Pradesh, found growing on *Mangifera indica* tree trunk in orchard area. It can be differentiated from other species of *Hyperphyscia* by its much darker (brownish) colouration and the thallus is firmly attached to the bark. The samples collected from Uttar Pradesh consists of several decorticated soralia like structures devoid of soredia. It may be a common species in the state; however only one specimen has been collected, may be due it is much darker thallus which camouflage the species with substratum.

Lecanora Ach. (Family: Lecanoraceae)

Luyken, Kongl. Vetensk. Acad. Nya Handl. 31: 66. 1809.

Thallus crustose, granular, areolate or placodioid; photobiont *Trebouxia* or other chlorococcoid algae. Ascomata apothecia sessile or shortly stipitate, margin thin to thick, concolours with the thallus. True exciple poorly developed; thalline exciple prominent; epihymenium greenish brown to dark brown, hymenium hyaline, I+ blue; hypothecium hyaline; paraphyses simple to septate, apices slightly swollen. Asci elongate-clavate, Lecanora type; ascospores ellipsoid to subglobose, hyaline, simple, smooth walled.

World wide 552 species; India 90 species; Literature: Nayaka 2004; Lumbsch 1994; Saag *et al.* 2009.

Key to the species of Lecanora

1a. Thallus leprose, bluish grey, minutely lobate, usnic acid ad zeorin present ..... *L. coriensis*

1b. Thallus crustose to squamulose 2

2a. Apothecia disc densely pruinose, exciple with large crystals, epihymenial pigment dissolving in K, usnic acid present ..... *L. flavidomarginata*

2b. Apothecia disc epruinose to slightly pruinose 3

3a. Hypothecium brown to dark brown 4

3b. Hypothecium hyaline to pale yellow 5

4a. Thallus with 2'-O-methyl perlatolic acid, exciple with large crystals ..... *L. concilians*

4b. Thallus lacking 2'-O-methyl perlatolic acid, exciple with small and large crystals ..... *L. coronulans*

5a. Thallus saxicolous, crustose to squamulose, epihymenial pigment not dissolving in K, 2'-O-methyl perlatolic acid present ..... *L. pseudistera*

5b. Thallus corticolous 6

6a. Epihymenial pigment dissolving in K 7

6b. Epihymenial pigment not dissolving in K 15

7a. Thallus containing usnic acid 8

7b. Thallus lacking usnic acid 10

8a. Thallus containing 2'-O-methylperlatolic acid, apothecia orange brown ..... *L. achroa*

8b. Thallus lacking 2'-O-methylperlatolic acid 9

9a. Arthothelin present, apothecia dark orange brown to red brown ..... *L. interjecta*

9b. Arthothelin absent, apothecia pale red-brown to brown ..... *L. austrointumescens*

10a. Thallus containing 2'-O-methylperlatolic acid, apothecia pale brown to orange ..... *L. helva*

10b. Thallus lacking 2'-O-methylperlatolic acid 11

11a. Thallus containing pannarin, apothecia orange brown, pale to dark reddish brown ..... *L. cinereofusca*

11b. Thallus lacking pannarin 12

12a. Thallus containg gangleodin -..... 13

12b. Thallus lacking gangleodin 14

13a. Chloroatranorin present, apothecial pale orange to yellowish brown, younger apothecia immersed, margin thin ..... *L. leprosa*

13b. Chloroatranorin absent, apothecia orange brown to pale brown, margin thick ..... *L. rugosella*

14a. Apothecia subimmersed to constricted at base, usually smaller, ascospores smaller ..... *L. cenisia*

14b. Apothecia sessile, larger, ascospores larger ..... *L. chlarotera*

15a. Thallus containing usnic acid, apothecial disc red brown to brown ..... *L. alba*

15b. Thallus lacking usnic acid 16

16a. Thallus containing gangleodin, apothecia pale to dark reddish brown ..... *L. argentata*

16b. Thallus lacking gangleodin 17

17a. Amphithecium with small and large crystals, apothecia usually larger, chodatin present . . . . . *L. tropica*

17b. Amphithecium with only large crystals, apothecia smaller . . . *L. perplexa*

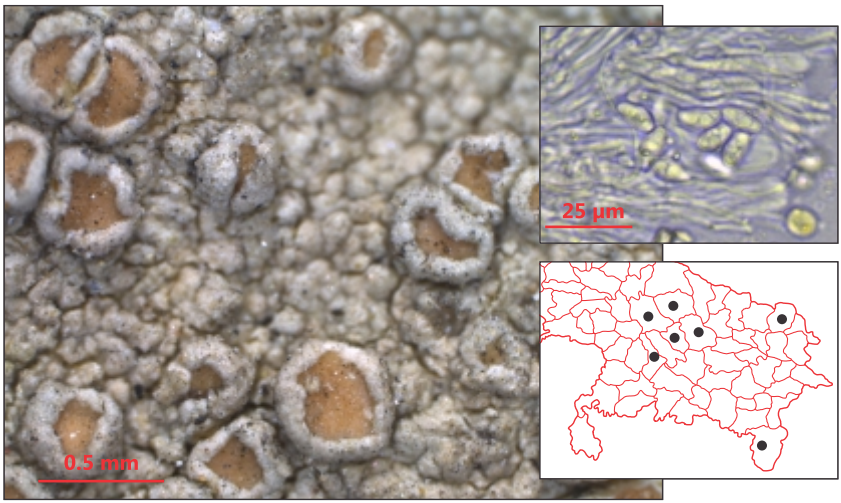
Lecanora achroa Nyl. in J.M. Crombie

J. Bot. 14: 263. 1876.

Thallus corticolous, crustose, continuous to rimose areolate, slightly verruculose, grey to yellowish grey, greenish grey, shiny; prothallus brownish black. Apothecia numerous, sessile, 0.2-1.0 mm in diam.; margin thick, thalline, smooth, entire to verruculose, persisting or becoming excluded at maturity, concolours with the thallus; disc orange to orange brown, epruinose. Exciple with algal cells, large crystals in groups, 18 – 35 µm thick; epihymenium yellowish brown, granular, pigmentation dissolving in K, 10 – 15 µm thick; hymenium hyaline, 45 – 60 µm thick; hypothecium hyaline, 20 – 30 µm thick; paraphyses sparingly branched, apical cell swollen, hyaline. Asci 8 spored, clavate, 40 – 50 × 8 – 12 µm; ascospores hyaline, simple, ellipsoidal to broadly ellipsoidal, 9.5 – 17.1 × 6.2 – 9.1 µm.

Chemistry: Thallus K+ yellow, C- or + orange, KC-, P+ yellow. TLC: Atranorin, 2'-O-methylperlatolic, usnic acid, ± arthothelin and traces of unidentified terpenes.

Comments: *Lecanora achroa* is one the common lichen species in Uttar Pradesh, found growing mostly on *Mangifera indica* trees, and occasionally on



Acacia nilotica and *Shorea robusta* tree trunk. It is characterized by the comparatively small apothecia with orange brown discs, large crystals in exciple, dissolving epihymenium, small ascospores and the presence of usnic acid. It is close to *L. helva* and *L. leprosa* with respect to general morphology, but both later species lack usnic acid and have different chemistry. It is also close to *L. alba* which differs in having egranulose epihymenium.

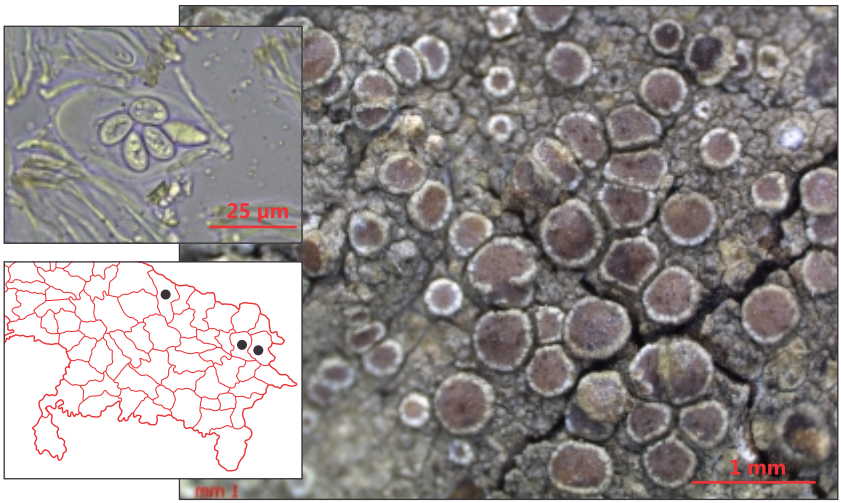
Lecanora alba Lumbsch, in H.T. Lumbsch, G.B. Feige and J.A. Elix

Bryologist 98: 565. 1995.

Thallus corticolous, crustose, continuous to verruculose, yellowish grey to greenish white or whitish grey; prothallus indistinct blackish brown. Apothecia numerous, sessile, 0.5 – 1.2 mm diam.; margin smooth to verruculose, entire, thalline, concolours with the thallus; disc red brown to brown, epruinose. Exciple with algal cells, large crystals present in groups, 30 – 30 µm thick; epihymenium red-brown, egranular, lacking crystals, pigmentation not dissolving in K, 10 – 15 µm thick; hymenium hyaline, 45 – 60 µm thick; hypothecium hyaline, 25-35 µm thick; paraphyses simple to sparingly branched, apical cell thickened, brownish pigmented. Asci 8 spored, clavate, 35–50 × 8–12 µm; ascospores, simple, ellipsoidal, 9.2–13.4 × 5.1–8.3 µm.

Chemistry: Thallus K+ yellow, C- or + orange, KC-, P+ yellow. TLC: Arthothelin, atranorin and usnic acid.

Comments: *Lecanora alba* is less frequent species in Uttar Pradesh, found growing on *Mangifera indica*, *Polyalthia* spp. and *Shorea robusta* tree trunks. It is characterized by smaller apothecia, non-granulose epihymenium, larger



crystals in exciple, and the presence of arthothelin and usnic acid.

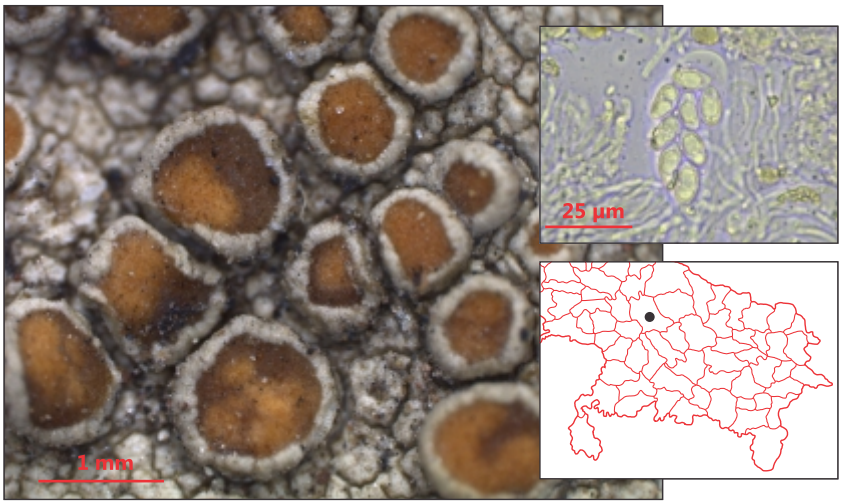
Lecanora argentata (Ach.) Degel. in Nilsson

Ark. Bot. 24A: 78. 1931. – *Parmelia subfusca* f. *argentata* Ach., *Meth. Lich.*: 169. 1803.

Thallus corticolous, crustose, continuous, smooth to verruculose, yellowish white to yellowish grey or whitish grey, sometimes dark grey to pale brown; prothallus whitish to greyish white or invisible. Apothecia numerous, crowded, sessile, constricted at base, 0.4 – 0.8 mm diam.; margin thick, entire to crenulate, smooth to ± verrucose, thalline, concolours with the thallus; disc pale to dark reddish brown, shiny, plane to concave, epruinose. Exciple hyaline, algal cell present, large crystals present in groups, 25 – 45 µm thick; epihymenium reddish brown, egranular, pigmentation not dissolving in K, 10 – 15 µm thick; hymenium hyaline, 55 – 80 µm high; hypothecium hyaline, 35 – 50 µm thick; paraphyses sparingly branched apically, apical cell slightly swollen, reddish brown pigmented. Asci 8 spored clavate, 25 – 50 × 10 – 15 µm; ascospores hyaline, simple, ellipsoidal, 9.1 – 15.3 × 6.0 – 8.2 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin and gangaleoidin present.

Comments: *Lecanora argentata* is a rare species in Uttar Pradesh, found growing on *Mangifera indica* tree trunk is orchard. It is characterized by the non dissolving epihymenium, the large crystals in exciple and the presence of gangaleoidin.



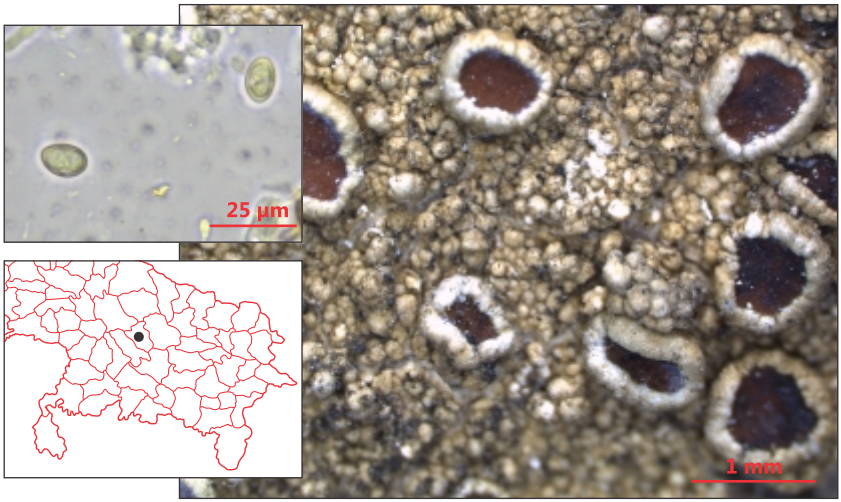
Lecanora austrointumescens Lumbsch and Elix

Mycotaxon 67: 393. 1998.

Thallus corticolous, crustose, granular verruculose to verrucose, yellowish white to whitish grey. Apothecia numerous, dense, sessile, constricted at base, 0.3 – 1.5 mm diam.; margin thalline, entire, thick, smooth in young apothecia, thin, verrucose, flexuose at maturity, concolours with the thallus; disc pale red-brown to brown, epruinose to slightly grey pruinose, plane to convex. Exciple with algal cells, numerous large and small crystals, 26 – 43 µm thick; epihymenium reddish brown, granular, with small crystals, pigmentation dissolving in K, 10 – 12 µm thick; hymenium hyaline, 60-70 µm thick; hypothecium hyaline, 20 – 35 µm thick; paraphyses sparingly branched, apical cell swollen. Asci 8 spored, cylindrical to clavate, 36 – 52 × 12 – 20 µm; ascospores hyaline, simple, ellipsoid, 9 – 20 × 5 – 8 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P+ yellow. TLC: Atranorin and usnic acid present.

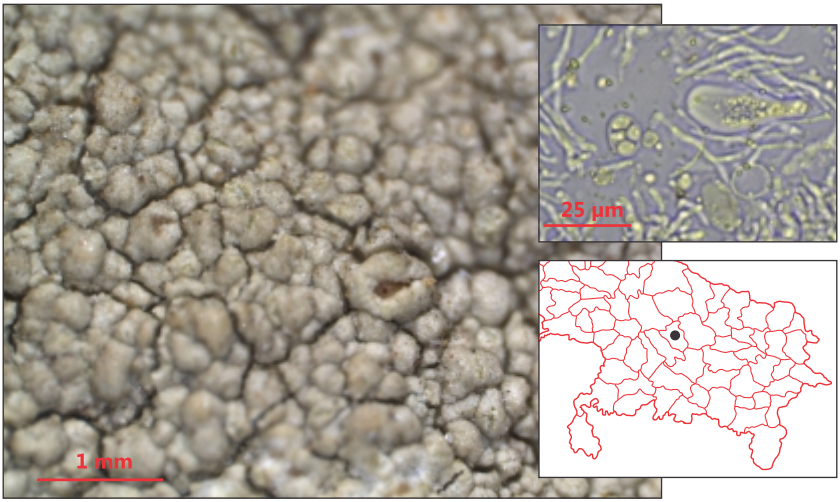
Comments: *Lecanora austrointumescens* is a rare lichen species in Uttar Pradesh, found growing on *Mangifera indica* tree trunk in orchards. It is characterized by the red brown to brown apothecia with flexuose margin, large and small crystals in exciple and presence of usnic acid.



Lecanora cenisia Ach.

Lichenogr. Universalis: 361. 1810.

Thallus corticolous, crustose, dispersed areolate to continuous, verruculose to



verrucose, whitish grey to yellowish grey. Apothecia frequent, subimmersed to constricted at base, 0.3 – 0.6 mm in diam.; margin prominent, thalline, smooth to slightly verrucose, entire to flexuose, thick, concolours with the thallus; disc yellowish orange to yellowish brown, slightly pruinose. Exciple with algal cells and with large crystals in groups, 27 – 45 µm thick; epihymenium yellowish brown, pigmentation dissolving in K, 10-15 µm thick; hymenium hyaline, 60 – 75 µm high; hypothecium hyaline, 25 – 35 µm thick; paraphyses simple to sparingly branched, apical cell not or slightly swollen, often brownish pigmented. Asci 8 spored, clavate, 40 – 60 × 8 – 12 µm; ascospores hyaline, simple, ellipsoidal, 10 – 13 × 6 – 8 µm.

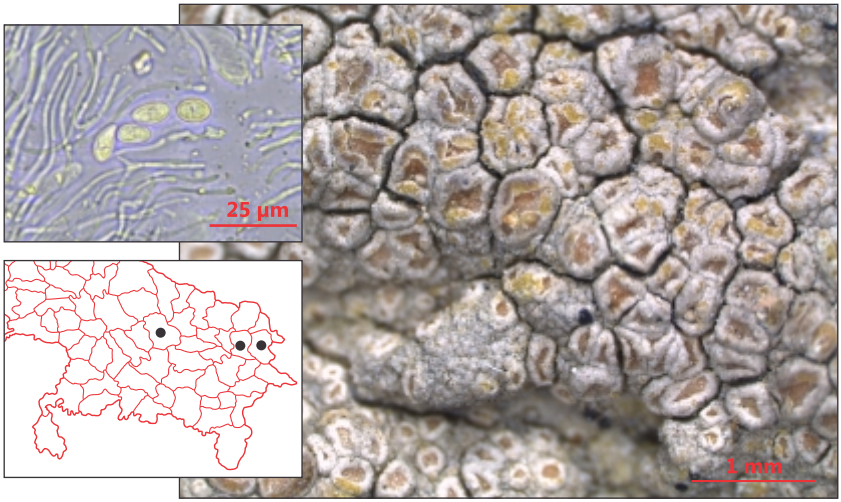
Chemistry: Thallus K+ yellow, C-, KC-, P+ pale yellow. TLC: Atranorin present.

Comments: *Lecanora cenisia* is a rare lichen species in Uttar Pradesh, found growing on *Mangifera indica* trees in orchards. It is characterized by whitish grey, dispersed verrucose thallus, yellow orange to yellow brown apothecial discs, large crystals in exciple, dissolving pigment in epihymenium. It is close to *L. helva* but *L. cenisia* differs in having comparatively smaller apothecia and atranorin in chemistry.

Lecanora chlarotera Nyl.

Bull. Soc. Linn. Norm. ser. 2, 6: 274. 1872.

Thallus corticolous, crustose, continuous, smooth to verruculose, granular, ashy grey, yellow grey to yellowish brown. Apothecia numerous, crowded, sessile, constricted at base, 0.3 – 1.7 mm in diam.; margin thick, thalline, entire



to crenulate, smooth to verrucose, concolours with the thallus; disc pale brown to red brown or dark brown, slightly pruinose, plane to convex. Exciple algal cells and large crystals, 28 – 37 µm thick; epihymenium pale brown to brown, granular, pigmentation dissolving in K, 12 – 15 µm thick; hymenium hyaline, 50 – 70 µm high; hypothecium hyaline, 25 – 35 µm high; paraphyses simple to sparingly branched, apical cell swollen. Asci 8 spored, cylindrical to clavate, 40 – 60 × 14 – 20 µm; ascospores hyaline, simple, ellipsoidal, 12 – 16 × 7 – 10 µm.

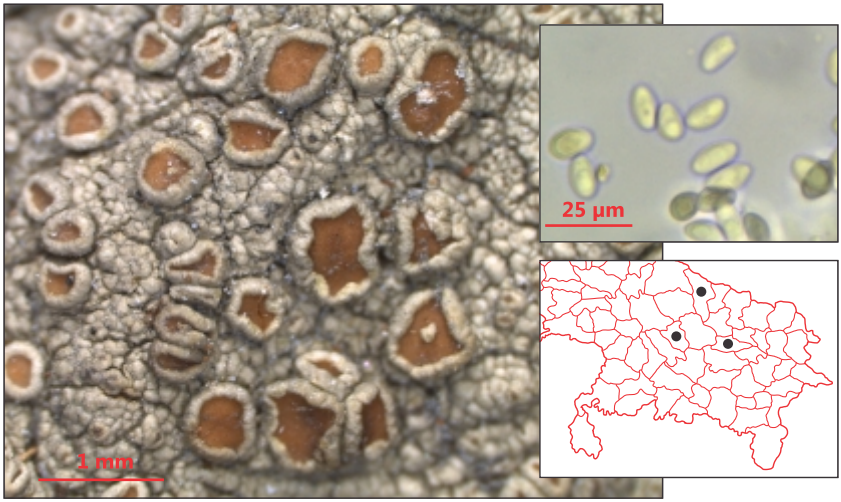
Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin present.

Comments: *Lecanora chlarotera* is a common lichen species in Uttar Pradesh, found growing on *Mangifera indica* tree trunk in orchards. It is characterized by crowded, pale brown to brown, apothecia having large crystasl in exciple and dissolving epihymenium.

Lecanora cinereofusca H. Magn.

Meddel. Göterb. Bot. Trädg. 7: 86. 1932.

Thallus corticolous, crustose, continuous, rough verruculose, greenish white to greenish grey. Apothecia numerous, crowded, immersed when young, sessile, constricted at base at maturity, 0.3 – 1.2 mm diam.; margin usually thin, thalline, verrucose, continuous to strongly flexuose, concolours with the thallus; disc orange brown, pale to dark reddish brown, shiny, epruinose, plane to slightly convex. Exciple with algal cells and large crystals, 22 – 30 µm thick; epihymenium red brown to brown, pigmentation dissolving in K, 8 – 15 µm thick; hymenium hyaline, 50 – 90 µm thick; hypothecium hyaline, 35 – 40 µm thick; paraphyses simple to sparingly branched, apical cell slightly swollen.



Asci 8 spored, clavate, 40 – 60 × 14 – 20 µm; ascospores hyaline, simple, ellipsoidal, 12 – 14 × 6 – 8 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P+ yellow. TLC: Atranorin and pannarin present.

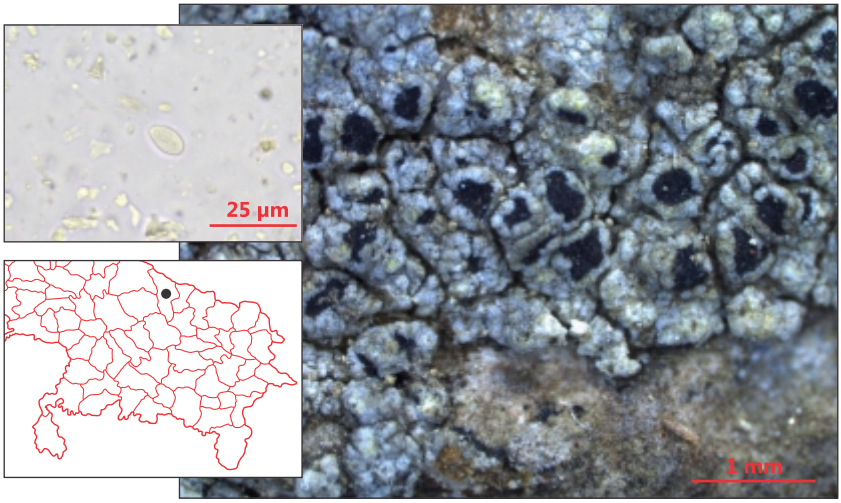
Comments: *Lecanora cinereofusca* is common lichen species in Uttar Pradesh, found growing on *Grevillea robusta* in garden and *Mangifera indica* trees in orchards. It is characterized by immersed apothecia during young, reddish orange to reddish brown apothecia, large crystals in exciple, epihymenium dissolving in K and pannarin in chemistry.

Lecanora concilians Nyl.

Acata Soc. Sci. Fenn. 7: 445. 1863.

Thallus corticolous, crustose, greenish grey, verruculose, areolate. Apothecia numerous, round, irregularly folded when crowded, 0.2 – 0.6 mm diam.; margin smooth verrucose, thick, thalline, concolours with the thallus, lecanorine; disc dark brown to black, plane to convex, epruinose. Exciple with mostly large crystals, algal cell present, up to 135 µm thick; epihymenium yellow brown, pigment not dissolving in K, 13 – 21 µm thick; hymenium hyaline, not inspersed, up to 100 µm thick; hypothecium yellow brown, up to 80 µm thick; paraphyses simple to branched, apical cell slightly swollen. Ascus 8 spored, clavate-cylindrical, 35 – 47 × 10 – 14 µm; ascospores hyaline, simple, ellipsoid, 12.0 – 14.3 × 7.0 – 8.0 µm.

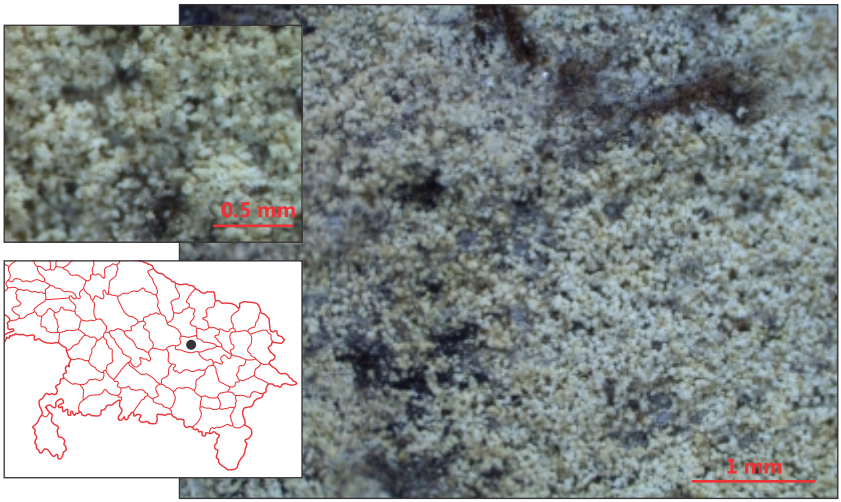
Chemistry: Thallus K+ yellow, C-, KC- or yellow, P-: TLC: Atranorin and 2-O'-methylperlatolic acid present.



Comments: *Lecanora concilians* is a rare lichen species in Uttar Pradesh, found growing on tree bark in deciduous forest areas. It is characterized by brown to dark brown apothecia, exciple with large crystals, non-dissolving epihymenium, yellow brown hypothecium and methylperlatolic acid in chemistry.

Lecanora coriensis (Hue) J.R. Laundon

Nova Hedwigia 76(1-2): 97. 2003. –*Crocynia coriensis Hue, Bull. Soc. Bot. Fr.* 71: 386. 1924.



Thallus saxicolous, leprose, whitish to bluish grey, minutely lobate or not, granules 0.3–0.7 mm across.

Chemistry: Thallus K-, C-, KC-, P-. TLC: Usnic acid and zeorin present.

Comments: *Lecanora coriensis* is a rare lichen species in Uttar Pradesh, found growing luxuriantly on lime plaster of old monument. It is characterized by leprose thallus, and presence of usnic acid and zeorin. The lobes of the species is hardly recognizable, but it can be identifiable through its unque chemistry.

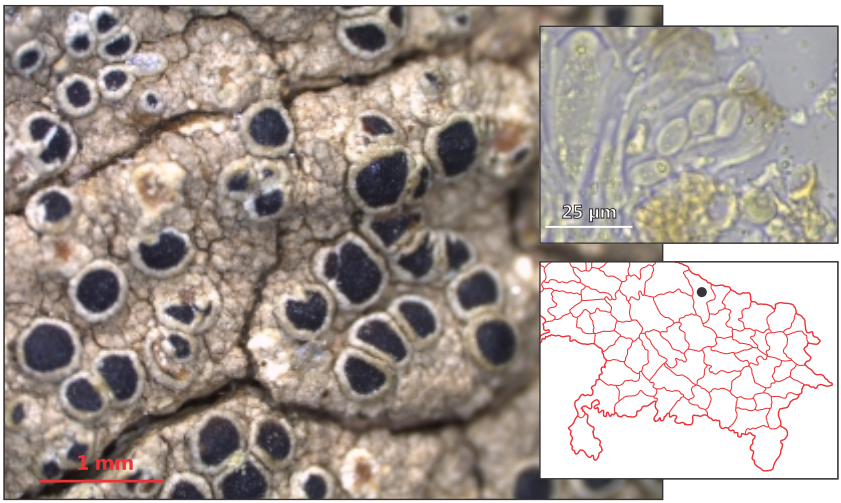
Lecanora coronulans Nyl.

Flora 59: 510. 1876.

Thallus corticolous, crustose, verruculose to verrucose, whitish grey to yellowish grey. Apothecia, numerous, crowded, sessile, 0.3-1.2 mm in diam.; margins thalline, entire, verruculose to flexuose, concolours with the thallus; disc red brown to dark brown, epruinose. Exciple with small and large crystals, algal cell present, 25 – 40 µm thick; epihymenium brown, red brown to dark brown, egranular, pigmentation not dissolving in K; hymenium hyaline 50 – 100 µm high; hypothecium upper part yellow to reddish brown, lower part orange to dark red brown, 40 – 60; paraphyses simple to branched, apical cell slightly swollen, brownish pigmented. Asci clavate, 52 – 60 × 8 – 12 µm; ascospores hyaline, simple, ellipsoid to broadly ellipsoidal, 9 – 12 × 5 – 7 µm.

Chemistry: Thallus K+, C-, KC-, P-. TLC: Atranorin and zeorin present.

Comments: *Lecanora coronulans* is a rare lichen species in Uttar Pradesh, found growing on bark of trees in deciduous forest. It is characterized by the



brown to dark brown apothecial discs, large and small crystals exciple, not dissolving epihymenial pigment and presence of zeorin.

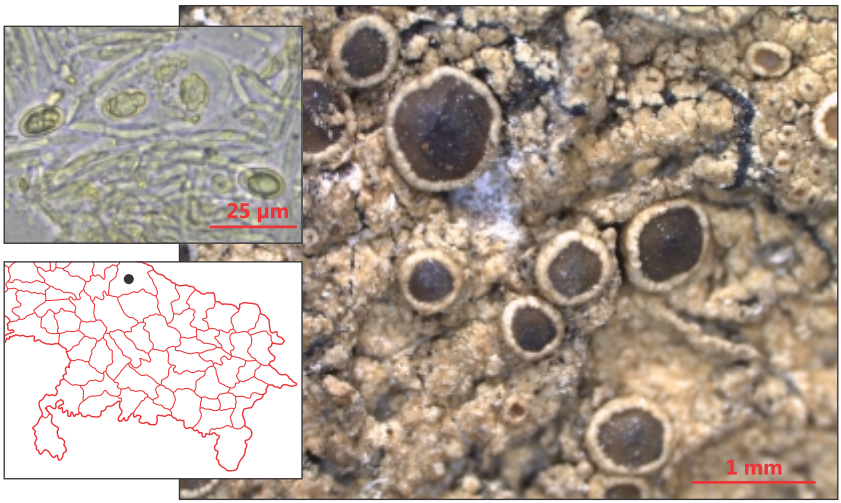
Lecanora flavidomarginata B. de Lesd.

Lich. Mexique: 14. 1914.

Thallus corticolous, crustose, dispersed-verrucose to verruculose, areolate, whitish grey to yellowish grey. Apothecia, numerous, dense, sessile to slightly constricted at the base, 0.2 – 1.0 mm diam.; margin thin, thalline, smooth, ± verrucose to crenulate, concolours with the thallus; disc pale red-brown to grey-brown, pruinose, pruina bluish grey – to pale grey or whitish. Exciple with algal cells and large crystals in groups, 25 – 40 µm; epihymenium pale brown to yellowish brown, 7 – 12 µm thick, with small crystals, pigmentation dissolving in K; hymenium hyaline, 57 – 80 µm high, hypothecium hyaline, 35-45 µm thick; paraphyses simple sparingly branched, apical cell swollen. Asci cylindrical to clavate, 32 – 57 × 16 – 18 µm; ascospores simple, ellipsoid to broadly ellipsoidal, hyaline, 9 – 14 × 5 – 6 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P+ pale orange. TLC: Atranorin, usnic acid, zeorin, unidentified terpenes and pale yellow spot at Rf class 4 present.

Comments: *Lecanora flavidomarginata* is a rare lichen species in Uttar Pradesh, found growing on tree bark in deciduous forest area. It is characterized by bluish grey-pruinose apothecial discs, large crystals in exciple, dissolving epihymenium and the presence of usnic acid in addition to atranorin and zeorin.



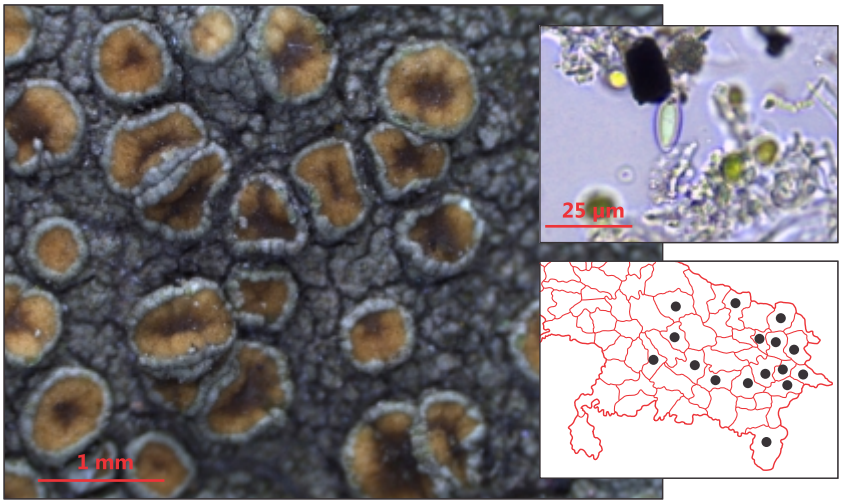
Lecanora helva Stizenb.

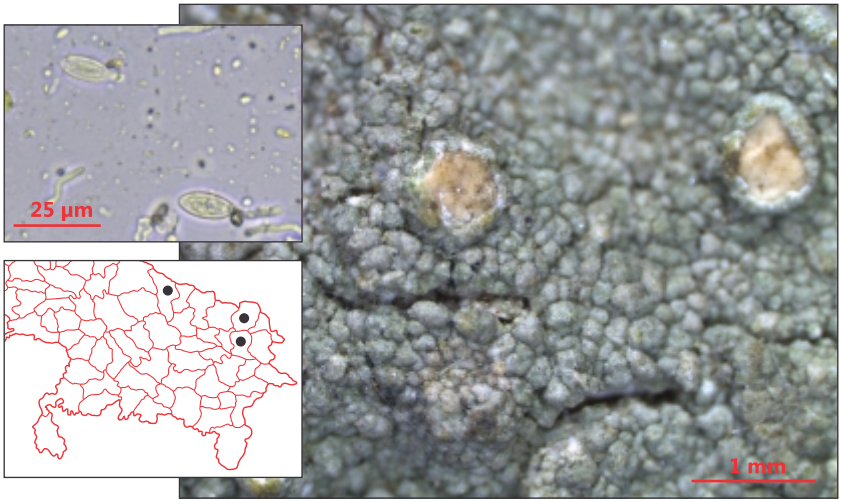
Ber. Thätigk. St. Gall. Naturw. Ges. 1888/89: 218. 1890.

Thallus corticolous, crustose, continuous or areolate, smooth to verruculose, yellowish white to yellowish green or greenish grey. Apothecia numerous, crowded, immersed when young, becoming sessile, 0.3 – 0.9 mm diam.; margin thin, entire, smooth to verruculose, thalline, concolours with the thallus; disc pale brown to orange, epruinose or slightly pruinose. Exciple with algal cells, large crystals in groups, 25 – 40 µm thick; epihymenium pale yellowish to brown, granular, pigmentation dissolving in K, 10 – 15 µm thick; hymenium hyaline, 60 – 85 µm thick; hypothecium hyaline, 30 – 45 µm thick; paraphyses sparingly branched, apical cell not or slightly swollen. Asci 8 spored, clavate, 40 – 70 × 15 – 20 µm; ascospores hyaline, simple, ellipsoidal, 13.3 – 18.0 × 5.9 – 7.8 µm.

Chemistry: Thallus K+ yellow, C-, KC-, PD+ pale yellow to orange. TLC: Atranorin and 2'-O-methylperlatolic acid present.

Comments: *Lecanora helva* is a very common lichen species in Uttar Pradesh, found growing on variety of trees such as *Acacia nilotica, Artocarpus heterophyllus, Azadirachta indica, Litchi chinensis, Mangifera indica, Shorea robusta,* and *Syzygium cumini*. It is characterized by the small orange to pale brown apothecial discs, large crystals in exciple, epihymenium dissolving in K and 2'-O-methylperlatolic acid in chemistry.





Lecanora interjecta Müll. Arg.

Nuov. Giorn. Bot. Ital. 23: 390. 1891.

Thallus corticolous, crustose, verrucose to verruculose, yellowish grey to greenish grey. Apothecia numerous, sessile, constricted base, 0.3 – 0.8 mm diam.; margin thin, smooth to verruculose, thalline, concolorous with the thallus; disc dark orange brown to red brown, epruinose. Exciple with algal cells, large crystals in groups, 30 – 45 µm thick; epihymenium pale brown to reddish brown, granular, with numerous small crystals, pigmentation dissolving in K, 10 – 15 µm thick; hymenium hyaline, 60 – 80 µm thick; hypothecium hyaline, 25-35 µm thick; paraphyses sparingly branched, apical cell swollen. Asci 8 spored, clavate, 45 – 70 × 13 – 18 µm; ascospores hyaline, simple, ellipsoidal, 10 – 15 × 7 – 10 µm.

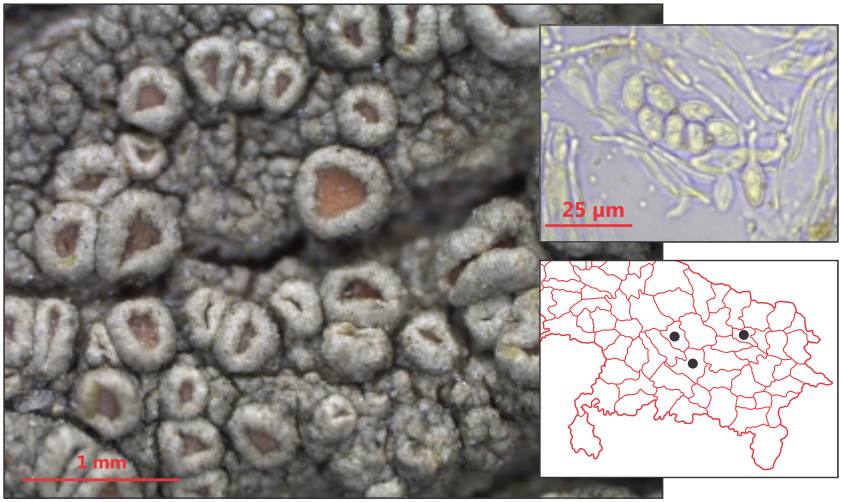
Chemistry: Thallus K+ yellow, C+ orange, KC+ orange, P+ pale orange. TLC: Arthothelin, atranorin and usnic acid present.

Comments: *Lecanora interjecta* is a common lichen species in Uttar Pradesh, found growing on various trees, including *Shorea robusta* and *Syzygium cumini* in deciduous forest area. It is characterized by the presence of arthothelin, large crystals in exciple, dissolving epihymenium in K and the red-brown apothecial discs.

Lecanora leprosa Fée

Essai Crypt. 1: 118. 1824.

Thallus corticolous, crustose, continuous to areolate, smooth to dispersed



verrucose, yellowish white to yellowish grey or greenish grey. Apothecia numerous, immersed when young, becoming sessile, 0.2 – 1.0 mm diam.; margin thick, entire to crenulate, sometimes verrucose, thalline, concolorous with the thallus; disc pale orange to yellowish brown, plane to convex, epruinose to slightly pruinose. Exciple with algal cells, large crystals in groups, 25 – 40 µm thick; epihymenium pale yellow to yellowish brown, with numerous crystals, pigmentation dissolving in K, 8 – 12 µm thick; hymenium hyaline, 50 – 72 µm thick; hypothecium hyaline or yellowish to pale yellowish brown, 15 – 25 µm thick; paraphyses sparingly branched, apical cell swollen. Asci 8 spored, cylindrical to clavate, 40 – 65 µm; ascospores hyaline, simple, narrow to oval ellipsoidal, 9 – 14 × 5 – 7 µm.

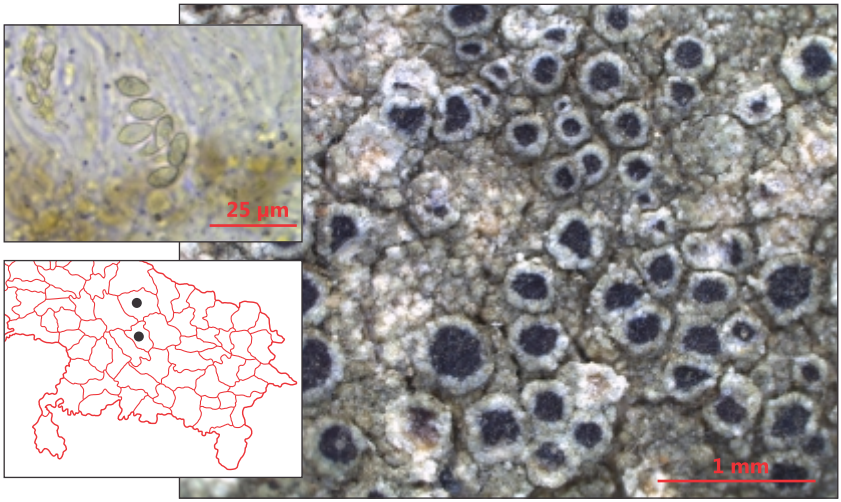
Chemistry: Thallus K+ yellow, C-, KC-, P+ yellow. TLC: Atranorin, gangaleoidin and chloroatranorin present.

Comments: *Lecanora leprosa* is a common like lichen species in Uttar Pradesh, found growing on bark of *Artocarpus heterophyllus, Madhuca indica, Mangifera indica*, and *Pongamia pinnata* trees in orchard and along road side. It is characterized by the orange to yellowish brown apothecial discs, dissolving epihymenium, yellow to brownish hypothecium, large crystals in exciple and presence of gangaleoidin.

Lecanora perplexa Brodo

Beih. Nova Hedwigia 79: 148. 1984.

Thallus corticolous, crustose, rough, granular to slightly verrucose, areolate, whitish grey to greenish grey. Apothecia numerous, crowded when numerous,



sessile, constricted at base, 0.3 – 1.0 mm in diam.; margin thick, smooth to verruculose, entire to rarely flexuouse, thalline, concolours with the thallus; disc reddish brown to dark brown, epruinose, plane to concave or slightly convex. Exciple with algal cells and large crystals in groups, 32 – 45 µm thick; epihymenium pale yellow to red brown, egranular, lacking crystals, pigmentation not dissolving in K, 8 – 12 m thick; hymenium hyaline, 50 – 90 m thick; hypothecium hyaline, 25 – 35 µm thick; paraphyses sparingly branched, apical cell swollen. Asci 8 spored, cylindrical to clavate, 30 – 60 × 14 – 20 m; ascospores simple, hyaline, ellipsoidal, 12 – 16 × 5 – 8 m.

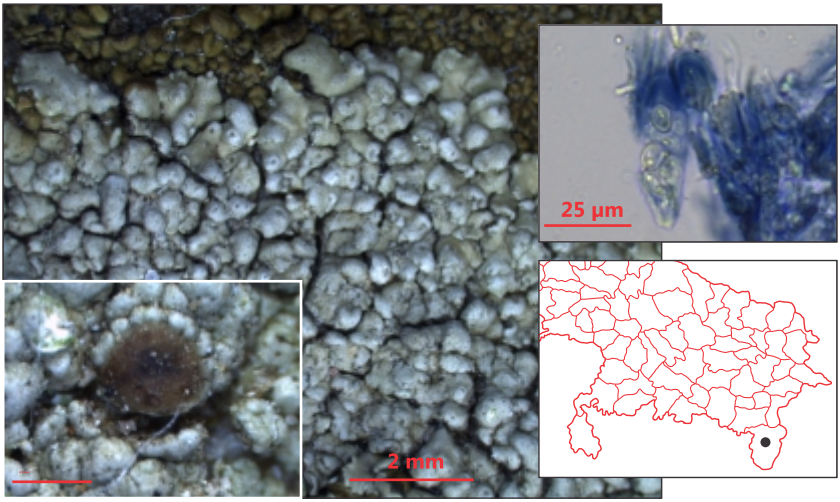
Chemistry: Thallus K+ yellow, C-, KC-, P+ pale yellow. TLC: Atranorin and zeorin present.

Comments: *Lecanora perplexa* is a rare lichen species in Uttar Pradesh, found growing on *Mangifera indica* trees in orchard areas. It is characterized by granular to slightly verrucose thallus, red brown apothecia, large crystals in exciple, non-dissolving epihymenium and presence of zeorin in chemistry.

Lecanora pseudistera Nyl.

Flora 55: 354. 1872.

Thallus saxicolous, squamulose to lobate, whitish grey; squamules convex to bullate, closely adpressed, continuous, dispersed indeterminately or forming orbicular, lobate patches, marginal lobes 0.3 – 0.5 mm wide. Ascomata apothecia, rare to frequent, sub-immersed to sessile, 0.4 – 0.8 mm diam.; margin thalline, concolours with thallus, thick, smooth to verrucose; disc orange brown becoming dark brown and black at maturity, convex, epruinose. Exciple with algal cells, large crystals in group, 47 – 131 µm thick; epihymenium



red brown, pigment not dissolving in K, 17 – 28 µm thick; hymenium hyaline, inspersed with oil globules, KI+ blue, 54 – 96 µm thick; hypothecium hyaline 96 – 111 µm thick; paraphyses sparingly branching and slightly anastamosing, septate, apical cell swollen and pigmented. Ascus 8 spored, cylindrical – clavate, 40 – 57 × 11 – 14 µm; ascospores hyaline, simple, oblong to ellipsoid, 9.6 – 11.6 × 5.3 – 7.0 µm. Pycnidia immersed, black, U-shaped; conidia globose, up to 3.6 µm.

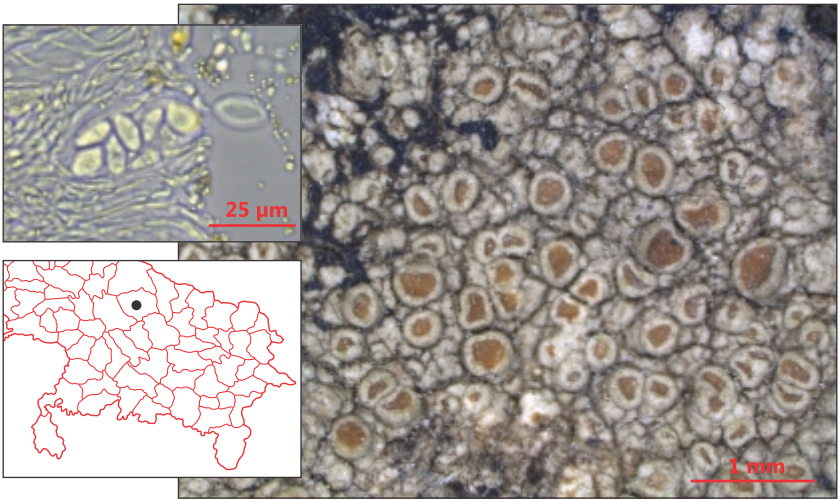
Chemistry: Thallus K+ yellow, C-, KC-, P+ yellow. TLC: Atranorin, 2'-O-methylperlatolic acid, pale cream colour spot at Rf class 4 present.

Comments: *Lecanora pseudistera* is a rare lichen species in Uttar Pradesh, found growing on exposed rocks. It is easily identified from other species of Lecanora due to its squamulose-lobate thallus, red brown apothecia, large crystals in exciple, non-dissolving epihymenium in K and 2'-O-methylperlatolic acid in chemistry.

Lecanora rugosella Zahlbr.

Cat. Lich. Univers. 5: 524. 1928.

Thallus corticolous, crustose, continuous to areolate, rough, granular verrucose, greenish grey to brownish grey. Apothecia numerous, crowded, sessile, constricted at base, 0.2 – 1.0 mm in diam.; margins thick, smooth to verrucose, entire, thalline, concolours with the thallus; disc orange brown to pale brown, epruinose, plane to slightly convex. Exciple with algal cells, large crystals, 25 – 40 µm thick; epihymenium pale brown to brown, granular, with coarse crystals, pigmentation dissolving in K; hymenium hyaline, 50 – 70 µm



thick; hypothecium hyaline, 30 – 40 µm thick; paraphyses sparingly branched, apical cell swollen, hyaline. Asci 8 spored, cylindrical to clavate, 30 – 50 × 12 – 18 µm; ascospores hyaline, simple, oval to ellipsoidal, 8 – 15 × 5 – 8 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P+ pale yellow. TLC: Atranorin and gangaleoidin.

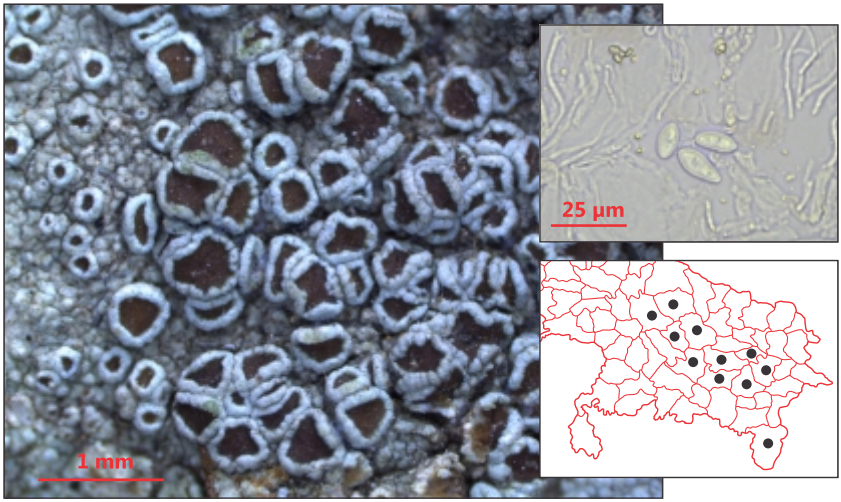
Comments: *Lecanora rugosella* is a rare lichen species in Uttar Pradesh, found growing on *Mangifera indica* in orchard areas. It is characterized by coarsely verrucose thallus, pale brown to brown apothecia, exciple with large crystals, dissolving epihymenium and presence of gangaleoidin.

Lecanora tropica Zahlbr.

Cat. Lich. Univers. 5: 589. 1928.

Thallus corticolous, crustose, rough, verrucose to verruculose, continuous to areolate, whitish grey to yellowish grey. Apothecia numerous, crowded, sessile, 1.3 – 3.2 mm diam.; margin thick, verrucose to verruculose, entire, thalline, concolours with the thallus; red brown to dark brown, epruinose, plane to concave. Exciple with algal cells, with large and small crystals, 25 – 45 µm thick; epihymenium reddish brown, egranular, lacking crystals, pigmentation not dissolving in K, 10 – 15 µm thick; hymenium hyaline, 60 – 70 m thick; hypothecium hyaline, 20 – 30 µm thick; paraphyses sparingly branched, apical cell ± swollen, hyaline; asci 8 spored, clavate, 45 – 55 × 20 – 25 µm; ascospores hyaline, simple, ellipsoidal, 8 – 17 × 6 – 9 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P+ yellowish. TLC: Atranorin, chodatin and zeorin present.



Comments: *Lecanora tropica* is a common lichen species in Uttar Pradesh, found growing on *Acacia nilotica, Mangifera indica,* and *Mangifera indica* tree bark in orchard and forested areas. It is characterized by red brown apothecia, exciple with large and small crystals, epihymenial pigments not dissolving and chodatin in chemistry.

Lecidea Ach. (Family: Lecideaceae)

Methodus: 32. 1803.

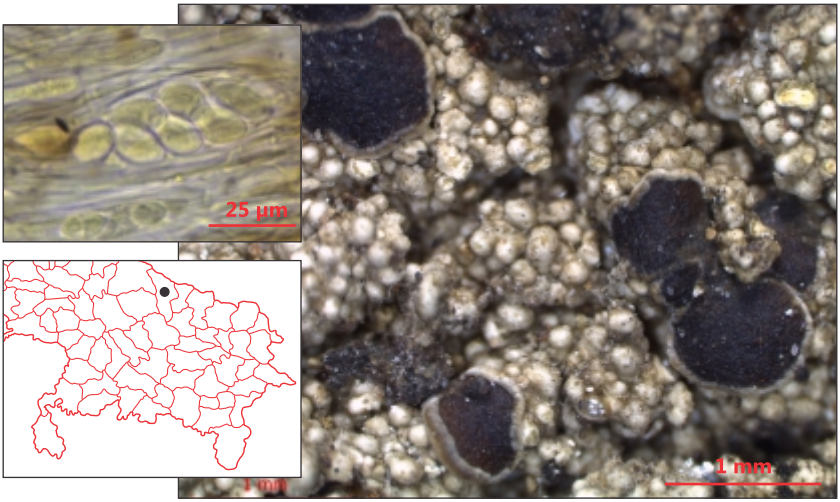
Thallus crustose, superficial, or immersed, continuous to areolate, grey; prothallus present or absent; photobiont a *Trebouxia*. Ascomata apothecia immersed to sessile, true exciple of irregular chains of swollen cells, outer layer brown to dark brown, hymenium I + blue; hypothecium hyaline to brown or black; hymenium of simple or sparsely branched paraphyses; asci elongate-clavate, *Lecidea* type; ascospores ellipsoid to oblong, simple with a central plasma bridge, smooth, hyaline.

World wide 100 species; India 18 species; Literature: Singh 1981.

Lecidea granifera (Ach.) Vain. in Hiern

Cat. Afr. Pl. 2(2): 424. 1901. –*Lecanora granifera* Ach., *Syn. Meth. Lich.*: 164. 1814.

Thallus corticolous, crustose, rough, verrucose to granular, pale yellow to yellowish grey. Apothecia sessile, constricted at base, round to irregular in shape, 0.6–1.7 mm diam.; margin thick, smooth to verruculose, thalline,



concolours with the thallus; disc plane to convex, red brown to dark brown, much darker ner periphery, epruinose to slightly pruinose. Proper exciple brown, in continuation with hypothecium, 16 – 37 µm thick; thalline exciple pale, algal cell present, 54 – 73 µm thick; epihymenium brown, 21 – 38 µm thick; hymenium 95 – 119 µm thick; hypothecium brownish, 57 – 84 µm thick; paraphyses branching, apical cells slightly swollen and pigmented. Asci 8 spored, clavate, 73 – 97 × 18 – 25 µm; ascospores hyaline, simple, ellipsoid, 12.6 – 23.3 × 6.6 – 15.0 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P+ yellowish. TLC: Atranorin, chodatin and zeorin.

Comments: *Lecidea granifera* is a common lichen species in Uttar Pradesh, found growing on bark of various trees including *Mangifera indica* in forested areas. It is characterized by verrucose to granular thallus, red brown apothecia and characteristically brown proper exciple and simple ascospores.

Letrouitia Haf. & Bellem. (Family: Letrouitiaceae)

Nova Hedwigia 35: 281. 1982.

Thallus crustose, pale yellow to greenish-yellow or orange yellow. K+ violet-purple, corticolous; photobiont a green alga. Ascomata apothecia sessile, constricted at base, else yellow-orange to orange or brownish, margin prominent, pale orange, generally lighter than disc, exciple biatorine, K+ purple or blue-violet; paraphyses slightly branched and anastomosing. Asci with inner apical apparatus and wall layers, non-amyloid, (1)2 – 8 spored;

spores hyaline, transversely septate, with lens shaped locules, submuriform by vertical septa in some locules or muriform.

World wide 15 species; India 7 species; Literature: Awasthi & Srivastava 1989; Awsthi, 1991.

Key to the species of *Letrouitia*

1a. Thallus isidiate, ascospores 21 – 33 × 8 – 11 µm . . . . . *L. leprolyta*

1b. Thallus lacking isidia, ascospores 30 – 45 × 12 – 17 µm . . . . . *L. transgressa*

Letrouitia leprolyta (Nyl.) Hafellner

Nova Hedwigia 35: 693. 1983. – *Lecanora leprolyta* Nyl., *Flora* 52: 70. 1869.

Thallus corticolous, crustose, smooth to uneven, yellow to yellowish brown, isidiate; isidia simple to rarely coralloid branched, globose to granular. Apothecia, round to irregular, sessile, 0.3 – 0.8 mm diam.; margin prominent, biatorine, yellow-orange; disc brown to dark brown, white pruinose. Exciple hyaline to pale brown, K+ pink, 42 – 83 µm thick; epihymenium brown to dark brown, 10 – 15 µm thick, K+ pink; hymenium hyaline, 72 – 110 µm thick; hypothecium pale yellow, 66 – 94 µm thick; paraphyses branching and anastomosing. Asci 8 spored, clavate, 62 – 93 × 16 – 20.4 µm; ascospores hyaline, ellipsoid to fusiform, transversely 5 – 7 septate, locules lens shaped, 21.3 – 33.1 × 8.6 – 10.6 µm.

Chemistry: Thallus K+ purple, C-, KC-, P-. TLC: Parietin present.

Comments: *Letrouitia leprolyta* is a rare lichen species in Uttar Pradesh, found

growing on tree trunk in deciduous forests. It is characterized by isidiate, K+ purple thallus, yellow-orange margined apothecia, K+ purple epihymenium, mostly transversely septate ascospores with lens shaped locules.

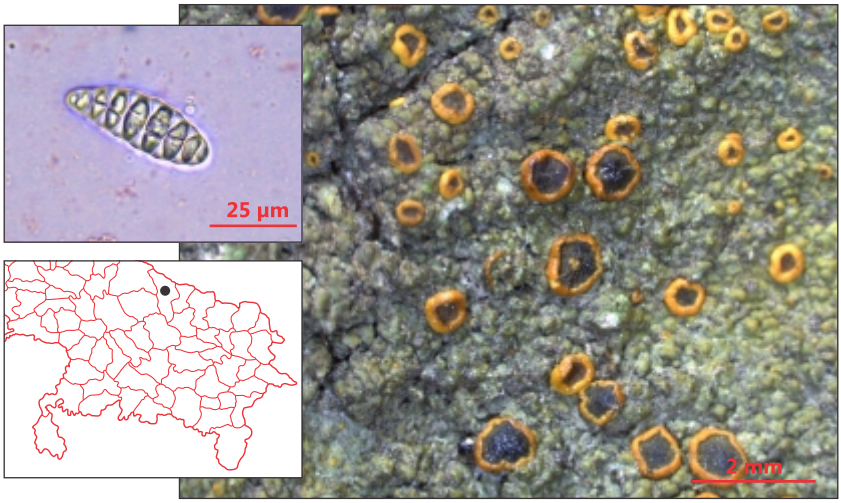
Letrouitia transgressa (Malme) Haf. & Bellem. in Hafellner

Nova Hedwigia 35: 710. 1983. – *Bombyliospora domingensis* f. *transgressa* *Malme, Ark. Bot.* 18(12): 5. 1923.

Thallus corticolous, crustose, verruculose to thick verrucose, yellowish green, K+ purple. Apothecia, numerous, round to irregular in shape, 0.3 – 1.0 mm diam.; margin thick, prominent, orange, smooth to flexuouse; disc orange brown to brown, plane to concave. Exciple biatorine, yellow to orange, K+ pink to purple, 70 – 85 µm thick; epihymenium yellow brown, K+ pink to purple, 14 – 20 µm high; hymenium hyaline, K- or K+ pinkish, 90 – 100 µm high; hypothecium hyaline, K- or K+ pinkish, 45 – 50 µm high; paraphyses branched and anastamosing. Ascus 8 spored, cylindrical to clavate, 70 – 85 × 12 – 18 µm; ascospores hyaline, oval to ellipsoid, 30.5 – 45.2 × 12.9 – 16.6 µm, transversely 6 – 7 septate, occasionally 1 – 2 vertical septa in some locules, locules lens shaped.

Chemistry: Thallus K+ purple, C-, KC-, P-. TLC: Parietin present.

Comments: *Letrouitia transgressa* is a common lichen species in Uttar Pradesh, found growing on variety of trees including *Shorea robusta* in deciduous forests. It is characterized by K+ purple thallus, orange margined apothecia, K+ purple epihymenium, mostly transversely septate ascospores with lens shaped locules.



Lichinella Nyl. (Family: Lichinaceae)

Bull. Soc. Linn. Normandie, ser. 2, 6 301. 1872.

Thallus foliose, dwarf fruticose, squamulose, peltate or crustose, gelatinous when wet; upper surface blackish dark olive when moist, sometimes with isidia, ecorticate, usually heteromerous with a loose or compact, sometimes fountain like central hyphal strand and with reticulate hyphae; photobiont *Chroococcus*. Ascomata as thallinocarp, laminal, marginal or terminal, orbicular or irregular shaped, with thalline rim, single or in groups. Asci irregularly shaped, ± cylindrical to clavate, prototunicate, not amyloid, 16 – 32 spored; ascospores hyaline, simple, ellipsoid, thin walled.

World wide 35 species; India 1 species; Literature: Schultz 2005, 2007.

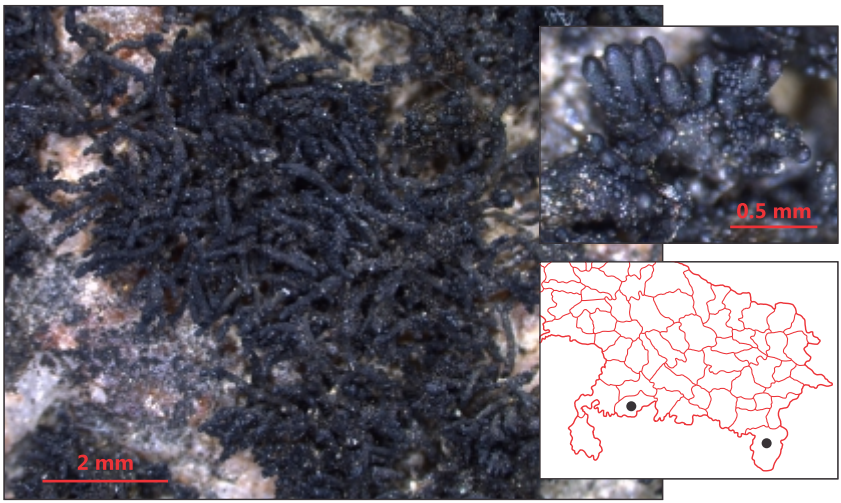
Lichinella flexa Henssen, Büdel & Nash

Bryologist 88: 287. 1985.

Thallus saxicolous, fruticose, small, in rosettes, sometimes as scattered cushions, black, adpressed to ascending; lobes terete, furcated to dichotomously branched, 1.5 – 2.0 mm long and 0.05 – 0.15 mm thick, with deflexed tips; attached with the tufts of rhizohyphae. Thallinocarp absent.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No substances detected.

Comments: *Lichinella flexa* is a common cyanolichen in Uttar Pradesh, found growing on exposed rocks mostly in small hillocks of rock. It is characterized by blackish, thread like thallus. It is a new record for India, earlier known from North America (Schultz, 2007).



Opegrapha Ach. (Family: Roccellaceae)

Kongl. Vetensk. Acad. Nya Handl. 30: 97. 1809.

Thallus crustose, uniform, ecorticate, corticolous; photobiont *Trentepohlia* or *Phycopeltis*. Ascomata sunken or sessile, round to elongate, exciple black-carbonaceous, disc narrow or widened. Exciple carbonized; hypothecium dark or hyaline; paraphyses branched and anastomosing; hymenium I+ blue, vinose or vinose red. Asci bitunicate, globular-elongate (4) 8 spored; ascospores hyaline to pale brown, ellipsoid to elongate, straight or curved.

World wide 361 species; India 20 species; Literature: Awasthi 1991; Ertz 2009.

Key to the species of *Opegrapha*

1a. Disc of the lirellae white pruinose, wide, exciple incomplete below, ascospores 4 -5 septate . . . . . *O. astraea*

1b. Disc epruinose, slit like 2

2a. Exciple incomplete below, ascospores 3 septate . . . . . *O. maldiveana*

2b. Exciple continuous below 3

3a. Ascospores consistently 3 septate, fusiform to acicular . . *O. agelaeotera*

3b. Ascospores 4 – 7 septate 4

4a. Middle locule of the ascospore larger, perispore thick, exciple thinning below . . . . . *O. varia*

4b. All locules of the ascospores equal size . . . . . *O. subvulgata*

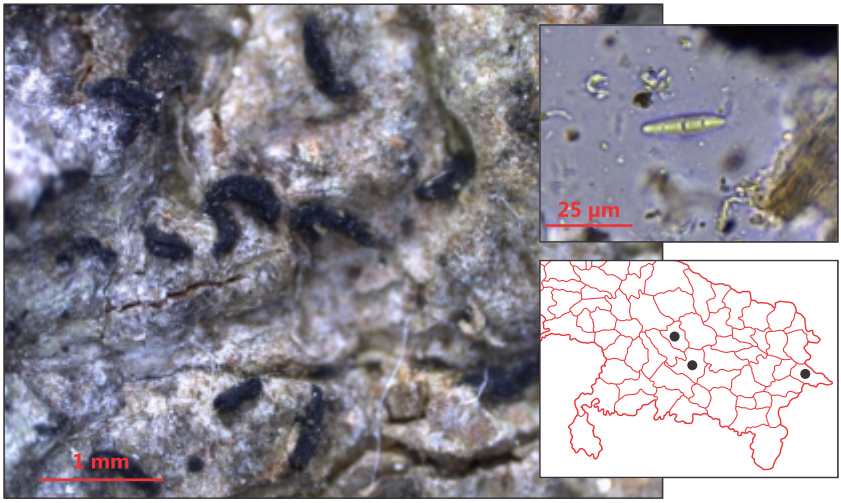
Opegrapha agelaeotera Vainio

Bol. Soc. Brot., sér. 2(6): 165. 1929.

Thallus corticolous, crustose, greenish-grey, continuous, ecorticate. Apothecia lirelliform, straight to curved, simple, rarely branched, dark brown to black, 0.6 – 0.8 × 0.1 – 0.2 mm; disc wide, epruinose, brown. Exciple dark brown to carbonaceous, convergent, continuous at base, 20 – 42 µm thick; epihymenium olive green to brown, I+ reddish, 22 – 25 µm high; hymenium hyaline or pale yellowish, I+ reddish, 45 – 75 µm high; hypothecium, I-, 35 – 42 µm high; paraphysoids branching and anastamosing. Ascus 8 spored, clavate, 48 – 60 µm; ascospores consistently 3 septate, all locules are of equal size, locules broader than length, fusiform to acicular, 22.2 – 27.3 × 6.3 – 8.9 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Opegrapha agelaeotera* is a rare lichen species in Uttar Pradesh, found growing on *Ficus religiosa* and *Mangifera indica* trees in orchard and



avenue trees along road side. It is characterized by black lirellae, convergent and continuous exciple, 3 septate ascospores with equally sized locules. In comparison to the description provided by Ertz (2009) specimens of Uttar Pradesh have slightly larger ascospores (12.5 – 17.5 (–20) × 4.0 – 6.0 µm), thick perispore and slit like disc.

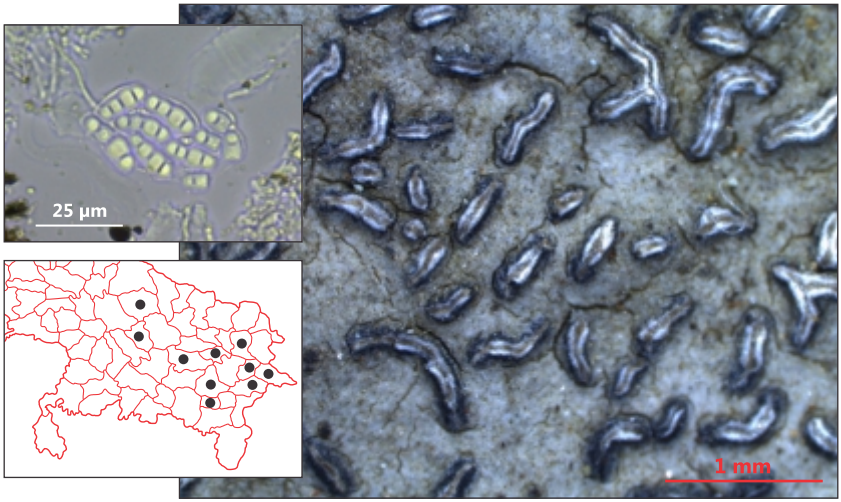
Opegrapha astraea Tuck.

Lichens of California (Berkeley): 33. 1866.

Thallus corticolous, crustose, whitish grey, smooth, ecorticate, determinant; prothallus absent or indistinct. Lirellae flexuose, simple to forked or branched, acute to blunt ends, scattered uniformly or sometimes 2 – 3 in grouped and or asteroid; disc white, slightly to wide open, white pruinose. Exciple black, carbonaceous, convergent, discontinuous below hymenium, broad at base, 43 – 37 µm thick; epihymenium lower part hyaline, upper part (with deposition) olive green to yellow green, granular, K-, I+ blue, KI+ blue; hymenium; hymenium hyaline to pale brown, I+ blue, KI+ blue, 61 – 75 µm high; hypothecium hyaline, 38 – 40 µm high; paraphysoids branched, slightly anastamosing. Ascus 8 spored, cylindrical – clavate, I+ red to vinose, tip pale blue, KI+ red, tip blue, 60 – 68 × 9 – 12 µm; ascospores hyaline, acicular to fusiform, transversely 4 – 5 septate, all cells are mostly equal size, cells broader than long, 12.3 – 15.7 × 4.4 – 4.8 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Opegrapha astraea* is a common species in Uttar Pradesh, found



growing on *Artocarpus heterophyllus, Madhuca indica, Mangifera indica, Syzygium cumini* and palms in mostly in orchard areas. It is characterized by whitish lirellae, discontinuous exciple, 4 – 5 septate ascospores. This is a new record for India. It is a pantropical species, earlier reported from Africa (Kenya, Rwanda, Sierra Leone, South Africa and Zambia), Asia (Christmas Island, Papua New Guinea, Thailand, Philippines) and Australia.

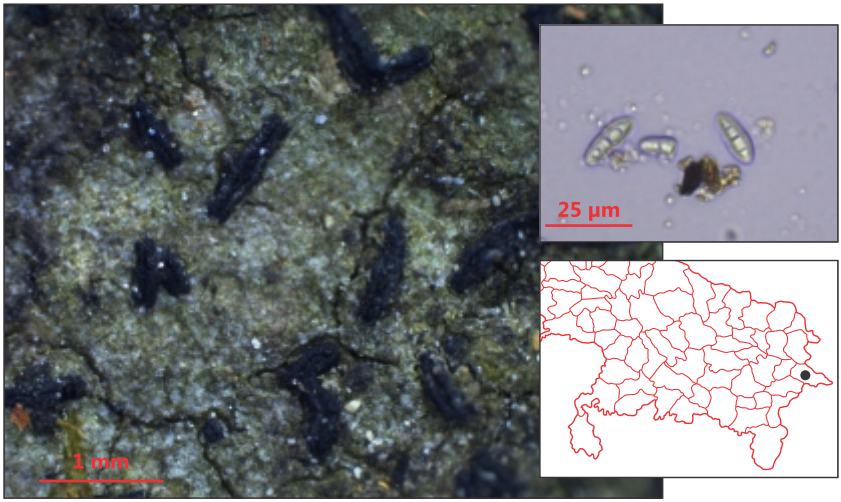
Opegrapha maldiveana Ertz

Biblthca Lichenol. 102: 77. 2009.

Thallus corticolous, crustose, thin, greenish grey, in small patches of 0.2 – 0.5 cm across; prothallus indistinct. Lirellae emergent, simple to furcated, black, 0.1 – 0.7 mm long; disc slit like, epruinose. Exciple carbonaceous, convergent, incomplete at base, 18 – 27 µm thick; epihymenium olive brown to pale brown, K-, I+ vinose red, KI+ pale blue, 12 – 25 µm high; hymenium hyaline, lacking oil globules, I+ vinose orange to red, KI+ pale blue; hypothecium hyaline to pale brown, 27 – 32 µm; paraphyses branching and anastamosing, slightly swollen at apex. Ascus 8 spored, clavate, 35 – 45 × 1 – 13 µm; ascospores hyaline, acicular, transversely 3 septate, 16.2 – 20.3 × 6.5 – 7.0 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Opegrapha maldiveana* is a rare species in Uttar Pradesh, found growing on bark of *Mangifera indica* in orchards. It is characterized by black lirellae, discontinuous exciple, transversely 3 septate, acicular spores. It is a new

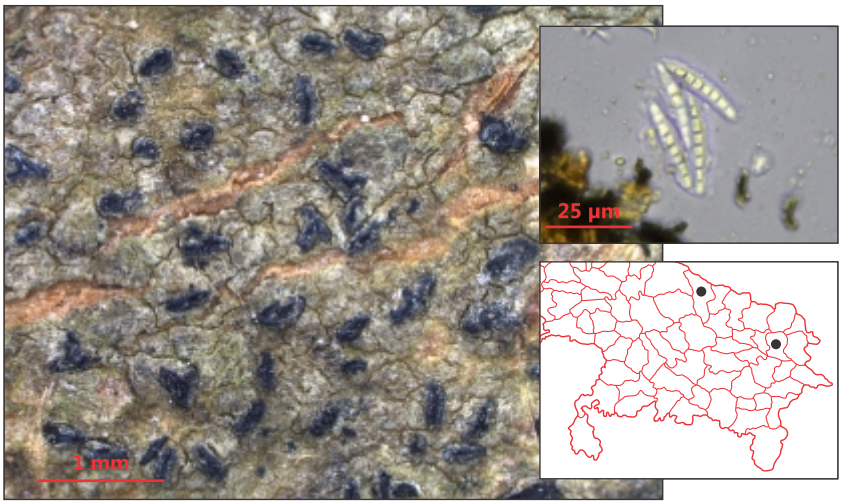


record of lichens for India, earlier reported from Maldives and Chagos Archipelago (Ertz 2009).

Opegrapha subvulgata Nyl.

Flora 52: 71. 1869.

Thallus corticolous, crustose, thin, smooth. yellowish grey to inconspicuous. Lirellae numerous, simple, straight to slightly curved, black, 0.3 – 1.2 mm long;



disc slit like, epruinose. Exciple dark brown to carbonized, continuous below hymenium, 23 – 45 µm thick; hymenium hyaline, 49 – 70 µm thick; hypothecium hyaline to pale brown, 17 – 20 µm thick; paraphyses branching and anastomosing. Asci 8 spored, clavate, up to 62 × 16 µm; ascospores hyaline, fusiform, transversely 5 – 7 septate, all locules mostly equal sized, 25.6 – 32.1 × 4.3 – 5.2 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

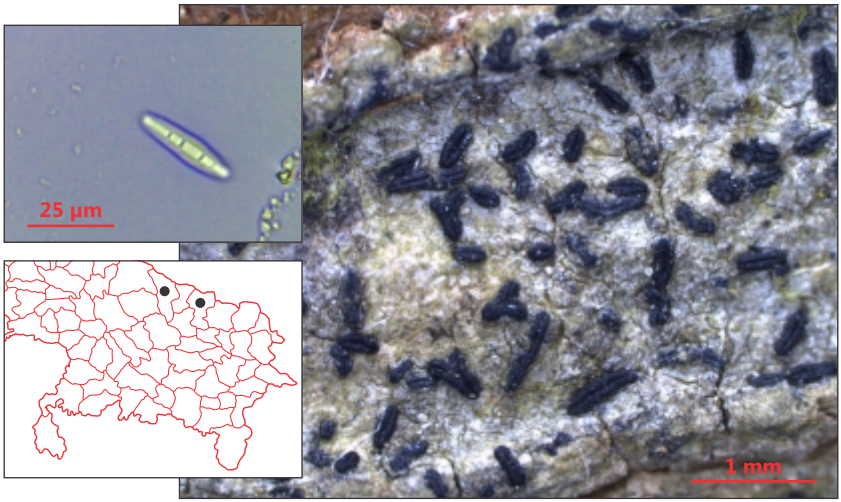
Comments: *Opegrapha subvulgata* is a rare lichen species in Uttar Pradesh, found growing on tree trunks including *Shorea robusta* in forested areas. It is characterized by yellowish grey thallus, simple, black lirellae, continuous exciple, 5 – 7 septate ascospores.

Opegrapha varia Pers.

Ann. Bot. (Usteri) 1: 30. 1794.

Thallus corticolous, crustose, ecorticate, greenish grey, sometimes inconspicuous. Lirellae black, mostly simple, rarely furcated, 0.3 – 0.7 × 0.1 – 0.2 mm; disc slit like, epruinose. Exciple brown black to carbonized, convergent, thinning and continuous below hymenium 16 – 34 µm thick; epihymenium olive green, up to 10 µm high; hymenium hyaline to slightly yellowish, up to 38 µm high; hypothecium, hyaline to pale brown, up to 28 µm high; paraphysoids branched and anastamosing. Ascus 8 spored, clavate, 57 – 71 × 17 – 22 µm; ascospores hyaline, 4 – 5 septate, middle locule slightly larger, fusiform with thick perispore, 31.1 – 33.8 × 7.1 – 9.9 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.



Comments: *Opegrapha varia* is common species in Uttar Pradesh, found growing on various trees in forested areas. It is characterized by black lirellae, continuous exciple, 4 – 5 septate, fusiform ascospores.

Parmotrema A. Massal. (Family: Parmeliaceae)

Atti Reale Ist. Veneto Sci. Lett. Arti, Ser. 3, 5: 248. 1860.

Thallus foliose, usually loosely attached to substratum, large, lobes apically rotund, margins with or without simple or branched cilia, grey to grey-green, with or without white-maculae, isidia and soredia; lower side brown to black, rhizines simple or mostly in the central part; a wide marginal zone paler and nude; photobiont a green alga, *Trebouxia*. Ascomata apothecia, laminal, lecanorine, generally pedicellate; disc brown, entire or perforate; hymenium hyaline, l+ blue. Asci 8-spored; ascospores hyaline, simple, ellipsoid, thick walled. Pycnidia laminal, immersed; pycnoconidia sublageniform, filiform or bacilliform. Atranorin usually present in upper cortex with usnic acid or lichexanthone.

World wide 350 species; India 51 species; Literature: Divakar & Upreti 2005.

Key to the species of *Parmotrema*

1a. Thallus lacking isidia and soredia, margin eciliate, medulla with all -ve colour spot reaction . . . . . *P. mesotropum*

1b. Thallus sorediate or isidiate 2

2a. Thallus sorediate, margin eciliate, medulla with all -ve colour spot reaction . . . . . *P. praesorediosum*

2b. Thallus isidiate, margin eciliate, medulla P+ orange-red . *P. saccatilobum*

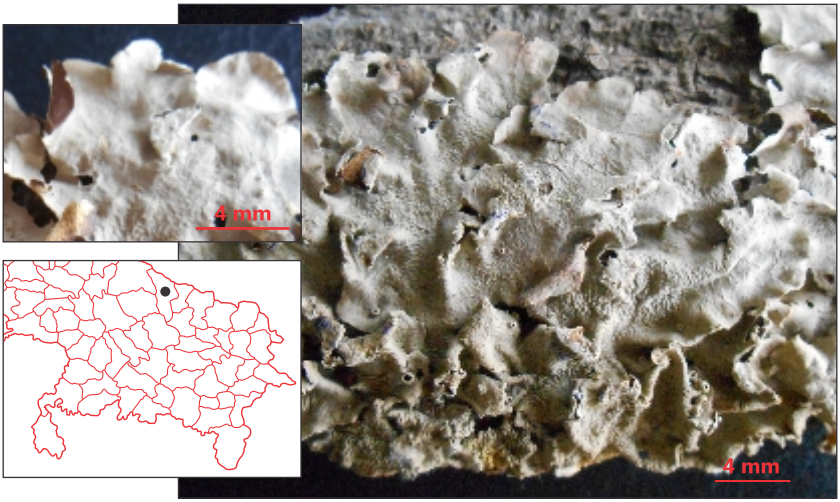
Parmotrema mesotropum (Müll. Arg.) Hale

Phytologia 28: 337. 1974. –*Parmelia mesotropa* Müll. Arg., *Rev. Mycol.* 10: 55. 1888.

Thallus corticolous, foliose, somewhat loosely attached, thick, leathery, light grey to grey, shinning, 2 – 4 cm across; lobes rotund, 2.5 – 4.5 mm wide, margin entire, eciliate; lower surface dark brown to black, marginal zone pale brown, shinning, erhizinate; rhizines simple, sparse, restricted towards centre. Ascomata absent.

Chemistry: Thallus K+ yellow; medulla K-, C-, KC-, P-. TLC: Atranorin, fatty acid (caperatic acid) present.

Comments: *Parmotrema mesotropum* is a rare lichen species in Uttar Pradesh, found growing on tree bark in moist deciduous forests. It is characterized by grey thallus, absence of vegetative propagules, erhizinate, shinning lower surface and all negative colour spot tests on medulla.

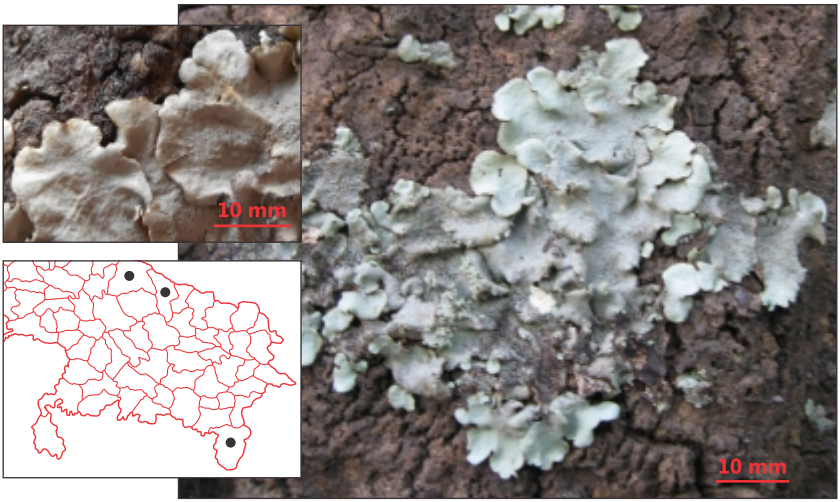


Parmotrema praesorediosum (Nyl.) Hale

Phytologia 28: 338. 1974. –*Parmelia praesorediosa* Nyl., *Sert. Lich. Trop.*: 18. 1891.

Thallus corticolous, foliose, suborbicular, thick, whitish grey to grey, loosely adnate, 4–8 cm across; lobes rotund, 1–6 mm wide, eciliate, sorediate; sorelia marginal; soredia granular; lower surface dark brown to black, shinning brown and naked towards margin, rhizinate; rhizines simple, restricted towards centre; medulla white. Ascomata absent.

Chemistry: Thallus K+ yellow; medulla K-, C-, KC-, P-. TLC: Atranorin present.



Comments: *Parmotrema praesorediosum* is a common lichen species in Uttar Pradesh, found growing on various trees including *Shorea robusta* in forest areas. It is characterized by whitish grey thallus with broad, eciliate lobes, shinning, naked lower surface and negative colour spot tests. The specimens collected from Sonbhadra areas had rough upper surface, especially towards centres, producing nodular to coralloid isidiate structures which in some cases breaks to form soredia. As per the expert opinion (personal communication with Dr. P. K. Divakar) the characteristic upper surface of the specimen is the ecological variation and do not carry any strong taxonomic significance to differentiate the specimen as a novel taxa. However, DNA analysis is of these samples is still in progress.

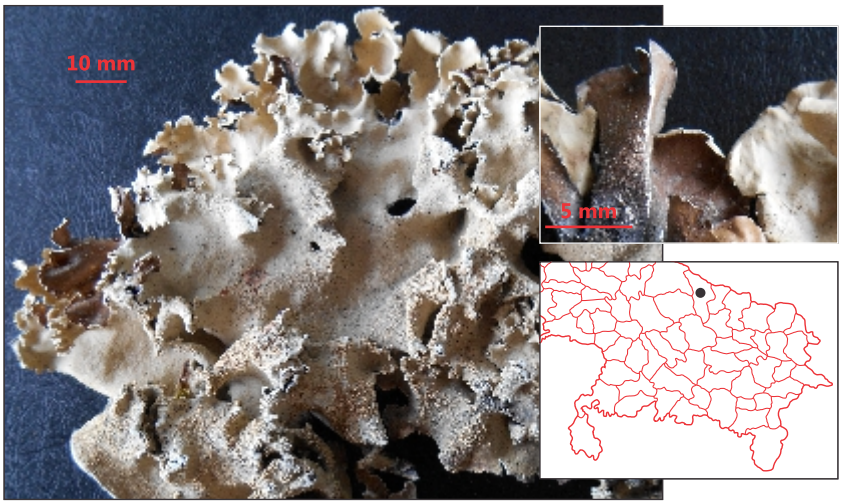
Parmotrema saccatilobum (Taylor) Hale

Phytologia 28: 339, 1974. –*Parmelia saccatiloba* Taylor in Hook.f., *London J. Bot.* 6: 174. 1847.

Thallus corticolous, loosely adnate, large, thick, 4 – 6 cm across, sub orbicular, creamish grey to grey, older portions rough and cracked, isidiate; lobes rotund, broad, 4 – 6 mm wide, curling downwards, margin entire to crenate, eciliate; isidia laminal, simple, granular to filiform; lower surface black towards centre, marginal zone pale brown to brown, shinning; rhizines sparse, restricted to centre; medulla white. Ascomata absent.

Chemistry: Thallus K+ yellow; medulla K-, C-, KC-, P+ orange-red. TLC: Atranorin, protocetraric acid present.

Comments: *Parmotrema saccatilobum* is a rare lichen species in Uttar Pradesh, found growing on tree bark in moist deciduous forest. It is characterized by loosely attached, isidiate thallus with large lobes and protocetraric acid in chemistry.



Peltula Nyl. (Peltulaceae)

Ann. Sci. Nat. Bot. ser. 3, 20: 316. 1853.

Thallus areolate, squamulose-peltate or subfruticose, rhizinate or umbilicate; upper side olive-brown to brown; photobiont a cyanobacteria, *Anacystis*. Ascomata apothecia, initially immersed, later emergent, disc brown, red or orange brown. Thalline exciple as a rim; hymenium I+ blue or vinose; hypothecium hyaline; paraphyses simple, capitate. Asci unitunicate-rostrate with gelatinous sheath around the apex, multi spored (16 – 100 or more); ascospores hyaline, simple. Pycnoconidia bacilliform to fusiform.

World wide 40 species; India 10 species; Literature: Awasthi 2007; Upreti & Büdel 1990.

Key to the species of *Peltula*

1a. Thallus corticolous, sorediate, greenish . . . . . *P. corticola*

1b. Thallus saxicolous 2

2a. Thallus sorediate along the margin, squamules large . . . . . *P. euploca*

2b. Thallus lacking soredia 3

3a. Apothecial disc expanded 4

3b. Apothecia immersed, punctiform 5

4a. Thallus orbicular, squamule surface reticulate-rugose, margin upturned to forming rim . . . . . *P. patellata*

4b. Thallus rosettiform, surface smooth . . . . . *P. obscurans*

5a. Thallus subfruticose, squamules cylindrical, ascending to upright . . . . . *P. tortuosa*

5b. Thallus squamulose, inflated, horizontal . . . . . *P. zahlbruckneri*

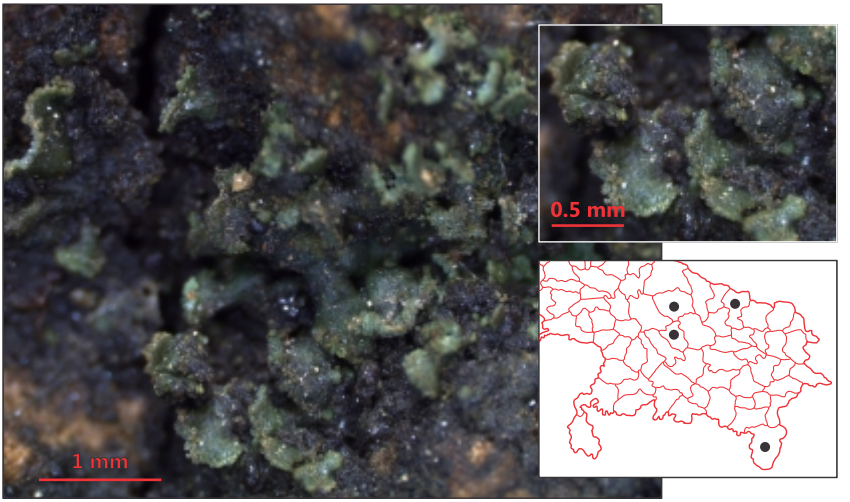
Peltula corticola Büdel & R. Sant.

Biblthca. Lichenol. 23: 79. 1987.

Thallus corticolous, squamulose; squamules greenish brown, black, gelatinous when wet, imbricate, 0.4 – 0.6 mm, marginally sorediate, sometimes soredia arising form lower surface; soredia granular, labriform. Apothecia absent.

Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *P. corticola* is one of the common corticolous species under the genus *Peltula*. It grows on mango tree trunk, completely camouflaged with the colour of the bark deposited with algal mat. It can be distinguishable after wetting the bark. It is a new record for India (Khare *et al.* 2013, in press), earlier reported from Eastern Africa (Büdel 1987), Arabian Peninsula, SW North

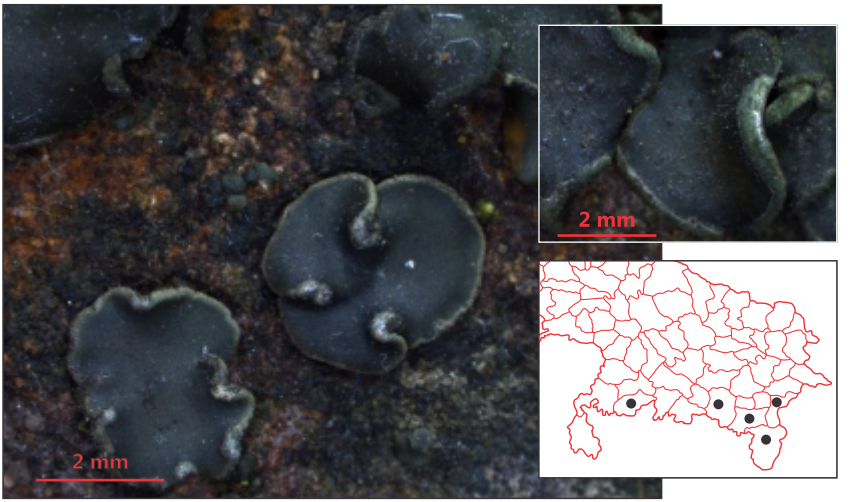


America (Wetmore 1970) and Sonoran Desert (Büdel *et al.* 2007).

Peltula euploca (Ach.) Poelt in Pisut

Sborn. Slov. Nar. Muz. Pøiø. Vedy 13: 8. 1967. – *Lichen euplocus* Ach., *Lichenogr. Suec. Prodr.*: 141. 1798.

Thallus saxicolous, squamulose, peltate; squamules monophyllous, solitary or polyphyllous and in groups, imbricate, orbicular to suborbicular, large 1.0 – 6.0



mm; margin smooth to flexuouse or folded, finely sorediate, sometimes sorelia laminal as circular pecks; upper surface yellow brown when dry, olive green when wet, smooth, epruinose; lower surface pale, creamish or yellowish, attached at the centre, umbilicate. Thallus heteromerous, corticated on both the surface; upper cortex thin, 15 – 25 µm thick, yellow to golden yellow; photobiont cyanobacteria, layer 87 – 135 µm thick; medulla hyaline, 95 – 175 µm thick; lower cortex well developed, 75 – 118 µm thick. Apothecia absent.

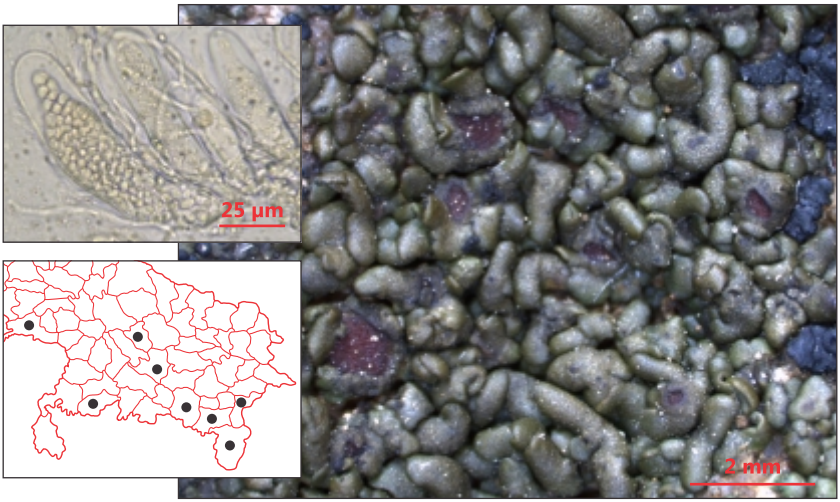
Chemistry: K-, C-, KC-, P-. TLC: No chemical detected.

Comments: *Peltula euploca* is a most common lichen species in Uttar Pradesh, found growing on exposed rocks. It is characterized by larger, orbicular, sorediate lobes.

Peltula obscurans (Nyl.) Gyelnik

Repert. Spec. Nov. Regni Veg. 38: 308. 1935. – *Endocarpon obscurans* Nyl., *Bull. Soc. Linn. Normandie,* ser. 2, 6: 309. 1872.

Thallus saxicolous, squamulose, scattered or rosette forming; squamules small, 0.4 – 1.0 mm, margin down turned; upper surface greenish brown, olive brown, greenish when wet; lower surface pale. Apothecia frequent, 1 per squamule, laminal, semi-emergent to emergent, 0.4 – 1.2 mm diam.; margin prominent, thin, thalline, concolours with thallus; disc wide, reddish brown, concave. Exciple with cyanobacterial cells, 21 – 41 µm thick; epihymenium yellow brown, 29 – 43 µm; hymenium hyaline, 62 – 77 µm; hypothecium hyaline, 36 – 56 µm. Asci multispored; ascospores hyaline, simple, oval to ellipsoid, 2.3 – 3.5 × 1.5 – 2.4 µm..



Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Peltula obscurans* is one of the common lichen species in Uttar Pradesh, found growing on exposed rocks. It is characterized by rosette forming squamules, sunken to emergent apothecia with wide disc.

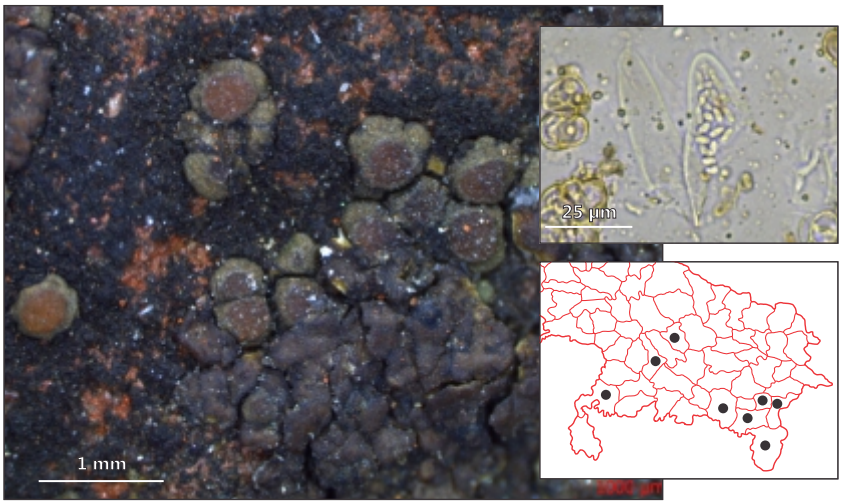
Peltula patellata (Bagl.) Swinscow & Krog

Norweg. J. Bot. 26: 221. 1979. – *Acarospora patellata* Bagl., *Nuovo Giorn. Bot. Ital.* 7: 245. 1875.

Thallus saxicolous, squamulose, brown to dark olive brown; squamules almost circular, 0.2 – 0.6 mm across, margin slightly raised; lower surface brownish. Apothecia sunken, depressed to semi-emergent, 1 – 3 per squamule; margin indistinct to thin; disc orange red to reddish. Exciple with algal cell; epihymenium brown, 15 – 22 µm thick; hymenium hyaline, 73 – 92 µm thick; hypothecium pale yellow, 54 – 66 µm thick. Asci multispored, clavate, 75 – 95 × 12 – 15 µm; ascospores simple, hyaline, globose, 3.1 – 4.6 × 1.7 – 2.4 µm.

Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

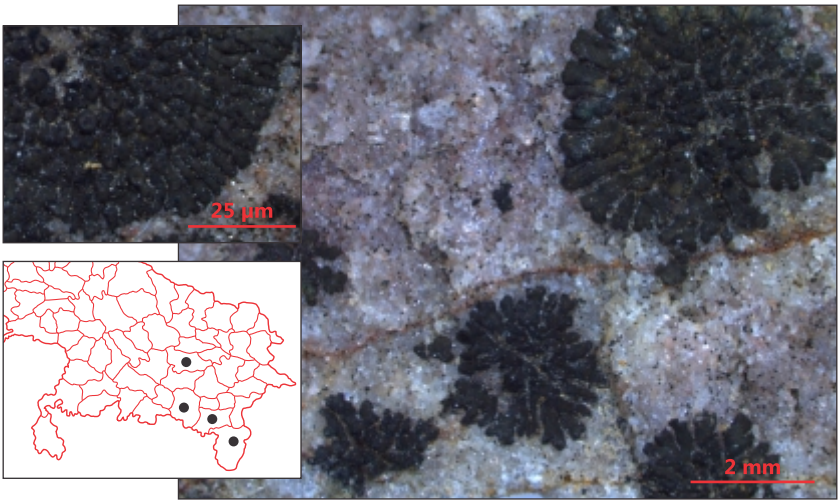
Comments: *Peltula patellata* is common lichen species in Uttar Pradesh, found growing on exposed rocks, brick and lime plaster of old monuments and even on cement plasters of buildings. It is characterized by circular squamules with slightly upturned margins, apothecia with wide orange-red disc.



Peltula placodizans (Zahlbr.) Wetmore

Ann. Mo. Bot. Gdn. 57: 179. 1970. – *Heppia placodizans* Zahlbr., *Bull. Torrey, Bot. Club.* 35: 299. 1908.

Thallus saxicolous, squamulose to placodioid, orbicular, effigurate, 1.6 – 10.0 mm diam., with long radiating lobe, olive brown to brown. Apothecia present towards centre of the thallus, round, 0.4 – 0.5 mm diam.; margin thick, concolours with the thallus; disc red brown, concave, small, 0.12 – 0.15 mm. Exciple with algal cells, corticated, up to 136 µm; epihymenium yellowish brown, I+ reddish, KI+ blue, up to 38 µm high; hymenium hyaline, I+ reddish, KI+ blue, up to 100 µm high; hypothecium hyaline to pale brown, 95 µm high. Ascus multi spored, >100 in number, clavate, I+ reddish, KI+ blue, 50 – 59 × 11 – 13 µm; ascospores hyaline, simple, oval to broadly ellipsoid, 4.3 – 6.1 × 2.1 – 3.4 µm.



Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Peltula placodizans* is a common lichen species in Uttar Pradesh, found growing on exposed rocks. It is characterized by placodioid, effigurate thallus with long, radiating lobes, red brown apothecia. Sometimes squamules scattered and grow along with other *Peltula* sp., and can be identified by their long lobules.

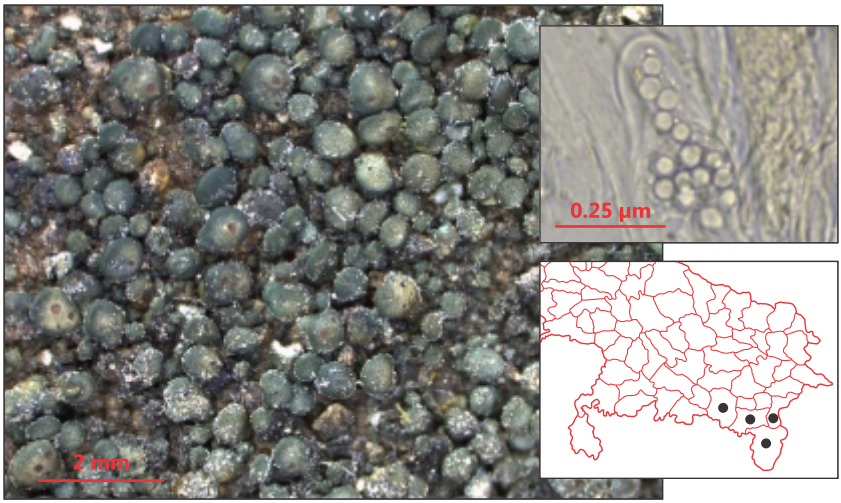
Peltula tortuosa (Nees) Wetmore

Ann. Missouri Bot. Gard. 57: 205. 1971. – *Dufourea tortuosa* Nees, *Horae Phys. Berol.*: 43. 1820.

Thallus saxicolous, squamulose to subfruticose, olive brown, bluish green when wet; squamule minute, flat to cylindrical, upright, 0.1 – 0.2 mm diam.. Apothecia perithecioid apothecia, frequent, sunken, 0.05 – 0.23 mm diam.; ostiole punctiform, black, distinct. Exciple hyaline, up to 23 µm thick; hamathecium conical to semi-globose, hyaline, 215 – 230 µm across. Ascus multispored; ascospores hyaline, simple, globose, 2.1 – 4.0 × 2.1 – 3.2 µm.

Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Peltula tortuosa* is a common lichen species in Uttar Pradesh, found growing on exposed rocks. It is characterized by squamulose to

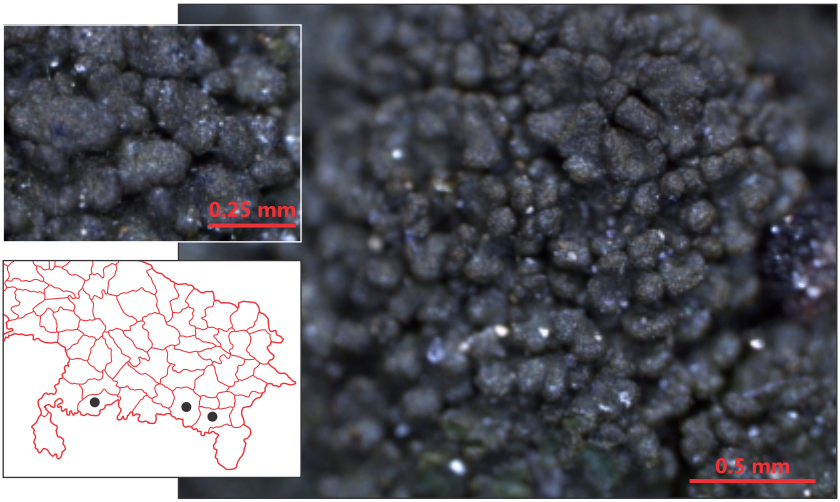


subfruticose thallus, with minute, circular, upright squamules and sunken, punctiform apothecia.

Peltula zahlbrucknerii (Hasse) Wetmore

Ann. Missouri Bot. Gard. 57: 205. 1971. –*Heppia zahlbrucknerii* Hasse, *Bryologist* 14: 100. 1911.

Thallus saxicolous, squamulose, olive brown; squamules minute, dense, circular, inflated, horizontal, umbilicate, 0.5 – 0.48 mm diam. Apothecia absent.



Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Peltula zahlbrucknerii* is a common lichen in Uttar Pradesh, found growing on exposed rocks. It is characterized by dense, minute, circular, olive brown squamules spread over the rock. It produces immersed, punctiform apothecia. However, such apothecia are lacking in most of the specimens studied from Uttar Pradesh.

Pertusaria DC. In Lam. & DC. (Family: Petusariaceae)

Fl. Franç., ed. 3, 2: 319. 1805.

Thallus crustose, granular or verrucose, fissured or areolate, corticated, usually corticolous or on plant remains; photobiont green alga, *Trebouxia*. Ascomata apothecia, generally elevated and innate in fertile verrucae, single or several in each verrucae, disc wide, lecanorine or small, punctiform. Paraphyses branched and variously reticulately anastomosing. Asci thick walled, 1 – 8 spored; ascospores hyaline, oval ellipsoid, spore wall thick, single, double or triple layered, often constulate and rarely laminate.

World wide 525 species; India 54 species; Literature: Awasthi 1991; Archer 1997.

Key to the species of *Pertusaria*

1a. Thallus sorediate, lacking apothecia . . . . . *P. leucosora*

1b. Thallus esorediate, apothecia always present 2

2a. Thallus containing norstictic, stictic acid complex 3

2b. Thallus containing atranorin, ascospores

up to 48 – 61 × 25 – 31 µm ..... *P. punctata*

3a. Fertile verrucae and ostiolar region tubercled verrucose, ascospores 71 – 100 × 32 – 41 µm ..... *P. quassiae*

3b. Fertile verrucae smooth 4

4a. Thallus with stictic acid, ostiole 1 – 2 per verrucae, ascospores 67 – 83 × 29 – 34 µm ..... *P. albidella*

4b. Thallus with norstictic acid, ostiole may per verrucae, ascospores 95 – 163 × 32 – 53 µm ..... *P. leucostoma*

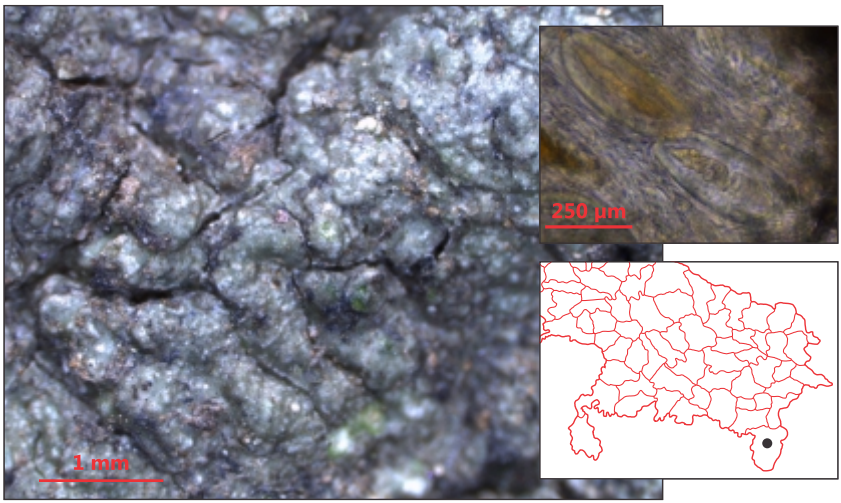
Pertusaria albidella Nyl.

Acta Soc. Sci. Fenn. 7: 447. 1863.

Thallus corticolous, crustose, greenish-grey, verrucose, paler at margin. Ascomata apothecia, perithecioid, fertile verrucae not tubercled or granular, dome shaped, flat at apex; ostiole pale, white to indistinct. Exciple up to 53 µm thick, externally covered by thallus; hymenium hyaline, concial, 416 × 302 µm across. Ascus 2 spored, 205 × 38 µm; ascospores hyaline, simple, oblong, 67.8 – 83.2 × 29.0 – 34.3 µm, thick walled, constulate, 9.4 – 10.5 µm thick.

Chemistry: K+ yellow turning red, C-, KC-, P-. TLC: Norstictic, hypostictic acid, zeorin present.

Comments: *Pertusaria albidella* is a rare lichen species in Uttar Pradesh, found growing on *Acacia nilotica* tree trunk in deciduous forest. It is characterized by perithecioid apothecia, thick walled ascospores with radial constolation and norstictic acid in chemistry.



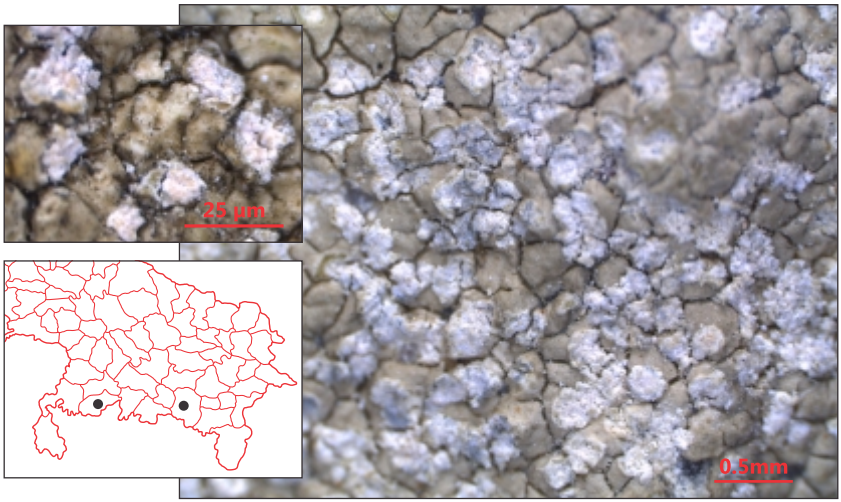
Pertusaria leucosora Nyl.

Flora 60: 223. 1877.

Thallus saxicolous, crustose, thick, whitish to creamish grey, rough to verruculose, rimose areolate, sorediate; sorelia irregular to capitate; soredia bluish grey, P+ yellow-orange. Apothecia absent.

Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin present.

Comments: *Pertusaria leucosora* is a common lichen in Uttar Pradesh, found growing on exposed rocks. It is characterized by its sterile, rimose areolate thallus with soredia that turns P+ yellow-orange.

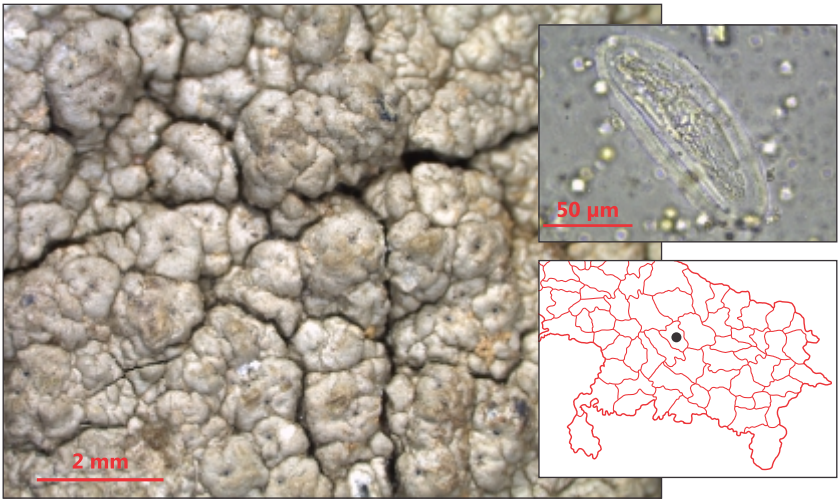


Pertusaria leucostoma (Bernh.) A. Massal.

Ric. Auton. Lich. Crost.: 188, 387. 1852. –*Sphaeria leucostoma* Bernh. in Roem., *Arch. Bot. (Leipzig)* 2: 11, tab. 1, fig.1, 2. 1799.

Thallus corticolous, crustose, verrucose, yellowish grey to brownish. Ascomata perithecioid apothecia, sunken in verrucae; fertile verrucae hemispherical to conical, not constricted at base; ostiole distinct, 1 – 3 per verrucae. Exciple brown, 14 – 30 µm thick; hymenium hyaline, 93 – 115 µm across. Asci 2 spored, cylindrical to clavate, 239 – 4.8 × 41 – 50 µm; ascospores hyaline, broadly ellipsoid, double walled, outer wall constulate, 95.6 – 163.4 × 32.5 – 52.9 µm.

Chemistry: Thallus K± yellow, C-, KC-, P+ yellow. TLC: Stictic acid complex present.

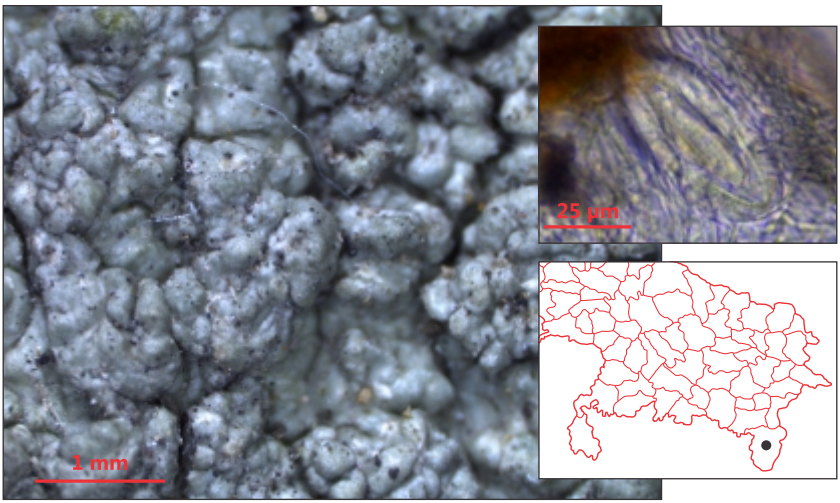


Comments: *Pertusaria leucostoma* is a rare lichen species in Uttar Pradesh, found growing on trunks and branches of trees in orchard and forested areas. It is characterized by 2 spored asci, double walled ascospore with contulate outer wall and stictic acid complex in chemistry.

Pertusaria punctata Nyl.

Bull. Soc. Linn. Normandie, ser. 2, 2: 71. 1868.

Thallus corticolous crustose, verrucose, olivaceous grey to grey, faintly pseudocyphellate. Ascomata apothecia, perithecioid, rare, solitary, fertile



verrucae not constricted at base; ostiole single, brown black. Exciple 29 – 40 µm thick, externally covered by thallus; hymenium hyaline, 364 – 370 × 244 – 276 µm across. Ascus 2 spored, up to 193 × 48 µm; ascospores hyaline, 48.9 – 61.7 × 25.3 – 31.1 µm, double walled, wall 8.4 – 9.8 µm thick, constulate.

Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin, arthothelin?, pale yellow spot at Rf class 4 – 5.

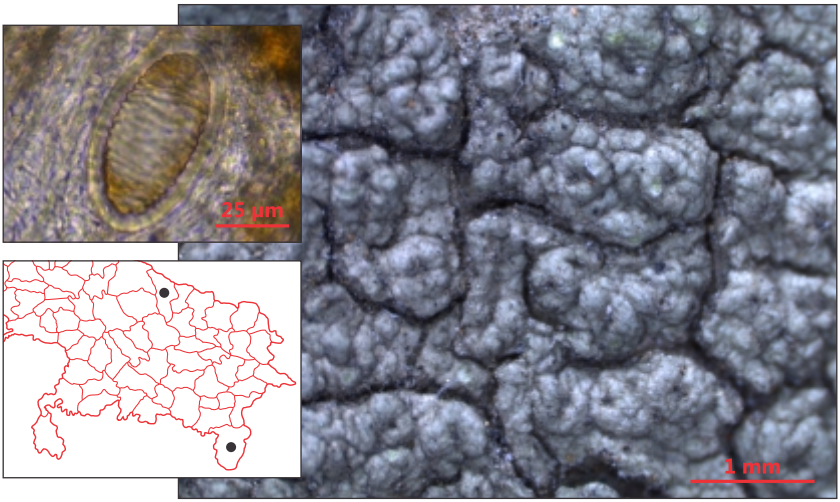
Comments: *Pertusaria punctata* is a rare lichen species in Uttar Pradesh, found growing on *Acacia nilotica* tree trunk in deciduous forest. It is characterized by perithecioid apothecia, thick walled ascospores and atranorin in chemistry.

Pertusaria quassiae (Fée) Nyl.

Ann. Sci. Nat., Bot., ser. 4, 15: 45. 1861. – *Porina quassiae* Fée, *Essai Crypt. Ecorc.:* 81. 1824.

Thallus corticolous, crustose, verrucose, cracked, grayish white; prothallus prominent, white. Ascomata apothecia, perithecioid, fertile verrucae hemispherical, constricted at base, 0.4 – 0.6 mm, verrucose to tubercled at top near the ostiole; ostiole black, slightly wider. Exciple 32 – 45 µm thick, covered thalline layer; hymenium conical to U-shaped, 177 – 279 µm across. Ascus 2 spored, rarely 4 spored, up to 193 × 41 µm; ascospores oblong, hyaline, 71.3 – 100.0 × 32.3 – 40.9 µm, double walled, walls radially constulate, up to 5.5 µm thick.

Chemistry: Thallus K+ red, C-, KC-, P+ yellow orange. TLC: Hypostictic, stictic, norstictic acid and triterpene at Rf class 5 – 6.



Comments: *Pertusaria quassiae* is a common lichen species in Uttar Pradesh, found growing on the bark of *Acacia nilotica* and *Shorea robusta* in forested areas. It is characterized by perithecioid apothecia, 2 – 4 spored asci, double walled, radially constulate ascospores and norstictic acid in chemistry.

Phaeophyscia Moberg (Family: Physciaceae)

Symb. Bot. Upsal. 22(1): 29.1977.

Thallus foliose, loosely adnate, lobes radiating; greenish brown to brown; lower side brown to black, rhizinate; photobiont a green alga, *Trebouxia*; medulla white. Ascomata apothecia, laminal, mostly rhizinate at base (coronate), disc brown to black. Exciple lecanorine; hymenium hyaline; hypothecium hyaline; paraphyses apically thickened; asci 8 spored; ascospores brown, 1 septate, *Physcia* or *Pachysporaria*-type. Pycnidia laminal; pycnoconidia ellipsoid, less than 4 µm long. Atranorin always absent in upper cortex.

World wide 28 species; India 15 species; Literature: Awasthi 2007.

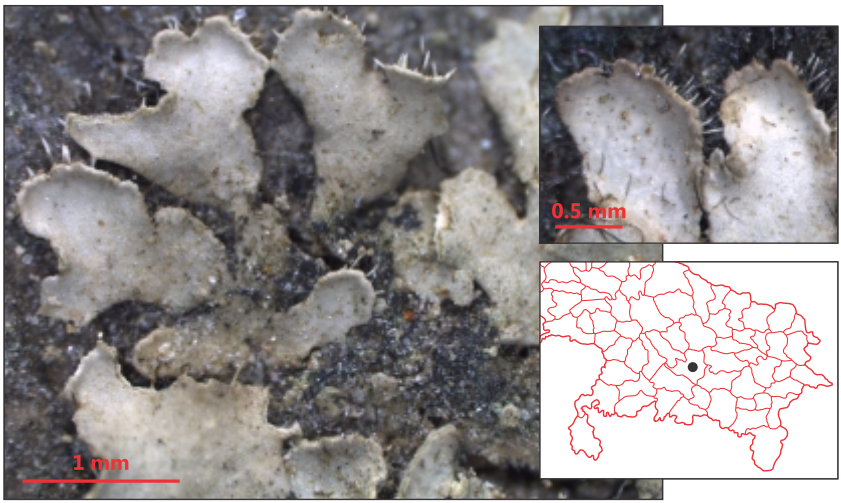
Key to the species of *Phaeophyscia*

1a. Thallus large, 2 – 6 cm across, lobes 0.3 – 1.2 mm wide . . . . . *P. hispidula*

1b. Thallus small, 1 – 3 cm across, lobes 0.2 – 0.6 mm wide . . . . . *P. orbicularis*

Phaeophyscia hispidula (Ach.) Moberg

Bot. Not. 131: 260. 1978. – *Parmelia hispidula Ach., Lichenogr. Universalis*: 468. 1810.



Thallus corticolous, foliose, closely adnate, 2 – 6 cm across, orbicular to suborbicular, greenish to brownish grey, sorediate; lobes rotund, lacinate, 0.3 – 1.18 mm wide, sometimes slightly pruinose, loose, ascending; sorelia laminal, capitate; soredia granular; lower surface pale at margin, black towards centre, rhizinate; rhizines dense, dark grey to black, sometimes with white tips, projecting beyond the lobes; medulla white to off-white. Apothecia absent.

Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Phaeophyscia hispidula* is a rare lichen in Uttar Pradesh, found growing on *Mangifera indica* trees in orchards and avenue trees along road side. It is characterized by sorediate, grayish brown thallus and projecting out, dense rhizines under the thallus.

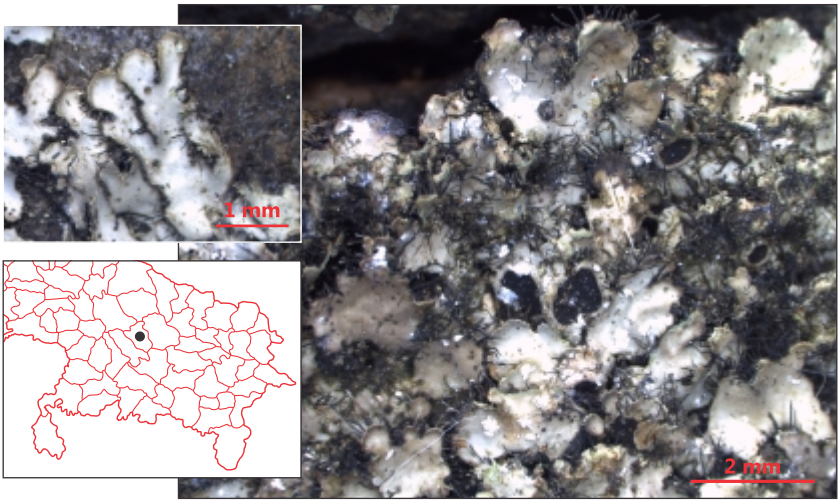
Phaeophyscia orbicularis (Neck.) Moberg

Symb. Bot. Upsal. 22(1): 44. 1977. – *Lichen orbicularis* Neck., *Delic. Gallo-Belg.:* 509. 1768.

Thallus corticolous, foliose, orbicularis, closely adnate, 1 – 3 cm across, grey brown to green brown, sorediate; lobes rotund, lacinate, 0.2 – 0.6 mm wide; sorelia laminal to marginal, capitate; soredia farinose; lower surface black, rhizinate; rhizines dense, black, projecting beyond lobes; medulla off-white. Ascomata absent.

Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Phaeophyscia orbicularis* is a rare lichen species in Uttar Pradesh, found growing on *Mangifera indica* trees in orchards and avenue trees along



road side. It is characterized by smaller thallus and lobes, sorediate condition, dense, black rhizines that project beyond the lobes.

Phylliscum Nyl. (Family: Lichinaceae)

Ann. Sci. Nat., Bot., ser. 3, 20: 320. 1853.

Thallus minutely discoid with an umbilicus on lower surface attaching thallus to substrate, saxicolous; photobiont a blue-green alga, *Chroococcus*. Ascomata apothecia, laminal, sunken in thallus or sessile with thick thalline exciple, disc initially closed, open later. Exciple thalline, paraphyses branched, anastomosing. Asci thin walled, 8 – 16 spored; spores hyaline, simple, thin walled, elongate-ellipsoid.

World wide 8 species; India 4 species; Literature: Awasthi 1991; Awasthi & Singh 1977; Upreti 1988.

Key to the species of *Phylliscum*

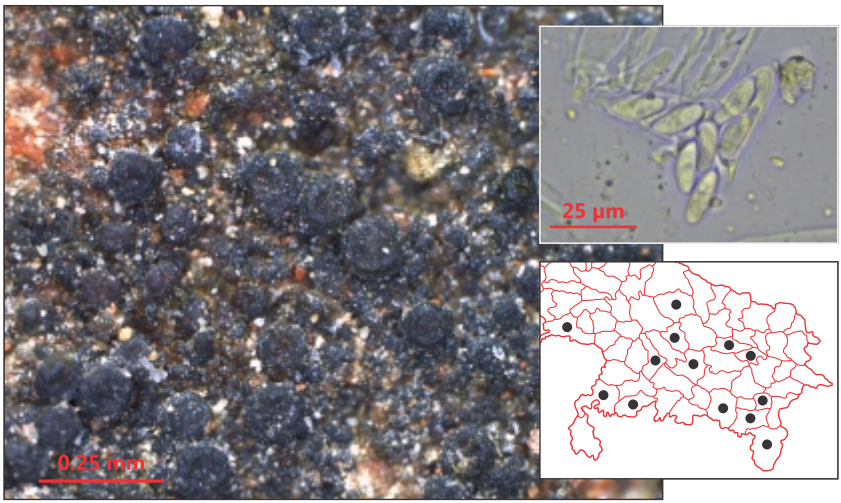
1a. Apothecia emergent, towards margin of the thallus, ascospores 14 – 18 × 5 – 8 µm ..... *P. indicum*

1b. Apothecia sunken, ascospores 9 – 14 × 5 – 6 µm ..... *P. testudineum*

Phylliscum indicum Upreti

Curr. Sci. 57(16): 906. 1988.

Thallus saxicolous, squamulose; squamules circular, closely aggregated, dark brown to black, 0.08 – 0.17 mm across. Apothecia mostly marginal, round,



sessile, 0.10 – 0.22 mm diam.; margin prominent, smooth, thalline, concolours with the thallus; disc dark brown or slightly paler than the disc, plane. Exciple brownish, with cyanobacterial cells, 38 – 67 µm thick; epihymenium brown, 9 – 18 µm thick; hymenium hyaline to yellowish, 57 – 64 µm; hypothecium pale brown, 20 – 44 µm thick; paraphyses branching and anastamosing. Asci 8 spored, clavate, 57 – 71 × 10.7 – 15.7 µm; ascospores simple, ellipsoid, hyaline, 14.6 – 17.7 × 5.9 – 7.3 µm.

Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

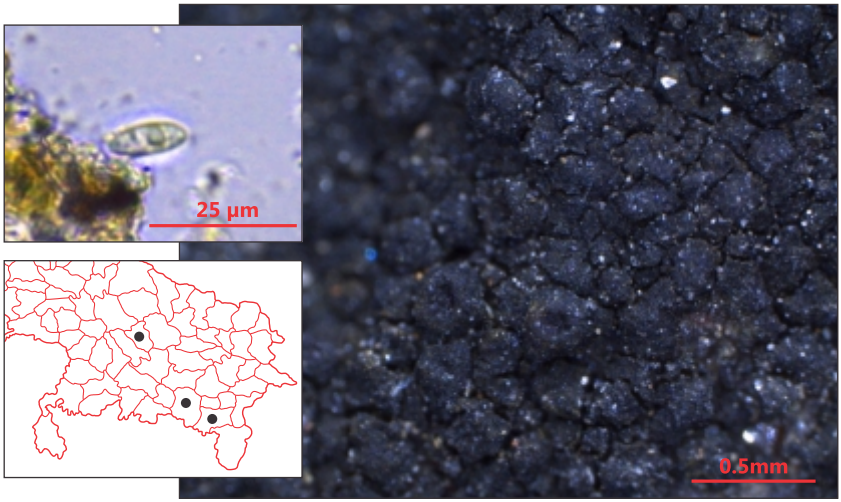
Comments: *Phylliscum indicum* is a very common lichen species in Uttar Pradesh, found growing over exposed rock as well as lime/cement plasters of old monuments and buildings. It is characterized by circular, dark brown to black, squamules marginal apothecia and slightly larger ascospores.

Phylliscum testudineum Henssen

Svensk Bot. Tidskr. 57(2): 153. 1963.

Thalus saxicolous, crustose to subsquamulose, dark brown to black, peltate, umblicate, discoid. Ascomata apothecia frequent, almost sunken, laminal; margin thick, concolours with thallus; disc brown, concave. Exciple brown, with cyanobacterial cells, 41 – 58 µm thick; epihymenium pale brown to brown, 16 – 25 µm thick; hymenium hyaline, 46 – 62 µm thick; hypothecium hyaline to pale brown, 25 – 38 µm. Ascus 8 spored, clavate, up to 53 × 14 µm; ascospores hyaline, ellipsoid, simple, 9.9 – 14.4 × 5.4 – 6.2 µm.

Chemistry: K-, C-, KC-, P-. TLC: No chemical detected.



Comments: *Phylliscum testudineum* is a common lichen in Uttar Pradesh, found growing on exposed rocks and cement plaster of compound walls. It is characterized by dark brown to black, squamulose, umbilicate thallus, sunken apothecia and simple, smaller ascospores.

Phyllopeltula Kalb (Family: Peltulaceae)

Biblioth. Lichenol. 23: 40. 1987.

Thallus squamulose, subfoliose to foliose, heteromerous, paraplectenchymatous, comprising ± globose hyphal cells, attached to the substratum (bark) by fascicles of rhizohyphae; photobiont a cyanobacteria. Ascomata apothecia, laminal, 0.3 – 1.0 mm diam. Exciple rudimentary; hymenium hyaline; paraphyses not or rarely branched with few anastomosing, apices slightly swollen. Asci clavate, with c. 32 – 128 spores; ascospores globose, 3 – 4 µm diam.

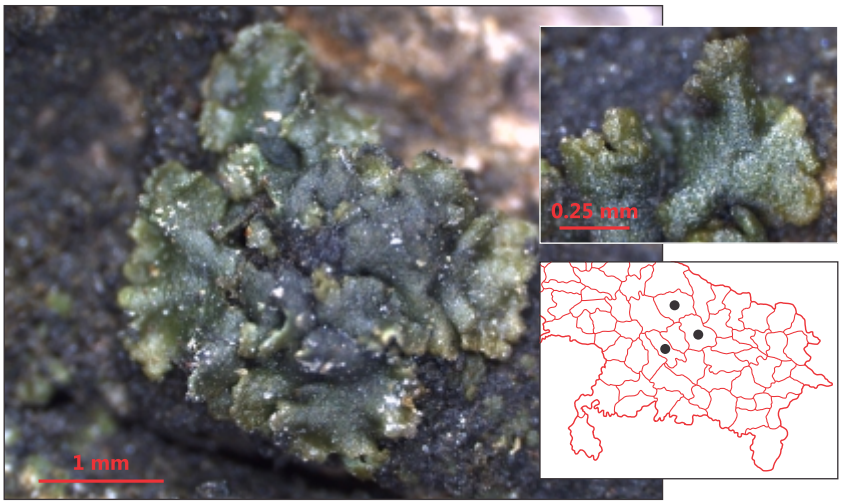
World wide 1 species; India 1 species; Literature: Kalb 2001.

Phyllopeltula steppae Kalb.

Biblioth. Lichenol. 78: 159. 2001.

Thallus corticolous, squamulose to subfoliose, olive brown, 1 – 3 cm across, marginally lobate; lobes concave, 1 – 2 mm long, 0.5 – 1.0 mm wide; upper surface ecorticate. Medulla and algal layer inseparabale; lower cortex distinct, consist of 3 – 4 rows of isodiametric cells; lower surface attached by bundles of rhizohyphae. Ascomata absent.

Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.



Comments: *Phyllopeltula steppae* is a common lichen species in Uttar Pradesh, found growing on bark of *Mangifera indica* trees trunks in orchard and avenue trees along road side. It is characterized by squamulose to subfoliose, olive brown thallus with cyanobacteria. *P. steppae* is an apotheciate species, however specimens of Uttar Pradesh are sterile. The species is earlier known from Neotropics and it is a new record for India (Khare *et al.* 2013, inpress).

Physcia (Schreb.) Michaux
(Family: Physciaceae)

FI. Boreali-americana, Tom 2: 326. 1803.

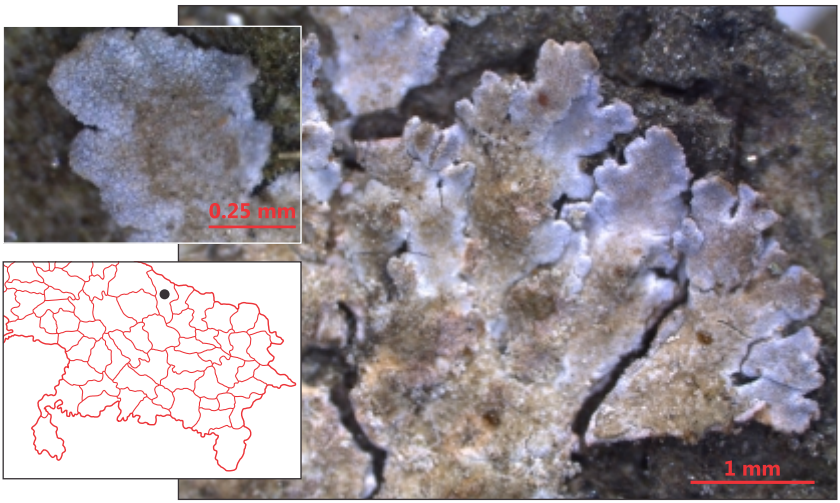
Thallus foliose, loosely attached, often suborbicular, radially lobate, pale grey to darker, with or without isidia and soredia; lower side pale brown to black, with concolours rhizines; photobiont *Trebouxia*, medulla white. Ascomata apothecia, laminal, lecanorine, disc brown to black. Exciple lecanorine; hymenium and hypothecium hyaline; paraphyses branched, brown at apices. Asci 8 spored; ascospores *Physcia* or *Pachysporaria* type, brown, 2 celled, ellipsoid. Pycnidia laminal; pycnoconidia subcylindrical, 4–6 µm long. Atranorin always present in upper cortex.

World wide 73 species; India 17 species; Literature: Awasthi 2007.

Physcia dimidiata (Arn.) Nyl.

Flora 64: 537. 1881. – *Parmelia pulverulenta* var. *dimidiata* Arn., *Flora* 48: 594. 1864.

Thallus corticolous, foliose, orbicularis, small, 0.5 – 3.0 cm across, bluish to



whitish grey, turning brownish in preservation, delicate, sorediate; lobes lacinate, 0.2 – 0.6 mm wide, densely pruinose; sorelia laminal or marginal; soredia granular; lower side pale brown, rhizinate; rhizines brownish; medulla white. Ascomata absent.

Chemistry: K+ yellow, C-, KC-, P-. TLC: Atranorin present.

Comments: *Physcia dimidiata* is a rare lichen species in Uttar Pradesh, found growing on tree trunk in moist deciduous forest. It is characterized by densely white pruinose, K+ yellow thallus and laminal to marginal soredia. It is mostly a Himalayan species, however currently studied specimen from Uttar Pradesh closely resembles to this species.

Porina Müll. Arg. (Family: Porinaceae)

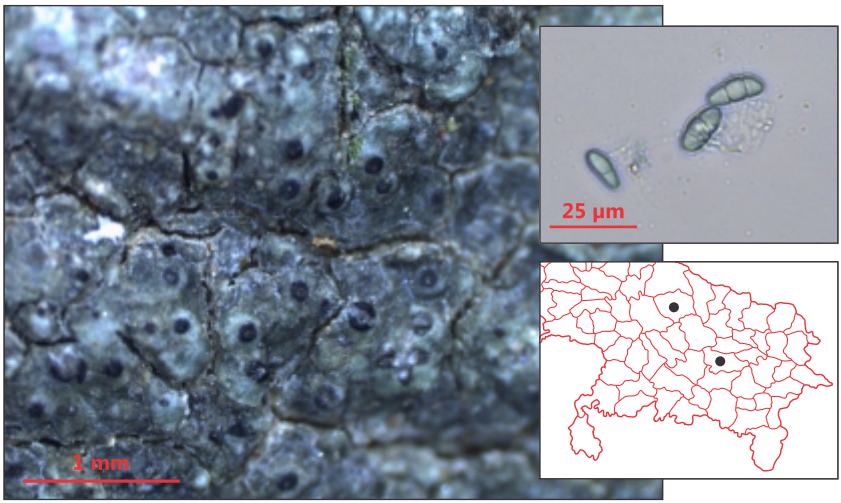
Kongl. Vetensk. Akad. Nya Handl. 30: 158. 1809.

Thallus crustose, ecorticated, epiphyllous or epi or endodophloeodal; photobiont a green alga, *Trentepohlia* or *Phycopeltis*. Ascomata perithecia, singular, dispersed, with pale or dark, semiglobose to globular and erect punctiform ostiole. Exciple not differentiated or distinguished into two walls, an outer involucrellum, black, brown or reddish brown and an inner wall hyaline or coloured; paraphyses simple, free. Asci 6–8 spored; ascospores hyaline, transversely 1 many septate, elongate, spindle form, fusiform or needle shaped.

World wide 336 species; India 61 species; Literature: Upreti 1994.

Porina aenea (Wallr.) Zahlbr.

Cat. Lich. Univers. 1: 363. 1922. – *Verrucaria aenea* Wallr., *Fl. Crypt. Germ.* 3: 299. 1831.



Thallus corticolous, crustose, cracked areolate, grey to dark grey or greenish grey, rough to uneven, indeterminate. Ascomata perithecia, numerous, emergent, solitary, paler than the thallus, partially covered by the thallus, exposed portion black, 0.1 – 0.3 mm diam.; ostiole pale, distinct. Involucrellum running close to perithecial wall up to half way, brown to dark brown, thick at top and tapering below, 30 – 47 µm thick; exciple hyaline, sometimes darker outwards, 8 – 18 µm thck; hamathecium hyaline, not inspersed, 130 – 132 × 139 – 145 µm across; paraphyses branching, persistent. Ascus 8 spored, cylindrical, 22 – 84 × 13 – 15 µm; ascospores hyaline, transversely 1 – 3 septate, 1 septate spores (immature) small and appearing spindle shaped, 13.0 – 13.7 × 6.8 – 7.3 µm, 3 septate (mature) spores broadly ellipsoid – fusiform, with round to acute ends, 15.2 – 21.3 × 6.5 – 8.6 µm. Pycnidia black, small, 0.08 – 0.12 mm diam., immersed; conidia ellipsoid, hyaline, 2.4 – 2.8 µm.

Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Porina aenea* is a common lichen species in Uttar Pradesh, found growing on trunks of *Madhuca indica* and *Mangifera indica* in orchards areas. It is characterized by greenish grey thallus, partially covered perithecia and transversely 1 – 3 septate ascospores.

Pyrenopsis (Nyl.) Nyl. (Family: Lichinaceae)

Syn. Meth. Lich. 1: 197. 1858.

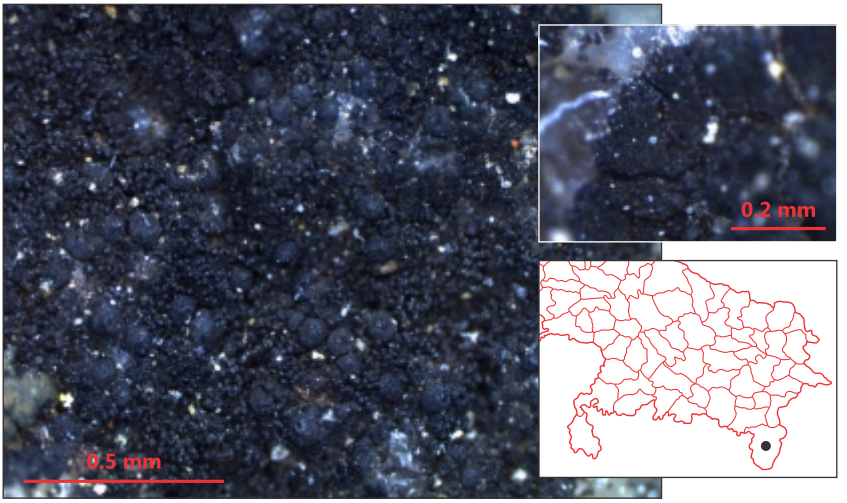
Thallus crustose, areolate, granulose, gelatinous when wet, dark reddish brown or blackish, smooth or rimose, plane or uneven; photobiont chroococcoid cyanobacterium with reddish or purplish gelatinous sheath. Ascomata apothecia, laminal or terminal on tiny coralloid granules, immersed to sessile, with thin thalline rim. Asci rostrate, Lecanoralean with amyloid inner cap or prototunicate; ascospores hyaline, simple, ellipsoid to broad ellipsoid.

World wide 60 species; India 1 species; Literature: Schultz 2007.

Pyrenopsis triptococca Nyl.

Flora, Jena 64: 2. 1881.

Thallus saxicolous, crustose, areolate to squamulose, marginal squamules sometimes elongate to effigurate, dark reddish brown to black, thin, gelatinous when wet; upper surface with granular, corroloid, isidioid outgrowths, thallus appearing granular. Ascomata apothecia, frequent, sessile, round to globose, 0.1 – 0.4 mm diam.; margin thick, black, concolours with thallus; disc small, mostly punctiform, concave, black, concolours with margin. Exciple with algal cell, orange brown, 49 – 72 µm thck; epihymenium yellow brown, K-, KI+ blue, 13 – 21 µm high; hymenium hyaline, I+, KI-; hypothecium hyaline to brownish, 18 – 28 µm high, I+, KI-; paraphyses septate, up to 2 mm thick, branched,



sometimes moniliform. Ascus 8 spored, clavate, 29 – 54 × 7 – 10 µm; ascospores hyaline, simple, ellipsoid, 9.1 – 12.0 × 5.1 × 8.1 µm.

Chemistry: K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Pyrenopsis triptococca* is a rare lichen species in Uttar Pradesh, found growing over exposed rocks. It is characterized by squamulose to effigurte, blackish thallus, round to globose apothecia with thick margin and hyaline, simple, ellipsoid ascospores. It is a new record for India, earlier it is known from S.W. Europe, N.W. Africa, Canary Islands & S.W. North America (Schultz 2007).

Pyrenula Ach. (Family: Pyrenulaceae)

Syn. Meth. Lich.: 117. 1814.

Thallus crustose, epi or endophloeodal; photobiont green alga, *Trentepohlia*. Ascomata perithecia, solitary or rarely 2 – 3 confluent, immersed to emergent, covered with thallus or naked in upper part, hemispherical to globose. Exciple black, carbonized, spreading laterally, much thickened laterally and in upper part, usually thinner at base, ostiole apical, depressed to papillate; paraphyses simple, persistent. Asci cylindrical to clavate, bitunicate, 8 spored; ascospores brown, ovoid, ellipsoid to fusiform, thick walled, 1 5 septate to muriform.

World wide 200 species; India 92 species; Literature: Upreti 1998.

Key to the species of *Pyrenula*

1a. Ascospore ends thin walled and papillate, hamathecium with oil globules, exciple not spreading . . *P. subacutalis*

1b. Ascospore ends not papillate 2

2a. All locules of ascospore rounded or lentiform 3

2b. Two middle locules of ascospores are rhomboidal 5

3a. Hymenium lacking oil globules, exciple laterally spreading, ostiole indistinct . . . . . *P. brunnea*

3b. Hymenium with oil globules, ostiole mamillate-papillate 4

4a. Thallus yellowish brown, exciple laterally spreading . . . . . *P. mamillana*

4b. Thallus ash-grey, exciple slightly laterally spreading . . *P. subglabriuscula*

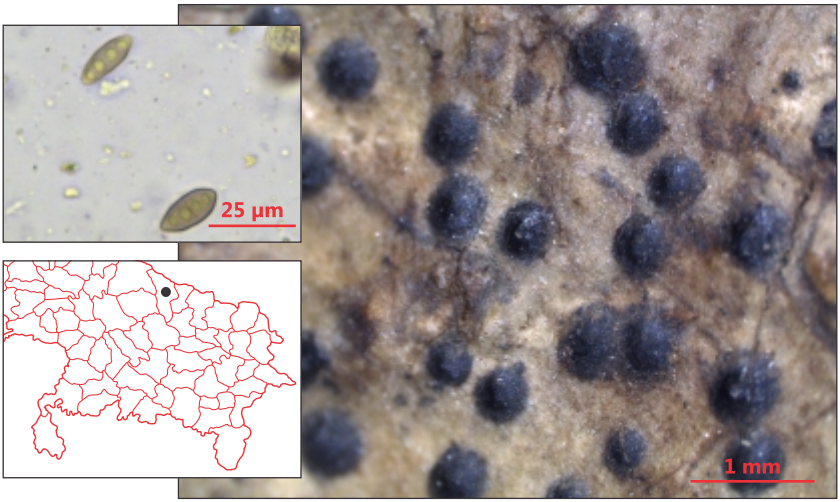
5a. Hymenium with abundant oil globules, thallus yellow brown *P. comirana*

5b. Hymenium lacking oil globules, thallus whitish grey . . . . . *P. melaleuca*

Pyrenula brunnea Fée

Essai Crypt. Ecorc. Suppl.: 81. 1837.

Thallus corticolous, crustose, brownish grey to yellowish brown, smooth. Perithecia numerous, solitary, black, depressed to semi-globose, 0.3 – 0.7 mm diam.; ostiole indistinct, apical. Exciple carbonized, 32 – 89 µm, spreading laterally; hamathecium clear, 102 – 203 µm. Asci 8 spored, clavate to cylindrical, up to 73 × 22 µm; ascospores brown, broadly oblong to ellipsoid, transversely 3 septate, all locules rounded to lentiform, 15.3 – 29.2 × 6.4 – 11.6 µm.



Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Pyrenula brunnea* is a rare lichen species in Uttar Pradesh, found growing on tree bark in deciduous forest. It is characterized by brownish smooth thallus, laterally spreading exciple and ascospores with all rounded to lentiform locules.

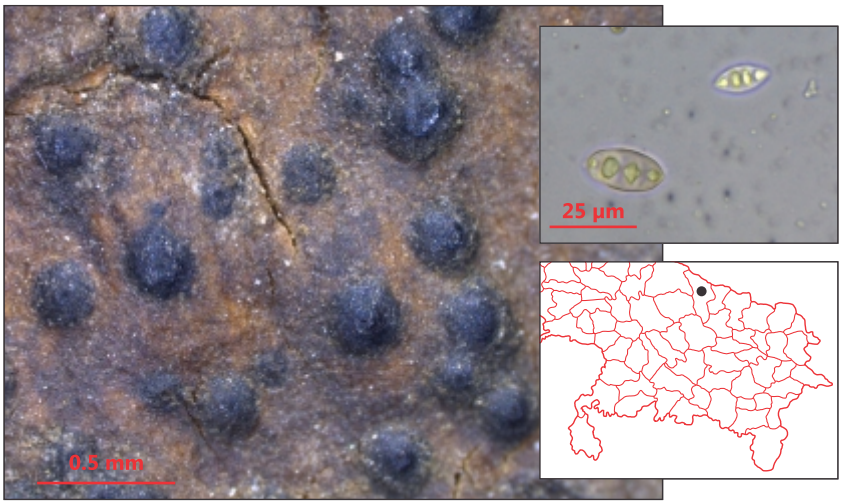
Pyrenula comirana Vainio

Ann. Acad. Sci. Fenn., ser. *A*, 15: 337. 1920.

Thallus corticolous, crustose, smooth, yellowish to green brown, smooth. Perithecia black, semi-emergent, 0.2 – 0.7 mm diam.; ostiole indistinct. Exciple carbonized, slightly spreading, 23 – 46 µm thick; hamathecium with oil globules, 181 – 223 µm across. Ascospores brown, transversely 3 septate, P. mastophora type, 16.5 – 33.3 × 9.1 – 12.0 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No substances detected.

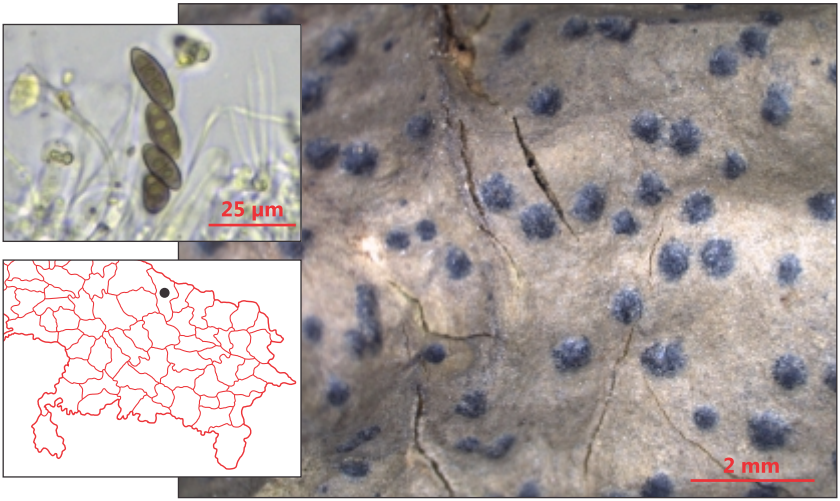
Commenta: *Pyrenula comirana* is a less frequent lichen species in Uttar Pradesh, found growing on bark of trees in forested areas. It is characterized by yellowish to greenish brown thallus, slightly spreading exciple, oil globules in hamathecium and ascospores with end locules triangular in shape and base of the triangle facing against end of the ascospore (*P. mastophora* type – *sensu* Upreti 1998).



Pyrenula mamillana (Ach.) Trevis.

Consp. Verruc.: 13. 1860. – *Verrucaria mamillana* Ach., *Methodus*: 120. 1803.

Thallus corticolous, crustose, yellowish brown to grey brown, smooth. Perithecia black, depressed to semi-globose, solitary, naked, 0.3 – 0.7 mm diam.; ostiole apical, papillate. Exciple carbonized, laterally spreading, 55 – 72 µm; hamathecium hyaline, with oil globules, up to 269 – 339 µm across. Asci 8 spored, cylindrical to clavate, 66 – 98 × 12 – 16 µm; ascospores brown, ellipsoid, transversely 3 septate, locules rounded to lentiform, 18.7 – 23.4 × 7.2 – 9.8 µm.



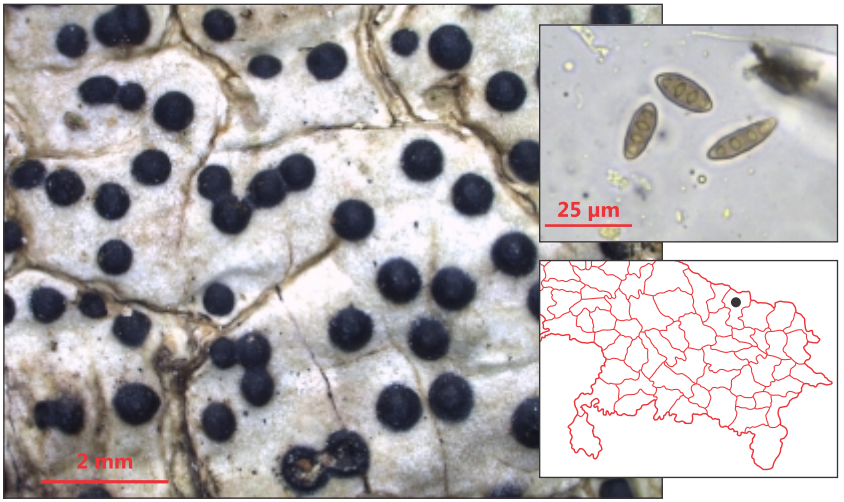
Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Pyrenula mamillana* is a rare lichen species in Uttar Pradesh, found growing on tree bark in deciduous forest. It is characterized by pale brown thallus, black perithecia with papillate ostiole, laterally spreading exciple, oil globules in hamathecium and ascospores with rounded to lentiform locules.

Pyrenula melaleuca Müll. Arg.

Nuovo Giorn. Bot. Ital. 30: 403. 1891.

Thallus corticolous, crustose, smooth, yellowish to whitish grey. Perithecia numerous, black, solitary, occasionally 2 – 3 in groups, hemispherical, 0.4 – 0.8 mm diam.; ostiole indistinct, apical. Exciple dark brown to black, slightly spreading laterally, complete and thinning below, 35 – 86 µm thick;



hamathecium conical, 287 × 166 µm, oil globules absent. Asci 8 spored, cylindrical to clavate, 53 – 80 × 11 – 13 µm; ascospores brown, broadly ellipsoid, transversely 3 septate, *P. mastophora* type (sensu Upreti 1998), 6.1 – 19.4 × 7.0 – 9.1 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Pyrenula melaleuca* is a rare lichen species in Uttar Pradesh, found growing on bark of trees in deciduous forest. It is characterized by smooth, whitish grey thallus, black perithecia, brown, 3 septate *P. mastophora* type of ascospores (with two middle locules rhomboidal, end locules ± triangular with the base of triangles against the end of the ascospore).

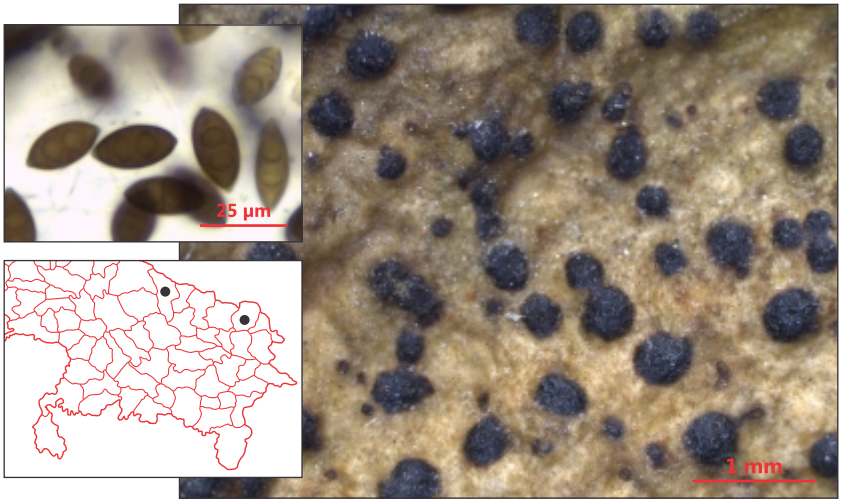
Pyrenula subacutalis Upreti

Feddes Repert 102: 429. 1991.

Thallus corticolous, crustose, smooth, pale brown to brown. Perithecia, black, solitary, rarely in group of few, 0.2 – 0.6 mm diam.; ostiole apical, indistinct. Exciple dark brown to black, not spreading laterally, 29 – 45 µm thick; hamathecium conical, oil globules in abundance. Asci 8 spored, cylindrical to clavate, 72 – 92 × 19 – 25 µm; ascospores brown, broadly ellipsoid, 3 septate, *P. approximans*-type, 14.1 -23.3 × 6.7 – 12.1 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Pyrenula subacutalis* is a common lichen species in Uttar Pradesh, found growing on bark of trees including *Shorea robusta* in saal forests. It is characterized by brownish thallus, black perithecia, oil globules in hymenium

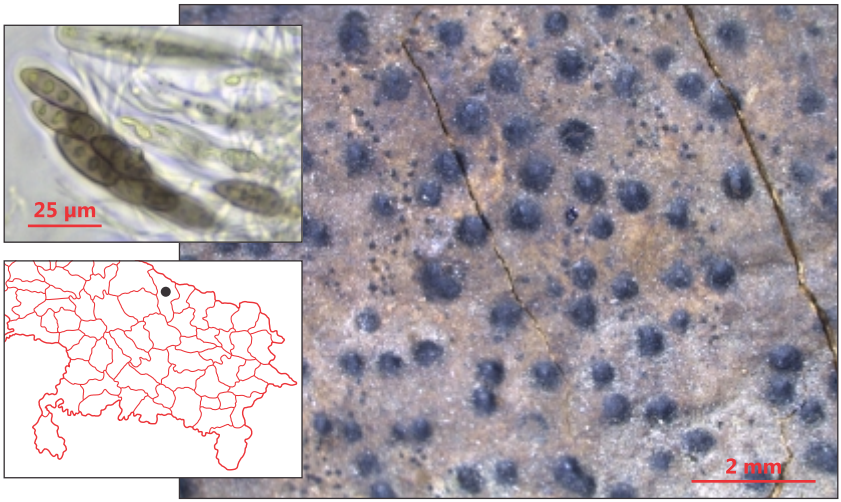


and *P. approximans* -type of ascospores (ascospore ends thin walled, ± papillate).

Pyrenula subglabriuscula Vainio

Ann. Acad. Sci. Fenn., ser. A, 15: 244. 1920.

Thallus corticolous, crustose, pale brown to ashy grey, smooth. Perithecia black, depressed to hemi-spherical, solitary, 0.37 – 0.9 mm diam.; ostiole apical, papillate. Exciple carbonized, slightly spreading laterally, indistinct or



absent at base, 37 – 76 µm thick; hamathecium hyaline, with oil globules, 15 – 198 µm across; ascospores brown, ellipsoid, transversely 3 septate, locules rounded to lentiform, 11.1 – 22.7 × 5.2 – 7.6 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Pyrenula subglabriuscula* is a common lichen species in Uttar Pradesh found growing on various trees including *Phyllanthus emblica* both in orchard and forest areas. It is characterized by ashy grey thallus, black perithecia, oil globules in hamathecium and ascospores with rounded to lentiform locules.

Pyxine Fr. (Family: Physciaceae)

Syst. Orb. Veget. I: 267. 1925.

Thallus foliose, lobes radiating, branched; pale grey, whitish grey, dark grey; pruina diffused or in glistening plaques; maculae persistent or fissured into pseudocyphellae; with or without isidia and soredia; lower side brown-black, rhizinate; photobiont green alga, *Trebouxia*. Ascomata apothecia, laminal, disc black. Thalline exciple persistent or becoming black at maturity or exciple black since initial stages of development, brown-black part of exciple K+ violet-purple; epihymenium K+ purple; hypothecium brown. Asci 6 – 8 spored; ascospores brown, 1 septate, mischoblastiomorph. Atranorin usually present in upper cortex, lichexanthone present or absent.

World wide 60 species; India 29 species; Literature: Awasthi 2007.

Key for the species of *Pyxine*

1a. Thallus sorediate 2

1b. Thallus esorediate 4

2a. Thallus UV-, medulla yellow, soralia yellowish, marginal to submarginal, linear . . . . . *P. meissnerina*

2b. Thallus UV+ yellow 3

3a. Medulla white to off white, soralia marginal and laminal . . . . . *P. cocoes*

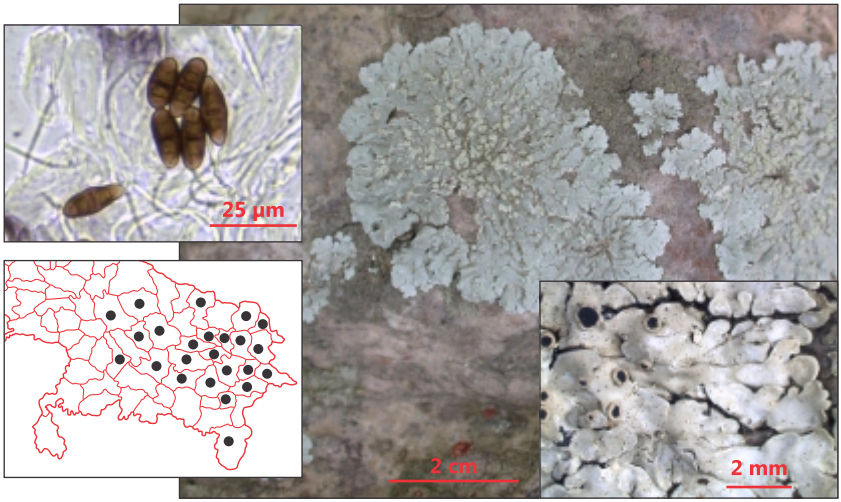
3b. Medulla yellow, soralia marginal . . . . . *P. subcinerea*

4a. Thallus UV+ yellow, medulla white . . . . . *P. petricola*

4b. Thallus UV-, medulla deep yellow to orange . . . . . *P. himalayensis*

Pyxine cocoes (Sw.) Nyl.

Mem. Soc. Imp. Sci. Nat. Cherbourgh 5: 108. 1857. – *Lichen cocoes Sw., Nov. Gen. Sp. Pl.*: 146. 1788.



Thallus corticolous, foliose, whitish grey, orbicular, 1.8 – 6.0 cm across, UV+ yellow, maculate, sorediate; lobes rotund, pruinose, 0.4 – 1.3 mm wide; medulla white to off-white; maculae laminal and marginal, sometimes forming pseudocyphellae; sorelia laminal to submarginal, linear, soredia granular; lower surface pale yellow to brown, rhizines brownish. Ascomata apothecia, rare, 0.3 – 1.2 mm diam.; margin thin, thalline, entire, concolours with the thallus, gradually darkening and becoming lecidine; disc black, plane to concave, epruinose of slightly white pruinose. Exciple hyaline, with algal cell when young, brownish at maturity, 20 – 35 µm thick; epihymenium brown, K+ purple, 10 – 18 µm thick; hymenium hyaline to slightly yellowish, 45 – 60 µm thick; hypothecium brown, 25 – 35 µm thick; paraphyses simple to branching, apical cell swollen and brown pigmented. Ascus 8 spored, clavate, 40 – 50 × 18 – 22 µm; ascospores brown, transversely 1 septate, mischoblastiomorphic, oblong, 15.3 – 22.1 × 7.6 – 9.1 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin, lichexanthone present at Rf class 6 – 7, triterpenes at 4 -5, and above 7.

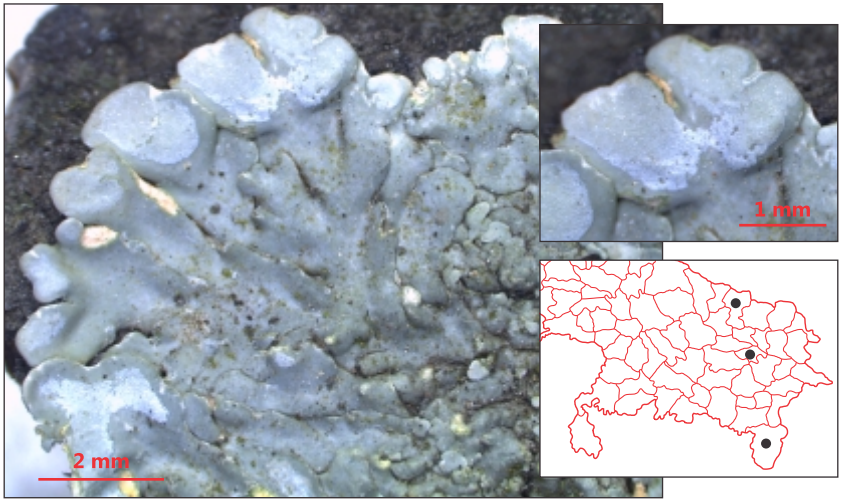
Comments: *Pyxine cocoes* is a most common lichen species in Uttar Pradesh, found growing on variety of trees such as *Acacia nilotica, Artocarpus heterophyllus*, *Azadirachta indica, Bombax ceiba, Citrus* spp., *Ficus bengalensis, Litchi chinensis, Madhuca indica, Mangifera indica,* Palm, *Shorea robusta* and *Syzygium cumini*, in orchards, forest areas as well as along the road side. It is a pollution tolerant species and excellent accumulator of both organic and inorganic metals, hence widely used in air pollution and biomonitoring studies. It is characterized by strikingly whitish, circular thallus that emits florescent yellow colour under UV lamp due to presence of lichexanthone. In

most of the cases *P. cocoes* reproduces vegetatively with soredia hence rarely it produces apothecia.

Pyxine himalayensis D.D. Awasthi

Phytomorphology 30: 371. 1980.

Thallus corticolous, foliose, orbicular, 1.3 – 3.5 cm across, whitish to bluish grey, maculate; lobes rotund, 0.4 – 1.6 mm wide, pruinose; maculae laminal and marginal; medulla orange to reddish; lower surface pale to grayish, rhizinate. Apothecia absent.



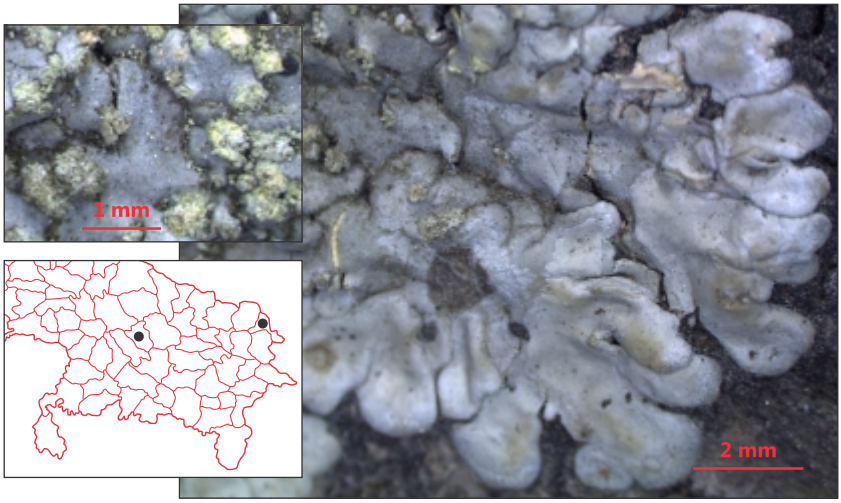
Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin and triterpenes present.

Comments: *Pyxine himalayensis* is a less frequent lichen species in Uttar Pradesh, found growing on the bark of *Acacia nilotica* and *Mangifera* indica avenue trees along the road side in dense vegetated areas. It is characterized by whitish to bluish grey thallus, pruinose lobes and orange medulla. The thallus of Uttar Pradesh specimens were small and immature, hence apothecia were not developed.

Pyxine meissnerina Nyl.

Bull. Soc. Linn. Normandie, ser. 2, 7: 164. 1973.

Thallus corticolous, foliose, orbicular, 2.0 – 5.6 cm across, whitish grey or grey, sorediate, maculate; lobes rotund, pruinose, 1.1 – 1.9 mm wide; sorelia marginal to laminal; soredia granular, yellow; medulla yellow; lower surface pale yellow to grayish, rizhine pale. Apothecia absent.

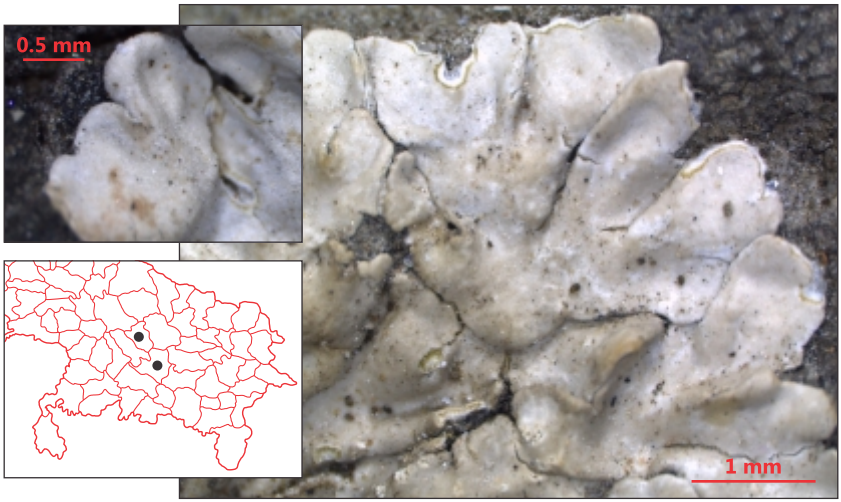


Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin and triterpenes present.

Comments: *Pyxine meissnerina* is a common lichen species in Uttar Pradesh, found growing mostly on *Mangifera indica* tree trunks in orchards and along road side. It is characterized by grayish orbicular thallus, yellow medulla and yellow soredia.

Pyxine petricola Nyl. in Cromb.

J. Bot. London 14: 263. 1876.



Thallus corticolous, foliose, greenish to whitish grey, orbicular, 0.8 – 4.7 µm across, maculate, UV+ yellow; lobes rotund, 0.7 – 1.0 mm wide, pruinose; lower surface yellow to brown, rhizinate; rhizines brownish; medulla white to off-white. Apothecia absent.

Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin, lichexanthone present.

Comments: *Pyxine petricola* is a less frequent lichen species in Uttar Pradesh, found growing on the bark of *Mangifera indica* trees in orchards. It is characterized by whitish grey, circular thallus which emits florescent yellow colour under UV lamp. Usually reproduces with ascospores, however specimens from Uttar Pradesh were sterile and did not produce apothecia.

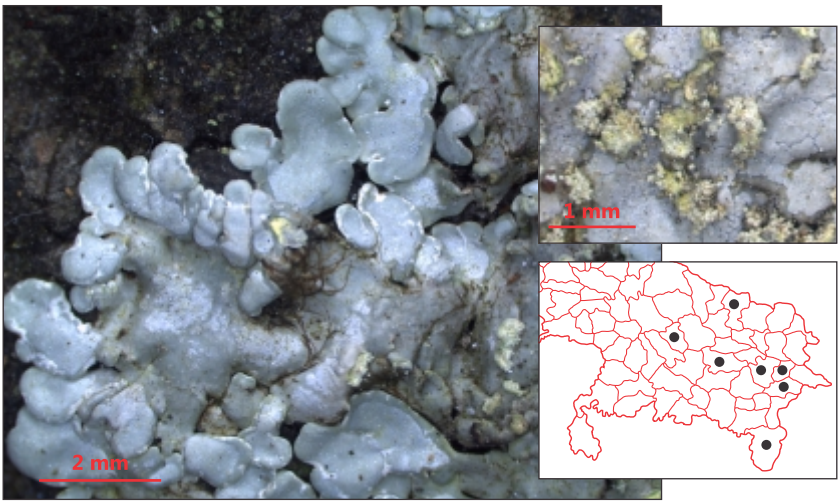
Pyxine subcinerea Stirt.

Trans. & Proc. New Zealand Inst. 30: 397. 1898.

Thallus corticolous, foliose, orbicular, 1.5 – 5.0 cm across, whitish to bluish grey, maculate, sorediate, UV+ yellow; lobes rotund, 0.5 – 1.3 mm wide, pruinose; maculae laminal to marginal, sometimes developing in to pseudocyphellae; sorelia mostly marginal, linear, soredia granular, bluish grey; medulla yellow to orangish; lower surface yellowish to brownish, rhizinate; rhizines pale to dark grey. Apothecia absent.

Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin, lichexanthone present.

Comments: *Pyxine subcinerea* is a common lichen species in Uttar Pradesh, found growing on *Bombax cebia, Madhuca indica,* and *Mangifera indica* trees in



orchards. It is distinguishable from other species of *Pyxine* with bluish grey, thick thallus with comparatively larger lobes, marginal sorelia, yellow medulla and lichexanthone as secondary metabolite.

Ramonia Stizenb. (Family: Gyalectaceae)

Ber. St. Gall. Nat. Gesell.: 168. 1862.

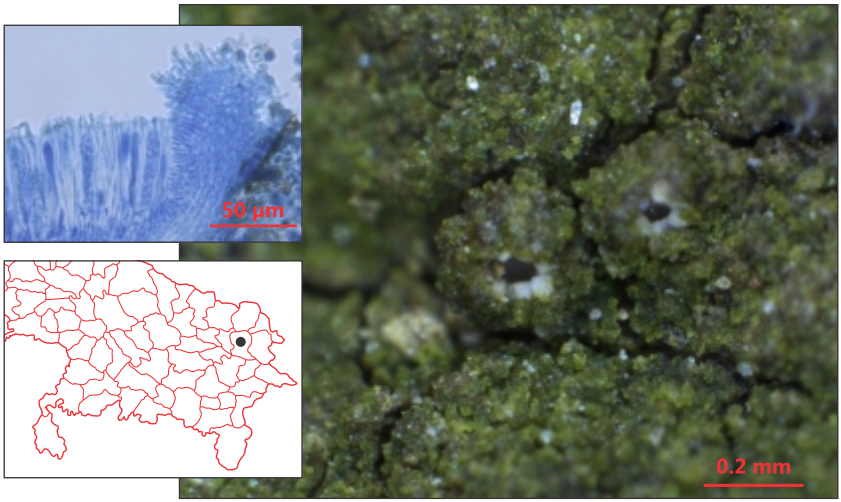
Thallus crustose, epiphloeodal or partly immersed, effuse; photobiont *Trentepohlia*. Ascomata apothecial gyalectifom, urceolate, initially immersed, globose or depressed globose, concave, pinkish or gray white; thalline margin thin or thick, wrinkled, lacerate, disappearing or closed over disc. True exciple thin, well developed laterally; hymenium hyaline; periphyses present; paraphyses slender, septate, conglutinate. Asci clavate to ± subcylindrical, 8 to many spored; ascospores hyaline, simple or 1(to many) septate, smooth, boat shaped.

World wide 16 species; India 1 species; Literature: Lendemer & Knudsen 2011.

Ramonia microspora Vězda

Folia Geobot. phytotax. 1: 162. 1966.

Thallus corticolous, crustose, squamulose to dispersed granular, green, epiphloeodal, thin or irregularly thickened, ecorticate. Ascomata apothecia, appearing as perithecioid, gyalectiform, urceolate, frequent, round, sunken to slightly emergent, solitary, dispersed, 0.07 – 0.14 mm in diam.; rim of the pore white, occasionally splitting radially; disc white to pinkinsh, concave,



epruinose. Thalline margin thin, running parallel to proper exciple and forming pore; proper exciple hyaline, thin, well developed, continuous below hymenium, extending above hymenium level and forming periphyses; periphyses radiating, with ±pointed apices, hyaline; epihymenium hyaline, I+ blue; hymenium hyaline, I+ light blue, not inspersed, 58 – 83 µm high; hypothecium hyaline, 19 – 27 µm high; paraphyses simple, slender, septate, unbranched, straight, conglutinated, slightly swollen at tips. Ascus multispored, up to 50 spores, clavate, non-amyloid or pale blue, 58 – 64 × 8 – 11 µm; ascospore hyaline, simple, rounded, 4.0 – 5.8 µm in diam.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Ramonia microspora* is a rare species in Uttar Pradesh, found growing on *Shorea robusta* tree bark in forest area. It is characterized by greenish thallus, apothecia opening by pore, radiating periphyses and multispored ascus. To the first sight the specimen appears as greenish, sterile crust. However, close observation under stereozoom microscope reveals the presence of urceolate apothecia embedded in the thallus. Owing to its sterile crust like thallus, the species is not collected frequently and a single specimen of the species is so far available for the study. However, the saal forest in Gorakhpur areas appears a most suitable habitat for this species and intensive survey in the area will definitely help to collect more specimens for further study. It is a new record for India and it is also known from Brazil (Aptroot 2002), Papua New Guinea (Aptroot 1998), North America (Lendemer & Knudsen 2011).

Rinodina (Ach.) Gray (Family: Physciaceae)

Nat. Arr. Brit. Pl. 1: 448. 1821.

Thallus crustose to subsquamulose, continuous, rimose or areolate, pale to dark grey, yellow, yellow-brown or dark brown. Ascomata apothecia, immersed to sessile, disc brown to black, rarely pruinose, plane to convex; margin concolours with the thallus, lecanorine or sometime lecidine. Exciple usually hyaline, rarely brown; hymenium hyaline, amyloid; hypothecium hyaline to pale brown; paraphyses septate, simple or with short branches near the apices, apices. Asci *Lecanora*-type, clavate, (4) 8 spored; ascospores olive-green or pale or dark brown, 1 – 5 septate, mainly double walled, the walls variously thickened, ellipsoidal, septa well developed at maturity.

World wide 265 species; India 11 species; Literature: Awasthi 1991.

Key to the species of *Rinodina*

1a. Thallus saxicolous, ascospores mischoblastiomorphic ..... *R. oxydata*

1b. Thallus corticolous 2

2a. Ascospore locules simple,
wall uniformly thickened . . . . . *R. sophodes*

2b. Ascospore locules mischoblastiomorphic,
wall irregularly thickened . . . . . *R. exigua*

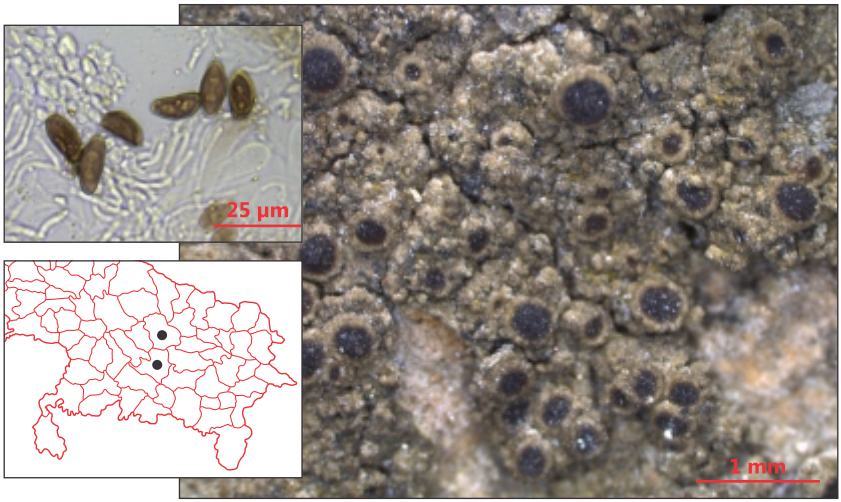
Rinodina exigua (Ach.) Gray

Nat. Arr. Brit. Pl. 1: 450. 1821. – *Lichen exiguus Ach., Lich. Suec. Prodrom.*: 69. 1798.

Thallus corticolous, crustose, rough, verruculose, cracked areolate, yellowish grey to greenish grey. Ascomata apothecia, numerous, round, 0.2 – 0.6 mm diam.; margin prominent, smooth, thalline, concolours with the thallus; disc dark brown to black, epruinose, plane to rarely convex. Exciple with algal cell, 39 – 66 µm thick; epihymenium brown, 12 – 18 µm thick; hymenium hyaline, 34 – 50 µm thick; hypothecium pale brown, 46 – 70 µm thick; paraphyses simple, apical cell swollen and pigmented. Asci 8 spored, clavate, 40 – 52 × 9.8 – 14.4 µm; ascospores brown, transversely 1 septate, oblong, locules mischoblastiomorphic, 11.7 – 22.2 × 5.0 – 10.8 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P-. Atranorin present.

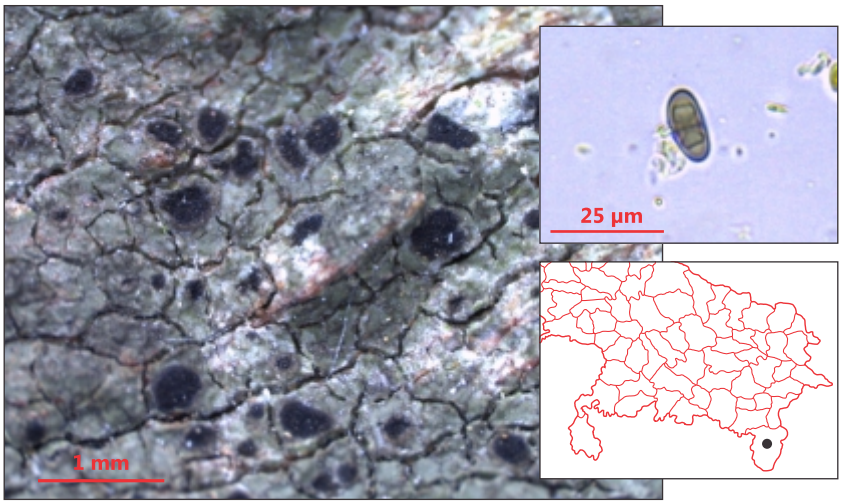
Comments: *Rinodina exigua* is a common lichen species in Uttar Pradesh, found growing on *Artocarpus heterophyllus* and *Mangifera indica* in avenue and orchard area trees. It is characterized by verrucose thallus, lecanorine apothecia and ascospores with 1 septate and mischoblastiomorphic locules.



Rinodina oxydata (Massal.) Massal.

Geneac. Lich.: 19. 1854; – *Mischoblastia oxydata* A. Massal, *Ric. Auton. Lich. Crost.*: 42. 1852.

Thallus saxicolous, crustose, cracked areolate, greenish grey. Ascomata apothecia, frequent, sunken to sessile, 0.1 – 0.4 mm diam.; margin thalline, thin, concolours with the thallus; disc black, concave, epruinose. Exciple with algal cells, up to 64 µm thick; epihymenium brown, 15 – 25 µm thick; hymenium hyaline, up to 67 µm thick; hypothecium hyaline to yellowish, up to 135 µm thick; paraphyses simple, apical cell swollen, brown pigmented. Ascus 8 spored, cylindrical to clavate, 53 – 55 × 11 – 15 µm; ascospores brown, transversely 1 septate, spore wall thick, locules mischoblastia-type, 16.4 – 19.0 × 7.0 – 10.6 µm.



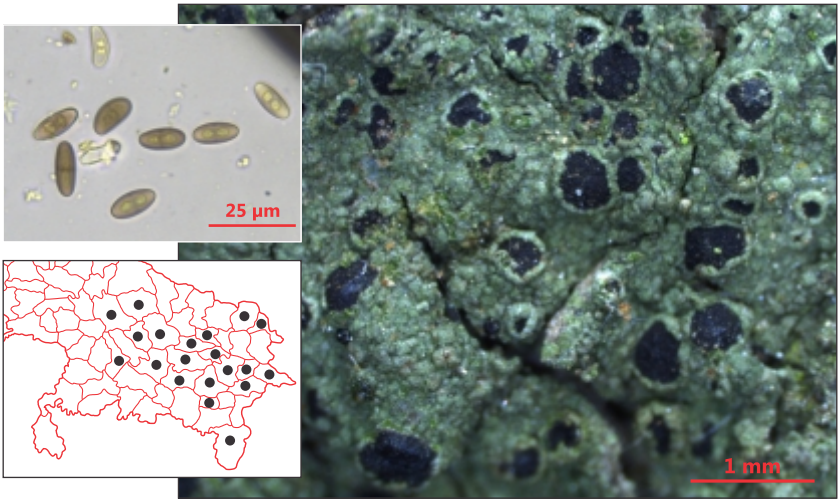
Chemistry: Thallus K+ yellow, C-, KC-, P-. Atranorin present.

Comment: *Rinodina oxydata* is a rare lichen in Uttar Pradesh, found growing on exposed rocks. It is characterized by lecanorine apothecia, 1 septate, brown ascospores with mischoblastiomorphic locules.

Rinodina sophodes (Ach.) A. Massal.

Ric. Auton. Lich. Crost.: 14. 1852. – *Lichen sophodes* Ach., *Lichenogr. Suec. Prodr.*: 67. 1798.

Thallus corticolous, crustose, smooth, thin, ecorticate, greyish green to brownish green. Ascomata apothecia, common, sessile, constricted at base or



closely adpressed, 0.8 – 3.0 mm diam.; margin lecanorine, thick, concolours with the thallus; disc brown, dark brown to black, plane to concave, epruinose. Exciple with algal cells, 60 – 73 µm thick; epihymenium yellow brown to dark brown, 18 – 20 µm high, K-, I+ blue; hymenium hyaline, 85 – 95 µm high, I+ blue; hypothecium hyaline to pale brown, I-, 78 – 95 µm high; paraphyses sparingly branched, apical cell slightly swollen and pigmented. Ascus 8 spored, cylindrical to clavate, 65 – 72 × 5 – 8 µm; ascospores brown, ellipsoid to oblong, transversely 1 septate, locules simple, round, 12.8 – 14.7 × 5.4 – 6.7 µm.

Chemistry: Thallus K+ yellow, C-, KC-, P-. TLC: Atranorin present.

Comments: *Rinodina sophodes* is a most common species in Uttar Pradesh, found growing on variety of trees such as, *Albizia lebbeck, Artocarpus heterophyllus, Citrus* sp., *Ficus benghalensis, Ficus infectoria, Ficus religiosa, Grevellia robusta, Litchi chinensis, Madhuca indica, Mangifera indica, Prosopis juliflora,* and *Shorea robusta.* It characterized by smooth, greyish green thallus, lecanorine apothecia, brown, 1 septate ascospores with simple locules. *R. sophodes* exhibits a lot of variation in morphology in different habitats. The thallus is mostly smooth but become granular to furfuraceous. Sometimes in moist, damp, wet conditions algal mat grows over thallus giving it a sorediate appearance. It is a pollution tolerant lichen species frequently used in pollution monitoring studies in tropical regions of India.

Sphinctrina Fr. (Family: Sphinctrinaceae)

Syst. Orb. Veg.: 120. 1825.

Thallus parasitic or parasymbiotic on other lichens. Apothecia mazaedium, black, sessile or stalked, black. Ascospores rarely 1 septate, spherical to ellipsoid, with a hyaline coat.

World wide 8 species; India 3 species; Literature: Pant & Awasthi 1989.

Key to the species of Sphinctrina

1a. Mazaedium stalked, capitulum pruionose . . . . . *S. anglica*

1b. Mazaedium subsessile, capitulum epruinose . . . . . *S. tubaeformis*

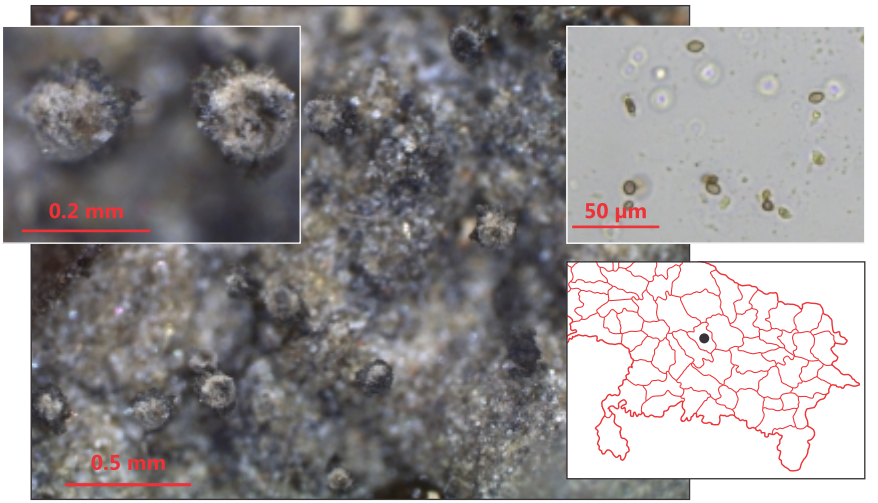
Sphinctrina anglica Nyl.

Sys. Meth. Lich. (Parisiis) 1(2): 143. 1860.

Thallus corticolous, crustose to inconspicuous. Ascomatal stalk, 0.15 – 0.41 mm long, dark grey to black; capitulum round, 0.10 – 015 mm diam., surface white pruinose. Ascospores simple, brown, globose to ovate, with hyaline coat, rarely oblong, 4.1 – 7.1 × 2.9 – 3.3 µm.

Chemistry: Not done.

Comments: *Sphinctrina angelica* is a rare lichen species in Uttar Pradesh, found growing on *Mangifera indica* trees trunks in orchard areas. It is characterized by inconspicuous thallus, stalked, pruinose ascomata (mazaedium) and brown, simple ascospores with hyaline coat which quickly dissolves.

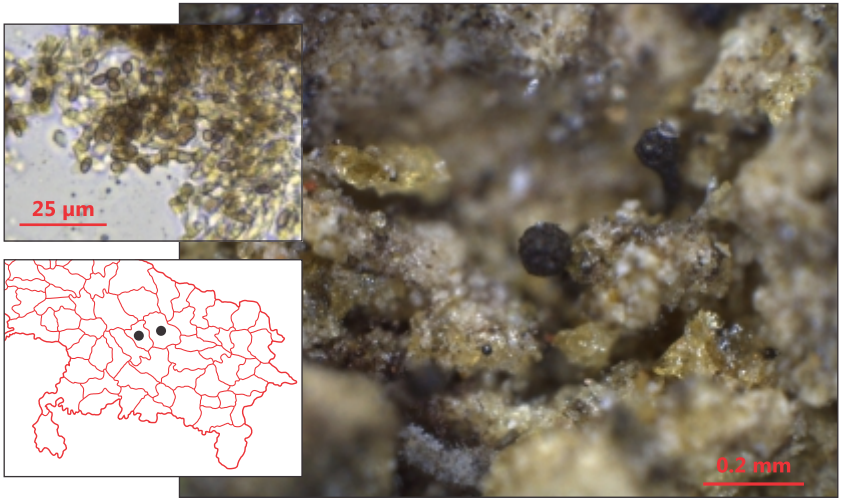


Sphinctrina tubaeformis A. Massal.

Mem. Lichenogr.: 155. 1853.

Thallus corticolous, crustose to inconspicuous, parasitic on other sterile lichens. Ascomata mazaedium, subsessile, stalk short; capitulum round, 0.08 – 0.11 mm diam., epruinose. Ascospores brown, simple, globose to ovate, with hyaline coat, 3.25 – 5.0 × 2.4 – 3.4 µm.

Chemistry: Not done.



Comments: *Sphinctrina tubaeforemis* is a rare lichen species in Uttar Pradesh, found growing on Mangifera indica trees trunks in orchard areas. It is characterized by parasitic, inconspicuous thallus, subsessile ascomata and brown, simple ascospores.

Strigula Fr. (Family: Stereocaulaceae)

Kongl. Vet..Akad. Handl. 1821: 323. 1821.

Thallus crustose, subcuticular, ecorticate, effigurate, lobes distinct or confluent, foliicolous; photobiont *Cephaleuros*. Ascomata perithecia, convex to conical, partially immersed in thallus or totally covered by thallus. Exciple complete or dimidiate; usually differentiated into an outer brown or black involucrellum and an inner brown-black or hyaline wall; paraphyses simple. Asci thin walled, 8 spored; ascospores hyaline, transversely 1 – 3 septate. Pycnidia convex, macro conidia 1 – 7(– 9) septate, filiform or bacillar, micro conidia simple, ellipsoid or fusiform.

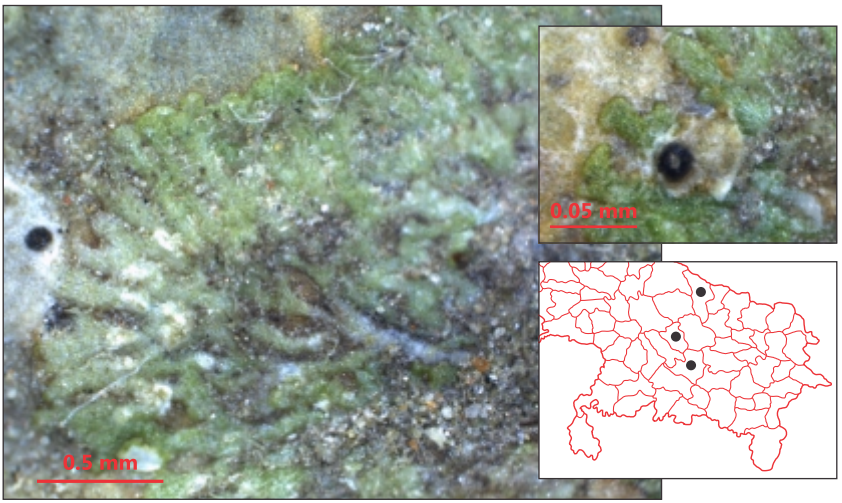
World wide 265 species; India 17 species; Literature: Awasthi 1991.

Strigula smaragdula Fr.

Linnaea 5: 550. 1830.

Thallus epiphyllous, crustose, greenish grey, lobate at margin, lobes 0.1 – 0.2 mm, upper surface with hyaline hairs distributed at the centre of thallus. Perithecia, black, semi-immersed, up to 0.2 mm diam.; ostiole pale. Exciple brown to dark brown.; involucrellum present.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.



Comments: *Strigula smaragdula* is a common lichen species in Uttar Pradesh, found growing on leaves of *Mangifera indica* trees. It is characterized by crustose, greenish grey thallus and blackish perithecia. The species can easily be identified as it forms rounded greenish structures on the upper side of the leaves. The green thallus bear dark black perithecia embedded in it. Most of the samples collected exhibit immature and deformed perithecia.

Thelenella Nyl. (Family: Thelenellaceae)

Mem. Soc. Imp. Sci. Nat. Cherbourg 3: 193. 1855.

Thallus crustose, corticolous, saxicolous or foliicolous, externally covered by an epinecral layer of fungal tissue; photobiont green alga, *Trebouxia*. Ascomata perithecia, singular or grouped, sunken in thallus or verrucae, ostiole erect, dark. Exciple globular to conical, brown-black pigmented; paraphyses branched and anastomosing in upper part; periphyses present near ostiole. Asci bitunicate, not amyloid, 4 – 6 spored; ascospores hyaline or rarely brownish, submuriform to muriform, thin walled.

World wide 33 species; India 3 species; Literature: Mayrhofer 1987.

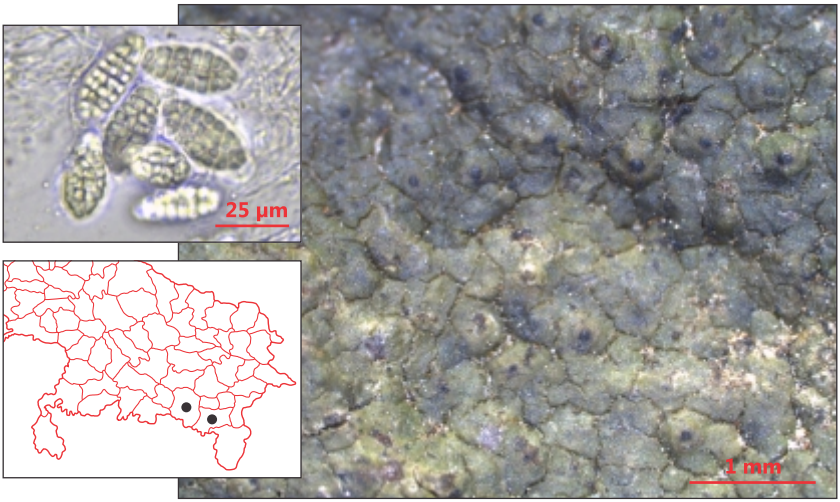
Thelenella luridella (Nyl.) H. Mayrhofer

Biblioth. Lichenol. 26: 45. 1987. – *Verrucaria luridella* Nyl., *Mem. Soc. Acad. Maine Loire* 4: 41. 1858.

Thallus saxicolous, crustose, olive brown to brown, areolate to rimose areolate, smooth; prothallus indistinct. Ascomata perithecia, immersed, completely or partially covered by thallus, 0.2 – 0.5 mm diam.; ostiole indistinct, ostiolar region black. Involucrellum absent; exciple brown at top, hayaline remaing portion, 17 – 25 µm thick; subhymenial disc up to 45 µm high; hamathecium globose, 240 × 206 µm across; paraphyses persistent, branching and anastamosing; periphysoid absent or indistinct. Ascus cylindrical to clavate, 91 – 104 × 21 – 27 µm; ascospores hyaline, muriform, transversely 4 – 7 septate, vertically 1 – 3 septate, ellipsoid to ovate, 21.5 – 31.1 × 10.5 – 13.9 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Thelenella luridella* is a common lichen species in Uttar Pradesh, however ignored because of its inconspicuous thallus and indistinct perithecia. It is is characterized by immersed perithecia, muriform, hyaline ascospores and persistent paraphyses. *T. luridella* earlier reported else where from India (Awasthi 1991) have larger ascospores ranging between 30 – 45 × 12 – 19 µm. The specimens of Uttar Pradesh resembles much to *T. inductula* (Nyl.) H. Mayrhofer, with respect to exciple colour and ascospore size. However, *T. inductula* is a temperate species exhibit its occurrence in S.W. Europe, Macronesia and North America (Mayrhofer, 2002), while *T. luridella* is a



tropical – subtropical species and common in India. Hence, specimen is designated as *T. luridella*, and description provided is a variation of the species.

Thelotrema Ach. (Family: Graphidaceae)

Methodus: 130. 1803.

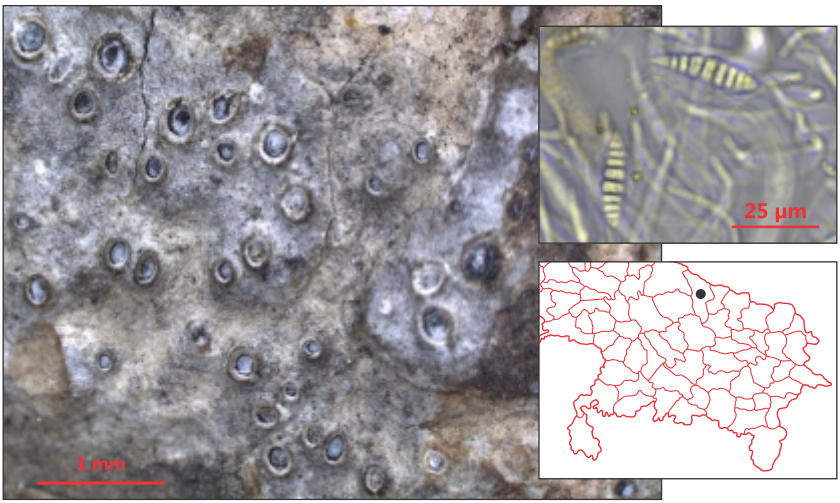
Thallus crustose, epi or endophloeodal, corticolous; photobiont green alga, *Trentepohlia*. Ascomata apothecia immersed to semi-emergent or emergent, thalline wall incurved, erect to recurved. Exciple free or fused, the inner face with short periphyses, pore often broad and gaping. Asci 1 – 8 spored, spores hyaline or brown, transversely septate or muriform, 1+ blue or I-.

World wide 126 species; India 44 species; Literature: Mangold *et al.* 2009.

Thelotrema subtile Tuck.

Amer. J. Sci. Arts, ser. 2, 25: 426. 1858.

Thallus corticolous, crustose, epiphloeodal, ecorticated, whitish grey to grey, smooth, continuous. Ascomata apothecia, appearing as pores from above, round to slightly elongated, solitary, semi-emergent to emergent, 0.4 – 0.8 mm diam.; margin or rim prominent, raised much above the disc, concolours to the thallus; disc exposed, densely white pruinose. Proper exciple, free from thalline exciple, brown, thickened above, thinning laterally, 17 – 59 µm thick; thalline exciple, entire, thickened; epihymenium hyaline to greyish, 8 – 16 µm high; hymenium, hyaline, 137 – 154 µm high; paraphyses simple, straight, parallely arranged, slightly thickened at apex. Asci 4 – 8 spored, 84 – 106 × 9.3 – 16 µm;



ascospores hyaline, brownish at maturity, transversely 8 – 14 septate, fusiform to ovoid, 34.9 – 38.8 × 6.5 – 9.1 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Thelotrema subtile* is a rare lichen species in Uttar Pradesh found growing on tree trunk in moist deciduous forest. It can be easily distinguishable by its occellularioid, pored apothecia and transversely septate hyaline ascospores.

Thyrea A. Massal. (Family: Lichinaceae)

Sched. Crit.: 75. 1856.

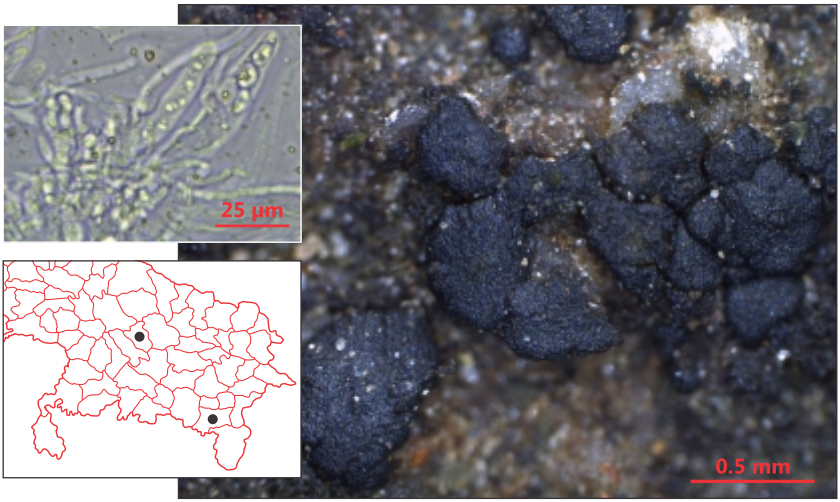
Thallus mostly on calcareous rocks, umbilicate, monophyllous, discoid, incised, homoiomerous, ecorticated, hyphae reticulately arranged forming a pseudoparenchymatous structure; lobes wide or narrow; photobiont cyanobacteria, *Gloecapsa*. Ascomata pycnoascocarp, immersed to adnate, discoid, lecanorine. Paraphyses branched, anastomosing. Asci 8 – 24 spored; spores hyaline, ellipsoid, simple.

World wide 23 species; India 1 species; Literature: Moreno & Egea 1992.

Thyrea plectospora Massal.

Sched. Crit. 4: 75. 1856.

Thallus saxicolous, squamulose, in rosettes, up to 3 mm in diameter, weakly lobed, surface irregular, brown to dark-olive to black; squamules attached to the substrate by a central umbilicus. Thallus heteromerous consisting of



hyphae arranged in a loose network, photobiont a *Gloecapsa*. Ascomata pycnoascocarps, immersed, with the punctate disc up to 0.3 mm in diameter, reddish brown and concave. Exciple thin, gelatinous; hamathecium hyaline; paraphyses thin, septate and anastomosing. Asci 8 spored, cylindrical to clavate, up to 57 × 11 µm; ascospores simple, hyaline, globose to broadly ellipsoid, 9 – 14 × 6 – 7 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Thyrea plectospora* is a common cyanolichen species of Uttar Pradesh, found growing on rock in exposed areas and lime plasters of old monuments. It is characterized by dark olive brown to black, umbilicate, squamulose thallus, pycnoascocarp with simple, hyaline, globose ascospores. It is a new record for India, earlier known from Southern Europe (France, Italy) (Moreno & Egea 1992).

Verrucaria Schrader (Family: Verrucariaceae)

Spic. Fl. Germ.: 108. 1794.

Thallus crustose, usually saxicolous; photobiont a green alga. Ascomata perithecia, immersed or sessile, globose, subglobose or hemispherical. Exciple hyaline or black, often with an involucrellum, ostiole vertically straight; paraphyses becoming gelatinized. Asci 8 spored; ascospores hyaline, simple, ellipsoid to ovoid.

World wide 500 species; India 10 species; Literature: Awasthi, 1991.

Key to the species of *Verrucaria*

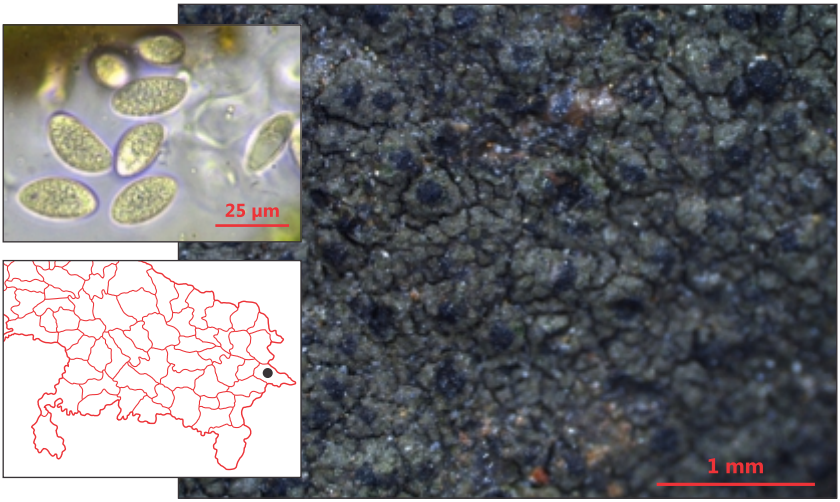
1a. Involucrellum distinct, thallus greenish brown . . . . . *V. margacea*

1b. Involucrellum absent, thallus brown . . . . . *V. pinguicula*

Verrucaria margacea (Wahlenb.) Wahlenb.

Fl. Lappon.: 465. 1812. – *Thelotrema margaceum* Wahlenb. in Ach., *Methodus Suppl.*: 30. 1803.

Thallus saxicolous, crustose, 0.5 – 1.5 cm across, greenish brown or olive brown, areolate, areoles round to angular, 0.15 – 0.38 mm diam.; prothallus absent. Ascomata perithecia, sunken to emergent, black, flat to hemispherical, 0.13 – 0.15 mm diam.; ostiole indistinct or pale. Involucrellum present, incomplete, running up to the base of perithecia, slightly laterally spreading and thickening, sometimes separating from exciple, 36 – 60 µm thick; exciple thin, pale brown to brown throughout or paler towards base, 19 – 22 µm thick; hamathecium lacking paraphyses and algal cells, oil globules present; periphyses present towards ostiolar canal. Ascus 8 spored, clavate, 76 – 78 × 25 – 31 µm; ascospores broadly ellipsoid to ovoid, hyaline, simple, cell contents sometimes appearing granular, 62.2 – 70.6 × 42.8 – 31.3 µm.

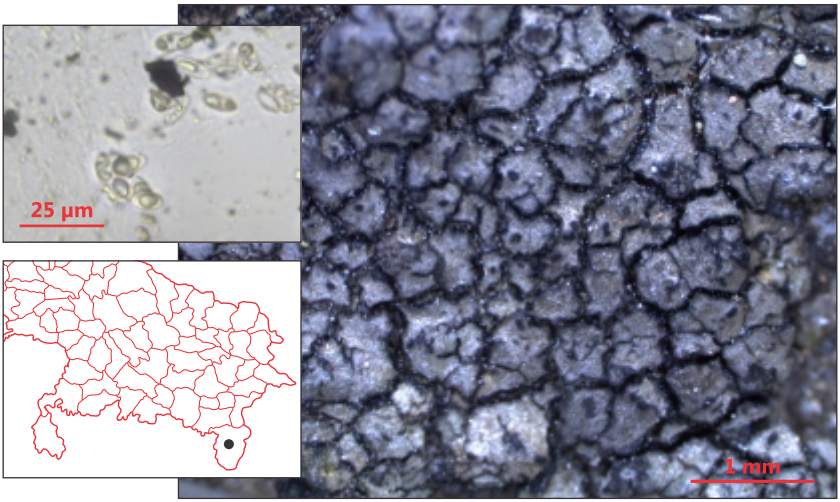


Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Verrucaria margacea* is a rare lichen species in Uttar Pradesh, found growing on rocks in moist places. It is characterized by olive brown thallus, sunken perithecia with distinct involucrellum, simple, hyaline ascospores.

Verrucaria pinguicula (Nyl.) Massal.

Lotos 6: 80. 1856. – *Verrucaria plumbea* var. *pinguicula* Nyl., *Mem. Soc. Imp. Sci. Nat. Cherbourg* 5: 137. 1857.



Thallus saxicolous, crustose, rimose areolate, grey brown to brown. Ascomata perithecia, frequent, mostly solitary, rarely 2 per areole, immersed; ostiole black, sunken to semi-emergent. Involucrellum absent; exciple brown, complete, broader at apex, 27 – 55 µm thick; hamathecium hyaline, conical to globose, 138 – 140 µm across. Ascus 8 spored, clavate, up to 62 × 12 µm; ascospores hyaline, ellipsoid to ovoid, simple, 10.4 – 12.9 × 4.6 – 7.0 µm.

Chemistry: Thallus K-, C-, KC-, P-. TLC: No chemicals detected.

Comments: *Verrucaria pinguicula* is a rare lichen species in Uttar Pradesh, found growing on exposed rocks. It is characterized by rimose areolate, brownish thallus, immersed perithecia that lacks Involucrellum, but has hyaline, ovoid, simple ascospores.

References

1. Acharius, E. 1810. *Lichenographia Universalis.* Danckwerts, Göttingen.
2. Acharius, E. 1814. *Synopsis Methodica Lichenum*. Svanborg et Sco., Lundae.
3. Akhtar, P. & Awasthi, D.D. 1980. The lichen genus *Collema* in India. *Biol. Mem*. 5(1): 13-29.
4. Aptroot, A. 1998. New lichens and lichen records from Papua New Guinea, with the description of *Crustospathula*, a new genus in the Bacidiaceae. *Tropical Bryology* 14: 25-34.
5. Aptroot, A. 2002. New and interesting lichens and lichenicolous fungi in Brazil. *Fungal Diversity* 9: 15-45.
6. Archer, A.W. 1997. *The lichen genus Pertusaria in Australia.* Biblioth. Lichenol., 69, J. Cramer, Berlin, Stuttgart.
7. Awasthi, D.D. & Mathur, R. 1987. Species of the lichen genera *Bacidia, Badimia, Fellhanera* and *Mycobilimbia* from India. *Proceedings of the Indian Academy of Sciences* (Plant Sciences) 97(6): 481-503.
8. Awasthi, D. D. & Singh, K.P. 1977. Additions to the lichen flora of India-IV. *Geophytology* 7: 276-277.
9. Awasthi, D.D. 1965. *Catalogue of Lichens from India*, Nepal, Pakistan, and Ceylon. Beihefte zur Nova Hedwigia, Heft 17. Verlag von J. Cramer, Weinheim.
10. Awasthi, D. D. 1975. *A monograph of the lichen genus Dirinaria*. Biblioth. Lichenol. 2: 1-108.
11. Awasthi, D.D. 1980. *Pyxine* in India. *Phytomorphology* 30: 359-379.
12. Awasthi, D.D. 1988. A key to the macrolichens of India and Nepal. *J. Hattori Bot. Lab.* 65: 207-302.
13. Awasthi, D.D. 1991. *A Key to the Microlichens of India, Nepal and Sri Lanka.* Biblioth. Lichenol., Bd. 40, J. Cramer, Berlin, Stuttgart.
14. Awasthi, D.D. 2000. *Lichenology in Indian Subcontinent - A Supplement to "A Handbook of Lichens"*. Bishen Singh Mahendra Pal Singh, Dehra Dun.
15. Awasthi, D. D. 2007. *A Compendium of the Macrolichens from India*, Nepal and Sri Lanka. Bishen Singh Mahendrapal Singh, Dehradun.
16. Awasthi, D.D. & Srivastava, P. 1989. Lichen genera *Brigantiaea* and *Letrouitia* from India. *Proc. Indian Acad. Sci.*, Pl. Sci. 99(3): 165-177.
17. Ayub, A. 2005. *Lichen Flora of Some Major Historical Monuments and Buildings of Uttar Pradesh.* Dept. of Botany, Dr. R.M.L Avadh Univeristy, Faizabad (Ph.D. Thesis).
18. Bajpai, R., Upreti, D.K. & Nayaka, S. 2010a. Accumulation of arsenic and fluoride in lichen *Pyxine cocoes* (Sw.) Nyl., growing in the vicinity of coal based thermal power plant at Raebareli, India. *J. Expt.* Sci. 1(4): 37-40.
19. Bajpai, R., Upreti, D.K., Nayaka, S. & Kumari, B. 2010b. Biodiversity, bioaccumulation and physiological changes in lichens growing in the vicinity of coal-based thermal power plant of Raebareli district, north India. *J. Hazardous Material* 174: 429-436.
20. Bajpai. R., Upreti, D.K., Pandey, V. & Mishra, S.K. 2004. Pollution monitoring with the help of lichen transplant technique in some residential sites of Lucknow City. *J. Environ.*

Biol. 22(2): 191-195.

21. Bélanger, M.C. 1834-38. *Voyage aux Indes* Orientales. *Années 1825-29*. Botanique, II. partie, Cryptogamie par Ch. Bélanger et Bory de St. Vincent. Paris. Pp. 113-144.

22. Büdel, B. 1987. *Zur Biologie und Systematik der Flechtengattung* Heppia *und* Peltula *im sudlichen Afrika*. Bibliotheca Lichenologica No. 23, J. Cramer, Berlin and Stuttgart.

23. Büdel, B., Rauhut, A. & Schultz, M. 2007. *Peltula*. *In Lichen Flora of the Greater Sonoran Desert Region. 3* (Eds. T.H. Nash, III, C. Gries & F. Bungartz). Lichens Unlimited, Arizona State University, Tempe. Pp. 388-389.

24. Cavalier-Smith, T. 2004. Only six Kingdoms of life. *Proc. R. Soc. Lond.* B 271: 1251-62.

25. Chatterjee, S., Sinha, G.P., Upreti, D.K. & Singh, A. 1996. Preliminary observation on lichens growing over some Indian monuments. *Flora & Fauna* 2(1): 1-4.

26. Chopra, G.L. 1934. *Lichens of the Himalayas, pt. I. Lichens of Darjeeling and Sikkim Himalayas.* Punjab University, Lahore.

27. Divakar, P.K. & Upreti, D.K. 2005. *Parmelioid Lichens in India (A Revisionary Study)*. Bishen Singh Mahrendra Pal Singh, Dehradun.

28. Dubey, A.N., Pandey, V., Upreti, D.K. & Singh J. 1999. Accumulation of lead by lichens growing in and around Faizabad, U.P., India. *J. Environ. Biol.* 20(3): 223-225.

29. Elix, J.A. & Stocker-Wörgötter, E.2008. Biochemistry and secondary metabolites. In *Lichen Biology. Second Edition* (Ed. T.H. Nash, III). Cambridge University Press, Cambridge. Pp. 104-133.

30. Fries, E.M. 1825. *Systema Orbis Vegetabilis*. Lundae.

31. Ertz, D. 2009. *Revision of the Corticolous Opegrapha Species from the Paleotropics*. Biblioth. Lichenol. No. 102. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, Berlin and Stuttgart.

32. Gauniyal, A.K. 2005. *Morpho-Taxonomic Studies on Pyrenocarpous Lichens of India.* Dept. of Botany, Dr. R.M.L Avadh Univeristy, Faizabad (Ph.D. Thesis).

33. Joshi, S., Upreti, D. K. & Nayaka, S. 2012. The lichen genus *Chapsa* (Graphidaceae) in India. *Mycotaxon* 120 (11): 23-33.

34. Joshi, Y. 2008. *Morphotaxonomic Studies on Lichen Family Teloschistaceae from India.* Dept. of Botany, University of Kumaun, Nainital (Ph.D. Thesis).

35. Joshi, Y. & Upreti, D.K. 2007. New species and new records of the lichen genus *Caloplaca* from India. *Lichenologist* 39(6): 505-508.

36. Joshi, Y. & Upreti, D.K. 2008. Sorediate and isidiate species of the lichen genus *Caloplaca* (Ascomycetes, Teloschistaceae) from India. *Nova Hedwigia* 86(1-2): 259-272.

37. Kalb, K. 1988. *Lichenes Neotropici.* Fascikel X (No. 401-450). Schedae, Neumarkt.

38. Kalb, K. 2001. *New or otherwise interesting lichens.* I. In: McCarthy PM, Kantvilas G, Louwhoff SHJJ (Eds). Biblioth. Lichenol. 78:141-167.

39. Kalb, K., Staiger, B. Elix, J.A. 2004: A monograph of the lichen genus *Diorygma* - a first attempt. *Symbolae Botanicae Upsalienses* 34(1): 133-181.

40. Khare, R., Rai, H., Upreti, D.K. & Gupta, R.K. 213. The cyanolichen genera *Peltula* and *Phyllopeltula* (Lichinales, Peltulaceae) in India. *Bangladesh Journal of Plant Taxonomy* (In press).

41. Lendemer, J.C. & Knudsen, K. 2011. Studies in lichens and lichenicolous fungi: 7. More notes on taxa from North America. *Mycotaxon* 115: 45-52.

42. Lücking, R. 1999. Ecology of foliicolous lichens at the 'Botarrama' trail (Costa Rica), a neotropical rainforest. IV. Species associations, their salient features and their dependence on environmental variables. *Lichenologist* 31(3): 269-289.

43. Lücking, R. 2009. The taxonomy of the genus *Graphis* sensu Staiger (Ascomycota: Ostropales: Graphidaceae). *Lichenologist* 41(4): 319-362.

44. Lücking, R., Archer, A. W. & Aptroot, A. 2009. A world-wide key to the genus *Graphis* (Ostropales: Graphidaceae). *Lichenologist* 41(4): 363-452.

45. Lücking, R. & Matzer, M. 2001. High foliicolous lichen alpha-diversity on individual leaves in Costa Rica and Amazonian Ecuador. *Biodiversity and Conservation* 10: 2139-2152.

46. Lumbsch, H.T. 1994. Die *Lecanora* subfusca-Gruppe in Australasien. *J. Hattori Bot. Lab.*77: 1-175.

47. Lumbsch, H.T. & Huhndorf, S.M. (ed.) 2007. Outline of Ascomycota - 2007. *Myconet* 13: 1 - 58.

48. Mangold, A., Elix, J. A. & Lumbsch, H. T. 2009. *Thelotremataceae. In Flora of Australia Volume 57. Lichens 5* (Ed. P. M. McCarthy). ABRS and CSIRO Publishing, Canberra and Melbourne. Pp. 195-420.

49. Marbach, B. 2000. *Corticole und lignicole Arten der Flechtengattung Buellia sensu lato in den Subtropen und Tropen.* Biblioth. Lichenol., 74, J. Cramer, Berlin, Stuttgart.

50. Mayrhofer, H. 1987. *Monographie der Flechtengattung Thelenella.* Biblioth. Lichenol. 26: 1-106.

51. Mayrhofer, H. 2002. *Thelenella*. In *Lichen Flora of the Greater Sonoran Desert Region. I* (Eds. T.H. Nash III, B.D. Ryan, C. Gries & F. Bungartz). Lichens Unlimited, Arizona State University, Tempe, Arizona. Pp. 479-481.

52. Mishra, S.K., Upreti, D.K., Pandey, V. & Bajpai, R. 2003. Pollution monitoring with the help of lichen transplant technique in some commercial and industrial areas of Lucknow city. *Pollut.* Res. 22(2): 221-225.

53. Moreno, P. P., & Egea J. M. 1992. Estudios sobre el complejo *Anema-Thyrea-Peccania* en el sureste dc *España* y norte de Africa. *Acta Bot. Barcinonensia* 41: 1-66.

54. Nayaka, S. 2004. *Revisionary Studies on Lichen Genus Lecanora Sensu Lato in India.* Dept. of Botany, Dr. R.M.L Avadh Univeristy, Faizabad (Ph.D. Thesis).

55. Nayaka, S., Upreti, D.K. & Khare, R. 2010. Medicinal lichens of India. In *Drugs from Plants* (Ed. P.C. Trivedi). Avishkar Publishers Distributors, Jaipur. Pp. 1-38.

56. Nayaka, S. & Upreti, D.K. 2011. An inventory of lichens in Uttar Pradesh through bibliographic compilation. In *National Conference on Forest Biodiversity: Earth's Living Treasure*. Uttar Pradesh State Biodiversity Board, Lucknow. Pp. 24-35.

57. Nayaka, S., Upreti, D.K. & Khare, R. 2011. Diversity and distribution of lichens in Katarniaghat Wildlife Sanctuary, Uttar Pradesh. *J. Indian Bot. Soc.*90 (3 & 4) : 360-366.

58. Pant, G. & Upreti, D.K. 1993. The lichen genus *Diploschistes* in India and Nepal. *Lichenologist* 25(1): 33-50.

59. Pant, G. & Awasthi, D.D. 1989. *Caliciales* from India and Nepal. *Biovigyanam* 15(1): 3-27.

60. Quraishi, A.A. 1928. *Lichens of Western Himalayas.* Proc. 15th Indian Sci. Congr. Abstracts.

61. Saag, L., Saag, A. & Randlane, T. 2009. World survey of the genus *Lepraria* (Stereocaulaceae, lichenized Ascomycota). *Lichenologist* 41(1): 25-60.

62. Satya & Upreti, D.K. 2009. Correlation among carbon, nitrogen, sulphur and physiological parameters of *Rinodina sophodes* found at Kanpur city, India. *J. Hazardous Material* 169 (1-3): 1088-1092.

63. Satya, Upreti, D.K. & Patel, D.K. 2011. *Rinodina sophodes* (Ach.) Massal.: a

bioaccumulator of polycyclic aromatic hydrocarbons (PAHs) in Kanpur City, India. Environ. *Monit. Assess* (DOI 10.1007/s10661-011-1962-5)

64. Saxena, S. 2004. *Lichen Flora of Lucknow district with Reference to Air Pollution Studies in the Area.* Dept. of Botany, Lucknow Univeristy, Lucknow (Ph.D. Thesis).

65. Saxena, S., Upreti, D.K. & Sharma, N. 2003. Distribution of lichens in surroundings of Lucknow city, Uttar Pradesh, India. In *Proc. 90th Indian Science Congress Part III*. Bangalore (Abstract).

66. Saxena, S., Upreti, D.K. & Sharma, N. 2007. Heavy metal accumulation in lichens growing in north side of Lucknow City, India. *J. Environ. Biol.* 28(1): 49-51.

67. Saxena, S., Upreti, D.K., Singh, A. & Singh, K.P. 2004. Observation on lichens growing on artifacts in the Indian Subcontinent. In *Biodeterioration of Stone Surface* (Eds. L.L. St. Clair & M.R.D. Seaward), Kluwer Academic Publishers, London. Pp. 181-193.

68. Schultz, M. 2005. An Overview of *Lichinella* in the Southwestern United States and Northwestern Mexico, and the New Species Lichinella *granulose. Bryologist* 108(4): 567-590.

69. Schultz, M. 2007. Pyrenopsis. In: T. H. Nash, III, C. Gries & F. Bungartz: *Lichen Flora of the Greater Sonoran Desert Region. Volume 3.* Lichens Unlimited, Arizona State University, Tempe, pp. 286-287.

70. Sharma, B. & Khadilkar, P. 2012. Four new species of *Diorygma* in India. *Mycotaxon* 119 (10): 1-10.

71. Sharma, B., Khadilkar, P. & Makhija, U. 2012. New species and new combinations in the lichen genera *Fissurina* and *Hemithecium* from India. *Lichenologist* 44:339-362.

72. Singh, A. 1964. Lichens of India. *Bull. Natl. Bot. Gard.* Lucknow. 93: 1-356.

73. Singh, A. 1980. *Lichenology in Indian Subcontinent 1966-1977.* Economic Botany Information Service, National Botanical Research Institute, Lucknow.

74. Singh, A. & Upreti, D. K. 1984. The lichen genus *Endocarpon* from India. *Candollea* 39: 539-548.

75. Singh, A. & Upreti, D. K. 1991. Lichen flora of Lucknow with special reference to its historical monuments: In *Biodeterioration of Cultural Property* (Eds. O. P. Agarwal & S. Dhawan). MacMillan India Ltd., New Delhi. Pp. 219-231.

76. Singh, K.P. 1981. Microlichens from Manipur, India. *Geophytology* 11(2): 242-256.

77. Singh, K.P. & Sinha, G.P. 1997. Lichens. In *Floristic diversity and conservation strategies in India*. Vol.1. *Cryptogams and Gymnosperms* (Eds. V. Mudugal & P.K. Hajara). Botanical Survey of India, Ministry of Environment and Forest, Govt. of India. Pp 195-234.

78. Singh, K.P. & Sinha, G.P. 2010. *Indian Lichens an Annotated Checklist.* Botanical Survey of India. Kolkata.

79. Srivastava, S.K. 2004. Floristic diversity in Uttar Pradesh - an overview. *J. Econ. Taxon.* Bot. 28(2): 292-334.

80. Staiger, B. 2002. *Die Flechtenfamilie Graphidaceae. Studien in Richtung einer natürlicheren Gliederung.* Biblioth. Lichenol., 85, J. Cramer, Berlin, Stuttgart.

81. Upreti, D.K. 1988. A new species of lichen genus *Phylliscum* from India. *Current Scence.* 57(16): 906-907.

82. Upreti, D.K. 1997. Notes on corticolous K+ yellow species of *Lecanora* in India. *Feddes Repert.* 108(3-4): 185-203.

83. Upreti, D.K. 1994. Notes on corticolous and saxicolous species of *Porina* from India, with *Porina subhibernica* sp. nov. *Bryologist* 97(1): 73-79.

84. Upreti, D. K. 1998. A key to the lichen genus *Pyrenula* from India, with nomenclatural notes. *Nova Hedwigia* 66 (3-4): 557-576.

85. Upreti D.K. 2005. Lichens in the changed environment of Lucknow. *Environews* 11 (1): 9.

86. Upreti, D.K. & Bajpai, A. 2001. *Pollution monitoring with the help of lichen transplant technique in Lucknow city.* In *2nd International Conference on Plants and Environmental Pollution (ICPEP-2).* NBRI, Lucknow (Abstract).

87. Upreti, D.K. & Büdel, B. 1990. The lichen genera *Heppia* and *Peltula* in India. *J. Hattori Bot. Lab.* 68: 274-284.

88. Upreti, D.K., Joshi, Y. & Bajpai, R. 2010. New records of lichens growing on monuments of Central India. *Geophytology* 38(1-2): 37-40.

89. Upreti, D.K. & Nayaka, S. 2006. *Anisomeridium calciccolum* sp. nov. and further new records of pyrenocarpous lichens from India. *Lichenologist* 38: 231-233.

90. Upreti, D.K. & Pant, G. 1993. Notes on *Arthopyrenia* species from India. *Bryologist* 96(2): 226-232.

91. Upreti, D.K., Yadav, V. & Nayaka, S. 2002. A note on lichens from environs of Lucknow district, U.P. India. In *Proc. 89th Indian Science Congress.* Lucknow University, Lucknow (Abstract).

91. Upreti, D.K., Divakar, P.K. & Nayaka, S. 2005. Commercial and ethnic use of lichens in India. *Economic Botany* 59(3): 269-273.

92. Walker, F. J. & James, W. 1980. A revised guide and microchemical techniques for the identification of lichen substances. *Bull. Brit. Lich. Soc.* 46: 13-29 (suppl.).

93. Wetmore, C.M. 1970. The lichen family Heppiaceae in North America. *Annales of Moussorie Botanical Garden* 57: 158-209.

Glossary

acicular: needle-shape; one end broad and other one tapering

adnate: closely attached, adpressed; used for the attachment of ascomata to thallus, or thallus to substratum

anastomosing: a joining together to form a net

apices: the growing point or tip

apothecium (pl. **apothecia**): a cup or soccer like ascom/fruiting body

areole: an angular, small portions of a crustose thallus separated from fine cracks

articulate: jointed like bones

ascoma (pl. **ascomata**): any asci containing structure; perithecia, apothecia, mazaedium

ascospores: reproductive spore formed within an ascus

ascus (pl. **asci**): cylindrical or clavate sac with ascospores

bacillar: rod-shaped

bacilliform: cylindrical with rounded ends, Bacillus like

biatorine: apothecial margin pale or coloured (other than dark brown or bak) and lacking algal cells

biseriate: in two rows

bitunicate: with two functional wall layers

byssoid: made up of delicate threads, cotton-like

capitate: head like, globular mass

carbonaceous: black

cartilaginous: consisting of a fine, dense, sometimes elastic tissue

chroodiscoid: like Chroodiscus where apothecia is immersed in the thallus but erumpent, margin formed by the recurved lobes of the ruptured tissue which originally covers the apothecia

cilium (pl. **cilia**): hair like structure on margin of lobes

clavate: club-like

coalescing: joining together

concave: hallowed out or basin like

concolours: of the same colour

confluent: blending or running together

convex: equally rounded or broadly obtuse

coralloid: coral like often brittle (usually of isidia)

cortex: the outermost layer of the thallus which, if present consists of compacted hyphae which may appear as either fibrous or cellular

corticolous: growing over barks

crateriform: cup or crate-like in form

crustose: crust-like, used for lichens having the thallus stretching over and finally fixed to the substratum by the whole of their lower surface, such thalli generally lack rhizines and a lower cortex

effigurate: having a definite form or figure like, especially towards margin

effuse: stretched out flat, especially as a spreading growth without a distinct margin

ellipsoid: elliptical in optical section (of spores)

endophloeodal: immersed in bark

epiphloeodal: on bark

epihymenium: upper part of hymenium, consisting of apices of the paraphyses embedded in a gelatinous substance which is often colored

epruinose: without pruina

euparaplectenchymatous: thick tissue with isodimertric lumina or cells

euthyplectenchymatous: thick tissue without cellular structure

exciple: tissue forming the margins or walls of an ascoma

farinose: like flour; fine powder

fawn: light brown colour

filiform: thread like; worm like

fissitunicate: ascus discharge involving the separation of wall layers

fissured: cracked, split

flexuous: wavy

foliicolous: growing over leaves

foliose: type of thallus with dorsiventral, more or less leaf like appearance, mostly having rhizines on lower surface

furcate: forked, split in two

fruticose: bush like; thallus attached at one point and remaining parts either erect or hanging; usually circular or angular in cross section

fusiform: spindle-like: narrowing towards the ends

globose: a spherical or almost so

glossy: smooth or shine

halonate: surrounded by an outer circle (of spores)

hamathecium: a neutral term for all kinds of hyphae or the other tissues between asci, or projecting into the locule or ostiole of an ascoma (of mostly perithecia)

hapter: attachment organ - it consist of closely or loosely packed rhizinae which usually occur as protuberances on lower surface.

homoiomerous: having mycobiont and photobiont components intermixed throughout thallus

hyaline: ± transparent or colourless

hymenium: the layer of tissue in which asci arise

hypothecium: the tissue below the hymenium and generative layer

imbricate: overlapping

immarginate: without a margin or well-defined edge

inconspicuous: not clearly visible

innate: immersed

involucrellum: tissue of upper part of perithecia (often pigmented)

isidium (pl. **isidia**): a corticated, photobiont containing protuberance or outgrowth of the cortex which may be warty, cylindrical, clavate, scale-like, **coralloid**, simple or branched

laminal: on the upper surface of the thallus

lecideine: lacking photobiont cells in exciple, usually dark brown to black in colour

lecanorine: like in case of Lecanora, with photobiont cells in exciple; thalline exciple

lignicolous: on dead barks

lirellae: modified apothecia, with a long narrow disc often branching or ± stellate (of family Graphidaceae and genus Opegrapha)

lobate: thallus divided into lobes

lobe: a rounded segment of a divided or incised thallus

lobulate: having small lobes

lobules: small lobes forming from the margin or upper surface of larger lobes

locule: cell or cavity (of ascospore)

matt: with a dull surface

mealy: pale in colour

microconidium (pl. microconidia): the smallest conidium in a species with two or more conidia types

mischoblastiomorphic: characteristic shape of ascospore locules due uneven thickening of walls

moniliform: bead like

muriform: divided by transverse and vertical or oblique cross walls

oblong: twice as long as wide and with rounded or truncate ends, margins parallel

obtuse: rounded or blunt

obviate: remove

ostiole: the opening of perithecia or perithecioid apothecia or pycnidia

paraphysis (pl. **paraphyses**): a slender, jointed, sterile filaments growing upwards in between asci

paraplectenchymatous: tissue composed of isodiametric cells

pedicellate: stalked

periphysoids: short interascal filaments growing down from the top of a perithecia or perithecioid apothecia

perithecia: a subglobose or flask like ascoma in which opens by pore called ostiole

placodioid: of a thallus, crustose at the centre and lobulate at the periphery, lacking rhizines on lower side

placodiomorphic: characteristic locule shape in ascospores formed due to uneven wall thickenings

plicate: folded or plates like

polaribilocular: (of ascospores) two-celled, the two lumina separated by a thick septum through which a narrow canal passes; locules appearing like two poles; domble shaped

prosoplectenchymatous: tissue with thick-walled hyphae having very minute lumina

prothallus: initial structure of hypahe without algae from which a lichenized thallus develops, often visible along the edge of the thallus or areoles

protuberance: state of protruding, extend beyond

pruina: a frost-like or flour like deposition on thallus and apothecial disc

pruinose: with pruina

pulverulent: powdery, dusty

pustules: a pimple or blister like swelling, often eroding

pycnidium (pl. **pycnidia**): ± flask-shaped, small sterile spore (conidia) producing structure

pycnoconidium: sterile spores produced in a pycnidium

rammicolous: growing over twigs

reniform: kidney-like

rhizines: small root like structures on lower surface

rimose: finely cracked

saxicolous: growing over rocks

scurfy: flaky thallus surface

sessile: not stalked, attached directly to thallus surface (usually of apothecia)

soredium (pl. **soredia**): granular, loose, ecorticate structures arising from thallus, composed of photobiont cells and fungal hyphae; having the appearance of a powdery granule and capable of reproducing a lichen thallus; a vegetative propagules

sparingly: moderate

squamules: small scale-like structures with dorsiventral part attached to the substrate or to the thallus

squamulose: with squamules

stellate: star-like

sterile: not producing sexual spores (ascospores) or ascomata

stipitate: stalked

striate: (dark) lined or differentiated in to grooves or edges

stroma: mass or matrix of vegetative hyphae (usually black) with or without tissue of the host or substrate

sulcate: grooved

teretiform: circular in transverse section, either narrowly cylindrical or tapering

terricolous: growing over the soil

thallus: the vegetative body; plant body that is not differentiated in to root, stem or leaf

umbilicus: a protuberance at the centre, often the point of attachment e.g. Umbilicaria

unitunicate: with one layer (of an ascus which has no inner wall)

uniseriate: in one row or line

urceolate: cup-shaped, urn-shaped, concave, hollow

verrucose: rough, wart like

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About the Authors

Dr. Sanjeeva Nayaka is Principal Scientist at Lichenology Laboratory, CSIR-National Botanical Research Institute, Lucknow and has more than 12 years of research experience in various aspects of Lichenology. Dr. Nayaka has obtained Ph.D. degree from Dr. RML Avadh University, Faizabad, under the supervision of Dr. D. K. Upreti for his thesis on 'Revisionary studies of lichen genus *Lecanora* from India'. Dr. Nayaka has widely travelled across India for exploration of lichens and visited Antarctica twice for carrying out floristic and physiological studies. Dr. Nayaka has discovered a total of 20 new species of lichens and reported 40 new distributional records to India. To his credit Dr. Nayaka has one book and about 100 research publications in peer reviewed journals.

Dr. D. K. Upreti is Chief Scientist at Lichenology Laboratory, CSIR-National Botanical Research Institute, Lucknow and has more than 30 years of research experience in the field of Lichenology. Dr. Upreti has done his doctoral research work under the able guidance of Dr. D.D. Awasthi, FNA and 'The Father of Indian Lichenology' at Lucknow University. Dr. Upreti is a leading Lichenologist of India who has guided more than 25 Ph.D. students and published about 200 research papers on various aspects of Indian lichens. Dr. Upreti is a recognized guide and examiner to several Universities in India including Lucknow University, B. B. Ambedkar University, Dr. R. M. L. Avadh University, Kumaon University, H. N. B. Garhwal University, Assam University, Jammu University, and Chatrapati Sahuji Maharaj University. Dr. Upreti has so far described about 100 new species and more than 200 new records for India lichen mycota. Dr. Upreti is a winner of several prestigious awards including Prof. B. A. Razi Medal of Association for Plant Taxonomy for his outstanding studies on Indian lichens.