

MACROLICHENS OF SIKKIM



G. P. SINHA & K. P. SINGH

BOTANICAL SURVEY OF INDIA
Ministry of Environment & Forests

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Date of Publication : December, 2005

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ISBN : 81-8177-011-0

Price : Rs. 1080.00/- \$ 115.00

Cover Photo : *Evernia mesomorpha* Nyl.

Back Photo: *Heterodermia himalayensis* (Awasthi) Awasthi

FOREWORD


Lichens, the most remarkable and successful alliances in nature, are one of the important components of biological diversity. Lichens with cyanobacterial symbionts contribute significantly to nitrogen fixation. Besides their economic value as food, fodder, dyes, perfumes and medicine, lichens are also used as indicators of health of forest ecosystem, air pollution and in dating of rocks. To facilitate future researches in the field of lichen ecology, eco-physiology, pollution studies, conservation, etc., lichen taxonomy is identified as one of the thrust areas to work out in India. About 2180 species are known to be distributed on various substrata in different climatic regions of India. But state-wise statistics based on exhaustive explorations is not available.

Botanical Survey of India, the premier organization in the field of taxonomy and floristic studies, has taken a lead to explore and document the lichen diversity of the country. The Lichen Flora of Nagaland, published by same authors was the first major step in this direction. The present effort is a further contribution in this endeavour.

Macrolichens of Sikkim is an outcome of extensive collections of lichens and critical laboratory investigations on their taxonomy by the authors over a period of 9 years. The documentation of 320 species, distributed under 72 genera with many colour photographs from the state of Sikkim is a significant contribution to Indian lichenology.

It is hoped that the present contribution would adequately serve the need of researchers, academicians, bioresource managers as well as nature lovers.

I congratulate the authors for this successful endeavour.



(M. Sanjappa)
Director
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ACKNOWLEDGEMENTS

The authors express their sincere gratitude to Dr. P.K. Hajra and Dr. N.P. Singh former Directors, Botanical Survey of India for their encouragement and advice and to Dr. M. Sanjappa, present Director, Botanical Survey of India for encouragement, facilities during the final stages of work and providing a foreword for the same. This work would not have been possible without the constant encouragement of Dr. A.S. Chauhan, former Joint Director, Sikkim Himalayan Circle, Botanical Survey of India, Gangtok who provided all possible help to establish a new lichen herbarium.

We express our thanks to Dr. D.D. Awasthi, F.N.A., for going through the manuscript and offering his critical suggestions; to Dr. D.K. Singh, Joint Director, Botanical Survey of India, Kolkata for his advice from time to time; to Dr. Paramjit Singh, Scientist D & Incharge, Publications, Botanical Survey of India, Kolkata for providing his lichen specimens collected from Tamsey and Varshey areas of Sikkim during his stay at Gangtok; to Dr. D.K. Upreti and his co-workers, Lucknow, Dr. T.L. Esslinger, North Dakota, U.S.A., Dr. J.A. Elix, Australia, Dr. T. Ahti, Finland for their help in providing literature and verification of certain taxa during the study period.

Thanks are also due to Shri T.R. Sharma, Principal Chief Conservator of Forests and other officials of the forest department, Government of Sikkim for extending their facilities during the survey work; to colleagues of Sikkim Himalayan Circle, Botanical Survey of India, for their co-operation during the entire period of study to one of the authors (GPS) at Gangtok.

G.P. Sinha & K.P. Singh

CONTENTS

Introduction	1
Topography	1
Geology & Soil	2
Climate	3
Lichenological Collections and Publications in Sikkim	4
Material and Methods	5
Presentation	6
Lichen Vegetation	6
Uses	11
Discussion and Conclusion	12
Taxonomic Treatment	15
References	248
Index	251

INTRODUCTION

Lichens are one of the most remarkable and successful alliances in nature represented by about 20,000 species in world and about 2180 species in India. In Indian context, the knowledge accumulated so far clearly shows that the 3 regions viz. Eastern Himalaya, Western Ghats and Western Himalaya have rich and luxuriant lichen flora. But, in comparison to the higher plants, the lichen flora of India in general and lichens of Eastern Himalaya including the North-Eastern states in particular remained the "Cinderella" group of flora by majority of professional botanists. Nonetheless, there has been a welcome awakening of interest in Indian lichens in preceding years. To facilitate future research in the field of ecology, ecophysiology, pollution studies, conservation, etc. lichen taxonomy is identified as one of the important areas to work out. Botanical Survey of India, the premier organization in the field of Taxonomy and Floristic studies, has taken up the task to explore the lichen flora of North-Eastern states. As a result of this, lichens of Manipur (K. Singh, 1981a, 1981b), Lichen Flora of Nagaland (K. Singh & Sinha, 1994) and innumerable papers comprising new species, new records for India, systematic accounts, etc. have already been published from the region.

Eastern Himalaya, one of the main centres of speciation is also a Hot Spot of Biodiversity. The flowering plants are well worked out while knowledge of non-flowering plants such as lichens is meager. To begin with, the Lichen Flora of Sikkim particularly macrolichens were chosen to work out first as these are easily eye-catching, dominant, in temperate and alpine regions and most of the nature lovers as well as professional botanists remain desirous to know about these plants. Awasthi (1988) reported 697 species of macrolichens from India and Nepal while K. Singh (1999) reported 386 species from Eastern Himalaya including North-Eastern States. The present account primarily based on one of the author's (GPS) own field work and supplemented by authentic published work, deals with 320 macrolichen species, distributed within 72 genera from the state of Sikkim, which forms about 45 % of Indian and about 82 % of Eastern Himalayan macrolichens. This number is a clear indication of rich macrolichen diversity in such a small geographical area of the country (0.21%).

Squamulose, foliose, subfruticose and fruticose taxa falling under macrolichens have been dealt in the present study. These are fairly conspicuous in habit and to a certain extent can be identified to generic level with the help of external appearance.

TOPOGRAPHY

The state of Sikkim situated between the latitudes 27° 4' and 28° 7' 48" N and longitudes 88° 58' and 88° 55' 25" with a geographical area of 7096 sq km

came into existence as 22nd Indian state on 16th May, 1975. It lies on the western flank of Eastern Himalaya, bounded by Nepal in the west, Bhutan in the south-east, Tibet in the north and north-east and the Darjeeling district of West Bengal in the south. The mountain chains run southwards from the main himalayan ranges form the natural boundaries of Sikkim. The snow clad peaks of Chola ranges with altitudes above 4000 m divide it from Tibet in north-east and Bhutan in the south-east. Likewise Singatela range separates the state from Nepal in the west with east west axis of the Great Himalaya forming the barrier between Sikkim and Tibet in the north. The mountain passes along these ranges over the years have sustained two ways traffic of traders, pilgrims and adventurers from Nepal, Tibet and Central Asia. The most renowned of these passes are Nathula (4392 m), Jelep La (4388 m), Donkia La (5520 m) and Kongra La (4809 m). Sikkim has quite varied topography with altitudes ranging from 250 to 8598 m, and almost no flat piece of land anywhere. Mt. Kanchendzonga (8598 m) in north west border of the state is the third highest mountain peak in the world. It is sacred to the people of Sikkim and considered as their guardian diety. The picturesque landscapes and snow clad mountain ranges in Sikkim and their scenic beauty along with cultural richness of the state allure nature lovers and tourists from near and distant places.

The state abounds in a number of high altitude perennial lakes, a large number of perennial and seasonal streams and mountain springs. Teesta and Ranjeet are the two main rivers which flow in the north to south direction and create in their wake the gorges and valleys. Ranjeet merges with Teesta at Melli, then Teesta flows down through Darjeeling district of West Bengal to finally drains to the mighty river Brahmaputra.

Administratively, Sikkim, with state capital at Gangtok, has been divided into four districts *viz.* East district with an area of 954 sq km, North district (4226 sq km South district (750 sq km) and West district (1166 sq km) with their headquarters at Gangtok, Mangan, Namchi and Geyzing respectively.

Forest is the main land use system in the state and nearly 40% of the total geographical area is under varying densities of forest cover. The available agricultural land to the local inhabitants *viz.* Lepcha, Bhutia and Nepali people is approximately 12% of the total geographical area and is usually confined to the altitudes below 2000 m. Terraced cultivated fields with interspersed nullahs, the bamboo clumps and tree groves are the traditional habitations along the hill slopes of Sikkim. The major agricultural crops are rice, maize and millet while major cash crops are large cardamom, ginger, oranges and potatoes.

GEOLOGY AND SOIL

Geologically, Sikkim encompasses the Lesser Himalaya, Central Himalaya and the Tethys Himalaya (Raina & Srivastava, 1981). Major portion of Sikkim is covered by precambrian rock and is much younger in age. The geological position is known as "Younger units of Paleozoic age." The southern area has sedimentary

and metasedimentary rocks. The physical configuration of Sikkim is partly due to its geographical structure. The north-eastern and western portions of the state are composed of hard massive gneiss rock capable of resisting denudation. The south and central region is chiefly formed of comparatively soft thin slates and half schistern rock which denudes very easily. The trends of mountain system as a whole is east-west direction. The boundary ridges, however, run in a more or less north-south direction, i.e. Singalila and Chola ridges and another north south ridge in the central portion *viz.* Tendong ridge, divides the Ranjeet from the Teesta valley.

Most of the important forests species grow in black, red and lateritic soils. Black soil developed from ballistic rocks and cracks widely and deeply in dry season. It is neutral to alkaline, poor in Nitrogen and Phosphorus and good in lime and potash. The dark colour is due to mineral constituents and humus. The red soil is associated with granites, gneisses and ferrolitic nature. These are typically coarse, often with ferric concentrations, neutral to acidic with poor organic/ mineral nutrients. Lateritic soil is characteristic of the tropics with monsoon rainfall which tends to cap the hills in most part of peninsula. The soils are developed from basic rocks and these are acidic with poor mineral and low silica/oxide ratios.

CLIMATE

Sikkim has been known to be the most humid region in the whole range of Himalaya due to its direct exposure to the south - west monsoon from the Bay of Bengal. The rainfall varies from 2000-5000 mm in most of the inner valleys except for northern most region, *viz.* Llonakh valley and Cholamu plains where rainfall is scanty throughout the year. From June to September, the state experiences heavy rainfall. Lower hills and valleys enjoy a subtropical climate, warm in winter, hot and extremely humid in summer. Towards the interior and with rise in altitude, the climate becomes gradually more temperate with cool winters and hot summers and often there is a heavy rainfall. In the northern part of the state, summers are short and cool, while winters are with considerable snowfall and frost.

Climate and natural features of Llonakh valley are quite different from the rest of the places. There is no area in Sikkim which is quite parallel to Llonakh area (Smith & Cave, 1911). Llonakh valley constitutes flats and screes along the streams of Lungma chu and Naku chu, which join together and form Llonakh chu. Llonakh flats form a wonderful expanse of gently undulating ground amidst the highest peaks in the Himalaya. These are the level floor, formed by the action of some huge glaciers at the heads of all the valleys. On the flanks of this flat valley are huge moraines - accumulations of mighty boulders with a very limited plant life. Small lakes in the shallow basins are found regularly below the foot of each glacier.

LICHENOLOGICAL COLLECTIONS AND PUBLICATIONS IN SIKKIM

Sir J. D. Hooker and T. Thomson collected specimens of lichens during the famous botanical expedition from 1846 - 48. Later, these collections were studied, described and published in *Synopsis Methodica Lichenum* by W. Nylander (1860). Majority of the species reported were macrolichens. A small collection by Stevens from Sikkim was also enumerated by Müll. Arg. (1895) in "Lichenes Sikkimensis", comprising 12 species of microlichens, but actually these were collected from Dajreeling hills of West Bengal and not from the present political boundary of Sikkim. In the late twenties, lichens from the Himalayan region were collected by Kashyap, Chaudhuri and Chopra. These were determined by A. L. Smith (1931) and apparently based on these determinations, Chopra (1934) published an account "Lichens of the Himalayas" comprising 75 species from Sikkim Himalaya (Darjeeling and East Sikkim up to Gangtok). Awasthi (1965, 1988, 1991), Asahina (1966), Sinha (1999), altogether enumerated 219 species including 162 macrolichens from Sikkim. Recently Upreti *et al.* (2003) reported 181 additional species including 56 macrolichens from the area. In sporadic publications, mainly in the form of new species and new records for India, Sinha and Chauhan (1996), Divakar *et al.* (2001a, 2001b, 2003), Ahti *et al.* (2002), Sinha (2003), Sinha and Elix (2003), Ahti and Upreti (2004) made some other significant contributions. Thus, a total number of lichens reported in these publications comes to 430 species, out of this 248 species were macrolichens.

MATERIAL AND METHODS

(A) Field work: During the period from 1994-2000, twelve intensive exploration trips were undertaken in tropical to alpine areas ranging from 500 to 5500 m altitude. While collecting specimens, special attention was paid to gather the data on habit, habitat, association with other species, ecological features and other interesting aspects. Attempts were also made to study the distribution pattern of each species in the state. As a result of these explorations, 1775 specimens were collected from various localities and their environs (see map).

The lichen samples, thus, collected were dried between blotting sheets, mounted on cards and made into suitable herbarium specimens. These specimens were carefully studied in respect of their morphology, anatomy and chemical colour reactions, microcrystallography and TLC wherever required following Culberson & Kristinsson (1970), Culberson (1972), Hale (1974) and White & James (1985). Anatomical details were studied with the help of a compound microscope.

The specimens thus studied were identified by comparing the descriptions available in the Floras and latest monographic work of various genera. Most of these taxa were authenticated in the lichen herbarium at National Botanical Research Institute, Lucknow (LWG) where vast collections of D. D. Awasthi and his associates are housed (Herb. AWAS, LWU in LWG) along with authenticated specimens of different renowned lichenologists. Besides these recent collections, the report of several taxa hitherto described or recorded from Sikkim by

MAP OF SIKKIM SHOWING IMPORTANT COLLECTION LOCALITIES



lichenologists viz. T. Ahti, Y. Asahina, D.D. Awasthi, G. Degelius, D. K. Upreti and his associates, etc. have also been incorporated in the present work. Apart from this, many specimens from the area were also identified by various specialist such as species of *Cladonia* by T. Ahti; species of genera *Heterodermia*, *Oropogon*, *Phaeophyscia* and *Physconia* by T. L. Esslinger; *Ramalina* by H. Kashiwadani; *Parmelia s.l.* by D. K. Upreti and J. A. Elix; *Cetraria s.l.* by D. D. Awasthi and J. A. Elix; *Stereocaulon* by D.K. Upreti. All the identified specimens are deposited in Cryptogamic herbarium, Botanical Survey of India, Sikkim Himalayan Circle, Gangtok (BSHC).

PRESENTATION

The account of macrolichen flora has been arranged according to the system of classification proposed by Tehler (1996). A generic key to all 72 genera is provided. Genera under each family and species under each genus are arranged alphabetically and numbered when they are more than one. Genus description provided in brief is mainly based on monographic treatment in order to facilitate the future researchers to develop overall concept of the genus. In treatment of species, the current valid name is followed by the citation of relevant literature, the basionym and synonyms, if any. The references cited in the text have been abbreviated according to usual convention. Each species is described briefly while generic characters have usually been omitted. Habitat and distribution in India as well as outside, as per available information for each species is provided. Colour photographs of habit and herbarium specimens of some selected species have been provided for easy identification. Majority of specimens cited are collected by G.P. Sinha, except for a few provided by others are abbreviated as Sinha. Unless otherwise stated, all the specimens are deposited in the herbarium of Sikkim Himalayan Circle, Botanical Survey of India, Gangtok (BSHC). Citation of specimens examined are arranged district wise and alphabetically. In few cases, where too many specimens examined, only selected representatives have been cited.

LICHEN VEGETATION

The state of Sikkim is frequently referred to as a botanist's paradise on account of its one third land area covered with dense forests which boast of providing suitable niche for the growth of commercially important plants *viz.* Sal, Teak, Bamboo and several species of Orchids on one hand while rich and diverse flora comprising an estimated number of 4500-5000 species of higher plants on the other hand. Tree trunks and branches of *Abies*, *Acer*, *Castanopsis*, *Cotoneaster*, *Juniperus*, *Larix*, *Michelia*, *Quercus*, *Rhododendron*, *Salix* show luxuriant growth of epiphytic lichens, mosses, pteridophytes, etc. This rich diversity of plant wealth is protected, particularly under Kanchendzonga Biosphere Reserve (North Sikkim and West Sikkim, 2619.92 sq km) and a number of Wild Life Sanctuaries *viz.* Singba Rhododendron Sanctuary (North Sikkim, 43 sq km), Varshey Rhododendron Sanctuary (West Sikkim, 104 sq km), Kyangnosla Alpine Sanctuary (East Sikkim, 31 sq km), Maenam Wildlife Sanctuary (South Sikkim, 35.34 sq km), Fambong Lho Wildlife Sanctuary (East Sikkim, 51.76 sq km).

The lichen vegetation of Sikkim can be grouped into following four types.

1. Tropical lichens

These lichens are mainly confined in foot hills and lower hilly regions between 250 and 900 m altitude in Teesta and Ranjeet valleys bordering to the state of

West Bengal. The forests comprise three distinct sub types viz. Sal, dry mixed and wet mixed forests. At some places Pine forests are also found along with Sal forests. Dry mixed forests are mainly deciduous and occur on ridges and drier slopes. Wet mixed forests are mainly confined in deep valleys with high humid climate. The arboreal elements in this area comprise *Shorea robusta*, *Aglaia lawii*, *Alstonia neerifolia*, *A. scholaris*, *Bombax ceiba*, *Chukrasia tabularis*, *Bauhinia purpurea*, *Lagerstromia parviflora*, *Eugenia kurzii*, *Duabanga grandiflora*, *Terminalia alata*, *T. bellirica*, *T. chebula*, *T. myricorpa*, *Phyllanthus embilica*, *Ficus hirta*, *Albizia gamblei*, *A. odoratissima* and *A. procera*. The trunks of these trees barely support macrolichen taxa, though microlichen taxa (not dealt here) belonging to families Graphidaceae, Pyrenulaceae, Lecanoraceae, Caliciaceae, Pertusariaceae, Arthoniaceae are quite common. Wherev'er moist conditions due to streams, rivers and rivulets prevail a few macrolichen species of genera *Dirinaria*, *Pyxine*, *Parmotrema* and *Usnea* are found.

2. Subtropical lichens

The subtropical lichens are found between altitudes 900 and 1800 m in the vicinity of Bey, Chungthang, Mangan, Namprik, Pentong, Sakyong, Singhik in North Sikkim district; Sumbuk - kartikey and Temi in South Sikkim district; lower ridges of Gangtok, Ranipul, Regu, Rumtek, etc. in East Sikkim district; Geyzing, Kacheopalri, Soreng, Tashiding, Narkhola, Yoksum, etc. in West Sikkim district. The arboreal elements are composed of *Alnus nepalensis*, *Alangium chinense*, *Bischofia javanica*, *Callicarpa arborea*, *Castanopsis indica*, *Eurya cerasifolia*, *Gynocordia odorata*, *Haldina cordifolia*, *Helicia nilagirica*, *Macaranga denticulata*, *Taluma hodgsonii*, *Michelia velutina*, *Mangifera sylvatica*, *Saurauja napaulensis*, *Erythrina arborescens*, *Ficus auriculata* and *F. semicordata*. These trees usually support a good number of epiphytic flora which include orchids, ferns, microlichens and a few macrolichen taxa. Amongst macrolichens, the foliose taxa viz. *Bulbothrix isidiza*, *Everniastrum nepalense*, *Heterodermia diademata*, *Parmelinella wallichiana*, *Myelochroa xantholepis*, *Parmotrema sanctae-angelii*, *P. tinctorum*, *Rimelia reticulata*, *Pseudocyphellaria aurata* are fairly common on trunks of these trees. In moist places *Leptogium burnetiae*, *L. denticulatum*, *Lobaria retigera*, *Peltigera dolichorrhiza* are more common. Besides, a few fruticose taxa viz. *Usnea baileyi* and *U. orientalis* grow on tree trunks while *Cladonia scabriuscula*, *Stereocaulon piluliferum*, *S. pomiferum* are usually found on mossy rocks.

3. Temperate lichens

These lichens occur between altitudes 1800 and 3600 m in the vicinity of Chhaten, Jakthang, Lachen, Lachung, Phuni, Thangu, Tholung, Yakehe, Yumthang, etc. in North Sikkim district; Damthang, Mainam, Namchi, Rabangla, Tendong, etc. in South Sikkim district; Gangtok, Karponang, Penengla, Pangolakha, Phadamchen, Rechala, etc. in East Sikkim district and Bakhim, Karchi,



Fig. 1. Coniferous forest - a habitat of temperate lichens at Jakthang, North Sikkim.
Fig. 2. *Abies densa* Griff. ex Parker supporting luxuriant growth of *Usnea longissima* Ach. at Jakthang, North Sikkim.



Fig. 3. *Rhododendron* trees supporting luxuriant growth of *Bryoria* spp. at Dzungri, West Sikkim. Fig. 4. Alpine vegetation - Llonakh Valley, North Sikkim.

Kongri, Labdang, Pemayangtse, Phedang, Tsoka, etc. in West Sikkim district. The temperate climate offers the optimum conditions for luxuriant growth of macrolichens. The tree trunks of *Acer campbelli*, *Engelhardia spicata*, *Exbucklandia populnea*, *Juglans regia*, *Populus ciliata*, *Prunus nepalensis*, *Malus sikkimensis*, *Quercus glauca*, *Lithocarpus pachyphylla*, *Rhododendron* spp., *Viburnum* spp., etc. provide suitable habitat for growth of different foliose species like *Cetrelia braunsiana*, *Coccocarpia erythroxyli*, *Everniastrum cirrhatum*, *E. vexans*, *Heterodermia boryi*, *Lobaria kurokawae*, *Nephromopsis pallescens*, *Parmelaria thomsonii*, *Parmotrema nilgherrense*, *Platismatia erosa*, *Sticta nylanderiana* while fruticose taxa viz. *Bryoria himalayana*, *Sulcaria sulcata*, *Usnea himalayana*, *U. longissima*, *U. thomsonii* are usually seen pendent from tree twigs and trunks. The fruticose forms like *Baeomyces pachypus*, *Cladonia furcata*, *C. squamosa*, *Stereocaulon paradoxum*, *S. piluliferum*, *S. pomiferum*, etc. grow abundantly on the ground as well as on exposed boulders in moist shady places. In upper reaches beyond 3000 m altitude, most of the exposed boulders are, however, characteristically dominated by foliose *Umbilicaria indica*, *U. vellea* and *U. yunnana*. Similarly foliose taxa such as *Lobaria kurokawae*, *L. pseudopulmonaria*, *Peltigera canina*, *Sticta nylanderiana*, *S. weigelii* are well distributed and usually grow on dead wood as well as on the ground and over mosses in humid places.

The coniferous forests found between 2750 and 3350 m altitudes in temperate zone, often considered as subalpine forests, with *Abies densa*, *Larix griffithiana*, *Picea spinulosa*, *Tsuga dumosa* as the dominant tree species mixed with a number of *Rhododendron* spp., *Acer*, *Lonicera*, *Sorbus* spp. as the second tier tree species hosting a multitude of macrolichens in abundance. Some of the commonest lichen taxa of foliose forms are *Hypogymnia hypotrypa*, *Menegazzia terebrata*, *Melanelia stygia*, *Nephromopsis stracheyi*, *Parmelia adaugescens*, *Punctelia rudecta* while fruticose forms are represented by *Usnea longissima*, *U. montis-fuji*, *U. nepalensis*, *Sulcaria virnes*, etc.

4. Alpine lichens

These lichens usually grow at an altitude of 3600 m and above in the vicinities of Lasher, Lonakh valley, Sebu La, Thangu, Kareng, Yangdi, Gaigong, Chholamu, Theu La, most of the core areas of Kanchendzonga Biosphere Reserve and Yomesamdong in North Sikkim district; Chhangu, Jelep La, Nathula, Kupup and Tamsey in East Sikkim district and Dzongri, Thangsing and Samiti in West Sikkim district. A majority of alpine lichens are saxicolous or terricolous in habit as large trees are altogether absent in this region. However, the dwarf bushes of species of *Rhododendron*, *Cotoneaster*, *Salix*, *Juniperus*, *Myricaria*, *Berberis* are found laden with macrolichen genera like *Bryoria*, *Lethariella*, *Usnea* and *Nephroma*. Saxicolous microlichen taxa viz. yellow patches of *Rhizocarpon*; foliose *Xanthoria*; fruticose *Acroscyphus*, and terricolous white *Thamnolia* are the four characteristic lichens representing the alpine lichen vegetation. Besides, on

exposed boulders fruticose species like *Cladia aggregata*, *Cladonia rangiferina*, *Stereocaulon coniophyllum*, *S. massartianum*, *S. macrocephalum* and foliose species *Allocetraria stracheyi*, *C. islandica*, *C. melaloma*, *Lobaria pseudopulmonaria*, *Nephroma nakaoi*, *Nephromopsis leucostigma*, *Physcia caesia*, *P. dilatata*, *Umbilicaria* spp., etc. are fairly abundant in the area.

Uses

Lichens are well known for their various uses. As far as the uses of lichens of Sikkim area are concerned, a thorough study is required in this direction. However, some uses along with already recorded information (Saklani & Upreti, 1992; Sinha 2000) are enumerated below in tabular form.

Sl. No.	Name of the species	Vernacular names	Uses
1.	<i>Cladonia rangiferina</i> (L.) Wigg.	Lepcha- Anokbu-singlion	Dried thalli powder applied for curing of eczema and other skin diseases.
2.	<i>Everniastrum nepalense</i> (Fr.) Hale ex Sipman	Nepalese- Rukh ka jhau	Thalli boiled, fried and eaten as vegetables.
3.	<i>Heterodermia diademata</i> (Taylor) Awasthi	Nepalese- Dhungo ku seto jhau	Paste of thalli applied as plaster in cuts and injuries.
4.	<i>Lethariella cladonioides</i> (Nyl.) Krog	Bhutia- Chussa	Raw thalli mixed with garlic and chilly and eaten as pickle. Boiled thalli eaten as vegetables.
5.	<i>Peltigera polydactyla</i> (Neck.) Hoffm.	Nepalese- Jhau Lepcha- Phatdorbi	Paste of thalli applied on cut injury to stop bleeding.
6.	<i>Stereocaulon foliolosum</i> var. <i>strictum</i> (C. Bab.) Lamb	Lepcha- Longdorbi	Raw thalli after washing chewed to cure kidney stones.
7.	<i>S. himalayense</i> Awasthi & Lamb	Nepalese- Dhungo ku jhau	Decoction of pounded and boiled thalli taken orally to treat burning sensation during urination, in other urinary troubles and for the cure of blisters of tongue.
8.	<i>Sticta nylanderiana</i> Zahlbr.	Lepcha - Sangfon	Crushed thalli taken orally for relief in excessive cough.
9.	<i>Thamnolia vermicularis</i> (Swartz) Ach. ex Schaerer	Bhutia- Khange	Thalli as one of the ingredients in preparation of 'Dhoop'.
10.	<i>Umbilicaria indica</i> Frey	Bhutia- Sekdor	Washed thalli fried and consumed as vegetables.
11.	<i>Parmelaria thomsonii</i> (Stirton) Awasthi	Lepcha- Kungrif	Smoke of thalli for relief in eye pain.
12.	<i>Usnea longissima</i> Ach.	Lepcha- Gajetho	Thalli as one of the ingredients in preparation of 'Dhoop'. Also as fodder for yak.

DISCUSSION AND CONCLUSION

The present account of macrolichens of Sikkim is primarily based on specimens collected from different areas of Sikkim between the years 1994 and 2000. The state of Sikkim, situated in the lap of Eastern Himalaya, possesses rich and varied macrolichen flora on account of its geographical location, varied climatic conditions and altitudinal ranges. Through extensive explorations, 1775 specimens were collected from various localities at different altitudes from all the four districts of the state. Critical investigations of these specimens as well as published information from the area have resulted to a total number of 320 macrolichen species including 6 new records for India (*Bryoria nitidula* (Th.Fr.) Brodo & D. Hawksw., *Cetraria nigricans* Nyl., *Melanelia olivacea* (L.) Essl., *M. poeltii* Essl., *Tuckneraria ahtii* Randle & Saag and *Usnea norkettii* G. Awasthi), disposed under 72 genera and 19 families.

Prior to this study, 248 macrolichen taxa were known from Sikkim. Present study has added 72 additional macrolichen species to Sikkim lichen flora. An analysis of the data thus accumulated shows that Parmeliaceae is the largest family, represented by 145 species. It is followed by Physciaceae (45 spp.), Cladoniaceae (32 spp.), Collemataceae (18 spp.), Lobariaceae (15 spp.), Stereocaulaceae and Peltigeraceae (12 spp. each) and Umbilicariaceae (10 spp.). Like wise in terms of number of species genus *Cladonia* is the largest with 30 species, followed by *Heterodermia* and *Usnea* (25 spp. each), *Hypotrachyna* (17 spp.), *Leptogium* (13 spp.), *Stereocaulon* (12 spp.) and *Peltigera* (10 spp.).

The macrolichens of Sikkim possess 7 interesting species as endemics. These are *Collema hookeri*, *Heterodermia togashii*, *Hypogymnia sikkimensis*, *H. thomsoniana*, *Hypotrachyna neosingularis* and *Nephroma sikkimense*. The species viz. *Anzia physoidea*, *Bryoria levis*, *Heterodermia indica*, *Hypotrachyna rigidula*, *Lethariella cladonioides*, *Nephromopsis isidioidea*, *N. leucostigma* endemic to Eastern Himalayan region and adjacent trans Himalayan areas of Tibet China and Nepal and the taxa viz. *Allocetraria ambigua*, *Leptogium askotense*, *Parmelaria subthomsonii*, *P. thomsonii* and *Usnea sordida* endemic in Himalayas as a whole are also present in the flora. One of the interesting features of Sikkim flora is the presence of some taxa viz. *Acroscyphus sphaerophoroides*, *Alectoria ochroleuca*, *Allocetraria flavonigrescens*, *Heterodermia chondroidea*, *Oropogon formasanus*, *Platismatia erosa*, etc. which are known only from Sikkim among Indian states but are not endemic.

Besides these interesting features, as expected, a number of cosmopolitan taxa viz. *Candelaria concolor*, *Cladonia amaurocraea*, *C. pyxidata*, *C. ramulosa*, *Coccocarpia erythroxyli*, *Peltigera polyductyla*, *P. rufescens*, *Pseudocyphellaria aurata*, *Punctelia borreri*, *Solorina crocea*, *Thamnolia vermicularis*, *Umbilicaria vellea*, etc. on one side and a few circumpolar taxa viz. *Cladonia borealis*, *C. coccifera*, *Melanelia hepatizon*, *Stereocaulon glareosum*, etc. on the other side are also present in the flora. The macrolichen flora exhibits some

striking resemblance with the flora of distant and neighbouring regions. There are over 160 species of Sikkim macrolichens common with neighbouring Darjeeling district of West Bengal. Some of these are *Anzia physoidea*, *Bryoria bicolor*, *Bulbothrix meizospora*, *Cetraria melaloma*, *Cetrelia cetrarioides*, *Cladonia chlorophaea*, *Erioderma meiocarpum*, *Everniastrum cirrhatum*, *Gymnoderma coccocarpum*, *Heterodermia albidiflava*, *Hypogymnia pseudohypotrypa*, *Hypotrachyna exsecta*, *Lobaria isidiosa*, *Melanelia stygia*, *Parmelia sulcata*, *Pyxine soredata*, *Ramalina himalayensis*, *Stereocaulon himalayense*, *Usnea montis-fuji*, etc. Similarly over 70 species are common with Arunachal Pradesh macrolichens (as per present record) viz. *Bryoria confusa*, *Bulbothrix setschwanensis*, *Cetreliaopsis rhytidocarpa*, *Cladia aggregata*, *Cladonia luteoalba*, *C. singhii*, *Heterodermia lutescens*, *Hypotrachyna infirma*, *Lobaria retigera*, *Myelochroa aurulenta*, *Peltigera dolichorrhiza*, *Ramalina conduplicans*, *Stereocaulon macrocephalum*, *Sulcaria virens*, *Usnea pectinata*, etc. Interestingly, macrolichens of Sikkim also share about 174 species common with Western Himalayan lichens such as *Allocetraria stracheyi*, *Bryoria implexa*, *Canomaculina subtinctoria*, *Cetraria islandica*, *Cladonia mongolica*, *Flavopunctelia flaventior*, *Heterodermia awasthii*, *Hypogymnia alpina*, *Hypotrachyna crenata*, *Nephroma isidiosum*, *Parmelaria subthomsonii*, *Parmelia saxatilis*, *Parmelina tiliacea*, *Parmotrema rampoddense*, *Phyllopsora corallina*, *Physcia dimidiata*, *Physconia detersa*, *P. muscigena*, *Ramalina roesleri*, *Stereocaulon myriocarpum*, *Umbilicaria virginis*, *Usnea pangiana*, *Vulpicidia pinastri*, *Xanthoparmelia tinctina*, *Xanthoria soredata*, etc. The macrolichen flora of Sikkim, owing to its unique geographical position, shows resemblance with neighbouring countries like Bhutan, Nepal and China. An analysis of available data shows that there are 55 species common between Sikkim and Bhutan such as *Cladonia coccifera*, *Coccocarpia palmicola*, *Everniastrum cirrhatum*, *E. nepalense*, *Cetreliaopsis rhytidocarpa*, *Hypogymnia physodes*, *H. vittata*, *Heterodermia boryi*, *H. tremulans*, *Parmotrema praesorediosum*, *Rimelia reticulata*, *Sulcaria sulcata*, *Tuckneraria laureri*, *Usnea longissima*, *U. subfloridiana*, etc.; about 110 species common with Nepal viz. *Cetrelia braunsiana*, *C. olivetorum*, *Everniastrum nepalense*, *Flavocetraria cucullata*, *Hypogymnia hypotrypa*, *Hypotrachyna crenata*, *Leprocaulon arbuscula*, *Lobaria retigera*, *Myelochroa irrugans*, *Nephroma nakaai*, *Nephromopsis leucostigma*, *Parmelaria thomsonii*, *Parmelia meiophora*, *Phaeophyscia pyrrophora*, *Siphula ceratites*, *Sticta praetextata*, *Umbilicaria nanella*, *Usnea norkettii*, *U. robusta*, etc.; about 61 species common with China viz. *Acroscyphus sphaerophoroides*, *Bryoria perspinosa*, *Bulbothrix setschwanensis*, *Cetrelia collata*, *Cladonia yunnana*, *Everniastrum vexans*, *Gymnoderma coccocarpum*, *Heterodermia firmula*, *Lobaria kurokawae*, *Lethariella cladonioides*, *Oropogon formasanus*, *Platismatia erosa*, *Ramalina sinensis*, *Sulcaria virens*, *Umbilicaria virginis*, *U. yunnana*, *Usnea eumitrioides*, etc. This similarity extends up to far east in Japan. Over 68 species are common with Japan flora viz.

Alectoria ochroleuca, *Cetrelia sanguinea*, *Collema japonicum*, *Heterodermia pseudospeciosa*, *Hypotrachyna koyaensis*, *Leptogium pedicellatum*, *Myelochroa metarevoluta*, *Parmelia squarrosa*, *Peltigera membranacea*, *Ramalina shinanoana*, *Stereocaulon coniophyllum*, *Tuckermannopsis sepincola*, *Usnea aciculifera*, *U. bismolliuscula*, etc. Further, the high altitude macrolichens of Sikkim resemble with the flora of Europe as shown by the species like occurrence of *Alectoria ochroleuca*, *Bryoria implexa*, *Cladonia arbuscula*, *C. subulata*, *Cetraria islandica*, *Heterodermia speciosa*, *Lobaria isidiosu*, *Phaeophyscia decolor*, *Physcia caesia*, *P. dimidiata*, *Rhizoplaca chrysoleuca*, *Tuckneraria laureri*, *Umbilicaria cylindrica*, *Usnea subfloridiana*, *Xanthoria sorediata* in both the areas and North America as exemplified by the occurrence of *Acroscyphus sphaerophoroides*, *Arctoparmelia subcentrifuga*, *Bryoria tenuis*, *Cladonia kanewskii*, *Collema flaccidum*, *Heterodermia podocarpa*, *Hypogymnia enteromorpha*, *Lasallia pustulata*, *Leprocaulon arbuscula*, *Lobaria pseudopulmonaria*, *Melanelia stygia*, *Peltigera horizontalis*, *Stereocaulon alpinum* and *Vulpicidia pinastri* in both the areas.

Like other states, there has been a great deal of damage to the richness of the biodiversity of Sikkim Himalaya. The forests have been denuded by the large scale felling of trees for timber, through unmanaged grazing, road construction activities, etc. However, there has been a welcome awakening with regard to Biodiversity conservation in this small Himalayan state in recent past. Presently, the rich diversity of plant wealth including lichens are protected under Kanchendzonga Biosphere Reserve and a number of Wild Life Sanctuaries viz. Singbha Rhododendron Sanctuary, Varshey Rhododendron Sanctuary, Kyangnosla Alpine Sanctuary, Maenam Wild Life sanctuary and Fambong Lho Wild Life Sanctuary. If these areas are protected with care, the lichens would need no special conservation measures separately.

Finally, in the light of above discussion it can be concluded that due to unique geographical position, snow capped peaks and presence of cold desert areas in North Sikkim district adjacent to Nepal and Tibet area of China, the macrolichens of Sikkim show general affinity to Eastern Himalayan and South East Asian lichen flora.

TAXONOMIC TREATMENT

Artificial key to the Macrolichen genera

- 1a. Thallus foliose 2
- 1b. Thallus subfruticose or fruticose 67
- 2a. Thallus bright yellow to orange 3
- 2b. Thallus otherwise 4
- 3a. Thallus K+ purple-red; parietin present **Xanthoria**
- 3b. Thallus K-; parietin absent **Candelaria**
- 4a. Thallus umbilicate 5
- 4b. Thallus non umbilicate 7
- 5a. Thallus brown black to black; cortex with necral layer;
apothecia usually gyrose, lecideine 6
- 5b. Thallus yellowish grey to grey; cortex lacking
necral layer; apothecia not gyrose, lecanorine **Rhizoplaca**
- 6a. Thallus pustulate; asci 1-2 spored; spores
brown, muriform **Lasallia**
- 6b. Thallus lacking pustules; asci 8-spored; spores
colourless to brown, simple to muriform **Umbilicaria**
- 7a. Thallus underside with well developed rhizines,
lacking distinct vein like markings from which rhizines
arise 8
- 7b. Thallus underside apparently devoid of rhizines
or sparsely rhizinate at margins only, or tomentose,
or on a spongy indumentum or prothallus,
sometimes cyphellae, pseudocyphellae or with
distinct vein like markings from which rhizines arise 50
- 8a. Lobes marginally ciliate 9
- 8b. Lobes marginally eciliate 23
- 9a. Cilia bulbate **Bulbothrix**
- 9b. Cilia not bulbate 10
- 10a. Pycnidia marginal, either emergent or on projections,
if laminal, present only on projections 11
- 10b. Pycnidia laminal, immersed 13
- 11a. Apothecia marginal, nephromoid 12

- 11b. Apothecia laminal **Parmelaria**
- 12a. Upper surface yellowish grey or yellowish green; usnic acid present; pseudocyphellae present on lower surface **Tuckneraria**
- 12b. Upper surface pale olive grey to olive brown; atranorin present; pseudocyphellae absent on either surfaces **Tuckermannopsis**
- 13a. Cilia sharply tapered, often forked **Canomaculina**
- 13b. Cilia not markedly tapered, rarely forked 14
- 14a. Spores transversely 2-celled; lobes up to 2 mm wide 15
- 14b. Spores simple; lobes usually more than 2 mm wide 16
- 15a. Thallus K+ yellow; atranorin present **Heterodermia**
- 15b. Thallus K-; atranorin absent **Phaeophyscia**
- 16a. Lobes broader, more than 5 mm wide 17
- 16b. Lobes narrower, less than 5 mm wide 19
- 17a. Upper surface emaculate, or if maculate, maculae not forming reticulate cracks; rhizines simple or rarely branched, not squarrose or dimorphous 18
- 17b. Upper surface with reticulate maculae, forming cracks; rhizines squarrose or simple or dimorphous **Rimelia**
- 18a. Lobe tips broadly round, with a broad naked marginal zone below **Parmotrema**
- 18b. Lobe tips narrow, truncate to subrotund, without naked marginal zone below **Parmelinella**
- 19a. Rhizines dichotomously branched **Hypotrachyna**
- 19b. Rhizines simple or squarrosely branched 20
- 20a. Lobes canaliculate **Everniastrum**
- 20b. Lobes flat 21
- 21a. Medulla yellow to orange, at least in part, C- or C+ more intensely yellow; containing terpenes and secalononic acids **Myelochroa**
- 21b. Medulla white, or if partly yellow C+ rose or red; lacking terpenes and secalononic acids 22

- 22a. Lobe apices truncate, cilia evenly dispersed **Parmelinopsis**
- 22b. Lobe apices subrotund, cilia mainly in lobe axils **Parmelina**
- 23a. Apothecia present on lower surface of lobe
apices, nephromoid 24
- 23b. Apothecia present on upper surface of lobes, not
nephromoid 26
- 24a. Thallus greenish-brown to brown; lower surface
pubescent or tomentose; spores transversely
3 -septate **Nephroma**
- 24b. Thallus yellow-green or grey; lower surface lacking
tomentum; spores simple 25
- 25a. Pseudocyphellae present on both surfaces **Cetrellopsis**
- 25b. Pseudocyphellae present only on lower surface **Nephromopsis**
- 26a. Thallus brown or olive 27
- 26b. Thallus white, grey, straw yellow to yellow green 30
- 27a. Photobiont a blue green alga; upper cortex tomentose **Erioderma**
- 27b. Photobiont a green alga; upper cortex etomentose 28
- 28a. Upper cortex pseudocyphellate; spores colourless,
simple **Melanelia**
- 28b. Upper cortex lacking pseudocyphellae; spores brown,
2 -celled 29
- 29a. Lobes whitish pruinose; lower cortex
prosopectenchymatous; rhizines squarrose **Physconia**
- 29b. Lobes epruinose; lower cortex paraplectenchymatous;
rhizines simple **Phaeophyscia**
- 30a. Thallus straw yellow to yellow green or yellowish
brown 31
- 30b. Thallus white or whitish grey to grey 37
- 31a. Pycnidia marginal on projections 32
- 31b. Pycnidia laminal, not on projections 34
- 32a. Pseudocyphellae present; vulpinic acid absent 33
- 32b. Pseudocyphellae absent; vulpinic acid present **Vulpicidia**

- 33a. Pseudocyphellae present on lower surface; apothecia both laminal and marginal, not nephromoid **Allocetraria**
- 33b. Both upper and lower surfaces pseudocyphellate; apothecia only marginal, nephromoid **Cetreliaopsis**
- 34a. Upper surface pseudocyphellate **Flavopunctelia**
- 34b. Lower and upper surfaces not pseudocyphellate 35
- 35a. Lower surface velvety **Arctoparmelia**
- 35b. Lower surface not velvety 36
- 36a. Lobes narrow, truncate; usnic acid present in cortex, atranorin absent **Xanthoparmelia**
- 36b. Lobes subrotund; usnic acid and traces of atranorin present in cortex **Flavoparmelia**
- 37a. Photobiont blue green; upper surface with concentric rings **Coccocarpia**
- 37b. Photobiont green 38
- 38a. Upper surface pseudocyphellate 39
- 38b. Upper surface non pseudocyphellate 43
- 39a. Spores brown, transversely 2-celled; lobes usually less than 2 mm wide **Pyxine**
- 39b. Spores colourless, simple, lobes usually more than 2 mm wide 40
- 40a. Pycnidia marginal, immersed 41
- 40b. Pycnidia laminal, immersed 42
- 41a. Upper surface reticulately ridged; apothecia (absent in Sikkim specimens) eperforate; spores ellipsoid to subspherical, 5-8 x 3-5 μm **Platismatia**
- 41b. Upper surface not reticulately ridged; apothecia perforate; spores ellipsoid, 11-22 x 6-12 μm **Cetrelia**
- 42a. Upper surface with linear or reticulate pseudocyphellae; lower surface black; some rhizines squarrose; conidia cylindrical or weakly bifusiform **Parmelia**
- 42b. Upper surface with punctiform pseudocyphellae; lower surface jet black; all rhizines simple; conidia unciform to filiform **Punctelia**

- 43a. Rhizines dichotomously branched, usually projecting beyond margins 44
- 43b. Rhizines simple, squarrose, usually not projecting beyond margins 45
- 44a. Upper cortex palisade plectenchymatous; spores colourless, simple **Hypotrachyna**
- 44b. Upper cortex composed of longitudinally disposed hyphae; spores brown, transversely 2-celled **Heterodermia**
- 45a. Spores colourless, simple; thallus usually loosely attached on substratum; lobes rotund to subrotund, more than 3 mm wide 46
- 45b. Spores brown, transversely 2-celled; thallus usually closely adpressed on substratum; lobes otherwise, less than 3 mm wide 47
- 46a. Rhizines restricted to the centre leaving a bare, more than 2 mm wide marginal zone **Parmotrema**
- 46b. Rhizines up to margin but leaving a small, less than 2 mm wide erhizinate or papillate marginal zone **Canoparmelia**
- 47a. Thallus UV+ yellow; lichexanthone present **Pyxine**
- 47b. Thallus UV-; lichexanthone absent 48
- 48a. Lobes plicate, coalescing laterally **Dirinaria**
- 48b. Lobes discrete, neither plicate not coalescing laterally ... 49
- 49a. Lobes sublinear, closely appressed, usually marginally pseudocyphellate; apothecia lecideine **Pyxine**
- 49b. Lobes irregular with subrotund apices, marginal pseudocyphellae absent; apothecia lecanorine **Physcia**
- 50a. Lower surface cyphellate or pseudocyphellate or with vein like markings which bear rhizines 51
- 50b. Lower surface lacking cyphellae, pseudocyphellae or vein like markings 54
- 51a. Lower surface vein like 52
- 51b. Lower surface cyphellate or pseudocyphellate 53
- 52a. Apothecia terminal on digitate lobes **Peltigera**

- 52b. Apothecia sunken on the thallus **Solorina**
- 53a. Lower surface cyphellate **Sticta**
- 53b. Lower surface pseudocyphellate **Pseudocyphellaria**
- 54a. Rhizines sparse, restricted to margin or constrictions
in thallus 55
- 54b. Rhizines absent 56
- 55a. Lower surface with brown-black
spongiostratum layer; lobes articulated **Anzia**
- 55b. Lower surface lacking such layer; lobes
not articulated **Heterodermia**
- 56a. Photobiont a blue green alga 57
- 56b. Photobiont a green alga 60
- 57a. Thallus homoiomerous (not zoned in sections) 58
- 57b. Thallus heteromerous (zoned in sections) 59
- 58a. Thallus blue grey, brown or grey black; upper cortex
single layered of well defined cells **Leptogium**
- 58b. Thallus brown or green black, without a cellular
upper cortex **Collema**
- 59a. Upper surface with stiff prominent hairs;
lower surface with yellow tomentum **Erioderma**
- 59b. Upper surface usually scrobiculate, lacking
stiff prominent hairs; lower surface usually bullate with
rhizines in convexities, lacking yellow tomentum **Lobaria**
- 60a. Thallus inflated and hollow, or medulla more
than twice as thick as upper cortex and often loose
and cobweb like 61
- 60b. Thallus not inflated, solid, medulla less than twice as thick
as upper cortex 62
- 61a. Upper cortex pierced by holes **Menegazzia**
- 61b. Lower cortex pierced by holes at margins or at
branching axis **Hypogymnia**
- 62a. Thallus corticated only on upper surface 63
- 62b. Thallus corticated both on upper and lower surfaces 64

- 63a. Thallus squamulose to foliose on hypothallus; apothecia
laminal, sessile **Phyllopsora**
- 63b. Thallus foliose, lobate, not on hypothallus; apothecia
marginal, stalked **Gymmoderma**
- 64a. Lobes plicate and coalescing laterally **Dirinaria**
- 64b. Lobes discrete, neither plicate or coalescing laterally 65
- 65a. Upper surface usually scrobiculate or thick
and rugose; spores transversely septate; lower surface
bullate or with diffuse tomentum **Lobaria**
- 65b. Upper surface \pm smooth; spores simple; lower surface
etomentose 66
- 66a. Thallus erect; lobes strongly canaliculated or subtubular,
once or twice dichotomously branched, yellowish;
pseudocyphellate on lower surface; usnic
acid present **Flavocetraria**
- 66b. Thallus dorsiventral; lobes linear elongate repeatedly
dichotomously branched, lacking pseudocyphellae
on both surfaces; usnic acid absent **Everniastrum**
- 67a. Thallus dimorphic, primary thallus crustose, leprose
or squamulose; secondary thallus erect, arising from
primary thallus with or without apothecia 68
- 67b. Thallus not as above 72
- 68a. Primary thallus leprose; secondary thallus of erect,
short white podetia with a continuous sorediate
crust; apothecia not known **Leprocaulon**
- 68b. Primary thallus crustose, granular or squamulose 69
- 69a. Primary thallus at least crustose in central part;
peripheral margin foliose or not; apothecial stalk small .. 70
- 69b. Primary thallus granular or squamulose 71
- 70a. Primary thallus crustose throughout; apothecial disc
pinkish **Dibaeis**
- 70b. Primary thallus lobate along peripheral margin;
apothecial disc black **Baeomyces**
- 71a. Podetia hollow, usually with apical cups and squamules;
phylocladia and cephalodia absent; spores simple **Cladonia**

- 71b. Pseudopodetia solid with granular peltate or finger like phyllocladia, lacking apical cups and squamules, usually with pale brown to blackish cephalodia; spores transversally septate **Stereocaulon**
- 72a. Thallus flattened, strap -shaped, dorsiventral (with a distinct, differently coloured upper and lower surfaces); algae concentrated near the upper surface only 73
- 72b. Thallus not flattened, terete or, if flattened, algae distributed on both lower and upper sides 78
- 73a. Marginal cilia present; thallus usually subpendulous on cliffs **Heterodermia**
- 73b. Marginal cilia absent; thallus usually in tufts (except a few *Ramalina*) 74
- 74a. Pycnidia emergent; spores simple 75
- 74b. Pycnidia immersed or absent; spores transversely 1 -septate 77
- 75a. Apothecia nephromoid 76
- 75b. Apothecia not nephromoid **Cetraria**
- 76a. Lower surface pseudocyphellate; spores ellipsoid; usnic acid usually present **Nephromopsis**
- 76b. Pseudocyphellae absent on both surfaces; spores subspherical; usnic acid absent **Tuckermannopsis**
- 77a. Thallus soft, shrubby foliose; lobes dorsiventral with paler lower surface, photobiont cells mainly confined to upper side **Evernia**
- 77b. Thallus cartilaginous, shrubby, often tufted; branches generally markedly compressed or strap -shaped, rarely rounded, not dorsiventral, of uniform colour on all sides **Ramalina**
- 78a. Thallus, podetia or pseudopodetia solid 79
- 78b. Thallus or podetia hollow in the centre 87
- 79a. Spores in mazaedium; thallus saxicolous in alpine himalaya **Acrosyphus**
- 79b. Spores not in mazaedium 80

- 80a. Thallus with a central chondroid axis within medulla 81
- 80b. Thallus lacking central chondroid axis 82
- 81a. Thallus orange to orange grey with dense longitudinal wrinkles and grooves on surface; usnic acid absent **Lethariella**
- 81b. Thallus yellowish grey to grey, lacking longitudinal wrinkles and grooves on surface; usnic acid usually present **Usnea**
- 82a. Thallus chalk white, on acidic soil and peat; a few mm tall **Siphula**
- 82b. Thallus neither chalk white nor grow on acidic soil or peats; usually larger, filamentous, caespitose 83
- 83a. Thallus brown, dark brown to black; spores colourless simple **Bryoria**
- 83b. Thallus yellow, yellowish grey; spores colourless or brown at maturity 84
- 84a. Thallus sulcate pseudocyphellate throughout its length **Sulcaria**
- 84b. Thallus otherwise 85
- 85a. Branches entirely flattened; spores transversely 1-septate, ellipsoid or kidney-shaped **Ramalina**
- 85b. Branches filamentous, not flattened; spores simple, colourless or brown 86
- 86a. Thallus yellow with brown black apices; papillae and tubercles absent; spores (absent in Sikkim specimens) brown at maturity **Alectoria**
- 86b. Thallus yellowish grey or with brownish tinge; papillae and tubercles usually present; spores colourless **Usnea**
- 87a. Thallus hollow within the central chondroid axis **Usnea**
- 87b. Thallus lacking central chondroid axis 88
- 88a. Thallus podetial in nature, with or without squamules 89
- 88b. Thallus otherwise, lacking squamules 92
- 89a. Podetia frequently present with squamules, cups or soredia **Cladonia**

- 89b. Podetia or pseudopodetia lacking squamules,
cups or soredia 90
- 90a. Podetia simple to furcated, tapering, vermiform, milky
white to grey **Thamnolia**
- 90b. Podetia profusely branched 91
- 91a. Podetial surface with elliptic perforations in cortex **Cladia**
- 91b. Podetial surface lacking perforations in cortex; primary
thallus crustose of diffuse verrucae becoming
evanescent later **Cladonia**
- 92a. Thallus usually in tufts; branches entirely flattened;
asci 8-spored; spores colourless, transversely
1-septate, ellipsoid or kidney-shaped **Ramalina**
- 92b. Thallus caespitose; branches filamentous, rounded;
asci 1-spored; spores brown, muriform **Oropogon**

CALICIACEAE

Acroscyphus Lév.

Thallus dwarf fruticose, erect, solid, firmly attached to the substratum. Podetia arising from verruculose mass, numerous, irregularly thickened; medulla solid, yellow at first, thereafter chondroid cartilaginous. Apothecia black, clavate to subglobose, mazaedium on podetial tips; spores transversely bicelled, constricted in the middle.

A monotypic genus distributed in high montane regions of Asia and America. In India, it is known only from Sikkim by the following species.

Acroscyphus sphaerophoroides Lév., Ann. Sci. Nat. Bot., ser. 3, 5: 262. 1846; Zahlbr., Cat. lich. univ. 1:681. 1922; G. Pant & D. Awasthi, Biovigyanam 15(1):4. 1989. (Figs. 5, 6)

Thallus yellowish grey to grey, irregularly thickened, rigid, occurring in large irregular patches. Podetia crowded, cylindrical to clavate, repeatedly dichotomously branched, up to 4.5–5 cm tall, 1–2 mm diam.; podetial surface verrucose. Apothecia sunken, globose, 0.5–3 mm diam., blackish; spores dark greyish, 20–30 x 10–13 µm. Chemistry: Cortex K-; medulla K-, C-, KC-, P+ red; calycin, gyrophoric acid and two unknown substances present.

It is abundant in alpine areas and grows on bare boulders in association with species of *Cetraria*.



Figs. 5-6. *Acrosyphus sphaerophorioides*. **Fig. 7.** *Baeomyces pachypus*.
Fig. 8. *Cladia aggregata*.



Fig. 9. *Cladonia amourocraea*. **Fig. 10.** *C. arbuscula*. **Fig. 11.** *C. chlorophaea*.
Fig. 12. *C. fenestralis*.

Distribution: India (Sikkim), China, Japan and Nepal; tropical America.

Specimens examined: *East Sikkim:* Kupup, near Bethang lake, alt. 4100 m, Sinha 1453. *North Sikkim:* Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1645. Theu La base camp, south side, alt. 4500 m, Sinha 1704. *West Sikkim:* Dzungri, alt. 4000 m, Sinha 760. On way between Dzungri-Thangsing, alt. 3700-3500 m, Sinha 805, 839.

BAEOMYCETACEAE

Baeomyces Pers.

Thallus marginally foliose, attached by medullary hyphae or rhizines, terricolous or saxicolous. Podetia simple, rarely branched, supporting apothecia. Photobiont green, *Cystococcus* in a continuous zone in the primary thallus. Apothecia round, swollen or expanded on tip of podetia, often clustered on ± distinct stipes; asci 8-spored; spores colourless, simple, oval or ellipsoid.

A cosmopolitan genus with ca. 40 species in the world; 2 species known from India and 1 in Sikkim.

1. **Baeomyces pachypus** Nyl., Syn. Lich. 1: 82. 1860; Upreti, Geophytology 15: 161. 1985. (Fig. 7)

Primary thallus yellowish grey, ± growing in orbicular patches, verruculose to squamulose foliose, lobate; lobes closely adpressed, 2-4 mm broad, only distinct along periphery of thallus. Podetia scattered, 6-10 mm tall, 1-3 mm diam., grey, corticate, cylindrical to compressed, cortex verruculose - areolate. Apothecia brown black, glomerulose, 1-4 mm diam.; disc convex, K-; hymenium 95-150 µm high, I+ blue; asci 50-110 x 7-13 µm; spores 8-20 x 3-6 µm. Chemistry: Primary thallus and podetia K+ yellow, C-, KC-, P-; stictic acid and two unidentified substances present.

The species grows sparsely in temperate and alpine regions on moist ground.

Distribution: India (Sikkim and West Bengal).

Specimens examined: *West Sikkim:* Near Bakhim, alt. 2500-2700 m, Sinha 739. Phedang - Dzungri foot track, alt. 3900-4025 m, Sinha 251.

ICMADOPHILACEAE

Dibaeis Clements

Primary thallus crustose, thin and smooth to minutely squamulose and verruculose, continuous to areolate, with a white hyphal mat visible between individual verrucae or areoles, sparingly lichenised on rock and some fine textured soils. Stipes absent, rare or abundant, fertile, simple or rarely sparingly branched. Apothecia ± white pruinose, sessile and adnate to stipitate; asci with I+ blue

internal apical miniscus like region (apical cap); spores simple, rarely transversely 1-septate.

A cosmopolitan genus occurring from cool temperate to tropical regions with the greatest diversity in the tropics; 13 species in the world; one in India as well as in Sikkim.

Dibaeis baeomyces (L.f.) Rambold & Hertel, *Bibliotheca Lichenol.* 53:231. 1993. – *Lichen baeomyces* L.f., *Suppl. Pl.*:450. 1782. – *Baeomyces roseus* Pers., *Ann. Bot. (usteri)* 7:19. 1794; Upreti, *Geophytology* 15:162. 1985.

Primary thallus grey, crustose to granular crustose, growing in irregular patches. Podetia numerous, scattered, 2-4 mm tall, 1-1.5 mm diam., white to reddish white, simple, cylindrical, furrowed, ecorticate. Apothecia flesh -coloured, ca. 2 mm diam.; disc convex, K+ yellow; hymenium 80-100 μ m high, I+ blue; asci 60-80 x 7-9 μ m; spores 8-18 x 3-5 μ m. Chemistry: Primary thallus and podetia K+ yellow, C-, KC-, P+ yellow; baeomycesic acid and an unidentified substance present.

It commonly grows on rocks as well as on hard soil in moist areas in temperate - alpine region.

Distribution: India (Sikkim and West Bengal); widely distributed in temperate regions of the world.

Specimen examined: West Sikkim : On way between Thangsing-Phedang track, alt. 3500 m, Sinha 865.

CLADONIACEAE

1. *Cladia* Nyl.

Thallus fruticose, composed of pseudopodetia. Pseudopodetia variously perforate, brittle, dichotomously to irregularly branched, hollow or filled with loose compacted or stranded medulla. Photobiont green, *Trebouxia*. Apothecia minute, terminal, on apices of short - terminal branches; asci 8 -spored; spores colourless, simple. Pycnidia terminal on narrow branches of sterile pseudopodetia; conidia colourless, curved.

Cladia with 8 species in the world is predominantly a southern hemisphere genus; one species in India as well as in Sikkim.

Cladia aggregata (Swartz) Nyl., *Bull. Soc. Linn. Normandie*, ser. 2, 4: 69.1870; Filson, *Journ. Hattori. Bot. Lab.* 49: 14. 1981; Upreti, *J. Econ. Tax. Bot.* 7(3): 722. 1788. – *Lichen aggregatus* Swartz, *Nov. Gen. Sp. Pl.*: 147. 1788. (Fig. 8)

Thallus occurring in upright bushy form, up to 8 cm tall. Pseudopodetia 1-3 mm diam., greyish to dark greyish, axils closed, cups absent, ends attenuate or spine like, pycnidiate or some lacking pycnidia; surface shining with numerous elliptic to oval perforations; central canal smooth. Apothecia not seen. Pycnidia

black, terminal or spine like narrow branches, ellipsoidal; conidia 3.5-5 x 0.5 μ m. Chemistry: Pseudopodetia K-, C-, KC-, P-; barbatic acid present.

The taxon is sparsely distributed in temperate regions and grows on ground in moist places.

Distribution: India (Arunachal Pradesh, Meghalaya, Nagaland, Sikkim and West Bengal). Widely distributed in Asia, Africa, America and Australia.

Specimens examined: *North Sikkim:* On way between Yakehey - Lachung, alt. 2600 m, Sinha 1108; Between Rabong - Chhaten, alt. 2350 m, Sinha 1130. *West Sikkim:* Dzungri, 4000 m, Sinha 790.

2. *Cladonia* P. Browne

Thallus dimorphic. Primary or vegetative thallus crustose to squamulose, persistent or disappearing, heteromerous, corticate on upper side, ecorticate on lower side; cortex dense, formed of + vertical hyphae; medulla white of thick walled hyphae; photobiont green, *Trebouxia*. Secondary thallus or podetia hollow, arising from primary thallus, usually upright, simple to branched, axils open or close, cup forming or cupless; surface of podetia prosoplectenchymatous, corticate or ecorticate; podetial medulla containing symbiotic algae in the form of a thin layer, outer medulla usually arachnoid and inner medulla chondroid or in strands; central cavity smooth or uneven; soredia, verrucae and squamules present or absent. Apothecia terminal on margin of cups or on podetia, lecideine, red, pale brown to brown black, usually emarginate, convex, coalescent; asci elongate-clavate, thickened at the apex, with I+ blue tholus and I+ blue outer gelatinous sheath, 8 -spored; spores colourless, simple, fusiform, oblong or ovoid; paraphyses simple, swollen at tips. Pycnidia at apices of podetia, cup rims or on basal squamules, sessile or short stalked; conidia 5-14 x 0.5-1 μ m, cylindrical, thread like, curved or rarely straight.

About 300 species in the world; ca. 60 species in India and 30 species in Sikkim.

Key to the species

- | | |
|---|-------------------------|
| 1a. Podetial axils and cups closed | 2 |
| 1b. Podetial axils and cups open | 23 |
| 2a. Apothecia and pycnidia red | 3 |
| 2b. Apothecia and pycnidia brown | 6 |
| 3a. Podetia cupless or with abrupted cups, 5-15(-20) mm tall,
awl -shaped, sorediate; barbatic, didymic and
usnic acids present | 18. <i>C. macilenta</i> |

- 3b. Podetia with distinct cups 4
- 4a. Zeorin present (fine needle crystals on surface of mature specimens) along with usnic acid; podetia 8-20 mm tall 7. **C. coccifera**
- 4b. Zeorin absent, usnic acid present 5
- 5a. Podetia 5-10 mm tall, 0.5-1 mm diam.; barbatic acid present 4. **C. borealis**
- 5b. Podetia usually more than 10 mm tall, 1-3 mm diam.; squamatic acid present 30. **C. yunnana**
- 6a. Podetia with usnic acid 7
- 6b. Podetia lacking usnic acid 10
- 7a. Podetia rudimentary, if present 3-10 mm tall with gradually flaring cups; primary squamules large, up to 10 mm wide, yellow 17. **C. luteoalba**
- 7b. Podetia well developed, more than 10 mm tall; primary squamules if present, up to 2 mm wide, rarely up to 5 mm wide, not yellow 8
- 8a. Podetia large, usually more than 60 mm tall, repeatedly 2-4 times branched; upper halves farinose sorediate 16. **C. taii**
- 8b. Podetia small, up to 30 mm tall, not repeatedly branched, either lacking soredia or with granular soredia 9
- 9a. Podetia lacking soredia, 10-20(-30) mm tall, 1-2 mm diam., primary squamules persistent 15. **C. kanewskii**
- 9b. Podetia with granular soredia, (10-)15-25(-30) mm tall, 0.5-1 mm diam.; primary squamules evanescent 13. **C. fruticulosa**
- 10a. Cups usually more wider than podetia 11
- 10b. Cups either absent or when present, usually as wide as podetia 13
- 11a. Podetia sorediate in upper part, 5-10 mm tall, simple, completely ecorticated, lacking peltate squamules; cups goblet-shaped, gradually flaring, margin denticulate 6. **C. chlorophaea**
- 11b. Podetia lacking soredia, with peltate squamules 12
- 12a. Primary squamules 1.5 x 0.5 mm, thick, leathery, forming distinctive rosettes around podetia; podetia 6-10(-20) mm tall 22. **C. pocillum**

- 12b. Primary squamules 1-3.5 x 0.5-2 mm, thin, not rosette forming; podetia 10-15(-20) mm tall 23. **C. pyxidata**
- 13a. Podetia sorediate 14
- 13b. Podetia lacking soredia 20
- 14a. Soredia farinose 15
- 14b. Soredia granular 17
- 15a. Cups altogether absent; primary squamules 1-2 mm diam., sometimes sorediate; podetia 15-25 mm tall, apices subulate; soredia shed with age and bare furrowed stereome visible 8. **C. corniculata**
- 15b. Cups present; primary squamules lacking soredia 16
- 16a. Primary squamules smaller, 2-3 x 1.5 mm; podetia larger, 17-35 mm tall; cups 1-2.5 mm diam.; basal part of podetial surface microsquamulose 29. **C. subulata**
- 16b. Primary squamules larger, (2-) 4-6 x 3 mm; podetia smaller, (5-)10-20(-25) mm tall; cups 2-4 mm diam.; basal part of podetial surface areolate, lacking microsquamules 21. **C. ochrochlora**
- 17a. Primary squamules inconspicuous; cups absent; podetia 15-35 mm tall, 0.5-1 mm diam.; surface microsquamulose sorediate 27. **C. singhii**
- 17b. Primary squamules distinct; cups present or absent 18
- 18a. Primary squamules marginally sorediate; podetia 10-20(-30) mm tall, 0.5-1.5 mm diam.; both cup bearing podetia and cupless podetia and sorediate or esorediate podetia may be found in one population 24. **C. ramulosa**
- 18b. Primary squamules lacking soredia 19
- 19a. Cups lacking; primary squamules 1-4 x 0.5-2 mm; podetia up to 15 mm tall; soredia mixed with minute squamules; pycnidia on primary squamules 5. **C. cartilaginea**
- 19b. Cups present; primary squamules 0.5-2 x 0.5 mm; podetia more than 15 mm tall; soredia not mixed with squamules; pycnidia occur on cup proliferations 3. **C. awasthiana**
- 20a. Podetia large, more than 40 mm tall 21
- 20b. Podetia smaller, less than 30 mm tall 22

- 21a. Podetia 70-110(-120) mm tall, 0.5-1 mm diam.; cups rarely present, gradually flaring, ca. 4 mm deep; podetial surface with ascending squamules 12. *C. fenestralis*
- 21b. Podetia 40-60 mm tall, 1-1.8 mm diam.; cups absent; podetial surface with dense upturned squamules and microsquamules 19. *C. macroptera*
- 22a. Podetia 5-8(-10) mm tall, 0.5-1.5(-2) mm diam., brownish, simple; surface with dense downturned microsquamules 20. *C. mongolica*
- 22b. Podetia 10-20(-30) mm tall, 0.5-1.5 mm diam., whitish grey, simple to irregularly branched; surface squamulose or lacking squamules, not microsquamulose and downturned 24. *C. ramulosa*
- 23a. Usnic acid present 24
- 23b. Usnic acid absent 26
- 24a. Podetia P+ red; fumarprotocetraric acid present 2. *C. arbuscula*
- 24b. Podetia P-; fumarprotocetraric acid absent 25
- 25a. Podetia 50-85 mm tall, branches divaricate; fertile podetia with narrow cups 1. *C. amourocræa*
- 25b. Podetia 30-45 mm tall, branches unidirectional; fertile podetia lacking cups 11. *C. delavayi*
- 26a. Distal part of podetia incompletely corticate, scabrose, microsquamulose to granulose, sometimes sorediate 26. *C. scabriuscula*
- 26b. Podetia otherwise, lacking soredia 27
- 27a. Podetia P+ red; fumarprotocetraric acid present 28
- 27b. Podetia P-; squamatic or rangiformic acids present 30
- 28a. Primary thallus absent; podetia in tufts or extensive mats, tetra or pentachotomously branched, lacking lateral fissures; branchlets in whorls of 2-3 25. *C. rangiferina*
- 28b. Primary thallus squamulose; podetia erect, not in tufts or extensive mats, anisotomic dichotomous or subcymose to subcorymbosely branched with lateral fissures; branchlets not in whorls 29
- 29a. Podetia dichotomously or irregularly branched, 30-80(-100) mm tall, cups absent; podetial surface densely squamulose, corticated with some areolation 14. *C. furcata*

- 29b. Podetia subeymose to subcorymbosely branched, 20-35(-40) mm tall, short subulate branch tips bearing pycnidia appear like cups or funnel-shaped; podetial surface esquamulose or with few squamules, discontinuously corticated9. *C. corymbescens*
- 30a. Podetia 60-90 mm tall, surface with few squamules at base; cups absent; squamatic acid present10. *C. crispata* var. *cetrariiformis*
- 30b. Podetia less than 35 mm tall; cups present or absent; surface squamulose in upper parts; squamatic acid present along with barbatic and thamnolic acids 28. *C. squamosa*

1. *Cladonia amaurocraea* (Flörke) Schaerer, Lich. helvet. spic. : 34.1823; Vainio, Acta. Soc. Fauna. Fl. Fenn. 4: 243.1887. -*Capitularia amaurocraea* Flörke in Weber & Mohr., Beitr. Naturk: 334.1810. (Fig. 9)

Primary thallus not seen. Podetia dying off in the basal region, forming mat, 50-85 mm tall, 1.5-2 mm diam., yellowish grey to grey, cylindrical, anisotomic dichotomously branched; axils open; branches tapering, ± divaricate, without squamules, generally without cups, rarely with cups; cups narrow, denticulate, with pedicellate black apothecia, 2-3 mm diam., 1.5 mm deep, abruptly flaring, interior of cups closed or open; cupless podetia with open axils; podetia esorediate, corticate; cortex continuous to dispersed verruculose. Apothecia up to 0.5 mm diam., mostly single, sometimes coalescent. Pycnidia brown. Chemistry: Podetia K-, C-, KC+ yellow, P-; usnic and barbatic acids present.

It is commonly found on ground in temperate and alpine regions.

Distribution: India (Sikkim), Nepal. Cosmopolitan.

Specimens examined: North Sikkim: Jakthang to Zema -II foot track, alt. 3400-2800 m, Sinha 1732. Sebu La base camp, west side, alt. 4500-4800 m, Sinha 1206. Theu La to Jakthang way, Sinha 1719. West Sikkim: Phedang-Dzongri foot track, 3 km point, alt. 3900-4025 m, Sinha 260. Yoksum, Bose 60:74 (LWU & Herb. Awasthi)

2. *Cladonia arbuscula* (Wallroth) Hale & W. Culb., Bryologist 73:510,1970; Ahti, Fl. Neotropica 78:43. 2000. -*Patellaria foliacea* var. *arbuscula* Wallroth, Naturgesch. Saulchen -Flecht. :169. 1829. (Fig. 10)

Primary thallus not seen. Podetia 40-60(-100) mm tall, yellow green, richly branched; terminal branches strongly oriented in one direction, branching predominantly trichotomous and tetrachotomous at apices; young apices up to 2 mm diam., blunt, forming a dense crown; axils open; podetial surface slightly verruculose. Apothecia brown, inconspicuous, rather rare. Pycnidial jelly colourless. Chemistry: Podetia K-, C-, KC+ yellow, P+ red, UV-; fumarprotocetraric and usnic acids present.

It sparsely grows in upper limit of temperate and alpine zone on ground particularly amongst *Rhododendron* and *Juniperus* shrubs.

Distribution: India (Sikkim), Nepal; Asia, Europe, North and South America.

Specimens examined: North Sikkim : Near Chungthang, alt. ca.2450 m, Sastry 673. Sebu La base camp, alt. 4960 m, Sinha 1243. Thangu, along Teesta Bank, alt. 3800 m, Sinha 1153.

3. *Cladonia awasthiana* Ahti & Upreti, Bibliotheca Lichenol. 88:9. 2004.

Primary thallus squamulose; squamules 0.5-2 x 0.5 mm, irregularly crenate, upper surface grey green, lower surface white, esorediate. Podetia 15-35 mm tall, 0.7-1.2 mm diam., whitish grey, usually sparsely dichotomously to trichotomously branched in upper halves, axils closed; podetial surface ecorticate, sorediate throughout; soredia granular; cups present, terminal, up to 2 mm diam., margin with small proliferations tipped with pycnidia, imperforate, sorediate. Apothecia not seen. Chemistry: Podetia K-, C-, KC-, P+ orange-red; fumarprotocetraric and homosekikaic acids present.

The species sparsely grows on ground amidst *Rhododendron* bushes.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Sikkim and Uttaranchal).

Specimen examined: North Sikkim: Theu La base camp, south side, alt. 4500 m, Sinha 1694.

4. *Cladonia borealis* S. Stenroos, Ann. Bot. Fenn. 26:160. 1989.

Primary thallus squamulose; squamules persistent, 3-6 mm long, 2-5 mm wide, whitish grey, sparsely divided in to roundish lobes. Podetia 5-10 mm tall, 0.5-1 mm diam., yellowish green, simple, cup bearing, gradually flaring; cups (1-)2-4 mm diam.; surface of podetia smoothly to shallowly areolate-corticate, with basal parts often slightly rugulose and squamulose, upper part sparsely squamulose, esorediate; interior of cups corticated; surface of central canal rugulose. Apothecia not seen. Pycnidia on cup margins; conidia 6 x 1 µm, falciform. Chemistry: Podetia K-, C-, KC+ yellowish, P-; usnic and barbatic acids present.

The species sparsely grows in alpine areas of Sebu La in North Sikkim on ground.

Distribution: India (Sikkim); circumpolar in Northern hemisphere, being common especially in boreal and arctic zones.

Specimen examined: North Sikkim: Sebu La base camp, east side, alt. 4960 m, Sinha 1236 (det. T. Ahti).

5. *Cladonia cartilaginea* Müll. Arg., Flora 63:20. 1880; Vainio, Acta Soc. Fauna. Fl. Fenn. 10: 19, 1894; Ahti *et al.*, Lichenologist 34(4): 307. 2002.

Primary thallus squamulose; squamules persistent to evanescent, 1-4 mm long, 0.5 - 2 mm wide, irregularly lobed, somewhat laciniate, upper surface yellowish grey, lower surface white. Podetia 6-15 mm tall, 0.5-2 mm diam. at base, grey to whitish grey, mostly simple, rarely dichotomously to irregularly branched near tips; branches anisotomic to isotomic with closed axils, cups absent; surface ecorticate, often granular sorediate, soredia mixed with minute squamules; stereome hard; central canal striate. Apothecia 0.5-1 mm diam., red brown, solitary or in corymbosely arranged groups, usually non coalescent; spores fusiform, $7 - 13 \times 2.5 - 3.5 \mu\text{m}$. Pycnidia on primary thallus, brown black. Chemistry: Podetia and squamules K-, C-, KC-, P + yellow - orange; fumarprotocetraric acid, traces of protocetraric and confumarprotocetraric acids present.

It grows on bare soil along roads.

Distribution: India (Arunachal Pradesh, Jammu & Kashmir, Manipur, Meghalaya, Karnataka, Kerala, Sikkim, Tamil Nadu and Uttaranchal); South and Middle America.

Specimens examined: East Sikkim: Gangtok, Tashi view point, alt. 1750 m, S. Chatterjee & P. K. Divakar 20-77178 (LWG). West Sikkim: Pemayangtse monastery surroundings, 2075 m, Sinha 175.

6. *Cladonia chlorophaea* (Flörke) Sprengel, Car. Linn. Syst. veg. ed. 16, 4: 273, 1827. -*Cenomyce chlorophaea* Flörke in Sommerf., Suppl. Fl. Lappon: 130, 1826. (Fig. 11)

Primary thallus squamulose; squamules persistent, 2 x 0.5 mm, irregularly lobed, flat or involute, upper surface greenish grey, lower surface white, esorediate or granular sorediate on margin. Podetia 5-10 mm tall, 0.5-1 mm diam. at base, grey to whitish grey, simple, with cups; cups 2-5 mm diam., 1-4 mm deep, goblet to trumpet-shaped, gradually flaring, imperforate and ecorticate, granular sorediate on inner side; margin entire, grooved - dentate and proliferate; entire margin with pycnidia; grooved - dentate margin with apothecia and proliferated margin with second tier of cups, proliferated 1-2 times; podetia corticate, verruculose to areolate near base, ecorticate sorediate above, rarely partially farinose to generally granular sorediate, sometimes granules enlarged, subverruculose, ecorticate areas striate, rugose, opaque to semipellucid. Apothecia on tips of minute stipes or sessile on the margin of cups, brown to brown black, less than 0.5 mm diam., non coalescent, K-; spores not seen. Pycnidia sessile on margin of cups, brown to brown black. Chemistry: Podetia and squamules K-, C-, KC-, P + orange - red; fumarprotocetraric acid present.

It sparsely grows on decaying wood and on the ground in open places.

Distribution: India (Jammu & Kashmir, Himachal Pradesh, Tamil Nadu, Uttaranchal and West Bengal), Nepal. Cosmopolitan.

Specimens examined: North Sikkim: Llonakh valley, Chhaber lake below Luna La, alt. 4600 m, Sinha 1598. Nampruk village surroundings, T. A. M. Jagadeesh Ram 1747.

7. *Cladonia coccifera* (L.) Willd., Fl. Berol. Prodr.:361. 1787. –*Lichen cocciferus* L., Sp. Pl. :1151. 1753. –*Cladonia applanata* Räsänen, Arch. Soc. Zool. Bot. Fenn. 'Vanamo' 5:28. 1950.

Primary thallus squamulose, persistent; squamules (2-)3-6 x 2-3 mm, whitish grey, ascending, lower surface brownish towards base. Podetia 8-20 mm tall, 1-2 mm diam., usually yellowish, rarely whitish grey, usually unbranched, tipped by single cup, but occasionally proliferating from cup to form another cup; cups gradually flaring, 3-8 mm diam.; surface smooth or uneven, ± corticated throughout with coarse granules, a few microsquamules and a few phyllidia extending up to cups; granules, microsquamules and phyllidia get detached with age, giving appearance of sorediate surface, but not truly sorediose; central canal ± smooth, slightly striate. Apothecia and pycnidia red, K+ red, common on margin of cups, disc up to 3 mm diam., spores fusiform to oblong, 5-8 x 2-3.5 µm. Conidia falciform, 3 x 0.5 µm. Chemistry: Podetia K-, C-, KC+ yellowish, P-; usnic acid, isousnic acid and zeorin present.

The species commonly grows on humus soils and occasionally on dead trunks of *Abies densa*.

Distribution: India (Arunachal Pradesh, Sikkim, Uttaranchal and West Bengal). Circumpolar in N. Hemisphere south to the Himalaya, Java, Papua New Guinea.

Specimens examined: North Sikkim: Llonakh valley, Chhaber lake below Luna La, alt. 4600 m, Sinha 1599. On way between Yakche-Lachung, 2600 m, Sinha 1106. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1042. Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1653. Theu La base camp, south side, alt. 4500 m, Sinha 1689. Zema -I, alt. 2750 m, Sinha 1530. West Sikkim: Dzungri, alt. 4000 m, Sinha 773.

8. *Cladonia corniculata* Ahti & Kashiwadani in H.Inoue, Stud. Cryptog. S. Chile :136. 1984; Ahti *et al.*, Lichenologist 34 (4): 307. 2002.

Primary thallus squamulose, persistent; squamules suborbicular, 1-2 mm wide, lobed, sometimes sorediate. Podetia greyish white, 15-25 mm tall, 0.5-1.5 mm diam., sparingly and unequally branched near apices, axils closed, cups absent, apices subulate; surface completely ecorticate or with very little cortex near base, sorediate, with age soredia are shed and only bare, slightly furrowed stereome visible; soredia farinose to slightly granulose; podetial microsquamules sometimes present at base only; stereome cartilaginous, central canal surface striate. Apothecia not seen. Pycnidia short, globose, conidia not seen. Chemistry: Podetia K-, C-, KC-, P+ red; fumarprotocetraric and stictic acid present. Protocetraric, constictic and norstictic acid also reported in traces.

The species has been misidentified as *C. coniocraea* (Flörke) Sprengel and *C. ramulosa* in Indian herbaria (LWG, ASSAM, BSHC). It commonly grows on soil along roadside at lower elevations in the mountains.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Kerala, Meghalaya, Sikkim, Tamil Nadu and Uttaranchal), China, Thailand; South Africa and South America.

Specimens examined: *East Sikkim:* Near Lower Zuluk, alt. 2300 m, Sinha 886. *North Sikkim:* On way between Yakche-Lachung, alt. 2600 m, Sinha 1107. *West Sikkim:* Kongri village forest, alt. 2000 m, Sinha 336 A. On way between Karchi-Narkhola, alt. 2100-1800 m, Sinha 359.

9. *Cladonia corymbescens* Nyl. ex Leighton, Ann. Mag. Nat. Hist. ser. 3, 18:407, 1866.

Primary thallus squamulose; squamules persistent or evanescent, 1-2.5 x 0.5-1 mm, lobed, upper surface greenish grey, lower surface white. Podetia 20-35(-40) mm tall, 0.6-1.2 mm diam., off white to partly brownish, irregularly branched, subcymose to subcorymbosely branched near apices, axils open; surface discontinuously corticated, with lateral fissures and perforation, esquamulose, microsquamulose to squamulose, esorediate; cups absent, but short subulate branch tip with pycnidia appear like cups; central canal surface minutely papillose. Apothecia rare, terminal, 0.2-0.4 mm diam., convex, pale brown to dark brown, spores not seen. Chemistry: Podetia K- or K+ weak yellow, C-, KC-, P+ yellow-orange; atranorin, fumarprotocetraric acid and protocetraric acid present.

The species commonly grows on soil along roadsides and along border of newly cut areas.

Distribution: India (Eastern and Western Himalaya, Sikkim), China, Nepal, Australia, Melanesia, New Zealand.

Specimens examined: *East Sikkim:* Kupup, alt. 4100-4200 m, Sinha 1504. *North Sikkim:* Lachen, alt. 2700 m, Sinha 1536. Lachung, alt. 2650 m, Sinha 1123. On way between Phuni-Yakche, alt. 3000 m, Sinha 1103. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1044. Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1654. Zema -I, alt. 2750 m, Sinha 1531. *West Sikkim:* Bakhim, alt. 2500-2700 m, Sinha 731, 733. Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 184, 256.

10. *Cladonia crispata* (Ach.) Flotow in Wendt var. ***cetrariiformis*** (Delise) Vainio, Acta. Soc. Fauna Fl. Fenn. 4:392. 1887. -*Cenomyce gracilis* var. *cetrariiformis* Delise in Duby, Bot. Gall. 2:625. 1830, as '*cetrariaeformis*'

Primary thallus squamulose; squamules persistent or evanescent, 1.5-2 x 1 mm. Podetia 60-90 mm tall, 1-1.5 mm diam., pale brown, irregularly or radiately branched, lacking cups; axils open; tips subulate or bluntish; surface minutely

rugulose, arachnoid towards tips, corticated to areolate with some squamules near base with occasional longitudinal slits; surface of central canal minutely papillose. Pycnidia dark brown, frequent, at apices of podetia. Chemistry: Podetia K-, C-, KC-, P-; UV+ white; squamatic acid present.

It sparsely grows on ground in alpine West Sikkim.

Distribution: India (Sikkim); Europe, N. America & S. America, Asia, Australia, New Zealand.

Specimen examined: West Sikkim: Dzungri, L.K.Rai. 1750 (det. T. Ahti).

11. *Cladonia delavayi* des Abb., *Candollea* 16: 203. 1958; K. Singh & Upreti, *Geophytology* 16 : 115. 1986.

Primary thallus not seen. Podetia in dense mats, erect to intertangled and with ascending apices, 30-45 mm tall, 1-2 mm diam., whitish grey to greenish grey, without squamules, cylindrical, dichotomously to trichotomously branched; branches generally unidirectional (helicoid), anisotomic or isotomic to sympodial; apices straight to sharply curved, tipped with apothecia or pycnidia; axils open, usually closed at lower branches; cups absent; podetia corticate, esorediate; cortex smooth to verruculose areolate. Apothecia on tips of branches, stipitate, dark brown to black, ca. 0.5 mm diam., coalescent or not, K-, immature. Pycnidia on the tips of branches, brown black. Chemistry: Podetia K-, C-, KC + yellow, P-; usnic acid and an unidentified substance present.

It commonly grows on ground amongst *Rhododendron* shrubs.

Distribution: India (Arunachal Pradesh, Sikkim, Uttaranchal and West Bengal), Nepal.

Specimens examined: East Sikkim: Chhangu, D.D.Awasthi 109 (LWU & Herb. Awasthi) Kupup, alt. 4000-4200 m, Sinha 1508. *North Sikkim:* Between Phuni-Yakche, alt. 3000 m, Sinha 1104. Lashar, alt. 4500 m, Sinha 1186. Llonakh valley, Chhaber lake below Luna La, alt. 4600 m, Sinha 1602. Sebu La base camp, west side, Sinha 1209. Thangu, Chepta valley, alt. 3900 m, Sinha 1643. Theu La base camp, south side, alt. 4500 m, Sinha 1693. *West Sikkim:* Dzungri, Bosc 60:97 & 60:127. (LWU & Herb. Awasthi). Phedang-Dzungri 3 km foot track, alt. 3900-4025 m, Sinha 262. Thangsing-Samiti foot track, 3 km point, alt. 3700 m, Sinha 825.

12. *Cladonia fenestralis* Nuno, *J. Jap. Bot.* 50:291. 1975. (Fig. 12)

Primary thallus not seen. Podetia 70-110(-120) mm tall, 0.5-1 mm diam. near base; basal part black, remaining part brownish grey, longitudinally splitting at places, squamulose; secondary squamules moderate to dense, ascending; axils closed; cups usually absent, when present 1-1.5 mm diam., up to 4 mm deep, gradually flaring, margin dentate, pycnidiate, with marginal proliferations; stereome compact; podetial surface corticated, cortex dispersed, scrobiculate,

ecorticated part brown; soredia absent. Mature apothecia not seen. Chemistry: Podetia and squamules K+ yellow or K-, C-, KC-, P+ red; fumarprotocetraric acid present.

It commonly grows on ground in open moist places above 3000 m altitudes.

Distribution: India (Eastern Himalaya), Malaysia.

Specimens examined: *East Sikkim:* Kupup, alt. 4100 m, Sinha 1440. *North Sikkim:* Between Phuni-Yakche, alt. 3000 m, Sinha 1102. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1045. Theu La base camp, alt. 4500 m, Sinha 1688. On way between Theu La-Jakthang, alt. 4600-3400 m, Sinha 1721. *West Sikkim:* Near Bakhim, alt. 2500-2700 m, Sinha 734 A. Between Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 263.

13. *Cladonia fruticulosa* Krempelh., Verh. K.K. Zool. Bt. Ges. Wien 30: 331. 1881.

Primary thallus squamulose; squamules persistent, 2-5 x 1 mm, slightly to deeply lacinate, upper surface grey to brownish, lower surface white, often granular sorediate on upper margin and below. Podetia (10-)15-25(-30) mm tall, 0.5-1 mm diam., simple, rarely branched, axils closed, cup bearing; surface corticate or completely ecorticate, often partly granular sorediate; cups well defined or deformed, up to 2 mm diam., inside ecorticate, often terminal with proliferations and second tier of cup. Apothecia 1-1.5 mm diam., stalked; disc convex, pale brown to dark brown; spores not seen. Pycnidia marginal on proliferations, conidia not seen. Chemistry: Podetia K-, C-, KC-, P+ deep yellow; fumarprotocetraric, psoromic, usnic and protocetraric acids present.

The species commonly grows on soil in open moist places particularly along road cuttings above 1600 m altitudes.

Distribution: India (Eastern Himalaya), Eastern Asia and Australia.

Selected specimens examined: *East Sikkim:* Gangtok, near Burtuk, alt. 1700 m, Sinha 91. On way between South Regu-Picrae forest, alt. 1900 m, Sinha 501. Singhanebans village surroundings, alt. ca. 2200 m, Sinha 949. *North Sikkim:* Near Lingzea village, alt. 1500 m, Sinha 651. Pentong village surroundings, alt. 1500 m, Sinha 632. *South Sikkim:* Namchi-Old Darthang road, 5 km point, alt. 1700-2000 m, Sinha 43. *West Sikkim:* Kacheopalri lake surroundings, alt. 1850 m, Sinha 283. Kongri village forest, alt. 2000 m, Sinha 335. Tashiding Monastery surroundings, alt. 1600 m, Sinha 323. Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 184.

14. *Cladonia furcata* (Huds.) Schrader, Spic. Fl. Germ.: 107. 1794; Vainio, Acta. Soc. Fauna. Fl. Fenn. 4: 316. 1887. -*Lichen furcatus* Huds., Fl. Angl.: 458. 1762.

Primary thallus squamulose; squamules evanescent, 1-4 x 0.5-2 mm, irregularly incised lobed, erect, involute, upper surface pale brown, lower surface white.

Podetia 30-80 (-100) mm tall, 0.5-2 mm diam. at base, whitish grey to yellowish brown, branching dichotomously to irregularly anisotomous, cylindrical to slightly compressed, axils open, dilated to longitudinally split near branching, cups absent; surface corticated with some areolation, esorediate, densely squamulose; central canal minutely papillose. Apothecia brown black, less than 1 mm diam., non coalescent, immature, K-. Pycnidia brown to brown black, present on sterile podetia; conidia falciform, 5-6 x 1 μ m. Chemistry: Podetia and squamules K- or K+ yellowish, C-, KC-, P+ yellow - orange red; fumarprotocetraric acid present.

It commonly grows on ground as well as on basal part of trees and bushes in temperate and alpine regions.

Distribution: India (Arunachal Pradesh, Manipur, Nagaland, Sikkim, Uttaraanchal and West Bengal); warm to cold temperate areas of the world.

Specimens examined: *East Sikkim:* Pangolakha scrub, alt. 2900 m, Sinha 938. *South Sikkim:* On Damthang-Tendong 6 km foot track, alt. 2000-2600 m, Sinha 144. *West Sikkim:* Phedang-Dzongri 3 km foot track, alt. 3900-4025 m, Sinha 758. Labdang forest, alt. 1900-2000 m, Sinha 459. Tsoka-Phedang foot track, alt. 3050-3900 m, Sinha 217.

15. *Cladonia kanewskii* Oxner, Ukr. Bot. Zhurn. 3: 9, 1926; Ahti *et al.*, Lichenologist 34(4): 308, 2002. (Fig. 13)

Primary thallus not seen. Podetia yellowish grey, somewhat robust, 10-20(-30) mm tall, 1-2 mm diam., branching isotomic dichotomous, sparse, ascending, subulate, with spine like tips in few, axils open or closed, esorediate, cups usually lacking, rarely present in few, terminal, up to 2 mm diam., perforated; surface bullate in appearance, with abundant unknown terpene crystals as whitish cover; inner podetial surface smooth with narrow cracks which expose floccose hyphae, with inner cartilaginous strands forming a continuous uneven layer around the central canal, some strands scattered in the middle. Pycnidia and apothecia not seen. Chemistry: Podetia K-, C-, KC+ yellow, P-; usnic acid. Abundant terpene crystals present on tips of podetia as whitish cover.

It grows on soil in moist alpine areas.

Distribution: India (Sikkim), Mongolia; Western North America.

Specimens examined: *East Sikkim:* Kupup, north border side, alt. 4100-4200 m, Sinha 1505. *North Sikkim:* Sebu La base camp, east side, alt. 4960 m, Sinha 1239.

16. *Cladonia laii* S. Stenroos, Acta Bryolichenol. Asiat. 1:53, 1990(1989); Ahti *et al.*, Lichenologist 34(4): 308, 2002. (Fig. 14)

Primary thallus squamulose; squamules persistent to evanescent, 1.5-2 x 0.5 mm, deeply divided into lobes, upper surface brownish grey, lower surface white. Podetia (25-)60-100 mm tall, 1-1.5 mm diam., yellowish green, usually elongated,

cup bearing, repeatedly 2-4 times branched by marginally proliferating cups; cups gradually flaring, 2-3.5 mm diam., shallow, margins dentate or with long proliferations; surface ecorticate, but in basal parts partially areolate-corticate and sparsely squamulose, upper half usually farinose sorediate, with occasional longitudinal slits; surface of central canal slightly grooved. Apothecia not seen. Pycnidia borne on short proliferations of cup margins, conidia not seen. Chemistry: Podetia K-, C-, KC-, P-; usnic, barbatic and 4-o-demethylbarbatic acids present.

It commonly grows on ground in moist alpine areas.

Distribution: India (Sikkim and Uttaranchal), Bhutan, Nepal, China, Taiwan.

Specimens examined: North Sikkim: Llonakh valley, Chhabber lake, below Luna La, alt. 4600 m, Sinha 1601, Thangu, Chepta valley, alt. 3900 m, Sinha 1659. Theu La to Jakthang way, alt. 4600-3400 m, Sinha 1718 (both specimens det. by T. Ahti).

17. *Cladonia luteoalba* Wheldon & A Wilson, Fl. W. Lancashire :450. 1907; Ahti *et al.*, Lichenologist 34(4): 308. 2002.

Primary thallus squamulose; squamules persistent, conspicuous, rounded, 2-10 mm wide, rarely indented, margin ascending, upper surface greenish yellow, lower surface pale yellow and cottony arachnoid, usually recurved, exposing lower surface, appear sorediate but not truly sorediate. Podetia up to 10 mm long, rare and rudimentary, ecorticate and blackened when old, usually hidden between squamules. Apothecia rare, on margins of cup, or sessile on squamules. Chemistry: Squamules and podetia K-, C-, KC+ yellow, P-; usnic acid and zeorin present.

It is a soil lichen or growing on other species of *Cladonia* on peaty soils of cold climate.

Distribution: India (Arunachal Pradesh, Sikkim and Uttaranchal), China, Japan, Nepal; Oceanic Europe.

Specimen reported: Sikkim, no locality, alt. 1830 m, J.D. Hooker 2102 (BM) – det. & reported by T. Ahti.

18. *Cladonia macilenta* Hoffm., Deut. Fl. :126. 1796; Vainio, Acta. Soc. Fauna. Fl. Fenn. 4: 98. 1887. (Fig. 15)

Primary thallus squamulose; squamules persistent, 0.5-2.5 mm long, 0.5-1.5 mm wide, irregularly lobed or incised, involute or flat, upper surface olive grey, lower surface white, marginally granular sorediate or esorediate. Podetia 5-15(-20) mm tall, 0.5-2 mm diam. at base, whitish grey, with dense squamules, mostly simple or rarely irregularly branched; axils closed, usually cupless but sometimes forming cup bearing axils; branches slightly tapering and tipped with apothecia; surface ecorticate in major part of podetia, granular sorediate or esorediate; basal part corticate; cortex continuous to verruculose areolate; central canal minutely

papillose. Apothecia on tips of branches or on margin of cups, red, less than 0.5 mm diam., coalescent or not, immature, K+ red colour oozes out. Pycnidia not seen. Chemistry: Podetia and squamules K-, C-, KC-, P-; barbatic, didymic and usnic acids present.

It sparsely grows on decaying wood stumps in open places.

Distribution: India (Tamil Nadu and West Bengal); Africa, Asia, North and South America, Australia and Europe.

Specimens examined: North Sikkim: Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1657, 1658.

19. *Cladonia macroptera* Räsänen, J. Jap. Bot. 16:149. 1980. (Fig. 16)

Primary thallus squamulose; squamules persistent, 1.5-3.5 x 1-2.5 mm, deeply incised to lacinate, upper surface grey green, lower surface white. Podetia 40-60 mm tall, 1-1.8 mm diam., greenish to grey black, anisotomic dichotomously or irregularly branched, tips usually furcated, narrow pointed, axils open or close, cupless, esorediate; surface corticated, cortex smooth to chinky areolate with dense upturned squamules and microsquamules; stereome brownish, slightly soft. Apothecia absent. Pycnidia brown black, present on narrow podetial tips, conidia not seen. Chemistry: Podetia K-, C-, KC-, P+ red; fumarprotocetraric acid present.

It commonly grows on base of tree trunks as well as on ground in open temperate areas.

Distribution: India (Eastern Himalaya), Japan.

Specimens examined: East Sikkim: Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1457. North Sikkim: Theu La-Jakthang way, alt. 4600-3400 m, Sinha 1720. West Sikkim: On way between Dzongri-Tangsing, 3900-3500 m, Sinha 806.

20. *Cladonia mongolica* Ahti in Huneck *et al.*, Nova Hedwigia 44:196. 1987; Ahti *et al.*, Lichenologist 34(4): 309. 2002. (Fig. 17)

Primary thallus squamulose; squamules persistent, 2-2.5 x 1.5(-2) mm, upper surface grey brown, lower surface brown in basal part, white along margin. Podetia short, 5-8(-10) mm tall, 0.5-1.5(-2) mm diam., stiff, brownish, unbranched, esorediate but with few granules in distal parts, with narrow, 1-1.5 mm diam. cups, tips otherwise blunt with reduced blackish apothecia; surface rough, with dense downturned microsquamules, detached microsquamules leave whitish area at places; inner cortex layer light brownish. Apothecia very reduced, spores not seen. Pycnidia not seen. Chemistry: Podetia K-, C-, KC-, P+ orange red or red; fumarprotocetraric acid present.

It sparsely grows on rotten wood and mossy boulders in open moist temperate areas.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Sikkim and Uttaranchal), Bhutan, China, East Nepal, Mongolia and Russian Far East.

Specimens examined: *East Sikkim:* Near Meimenchu check post, alt. 3700 m, Sinha 1416. *North Sikkim:* Theu La base camp, south side, alt. 4500 m, Sinha 1691 B.

21. *Cladonia ochrochlora* Flörke, De Cladon.: 75. 1828.

Primary thallus squamulose; squamules persistent or evanescent, (2-)4-6 mm long, ca. 3 mm wide, irregularly lobed, lobes subdigitately crenate to incised, concave or involute, ascending, upper surface dark grey, lower surface white, darkening towards base, sparingly granular-sorediate below. Podetia growing from upper surface of primary squamules, (5-)10-20 mm tall, 1-2 mm diam., cylindrical, unbranched or branched once by proliferating cups, rarely subulate; cups 2-3 mm diam., closed, shallow, imperforate, margin proliferating rarely in to second tier; surface continuous or areolate near base and below apothecia, elsewhere ecorticate and farinose sorediate, or whitish grey or olive, dying parts black, with or without podetial squamules; surface of central canal papillose. Apothecia brown, at tips of podetia or on margin of cups, 1-2.5 mm diam.; disc pale to dark brown; spores fusiform, 8-12 x 2 μ m. Pycnidia common on margin of cups; conidia 5-6 x 0.5-1 μ m, falciform. Chemistry: Squamules and podetia K- or K+ faint brownish, C-, KC-, P+ red; fumarprotocetraric and protocetraric acids present.

It commonly grows above 3000 m altitudes on tree bases, rotten wood as well as on humus soil.

Distribution: India (Eastern Himalaya), Nepal; temperate and boreal areas of southern and northern hemisphere.

Specimens examined: *East Sikkim:* Kupup, north border side, alt. 4100-4200 m, Sinha 1506. Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1458. *North Sikkim:* Between Phuni-Yakche, alt. 3000 m, Sinha 1101. Theu La base camp, south side, alt. 4500 m, Sinha 1692. *West Sikkim:* Near Bakhim, alt. 2500-2700 m, Sinha 734 B. On way between Thansing-Phedang, alt. 3500 m, Sinha 863.

22. *Cladonia pocillum* (Ach.) Grognot, Pl. Crypt. Saone-et-Loire : 82. 1863.

Baeomyces pocillum Ach., Meth. Lich. : 336. 1803. (Fig. 18)

Primary thallus squamulose; squamules persistent, 1.5 x 0.5 mm, margin entire, upper surface dark brown, lower surface chalk-white. Podetia 6-10(-20) mm long, 1-1.5 mm diam., greenish brown to brown black, simple, cup bearing; cups 2-6 mm diam., shallow, imperforate, gradually flaring, single or rarely with marginally proliferating additional cups, surface \pm corticated, verruculose to squamulose in lower parts, upper parts becoming ecorticate, granulose to phyllidoid including inside the cups; surface of central canal striate to grooved. Immature apothecia and pycnidia common on cup rims. Chemistry: Podetia and squamules K-, C-, KC-, P+ red; fumarprotocetraric acid, psoromic acid and atranorin present.

It commonly grows on calcareous soils and rocks in grasslands and alpine scrubs.

Distribution: India (Eastern Himalaya); widely spread in the world, primarily in temperate to arctic and antarctic regions extending to mountains in low altitudes.

Specimens examined: North Sikkim: Llonakh valley, Chhaber lake surroundings, alt. 4600 m, Sinha 1600. Theu La base camp, south side, alt. 4500 m, Sinha 1691 A.

23. *Cladonia pyxidata* (L.) Hoffm., Deut. Fl. 2: 121. 1796; Vainio, Acta Soc. Fauna Fl. Fenn. 10: 209. 1894; Thomson, Lich. Gen. Clad. North America: 104. 1966. *Lichen pyxidatus* L., Sp. Pl. : 1151. 1753.

Primary thallus squamulose; squamules persistent, 1-3.5 mm long, 0.5-2 mm wide, margin entire to irregularly lobed with few indentations, involute; upper surface greenish grey; lower surface white. Podetia 10-15(-20) mm tall, 1-2 mm diam. at base, greenish grey to blackish, young ones yellowish, simple with peltate appressed squamules, cup bearing; cups 3-5 mm diam., 1-3 mm deep, gradually flaring, marginally or centrally proliferating in to second tier of podetia or with pycnidia; surface corticated, becoming cracked, areolate and ecorticate above, usually with phyllidia and granules especially inside cups, esorediate; podetial wall inner surface smooth. Apothecia on tips of minute stipes, disc brown to brown black, up to 2 mm diam.; spores 7-12 x 3.5 μ m. Pycnidia common, on margin of cups, brown to brown black; conidia 5-7 x 1 μ m. Chemistry: Podetia and squamules K-, C-, KC-, P+ red; fumarprotocetraric acid present.

The species commonly grows on humus soil in open places in temperate areas.

Distribution: India (Jammu & Kashmir, Sikkim and Uttaranchal), Nepal. Cosmopolitan.

Specimens examined: North Sikkim: Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1655. West Sikkim : Thangsing-Samiti foot track, 3 km point, alt. 3700 m, Sinha 835.

24. *Cladonia ramulosa* (With.) J.R. Laundon, Lichenologist 16:225. 1984 -*Lichen ramulosus* With., Bot. Arr. Veg. Gr. Brit.:723. 1776. -*Cladonia pityrea* (Flörke) Fr., Nov. Sched. Crit. : 21. 1826.

Primary thallus squamulose; squamules 1-4 x 0.5-1.5 mm, upper surface whitish grey or pale grey, lower surface white, marginally soresediate, irregularly incised lobate. Podetia 10-20(-30) mm tall, 0.5-1.5 mm diam., whitish grey to brownish, simple to irregularly branched, axils closed, cups present or absent; cup bearing podetia cylindrical with blunt ends; cups abruptly flaring, 1-2 mm diam., imperforate, margin proliferating with apothecia; surface corticate,

squamulose, sorediate or esorediate; cupless podetia cylindrical, dichotomously to irregularly branched near apices, tapering with pointed ends; surface ecorticate, squamules absent, densely granular sorediate; medulla arachnoid; central canal \pm smooth. Apothecia sessile on tips of podetia or cup margins, crowded, dark brown to blackish, coalescent, up to 2 mm diam., K-; spores fusiform, 5-10 x 2-3 μ m. Pycnidia on cup margins, blackish. Chemistry: Podetia and squamules K-, C-, KC-, P+ yellow-orange; fumarprotocetraric acid present.

The taxon abundantly grows on hard soil along road cuttings in subtropical areas.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal). Cosmopolitan.

Specimens examined: East Sikkim: Gangtok, near Burtuk, alt. 1700 m, Sinha 91. Hanuman tok, Chhatterjee & Divakar 20-77020, 20-77081 (LWG). West Sikkim : Kongri village forest, alt. 2000 m, Sinha 335.

25. *Cladonia rangiferina* (L.) Wigg., Prim. fl. holsat. : 90. 1780; Vainio, Acta Soc. Fauna Fl. Fenn. 4: 9. 1887. -*Lichen rangiferinus* L., Sp. Pl.: 1153-1753. (Fig.19)

Primary thallus not seen. Podetia in tufts or in extensive mats, 50-110 mm tall, up to 3 mm diam. at base, grey to whitish grey in upper parts, blackish in basal dying parts, squamules absent; podetia tetra- or penta- chotomously branched, esorediate; branches anisotomic, ultimate branchlets in whorls of 2-3 around an open axil; branchlets curved to one side or spreading, tipped with pycnidia or apothecia; surface arachnoid with greenish areoles, verruculose; podetial wall inner surface smooth. Apothecia on the tips of branches, stipitate, brown black, less than 0.5 mm diam., coalescent or not, K-, immature. Pycnidia brown black, on tips; conidia not seen. Chemistry: Podetia K+ yellow, C-, KC-, P+ red; atranorin and fumarprotocetraric acid present.

Distribution: India (Arunachal Pradesh and Sikkim), Nepal; arctic to temperate regions of the world.

Specimens examined: West Sikkim: On way between Dzongri-Thangsing, alt. 3900-3700 m, Sinha 807. Phedang-Dzongri, 3 km foot track, 3900-4000 m, Sinha 261.

26. *Cladonia scabriuscula* (Delise) Nyl., Compt. Rend. Hebd. Seances Acad. Sci. 83: 88. 1876. -*Cenomyce scabriuscula* Delise in Duby, Bot. gall., ed 2: 623. 1830.

Primary thallus squamulose; squamules 1.5-3 x 1-1.5 mm, soon disappearing. Podetia 3-8 cm tall, 1-2 mm diam., greyish to greenish white, sparsely dichotomously branched, cups absent, tips subulate, axils open; surface areolate, corticated; cortex smooth, thin, scaling off to form podetial squamules; podetial

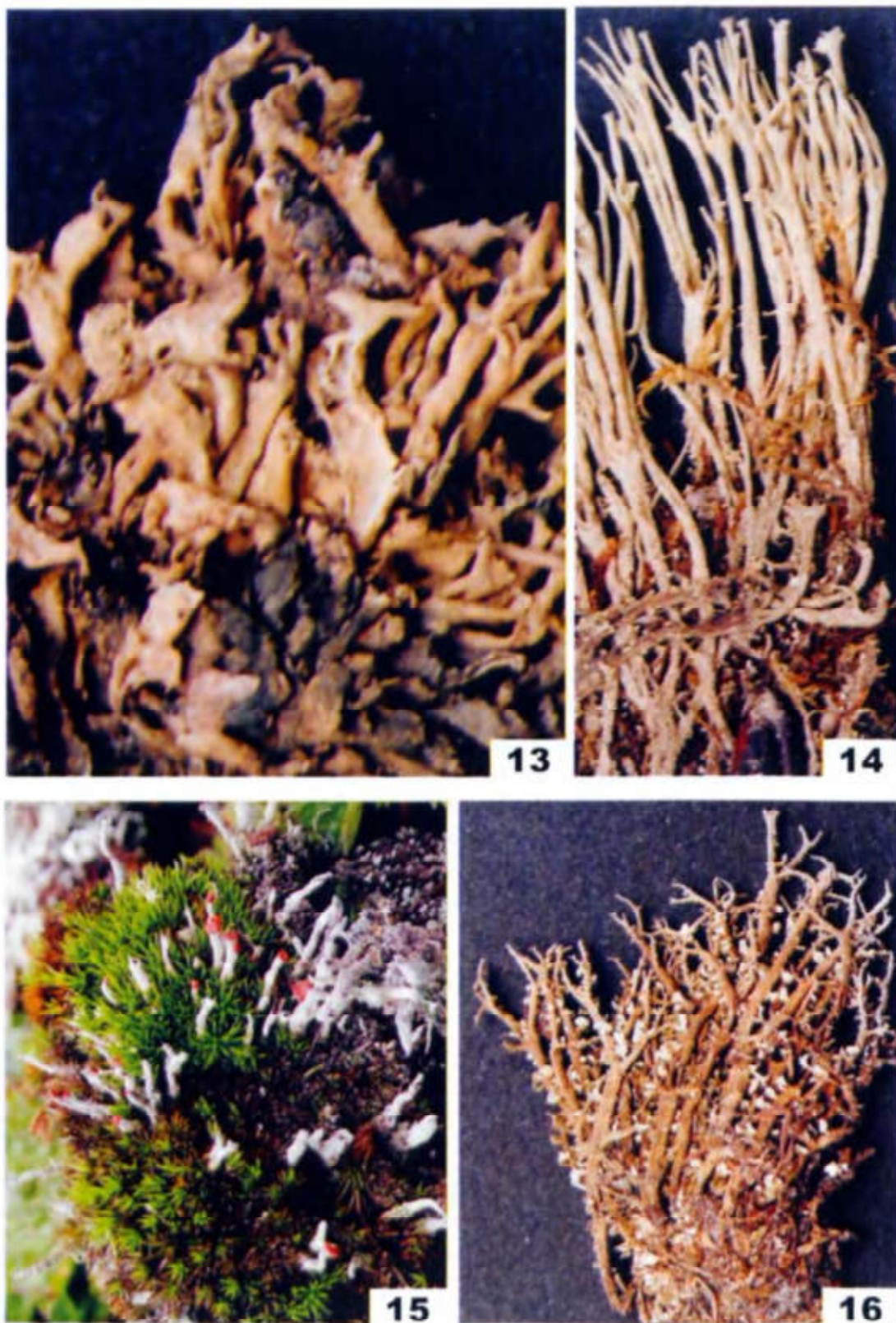


Fig. 13. *C. laii*. **Fig. 14.** *C. kanewskii*. **Fig. 15.** *Cladonia macilentata*. **Fig. 16.** *C. macroptera*.



Fig. 17. *C. mongolica*. Fig. 18. *C. pocillum*. Fig. 19. *C. rangiferina*. Fig. 20. *C. yunnana*.

squamules up to 4 mm long, 2-3 mm wide; upper part incompletely corticate, microsquamulose to scarcely granulose or scabrose, sometimes slightly soresediate; surface of central canal glossy, uneven. Apothecia brown on short lateral branches towards apices, disc *ca.* 0.5 mm diam. Pycnidia dark brown; conidia 4 x 1 μ m. Chemistry: Podetia and squamules K-, C-, KC-, P+ red; fumarprotocetraric acid present.

It commonly grows on ground and sometimes on rotten logs in temperate areas.

Distribution: India (Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Asia, North and South America, Australia and Europe.

Specimens examined: *East Sikkim:* Rechala surroundings, alt. 2700-2900 m, Sinha 998. *North Sikkim:* Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 608. On way between Yakche-Lachung, alt. 2600 m, Sinha 1105. Yumthang, along river side forest, alt. 3530 m, Sinha 1086. *West Sikkim:* Dzungri, 4000 m, Sinha 772. Karchi Reserve forest, alt. 2000-2400 m, Sinha 408. Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 195.

27. *Cladonia singhii* Ahti & Dixit in Ahti *et al.*, Lichenologist 34(4):306. 2002.

Primary thallus inconspicuous, fine lacinate, grey, evanescent. Podetia 15-35 mm tall, 0.5-1 mm diam., brownish grey, unbranched or sparsely dichotomously branched, axils closed, tips subulate, cups absent; surface of podetia rough, ecorticate or cortex discontinuous, microsquamulose – granulose soresediate; podetial wall with hard cartilaginous stereome; central canal furrowed and irabeculate. Apothecia rare, on tips of branches, disc *ca.* 0.5 mm diam., brown; spores not seen. Pycnidia infrequent on podetial tips. Chemistry: Podetia K-, C-, KC-, P+ red; fumarprotocetraric, confumarprotocetraric, protocetraric and convirensic acids present.

It commonly grows on bare soils along roadside and on bark of trees in basal region.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Sikkim, Tamil Nadu and Uttaranchal), East Nepal and Thailand.

Specimens examined: *East Sikkim:* Gangtok, Bhusuk, alt. 2000 m, Upreti & Chatterjee 01-26624 (LWG). Between Premlakha-Tanjibir foot track, alt. 2000 m, Sinha 908. *North Sikkim* Tholung-Kissong foot track, at 5 km point, alt. 2475 m, Sinha 607.

28. *Cladonia squamosa* Hoffm., Deut. Fl. 2: 125. 1796; Vainio, Acta Soc. Fauna Fl. Fenn. 4: 411. 1887; Thomson, Lich. Gen. Clad. North America : 128. 1966.

Primary thallus squamulose; squamules persistent or evanescent, 1-3 x 0.5-

1.5 mm, indented, upper surface grey brown, lower surface white, esorediate. Podetia 20-30(-35) mm tall, 1-2.5 mm diam. at base, greenish grey to brownish grey, unbranched to little branched, with dense squamules, esorediate, axils open, irregularly cup bearing; cups up to 3 mm diam., 1-2 mm deep, imperforate; margin proliferating; proliferations cup bearing or branched; cupless proliferations blunt tipped with apothecia; surface mostly ecorticate; central canal papillate. Apothecia dark brown-black, 0.5-4 mm diam., K-; spores 6-10 x 2-3 μ m. Pycnidia on the apices of the branches, brown to black; conidia not seen. Chemistry: Podetia and squamules K- or K+ yellow, C-, KC-, P- or P+ yellow; squamatic, barbatic and thamnolic acids present.

The species has much variable growth forms and at least two chemotypes (K-, P-) with squamatic and barbatic acid and the second (K+, P+) with thamnolic acids are present. It commonly grows on rotting wood, old tree stumps and on humus soil in temperate areas.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Sikkim, Uttaranchal and West Bengal), Nepal; widespread in temperate and colder regions in northern and southern hemispheres.

Specimens examined: North Sikkim : Sebu La base camp, west side, alt. 4500-4800 m, Sinha 1214. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1043. Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1656. Theu La base camp, south side, alt. 4500 m, Sinha 1687. West Sikkim: Varshey Rhododendron Sanctuary, alt. 2700 m, Sinha 1329.

29. *Cladonia subulata* (L.) Wigg., Prim. fl. holsat.:90. 1780. –*Lichen subulatus* L., Sp. Pl.:1153. 1753.

Primary thallus squamulose; squamules persistent or often absent, 2-3 x 1.5 mm, deeply incised, upper surface grey white, lower surface white. Podetia 17-35 mm tall, 0.8-2 mm diam., whitish grey to grey brown, simple, sometimes furcated towards apices and appearing antler like, usually thin with pointed apices, occasionally with irregular cups; cups 1-2.5 mm diam., shallow, imperforate, proliferate from margin; surface ecorticate, farinose sorediate throughout, sometimes basal part corticated and microsquamulose. Apothecia not seen. Pycnidia brown black, on margin of cup proliferations as well as on podetial apices; conidia not seen. Chemistry: Podetia K-, C-, KC-, P+ orange-red; fumarprotocetraric acid present.

It sparsely grows on soil in open moist places of temperate areas.

Distribution: India (Sikkim, Himalayan region); Asia, Europe, South & N. America.

Specimen examined: North Sikkim: Lachen, Gumpa side forest, alt. 2700 m, Sinha 1537.

30. *Cladonia yunnana* (Vainio) des Abb. ex J. C. Wei & Y.M. Jiang, Lich. Xizang: 84. 1986. -*C. transcendens* Vainio var. *yunnana* Vainio in Nouv. Arch. Mus. Hist. Nat., ser. 3, 10: 262. 1898; Zahlbr., Cat. lich. univ. 4:615. 1927. (Fig. 20)

Primary thallus squamulose; squamules persistent, 3-10 mm long, 5-10 mm wide, irregularly lobed, involute or flat, upper surface greenish to brownish grey, lower surface white, esorediate. Podetia (5-)10-40(-55) mm tall, 1-3 mm diam. at base, yellowish, with squamules in the basal region, usually branched, axils closed, cup bearing; cups 3-5 mm diam., 1-2 mm deep, gradually flaring, imperforate, esorediate, corticate on inner side; margin entire to crenate or proliferate; entire margin with pycnidia; crenate-dentate margin usually with apothecia and proliferate margin with second tier of cups, proliferating 2-3 times; surface corticated in lower half of podetia, ecorticate above, farinose sorediate. Apothecia on the tips of the short stipes, red, 0.5-2 mm diam., crowded on proliferating margin, K+ red colour oozes out; spores not developed. Pycnidia on margin of cups, red brown to black. Chemistry: Podetia and squamules K-, C-, KC-, P-, squamatic and usnic acids present.

It commonly grows on soil in open places of temperate and alpine areas.

Distribution: India (Sikkim), China, Nepal; America.

Specimens examined: *East Sikkim:* Chhangu lake surroundings, alt. 3350 m, Sinha 1365. *North Sikkim:* Jakthang to Zema -II foot track, alt. 3400-2800 m, Sinha 1733, 1735. Theu La to Jakthang way, alt. 4600-3400 m, Sinha 1722. *West Sikkim:* Near Bakhim, alt. 2500-2700 m, Sinha 732. On way between Dzongri-Tangsing, alt. 3900-3500 m, Sinha 808. Karchi Reserve forest, alt. 2000-2400 m, Sinha 407. Phedang-Dzongri 3 km foot track, alt. 3900-4025 m Sinha 259.

3. *Gymnoderma* Nyl.

Thallus squamulose, appearing foliose and lobate; squamules broadly fan shaped, only the upper surface corticated; photobiont green alga. Apothecia almost sessile on the margin of primary thallus without podetia or sometimes with very short, solid podetia without symbiotic algae; asci 8-spored; spores biseriolate, colourless, simple.

Represented by 3 species in the world and one from Sikkim in India.

Gymnoderma coccocarpum Nyl., Flora 43:546. 1860; Awasthi, Journ. Hattori Bot. Lab. 65: 232. 1988. Wei & Ahti, Lichenologist 34(1):28. 2002. -*Cladonia coccocarpa* (Nyl.) Evans, Bryologist 50:50. 1947.

Primary squamules large, up to 4 cm long, ca. 0.8 cm wide; upper surface smooth to scrobiculate, yellow brown; lower surface white, lacking rhizines. Apothecia marginal, stalked, simple or aggregated, glomerulate, light brown to brown with proper exciple; spores elongate-ellipsoid, 9-12 x 2.5-3.5 µm. Chemistry: Squamules UV+, KC+ rose; unidentified medullary substances present.

It is reported to grow on bark of trees. No specimen could be collected during the present investigation. The present report is based on Wei & Ahti (2002). Awasthi's (*l.c.*) description is provided here for correct identification of this species from the area.

Distribution: India (Sikkim and West Bengal), China, Japan, Malaysia, Taiwan. Confined to E. Asia.

Earlier record: Sikkim, Mainomcha, J.D. Hooker & T. Thomson 2101 (NY) *vide* Wei & Ahti (2002).

STEREOCAULACEAE

Stereocaulon (Schreber) Hoffm.

Thallus dimorphic; primary thallus crustose, granular, verrucose or squamulose, in most species disappearing early; secondary thallus in the form of pseudopodetia; pseudopodetia erect, solid, often richly branched, corticate or not, phyllocladia cylindrical, terete or verrucose, granular to squamulose, coralloid; cephalodia frequent on both pseudopodetia and phyllocladia, containing *Nostoc*, *Scytonema* or *Stigonema*, sacculate, protosacculate or verrucose botryose; photobiont trebouxoid; medulla loosely interwoven; chondroid axis of thick walled longitudinal hyphae. Apothecia terminal or lateral, lecideine; disc usually becoming convex, pale brown to dark brown; thalline exciple absent; asci (4-)6-8 -spored; spores colourless; pycnidia mostly immersed at tips of phyllocladia, ovoid to spherical, darkened about ostiole; conidia simple, thread like to cylindrical, straight or curved; atranorin present in all species.

About 123 species widely distributed throughout the world; 14 species in India and 12 species in Sikkim.

Key to the species

- 1a. Cephalodia verrucose to botryose with poorly developed parenchymatous tissue 2
- 1b. Cephalodia protosacculate or sacculate with well developed gelatinized cortical tissue 3
- 2a. Pseudopodetia 0.6-1 cm tall, tomentose; lobaric acid present 4. ***S. glareosum***
- 2b. Pseudopodetia larger, up to 7 cm tall, etomentose; lobaric acid absent 8. ***S. myriocarpum***
- 3a. Cephalodia protosacculate (solid cored) 6
- 3b. Cephalodia sacculate (loose cored) 4
- 4a. Phyllocladia P+ red. stictic and norstictic acid present. 10. ***S. piluliferum***

- 4b. Phyllocladia P+ pale yellow, lobaric acid present 5
- 5a. Pseudopodetia sparingly branched;
apothecia hypophysate 7. **S. massartianum**
- 5b. Pseudopodetia caespitose; apothecia not hypophysate 12. **S. togashii**
- 6a. Pseudopodetia sorediate, phyllocladia not developed,
replaced by soredia 1. **S. coniophyllum**
- 6b. Pseudopodetia lacking soredia 7
- 7a. Phyllocladia verrucose-squamulose to foliose 8
- 7b. Phyllocladia distinctly cylindrical, terete 10
- 8a. Pseudopodetia surface spongy or tomentose,
up to 3.5 cm long 9
- 8b. Pseudopodetia lacking tomentum, usually longer,
up to 8 cm long 3. **S. foliolosum**
- 9a. Cephalodia ca. 0.5 mm across, greyish white,
usually concealed within tomenta on lower side 1. **S. alpinum**
- 9b. Cephalodia 0.8-4 mm across, brownish or with
greenish olivaceous tinge, distributed throughout,
usually the lower ones larger in size 5. **S. himalayense**
- 10a. Pseudopodetia prostrate, tomentose; phyllocladia
digitate to cylindrical coralloid; lobaric acid present .. 9. **S. paradoxum**
- 10b. Pseudopodetia erect, lacking tomentum; phyllocladia
not digitate; lobaric acid absent 11
- 11a. Pseudopodetia 1.5-2.5 cm long, simple to bifurcated
towards apex; P+ yellow-orange, stictic acid
present 6. **S. macrocephalum**
- 11b. Pseudopodetia 2.5-7 cm tall, subcorymbosely branched
towards apex; P+ red, norstictic and stictic acid present 11. **S. pomiferum**
1. **Stereocaulon alpinum** Laur. ex Funck, Cryptog. –Gewachse 33: 6. 1827.

(Fig. 21)

Primary thallus not seen. Pseudopodetia caespitose, decumbent, with distinct main axis, firmly attached on the ground, 2-3.5 cm tall, 1-1.2 mm diam. at base, base pale brownish, sparingly branched without phyllocladia but with whitish tomentum; phyllocladia crowded towards apices, whitish grey, granuliform, or united, somewhat flattened, lobate, indistinctly stalked, appressed to the pseudopodetium; cephalodia on lower side, rounded, greyish white, ca. 0.5 mm across, usually concealed within tomentum containing *Nostoc*. Apothecia not

seen. Chemistry: Phyllocladia K+ yellow, C-, KC-, P-; atranorin and lobaric acid present.

It sparsely grows on ground in alpine areas.

Distribution : India (Himalaya); North and South America; Southern Hemisphere.

Specimen examined: North Sikkim: Llonakh valley, Chhabber lake below Luna La, alt. 4600 m, Sinha 1594.

2. **Stereocaulon coniophyllum** Lamb, Bot. Notiser 114(3): 266. 1961; Pant and Upreti in Mukerji *et al.* (eds.), Biol. Lichens : 255. 1999.

Pseudopodetia erect, attached to the substratum by basal holdfast, up to 4 cm tall, robust, irregularly branched, flattened, up to 2.5 mm diam., lacinulate, brown or blackish brown; tips of branches covered with dense, confluent, whitish, granular soredia; soredia replacing phyllocladia; cephalodia lateral, subglobose, brown, protosacculate, lumina of cortex round to palisade like, containing *Nostoc*. Apothecia not seen. Chemistry: Pseudopodetia and soredia K+ yellow, C-, KC-, P+ yellow; atranorin and lobaric acid present.

The taxon sparsely grows on boulders with mosses. It is the only sorediate species known from the Indian sub continent.

Distribution: India (Sikkim), Japan, Nepal, Arctic Canada and Central Europe.

Specimen examined: West Sikkim: Tsoka-Phedang-foot track, alt. 3500-3900 m, Sinha 216.

3. **Stereocaulon foliolosum** Nyl., Syn. Lich. 1(2):240. 1860; Lamb, Journ. Hattori Bot. Lab. 43:267. 1977.

Key to the varieties

- 1a. Phyllocladia foliose below, granular coralloid above .. 3.1 var. **strictum**
 1b. Phyllocladia digitate - squamulose, not distinctly
 foliose3.2 var. **botryophorum**

3.1. var. botryophorum (Müll. Arg.) Lamb, Journ. Hattori Bot. Lab. 43: 267. 1977; Pant & Upreti in Mukerji *et al.* (eds.), Biol. Lichens :256. 1999. -*Stereocaulon botryophorum* Müll. Arg., Flora 74: 371. 1891.

Pseudopodetia erect, up to 8 cm tall, subsimple near base, sparingly branched towards apical region, 1-1.5 mm diam. at base, up to 3 mm diam. at dichotomy, brown, lacinulate; phyllocladia sparse to absent in basal region, more abundant towards apical region, digitate squamulose, 1-2.5 mm long, somewhat granulose, paler, whitish at tips; cephalodia lateral on pseudopodetia, black, subglobose, 1-2 mm diam., sometimes divided into verrucose portions, protosacculate, containing

Nostoc. Apothecia black, 2-2.5 mm diam., sometimes globular; spores vermiform, 6-9-septate, 55-90 x 3 µm. Chemistry: Phyllocadia K+ yellow, C-, KC-, P+ yellow; atranorin and lobaric acid present.

The variety is reported to commonly grow on stones with mosses, on soil and on boulders.

Distribution: India (Himachal Pradesh, Sikkim, Uttaranchal and West Bengal), Nepal; Central Africa.

Earlier record: Pant & Upreti 1999 (*l.c.*).

3.2. var. strictum (C. Bab.) Lamb, *Canad. J. Bot.* 29: 582. 1951; *Journ. Hattori Bot. Lab.* 43: 268. 1977; Pant & Upreti in Mukerji *et al.* (eds.), *Biol. Lichens* :257. 1999. -*Stereocaulon ramulosum* var. *strictum* C. Bab., *Hookers J. Bot. Kew Gard. Misc.* 4: 250. 1852. (Fig. 22)

Pseudopodetia erect, 3-4.5 cm tall, 1-2 mm diam., robust, greyish to brown, surface somewhat sinuose; phyllocladia flattened, leaf like, 1-2 mm long, crenulate near basal region, somewhat coralloid and abundant towards apical region, paler on lower side; cephalodia lateral, subglobose, sometimes imperfectly divided into verrucose portions, brown, (0.5-)1-2 mm diam., protosacculate, lamina of cortex elongate, containing *Nostoc*. Apothecia black, plane to convex, 2-3 mm diam.; spores vermiform, 6-12-septate, 60-85 x 3 µm, apices rounded at one end, tapering on the other end. Chemistry: Phyllocladia K+ yellow, P+ yellow; atranorin and lobaric acid present.

It commonly grows on soil or on rocks in temperate to alpine regions.

Distribution: India (Himachal Pradesh, Sikkim, Uttaranchal and West Bengal), Nepal, China.

Specimens examined: *East Sikkim*: Kupup, alt. 4000 m, Sinha 1417, 1419. Near Meimenchu Memorial Check Post, alt. 3700 m, Sinha 1410. *North Sikkim*: Lachen, along road side, alt. 2710 m, Sinha 1140. Near Lachung, along road side, alt. 2500 m, Sinha 1028. On way between Phuni-Yakche, alt. 3000 m, Sinha 1099 B. *West Sikkim*: On way between Dzongri-Thangsing, alt. 3900-3500 m, Sinha 802.

4. *Stereocaulon glareosum* (Savicz) Magn., *Goteborgs K. Vetensk. Samh. Handl.* 30:60. 1926. -*S. tomentosum* f. *glareosum* Savicz, *Bull. Jard. Imp. Pierre le Grand* 14: 121. 1914.

Primary thallus composed of dense clusters of phyllocladia over the ground; pseudopodetia erect, firmly attached by basal holdfast, tufted, pale, sparingly branched, 0.6-1 cm tall, ca. 1 mm diam. at base, tapering upwards, greyish white tomentose; phyllocladia sparse towards base, clustered and branched at apices, cylindrical or papilliform, 0.3-0.8 mm long; cephalodia abundant among the phyllocladia on branches, verruciform or globose, rose whitish, containing

Nostoc, cortex poorly developed. Apothecia not seen. Chemistry: Phyllocladia K+ yellow, C-, KC-, P- or P+ pale; atranorin and lobaric acid present.

It sparsely grows on grounds in alpine areas.

Distribution: India (Jammu & Kashmir), Nepal. Circumpolar.

Specimen examined: North Sikkim: On midway between Thangu and Lashar. alt. 4300 m, Sinha 1175.

5. ***Stereocaulon himalayense*** Awasthi & Lamb, Journ. Hattori Bot. Lab. 43: 269. 1977; Pant & Upreti in Mukerji *et al.* (eds.), Biol. Lichens : 259. 1999.

Primary thallus persistent, grain like or lobate to subsquamulose, crowded phyllocladia around pseudopodetia base; pseudopodetia upright, tufted, 0.7-2.5(-3) cm tall, sparingly subdichotomously branched, or sometimes more or less congestedly branched from near the base and upwards. rather robust, rigid, 0.7-1.5 mm diam., terete, denuded and glabrous, with smooth to slightly spongy surface; phyllocladia unevenly scattered or crowded, whitish grey, minutely grain like to shortly dactylaeform-coralloid or occasionally indistinctly lobate-subsquamous but never flattened leaf like; cephalodia common on primary thallus and on pseudopodetia, greenish olivaceous or rarely dark brown, matt, protosacculate, containing *Nostoc*. Apothecia 4-5 mm diam., with irregularly crenate edge and the receptacle more or less thickly clothed with small graniform phyllocladia; disc brownish-black, smooth, epruinose; spores with 3 or 4 septa, 20-36 x 3.5-4.5 μm . Chemistry: Phyllocladia K+ yellow, C-, KC-, P+ pale - yellow; atranorin and lobaric acid present.

It commonly grows on ground in alpine areas.

Distribution: India (Himachal Pradesh, Sikkim, Uttaranchal and West Bengal), Nepal.

Specimens examined: North Sikkim: Lonakh valley, Chhabar lake, below Luna La, alt. 4600 m, Sinha 1593. Sebu La base camp, east side, alt. 4960 m, Sinha 1227 A.

6. ***Stereocaulon macrocephalum*** Müll. Arg., Flora 74: 371. 1891; Lamb, Journ. Hattori Bot. Lab. 43: 272. 1977; Pant & Upreti in Mukerji *et al.* (eds.), Biol. Lichens :262. 1999.

Pseudopodetia erect, 1.5-2.5 cm tall, simple or bifurcating at apex, ca. 2 mm diam., brown, surface rugose, corticate; phyllocladia cylindrical, terete, densely covering the pseudopodetia 1-2 mm long, sometimes furcated; cephalodia brown, lateral, usually near base, subglobose, up to 1 mm diam., protosacculate, containing *Nostoc*. Apothecia brown black to black, 1-2 mm diam.; spores vermiform, 16-26 -septate, 105-120 x 3-6 μm , one end round, other end tapering.

Chemistry: Phyllocladia K + yellow, C-, KC-, P+ yellow-orange; atranorin and stictic acid present.

Distribution: India (Sikkim and Uttaranchal), Nepal.

Earlier record: Pant & Upreti 1999 (*l.c.*).

7. *Stereocaulon massartianum* Hue, Nouv. Arch. Mus. Hist. Nat. ser. 3, 10: 252. 1898; Lamb, Journ. Hattori Bot. Lab. 43: 272. 1977; Pant & Upreti in Mukerji *et al.* (eds.), Biol. Lichens :263. 1999.

Pseudopodetia erect, 5-8 cm tall, ecorticate almost throughout, sparingly branched, 0.5-1 mm diam., flattened, pale yellow to brownish; phyllocladia dense, sparse to absent near base, cylindrical, terete, 1-2 mm long, simple to coralloid branched; cephalodia lateral, sessile, grey brown to yellow brown, wrinkled foveolate, up to 2.5 mm across, sacculate, cortex with round to palisade lumina, containing *Scytonema*. Apothecia on short lateral branches arising to right angles to pseudopodetia, sometimes somewhat subcorymbose, brown to blackish, up to 1 mm diam., on pyriform clavulae; spores 7-14 septate, 75-110 x 3 µm, spirally wound. Chemistry: Phyllocladia K+ yellow, C-, KC-, P+ yellow; atranorin and stictic acid present.

The species commonly grows on boulders in temperate areas.

Distribution: India (Arunachal Pradesh and West Bengal), Malaysia, Philippines, New Guinea and Formosa.

Specimens examined: East Sikkim: Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1459, 1490. Between Yakla-Sherathang, alt. 3800 m, Sinha 1401. West Sikkim: On way between Dzongri-Thangsing, alt. 3900-3500 m, Sinha 794.

8. *Stereocaulon myriocarpum* Th. Fr., De. Stereocaulis et Pilophoris Commentatio : 15 1857; Monographia Stereocaulorum et Pilophorum : 34. 1858; Lamb, Journ. Hattori Bot. Lab. 43: 224. 1977; Pant & Upreti in Mukerji *et al.* (eds.), Biol. Lichens :264. 1999.

Pseudopodetia tufted, erect to curved, up to 7 cm tall, basally subsimple, middle and apical region intricately branched to form an entangled glabrous mass with jumbled branching, branches 1-3 mm diam., surface faintly tomentose, nervose or striate, robust, brown; phyllocladia absent near base, dense apically, arising disharmonically from the pseudopodetium, verrucose to lobulate squamulose to digitate coralloid, paler to white tipped, 0.5-1.5 mm long; cephalodia lateral, greyish to grey brown, botryose, subglobose to verrucose, *ca.* 1.5 mm diam., cortex poorly developed, containing *Nostoc*. Apothecia abundant, lateral and terminal, black-brown, 0.5-1(-2) mm diam.; margin reflexed; spores spirally wound, 2-3(-4) -septate, 27-30 (-36) x 3 µm. Chemistry: Phyllocladia K+ yellow, C- KC-, P+ orange; atranorin, stictic acid, constictic acid and sometimes norstictic acid present.

It commonly grows on mossy boulders in temperate and alpine areas.

Distribution: India (Himalchal Pradesh, Sikkim and Uttaranchal), Nepal; widely distributed in Asia, South, Central and North America.

Specimens examined: *East Sikkim:* Kupup, alt. 4100 m, Sinha 1450. Nathula, alt. 4395 m, Sinha 1424. Chhangu lake surroundings, alt. 3500 m, Sinha 682. Sherathang, alt. 3700 m, Sinha 1770. *North Sikkim:* On way between Lashar and GSI Old Camp Hut, alt. 4400 m, Sinha 1199. Yomesamdong, Hot spring surroundings, alt. 4530 m, Sinha 1257. Sebu La base camp, east side, alt. 4960 m, Sinha 1227 B. *West Sikkim:* Near Bakhim, alt. 2700 m, Sinha 275. Dzungri, base camp, L.K. Rai 1751.

9. *Stereocaulon paradoxum* Lamb, Journ. Hattori Bot. Lab. 43: 275. 1977; Pant & Upreti in Mukerji *et al.* (eds.), Biol. Lichens :266. 1999.

Pseudopodetia prostrate, up to 5 cm long, irregularly branched, ca. 1 mm diam., terete, pale greyish, surface tomentose; phyllocladia dense, digitate to cylindric-coralloid, 0.5-1.5 mm long, pale to white, apices minute papillate; cephalodia brown, lateral, globose, 0.5-1 mm diam., protosacculate, lumina of cortex round, containing *Nostoc*. Apothecia not seen. Chemistry: Phyllocladia K+ yellow, C-, KC-, P+ pale yellow; atranorin and lobaric acid present.

The species commonly grows on mossy boulders in exposed places.

Distribution: India (Uttaranchal). Endemic.

Specimens examined: *North Sikkim:* Lachen, along road side, alt. 2710 m, Sinha 1139. Lashar, alt. 4500 m, Sinha 1191. *West Sikkim:* On way between Dzungri-Thangsing, alt. 3900-3500 m, Sinha 803. Phedang-Dzungri 3 km foot track, alt. 3900-4025 m, Sinha 239. Tashiding Monastery surroundings, alt. 1600 m, Sinha 309.

10. *Stereocaulon piluliferum* Th. Fr., De. Stereocaulis et Pilophorus Commentatio : 21. 1857; Monographia Stereocaulorum et Pilophorum : 33. 1858; Lamb, Journ. Hattori Bot. Lab. 43: 275. 1977; Pant & Upreti in Mukerji *et al.* (eds.), Biol. Lichens :266. 1999.

Pseudopodetia erect, 3-6 cm tall, simple to twice or thrice branched apically, 0.5-0.8(-2) mm diam., greyish brown to brown; phyllocladia absent near base, dense upwards, cylindrical, tapering, 1-5 mm long, simple to coralloid branched; cephalodia lateral, greyish - brown, globose to foveolate, 0.5-1 mm diam., sacculate, containing *Nostoc*. Apothecia brown- black, arising on subglobose to pyriform clavulae; spores spirally wound, 10-20(-25) -septate, (75-) 120-150 x 3 μ m. Chemistry: Phyllocladia K+ yellow, C-, KC-, P+ orange; atranorin, stictic and norstictic acid present.

It grows on soil or on rocks and boulders. It is one of the commonest species of *Stereocaulon* in the temperate regions.

Distribution: India (Arunachal Pradesh, Meghalaya, Sikkim, Uttarakhand and West Bengal), Nepal, China, East Tibet.

Selected specimens examined: *East Sikkim:* On way between Chhalangpong-Aritar, alt. 1500 m, Sinha 522. *North Sikkim:* Bey surroundings, alt. 1600 m, Sinha 558. Lachung to Yumthang, L.K. Rai 1351. Near Lingzea village, alt. 1500 m, Sinha 649. Zema -I, alt. 2750 m, Sinha 1527. *West Sikkim:* Karchi Reserve forest, alt. 2000-2400 m, Sinha 398. Kongri village forest, alt. 2000 m, Sinha 473. Pemayangtse Monastery surroundings, alt. 2075 m, Sinha 173. Sombaria, near Forest Rest House, alt. 1750 m, Sinha 1297. Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1330.

11. *Stereocaulon pomiferum* Duvign., *Lejeunia* Mem. 14: 119. 1956; Lamb, *J. Jap. Bot.* 43: 298. 1968; *Journ. Hattori Bot. Lab.* 43 :276. 1977; Pant & Upreti in Mukerji *et al.* (eds.), *Biol. Lich.* :268. 1999..

Pseudopodetia erect, 2.5-7 cm tall, subsimple to irregularly branched, subcorymbose at apices, ca. 3 mm diam. near base, gradually tapering upwards, brown; phyllocladia dense throughout, cylindrical, simple to branched in basal region, 1-3(-5) mm long; cephalodia lateral, more abundant near base, brown, subglobose, smooth to foveolate, (0.5-)1-2 mm across, prostosaccate, containing *Nostoc* Apothecia brown to brown black, 2-4 mm diam., on subglobose to pyriform clavulae, receptacle paler, terete-granulate, in young condition with distinct swollen hypophysis; spores vermiform, 10-20(-30) -septate, 90-165 x 3 µm. Chemistry: Phyllocladia K+ yellow, C-, KC-, P+ red; atranorin, norstictic and stictic acid present.

It commonly grows on boulders in subtropical to alpine areas.

Distribution: India (Nagaland, Sikkim and West Bengal), East Central Africa, China, Formosa and Japan.

Selected specimens examined: *East Sikkim:* Gangtok surroundings, alt. 1700-2000 m, Sinha 89, 94. Kupup, alt. 4000 m, Sinha 1418. Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1463. Near Mulkhark lake around W.B. border, alt. 2200-2300 m, Sinha 552. *North Sikkim:* Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 610. *South Sikkim:* On Damthang-Tendong 6 km foot track, alt. 2000-2650 m, Sinha 129. *West Sikkim:* Dentam, alt. 1300 m, Sinha 178. Dzongri, alt. 4000 m, Sinha 768 B. Soreng, alt. 1800-2000 m, P. Singh 74.

12. *Stereocaulon togashii* Lamb, *Journ. Hattori. Bot. Lab.* 43: 278. 1977; Pant & Upreti in Mukerji *et al.* (eds.), *Biol. Lichens* :270. 1999.

Pseudopodetia tufted, up to 6 cm tall, simple to sparingly branched, ca. 1

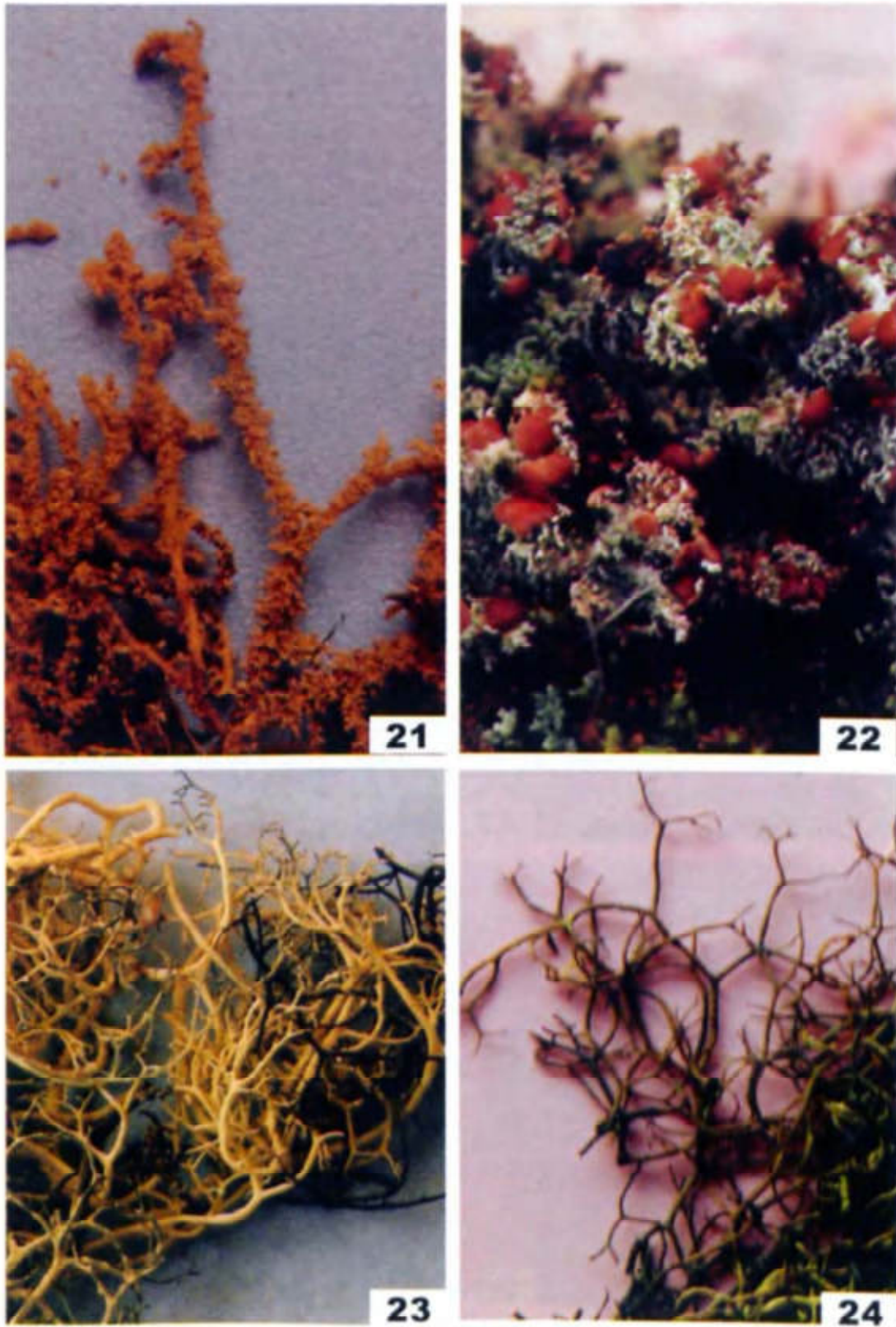


Fig. 21. *Stereocaulon alpijum*. **Fig. 22.** *S. foliolosum* var. *strictum*. **Fig. 23.** *Alectoria ochroleuca*. **Fig. 24.** *Orpogon formasanus*.

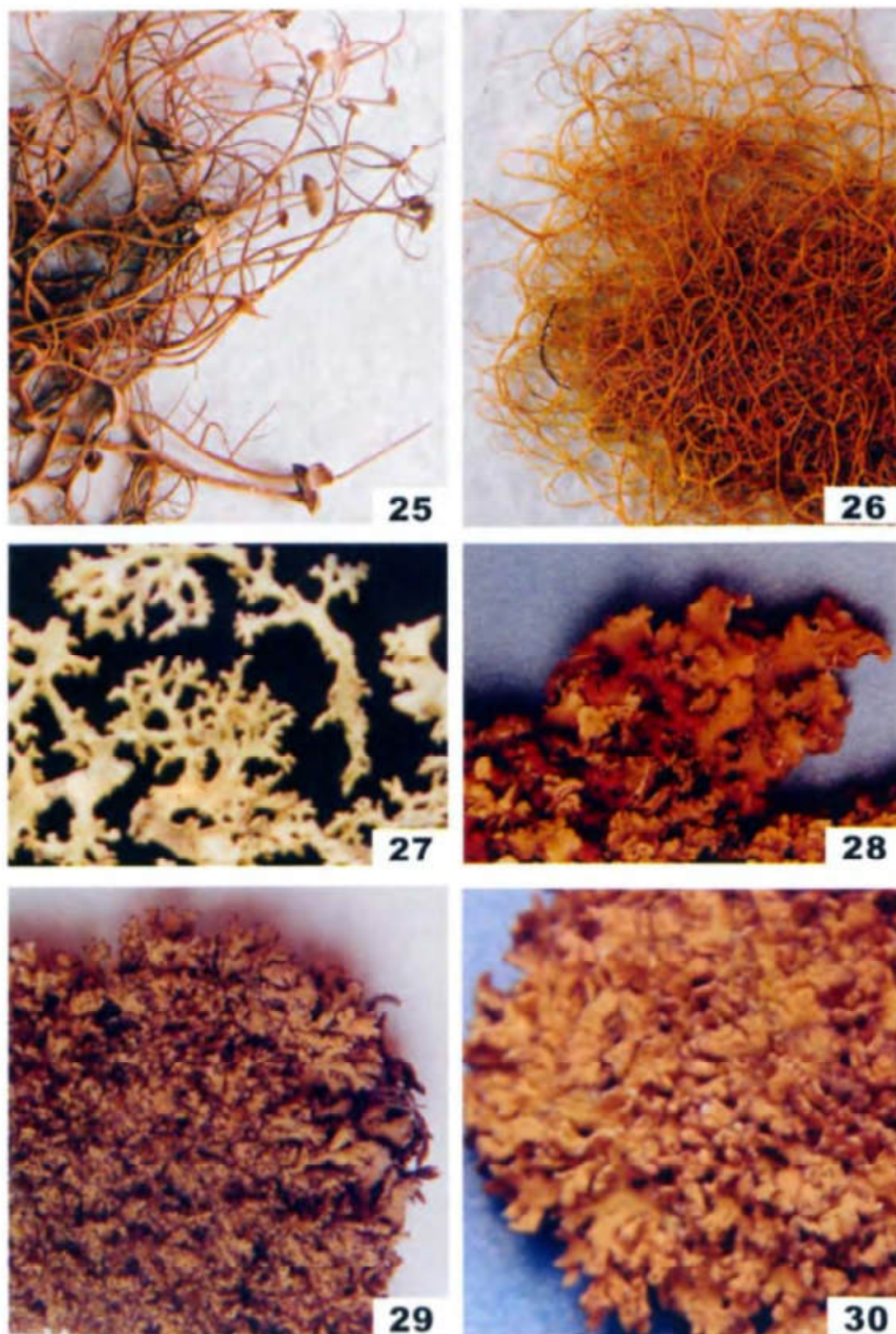


Fig. 25. *Sulcaria sulcata*. **Fig. 26.** *Sulcaria virens*. **Fig. 27.** *Allocetraria ambigua*. **Fig. 28.** *A. denticulata*. **Fig. 29.** *A. flavonigrescens*. **Fig. 30.** *A. globuans*.

mm diam., basally ecorticate, pale to greyish, glabrous; phyllocladia cylindric, simple to coralloid branched, 1-2 mm long; cephalodia lateral, sessile, brownish, wrinkled foveolate, ca. 2 mm diam., sacculate, lumina of cortex round to palisade, containing *Scytonema*. Apothecia on lateral branches, black, immarginate, up to 1 mm diam., on small pyriform clavulae; spores 7-14 -septate, 75-110 x 3 μ m, vermiform, one end round and the other tapering. Chemistry: Phyllocladia K+ yellow, C-, KC-, P+ yellow; atranorin and lobaric acid present.

The taxon sparsely grows on boulders in alpine areas.

Distribution: India (Sikkim), Bhutan, Nepal.

Specimen examined: West Sikkim: Dzongri, alt. 4000 m, Sinha 768 C.

ALECTORIACEAE

1. *Alectoria* Ach. in Luyken

Thallus erect or decumbent, much branched, terete to subterete, becoming compressed and \pm foveolate near base and at axils, mostly yellowish to blackened; isidia and soredia rarely present; lateral spinules absent; pseudocyphellae abundant, \pm raised, sometimes becoming sorediate; cortex of periclinal conglutinate hyphae. Apothecia lateral, rare; disc dark brown to black; exciple concolorous with thallus, eciliate; asci clavate, 2-4 -spored; spores exceeding 20 μ m in length, simple, brown when mature, ellipsoidal, with a distinct colourless, episore. Pycnidia rare, black; conidia straight, 7-8 x ca. 0.8 μ m.

A genus of 8 species, widely distributed in cold to cool temperate regions, particularly in North America. One species reported earlier from Nepal has now extended distribution in political boundary of India.

Alectoria ochroleuca (Hoffm.) Massal., Sched. Critic. Lich. Ital.:47. 1855; G. Awasthi & Awasthi, Candollea 40:306. 1985; Sinha, Bull. Bot. Surv. India 45(1-4):221. 2003. -*Usnea ochroleuca* Hoffm., Descr. adumb. Lich. 2(1):7. 1791.

(Fig. 23)

Thallus decumbent, ca. 5 cm long, pale yellow to yellow; branching moderate, \pm anisotomic dichotomous; branches 0.5-1.5 mm diam., mostly terete, never strongly compressed, tapering and grey black towards apices; surface matt, \pm pitted at base; pseudocyphellae sparse to dense, white, flat or raised, oblong to elongate, usually conspicuous on thicker branches; isidia and soredia absent; medulla hollow in major part. Apothecia not seen. Pycnidia on branch tips, black, ca. 0.1 mm diam. Chemistry: Medulla K-, C-, KC-, P-; usnic acid present.

The species sparsely grows on ground as well as on exposed boulders in alpine areas.

Distribution: India (Sikkim), China, Japan, Nepal, New Zealand; North America and Europe.

Specimens examined: North Sikkim: Lashar, alt. 4500 m, Sinha 1187. Llonakh valley, Llonakh chu surroundings, alt. 4500 m, Sinha 1610, 1669. Sebu La base camp, west side, alt. 4500-4800 m, Sinha 1208.

2. *Oropogon* Th. Fr.

Thallus fruticose, caespitose to pendant; branching primarily isodichotomous in most species, but with anisodichotomies sometimes, white to grey, grey black, tan, brown or black, sometimes mottled with two or more of these; branches mostly terete, \pm smooth, occasionally compressed especially at nodes, usually up to 1 mm diam.; lateral branchlets rare; isidia unknown; soredia or spinules common in only few species; pseudocyphellate, the pseudocyphellae plane and closed or becoming perforate and opening into hollow thallus centre; medulla \pm filled but often with gaps or voids associated with thin or thick medullary layer inside the cortex. Apothecia frequent in most species, lateral, sometimes appearing terminal, concave when young, becoming \pm flat to rather convex with age, up to 5 mm diam.; asci 1-spored; spores brown, muriform, 74-157 x 23-52 μ m. Pycnidia common in few species, immersed to weakly emergent, often blackened around the ostiole; conidia weakly and unequally bifusiform, 4-7 x 0.5-1 μ m.

Oropogon, primarily a southern hemisphere genus with 30 species in the world; 1 species known from India in Sikkim.

Oropogon formasanus Asah., J. Jap. Bot. 27:242. 1952; Esslinger, Am. Soc. Pl. Taxonomists Syst. Bot. Monogr. 28:66. 1989. (Fig. 24)

Thallus caespitose, 5-8 cm long; branching isodichotomous, internodes 3-7 mm long, main branches 0.5-0.7 mm diam., pale tan brown to red brown, black mottled in parts; lateral branchlets absent, surface matt, pseudocyphellate; pseudocyphellae narrow and barely open; medulla loose, white. Apothecia common, up to 2.5 mm diam., flat to concave; margins entire; spores 80-120 x 32-41 μ m. Pycnidia blackened at apices; conidia not seen. Chemistry: Cortex K-, P-; medulla K-, C-, KC-, P- or P+ pale; no chemical compound found in Sikkim specimen, however, protocetraric acid along with occasional fumarprotocetraric acid reported in Asian specimens.

The species was recorded from Sikkim by Asahina (1966) but not included by Awasthi (1988, 2000) from Indian Subcontinent. However, the present single specimen collected growing on mossy rocks from the same locality as of Asahina. Externally the species closely resembles species of genus *Bryoria* except its fertile nature, 1-spored asci and muriform spores.

Distribution: India (Sikkim), China, Nepal, Tibet, Philippines; Costa Rica, Colombia, Ecuador, Haiti, Panama and Venezuela.

Specimen examined: West Sikkim: Between Tsoka-Dzongri, alt. 3500-4000 m, Sinha 748 (det. T.L. Esslinger).

3. *Sulcaria* Bystrek

Thallus fruticose, erect to pendulous; branches longitudinally furrowed, pseudocyphellate throughout length; cortex prosoplectenchymatous; photobiont a green alga. Apothecia geniculate, lecanorine; asci thick walled, arrested bitunicate, 8-spored; spores transversely 1-3 septate, brown at maturity. Usnic acid absent.

Represented by 4 species in the world; 2 species in Himalayan region of India and also in Sikkim.

Key to the species

- 1a. Thallus erect, whitish grey to grey brown, branches ± terete;
medulla P+ deep yellow 1. *S. sulcata*
- 1b. Thallus pendulous, greyish yellow to yellowish green,
branches flattened; medulla P+ orange 2. *S. virens*

1. *Sulcaria sulcata* (Lév.) Bystrek ex Brodo & D. Hawksw., *Opera Bot.* 42:156. 1977; G. Awasthi & Awasthi, *Candollea* 40:316. 1985. – *Cornicularia sulcata* Lév. in Jacquem, *Voy. Inde Bot.*:179, tab. 180, fig. 3, 1841-44. – *Alectoria sulcata* (Lév.) Nyl., *Mem. Soc. Imp. Sci. Nat. Cherbourg* 5:98. 1857. (Fig. 25)

Thallus erect or pendulous, 10-15 cm long, ashy grey to grey brown; branching isotomic dichotomous to anisotomic dichotomous, sometimes anastomosing; branches up to 2 mm diam., tapering apically, apices blackened; surface smooth, at places twisted, ventrally longitudinally furrowed all along the length, secondary branches terete without distinct longitudinal furrows. Apothecia common, lateral, sometimes appearing terminal due to death of distal branches, constricted at base, 2-6 mm diam.; margin entire, undulate; disc initially concave, flat at maturity, ashy white to grey blackish, pruinose; spores 35-45 x 12-15 µm. Chemistry: Medulla K+ yellow, C-, KC-, P+ deep yellow; atranorin and psoromic acid present.

It commonly grows on trees as well as on exposed boulders in moist temperate and alpine areas.

Distribution: India (Arunachal Pradesh, Nagaland, Sikkim and Uttaranchal) and Himalayan region extending eastwards in Asia.

Specimens examined: *East Sikkim:* Pangolakha scrub, alt. 2900 m, Sinha 930. Rechala surroundings, alt. 2700-2900 m, Sinha 1008. *North Sikkim:* Between Phuni-Yakche, alt. 3000 m, Sinha 1097. Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 611. *West Sikkim:* Near Bakhim, alt. 2500-2700 m, Sinha 725. Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1320.

2. *Sulcaria virens* (Taylor) Bystrek ex Brodo & D. Hawksw., Opera Bot. 42:154. 1977; G. Awasthi & Awasthi, Candollea 40:318. 1985. -*Alectoria virens* Taylor in Hook., Lond. J. Bot. 6:188. 1847; Awasthi, Procd. Indian Acad. Sci. 54:37. 1961. (Fig. 26)

Thallus pendulous, 25-40 cm long, greyish yellow to yellowish green, soft, densely branched, point of attachment not seen; branching anisotomic dichotomous; branches elongated; primary branches up to 2 mm wide, dorsiventral, twisted; secondary branches \pm cylindrical with continuous slit like furrow (pseudocyphellae); lateral spinules sparse, short hook like with blackened tips. Apothecia not seen. Chemistry: Medulla K-, C-, KC-, P+ orange; vulpinic and virensic acids present.

It commonly grows on *Abies* and *Rhododendron* trees in temperate regions.

Distribution: India (Arunachal Pradesh, Nagaland, Sikkim and Uttaranchal), China, Japan and Nepal.

Specimens examined: North Sikkim: Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1050. On way between Theu La-Jakthang, alt. 4600 m, Sinha 1727. West Sikkim: On way between Tsoka-Dzongri foot track, alt. 3500-4000 m, Sinha 749.

ANZIACEAE

Anzia Stizenb.

Thallus foliose, dorsiventral, heteromerous, laciniate; laciniae narrow, sublinear, dichotomously to trichotomously branched, sometimes articulated, flat to convex, isidia or soredia present or absent; medulla white to pale; photobiont a green alga; lower surface with brown black spongiostratum layer; rhizines sparse, short, stout, simple to branched. Apothecia laminal, lecanorine; asci many-spored; spores colourless, simple, sickle shaped.

A cosmopolitan genus comprises about 20 species in the world; 3 species in India and 1 in Sikkim.

Anzia physoidea Smith, Trans. Brit. Mycol. Soc. 16: 131. 1931; Yoshimura *et al.*, Journ. Hattori Bot. Lab. 82: 349. 1997.

Thallus loosely adpressed to the substratum, ca. 5 cm across; laciniae unisodiametric dichotomously branched, 1.5-2 mm wide, internodes 1.5-3 mm long, lobe tips rounded; upper surface greyish green, more or less smooth, cracked at places, cracked parts with few lobules; lower surface brownish with black spongiostratum cushions; medulla pale. Apothecia not seen. Pycnidia numerous, black, usually prominent along margins, immersed. Chemistry: Cortex K+ pale yellow; medulla K-, C-, KC-, P-; lobaric acid, atranorin and an unidentified yellow substance present.

It sparsely occur in moist temperate thick canopy forest on boulders.

Distribution: India (Arunachal Pradesh, Nagaland and West Bengal). Endemic.

Specimen examined: North Sikkim : Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 601.

BIATORACEAE

Phyllopsora Müll. Arg.

Thallus squamulose to foliose on hypothallus. Squamules heteromerous, corticated on upper surface; photobiont a green alga. Apothecia sessile; thalline exciple absent; disc epruinose; true exciple often inconspicuous except occasionally when young, of radially oriented, thick walled gelatinized hyphae; epithecium poorly differentiated; hymenium I- or faintly blue; hypothecium colourless or brownish; asci clavate, 8 -spored, *Bacidia* type; spores colourless, simple or thinly septate.

Phyllopsora a tropical genus is represented by about 40 species in the world; 5 species in India and 1 in Sikkim.

Phyllopsora corallina (Eschw.) Müll. Arg., Bot. Jb. 20: 264, 1894; Upreti, Divakar & Nayaka, Bibliotheca Lichenol. 86:186, 2003. -*Lecidea corallina* Eschw. in Martius, Fl. Bras. 1: 256, 1833.

Prothallus red to reddish brown or brown black. Thallus squamulose, adjoined, yellow to yellowish-brown, 0.1-0.5 mm, lacinate; margin fibrillose, adnate; upper surface smooth, sometimes pubescent, isidiate; isidia numerous, cylindrical, coralloid branched, red tinged at apices or sometimes with colourless hairs; lower surface ecorticate. Apothecia rare, 0.5-1 mm diam., brown-dark brown, exciple red tinged or colourless; hypothecium colourless; spores 7-10 x 2.5-4 µm. Chemistry: Squamules K-, C-, KC-, P-; atranorin in traces or absent, UV+ bluish white spot at Rf class 4-5.

It sparsely grows on tree trunks in subtropical areas.

Distribution: India (Himachal Pradesh, Karnataka, Sikkim, Tamil Nadu and Uttaranchal), Australia, Ethiopia, Seychelles, South Africa, Tanzania; North and South America.

Specimen examined: South Sikkim : Temi Tea Estate, alt. 1500 m, Upreti and Chatterjee 01-26673 (LWG).

CANDELARIACEAE

Candelaria Massal.

Thallus foliose, heteromerous, dorsiventral; lobes yellow, narrow, corticated on both surfaces; photobiont green, *Protococcus*; cortex K-, not turning purple. Apothecia lecanorine; asci 16-32 -spored; spores colourless, simple or 1-septate.

A cosmopolitan genus comprises about 7 species in the world; 2 in India as well as in Sikkim.

Key to the species

- 1a. Thallus orange yellow; lobes *ca.* 0.5 mm wide with isidiate-sorediate margins 1. **C. concolor**
- 1b. Thallus partly yellowish orange and partly glaucous grey; lobes 0.7-1.3 mm wide with only soredia along margin 2. **C. indica**

1. Candelaria concolor (Dickson) Arnold, *Flora* 62: 364. 1879. -*Lichen concolor* Dickson, *Fl. Crypt. Brit.* 3: 18. 1739.

Thallus closely adnate to the substratum, orange yellow, growing in scattered patches, *ca.* 1 cm across; lobes short sublinear, overlapping, peripherally discrete, *ca.* 0.5 mm wide; margin irregularly crenate; upper surface smooth, shining; isidia and soredia both present along margins; medulla white; lower surface ashy, bearing concolourous rhizines; rhizines scattered, simple with blackish tips, *ca.* 0.5 mm long. Apothecia not seen. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; calycin and pulvinic dilactone present.

The taxon sparsely grows on road side *Cryptomeria japonica* trees in subtropical regions of West Sikkim.

Distribution: India (Jammu & Kashmir, Nagaland and Sikkim). Cosmopolitan.

Specimen examined: West Sikkim: Tashiding Forest Rest House compound, alt. 1450 m, Sinha 500.

2. Candelaria indica (Hue) Vainio, *Philipp. J. Sci. sect. C.* 8:99. 1913; Poelt & Reddi, *Khumbu Himal* 6:14. 1969. -*C. fibrosa* Müll. Arg. f. *indica* Hue, *Nouv. Arch. Mus.*, ser.4, 2:52. 1900.

Thallus adnate to the substratum, growing in small patches, partly yellowish orange and partly glaucous grey; lobes 0.7-1.3 mm wide; margin incised in young ones, mature ones rounded; surface smooth, marginally sorediate; soredia granular, isidia absent; medulla white. Apothecia sparse, adnate, up to 0.2 mm diam.; margin distinct; disc brown; spores 6-8 x 3-4 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; calycin and pulvinic dilactone present.

The species commonly grows in subtropical areas on *Alnus nepalensis* trunks.

Distribution: India (Sikkim and Tamil Nadu), Nepal; Asia and Australia.

Specimen examined: East Sikkim: Tashi view point, Upreti & Chatterjee 01-217598 (LWG).

PARMELIACEAE

1. *Allocetraria* Kurok. & M. J. Lai

Thallus foliose to subfruticose; lobes dichotomously branched; upper surface yellow green, lacking pseudocyphellae; upper cortex palisade plectenchymatous; lower surface with sparse, simple rhizines and punctiform to sublinear pseudocyphellae on margins or lamina. Apothecia laminal or terminal, eperforate; asci 8-spored; spores colourless, simple, ellipsoid, 5-9 x 3-5 μm . Pycnidia terminal on projections along the margins, emergent; conidia cylindrical, 6-7 x 1 μm . Usnic acid present in cortex.

Allocetraria, a genus of 10 species from the Himalayas and arctic-boreal regions of the northern hemisphere, is segregated from *Cetraria* which has bilayered upper cortex and lacks rhizines; 7 species from India and 5 species in Sikkim.

Key to the species

- 1a. Medulla white, lacking pigments 2
- 1b. Medulla yellow ochraceous, with pigments 4
- 2a. Medulla P+ orange red 3. **A. flavonigrescens**
- 2b. Medulla P- 3
- 3a. Lobes plain or concave on the upper side,
not indented 1. **A. ambigua**
- 3b. Lobes convex on the upper side, apically
indented 2. **A. denticulata**
- 4a. Lobes radially symmetrical, upper side convex,
lacking secondary lobes 5. **A. stracheyi**
- 4b. Lobes distinctly dorsiventral, upper side concave,
secondary lobes present 4. **A. globulans**

1. ***Allocetraria ambigua*** (C. Bab.) Kurok. & M. J. Lai, Bull. Nat. Sci. Mus. Tokyo, ser. B, 17:62. 1991; Randle et al., Mycotaxon 80:396. 2001. -*Cetraria ambigua* C. Bab., Hooker's J. Bot., Kew Gard. Misc. 4:244, 1852; Awasthi, Bull. Bot. Surv. India 24(1-4):19. 1982. (Fig. 27)

Thallus prostrate, subdichotomously divided, 1.5-2(-3) cm long; lobes lacinate, 1-2 mm wide; margins undulate, smooth, sparsely minutely black papillate on lacinules; upper surface yellowish, plane, smooth to faintly lacunose; medulla white; lower surface slightly brownish, \pm longitudinally reticulately lacunose scrobiculate, rhizines absent. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; lichesterinic, protolichesterinic and usnic acids present.

It abundantly grows in cold desert of Llonakh valley on ground and remain unattached.

Distribution: India (Sikkim and Uttaranchal) China and Nepal. Endemic in the Himalaya.

Specimens examined: North Sikkim: Donkia La, alt. 5200 m, U. Lachungpa 1746. Llonakh valley, Muguthang to Naku La, alt. 4500-4600 m, Sinha 1583.

2. *Allocetraria denticulata* (Hue) A. Thell & Randle in Daniels *et al.* (eds.), Flechten Follmann: 359. 1995; Divakar *et al.*, Mycotaxon 88:152. 2003. (Fig. 28)

Thallus foliose, yellow, erect 2-3 cm long, caespitose; lobes 1-1.5 mm wide, apically indented with marginal projections; upper surface smooth, convex; lower surface similar to the upper or slightly brownish, concave; upper cortex richly incrustated with crystals, lower cortex with less frequent crystals. Apothecia unknown. Pycnidia on marginal emergent projections, black; conidia filiform, 12-15 x 1 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; usnic, lichesterinic, protolichesterinic and caperatic acids present.

It sparsely grows on boulders in alpine areas.

Distribution: India (Sikkim), China.

Specimen examined: East Sikkim: Kupup, north border side, 4200 m, Sinha 1497.

3. *Allocetraria flavonigrescens* A. Thell & Randle in Daniels *et al.* (eds.), Flechten Follmann: 359. 1995; Randle *et al.*, Mycotaxon 80:399. 2001; Sinha & Elix, Mycotaxon 87: 83. 2003. (Fig. 29)

Thallus foliose to subfruticose, dorsiventral, loosely attached, cushion forming, yellow, 3-6 cm across; lobes subdichotomously branched, linear-laciniate, up to 1.2 mm wide; margin brown; upper surface dull, faintly lacunose, \pm convex, with reticulate maculae, numerous 1-2 mm tall laciniae present except peripheral part; medulla white; lower surface dark brown to black with paler margins, lamellate rugose, erhizinate. Pycnidia emergent, black, marginal to submarginal, fibrils not conspicuous. Apothecia not seen. Chemistry: Cortex K-; medulla K-, C-, KC-, P+ orange red; usnic acid and fumarprotocetraric acid present.

It sparsely grows on exposed boulders in cold desert of North Sikkim.

Distribution: India (Sikkim), China and Nepal.

Specimen examined: North Sikkim: Llonakh valley, Muguthang to Naku La track, 4500 m, Sinha 1575 (det. J. A. Elix)

4. *Allocetraria globulans* (Nyl.) A. Thell & Randle in Daniels *et al.* (eds.), Flechten Follmann: 360. 1995; Divakar *et al.*, Mycotaxon 88:153. 2003. – *Platysma globulans* Nyl., Flora 70:134. 1887. (Fig. 30)

Thallus foliose, yellowish. Lobes up to 8 mm wide with narrow secondary lobes 1-1.5 mm wide, dichotomously branched; upper surface plane to concave; medulla light yellow; lower surface brown with sparse concolorous rhizines. Apothecia not seen. Pycnidia numerous, marginally and a few laminally, located on black and somewhat emergent projections which often grow out from special warts of the thallus; conidia 10-18 x 0.5-2 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; usnic, lichesterinic, protolichesterinic and secalonic acid A present.

It sparsely grows on mossy rocks in alpine areas of North Sikkim.

Distribution: India (Sikkim), China and Nepal.

Specimen examined: North Sikkim: Llonakh valley between Muguthang and Naku La, 4500 m, Sinha 1571 B.

5. ***Allocetraria stracheyi*** (C. Bab.) Kurok. & M. J. Lai, Bull. Nat. Sci. Mus. Tokyo, ser. B, 17:62. 1991; Randlane *et al.*, Mycotaxon 80:406. 2001. -*Evernia stracheyi* C. Bab., Hooker's. J. Bot. Kew Gard. Misc. 4:244. 1852. -*Platysma everniellum* Nyl., Mem. Soc. Sci. Nat. Cherbourg 5:100. 1858. -*Cetraria everniella* (Nyl.) Krempelh., Verhandl. Zool. Bot. Gesellsch. Wien 18:315. 1868; Awasthi, Bull. Bot. Surv. India 24(1-4):20. 1982. -*Cetraria potaninii* Oxner, Zhurn. Bio-Bot. Tsyklu Vseukrains'K. Akad. Nauk 7-8:169. 1933. -*Allocetraria potaninii* (Oxner) Randlane & Saag, Mycotaxon 44:492. 1992. (Fig. 31)

Thallus suberect to erect, caespitose, 2-2.5 cm tall, yellow grey to brownish yellow, subdichotomously branched; lobes laciniate, 1.5-2 mm wide, slightly revolute; margin with black pycnidial papillae; upper surface \pm smooth, convex; medulla yellowish to ochraceous pigmented; lower surface deep yellow to reddish brown, concave, lacunose-scrabulate. Apothecia rare, terminal, 2-6 mm diam.; spores 5-7x5 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; usnic, protolichesterinic, lichesterinic acids and a pigment present.

It sparsely grows in alpine region of North Sikkim on ground along with mosses.

Distribution: India (Sikkim and Uttaranchal) China, Nepal; North America

Specimens examined: North Sikkim: On way between Lashar and GSI Old Camp Hut, alt. 4400 m, Sinha 1197. Sebu La base camp, west side, alt. 4500-4800 m, Sinha 1210. Llonakh valley, Chhaber lake below Luna La, alt. 4600 m, Sinha 1614. On midway between Thangu and Lashar, alt. 4300 m, Sinha 1171. Yomesamdong, Hot spring surroundings, alt. 4530 m, Sinha 1252. Yomesamdong, Tembawa river valley, alt. 4750 m, Sinha 1260.



31



32



33



34



35

Fig. 31. *Allocetraria stracheyi*. **Fig. 32.** *Pulbothrix isidiza*. **Fig. 33.** *Canomaculina subtinctoria*. **Fig. 34.** *Cetraria islandica*. **Fig. 35.** *C. muricata*.

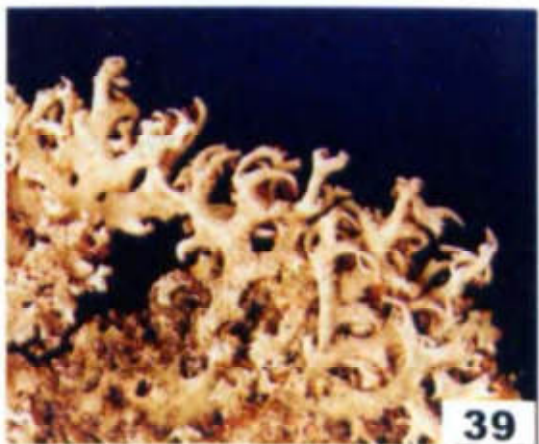
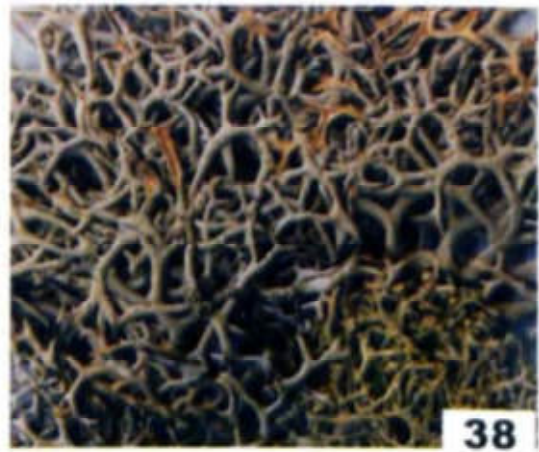


Fig. 36. *Cetrelia cetrarioides*. **Fig. 37.** *Evernia mesomorpha*. **Fig. 38.** *Everniastrum cirrhatum*. **Fig. 39.** *E. vexans*.

2. *Arctoparmelia* Hale

Thallus foliose, loosely to tightly adnate to the substratum, lobate; upper surface yellow green (usnic acid) or grey (atranorin) with or without soredia and isidia, without pseudocyphellae, smooth or rugulose, transversely to irregularly cracked; upper cortex with pored epicortex, palisade plectenchymatous; medulla white, loosely packed; lower surface velvety, flat or canaliculate, brown to black, smooth; rhizines sparse, simple to furcated. Apothecia laminal; disc eperforate; spores colourless, simple, ellipsoid, 10-12 x 4-6 μm . Pycnidia laminal, immersed; conidia bifusiform, 6 x 0.5 μm .

A saxicolous genus of ca. 5 species segregated from *Xanthoparmelia*, distributed throughout the arctic-boreal regions of Northern hemisphere; one species from Sikkim in India.

Arctoparmelia subcentrifuga (Oxner) Hale, *Mycotaxon* 25:252. 1986; Divakar *et al.*, *Mycotaxon* 79:249. 2001. -*Parmelia subcentrifuga* Oxner, *Journ. Bot. Acad. Sci. RSS Ukraine I* (3-4):39. 1940. -*Xanthoparmelia subcentrifuga* (Oxner) Hale, *Phytologia* 28:489. 1974.

Thallus foliose, loosely adnate, up to 4 cm across; lobes sublinear, dichotomously to subdichotomously branched, 0.5-1.5 mm wide; apices black, subrotund; upper surface yellow-green, pale yellow towards margin, dark green in centre, rugose-pustulate, reticulately cracked, cortex fragile, without soredia, isidia and maculae; lower surface velvety, flat, black to black brown, white near margins, smooth; rhizines short. Apothecia and pycnidia absent in the specimen examined. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; atranorin, usnic acid, alectoronic acid and an unknown fatty acid present.

The species sparsely grows on rocks over mosses in alpine desert.

Distribution : India (Sikkim), Nepal; Greenland, North America, Siberia.

Specimen examined: North Sikkim; Llonakh valley, alt. 4600 m, Sinha 1613.

3. *Bryoria* Brodo & D. Hawksw.

Thallus fruticose, erect, decumbent or pendent, dark brown or black; branches \pm terete and smooth, hair like, occasionally becoming flattened and pitted towards the base, with or without lateral spinules, soredia and pseudocyphellae present or absent; branching aniso- or isotomic dichotomous; cortex composed of periclinally congutinate hyphae; photobiont green, Trebouxioid. Apothecia lateral, very rare; asci thick walled, 8-spored; spores colourless, simple, ellipsoid, without distinctive perispore; paraphyses branched. Conidia minute, cylindrical to fusiform. Usnic acid absent, atranorin and chloroatranorin frequent.

About 46 species in the world; 15 species in Indian subcontinent and 8 in Sikkim.

Key to the species

- 1a. Thallus sorediate 2
- 1b. Thallus lacking soredia 3
- 2a. Thallus branching anisotomic dichotomous; branches up to 1 mm diam.; fumarprotocetraric acid present 7. **B. perspinosa**
- 2b. Thallus branching isotomic dichotomous; branches 0.3-0.5 mm diam.; psoromic and thamnolic acids present 4. **B. implexa**
- 3a. Medulla P+ orange red; fumarprotocetraric acid present 4
- 3b. Medulla P-; no lichen substances present 7
- 4a. Thallus more or less erect 5
- 4b. Thallus pendulous 6
- 5a. Thallus basally black, apically brown; lateral spinules dense 1. **B. bicolor**
- 5b. Thallus brown black throughout; lateral branches sparse 7. **B. nitidula**
- 6a. Branching isotomic dichotomous; lateral spinules absent 5. **B. levis**
- 6b. Branching anisotomic dichotomous; lateral spinules present 3. **B. himalayana**
- 7a. Thallus pseudocyphellate, sterile 8. **B. tenuis**
- 7b. Thallus lacking pseudocyphellae, usually fertile 2. **B. confusa**

1. **Bryoria bicolor** (Ehrh.) Brodo & D. Hawksw., Opera Bot. 42:99. 1977; G. Awasthi & Awasthi, Candollea 40: 308. 1985. -*Lichen bicolor* Ehrh., Beit. Naturk. 3:82.1788. -*Alectoria bicolor* (Ehrh.) Nyl., Acta. Soc. Linn. Bordeaux 21:291. 1856.

Thallus erect, 5-8 cm long, black in lower part, pale to dark brown in upper part; branching isotomic dichotomous to anisotomic dichotomous, divergent; branches up to 0.5 mm diam., terete, tapering apically; surface \pm smooth; lateral spinules dense, \pm perpendicular; pseudocyphellae slit like, white or brownish, usually distinct towards apices. Sterile. Chemistry: Cortex and medulla K-, C-, KC-, P+ orange; fumarprotocetraric acid present.

It is commonly found growing on bark of trees as well as on rocks among

mosses in temperate and alpine areas.

Distribution: India (Sikkim and West Bengal), Nepal. Widely distributed in the northern hemisphere.

Specimens examined: *North Sikkim:* Sebu La base camp, west side, alt. 4500-4800 m, Sinha 1216. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1049. *West Sikkim:* On way between Dzungri-Thangsing foot track, alt. 3900-3500 m, Sinha 812. On way between Tsoka-Dzungri foot track, alt. 3500-4000 m, Sinha 750 & 751.

2. ***Bryoria confusa*** (Awasthi) Brodo & D. Hawksw., Opera Bot. 42:155. 1977; G. Awasthi & Awasthi, Candollea 40:308. 1985. -*Alectoria confusa* Awasthi, Proc. Indian Acad. Sci. 72 B:152. 1970.

Thallus erect, 5-9 cm long, blackish or dark brown near base, paler towards apices; branching anisotomic dichotomous; branches up to 1 mm diam., terete, tapering; surface with depressions; lateral spinules numerous, \pm perpendicular to axis, short; pseudocyphellae absent. Apothecia common, up to 1 mm diam.; spores 6-10 \times 4-6 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

The species commonly grows on small tree branches in temperate areas.

Distribution: India (Arunachal Pradesh, Nagaland and West Bengal), China, Nepal and Taiwan.

Specimens examined: *East Sikkim:* Kupup, Near Bethang lake, alt. 4100 m, Sinha 1442. Pangolakha scrub, alt. 2900 m, Sinha 929. Rechala surroundings, alt. 2700-2900 m, Sinha 1007 A & 1007 B. Tamsey, alt. 3000-3500 m, P. Singh 679. Thegu, alt. 3700 m, Sinha 1388. *North Sikkim:* Lashar, alt. 4500 m, Sinha 1188. On midway between Thangu and Lashar, alt. 4300 m, Sinha 1176. Theu La base camp, south side, alt. 4500 m, Sinha 1686. *West Sikkim:* Dzungri, alt. 4000 m, Sinha 793. Thangsing-Samiti 3 km foot track, alt. 3700 m, Sinha 824.

3. ***Bryoria himalayana*** (Mot.) Brodo & D. Hawksw., Opera Bot. 42: 155. 1977; G. Awasthi & Awasthi, Candollea 40: 309. 1985. -*Alectoria himalayana* Mot., Fragm. Florist. Geobot. 6: 450. 1960.

Thallus pendulous, up to 15 cm long, anastomosing, grey brown to blackish; branching anisotomic dichotomous; branches up to 0.5 mm diam., terete, sometimes slightly flattened at branching points, tapering and attenuate apically; lateral spinules numerous, short or long, usually at right angles to main branches, dichotomously branched; surface shining, pseudocyphellate; pseudocyphellae sparse, streak like, concolorous with surface. Apothecia not seen. Chemistry: Cortex K-; medulla K-, C-, KC-, P+ yellow - orange; fumarprotocetraric acid present.

The taxon commonly grows on shrubs in alpine regions.

Distribution: India (Nagaland, Sikkim and West Bengal), Bhutan and Nepal.

Specimens examined: West Sikkim: Near Bakhim, alt. 2700 m, Sinha 270, 724. Tsoka-Phedang foot track, alt. 3050-3900 m, Sinha 220 A. Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 242.

4. **Bryoria implexa** (Hoffm.) Brodo & D. Hawksw., Opera Bot. 42:121. 1977; G. Awasthi & Awasthi, Candollea 40:309. 1985. -*Usnea implexa* Hoffm., Deut. Fl. 2:134. 1796.

Thallus erect, ca. 5 cm long, dark brown to blackish; branching isotomic dichotomous; branches up to 0.3 mm diam., terete, twisted and flattened at places; surface weakly pruinose; lateral spinules minute to long; pseudocyphellae absent; soralia scarce, fissural, elongate slit like, isidioid spinules absent. Sterile. Chemistry: Cortex K-; medulla K+ yellow-red, C-, KC-, P+ red; psoromic and thamnolic acid present.

The species sparsely grows on ground in open alpine areas.

Distribution: India (Uttaranchal); central and north Europe; North America.

Specimen examined: North Sikkim: On way between Lasher and GSI Old Camp Hut, alt. 4400 m, Sinha 1205.

5. **Bryoria levis** Awasthi in G. Awasthi & Awasthi, Candollea 40:310. 1985.

Thallus pendulous, ca. 7 cm long, yellowish brown to light chestnut brown, shining; branching isotomic dichotomous for the greater part, slightly anisotomic dichotomous in the apical region; branches divergent, or axils acute in younger branches; main branches up to 0.5 mm diam., terete, tapering; surface smooth; lateral spinules absent; thallus sparsely pseudocyphellate; pseudocyphellae minute, elongate, slit like. Apothecia not seen. Chemistry: Cortex and medulla K+ yellowish, C-, KC-, P+ orange; fumarprotocetraric acid and an unidentified substance present.

It sparsely grows on trees in temperate areas.

Distribution: India (Sikkim) and Nepal.

Specimens examined: North Sikkim: Singbha Rhododendron Sanctuary, Phuni, alt. 3350 m, Sinha 1048. Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1634, 1638.

6. **Bryoria nitidula** (Th. Fr.) Brodo & D. Hawksw., Opera Bot. 42:107. 1977; G. Awasthi & Awasthi, Candollea 40: 312. 1985. -*Bryopogon jubatum* var. *nitidum* Th. Fr., Nova Acta Reg. Soc. Sci. Upsal. ser. 3, 3:25. 1860.

Thallus erect, sometimes decumbent, 5-7(-12) cm long, dying from the base, dark brown to black throughout; branching anisotomic dichotomous; branches 0.3-0.7 mm diam., terete, flattened at places; surface smooth; lateral spinules sparse,

perpendicular, with slightly constricted base; pseudocyphellae sparse; isidia and soredia absent. Sterile. Chemistry: Cortex and medulla K-, C-, KC-, P+ orange-red; fumarprotocetraric acid present.

The species sparsely grows on branches of bushes in open places.

Distribution: Nepal. Arctic and subarctic regions of northern hemisphere. It is a new record for India.

Specimen examined: North Sikkim: Llonakh valley, Llonakh chu surroundings, alt. 4500 m, Sinha 1668.

7. **Bryoria perspinosa** (Bystrek) Brodo & D. Hawksw., *Opera Bot.* 42:155. 1977; G. Awasthi & Awasthi, *Candollea* 40:312. 1985. -*Alectoria perspinosa* Bystrek, *Khumbu Himal* 6(1):21. 1969.

Thallus erect to pendulous, 6-8 cm long, pale brown to blackish brown; branching anisotomic dichotomous; main branches up to 1 mm diam., terete, flattened and twisted at some places, tapering; lateral spinules numerous, perpendicular to main axis, short or elongate; surface of branches smooth with white raised, oblong – elongate or slit like pseudocyphellae and soralia; soredia lacking tufts of isidioid spinules. Sterile. Chemistry: Cortex and medulla K+ reddish, C-, KC-, P+ orange-red; fumarprotocetraric acid and an unidentified substance present.

The species sparsely grows on bushes in moist alpine area.

Distribution: India (Arunachal Pradesh), China and Nepal.

Specimen examined: West Sikkim: Thangsing-Samiti foot track, 3 km point, alt. 3500 m, Sinha 850.

8. **Bryoria tenuis** (Dahl) Brodo & D. Hawksw., *Opera Bot.* 42:112. 1977; G. Awasthi & Awasthi, *Candollea* 40:315. 1985. -*Alectoria tenuis* Dahl, *Meddl. Gronl.* 150(2):144. 1950.

Thallus 6-8 cm long, dark brown to black near base, brown or pale brown towards apices; branching isotomic dichotomous to anisotomic dichotomous; branches up to 0.5 mm diam., terete, slightly tapering; lateral spinules perpendicular to the axis, short; surface smooth; pseudocyphellae white, fissural, slightly raised; isidia, soredia absent. Sterile. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances.

The species sparsely grows on ground in alpine areas.

Distribution: India (Uttaranchal and West Bengal); Oceanic areas of Europe and America.

Specimen examined: North Sikkim: Yomesamdong Hot Spring surroundings, alt. 4530 m, Sinha 1251.

4. *Bulbothrix* Hale

Thallus foliose, dorsiventral, heteromerous, corticolous or saxicolous, lobate, subdichotomously branched; lobes sublinear; margin crenate, bulbate ciliate; upper surface smooth to rugose, soredia or isidia present or absent; corticated on both surfaces; cortex palisade plectenchymatous; photobiont green, *Trebouxia*; medulla white; lower surface brown or black, rhizinate; rhizines brown or black, simple or richly branched. Apothecia adnate, eperforate, coronate or ecoronate; asci 8-spored; spores simple, bicornute or oval-ellipsoid. Atranorin present in upper cortex.

Over 44 species are known from the world. Out of this 7 species occur in India and 3 species in Sikkim.

Key to the species

- 1a. Thallus isidiate 1. ***B. isidiza***
- 1b. Thallus lacking isidia 2.
- 2a. Lower surface brown 3. ***B. setschwanensis***
- 2b. Lower surface black 2. ***B. meizospora***

1. ***Bulbothrix isidiza*** (Nyl.) Hale, *Phytologia* 28:480. 1974; *Smithson. Contr. Bot.* 32:16. 1976. -*Parmelia isidiza* Nyl. in Henriques, *Bol. Soc. Broter.* 3:130. 1884; Awasthi, *Biol. Mem.* 1:178. 1976. (Fig. 32)

Thallus closely or loosely adnate, whitish grey, 5-7 cm across, irregularly lobate; lobes 1-4(-5) mm wide, rounded to truncate at apices; upper surface smooth, emaculate, isidiate; isidia laminal, cylindrical, simple to rarely coralloid branched, up to 0.5 mm long, tips brown; lower surface brown, moderately rhizinate; rhizines simple, ca. 0.5 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow turning red, C-, KC-, P+ orange; atranorin and salacinic acid present.

It commonly grows on tree trunks and rocks in secondary forest and along forest fringes at lower elevations between 600-1500 m altitudes, occasionally extending up to 2300 m altitudes.

Distribution: India (Andaman Islands, Arunachal Pradesh, Jharkhand, Karnataka, Madhya Pradesh, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal) and tropical regions of the world.

Specimens examined: *East Sikkim:* Gangtok, Tashi view point, alt. 1900 m, Sinha 1774 B. On way between Chhalongpong village and Aritar, alt. 1500 m, Sinha 525. *South Sikkim:* Sumbuk-kartikey village area, alt. 950-1050 m, Sinha 11.

2. **Bulbothrix meizospora** (Nyl.) Hale, *Phytologia* 28:480. 1974; *Smithson. Contr. Bot.* 32:19. 1976. -*Parmelia tiliacea* var. *meizospora* Nyl., *Syn. Lich.* 1:383. 1860. -*Parmelia meizospora* (Nyl.) Nyl., *Flora* 52:292. 1869; Awasthi, *Biol. Mem.* 1:181. 1976.

Thallus ± adnate, ashy grey, up to 7 cm across; lobes thick, leathery, 2-4 mm wide; margin dissected, cilia in notches, simple to furcated at tips; upper surface plane, sometimes wrinkled rugose, faintly maculate; lower surface black with narrow brown papillate marginal zone; rhizines simple, ca. 1 mm long. Apothecia common, adnate, 1-3 mm diam.; margin entire, involute; thalline exciple ecoronate, smooth; spores 12-16 x 8-10 µm. Pycnidia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow turning red, C-, KC-, P+ orange; atranorin and salacinic acid present.

It commonly grows on trees in open places in subtropical areas.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Nepal, Pakistan and Africa.

Specimens examined: *East Sikkim:* Near Phadamchen, on Lingtam-Phadamchen road, alt. 1800 m, Sinha 881 A. *West Sikkim:* Yoksum, near old Gumpa, alt. 1900 m, Sinha 688.

3. **Bulbothrix setschwanensis** (Zahlbr.) Hale, *Phytologia* 28:481. 1974; *Smithson. Contr. Bot.* 32:22. 1976. -*Parmelia setschwanensis* Zahlbr. in *Handl. -Mazz.*, *Symb. sin.* 3:184. 1930; Awasthi, *Biol. Mem.* 1:192. 1976.

Thallus mineral greyish, adnate, 5-10 cm across; lobes irregularly branched, ± imbricate, 2-5 mm wide; margin dissected; cilia 0.5-0.75 mm long; upper surface smooth, cracked and rugose in older parts; medulla white; lower surface brown throughout, moderately rhizinate; rhizines simple, brown, 1-1.5 mm long. Apothecia common, adnate, 2-7 mm diam.; margin entire, sometimes undulate and cracked; thalline exciple ecoronate, smooth; spores 12-18 x 7-9 µm. Pycnidia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow turning red, C-, KC-, P+ orange; atranorin and salacinic acid present.

The species grows on trees and boulders in open places up to 2000 m elevations.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Manipur, Nagaland, Sikkim, Uttaranchal and West Bengal), China and Nepal.

Specimens examined: *East Sikkim:* On way between South Regu and Picrae forest, alt. 1900 m, Sinha 509. *North Sikkim:* Bey surroundings, alt. 1600 m, Sinha 566. *South Sikkim:* Sumbuk - Kartikey village area, alt. 950-1050 m, Sinha 10. *West Sikkim:* Karchi village surroundings, alt. 2000 m, Sinha 432. Labdang village surroundings, alt. 1850 m, Sinha 476. On way between Narkhola-Karchi village, alt. 2100-1850 m, Sinha 358. Yoksum, near old Gumpa, alt. 1900 m, Sinha 689.

5. *Canomaculina* Elix & Hale

Thallus foliose, loosely adnate to adnate, 5-20 cm across; lobes flat, irregular to subirregular – elongate, 5-15 mm wide, subrotund to rotund, ciliate; cilia simple or often branched, often markedly tapered; upper surface pale grey to grey, grey green or pale green, conspicuously effigurate – maculate, becoming irregularly cracked but without true pseudocyphellae, ± pruinose towards lobe apices, with or without soredia; upper cortex palisade plectenchymatous with a pored epicortex; medulla white; lower surface pale tan to black; rhizines dimorphous, short rhizines extending to the margins or nearly so, simple or rarely branched, up to 0.5 mm long, with additional long coarse, ± grouped rhizines, *ca.* 1-2 mm long. Apothecia laminal; disc perforate or eperforate; margin of thalline exciple ciliate; asci 8-spored; spores broadly ellipsoidal to ellipsoidal, 8-20 x 5-12 µm. Pycnidia laminal, punctiform, immersed; conidia filiform, 9-16 x 1 µm.

Canomaculina is primarily a tropical genus with some species extending their range in to temperate zones. The genus comprises *ca.* 22 species in the world; 2 species from India as well as from Sikkim.

Key to the species

- 1a. Thallus isidiate 2. ***C. subtinctoria***
 1b. Thallus sorediate 1. ***C. subsumpta***

1. ***Canomaculina subsumpta*** (Nyl.) Elix, *Mycotaxon* 65:477. 1997. -*Parmelia subsumpta* Nyl., *Flora* 52:117. 1869; Zahlbr., *Cat. lich. univ.* 6:367. 1930; Hale, *Contr. U. S. Nat. Herb.* 36:315. 1965; Awasthi, *Biol. Mem.* 1:222. 1976.

Thallus loosely adnate, up to 15 cm across, coriaceous, mineral grey to pale grey; lobes up to 10 mm wide, marginally subascending, imbricate; margin crenate; cilia dense, *ca.* 1.5 mm long; upper surface plane, dull, white maculate, reticulately fissured in central parts; soralia marginal in central part, confluent and linear, sorediate lobes involute, soredia farinose or granular; lower surface pale brown to blackish in patches in central part, densely shortly rhizinate up to the margin, rarely with narrow erhizinate margin in few lobes. Apothecia rare, 3-5 mm diam., stipitate; thalline exciple sorediate along margin; spores 15-19 x 6-8 µm. Chemistry: Cortex K+ yellow; medulla K+ yellow-red, C-, KC-, P+ orange-red; atranorin and salacinic acid present.

The species was reported from Sikkim by Upreti *et al.* (2003). It sparsely grows on trees in subtropical areas.

Distribution: India (Meghalaya, Sikkim and Tamil Nadu); widely distributed in tropical America and Africa.

Specimen examined: East Sikkim: Gangtok, Baluakhani, Chatterjee & Divakar 20-77014/B (LWG).

2. *Canomaculina subtinctoria* (Zahlbr.) Elix, Mycotaxon 65:477. 1997. -*Parmelia subtinctoria* Zahlbr., Symb. sin. 3: 193. 1930; Hale, Contr. U.S. Nat. Herb. 36: 317. 1965; Awasthi., Biol. Mem. 1:222. 1976. -*Parmotrema subtinctorium* (Zahlbr.) Hale, Phytologia 28: 339. 1974. -*Rimeliella subtinctoria* (Zahlbr.) Kurok., Ann. Tsukuba Bot. Gard. 10: 19. 1991. (Fig. 33)

Thallus loosely attached, pale grey to dark grey, 5-10 cm across; lobes 7-15 mm wide; margin crenate-dentate, ciliate at dents; cilia simple to branched, 1-2 mm long; upper surface smooth, sometimes maculate in peripheral zone, becoming scabrid and reticulately cracked in older parts, densely isidiate; isidia laminal, filiform, simple to branched, often ciliate; lower surface pale brown, rarely brown black in central part, marginal zone shining and papillate; rhizines simple, uniformly distributed, 1-2 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow-red, C-, KC-, P+ orange; atranorin and salacinic acid present.

It is moderately common and found growing on trees and boulders in open moist places.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Manipur, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), tropical regions of the world and extends to temperate regions.

Specimen examined: West Sikkim: Karchi village surroundings, alt. 2000 m, Sinha 430.

6. *Canoparmelia* Elix & Hale

Thallus foliose, adnate or tightly adnate; lobes sublinear to subirregular, 0.5-8 mm wide, eciliate; apices subrotund to rotund, more rarely truncate; upper surface ashy white to grey or grey green, without pseudocyphellae, with or without maculae, isidia, pustules and soredia; upper cortex palisade plectenchymatous with pored epicortex; medulla white, rarely buff, or partly yellow or orange; lower surface commonly black, rarely pale brown with concolorous rhizines, lobe margins with a narrow, less than 1 mm wide, pale, erhizinate zone; rhizines simple, tufted or not. Apothecia laminal, sessile or subpedicellate; disc entire; asci 8-spored; spores commonly ellipsoidal, rarely elongated ellipsoidal or curved, 7-20 x 4-9 μ m. Pycnidia laminal or rarely marginal, punctiform or crateriform, immersed or rarely slightly emergent; ostiole jet black; conidia bifusiform, more rarely cylindrical, bacilliform, fusiform or filiform. Atranorin and chloroatranorin present in cortex.

Canoparmelia a segregate of *Pseudoparmelia* Lynge s. lat., contain about 39 species in the world; 9 species in India and 2 in Sikkim.

Key to the species

- 1a. Medulla KC-, yellow near soralia 1. *C. aptata*
 1b. Medulla KC+, white; divaricatic acid present 2. *C. texana*

1. ***Canoparmelia aptata*** (Krempelh.) Elix & Hale, Mycotaxon 27:278. 1986. -*Parmelia aptata* Krempelh. in Nyl., *Flora* 52: 291. 1869; Zhalbr., Cat. lich. univ. 6: 224. 1930; Awasthi, Biol. Mem. 1: 164. 1976. -*Pseudoparmelia aptata* (Krempelh.) Hale, *Phytologia* 29: 189. 1974.

Thallus closely adnate, 4-6(-8)cm across, coriaceous, ashy grey to dark grey; lobes subrotund, subimbricate and involuted, 2-4 mm wide; upper surface plane, dull, smooth to rough, with minute fleck of soredia on the lamina and better developed soredia along margin and in submarginal area, pustules absent; soredia ± granular; medulla mostly white, yellowish near soralia; lower surface black, rough, rhizinate up to the margin; rhizines short, simple. Apothecia usually present, 2-3 mm diam., adnate, constricted at base, eperforate; thalline exciple rugose, sorediate; spores colourless, simple, oval ellipsoid, 8-14 x 5-7 µm. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranoria and perlatolic acid present.

Distribution: India (Himachal Pradesh, Madhya Pradesh, Sikkim, Uttaranchal and West Bengal), Indonesia, Japan, Nepal; Africa, Australia.

Earlier record: Sikkim, Pamianchi (Asahina, 1966).

2. ***Canoparmelia texana*** (Tuck.) Elix & Hale, Mycotaxon 27:279. 1986. -*Parmelia texana* Tuck., Amer. J. Arts & Sci. ser. 2, 25: 424. 1859; Awasthi, Biol. Mem. 1: 195. 1976. -*Pseudoparmelia texana* (Tuck.) Hale, *Phytologia* 28:191. 1974; *Smithson. Contr. Bot.* 31:52. 1976.

Thallus closely adnate, ashy grey, 5-8 cm across; lobes sublinear, imbricate in central part, discrete at periphery, 2-5 mm wide; margin crenate to deeply incised, apices subrotund; upper surface smooth to reticulately cracked, emaculate to weakly maculate, sorediate; soralia laminal to submarginal, initially pustulate, becoming profusely sorediate later; soredia granular, sometimes diffused, ashy grey; lower surface black, with a narrow brown rhizinate margin; rhizines sparse, 0.3-0.5 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranorin and divaricatic acid present.

It sparsely grows on trees and boulders in open places.

Distribution: India (Karnataka, Kerala, Madhya Pradesh, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu and Uttaranchal); widely distributed in tropical and subtropical regions of the world.

Specimen examined: West Sikkim: Pemayangtse monastrey surroundings, alt. 2075 m, Sinha 164.

7. *Cetraria* Ach.

Thallus dorsiventral, heteromerous, subfruticose to fruticose, rarely appressed foliose, several individual thalli usually clumped together into small stands; lobes subterete, canaliculate to flat, dichotomously or irregularly branched, expanded portions often unbranched; margins usually entire, sometimes undulating or cucullate; marginal projections and cilia present in some; upper surface grey, olive green, brown or reddish brown, emaculate, with or without soredia, lacking isidia; upper cortex bilayered, with a non pored epicortex; pseudocyphellae often present on lower surface and the lobe margin, rare on upper surface, without rhizines. Apothecia marginal at lobe apices, sessile to subpedicellate; disc eperforate; asci clavate to cylindrical, 8-spored; spores ellipsoidal to subspherical, 6-10 x 3-5 μ m. Pycnidia common to rare, at ends of marginal projections; conidia oblong citriform.

The genus *Cetraria* has its centre of diversity in the Arctic regions with about 40 species in the world; ca. 10 species in India and 5 species in Sikkim.

Key to the species

- 1a. Thallus 1-2 cm high shrubby tuft, intricately branched, not erect; branches 0.5-1 mm wide, lacking pycnidial fibrils 4. *C. muricata*
- 1b. Thallus more than 2 cm high, suberect to erect, not intricately branched; branches more than 1 mm wide, pycnidial fibrils present 2
- 2a. Pseudocyphellae indiscernible, laciniae with cilia and pycnidial fibrils 5. *C. nigricans*
- 2b. Pseudocyphellae distinct 3
- 3a. Thallus yellow to yellowish grey; lower surface with brown black rimmed pseudocyphellae; medulla P-; usnic and salacinic acids present, fumarprotocetraric acid absent 3. *C. melaloma*
- 3b. Thallus brown to dark chestnut brown; upper surface pseudocyphellate; medulla P+ orange; fumarprotocetraric acid present, usnic acid absent 4
- 4a. Pseudocyphellae submarginal forming a distinct continuous line; lobes canaliculate to strongly tubular 2. *C. laevigata*
- 4b. Pseudocyphellae laminal to submarginal, not in continuous line; lobes flat to canaliculate 1. *C. islandica*

1. **Cetraria islandica** (L.) Ach., Meth. Lich.:293. 1803; Awasthi, Bull. Bot. Surv. India 24(1-4):22. 1982. -*Lichen islandicus* L., Sp. Pl.:1145. 1753. (Fig. 34)

Thallus suberect to erect, coriaceous, 2-6.5 cm tall, light brown to dark chestnut brown, densely divaricately branched; laciniae 1.5-3.5 mm wide, involute subcanaliculate, basally blackened; margin with dense brown to brown black pycnidial fibrils; upper surface smooth, pseudocyphellate; pseudocyphellae laminal to submarginal, whitish, laminal ones rounded to irregular, submarginal ones linear elongate, scarce; lower surface yellowish brown to brown, smooth to scrobiculate, shining to dull, pseudocyphellae not seen; apothecia not seen in the specimens examined. Chemistry: Cortex K-; medulla K- or K+ pale to reddish, C-, KC-, P+ orange - red; fumarprotocetraric, protocetraric and protolichesterinic acids present.

It sparsely grows on ground with mosses in alpine region.

Distribution: India (Uttaranchal), Nepal; Europe and Scandinavian countries.

Specimens examined: North Sikkim: Sebu La base camp, east side, alt. 4960 m, Sinha 1236. Theu La-Jakthang way, alt. 4600-3400 m, Sinha 1713.

2. **Cetraria laevigata** Rassad., Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komerov. Akad Nauk SSSR 5:133. 1945; Karnefelt, Opera Bot. 46:111-117. 1979; Awasthi, Bull. Bot. Surv. India 24(1-4):22. 1982.

Thallus suberect to erect, 2.5-6 cm tall, light brown to chestnut brown, densely divaricately branched, coriaceous, lacinate; laciniae 1.5-3 mm wide; margin with brown to brown black pycnidial fibrils; upper surface smooth, marginally to submarginally pseudocyphellate; pseudocyphellae distinct, in continuous line, whitish, particularly along tips; lower surface brown, ± smooth, distinct only in tip area, otherwise invisible due to strongly canaliculate-tubular nature. Apothecia absent in specimens examined. Chemistry: Cortex K-; medulla K-, C-, KC-, P+ orange-red; fumarprotocetraric and protolichesterinic acids present.

The species commonly grows on ground along with mosses in alpine regions.

Distribution: Himalaya.

Specimens examined: North Sikkim: Llonakh valley, Chhaber lake below Luna La, alt. 4600 m, Sinha 1607. On way between Lashar and GSI Old Camp Hut, alt. 4400 m, Sinha 1202. Yomesamdong, Tembawa river valley, alt. 4750 m, Sinha 1261. Yumthang, along river side forest, alt. 3530 m, Sinha 1081.

3. **Cetraria melaloma** (Nyl.) Krempelh., Verh. Zool.- Bot. Ges. Wien 18:315. 1868; Awasthi, Bull. Bot. Surv India 24(1-4):23. 1982. -*Platysma melalomum* Nyl., Syn. Lich. 1 :303. 1860. - *Cetraria pallida* Awasthi, Proc. Indian Acad. Sci. 45:130. 1957.

Thallus suberect to erect, 2-3 cm tall, yellow to yellowish grey, irregularly to dichotomously branched; laciniae 2-3(-5) mm wide, plane to involute, subcanaliculate; margin undulate, brown-lined, with 0.1-0.2 mm long black fibrils; upper surface smooth to faintly lacunose, pseudocyphellae absent; lower surface paler than upper surface, distinctly pseudocyphellate; pseudocyphellae brown black-rimmed, rounded to irregular in outline. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; protolichesterinic, lichesterinic, usnic and stictic acids present.

It commonly grows on ground with mosses in alpine areas.

Distribution: India (Sikkim), Bhutan, China and Nepal.

Specimens examined: North Sikkim: On way between Lashar and GSI Old Camp Hut, alt. 4400 m, Sinha 1194. West Sikkim: Dzungri, alt. 4000 m, Sinha 95. On way between Dzungri-Thangsing, alt. 3900 - 3500 m, Sinha 815.

4. ***Cetraria muricata*** (Ach.) Eckfeldt, Bull. Torrey Bot. Club 22:240. 1895. -*Lichen muricatus* Ach., Lich. suec. Prodr.:214. 1798. -*Coelocaulon muricatus* (Ach.) J. R. Laundon, Lichenologist 16:55. 1984.

Thallus forming shrubby tufts, 1-2 cm tall, matt to glossy brown; branching intricate, dense and spinulose; main branches rounded to somewhat flattened, 0.5-1 mm wide, usually with numerous, small lateral spinules; marginal cilia sparse; surface even, pseudocyphellate; pseudocyphellae flat, circular, not pitted; medulla solid. Apothecia not seen. Pycnidia on spinules. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; lichesterinic and protolichesterinic acids present.

The species sparsely grows on mossy boulders in moist alpine slopes.

Distribution: India (Uttaranchal); widespread in N. hemisphere, mountains in Africa and South America, extending to Antarctica.

Specimen examined: North Sikkim: Theu La base camp, south side, alt. 4500 m, Sinha 1697.

5. ***Cetraria nigricans*** Nyl., Herb. Musci Fenn. 109. 1859; Karnefelt, Opera Bot. 46:117-121. 1979; Awasthi, Bull. Bot. Surv. India 24(1-4):25. 1982. (Fig. 35)

Thallus 2-2.5 cm tall, subdichotomously divided, brown to dark brown; laciniae 1-1.5(-2) mm wide, subcanaliculate, margin undulate with moderate, 0.25-0.5 mm long pycnidial fibrils and 0.5-1 mm long cilia; pseudocyphellae almost indiscernible; lower side concolorous or paler brown, smooth to lacunose. Sterile. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; protolichesterinic and caperatic acids present.

It sparsely grows on mossy rocks in alpine areas.

Distribution: Nepal. It is a new record for India.

Specimen examined: North Sikkim: Sebu La, base camp area, west side, 4500-4800 m, Sinha 1224. West Sikkim: Dzungri, 4000 m, Sinha 790 A.

8. *Cetrelia* W. Culb. & C. Culb.

Thallus foliose, dorsiventral, heteromerous, lobate; lobes rounded, 5-25 mm wide; margins eciliate, ± ascending, entire to crenate dentate; upper surface shiny white or tan, always pseudocyphellate; isidia, soredia or lobules present or absent; cortex paraplectenchymatous; medulla white; photobiont green, *Trebouxia*; lower surface black with brown to whitish marginal zone, rhizinate, sometimes punctate. Apothecia rare, laminal to submarginal; disc perforate or not; asci 8-spored; spores colourless, ellipsoid, 11-22(-25) × 6-12 μm. Pycnidia marginal, immersed; conidia bifusiform (3-)4-6 × 1-1.5 μm. Chemistry diverse, atranorin always present in upper cortex.

Cetrelia is predominantly northern hemisphere genus, with a centre of speciation in Eastern Asia. About 17 species in the world; 8 species in India as well as in Sikkim.

Key to the species

- 1a. Thallus isidiate or sorediate 2
- 1b. Thallus lacking isidia and soredia 5
- 2a. Thallus isidiate 3
- 2b. Thallus sorediate 4
- 3a. Thallus isidiate only; medulla C-, KC+ pink; alectoronic and α-collatolic acids present 1. ***C. braunsiana***
- 3b. Thallus isidiate and lobulate both; medulla C+ pink; olivetoric acid present 7. ***C. pseudolivetorum***
- 4a. Medulla C+ pink, olivetoric acid present 6. ***C. olivetorum***
- 4b. Medulla C-, perlatic and imbricatic acid present 2. ***C. cetrarioides***
- 5a. Thallus with dorsiventral lobulae in tufts on upper surface or as fringe along margin 6
- 5b. Thallus without lobulae 8
- 6a. Medulla C-; lobulae well developed and abundant 5. ***C. japonica***
- 6b. Medulla C+ pink; lobulae well developed, infrequent or isidioid 7

- 7a. Isidia turning into lobulae along margin and on lamina; olivetoric acid present 7. *C. pseudolivectorum*
- 7b. Lobulae well developed, not originating from isidia, marginal; anziaic acid present 8. *C. sanguinea*
- 8a. Medulla KC+ pinkish; pseudocyphellae upto 1 mm across; imbricatic acid present 3. *C. collata*
- 8b. Medulla KC-; pseudocyphellae up to 0.5 mm across; perlatic acid present 4. *C. delavayana*

1. ***Cetrelia braunsiana*** (Müll. Arg.) W. Culb. & C. Culb., Contr. U. S. Nat. Herb. 34:493. 1968. -*Parmelia braunsiana* Müll. Arg., Flora 64:506. 1881.

Thallus loosely attached, 8-12 cm across, ashy white, uniformly brownish or tan in old specimens; lobes 5-15 mm wide; margin \pm ascending, entire to crenate; upper surface \pm smooth; pseudocyphellae small, punctiform to irregular, sometimes up to 1 mm wide, abundant on younger lobes; isidia simple, marginal to sometimes laminal, some coralloid isidia present along pseudocyphellae of old lobes; lower surface margin brown or greyish, not punctate; rhizines sparse, ca. 1 mm long. Apothecia not seen. Chemistry: Cortex K-; medulla K-, C-, KC+ pink, P-; atranorin, alectoronic and α -collatic acids present.

It commonly grows on trees and on boulders in open places in temperate regions.

Distribution: India (Himalayan region, Nagaland and Sikkim), China, Japan, Nepal, Philippines, Taiwan and New Zealand.

Specimens examined: North Sikkim: Lachen, Gumpa side forest, alt. 2700 m, Sinha 1553. Zema -I, alt. 2750 m, Sinha 1517. South Sikkim: Damthang - Tendong foot track, alt. 2000-2600 m, Sinha 136. West Sikkim: Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1312, 1331, 1335.

2. ***Cetrelia cetrarioides*** (Delise ex Duby) W. Culb. & C. Culb., Contr. U. S. Nat. Herb. 34:498. 1968. -*Parmelia perlata* var. *cetrarioides* Delise ex Duby, Bot. gall. 2:601. 1830. (Fig. 36)

Thallus loosely attached, pale grey, 6-10 cm across; lobes 6-15 mm wide; margin slightly ascending, undulate, entire to crenate; upper surface \pm smooth; pseudocyphellae small, elliptical, rarely elongate; soredia marginal, linear, farinose, abundant on crenate margin; lower surface margin pale brown, punctate with numerous white pores; rhizines sparse, ca. 1 mm long. Apothecia not seen. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; atranorin, perlatic and imbricatic acids present.

It commonly grows on trees in association with *C. pseudolivectorum* in temperate regions.

Distribution: India (Manipur, Nagaland, Sikkim and West Bengal), Japan, mountains of Southern Asia, Eastern North America and Western Europe.

Specimens examined: *East Sikkim:* Kupup, around Bethang lake, alt. 4100 m, Sinha 1433. Meimenchu Memorial check post, alt. 3700 m, Sinha 1409. Meimenchu lake surrounding forest, alt. 3200-3500 m, Sinha 1474. *North Sikkim:* Chungthang-Lachung road, 4 km point, alt. 1750 m, Sinha 1021. Sebu La base camp, west side, alt. 4500-4800 m, Sinha 1218. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1065. Theu La base camp, south side, alt. 4500 m, Sinha 1696. Thangu, along Teesta bank, alt. 3800 m, Sinha 1148. Zema -I, alt. 2750 m, Sinha 1517 A. *West Sikkim:* Near Bakhim, alt. 2500-2700 m, Sinha 708. Dzongri, alt. 4000 m, Sinha 783. On way between Dzongri-Thangsing, alt. 3900-3500 m, Sinha 811. Hilley-Varshay foot track, 1 km point, alt. 2250 m, Sinha 1310. Thangsing-Lampokhari foot track, 3 km point, alt. 3500 m, Sinha 857. Tsoka-Phedang foot track, alt. 3050-3900 m, Sinha 214.

3. *Cetrelia collata* (Nyl.) W. Culb. & C. Culb., Contr. U. S. Nat. Herb. 34:505. 1968. *-Platysma collatum* Nyl., Flora 70:134. 1887.

Thallus \pm loosely attached, whitish grey, ca. 9 cm across; lobes rounded, imbricate, 5-13 mm wide; margin \pm ascendent; upper surface smooth; pseudocyphellae pores large, many becoming confluent and exceeding 1 mm; lower surface margin dark brown or like upper surface, punctate; rhizines few, ca. 1 mm long. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC+ pinkish, P-; imbricatic acid and atranorin present.

It sparsely grows in open places on trees and shrubs.

Distribution: India (Himalaya, Sikkim), China and Nepal.

Specimen examined: *North Sikkim:* Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 590.

4. *C. delavayana* W. Culb. & C. Culb., Contr. U. S. Nat. Herb. 34:509. 1968; Sinha, Bull. Bot. Surv. India 45(1-4):221. 2003.

Thallus loosely attached, pale brownish, 5-8 cm across; lobes 12-15 mm wide; margin entire; upper surface smooth; pseudocyphellae few, small, up to 0.5 mm across; lower surface with dark brown margin, sparsely punctate; rhizines few. Apothecia not seen. Pycnidia large, marginal, unstalked; conidia rod-shaped, 5-6 x 1.5 μ m. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; atranorin and perlatolic acid present.

It sparsely grows on small shrubs in alpine areas.

Distribution: India (Sikkim), China.

Specimen examined: *North Sikkim:* Sebu La base camp, west side, alt. 4500-4800 m, Sinha 1221.

5. **Cetrelia japonica** (Zahlbr.) W. Culb. & C. Culb., Contr. U. S. Nat. Herb. 34:511. 1968; Sinha, Bull. Bot. Surv. India 45(1-4):222. 2003. -*Cetraria japonica* Zahlbr., Annal. Mycol. 14:60. 1916.

Thallus foliose, loosely adnate, greyish white, up to 8 cm across; lobes 5-9 mm wide, margin rarely rounded, usually densely fringed with lobulae; upper surface smooth; pseudocyphellae rounded to elongate, usually less than 0.5 mm in size; lower surface with chestnut brown marginal zone, punctae not seen; rhizines sparse, ca. 0.5 mm long. Apothecia not seen. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; atranorin and microphyllinic acid present.

It sparsely grows on tree trunks in high temperate coniferous forests.

Distribution: India (Sikkim), Borneo, Indonesia, Japan, South Korea and Taiwan.

Specimen examined: North Sikkim : Singbha Rhododendron Sanctuary, alt. 3350, Sinha 1066.

6. **Cetrelia olivetorum** (Nyl.) W. Culb. & C. Culb., Contr. U. S. Nat. Herb. 34: 515. 1968. -*Parmelia olivetorum* Nyl., Not. Salsk Fauna Fl. Fenn. Forhandl., n. ser. 5:180. 1866.

Thallus loosely attached, whitish grey or brownish, 8-10 cm across; lobes rounded, 8-15 mm wide; upper surface smooth; pseudocyphellae abundant, pores usually less than 0.5 mm across; soredia fine; lower surface with chestnut brown to whitish grey margin, not punctate; rhizines few, ca. 0.5 mm long. Apothecia and pycnidia not seen. Chemistry: Cortex K-; medulla K-, C+ pink red, KC+ pink, P-; atranorin and olivetoric acid present.

It sparsely grows on moist rocks in temperate areas.

Distribution: India (Sikkim), China, Japan, Nepal, Taiwan; Europe and N. America.

Specimen examined: North Sikkim: Lachen, Gumpa side forest, alt. 2700 m, Sinha 1554.

7. **Cetrelia pseudolivetorum** (Asah.) W. Culb. & C. Culb., Contr. U. S. Nat. Herb. 34:519. 1968. - *Parmelia pseudolivetorum* Asah., J. Jap. Bot. 27:16. 1952.

Thallus loosely attached, ashy grey to brownish, 5-15 cm across; lobes 5-13 mm wide; margin ascendent, entire or crenate lobulate; upper surface smooth, rugose in older lobes, lobulate; pseudocyphellae small, up to 0.5 mm wide, punctiform or slightly elongate; isidia simple to coralloid, turning into dorsiventral dissected lobules along margin and on surface; lower surface margin brown or ashy white, not punctate; rhizines sparse, black, ca. 1 mm long. Apothecia not seen. Chemistry: Cortex K-; medulla K-, C+ pink, KC-, P-; atranorin and olivetoric acid present.

It commonly grows on trees and boulders in open places in temperate regions.

Distribution: India (Nagaland, Sikkim and Uttaranchal), China, Japan, Nepal and Taiwan.

Selected specimens examined: *East Sikkim:* Pangolakha scrub, alt. 2900 m, Sinha 920. *North Sikkim:* On way between Phuni-Yakche, alt. 3000 m, Sinha 1090. Tholung, Gumpa surrounding forest, alt. 2500 m, Sinha 627. *South Sikkim:* On Damthang-Tendong foot track, alt. 2000-2600 m, Sinha 132, 140. *West Sikkim:* Karchi Reserve forest, alt. 2000-2400 m, Sinha 390. Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 236. Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 203.

8. *Cetrelia sanguinea* (Schaerer) W. Culb. & C. Culb., Contr. U. S. Nat. Herb. 34:521. 1968. -*Cetraria sanguinea* Schaerer in Moritzi, Syst. Verz.:129. 1846.

Thallus loosely attached, whitish grey, ca. 10 cm across; lobes 5-8 mm wide; margin entire to minutely lacerate or beset with small lobules; upper surface smooth to minutely wrinkled; pseudocyphellae with small pores, 0.1-0.4 mm wide, often inconspicuous or lacking on some lobes; lower surface jet black, margin whitish, sometimes dark brown, distinctly punctate, smooth to wrinkled; rhizines sparse, ca. 1 mm long. Apothecia many, cup-shaped, expanded irregularly, lacerated, 5-20 mm diam.; margin undulate, entire to minutely crenate; thalline exciple densely pseudocyphellate, minutely wrinkled; disc perforate; spores 16-21 x 9-12 μ m. Pycnidia large, marginal; conidia rod-shaped, 3-4 x 1 μ m. Chemistry: Cortex K-; medulla K-, C+ red, KC+ red, P-; atranorin and anziaic acid present.

It sparsely grows on upper branches of trees in temperate region.

Distribution: India (Himalaya, Manipur, Nagaland and Sikkim), China, Japan, Pakistan and Malaysia.

Specimen examined: *West Sikkim:* Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 202.

9. *Cetreliaopsis* M. J. Lai

Thallus foliose to subfruticose; lobes broad, \pm rotund, eciliate; upper surface yellow green, punctiform pseudocyphellae present; upper cortex paraplectenchymatous; lower surface sparsely rhizinate; rhizines simple. Apothecia marginal, nephromoid, eperforate; asci 8-spored; spores colourless, simple, oblong, 7-10 x 3-5 μ m. Pycnidia terminal on projections along the margins, emergent; conidia bifusiform, 5 x 1 μ m. Usnic acid present.

Cetreliaopsis segregated from *Cetraria s. lat.*, is represented by 5 species in the world; 1 species commonly grows in temperate areas of Eastern Himalaya and Nepal.

***Cetreliaopsis rhytidocarpa* (Mont. & v.d. Bosch) M. J. Lai, Quart. J. Taiwan Mus. 33:218. 1981. -*Cetraria rhytidocarpa* Mont. & v.d. Bosch in Jungh., Pl. Junghun.**

Fasc. 4:430. 1855; Awasthi, Bull. Bot. Surv. India 24(1-4):14. 1982. -*Nephromopsis rhytidocarpa* (Mont. & v.d. Bosch) Zahlbr., Anns Cryptog. exot. 1(2):208. 1928.

Thallus loosely attached, yellowish grey to glaucous yellow, ca. 7 cm across; lobes 5-20 mm across, irregularly undulate, imbricate; margin rounded with dense black pycnidial fibrils, lobulate; upper surface blackening along the margin; pseudocyphellae present on both the surfaces, black rimmed or whitish, generally with short black fibrils along the rim of pseudocyphellae; lower surface black with brownish margin; rhizines dispersed in groups, black, usually simple, sometimes furcated, ca. 1 mm long. Apothecia marginal, rounded, up to 9 mm across, nephromoid; margin crenulate; thalline exciple rugose, pseudocyphellate; spores 6-9 x 3-5 μ m. Chemistry: Cortex K-; medulla K+ yellow to red, C-, KC-, P+ orange; fumarprotocetraric and lichesterinic acids present.

It sparsely grows on trees in moist forest of temperate regions.

Distribution: India (Arunachal Pradesh, Nagaland, Sikkim and West Bengal), Bhutan, Java and Nepal.

Specimens examined: East Sikkim: Rechala surroundings, alt. 2700-2900 m, Sinha 1003 B. West Sikkim: Near Bakhim, alt. 2500-2700 m, Sinha 707.

10. *Evernia* Ach.

Thallus fruticose, erect to pendulous, attached by \pm spreading basal holdfast; lobes few to numerous, dorsiventral, flattened, strap-shaped, repeatedly dichotomously branched, corticate on both sides; lower surface paler than the upper; photobiont chlorococcoid; medulla arachnoid, lacking any mechanical axis. Apothecia (not reported in Indian specimen), lateral to terminal, lecanorine; asci 8-spored; spores colourless, simple, ellipsoid. Pycnidia rare, laminal and marginal, immersed, rounded, blackened around the ostiole; conidia needle-shaped. Atranorin, \pm usnic acid present in cortex; medulla with evernic or divaricatic acid.

3 species known from India and 1 from Sikkim.

Evernia mesomorpha Nyl., Lich. Scand. : 74. 1860; G. Awasthi, Bull. Bot. Surv. India 24(1-4): 97. 1982. (Fig. 37)

Thallus suberect to pendulous, caespitose, 5-10 cm long, yellowish green to pale grey, somewhat blackish near base, dichotomously to subdichotomously densely branched; main branches flat to irregularly round, up to 3 mm wide, gradually tapering apically, longitudinally to irregularly wrinkled, nervose foveolate; surface densely covered with sorediate isidia in major upper part; soredia granular. Apothecia not seen. Chemistry: Cortex and medulla K-, KC-, P-; divaricatic, evernic, sekikaic and usnic acids present.

The species sparsely grows on tree trunks and on exposed boulders in temperate and alpine areas between 3800-4100 m elevations.

Distribution: India (Himalchal Pradesh, Sikkim and Uttaranchal), Nepal.

Specimens examined: North Sikkim: On way between Thangu-Lashar foot track, at 4 km point, alt. 4100 m, Sinha 1167; Thangu, along Teesta river bank, alt. 3800 m, Sinha 1149. Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1637.

II. *Everniastrum* Hale ex Sipman

Thallus foliose, dorsiventral, heteromerous, composed of narrow (0.5-)1-2(-4) mm wide, regularly dichotomously branched lobes; upper surface usually convex, often bordered by a black line due to an extension of the lower cortex, sometimes grooved or maculate, with a pored epicortex, isidia or soredia present or absent; lower surface concave, brown to black, tips paler, bare or rhizinate; lobe margin usually ciliate by conspicuous marginal rhizines of ca. 1-3(-6) mm length; rhizines simple or more or less dichotomously branched, occasionally with perpendicular branchlets; upper cortex and lower cortex pachydermatic paraplectenchyma; algal cells of *Trebouxia* type. Apothecia more or less cup shaped, (1-)3-8(-17) mm diam., with a brown disc and grey margin, raised by a short hollow stalk; margin often maculate and wrinkled beneath; asci broadly elongate, often compressed at base, 8-spored; spores colourless, simple, (7-)10-16(-28) x 4-7(-11) μ m, the larger ones often slightly reniform and sometimes with 1-3 irregularly distributed transverse septa. Pycnidia immersed, with a black ostiole; conidia bifusiform, 4-7(-8) x <0.7 μ m, or filiform, 13-21 x 1 μ m.

The genus is represented by 31 species in the world; 5 species in India and 3 species in Sikkim. It has centres of speciation in tropical America and tropical Asia.

Key to the species

- 1a. Thallus isidiate 3. *E. vexans*
- 1b. Thallus lacking isidia 2
- 2a. Lower surface black; rhizines dense 2. *E. nepalense*
- 2b. Lower surface brown in major part; rhizines
absent or very sparse 1. *E. cirrhatum*

1. *Everniastrum cirrhatum* (Fr.) Hale ex Sipman, Mycotaxon 26:239. 1986.
Parmelia cirrhara Fr., Syst. orb. 1:383. 1825; Awasthi, Biol. Mem. 1:168.
1976. (Fig. 38)

Thallus loosely attached, suberect to pendulous, mineral greyish, 5-15 cm across; lobes elongate, 2-5 mm wide; margin brown, lateral margin involute; cilia simple to branched, 1-2 mm long; upper surface smooth, sometimes rugose in older parts; lower surface black, brown along periphery, erhizinate or sometimes rarely rhizinate in older parts; rhizines sparse, ca. 0.5 mm long. Apothecia sessile

to substipitate, 2-8 mm diam.; margin inflexed, entire to cracked; thalline exciple smooth; spores 15-20 x 7-8 μm . Chemistry: Cortex K+ yellow; medulla K+ yellow turning red, C-, KC-, P+ orange; atranorin and salacinic acid present.

It commonly grows on trees and boulders in open places in association with *E. nepalense*.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Kerala, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal) and widely distributed throughout the world.

Selected specimens examined: *East Sikkim:* Gangtok, Tashi view point, alt 1700 m, Sinha 102. Near Mulkhark lake, around W.B. border, alt. 2200-2300 m, Sinha 541. Pangolakha scrub, alt. 2900 m, Sinha 910. Near Zuluk, alt. 2300 m, Sinha 883. *North Sikkim:* Bey surroundings, alt. 1600 m, Sinha 573. Lachen, alt. 2710 m, Sinha 1134. Lachung, along river side, alt. 2650 m, Sinha 1113 A. Nampruk village, along river side, alt. 1200 m, Sinha 661. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1064. *South Sikkim:* Namchi-Mamle route, alt 1550-1750 m, Sinha 111. On Damthang-Tendong foot track, alt. 2000-2600 m, Sinha 119. *West Sikkim:* Near Bakhim, alt. 2500-2700 m, Sinha 710 A. Pelling, alt. 2300 m, P. Singh 78. Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 249. Tashiding Monastrey surroundings, alt. 1400-1600 m, Sinha 146.

2. *Everniastrum nepalense* (Taylor) Hale ex Sipman, Mycotaxon 26:241. 1986. *Parmelia nepalensis* Taylor, Lond. J. Bot. 6:172. 1847; Awasthi, Biol. Mem. 1:183. 1976.

Thallus loosely attached, usually pendulous, rarely suberect, grey to dark grey, 5-20 cm across; lobes elongate, tapering at apices, 2-4 mm wide; margin black, lateral margin involute; cilia simple to branched, 1-3 mm long; upper surface smooth to rugose; lower surface black, pale brown to brown near margin, moderately to densely rhizinate; rhizines simple to squarrosely branched, 1-3 mm long; rhizines and cilia sometimes inseparable. Apothecia common, sessile to substipitate, up to 12 mm diam.; margin entire to cracked; thalline exciple smooth to rugose; disc eperforate; spores 12-24 x 5-9 μm . Chemistry: Cortex K+ yellow; medulla K+ yellow turning red, C-, KC-, P+ orange; atranorin, norstictic and protolichesterinic acids present.

E. nepalense is a very common species in Sikkim and is well represented in subtropical to temperate regions. Temperate specimens are usually more rugose and robust in size. It grows on trees as well as on boulders.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Madhya Pradesh, Manipur, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Southern China, Nepal, Thailand, Indonesia and Taiwan.

Selected specimens examined: *East Sikkim:* On way between Chhalangpong-Aritar, alt. 1500 m, Sinha 529. Chhangu lake surroundings, alt. 3550 m, Sinha 1370.

Kupup, north border side, alt. 4100-4200 m, Sinha 1512. Kyangnosla Alpine sanctuary, alt. 3000 m, Sinha 1374. Meimenchu lake surrounding forest, alt. 3200-3500 m, Sinha 1467. North Regu, near Chhuba village, alt. 1000-1300 m, Sinha 969. Singhanebans surroundings, alt. 2200 m, Sinha 951. On way between South Regu-Picrae forest, alt. 1900 m, Sinha 512. On way between Yakla-Sherathang, alt. 3800 m, Sinha 1397. Tamsey, alt. 3000-3500 m, P. Singh 675. *North Sikkim*: Pentong village surroundings, alt. 1500 m, Sinha 636. Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 597. *South Sikkim*: Namchi-Old Damthang road, alt. 1700-2000 m, Sinha 27. Temi Tea Estate, alt. 1300 m, Sinha 48. *West Sikkim*: Dzungri, alt. 4000 m, Sinha 780. Kongri village forest, alt. 2000 m, Sinha 333. On way between Narkhola-Karchi village, alt. 2100-1800 m, Sinha 349. Sombaria Forest Rest House compound, alt. 1700 m, Sinha 1289. Soreng, alt. 1800-2000 m, P. Singh 73 A. Thangsing-Samiti foot track, 3 km point, alt. 3700 m, Sinha 832. Tsoka-Phedang foot track, 3050-3900 m, Sinha 215.

3. *Everniastrum vexans* (Zahlbr. ex W. Culb. & C. Culb.) Hale ex Sipman, Mycotaxon 26:242. 1986. -*Cetrariastrum vexans* Zahlbr. ex W. Culb. & C. Culb., Bryologist 84:294. 1981. -*Parmelia vexans* Zahlbr., Feddes Repert., Sp. Nov. 33:55. 1933; Awasthi, Biol. Mem. 1:197. 1976. (Fig. 39)

Thallus loosely attached, mineral grey to greyish, 5-10 cm across; lobes elongate, tapering, 1-3 mm wide; cilia originating mainly from lateral involute margin, simple to dichotomously branched, 2-4 mm long; upper surface convex, ± smooth, densely isidiate; isidia cylindrical, rarely branched, up to 1 mm high, tips brown to blackish, eciliate; lower surface black, shining brown near margin; rhizines sparse, subsimilar to cilia, simple to dichotomously branched or squarrose, 2-4 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow turning red, C-, KC-, P+ orange; atranorin, salacinic acid and protolichesterinic acid present.

It commonly grows on trees and boulders in temperate regions of Sikkim in association with *E. cirrhatum* and *E. nepalense*

Distribution: India (Kerala, Manipur, Nagaland, Sikkim, Tamil Nadu and West Bengal), China, Taiwan; tropical America.

Specimens examined: *East Sikkim*: On way between Talkharka-Lower Rechala, alt. 2000-2200 m, Sinha 979. *South Sikkim*: Namchi-Old Damthang road, 5 km point, alt. 1700-2000 m, Sinha 33. *West Sikkim*: Karchi Reserve forest, alt. 2100-2400 m, Sinha 389.

12. *Flavocetraria* Karnefelt & A. Thell

Thallus foliose, erect, main lobes once or twice dichotomously branched; lobes canaliculate, subtubular or rather flat; upper surface yellow, usually smooth and glossy; lower surface pale yellow, smooth, pseudocyphellate; cortical layers paraplectenchymatous, sometimes indistinctly palisade plectenchymatous,

composed of 2-3 layers of pachydermatous cells of different size with external cells relatively smaller; upper cortex richly encrusted with crystals of usnic acid. Apothecia brown, marginal, at lobe ends; exciple two layered, strongly gelatinized; asci 8-spored; spores colourless, simple, ellipsoidal, 5-10 x 3-5.5 μm . Pycnidia black, marginal, slightly bifusiform, ca. 6 x 1 μm .

Represented by 2 species in the world and 1 species from India as well as from Sikkim.

Flavocetraria cucullata (Béllardi) Karnefelt & A. Thell, Acta Bot. Fenn. 150:81. 1994; Randlane *et al.*, Mycotaxon 80:412. 2001. -*Lichen cucullatus* Béllardi, Osservaz. Fenn. :54. 1788. -*Cetraria cucullata* (Béllardi) Ach., Meth. Lich. :293. 1803; Awasthi, Bull. Bot. Surv. India 24 (1-4): 19.1982. -*Allocetraria cucullata* (Béllardi) Randlane & Saag, Mycotaxon 44:491-493. 1992.

Thallus yellow, basal parts reddish, 2-3 cm tall; main lobes 3-4 mm wide, strongly canaliculated or subtubular; upper surface smooth; lower surface pale yellow, smooth, pseudocyphellate; marginal projections absent. Apothecia and pycnidia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; usnic and protolichesterinic acids present.

It sparsely grows on grounds in dry alpine areas of Llonakh valley.

Distribution: India (Uttaranchal), China, Japan, Mongolia, Nepal; wide spread in temperate boreal and arctic regions of Northern Hemisphere and southern most South America.

Specimen examined: North Sikkim: Llonakh valley, Chhaber lake below Luna La, alt. 4600 m, Sinha 1606.

13. *Flavoparmelia* Hale

Thallus foliose, loosely or rarely tightly adnate, dorsiventral, orbicular, 3-20 cm wide; lobes irregular, 1-8 mm wide; margin without cilia; apices rotund or subrotund, never incised; upper surface yellow green to green, rarely yellow, smooth, rugulose or rugose, without pseudocyphellae, with or without maculae, soralia, dactyls, pustules and isidia; upper cortex palisade plectenchymatous with a thin pored epicortex; medulla white, or partly yellow or orange; lower surface black, with a narrow, brown, naked marginal zone; rhizines sparse to moderately abundant, simple, tufted or rarely dichotomously branched, usually concolorous, often pale at lobe apices. Apothecia laminal, sessile to subpedicellate, 1-10 mm wide; disc eperforate, shiny or matt, red brown to cinnamon brown or dark brown; asci 8-spored; spores ellipsoidal, 12-21 x 5-11 μm . Pycnidia laminal, subglobose to globose, immersed; ostiole black; conidia bifusiform, rarely fusiform or bacilliform, 4-12 x 1 μm . Usnic acid and traces of atranorin present in cortex.

Flavoparmelia, a cosmopolitan and temperate genus with centres of distribution in South America and Australia, is represented by about 30 species in the world and 1 species in India as well as in Sikkim.

Flavoparmelia caperata (L.) Hale, Mycotaxon 25: 604. 1986. -*Lichen caperatus* L., Sp. Pl. :1147. 1753. -*Parmelia caperata* (L.) Ach., Meth. Lich.: 216. 1803; Awasthi, Biol. Mem. 1: 203. 1976. -*Pseudoparmelia caperata* (L.) Hale, Phytologia 28: 189. 1974; Smithson. Contr. Bot. 31: 20. 1976. (Fig. 40)

Thallus ± loosely adnate, thick coriaceous, yellowish grey, ca. 8 cm across; lobes elongate, apically subrotund, ascending imbricate, 2-5(-8) mm wide; margin entire, rarely crenate in older parts, undulate; upper surface smooth in peripheral parts, ± rugulose in central part, with occasional scattered lobules in central parts; pustules laminal, developing into laminal, diffuse soralia; soredia granular; rhizines sparse, simple, 0.3-0.7 mm long. Apothecia not seen. Chemistry: Cortex K-; medulla K-, C-, KC-, P+ orange - red; usnic, protocetraric and caperatic acids present.

It sparsely grows on boulders in open - moist places in temperate areas.

Distribution: India (Assam, Himachal Pradesh, Jammu & Kashmir, Nagaland, Tamil Nadu, Uttaranchal and West Bengal), pantemperate on all major continents.

Specimens examined: North Sikkim: Chungthang-Lachung road, 4 km point, alt. 1750 m, Sinha 1022. Lachung, river side forest, alt. 2650 m, Sinha 1111.

14. *Flavopunctelia* (Krog) Hale

Thallus foliose, dorsiventral, heteromerous; lobes broad, rounded; upper surface with punctiform pseudocyphellae; upper cortex paraplectenchymatous with non pored epicortex; lower surface rhizinate; rhizines simple, black. Apothecia laminal, eperforate; asci 8-spored; spores colourless, simple, ellipsoid, 11-16 x 5-10 µm. Pycnidia laminal, immersed; conidia bifusiform, 6 x 1 µm. Usnic acid present in the cortex.

A genus of 5 species with a pantemperate tropical distribution, occurring on all continents except Australia; 3 species in India and 1 in Sikkim.

Flavopunctelia flaventior (Stirton) Hale, Mycotaxon 20: 682. 1984. -*Parmelia flaventior* Stirton, Scott. Nat. 4:254. 1877-78; Awasthi, Biol. Mem. 1:209. 1976.

Thallus closely adnate, about 8 cm across, yellowish green to grey; lobes 2.5-5 mm wide, imbricate to confluent; margin crenate dentate, eciliate, ascending; upper surface ± smooth, irregularly minutely white pseudocyphellate in the peripheral part; soralia marginal to submarginal, linear, occasionally also developing on the pseudocyphellae; medulla white; lower surface black, sparsely shortly rhizinate, marginal 2-3 mm wide zone erhizinate, brown to dark tan, upturned, smooth and shining; rhizines sparse, ca. 0.5 mm long. Sterile. Chemistry: Cortex K-; medulla K-, C+ red, KC+ red, P-; usnic and gyrophoric acids present.

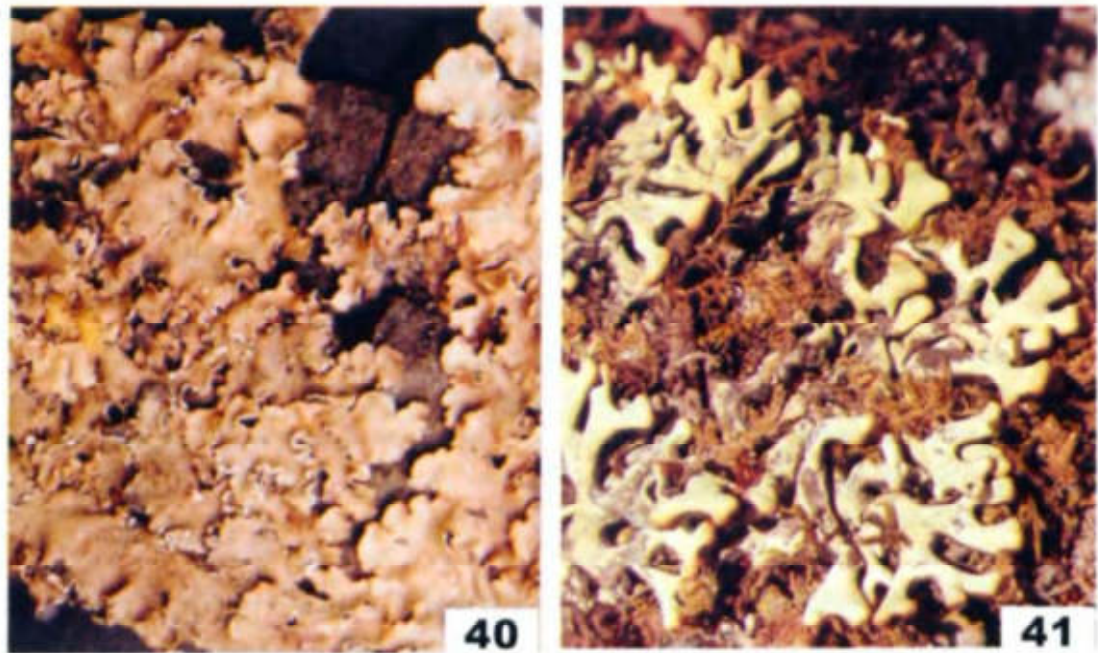


Fig. 40. *Flavoparmelia caperata*. **Fig. 41.** *Hypogymnia hypotrypa*. **Fig. 42.** *H. thomsoniana*.

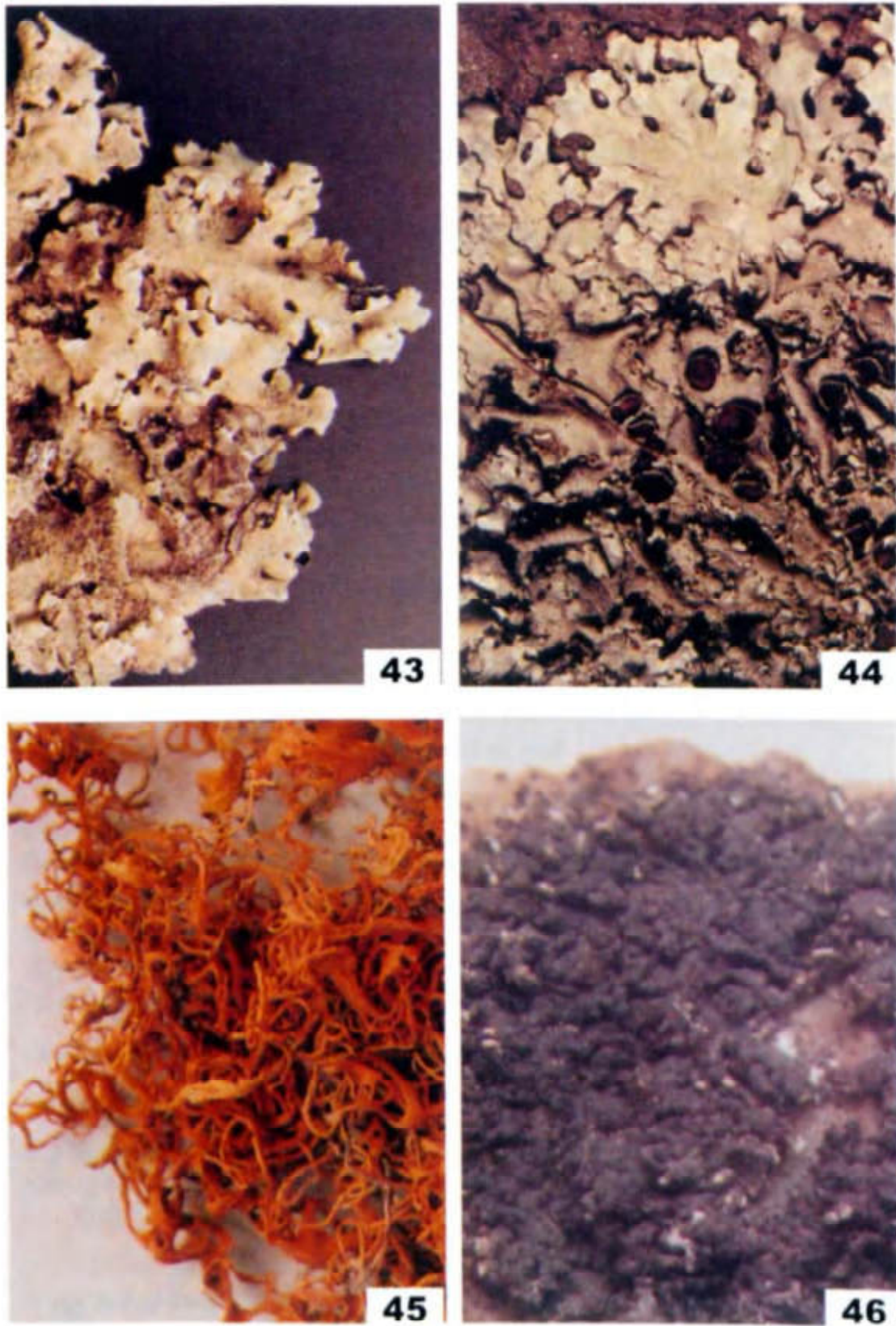


Fig. 43. *Hypotrachyna koyaensis*. **Fig. 44.** *H. scytophylla*. **Fig. 45.** *Lethariella cladonioides*. **Fig. 46.** *Melanelia microglabra*.

It sparsely grows on trees in open moist places in temperate areas.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Tamil Nadu and Uttaranchal); widely distributed in northern temperate countries.

Specimen examined: North Sikkim: Lachen, Gumpa side forest, alt. 2700 m, Sinha 1551.

15. *Hypogymnia* (Nyl.) Nyl.

Thallus foliose, heteromerous, attached by adhesive disc below or rarely by the whole lower cortex, lobate; lobes inflated, often \pm tubular, solid or hollow, deeply divided, corticated on both surfaces; upper cortex paraplectenchymatous, without perforations in the upper surface, with or without isidia and soredia, pseudocyphellae absent; photobiont green, *Trebouxia*; medulla white, loose, arachnoid; lower surface black, brown, corticate, wrinkled, thin often fissured or perforate, without rhizines. Apothecia lecanorine, sessile or prominently stalked; disc concave to plane, rarely perforate; epruniose; asci 8-spored; spores simple, colourless, \pm globose; pycnidia common in fertile species, minute, black, punctiform, immersed in upper surface; conidia cylindrical, straight to bifusiform. Atranorin present in upper cortex.

About 45 species in the world, primarily distributed in temperate and alpine regions; 14 species in India and 8 species in Sikkim.

Key to the species

- 1a. Thallus isidiate or sorediate 2
- 1b. Thallus lacking isidia and soredia 4
- 2a. Thallus isidiate, soredia absent 6. **H. sikkimensis**
- 2b. Thallus sorediate, isidia absent 3
- 3a. Medulla KC+ red, P-; physodic acid present 8. **H. vittata**
- 3b. Medulla KC-, P+ orange red; physodalic acid present 4. **H. physodes**
- 4a. Thallus yellow, greenish yellow to brownish yellow; lobes 4-6 mm wide; apices rounded 5
- 4b. Thallus grey to grey brownish; lobes less than 4 mm wide; apices attenuated 6
- 5a. Thallus yellow; medulla KC-, P+ orange; usnic and physodalic acids present 3. **H. hypotrypa**
- 5b. Thallus yellowish green, brown; medulla KC+ red, P-; physodic acid present 5. **H. pseudophypotrypa**
- 6a. Medulla P+ orange; adventive branchlets absent 7

- 6b. Medulla P-; adventive branchlets present.....7. **H. thomsoniana**
- 7a. Lobes 1-1.5 mm wide with dense laminal pycnidia; physodic and physodalic acids present 1. **H. alpina**
- 7b. Lobes 2-3 mm wide, lacking pycnidia; physodic acid present2. **H. enteromorpha**

1. **Hypogymnia alpina** Awasthi, Kavaka 12(2): 91. 1984.

Thallus foliose, adnate, grey brown, 2.5-4 cm across; lobes subdichotomously divided, compact, imbricate, 1-1.5 mm wide; upper surface smooth, becoming rough due to dense pycnidia; medulla hollow; lower surface black, brownish at tips, rugose, with small perforations. Apothecia not seen. Chemistry: Cortex K+ yellowish; medulla K-, C-, KC-, P+ orange or P-; atranorin, physodic and physodalic acids present.

It sparsely grows on *Rhododendron* shrubs in alpine areas.

Distribution : India (Uttaranchal). Endemic.

Specimens examined : North Sikkim : Lonakh valley, Chhaber lake, below Luna La, alt. 4600 m, Sinha 1604, 1605.

2. **Hypogymnia enteromorpha** (Ach.) Nyl., Acta Soc. Sci. Fenn. 26(10): 7. 1900; Awasthi, Kavaka 12(2): 91. 1984. -*Parmelia enteromorpha* Ach., Meth. Lich.: 252. 1803.

Thallus ca. 6 cm across, somewhat adnate, mineral grey to brownish; lobes inflated and puffy, 2-3 mm wide, not elongate, slightly black rimmed, irregularly branched, lower side of tips perforated; upper surface not sorediate, somewhat cracked, wrinkled; lower surface black to dark brown, wrinkled, thin; rhizines lacking; medullary cavity dark below, white to brown above. Apothecia 3-10 mm across, irregular, long stalked. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P+ orange; atranorin and physodic acid present.

Distribution: India (Sikkim), Korea; North America.

Earlier report: Lindsay (1866, p. 512) as a species of *Parmelia*.

3. **Hypogymnia hypotrypa** (Nyl.) Rassad., Acad. Sci. URSS, Inst. Bot. Nom. V.L. Komarovii: 297. 1967; Awasthi, Kavaka 12 (2): 92. 1984. -*Parmelia hypotrypa* Nyl., Syn. Lich. 1: 403. 1860. (Fig. 41)

Thallus loosely appressed, yellow, 4-8 cm across; lobes dichotomously divided, 2.5-5 mm wide, up to 6 mm wide at interdichotomous region, apices rounded to truncate, lateral margin brownish to blackish due to extension of lower surface, adventitive branchlets absent; upper surface smooth, matt; lower surface black, minutely wrinkled, perforated at apices and below dichotomy area, 2-4

mm across; medulla hollow. Apothecia not known. Chemistry: Cortex K-; medulla K-, C-, KC-, P+ orange; usnic acid physodalic acid present.

It commonly grows in temperate and alpine regions on *Abies* and *Rhododendron* trees.

Distribution: India (Sikkim), Nepal, extend up to China and Taiwan.

Specimen examined: West Sikkim: Thangsing-Samiti foot track, 3 km point, alt. 3700 m, Sinha 827.

4. *Hypogymnia physodes* (L.) Nyl., Lich. Envir. Paris :39. 1881; Awasthi, Kavaka 12(2):92. 1984. -*Lichen physodes* L., Sp. Pl.:1144. 1753. -*Parmelia physodes* (L.) Ach., Meth. Lich. :250. 1803.

Thallus ashy grey to grey, ca. 5 cm across, ascending at periphery; lobes subdichotomously branched, imbricate, 1-2 mm wide; upper surface convex, matt, cortex disintegrating in to sorediate mass throughout the surface, adventitious lateral branchlets present, labriform soredia not seen; lower surface black, strongly wrinkled. Apothecia not seen. Chemistry: Cortex K+ yellowish; medulla K-, C-, KC+ reddish, P+ orange-red; physodalic acid and atranorin present.

The species sparsely grows on mossy rocks in alpine area. It shows variation in presence of labriform soredia or its absence.

Distribution: India (Himachal Pradesh, Jammu & Kashmir and Uttaranchal); temperate regions of the world.

Specimen examined: West Sikkim; Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 233.

5. *Hypogymnia pseudophyotrypa* (Asah.) A. Singh, Lichenol. Ind. Subcontinent 1966-1977, Eco. Bot. Inform. Serv. Nat. Bot. Res. Inst. Lucknow: 2. 1980; Awasthi, Kavaka 12 (2): 93. 1984. -*Parmelia pseudophyotrypa* Asah. ex Nuno, J. Jap. Bot. 39: 89. 1964.

Thallus appressed, yellowish grey brown, lobes dichotomously divided, up to 6 mm wide, recalling shape and size of *H. hypotrypa*; upper surface smooth; lower surface black brownish at apices, perforated at apex and at dichotomy; perforations 1-2 mm across; outline of thallus more or less ellipsoid in cross section; medulla hollow. Apothecia absent in specimen examined. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ reddish, P-; atranorin, physodic acid and an unknown brown spot at Rf class 2 - 3.

The type specimens of this taxon is from Sikkim No. Specimen pertaining to this species have been found during present investigation. Description of Awasthi (*l. c.*) is provided here for ready reference. Morphologically *H. pseudophyotrypa* and *H. hypotrypa* are subsimilar. The two are distinguished

by the presence of atranorin and physodic acid in the former (medulla P-) and usnic acid and physodalic acid (medulla P+ orange - red) in the latter.

Distribution : India (Sikkim and West Bengal). Endemic.

6. *Hypogymnia sikkimensis* Sinha & Elix, Mycotaxon 87:81. 2003.

Thallus loosely adnate, pale grey to grey or yellowish grey, ca. 6 cm across; lobes separate to imbricate, linear elongate, subdichotomously branched, 1.5-4 mm wide, margin appressed; upper surface evenly inflated, dull, with irregular black patches and black margins, convex to flattened in older lobes, white maculate; isidia scattered, globose then short cylindrical, \pm ultimately becoming procumbent, flattened and lobulate; lobulae marginal or laminal, linear, simple, 1-2 mm long, 0.3-0.5 mm wide; medulla white at first, but soon darkening and becoming blackened adjacent to the lobe cavity; lower surface black, brown at apices, minutely wrinkled, with large ellipsoidal perforations, 1-1.4 x 0.5-1.5 mm across. Apothecia and pycnidia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; containing usnic acid (major), isousnic acid (major), atranorin (minor), chloroatranorin (minor), placodiolic acid (trace) and pseudoplacodiolic acid (trace).

The species resembles *H. zeylanica* (R. Sant.) Awasthi & K. Singh, but the former can clearly be separated by the linear-elongate lobes, the scattered, globose then short cylindrical isidia which may ultimately become procumbent, flattened and lobulate and the chemistry. The species is known from type locality, growing on mossy rock in high temperate East Sikkim.

Specimen examined: East Sikkim: Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1477 A (Holotype: BSHC; Isotype: CANAB).

**7. *Hypogymnia thomsoniana* (Müll. Arg.) Awasthi, Kavaka 12(2): 94. 1984.
Parmelia thomsoniana Müll. Arg., Flora 74: 379. 1891. (Fig. 42)**

Thallus foliose, ashy brown to copper brown; lobes lax, 6 cm long, 2-3 mm wide, dichotomously to trichotomously divided at interval of 5-8 mm, apices acute, adventive branchlets scarce; upper surface smooth with minute, dense black point like spots (pycnidia) and few slightly larger rounded areas, laterally irregularly black margined; lower surface black, minutely wrinkled, perforated; perforations at dichotomy, 1-1.5 mm across, sometimes transversely elongated. Apothecia absent but apothecial initials of about 1 mm diam. present. Conidia not distinct in pycnidia. Chemistry: Cortex K+ yellow; medula K-, C-, P-; atranorin (in trace) and physodic acid present.

It sparsely grows on coniferous trees at higher altitudes. The type specimens of this taxon is from Sikkim (no specific locality).

Distribution: India (Sikkim). Endemic to Sikkim.

Specimen examined : *East Sikkim*: On way to Thangu, alt. 2100m, K.P.S. Singh 2420 (BSA). *West Sikkim* : Tsoka-Phedang foot track, alt. 3050-3900 m, Sinha 224.

8. *Hypogynima vittata* (Ach.) Gasilien, Acta Soc. Linn. Bordeaux 53: 66. 1898; Awasthi, Kavaka 12(2): 94. 1984. -*Parmelia physodes* var. *vittata* Ach., Meth. Lich.: 251. 1803.

Thallus loosely attached, irregularly spreading, greyish, 2-5 cm across, lobes narrow elongated, discrete, imbricate or entangled, dichotomously to irregularly branched, 2-4 cm long, 0.5-2 mm wide, some with small adventitious lobules at right angles to main lobe; upper surface slightly convex, smooth or uneven with cracks in older parts, sorediate; soredia terminal, labriform, later diffused over surface; medulla white; lower surface black becoming dark or pale brown at apices, shining, strongly wrinkled with large round perforations at tips and at axils. Sterile. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ red, P-; atranorin and physodic acid present.

The species commonly grows on trees in temperate-alpine regions in *Rhododendron* and *Abies* forest.

Distribution: India (Himachal Pradesh, Nagaland and West Bengal), Bhutan, Indonesia, Japan, Norway, Papua New Guinea, Sweden and U.S.S.R.

Specimens examined: *East Sikkim*: Sherathang, alt. 3700 m, Sinha 1764. *North Sikkim*: Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1061, 1062. *West Sikkim*: Near Bakhim, alt. 2500-2700 m, Sinha 737. Phedang-Dzongri foot track, alt. 3900 - 4025 m, Sinha 231.

16. *Hypotrachyna* (Vainio) Hale

Thallus foliose, dorsiventral, heteromerous, corticolous or saxicolous, corticated on both surfaces; lobes sublinear, usually narrow, apically truncate, rarely subrotund; margin crenate, eciliate, rarely ciliate; pseudocyphellae absent; upper cortex palisade plectenchymatous; lower cortex paraplectenchymatous; photobiont green, *Trebouxia*; medulla white, rarely pigmented; lower surface black, rhizinate up to margins; rhizines black, dichotomously branched, often projecting beyond margins and forming a mat. Apothecia lecanorine, adnate; disc eperforate; asci 8-spored; spores simple, colourless, oval-ellipsoid. Pycnidia laminal, immersed; conidia colourless, bifusiform, 6 x 1 μ m. Atranorin always present in upper cortex.

Represented by about 140 species in the world; 36 species in India and 17 species in Sikkim.

Key to the species

- 1a. Thallus isidiate, sorediate or pustulate 2
 1b. Thallus lacking isidia, soredia or pustules 12

- 2a. Thallus isidiate 3
- 2b. Thallus sorediate or pustulate 9
- 3a. Isidia inflated, hollow, becoming crateriform with coarse soredia 3. **H. dactylifera**
- 3b. Isidia simple to coralloid branched, neither inflated nor becoming crateriform sorediate 4
- 4a. Medulla P+ yellow or orange 5
- 4b. Medulla P- 6
- 5a. Medulla P+ orange; protocetraric acid present 9. **H. koyaensis**
- 5b. Medulla P+ yellow; stictic acid present 2. **H. crenata**
- 6a. Medulla C+ pink 7
- 6b. Medulla C- 8
- 7a. Lobes 1-3 mm wide; lower surface with dense rhizines throughout; gyrophoric acid present 10. **H. neodissecta**
- 7b. Lobes 3-5 mm wide; lower surface papillate near margin; protolichesterinic and gyrophoric acids present 7. **H. incognita**
- 8a. Medulla KC+ rose; barbatic, obtusatic and norobtusatic acids present 6. **H. imbricatula**
- 8b. Medulla KC-; protolichesterinic and caperatic acids present 8. **H. infirma**
- 9a. Thallus UV+ orange; lichexanthone present 12. **H. osseoalba**
- 9b. Thallus UV-; lichexanthone absent 10
- 10a. Medulla K+ yellow to red, P+ orange-red 11
- 10b. Medulla K-, P+ yellow 4. **H. exsecta**
- 11a. Thallus pale greenish yellow; lobe margins sparsely ciliate; usnic acid present along with salacinic and norstictic acids 17. **H. sinuosa**
- 11b. Thallus greenish grey; lobe margins eciliate; usnic and norstictic acid absent, salacinic acid and zeorin present 14. **H. radiculata**
- 12a. Medulla yellow in lower half 15. **H. rigidula**
- 12b. Medulla white throughout 13

- 13a. Medulla P+ orange 1. **H. adducta**
 13b. Medulla P- 14
 14a. Medulla C+ pink or red 15
 14b. Medulla C- 16
 15a. Lobes maculate, loosely attached; barbatic and
 norobtusatic acids present 13. **H. physcioides**
 15b. Lobes emaculate, closely attached; gyrophoric
 acid present 16. **H. scytophylla**
 16a. Lobe margins lobulate; apothecia sessile, 1-2 mm
 across with dentate margins 11. **H. neosingularis**
 16b. Lobe margins lacking lobules; apothecia adnate to
 substipitate, 2-6 mm across with entire to undulate
 margins 5. **H. flexilis**

1. **Hypotrachyna adducta** (Nyl.) Hale, *Phytologia* 28:340. 1974. -*Parmelia adducta* Nyl., *Flora* 68:610. 1885; Awasthi, *Biol. Mem.* 1:164. 1976.

Thallus coriaceous, closely adnate, ashy grey to grey, *ca.* 5 cm across; lobes 2-4(-7) mm wide, short; margin rounded to notched; upper surface smooth, dull, emaculate; lower surface black, densely rhizinate up to margin; rhizines projecting beyond margin at axils, up to 1 mm long. Apothecia numerous, dense to crowded, sessile, constricted at base; margin inflexed, often excluded in larger ones, entire; thalline exciple smooth; spores (8-)16-20 x (5-)8-12 μm . Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P+ orange red; atranorin and protocetraric acid present.

It commonly grows on boulders in open places in temperate regions.

Distribution: India (Arunachal Pradesh, Manipur, Nagaland, Sikkim and West Bengal), Japan, Nepal, Philippines, Papua New Guinea, Taiwan and Thailand.

Specimens examined: *East Sikkim:* Near Mulkhark lake around West Bengal border, alt. 2200-2300 m, Sinha 542. *West Sikkim:* Labdang village surroundings, alt. 1850 m, Sinha 482. Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1334.

2. **Hypotrachyna crenata** (Kurok.) Hale, *Phytologia* 28:341. 1974. -*Parmelia crenata* Kurok. in Hale & Kurok., *Contr. U. S. Nat. Herb.* 36:168. 1964.

Thallus loosely attached, *ca.* 5 cm across, mineral grey; lobes irregularly branched, \pm imbricate, apices subrotund, 2-4 mm wide; margin crenate; upper surface smooth, emaculate; isidia laminal, short, cylindrical, often branched, *ca.* 0.5 mm long; medulla white; lower surface black; rhizines *ca.* 1 mm long. Sterile.

Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P+ yellow; atranorin, constictic acid, norstictic acid and stictic acid present.

It sparsely grows on mossy boulders as well as on trees in open places.

Distribution: India (Karnataka, Kerala, Maharashtra, Meghalaya, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Japan, Nepal, Taiwan and Thailand.

Specimens examined: East Sikkim: Gangtok, BSI compound, on *Alnus nepalensis* trunk, alt. 1500 m, Sinha 1360. On way between Premlakha-Tenjibir, alt. 2000 m, Sinha 898. West Sikkim: Near Bakhim, alt. 2500-2700 m, Sinha 712.

3. ***Hypotrachyna dactylifera*** (Vainio) Hale, *Smithson. Contr. Bot.* 25: 30. 1975. - *Parmelia dactylifera* Vainio, *Etud. Lich. Bresil.* 1:57. 1890; Awasthi, *Biol. Mem.* 1:169. 1976.

Thallus closely adnate, 5-8 cm across, mineral grey to grey, subdichotomously sinuate lobate; lobes sublinear, 1-3 mm wide, discrete to subimbricate in central part, apices truncate; upper surface smooth, shining at periphery, inwards densely isidiate; isidia large, inflated, clavate, up to 1 mm long, hollow, breaking at the top and then crateriform with coarse soredia like granules in a mass; lower surface black, moderately rhizinate up to the margin or with a narrow papillate margin; rhizines 0.5-1 mm long. Apothecia rare, ca. 3 mm diam.; spores 9-12 x 4.5-6.5 μ m. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ reddish, P-; atranorin and physodic acid present.

The species is characterized by inflated, large, hollow isidia which break in to crateriform structure.

Distribution: India (Meghalaya and Sikkim); South America.

Specimen examined: East Sikkim: Gangtok, Tashi view point, Chatterjee & Divakar 20-77160/C (LWG).

4. ***Hypotrachyna exsecta*** (Taylor) Hale, *Phytologia* 28:341. 1974. - *Parmelia exsecta* Taylor, *Lond. J. Bot.* 6:166. 1847; Awasthi, *Biol. Mem.* 1:173. 1976.

Thallus loosely attached, whitish mineral grey to dark grey, 5-11 cm across; lobes sublinear, sometimes divaricate, discrete to imbricate, 2-6 mm wide, apex dentate; margin subascending; upper surface smooth to \pm shining at the apical region, emaculate, pustulate-sorediate; pustules subapical, grey black, later becoming crateriform with granular soredia; medulla white; lower surface black, densely rhizinate, forming thick mat; rhizines 1-2 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ red, P- or P+ yellowish; atranorin, barbatic acid, 4-o-demethylbarbatic acid, obtusatic acid and echinocarpic acid present.

It sparsely grows on trees in moist forests.

Distribution: India (Arunachal Pradesh, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal). Widely distributed in tropical and subtropical regions of southern and eastern Pacific, including Australia.

Specimens examined: South Sikkim: Damthang-Tendong foot track, alt. 2000-2600 m, Sinha 143. West Sikkim: Varshey Rhododendron Sanctuary, alt. 2700-2500 m, Sinha 1333.

5. *Hypotrachyna flexilis* (Kurok.) Hale, Phytologia 28:34. 1974. -*Parmelia flexilis* Kurok. in Hara, Fl. Eastern Himal.: 607. 1966; Awasthi, Biol. Mem. 1:174. 1976.

Thallus loosely attached, 3-8 cm across, whitish grey; lobes imbricate, 3-5 mm wide; margin crenate; upper surface smooth, dull, emaculate; lower surface black, densely rhizinate up to the margin; rhizines ca. 1 mm long. Apothecia numerous, adnate to substipitate, 2-6 mm diam.; margin usually incurved, entire to undulate, rarely excluded; thalline exciple smooth; spores (8-)12-16(-21) x (4-)6-10 μ m. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranorin and protolichesterinic acid present.

It commonly grows on twigs as well as on boulders in open places.

Distribution: India (Arunachal Pradesh, Manipur, Nagaland, Sikkim and West Bengal); Nepal, Papua New Guinea and Taiwan.

Specimens examined: East Sikkim: On way between Chhalangpong and Aritar, alt. 1500 m, Sinha 527, 528. Gangtok, near Burtuk, Sinha 92. Near Mulkhark lake around West Bengal border, alt. 2200-2300 m, Sinha 543. Near Lower Zuluk, alt. 2300 m, Sinha 884. Pangolakha scrub, alt. 2900 m, Sinha 919. West Sikkim: Sombaria, Forest Rest House compound, alt. 1700 m, Sinha 1275.

6. *Hypotrachyna imbricatula* (Zahlbr.) Hale, Smithson. Contr. Bot. 25:41. 1975. -*Parmelia imbricatula* Zahlbr., Denks. Akad. Wiss. Wien Math. Nat. Kl. 83:168. 1909; Awasthi, Biol. Mem. 1:176. 1976.

Thallus closely adnate, 3-5 cm across, mineral grey to greyish; lobes 2-5 mm wide, crowded, discrete at periphery, longitudinally convolute; margin rounded to truncate, crenate, undulate; upper surface smooth, dull, indistinctly maculate; isidia dense, simple, filiform to coralloid branched; lower surface black, densely rhizinate, margin brown with rhizinal papillae; rhizines ca. 1 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ pink, P-; atranorin, barbatic, 4-o-demethylbarbatic, norobtusatic and obtusatic acids present.

It sparsely grows on boulders in moist open places.

Distribution: India (Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu and West Bengal), widely distributed in subtropical and temperate areas of the world.

Specimen examined: West Sikkim: Labdang forest, alt. 1900-2000 m, Sinha 463.

7. **Hypotrachyna incognita** (Kurok.) Hale, *Phytologia* 28:341. 1974. -*Parmelia incognita* Kurok. in Hara. *Fl. Eastern Himal.:* 608. 1966; Awasthi, *Biol. Mem.* 1:177. 1976.

Thallus loosely adnate, mineral grey to grey, 4-8 cm across; lobes imbricate, 2-5 mm wide; margin crenate; upper surface smooth, shining; isidia laminal, simple to coralloid branched, ciliate, brown tipped, up to 1 mm long, thin; lower surface black, with 1-2 mm wide, papillate, dark brown marginal zone, rhizinate; rhizines up to 1 mm long. Apothecia sessile, adnate, up to 2 mm diam.; margin crenate; thalline exciple smooth; spores 9-13 x 5-7 μm . Pycnidia not seen. Chemistry: Cortex K+ yellow; medulla K-, C+ rose, KC+ red, P-; atranorin, gyrophoric acid and protolichesterinic acid present.

It sparsely grows on *Pinus* bark as well as on boulders between 1000-1750 m elevations.

Distribution: India (Meghalaya, Sikkim and West Bengal), Japan, Nepal.

Specimen examined: East Sikkim: Gangtok, Hanuman tok, alt. 1750 m, Chatterjee & Diwakar 20-77193 (LWG).

8. **Hypotrachyna infirma** (Kurok.) Hale, *Phytologia* 28:341. 1974. -*Parmelia infirma* Kurok. in Hale & Kurok., *Contr. U. S. Nat. Herb.* 36:179. 1964; Awasthi, *Biol. Mem.* 1:177. 1976.

Thallus closely to loosely adnate, glaucous grey to grey, ca. 5 cm across; lobes sublinear, 2-5 mm wide at margin, imbricate; margin dentate, black rimmed; upper surface smooth, dull, emaculate; isidia dense, laminal, cylindrical, filiform, often branched, irregularly thickened, up to 1 mm long; lower surface black, margin dark brown to brown black, shining; rhizines moderately present, up to 1 mm long. Apothecia adnate to substipitate, 1-2 mm diam.; margin entire, inflexed; thalline exciple isidiate; spores 12-16 x 6-8 μm . Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranorin, protolichesterinic acid and caperatic acid present.

It commonly grows on boulders as well as on trees in open places.

Distribution: India (Arunachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Japan, Indonesia, Nepal, Taiwan and Thailand.

Specimens examined: East Sikkim: Gangtok, near Burtuk, alt 1700 m, Sinha 93. Gangtok, Tashi view point, alt. 2000 m, Sinha 107. On way between South Regu and Picrae forest, alt. 1900 m, Sinha 513. On way between Chhalangpong and Aritar, alt. 1500 m, Sinha 530. West Sikkim: Sombaria, Forest Rest House compound, alt. 1700 m, Sinha 1276.

9. **Hypotrachyna koyaensis** (Asah.) Hale, *Smithson. Contr. Bot.* 25:44. 1975. - *Parmelia koyaensis* Asah., *J. Jap. Bot.* 28:67. 1953; Awasthi, *Biol. Mem.* 1:178. 1976. (Fig. 43)

Thallus loosely adnate, mineral grey to grey, 6-10 cm across; lobes sublinear, imbricate, 3-6 mm wide; margin undulate, crenate to incised, minutely lobulate; upper surface smooth, dull, emaculate; isidia laminal, moderately distributed, globular to cylindrical, filiform to irregularly thickened, simple to branched, up to 0.8 mm long; lower surface brown black to black, marginal 1 mm wide zone sometimes erhizinate or with rhizinal papillae; rhizines usually furcated only once, ca. 1 mm long. Apothecia common, adnate, constricted at base, 1-2 mm diam.; margin entire to crenate, inflexed; thalline exciple smooth, often isidiate; spores 14-20 x 10-14 μ m. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P+ orange-red; atranorin and protocetraric acid present

It commonly grows on trees, boulders and on hard soil in open places.

Distribution: India (Arunachal Pradesh, Manipur, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Japan, Nepal, Taiwan and Mexico.

Specimens examined: West Sikkim: Kacheopalri lake surroundings, alt. 1850 m, Sinha 281. Near Chongrung village, alt. 1500 m, Sinha 300.

10. **Hypotrachyna neodissecta** (Hale) Hale, *Smithson. Contr. Bot.* 25:49. 1975. - *Parmelia neodissecta* Hale, *Phytologia* 22:94. 1971; Awasthi, *Biol. Mem.* 1:183. 1976.

Thallus closely adnate, ashy grey, ca. 4 cm across; lobes sublinear, 1-3 mm wide; margin subascending, crenate; upper surface dull, shining in marginal area, emaculate; isidia laminal, dense, irregularly thickened, filiform, simple to branched, ca. 1 mm long; lower surface black, densely rhizinate; rhizines up to 1 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C+ pink, KC+ red, P-; atranorin and gyrophoric acid present.

It sparsely grows on boulders in open place.

Distribution: India (Arunachal Pradesh, Manipur, Nagaland, Tamil Nadu and West Bengal), Nepal; Africa and America.

Specimen examined: West Sikkim: Dzongri, alt. 4000 m, Sinha 778.

11. **Hypotrachyna neosingularis** Divakar, Upreti & Elix, *Mycotaxon* 80:355. 2001.

Thallus loosely adnate to adnate, coriaceous, grey, becoming grey brown with age, up to 8 cm across; lobes sublinear to irregular, imbricate, 3-5 mm wide; lobules rounded, marginal and laminal, dense in central part, 0.2-1 mm wide; upper surface flat or buckled, smooth, shiny, emaculate, \pm irregularly cracked; lower surface black up to margin; rhizines moderately dense. Apothecia common,

sessile, 1-2.5 mm diam.; margin involute at first, dentate; thalline exciple smooth; spores 8-9 x 4.5-5.5 μ m. Pycnidia black, immersed; conidia weakly bifusiform, 6-8 x 1 μ m. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranorin, chloroatranorin, lichesterinic acid, protolichesterinic acid and unknown fatty acids present.

It sparsely grows on trees in subtropical areas.

Distribution: India (Sikkim). Endemic.

Specimen examined: East Sikkim: Gangtok, on bark, K.P. Srivastava s.n. July 1959 (Holotype: LWG).

12. *Hypotrachyna osseoalba* (Vainio) Park & Hale, Taxon 38(1):88. 1989. -*Parmelia osseoalba* Vainio, Ann. Soc. Zool. Bot. Fenn. 'Vanamo' 1:39. 1921. -*Parmelia formosana* Zahlbr., Feddes Repert. Sp. Nov., 33:57. 1934; Awasthi, Biol. Mem. 1:174. 1976. -*Hypotrachyna formosana* (Zahlbr.) Hale, Smithson. Contr. Bot. 25:38. 1975.

Thallus closely adnate to the substratum, glaucous grey to dark grey, 4-8 cm across; lobes sublinear, crowded, discrete, 1-4 mm wide, apices rounded to retuse; upper surface smooth, dull, plane to slightly convex, emaculate; pustules breaking apically and producing granular soredia; medulla sometimes ochraceous at places; lower surface black, densely rhizinate up to the margin; rhizines 1-1.5 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow, UV+ orange; medulla K+ reddish, C-, KC- or KC+ red, P- or P+ orange; lividic, physodic acids and lichexanthone present.

It commonly grows on trees and often on boulders in open places.

Distribution: India (Arunachal Pradesh, Kerala, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), widely distributed in subtropical and temperate regions of the world..

Specimens examined: West Sikkim: On way between Narkhola-Karchi village, alt. 2100-1800 m, Sinha 363. Karchi Reserve forest, alt. 2100-2400 m. Sinha 386.

13. *Hypotrachyna physcioides* (Nyl.) Hale, Smithson. Contr. Bot. 25:54. 1975. -*Parmelia physcioides* Nyl., Syn. Lich. 1:385. 1860; Awasthi, Biol. Mem. 1:185. 1976. -*Parmelia massartii* Hue, Nouv. Arch. Mus. Paris, ser. 3, 1:168. 1899; Awasthi, Biol. Mem. 1:180. 1976. -*Hypotrachyna massartii* (Hue) Hale, Phytologia 28: 341. 1974. -*Parmelia bostrychodes* Zahlbr., Ann. Crypt. Exot. 1:203. 1928; Awasthi, Biol. Mem. 1:190. 1976. -*Hypotrachyna bostrychodes* (Zahlbr.) Hale, Phytologia 28:340. 1974. -*Parmelia scytodes* Kurok. in Hale & Kurok., Contr. U. S. Nat. Herb. 36:185. 1964; Awasthi, Biol. Mem. 1:90. 1976. -*Hypotrachyna scytodes* (Kurok.) Hale, Phytologia 28: 341. 1974.

Thallus rather coriaceous, loosely adnate, 5-8 cm across, ashy grey to greyish; lobes sublinear, 2-5 mm wide, \pm discrete at periphery, often imbricate centrally; margin brown black rimmed, crenate; upper surface smooth, plane to convex, dull or shining, maculate; lower surface black, densely rhizinate, except brown papillate margin; rhizines 0.5-1 mm long. Apothecia few, laminal, adnate to substipitate, 4-7 mm diam.; margin inflexed, entire to minutely lobed; thalline exciple rugose; spores 12-16 x 6-8 μ m. Chemistry: Cortex K+ yellow; medulla K-, C+ pink, KC+ pink, P-; atranorin, barbatic acid, obtusatic acid and echinocarpic acid present.

The species sparsely grows on boulders in moist open places.

Distribution: India (Arunachal Pradesh, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal). Widely distributed in temperate regions of the world.

Specimens examined: *East Sikkim:* Pangolakha scrub, alt. 2900 m, Sinha 911. *West Sikkim:* Near Bakhim, alt. 2500-2700 m, Sinha 715. On way between Tsoka-Dzongri foot track, alt. 3500-4000 m, Sinha 741.

14. *Hypotrachyna radiculata* (Kurok.) Elix, Australasian Lichenology 48: 16. 2001; Divakar *et al.*, Mycotaxon 79:250. 2001. -*Parmelia radiculata* Kurok., Studies Crypt. Papua New Guinea :139. 1979.

Thallus loosely adnate, *ca.* 4 cm across, greenish grey; lobes sublinear-elongate, 1-3 mm wide, subirregularly branched, imbricate, margin occasionally crenate, ciliate; cilia sparse, simple, *ca.* 0.5 mm long; upper surface smooth, shiny, emaculate; soralia terminal or subterminal, capitate; soredia granular; medulla white; lower surface black; rhizines dense, simple to dichotomously branched. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow-red, C-, KC-, P+ orange-red; atranorin, chloroatranorin, consalacinic acid salacinic acid and zeorin present.

It sparsely grows on tree trunks and dead wood in moist open places.

Distribution: India (Sikkim and Uttaranchal); Australia, Papua New Guinea.

Specimen examined: *East Sikkim:* On way between Premlakha and Tenjabir foot track, Sinha 897.

15. *Hypotrachyna rigidula* (Kurok.) Hale, Phytologia 28:341. 1974. -*Parmelia rigidula* Kurok. in Hale & Kurok., Contr. U.S. Nat. Herb. 36:184. 1964; Awasthi, Biol. Mem.1:188. 1976.

Thallus coriaceous, loosely attached, *ca.* 10 cm across, mineral grey to dark grey; lobes 2-5 mm wide, imbricate, convolute; margin truncate; upper surface smooth, dull, emaculate with numerous black pycnidial dots; medulla yellow; lower surface black with narrow shining brown to dull, rhizinate-papillate marginal zone; rhizines dense, simple to dichotomously branched, 0.5-2 mm long. Apothecia

numerous, laminal, substipitate, up to 3 mm diam.; margin entire to minutely lobulate; thalline exciple smooth; spores (10-)12-15(-16) x 6(-8) μm . Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranorin and a yellow pigment present.

It sparsely grows on mossy boulders in open places.

Distribution: India (Nagaland, Sikkim and West Bengal). Endemic.

Specimen examined: North Sikkim: Tholung, Gumpa surrounding forest, alt 2500 m, Sinha 628.

16. *Hypotrachyna scytophylla* (Kurok.) Hale, Phytologia 28:342. 1974. -*Parmelia scytophylla* Kurok. in Hale & Kurok., Contr. U. S. Nat. Herb. 36:185. 1964; Awasthi, Biol. Mem.1:191. 1976. (Fig. 44)

Thallus thick coriaceous, \pm closely adnate, dull whitish grey, 5-8 cm across; lobes sublinear to irregular, 2-4 mm wide; margin crenate, black rimmed; upper surface smooth, dull, shining at periphery, emaculate, with numerous black dots; lower surface black, densely rhizinate up to the margin; rhizines simple to dichotomously branched, ca. 1 mm long. Apothecia common, adnate, substipitate, up to 8 mm diam.; margin minutely crenate, inflexed, undulate; thalline exciple smooth; spores 10-12 x 4-7 μm . Chemistry: Cortex K+ yellow; medulla K-, C+ pink, KC+ red, P-; atranorin and gyrophoric acid present.

It is moderately common in temperate region and grows in open places on boulders as well as on tree trunks.

Distribution: India (Himachal Pradesh, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Nepal.

Specimens examined: East Sikkim: Near Lower Zuluk, alt. 2300 m, Sinha 890. Premlakha, along Hunde river, alt. 2000 m, Sinha 944. North Sikkim: Lachen, alt. 2710 m, Sinha 1133. On way between Phuni-Yakche, alt. 3000 m, Sinha 1091. West Sikkim: Dzongri, alt. 4000 m, Sinha 777.

17. *Hypotrachyna sinuosa* (Smith) Hale, Smithson. Contr. Bot. 25: 63. 1975; Divakar & Upreti, Mycotaxon 86:73. 2003. -*Lichen sinuosus* Smith, Engl. Bot. 29:2050. 1809. -*Parmelia sinuosa* (Smith) Ach., Syn. Lich. :207. 1814.

Thallus loosely adnate, pale greenish yellow, suberect at periphery, 5-7 cm across; lobes sublinear, short, 1.5-3 mm wide; upper surface plane, continuous, sorediate; soralia capitate, orbicular to diffuse, subterminal; lower surface densely rhizinate, often forming a marginal mat. Apothecia not seen. Chemistry: Cortex K-; medulla K+ yellow turning red, C-, KC-, P+ orange; usnic, salacinic, norstictic and stictic (trace) acids present.

It sparsely grows on bark and twigs and rarely on rocks in temperate region.

Distribution: India (Sikkim), China, Japan, Nepal, Indonesia; North America and Europe.

Specimens examined: East Sikkim: Pangolakha scrub, alt. 2900 m, Sinha 918. North Sikkim: Yumthang, river side forest, alt. 3530 m, Sinha 1072. West Sikkim: Thangsing-Samiti foot track, 3 km point, alt. 3700 m, Sinha 838.

17. *Lethariella* (Mot.) Krog

Thallus fruticose, shrubby or pendulous, with dichotomous or irregular branching, heteromerous, corticated; surface wrinkled and grooved; photobiont a green alga; central axis rigid or elastic, solid or fissured; papillae, pseudocyphellae and fibrils absent. Apothecia extremely rare, with matt brown to black disc; thalline exciple without fibrils. Pycnidia unknown. Cortical substance atranorin, often with the addition of the orange pigment canarionic acid; usnic acid absent.

Lethariella with 6 species in the world has an old world distribution; 2 species known in India and 1 in Sikkim.

Lethariella cladonioides (Nyl.) Krog, Norw. J. Bot. 23:93. 1976. -*Chlorea cladonioides* Nyl., Syn. Lich. 1:276. 1860. -*Usnea hookeri* Mot., Lich. Gen. Usnea Stud. Monogr. Pars Syst. : 45. 1936-38; Zahlbr., Cat. lich. univ. 10: 589. 1940; Awasthi, Proc. Indian Acad. Sci., 51:7. 1960. -*Chlorea flexuosa* Nyl., Syn. Lich. 1:276. 1860. (Fig. 45)

Thallus decumbent, orange to orange brown, 4-10 cm long; branches divergent, flexuose, intricate and attenuate apically, longitudinally ridged and grooved, 0.3-0.7 mm wide, angular in most part, terete with few branchlets towards apical end; soredia sparsely present in apical region; central chondroid axis rigid, solid, white. Apothecia not seen. Chemistry: Thallus K+ deep purple, C-, KC-, P+ orange; canarionic, norstictic and psoromic acids and atranorin present.

The species is moderately common in Sikkim. It occurs on dry soils and on rocks in alpine region. It is used for dyeing wool in Tibet. In Sikkim, the thallus is mixed with chilly, salt and garlic and eaten as pickle.

Distribution: India (Sikkim) and Tibet China.

Specimens examined: East Sikkim: Kupup, north border side, alt. 4100-4200 m, Sinha 1499. North Sikkim: On way between Lasher and GSI Old camp hut, alt. 4400 m, Sinha 1204. Llonakh valley, Llonakh chu surroundings, alt. 4500 m, Sinha 1666. Muguthang meadow, S.K.Rai 9389. Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1639. Thangu to Goichung, D.C.S. Raju 8845. Theu La base camp, south side, alt. 4500 m, Sinha 1685. Theu La to Jakthang way, alt. 4600-3400 m, Sinha 1708.

18. Melanelia Essl.

Thallus foliose, dorsiventral, heteromerous, corticated on both surfaces, lobate; lobes narrow, often somewhat elongate, flat to rather distinctly convex or concave; upper surface with or without pseudocyphellae, brown, HNO_3^- ; upper cortex paraplectenchymatous with non pored epicortex; lower surface black, rhizinate; rhizines simple. Apothecia laminal, immersed. Conidia bifusiform, cylindrical, or fusiform, $6-10 \times 1 \mu\text{m}$.

About 43 species in the world; 16 species in India and 5 in Sikkim.

Key to the species

- 1a. Thallus corticolous; medulla P+ yellow-orange 2
- 1b. Thallus saxicolous; medulla P+ yellow-orange or P- 3
- 2a. Thallus isidiate; sterile 4. **M. poeltii**
- 2b. Thallus lacking isidia; fertile 3. **M. olivacea**
- 3a. Medulla C+ pink, P-; lobes 0.2-1 mm wide; sterile 2. **M. microglabra**
- 3b. Medulla C-, P+ orange 4
- 4a. Thallus forming mat like rosette, appressed; lobes 0.5-1.5 mm wide with marginal pycnidial papillae; thalline exciple lacking retrorse hairs 1. **M. hepatizon**
- 4b. Thallus otherwise, loosely appressed; lobes 0.5-3 mm wide; thalline exciple with retrorse hairs at base 5. **M. stygia**

1. Melanelia hepatizon (Ach.) A. Thell, Nova Hedwigia 60:419. 1995. -*Lichen hepatizon* Ach., Lich. succ. Prodr.: 110. 1798. -*Cetraria hepatizon* (Ach.) Vainio, Lich. Cauc. Taur. : 278. 1899; Awasthi, Bull. Bot. Surv. India 24 (1-4):9. 1982. *Tuckermannopsis hepatizon* (Ach.) Kurok., J. Jap. Bot. 66:158. 1991.

Thallus appressed, forming mat like rosettes, brown black, 1.5-2.5(-6) cm across; lobes 0.5-1.5 mm wide; upper surface shiny, smooth; margin and lamina with short, black, pycnidial papillae; lower surface black with sparse, short, black rhizines. Apothecia marginal, frequent, 1-2 mm diam.; margin crenulate; spores ellipsoid, $6-10 \times 4-6 \mu\text{m}$. Chemistry: Medulla K-, C-, KC-, P+ orange; stictic and norstictic acids present.

It occurs on siliceous rocks in open dry alpine areas of Llonakh valley. The species has been placed under different genera.

Distribution: India (Uttaranchal). Circumboreal.

Specimens examined: North Sikkim: Llonakh valley, near Chhaber lake, below Luna La, alt. 4600 m, Sinha 1589 B, 1596.

2. **Melanelia microglabra** Divakar, Upreti, Sinha & Elix, Mycotaxon 88:150. 2003 (Fig. 46)

Thallus loosely adnate to adnate, coriaceous, up to 1.5 cm across; lobes weakly imbricate, sublinear to irregular, 0.2-1 mm wide, margin eciliate, apices incised; upper surface brown black, flat or weakly convex, rugulose to warty; lower surface black, brown at the apices; rhizines sparse. Apothecia and pycnidia not seen. Chemistry: Cortex K-, HNO₃ + pale red; medulla K-, C+ pink, KC+ red, P-; gyrophoric acid (major), ovoic acid (submajor), lecanoric acid (minor), 2-o-methyllecanoric acid (minor) present.

It sparsely grows on boulders in cold desert areas of North Sikkim.

Distribution: India (Sikkim).

Specimen examined: North Sikkim: Llonakh valley, Muguthang, 4500 m, Sinha 1570 (Holotype : BSHC).

3. **Melanelia olivacea** (L.) Essl., Mycotaxon 7:48. 1978.-*Lichen olivaceus* L., Sp. Pl.: 1143.1753.-*Parmelia olivacea* (L.) Ach., Meth. Lich.: 213.1803.

Thallus closely appressed, somewhat raised at periphery, olive brown to dark brown, paler at the periphery, 5-9 cm across; lobes short and rounded to elongate and sublinear, 2-4(-6) mm wide, discrete to rather strongly imbricate; upper surface dull, strongly rugose and sometimes tuberculate in the older part, smooth and pitted near periphery, isidia and soredia absent; pseudocyphellae usually rather numerous; lower surface dark brown to black, paler at the periphery, smooth to rugose, moderately to densely rhizinate; rhizines more or less concolorous with the lower surface. Apothecia common, sessile to short stipitate, 1-5 mm diam., margin entire to crenate; spores 14-16.5 x 8 µm. Chemistry: Cortex K-, HNO₃ -; medulla K-, C-, KC-, P+ orange; fumarprotocetraric acid present.

Collected from a single gathering from the bark of small *Betula* tree plantations at 4100 m altitude.

Distribution: Japan, Nepal; Europe, North America. It is a new record for India.

Specimen examined: East Sikkim: Kupup, alt. 4200 m, Sinha 1491.

4. **Melanelia poeltii** Essl., Mycotaxon 28:215. 1987.

Thallus ± appressed throughout, ca. 7 cm across, olive brown; lobes 4-5 mm wide, ± flat, short and rounded, contiguous; upper surface smooth to slightly pitted or wrinkled, dull; isidia arising as small spherical papillae mostly on older parts, cylindrical to rather irregular; pseudocyphellae concolorous to upper surface; lower surface dark brown. Apothecia and pycnidia not seen. Chemistry: Cortex K-, P-; medulla K-, C-, KC-, P+ yellow orange; fumarprotocetraric acid (major), protocetraric acid (minor) and confumarprotocetraric acid.

It sparsely grows on shrubs in alpine areas.

Distribution: Nepal. It is a new record for India.

Specimen examined: East Sikkim: Kupup, north border side, alt. 4100-4200 m, Sinha 1492.

5. *Melanella stygia* (L.) Essl., Mycotaxon 7:47. 1978. -*Lichen stygius* L., Sp. Pl. 2:1143. 1753. - *Parmelia stygia* (L.) Ach., Meth. Lich. :203. 1803; Essl., Journ. Hattori Bot. Lab. 42:52. 1977; Awasthi, Indian J. Forestry 4(3): 202. 1981.

Thallus loosely attached, light brown to dark brown, ca. 8 cm across; lobes much imbricate, 0.5-3 mm wide; margin weakly crenate; upper surface concave to convex, dull to shining at apices; pseudocyphellae submarginal to laminal, irregular to effigurate, whitish; lower surface black; rhizines 2-3 mm long. Apothecia up to 10 mm diam.; thalline exciple rugose, with retrorse hairs at base; spores 8-17 x 4-7 μ m. Chemistry: Cortex K-, HNO₃ -; medulla K-, C-, KC-, P+ orange; fumarprotocetraric acid present.

It grows on boulders in moist shady places.

Distribution: India (Sikkim, Tamil Nadu, Uttaranchal and West Bengal) and temperate regions of Asia, Europe and North America.

Specimens examined: East Sikkim: Kupup, around Bethang lake, alt. 4100 m, Sinha 1437. North Sikkim: On way between Phuni-Yakche, alt. 3000 m, Sinha 1088. Thangu, along Teesta bank, alt. 3800 m, Sinha 1145. Sebu La base camp, west side, alt. 4500-4800 m, Sinha 1224 B. West Sikkim: Dzongri, alt. 4000 m, Sinha 787, 788, 789. Thangsing-Samiti foot track, alt. 3700 m, Sinha 834. Tsoka-Phedang foot track, alt. 3050-3900 m, Sinha 210.

19. *Menegazzia* Massal.

Thallus foliose, dorsiventral, heteromerous, lobate, \pm radiate, often forming rosettes or irregularly spreading, rather closely attached throughout; lobes sublinear, \pm inflated, hollow; upper surface corticated, smooth, with rounded perforations; soredia, isidia or maculae present or absent; photobiont chlorococcoid; lower surface corticated, naked, uneven, blackened, without rhizines or perforations. Apothecia sessile or stalked, lecanorine, cup-shaped; asci 2 or 8-spored; spores colourless, simple, ellipsoid, thick walled. Pycnidia immersed, minute, punctiform, laminal with a dark apex; conidia bacilliform. Atranorin present in cortex.

A southern hemisphere genus with about 45 species in the world and 1 species in India as well as in Sikkim.

***Menegazzia terebrata* (Hoffm.) Massal., Naeg. Lich. 3. 1854; Awasthi, Kavaka 12(2): 96. 1984. -*Lobaria terebrata* Hoffm., Deut. Fl. :151. 1796.**

(Fig. 47)

Thallus closely appressed, yellowish grey, radiating, 4-6 cm across; lobes elongate, subirregularly to dichotomously branched, 1-2 mm wide, compact and

imbricate centrally, discrete at periphery; margin brown, sometimes slightly upright; upper surface smooth, shining, slightly convex, perforate at axils; soralia capitate, soredia white, granular; medulla hollow; lower surface black in major part, brown to dark brown in apical region, strongly wrinkled. Sterile. Chemistry: Cortex K+ Yellow; medulla K+ yellow to reddish, C-, KC-, P+ orange; stictic, physodalic acid and atranorin present.

It sparsely grows on trees in temperate regions.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Nagaland, Sikkim and Uttaranchal), widely distributed in temperate regions of the world.

Specimens examined: *East Sikkim:* Kyangnosla Alpine Sanctuary, alt. 3000 m, Sinha 1767. *North Sikkim:* Near Lachung, alt, 2500-2600 m, Sinha 1030, 1117. *West Sikkim:* Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1326.

20. *Myelochroa* (Asah.) Elix & Hale

Thallus foliose, loosely adnate to adnate; lobes flat, sublinear to subirregular, 1-4 mm wide; margin ciliate; apices subrotund; cilia confined to axils of lobes or evenly dispersed, simple, slender; upper surface grey, occasionally with yellow tinge or rarely pale greenish white, emaculate or with simple maculae, without pseudocyphellae, with or without soredia and isidia; upper cortex fragile, palisade plectenchymatous, with a pored epicortex; medulla at least in part orange - red, yellow orange or pale yellow due to presence of secalonic acid A or related compounds; lower surface black; rhizines moderately dense to dense, simple or sparsely furcate or squarrosely branched. Apothecia laminal, sessile to subpedicellate; disc imperforate; asci 8-spored; spores ellipsoidal, 8-14 x 5-8 μm . Pycnidia immersed, laminal; conidia bacilliform or weakly bifusiform, 4-7 x 1 μm . Atranorin, chloroatranorin and secalonic acid A present.

Myelochroa is a segregate of genus *Parmelina* s. lat., with 22 species in the world; 11 species in India and 6 in Sikkim.

Key to the species

- 1a. Thallus isidiate, sorediate or pustulate 2
- 1b. Thallus lacking isidia, soredia or pustules 4
- 2a. Thallus isidiate 4. ***M. perisidians***
- 2b. Thallus sorediate or pustulate 3
- 3a. Medulla pigmented yellow throughout; P-, salacinic acid absent 1. ***M. aurulenta***
- 3b. Medulla pigmented orange only below soralia; P+ orange, salacinic acid present 3. ***M. metarevoluta***

- 4a. Lobes dimorphic 6. *M. xantholepis*
 4b. Lobes uniformly of one type 5
 5a. Upper surface faintly maculate in young lobes,
 lacking black discoloured patches; apothecia abundant. 2. *M. irrugans*
 5b. Upper surface emaculate, irregularly cracked with black
 discoloured patches; apothecia not known 5. *M. sikkimensis*

1. *Myelochroa aurulenta* (Tuck.) Elix & Hale, Mycotaxon 29: 240. 1987. *Parmelia aurulenta* Tuck., Am. J. Arts and Sci., ser. 2, 25: 424. 1858; Awasthi, Biol. Mem. 1: 165. 1976. -*Parmelina aurulenta* (Tuck.) Hale, Phytologia 28: 482. 1974; Smithson. Contr. Bot. 33: 19. 1976. -*Hypotrachyna aurulenta* (Tuck.) Krog & Swinscow, Lichenologist 19:420. 1987.

Thallus closely adnate, yellowish grey, grey to bluish dark grey, 3-10 cm across; lobes sublinear to subrotund, 1.5-4 mm wide; margin subascending, imbricate, dentate to truncate; cilia ca. 1 mm long, in notches; upper surface smooth, dull to shining at margins, marginal area bluish black rimmed, emaculate, pustulate-sorediate; soralia marginal to submarginal, coalescing into large subcapitate clumps, soredia granular; lower surface densely rhizinate; rhizines black, 1-2 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K- or more intensely yellow in pigmented region, C-, KC-, P-; atranorin, zeorin, leucotylic acid, associated triterpenes and secalonic acid A present.

It commonly grows on rocks and trees in open places.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Kerala, Madhya Pradesh, Manipur, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), tropical and montane tropical regions of the world.

Specimens examined: East Sikkim: Meimenchu lake surroundings, alt. 3200-3500 m Sinha 1469. Premlakha, along Hunde river, alt. 2000 m, Sinha 943. North Sikkim: Bey surroundings, alt. 1600 m, Sinha 565. Nampruk village surroundings, alt. 1200 m, Sinha 656. South Sikkim: Damthang-Tendong foot track, alt. 2000-2600 m, Sinha 133. Namchi-Mamle route, alt. 1550-1750 m, Sinha 110. West Sikkim: Near Bakhim, alt. 2500-2700 m, Sinha 713. Dzungri, alt. 4000 m, Sinha 779. Labdang village surroundings, alt. 1850 m, Sinha 477. On way between Narkhola-Kholak harka village forest, alt. 2000-2200 m, Sinha 414. Tsoka-Phedang foot track, alt. 3500-3900 m, Sinha 212.

2. *Myelochroa irrugans* (Nyl.) Elix & Hale, Mycotaxon 29: 241. 1987. -*Parmelia irrugans* Nyl., Lich. Jap. :26. 1890. -*Parmelina irrugans* (Nyl.) Hale, Smithson. Contr. Bot. 33:34. 1976. -*Parmelia homogenes* Nyl., Flora 68:607. 1885; Awasthi, Biol. Mem. 1:176. 1976. -*Parmelia subaurulenta* Nyl., Flora 68:606. 1885; Awasthi, Biol. Mem. 1:193. 1976. -*Parmelina subaurulenta* (Nyl.) Hale., Smithson. Contr.

Bot. 33:46.1976.

Thallus \pm closely adnate, mineral grey to grey, *ca* 10 cm across; lobes sublinear, 2-5 mm wide, imbricate, apically truncate; margin ciliate at axils, blackened; upper surface smooth, dull, plane to rugose in central part, faintly maculate in younger lobes; lower surface black, densely rhizinate up to the margin; rhizines simple to squarrosely branched, *ca.* 1 mm long. Apothecia numerous, laminal, adnate to substipitate, 0.5-3.5 mm diam.; margin crenate to minutely lobulate and inflexed; spores 12-16(-20) \times 5-12 μ m. Chemistry: Cortex K+ yellow; medulla intense yellow with K, C, KC & P; atranorin, zeorin, leucotylin, leucotylic acid, related triterpenoids and secalonic acid A present.

The species commonly grows on trees in open moist places in temperate areas.

Distribution: India (Kerala, Manipur, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Nepal and temperate Asia.

Specimens examined: East Sikkim: Gangtok, BSI complex on *Alnus nepalensis*, Sinha 1359. North Regu, near Chhuba village, alt. 1000-1300 m, Sinha 968. North Sikkim: Tholung-Kissong foot track, at 5 km point, alt. 2700 m, Sinha 593. West Sikkim: Phedang -Dzongri foot track, alt. 3900-4000 m, Sinha 257. Tashiding Monastery surroundings, alt. 1600 m, Sinha 314. On way between Tsoka-Dzongri foot track, alt. 3500-4000 m, Sinha 742.

3. *Myelochroa metarevoluta* (Asah.) Elix & Hale, Mycotaxon 29: 241. 1987. - *Parmelia metarevoluta* Asah., J. Jap. Bot. 35: 97. 1960. - *Parmelina metarevoluta* (Asah.) Hale, Phytologia 28: 483. 1974; Smithson. Contr. Bot. 33: 36. 1976; Patwardhan & Nagarkar, Curr. Sci. 51(10): 528. 1982.

Thallus adnate, pale olive buff, 4-6 cm across; lobes sublinear to elongate, 1-4 mm wide, margin ascending, lobules sometimes present on older lobe margins, \pm crenate, narrowly black rimmed; upper surface smooth, shiny, \pm rugose in older parts, emaculate; soredia subterminal, capitate, pale orange below; medulla pigmented yellowish only below soralia, otherwise whitish; lower surface black, densely rhizinate; rhizines simple *ca.* 0.5 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ reddish, C-, KC-, P+ orange; galbinic acid, trace of salacinic acids, atranorin, zeorin, leucotylin and associated terpenes and secalonic acid A present.

It sparsely grows on tree trunks as well as on boulders in subtropical-temperate areas.

Distribution: India (Manipur, Meghalaya and Sikkim), China, Japan, Eastern United States.

Specimen examined: East Sikkim: On way between Talkharka-Lower Rechala, alt. 2000-2200 m, Sinha 977.

4. **Myelochroa perisidians** (Nyl.) Elix & Hale, Mycotaxon 29: 241. 1987. *Parmelia perisidians* Nyl., Acta Soc. Sci. Fenn. 26(10): 6. 1900; Awasthi, Biol. Mem. 1: 185. 1976. -*Parmelina perisidians* (Nyl.) Hale, Phytologia 28: 483. 1974; Smithson. Contr. Bot. 33: 39. 1976.

Thallus adnate, pale grey to mineral grey, 3-6 mm across; lobes 1-3.5 mm wide, margin weakly notched; upper surface plane, smooth, slightly rugulose in older parts, emaculate; isidia laminal, dense, cylindrical, simple to rarely branched, generally with brown tips, ca. 1 mm long; lower surface densely rhizinate up to the margins; rhizines 1-2 mm long. Apothecia adnate, constricted at base, 1-4 mm diam., margin crenate; thalline exciple isidiate; spores 9-13 x 6-7 μ m. Pycnidia not seen. Chemistry: Cortex K+ yellow; medulla more intense yellow with K, C, KC, and P; atranorin, leucotylin and zeorin.

Distribution: India (Karnataka, Manipur, Nagaland, Sikkim and Tamil Nadu), Japan, Sri Lanka and Thailand.

Earlier report: Kurokawa from West Sikkim, Pamianchi (*vide* Awasthi, *l.c.*)

5. **Myelochroa sikkimensis** Divakar, Upreti, Sinha & Elix, Mycotaxon 79:248. 2001. (Fig. 48)

Thallus loosely to moderately adnate, coriaceous, pale grey to grey, up to 8 cm across; lobes subirregular to sublinear, 2-6 mm wide, imbricate; margin crenate or dentate; upper surface flat, emaculate, irregularly cracked with black discoloured patches; lower surface black to the margin; rhizines dense, forming a thick mat, simple, squarrose or irregularly branched, up to 1 mm long. Apothecia not seen. Pycnidia black, immersed; conidia bacilliform or weakly bifusiform, 4.5-6.5 x 1 μ m. Chemistry: Cortex K+ yellow; medulla K+ pale yellow, C-, KC-, P-; atranorin, secalonic acid A, xantholepinone A as major and xantholepinone D, zeorin, leucotylin etc., as minor constituents.

Distribution: India (Sikkim). Endemic in Eastern Himalaya.

Specimen examined: North Sikkim: Lachung, alt. 2650 m, Sinha 1115 (Holotype: BSHC).

6. **Myelochroa xantholepis** (Mont. & v.d. Bosch) Elix & Hale, Mycotaxon 29: 241. 1987. -*Parmelia xantholepis* Mont. & v.d. Bosch in Jungh., Pl. Junghun.: 428. 1855; Awasthi, Biol. Mem. 1: 199. 1976. -*Parmelina xantholepis* (Mont. & v.d. Bosch) Hale, Phytologia 28: 483. 1974; Smithson. Contr. Bot. 33: 53. 1976. (Fig. 49)

Thallus closely adnate, mineral grey to grey, 5-10 cm across, fragile; lobes dimorphic, primary lobes 2-4 mm wide, usually distinct in peripheral area, sparsely ciliate; secondary lobes or lobules develop from margin to primary lobes, dichotomously branched, crowded, 0.5-1.5 mm wide, margin entire or crenate, subascending; upper surface plane, \pm smooth, shining to rugulose, maculate in

peripheral zone; lower surface black, densely rhizinate up to the margin; rhizines simple to squarrosely branched, 1-2 mm long. Apothecia common, adnate, 1-3 mm diam.; margin crenate, lobulate; thalline exciple smooth; spores 8-13 x 5-7 μm . Chemistry: Cortex K+ yellow; medulla more intense yellow with K, C, KC and P; atranorin, zeorin, leucotylin, leucotylic acid, related triterpenoides and secalmic acid A present.

It commonly grows on trees in open and shady places.

Distribution: India (Karnataka, Kerala, Manipur, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal) and Nepal to Philippines in tropical and temperate regions.

Specimens examined: North Sikkim: Bey surroundings, alt. 1600 m, Shina 572. Nampruk village surroundings, alt. 1200 m, Sinha 657. Zema -I, alt. 2750 m, Sinha 1514. South Sikkim: Temi Tea Estate, alt. 1300 m, Sinha 50. West Sikkim: Tashiding Monastrey surroundings, alt. 1600 m, Sinha 160. Kongri village surroundings, alt. 2000 m, Sinha 326.

21. *Nephromopsis* Müll. Arg.

Thallus foliose to subfruticose; lobes dichotomously to irregularly branched; margin undulating; upper surface yellow-green or grey, lacking pseudocyphellae; upper cortex paraplectenchymatous, with non pored epicortex; lower surface with punctiform pseudocyphellae; rhizines simple, sparse. Apothecia marginal, nephroid (developing on the underside of the margins), eperforate; asci 8-spored; spores simple, colourless, subspherical, 5-7 μm in diam. Pycnidia marginal and laminal, emergent; conidia bifusiform, 5-6 x 1 μm . Usnic acid and atranorin present in cortex.

Nephromopsis is a genus of about 16 species from eastern Asia and Australasia; 9 species in India and 5 in Sikkim.

Key to the species

- 1a. Thallus foliose, horizontally spreading 2
- 1b. Thallus subfruticose, suberect, laciniate lobate 2. *N. leucostigma*
- 2a. Thallus with both laminal and marginal black fibrils ... 1. *N. isidioidea*
- 2b. Thallus lacking black fibrils on lamina and margins ... 4
- 3a. Medulla C+ red, KC+ red 5. *N. stracheyi*
- 3b. Medulla C-, KC- 4
- 4a. Apothecia 1-3 mm diam. with short pedicel; lower side of thallus markedly reticulate ridged, pseudocyphellae on ridges on plug like outgrowths . 4. *N. pallescens*

- 4b. Apothecia 4-7 mm diam., orbicular to semi reniform;
lower side of thallus plane to slightly reticulate
lacunose, pseudocyphellae on general surface or
immersed, not raised 3. **N. nephromoides**

1. **Nephromopsis isidioidea** (Räsänen) Randle & Saag, Mycotaxon 44: 487. 1992. -*Cetraria wallichiana* var. *isidioidea* Räsänen, Arch. Soc. Zool. Bot. Fenn. 'Vanamo' 5(1):25. 1950. -*Cetraria isidioidea* (Räsänen) Awasthi, Bull. Bot. Surv. India 24(1-4):10. 1982.

Thallus horizontally spreading, yellowish grey brown, ca. 2.5 cm across; lobes coriaceous, imbricate, irregularly divided, 3-10 mm wide; upper surface reticulately scrobiculate, with numerous simple to forked black fibrils on the ridges and along irregularly crenulate margin; lower surface brown, lamellate rugose with peg like outgrowths; pseudocyphellae present on general surface as well as on peg like outgrowths; rhizines absent. Apothecia not seen. Chemistry: Cortex and medulla K+ yellowish, C-, KC-, P-; lichesterinic, protolichesterinic and usnic acids present.

It sparsely grows on dead tree stumps in open temperate areas.

Distribution: India (West Bengal). Endemic.

Specimen examined: North Sikkim: Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1625.

2. **Nephromopsis leucostigma** (Lév.) Awasthi, Indian J. Forestry 21(1):42. 1998. -*Cetraria leucostigma* Lév. in Jacquem., Voy. dans. L'Inde Bot. p. 180, fig. 4. 1841-44; Awasthi, Bull. Bot. Surv. India 24(1-4):22. 1982. -*Cetraria sikkimensis* Räsänen, Arch. Soc. Zool. Bot. Fenn. 'Vanamo' 5(1):25. 1950.

Thallus suberect to erect, yellow brown to pale brown, 3-5(-8) cm tall, irregularly to subdichotomously branched, widest part 5-7(-10) mm; lobes usually 5 mm wide, plane to involute, subcanaliculate towards apices, undulate along margin; margin irregular with black, 0.2-0.4 mm long sparse to dense pycnidial fibrils; upper side smooth; lower side pale brown, light brown to chestnut brown, smooth to slightly lacunose rugose; pseudocyphellae white, ± depressed, 0.1-0.2(-0.5) mm across, with or without brown rim; sometimes thick black rhizines present in groups. Apothecia rare (in Isotype of *C. sikkimensis* also), ± peltate on the margin, round to oblong, 10 x 6 mm; thalline exciple scrobiculate rugose; spores 8-9 x 6 µm. Chemistry: Cortex and medulla K-, C-, KC-, P-; lichesterinic, protolichesterinic and usnic acids present.

Distribution: India (Himachal Pradesh and Sikkim) and Nepal.

Earlier record: Awasthi (*l.c.*) from Chhangu area of East Sikkim.

3. **Nephromopsis nephromoides** (Nyl.) Ahti & Randle, Cryptog. Bryol. Lichenol. 19:183. 1998. -*Platysma nephromoides* Nyl., Flora 52:442. 1869. -*Cetraria nephromoides* (Nyl.) Awasthi, Bull. Bot. Surv. India 24(1-4): 11. 1982. -*Nephromopsis stracheyi* f. *ectocarpisma* Hue, Nouv. Arch. Mus. Hist. Nat. ser. 4, 1:218. -*Nephromopsis ectocarpisma* (Hue) Gyelnik, Ann. Crypt. Exot. 4:169. 1931.

Thallus loosely attached by central part on lower surface, horizontally spreading, thick coriaceous, glaucous yellow to yellowish grey, 10-20 cm across, convoluted; lobes broad up to 20 mm wide, imbricate; margin entire to crenate, undulate, lacking black fibrils; upper surface reticulate rugose, lacunose; lower surface pale to brownish, reticulate rugose, lamellate, pseudocyphellate; pseudocyphellae present on general surface or on lamellate ridges but not as plug like outgrowth; rhizines sparse, brownish, simple, 1-2 mm long. Apothecia many, 4-10 x 3-5 mm; margin crenate, undulate; thalline exciple scrobiculate rugose; spores 6-8 x 3-4 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; lichesterinic, protolichesterinic and usnic acids present.

It commonly grows on trees in open moist forest.

Distribution: India (Arunachal Pradesh, Nagaland, Sikkim, Uttaranchal and West Bengal). Himalaya and eastwards in Asia.

Specimens examined: North Sikkim: Tholung-Kissong foot track, alt. 2400-2700 m, Sinha 585. West Sikkim: Hilley Reserve Forest, alt. 2200 m, P. Singh 287. Tsoka-Phedang foot track, alt. 3500-3900 m, Sinha 208.

4. **Nephromopsis pallescens** (Schaerer) Park, Bryologist 93:122. 1990. -*Cetraria pallescens* Schaerer in Moritzi, Syst. Verz. :129. 1845-46; Awasthi, Bull. Bot. Surv. India 24(1-4):13. 1982. -*Platysma pallescens* (Schaerer) Nyl., Mem. Soc. Sci. Nat. Cherbourg 5:100. 1858. *Sticta wallichiana* Taylor, Hook. J. Bot. 6:177. 1847-*Cetraria wallichiana* (Taylor) Müll. Arg., Flora 71:139. 1888; Awasthi, Bull. Bot. Surv. India 24(1-4):117. 1982. -*Cetrariopsis wallichiana* (Taylor) Kurok., Mem. Nat. Sci. Mus. Tokyo 13:140. 1980.

Thallus loosely attached by central lower part, coriaceous, yellow green to grey, 5-15 cm across; lobes rounded, 2-10 mm wide, imbricate, apices rotund to dissected; margin undulate, convoluted, lacking black fibrils; upper surface rugose-scrobiculate; lower surface pale to pale brownish, scrobiculate-lamellate; pseudocyphellae develop on plug like outgrowths or on general surface; rhizines sparse in groups, brownish, 0.5-2 mm long. Apothecia numerous, marginal or submarginal, shortly pedicellate to reflexed, 0.5-3 mm in diam.; margin sometimes excluded, smooth to crenulate; thalline exciple smooth; spores rarely mature, 5-9 x 2-4 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; lichesterinic and protolichesterinic acids present.

It commonly occurs on upper portion of trees in temperate regions.

Distribution: India (Arunachal Pradesh, Manipur, Nagaland, Sikkim, Uttaranchal and West Bengal), himalayas and extends eastwards in Asia and northwards in Japan.

Specimens examined: North Sikkim: Tholung-Kissong foot track, 2475-2700 m, Sinha 589. West Sikkim: Yoksum-Tsoka foot track, 1800-3050 m, Sinha 200.

5. ***Nephromopsis stracheyi*** (C. Bab.) Müll. Arg., Flora 74:374. 1891. -*Cetraria stracheyi* C. Bab., Hooker's Bot. Kew Gard. Misc. 4:245. 1852; Awasthi, Bull. Bot. Surv. India 24(1-4):16. 1982.

Thallus attached by rhizines near the central part, horizontally spreading, thick coriaceous, glaucous yellow to yellowish grey, 5-15 cm across; lobes \pm rounded, much variable in width, 0.8-3 cm wide; margin entire, lacking black fibrils, convoluted; upper surface smooth to rugose; lower surface pale brown, reticulately nervose rugose; pseudocyphellae on plain surface or on ridges; rhizines sparse, concolorous with lower surface, ca. 1 mm long. Apothecia marginal, sometimes reflexed upwards, 6-10 x 3-9 mm; margin entire to crenate, undulate; thalline exciple lacunose-rugose; spores 7 x 3 μ m. Chemistry: Cortex K-; medulla K-, C+ red, KC+ red, P-; olivetoric and usnic acids present.

It sparsely grows on trees in dense moist forests in temperate regions.

Distribution: India (Arunachal Pradesh, Nagaland, Sikkim, Uttaranchal and West Bengal), Himalayas and extend eastwards to eastern Asia.

Specimen examined: West Sikkim: Dzongri, alt. 4000m, M.N. Bose s. n. (LWG).

22. *Parmelaria* Awasthi

Thallus foliose, dorsiventral, heteromerous, corticated on both surfaces, lobate; lobes broad; margin irregularly crenate, narrow laciniate, ciliate; upper surface emaculate; pseudocyphellae, isidia and soredia absent; cortex prosoplectenchymatous; photobiont green, *Trebouxia*; medulla white; lower surface black with brown marginal zone, rhizinate; rhizines dispersed or occurring in groups, black, simple to rarely bifurcate. Apothecia lecanorine, submarginal, sometimes laminal; disc perforate or eperforate; asci 8-spored; spores colourless, simple, ellipsoid, epispore wall thick. Pycnidia abundant, marginal, black, verruciform, develop on narrow lacinales, ostioles wide; conidia filiform.

The genus is represented by only 2 endemic species from Himalaya as well as from Sikkim.

Key to the species

- 1a. Apothecia perforated; spores 20-32 x 5-25 μ m; epispore wall ca. 3 μ m thick 2. *P. thomsonii*
- 1b. Apothecia eperforate or rarely perforate; spores 12-20 x 10-14 μ m; epispore wall 1-1.5 μ m thick 1. *P. subthomsonii*

1. **Parmelaria subthomsonii** Awasthi, Journ. Hattori Bot. Lab. 63:370. 1987.

Thallus suborbicular in outline, adpressed, ashy white to glaucous grey, 10-15 cm across; lobes up to 15 mm wide, divided or dentate; margin crisp, entire, ciliate; upper surface matt, emaculate; lower surface black, chestnut brown at maturity; rhizines dispersed or in groups, short, never projecting beyond margin. Apothecia submarginal to laminal, substipitate, cup-shaped to plane, 5-10 mm across; margin entire to minutely crenulate; thalline exciple rugose, scrobiculate, maculate; disc usually eperforate, rarely perforate; spores $12-20 \times 10-14 \mu\text{m}$ with $1-1.5 \mu\text{m}$ thick epispore. Pycnidia black, marginal, verruciform, develop on narrow lacinules. Chemistry: Cortex K-; medulla K-, C-, KC+ pink, P-; atranorin, alectoronic acid and α -collatolic acid present.

The species sparsely grows on tree trunks in temperate areas.

Distribution: India (Sikkim, Uttaranchal and West Bengal). Endemic.

Specimen examined: East Sikkim: Chhangu, Chatterjee & Divakar 20-77062 (LWG).

2. **Parmelaria thomsonii** (Stirton) Awasthi, Journ. Hattori Bot. Lab. 63:368. 1987. -*Platsyma thomsonii* Stirton, Proc. Phil. Soc. Glasgow 11:321. 1879. -*Parmelia thomsonii* (Stirton) C. Culb., Bryologist 65:306. 1962. (Fig. 50)

Thallus loosely attached, mineral grey, 8-15 cm across; lobes 5-12 mm wide; margin entire to irregularly dentate crenate, ciliate; cilia up to 2 mm long; upper surface \pm smooth, emaculate; lower surface jet black with rugulose brown marginal zone; rhizines dispersed or in groups, simple, 2-3 mm long, sometimes projecting beyond margin. Apothecia laminal or submarginal, initially cup-shaped but later expanded, up to 14 mm diam.; margin entire to crenate, inflexed, finally lacinulate; thalline exciple smooth to rugose, white maculate; disc usually perforate; spores $20-32 \times 15-25 \mu\text{m}$ with ca. $3 \mu\text{m}$ thick epispore. Pycnidia black, marginal, prominent, verruciform, develop on narrow lacinules; ostioles wide; conidia filiform, 2-3 μm long. Chemistry: Cortex K-; medulla K-, C-, KC+ reddish, P-; atranorin, alectoronic and α -collatolic acid present.

It commonly grows on trees and boulders in temperate regions.

Distribution: India (Manipur, Nagaland, Sikkim, Uttaranchal and West Bengal) and Nepal.

Specimens examined: North Sikkim: Tingbong village area, alt. 1400 m, Sinha 641. Bey surroundings, alt. 1600 m, Sinha 571. South Sikkim: Damthang - Tendong foot track, alt. 2000-2600 m, Sinha 137. West Sikkim: Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1332.

23. **Parmelia** Ach.

Thallus foliose, dorsiventral, heteromerous, corticated on both surfaces, lobate; lobes sublinear to subirregular, rarely broad or rounded; margin ciliate;

upper surface pseudocyphellate; pseudocyphellae linear, effigurate or rarely punctiform; cortex prosoplectenchymatous with non pored epicortex; photobiont green, *Trebouxia*; lower surface black; rhizines simple, furcated to squarrosely branched. Apothecia adnate to substipitate; asci 8 -spored; spores colourless, simple, ellipsoid, 11-15 x 6-9 μm . Pycnidia common, immersed, laminal; conidia cylindrical or rarely weakly bifusiform, 5-7 x 1 μm .

About 47 species in the world; 10 species in India and 5 in Sikkim.

Key to the species

- 1a. Thallus isidiate or sorediate 2
 1b. Thallus lacking isidia and soredia; salacinic acid present 1. ***P. adaugescens***
 2a. Thallus sorediate 5. ***P. sulcata***
 2b. Thallus isidiate 3
 3a. Upper surface finely white maculate pseudocyphellate;
 pseudocyphellae less than 0.5 mm long 2. ***P. meiophora***
 3b. Upper surface with larger effigurate pseudocyphellae
 more than 0.5 mm long 4
 4a. Rhizines simple to furcate 3. ***P. saxatilis***
 4b. Rhizines squarrosely branched 4. ***P. squarrosa***

1. ***Parmelia adaugescens*** Nyl., Lich. Jap. :28. 1890; Awasthi, Biol. Mem. 1:164. 1976; Hale, Smithson. Contr. Bot. 66:19. 1987. -*Parmelia pseudomarmoriza* Awasthi, Biol. Mem.1:186. 1976.

Thallus loosely attached, whitish mineral grey, coriaceous, crisp, 5-7 cm across; lobes sublinear, 1.5-2(-3) mm wide; margin ascending, irregularly crenate; upper surface rugose, transversely cracked in older parts, smooth to rough in marginal parts; pseudocyphellae conspicuous, laminal to marginal, somewhat raised from the general surface, irregular in outline, partly fusing into a reticulate network; lower surface black, \pm smooth, densely rhizinate; rhizines black, ca. 1 mm long, simple to furcated. Apothecia numerous, shortly pedicellate, up to 18 mm diam.; margin lacerated to lobed; thalline exciple conspicuously rugose, pseudocyphellate; spores thick walled, 20-26 x 8-12 μm . Chemistry: Cortex K+ yellow; medulla K+ yellow red, C-, KC-, P+ yellow to orange; atranorin, and salacinic acid present.

It sparsely grows on boulders in moist shady places in temperate-alpine regions of West Sikkim.

Distribution: India (Nagaland, Sikkim and West Bengal), China, Japan, Nepal and Pakistan.

Specimens examined: West Sikkim: Near Bakhim, 2500-2700 m, Sinha 711. On way between Thangsing-Phedang foot track, alt. 3500 m, Sinha 870.

2. ***Parmelia meiophora*** Nyl., Lich. Insul. Guineens.:45. 1889; Awasthi, Biol. Mem.1:180. 1976.

Thallus loosely adnate, mineral grey to grey, thick coriaceous, 5-7 cm across, irregularly sinuate lobate; lobes 2-4 mm wide, more or less convoluted, much imbricate; margin crenate; upper surface densely white maculate, minutely pseudocyphellate; pseudocyphellae irregular in outline, cortex cracked in older parts; isidia present in older parts, globular to slightly elongate, simple, often dark tipped; lower surface black, densely rhizinate up to the margin; rhizines black, squarrosely branched. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ red, C-, KC-, P+ yellow-orange; atranorin, consalacinic acid and salacinic acid present.

It sparsely grows on boulders in moist places between 4500-4800 m altitudes.

Distribution: India (Himachal Pradesh and Uttaranchal). China, Nepal, Taiwan.

Specimen examined: North Sikkim: Sebu La base camp, west side, 4500-4800 m, Sinha 1223.

3. ***Parmelia saxatilis*** (L.) Ach., Meth. Lich.:204. 1803; Awasthi, Biol. Mem.1:190. 1976. -*Lichen saxatilis* L., Sp. Pl. : 1142. 1753.

Thallus ± loosely adnate, ashy grey to brownish grey, crisp, 5-8 cm across, subdichotomously to irregularly lobate; lobes sublinear, 2-3(-5) mm wide, subimbricate; margin crenate, often subascending; upper surface smooth, effigurate maculate, maculae laminal, often raised over general surface, turning to pseudocyphellae; isidia develop on margins of pseudocyphellae, globular to oblong, simple to coralloid branched; lower surface black, densely rhizinate up to the margin; rhizines simple, occasionally furcated, 0.5-1 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow-red, C-, KC-, P+ orange-red; atranorin and salacinic acid present.

It sparsely grows on boulders in temperate region of North Sikkim in open places.

Distribution: India (Jammu & Kashmir, Sikkim and Uttaranchal) and temperate regions of the world.

Specimen examined: North Sikkim: Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1624. Yumthang, river side forest, alt. 3530 m, Sinha 1073.

4. ***Parmelia squarrosa*** Hale, Phytologia 22: 29. 1971; Smithson. Contr. Bot. 66:43. 1987.

Thallus loosely adnate, whitish mineral grey, 3-5 cm across; lobes sublinear, imbricate, 2-4 mm wide; upper surface \pm plane, shiny, continuous but cracked along pseudocyphellae with age; pseudocyphellae angular, 0.5-1 mm long, marginal and laminal, forming a reticulate network; isidia coarse, clustered, cylindrical, often constricted at base, present along ridges and pseudocyphellae; lower surface black, shiny, densely rhizinate; rhizines simple to squarrosely branched, 0.5-1 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow-red, C-, KC-, P+ yellow-orange; atranorin and salacinic acid present.

The species sparsely grows on tree trunks and rarely on rocks in temperate forests.

Distribution: India (Himachal Pradesh and Sikkim), China, Japan, Nepal and North America.

Specimens examined: North Sikkim: Thangu, along Teesta bank, alt. 3800 m, Sinha 1146 & 1147. Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1624, 1631.

5. *Parmelia sulcata* Taylor in Mackay, Fl. Hibern. 2:145. 1836; Awasthi, Biol. Mem. 1: 195. 1976. (Fig. 51)

Thallus \pm loosely attached, orbicular to spreading, ashy grey to dark grey, 4-7 cm across; lobes sublinear, subdichotomously branched, imbricate, subtruncate, 2-5 mm wide, margin entire, sinuous; upper surface dull, smooth, effigurate maculate towards lobe apices, maculate areas fissured pseudocyphellate in older parts, later developing in to linear elongate to rounded soralia; soredia coarse, granular, derived from pseudocyphellae, in lines as a coarse reticulum; lower surface black with little or no naked marginal zone, densely rhizinate; rhizines 0.5-1 mm long, simple to squarrosely branched. Apothecia and pycnidia not seen. Chemistry: Cortex K + yellow; medulla K + yellow turning red, C-, KC-, P + orange-red; salacinic acid consalacinic acid and atranorin present.

It sparsely grows on boulders in open temperate - alpine areas.

Distribution: India (Himachal Pradesh, Jammu & Kashmir and Tamil Nadu), widely distributed in dry temperate and north boreal regions of the world.

Specimen examined: North Sikkim: Midway between Thangu and Lashar, alt. 4300 m, Sinha 1172.

24. *Parmelina* Hale

Thallus foliose, adnate, 2-10 cm wide; lobes flat, sublinear to subirregular, apically rounded, irregularly or rarely dichotomously branched, narrow, 0.5-5 mm wide; cilia mainly in lobe axils, sparse to moderately dense, simple; upper surface grey to grey green, lacking pseudocyphellae; maculae, soredia, pustules and isidia

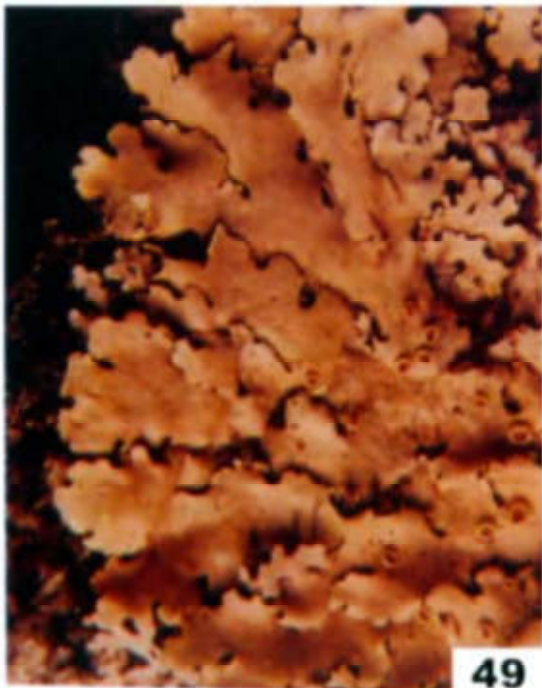


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Fig. 47. *Menegazzia terebrata*. **Fig. 48.** *Myelochroa sikkimensis*. **Fig. 49.** *M. xantholepis*. **Fig. 50.** *Parmelaria thomsonii*.



Fig. 51. *Parmelia sulcata*. **Fig. 52.** *Parmelinella wallichiana*. **Fig. 53.** *Parmelinopsis expallida*. **Fig. 54.** *Parmotrema tinctorum*.

often present; upper cortex palisade plectenchymatous, with a pored epicortex; medulla white or lower medulla yellow-orange; lower surface dark brown to black; rhizines simple or rarely squarrosely branched. Apothecia laminal, sessile to subpedicellate, up to 5 mm diam.; thalline exciple smooth; disc eperforate, pale to dark brown; asci 8-spored; spores colourless, simple, broadly ellipsoidal or suglobose, 8-14 x 5-9 μm . Pycnidia laminal, immersed, punctiform; conidia cylindrical or bacilliform to weakly fusiform, 3-8 x 1 μm . Atranorin and chloroatranorin present.

An old world genus with centres of speciation in Eurasia and Australasia, represented by *ca.* 12 species in the world; 4 species in India and 1 species in Sikkim.

Parmelina tiliacea (Hoffm.) Hale, *Phytologia* 28:481. 1974. -*Lichen tiliaceus* Hoffm., *Enum. Lich.* :96. 1784. -*Parmelia tiliacea* (Hoffm.) Ach. *em.* Vainio, *Term. Fuez.* 22:279. 1899; Awasthi, *Biol. Mem.* 1:196. 1976.

Thallus closely adnate, light mineral grey to bluish grey, 5-15 cm across; lobes irregularly branched, sublinear-elongate, often imbricate, rounded at the apices, 2-6 mm wide; margin crenate, undulate, narrowly black rimmed; cilia simple, coarse, up to 0.5 mm long; upper surface \pm shiny, maculate; isidia cylindrical, simple to branched, usually blackening at the tips; lower surface black, densely rhizinate; rhizines simple, 1-2 mm long. Apothecia rare, adnate, sometimes retrorsely rhizinate, up to 4 mm diam.; spores 8-11 x 5-6 μm . Chemistry: Cortex K+ yellow; medulla K-, C+ red, KC+ red, P-; atranorin and lecanoric acid present.

Distribution: India (Himachal Pradesh, Jammu & Kashmir and Sikkim); Europe.

Specimen examined: East Sikkim: Gangtok, Tashi view point, Chatterjee & Divakar 20-77163/B (LWG).

25. *Parmelinella* Elix & Hale

Thallus foliose, leathery, loosely adnate to adnate, 5-20 cm wide; lobes irregular, broad, 3-12 mm wide; margin ciliate; apices rotund; cilia sparse, \pm restricted to lobe axils, simple, slender; upper surface grey, often with a yellowish or greenish tinge, emaculate, lacking pseudocyphellae, with or without soredia and isidia; upper cortex palisade plectenchymatous, with a pored epicortex; medulla white; lower surface black, with narrow bare or papillate marginal zone; rhizines sparse to moderately dense, simple. Apothecia laminal, sessile; disc eperforate; asci 8-spored; spores ellipsoidal, 14-18 x 8-10 μm . Pycnidia laminal, immersed, punctiform; conidia bacilliform, 5-9 x 1 μm . Atranorin and chloroatranorin present.

Parmelinella a segregate of *Parmelina s. lat.*, with 5 species in the world; 3 species in India and 1 species in Sikkim.

Parmelinella wallichiana (Taylor) Elix. & Hale, Mycotaxon 29: 242. 1987.
Parmelia wallichiana Taylor in Hook., Lond. J. Bot. 6: 176. 1847; Awasthi, Biol. Mem. 1: 198. 1976. -*Parmelina wallichiana* (Taylor) Hale, Phytologia 28: 483. 1974; Smithson. Contr. Bot. 33: 51. 1976. (Fig. 52)

Thallus loosely or closely attached, yellowish-grey to grey-green, subdichotomously sinuate lobate, 10-15(-20) cm across; lobes rotund to subrotund; 3-10 mm wide; margin crenate, lobulate with age, notched; cilia present in notches, 0.5 mm long; upper surface smooth and shining at the peripheral region, rugulose, rough in older parts; isidia laminal, dense in the older parts of thallus, short to terete, simple to branched, often brown-black tipped, 0.1-1 mm long; lower surface black, smooth, densely rhizinate in the central part, marginal 2-6 mm wide zone often dark tan, shining, erhizinate or with rhizinal papillae; rhizines simple, 1-2 mm long. Apothecia infrequent, adnate, constricted at base, 2-8 mm diam; margin entire to isidiate; thalline exciple smooth to sparsely isidiate; spores 10-18 x 6-13 μ m. Chemistry: Cortex K⁺ yellow; medulla K⁺ yellow turning red, C⁻, KC⁻, P⁺ orange; atranorin, consalacinic acid and salacinic acid present.

P. wallichiana commonly grows on tree trunks and boulders in open places.

Distribution: India (Assam, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal); tropical and subtropical regions of the world.

Specimens examined: *East Sikkim:* Gangtok, Tashi view point, alt. 1900 m, Sinha 104. On way between South Regu and Picrae forest, alt. 1900 m, Sinha 511. *North Sikkim:* Bey surroundings, alt. 1600 m, Sinha 569. Lachen, Gumpa side forest, alt., 1700 m, Sinha 1555. Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 595. *South Sikkim:* Temi Tea Estate, alt. 1300 m, Sinha 49. *West Sikkim:* Kongri village surroundings, alt. 2000 m, Sinha 332. Pelling, alt. 2300 m, P. Singh 76. Sombaria, Forest Rest House compound, alt. 1700 m, Sinha 1293. Tashiding Monastrey surroundings, alt. 1600 m, Sinha 149. Phedang - Dzongri foot track, alt. 3900-4000 m, Sinha 243.

26. *Parmelinopsis* Elix & Hale

Thallus foliose, loosely to tightly adnate; lobes flat, linear to sublinear-elongate or sublinear, dichotomously to irregularly branched, 0.5-5 mm wide; margin ciliate, sometimes crenate; apices truncate; cilia sparse to dense, \pm evenly distributed, simple or rarely branched, slender, not bulbate; upper surface grey, sometimes darkening, lacking pseudocyphellae, emaculate, rarely sparingly maculate, with or without soredia, pustules and isidia; upper cortex palisade plectenchymatous, with a pored epicortex; medulla white or rarely partly pale yellow; lower surface ivory to pale brown or black; rhizines sparse to dense, simple or sparsely furcate to squarrosely or dichotomously branched. Apothecia laminal, sessile to subpedicellate; disc eperforate, sometimes radially split with

age, pale brown to dark brown; asci 8-spored; spores ellipsoidal, with thick walls, 9-20 x 6-14 μm . Pycnidia laminal, immersed; conidia cylindrical or bacilliform to bifusiform, 3-8 x 0.5-1 μm .

Parmelinopsis is a relatively recent segregate of the older heterogenous *Parmelina s. lat.*, with 24 species in the world; 8 species in India and 2 in Sikkim.

Key to the species

- 1a. Medulla KC+ red; lower surface black 2. ***P. horrescens***
 1b. Medulla KC-; lower surface pale brown to brown 1. ***P. expallida***

1. *Parmelinopsis expallida* (Kurok.) Elix & Hale, Mycotaxon 29: 242. 1987.
Parmelia expallida Kurok., Bull. Nat. Sci. Mus. Tokyo 11:191. 1968; Awasthi, Biol. Mem. 1:173. 1976. -*Parmelina expallida* (Kurok.) Hale, Phytologia 28: 482. 1974; Smithson. Contr. Bot. 33: 28. 1976. (Fig. 53)

Thallus loosely adnate, glaucous grey, 5-7 cm across; lobes sublinear, imbricate, 2-4 mm wide; margin rounded, weakly notched; cilia sparse, ca 0.5 mm long; upper surface smooth, emaculate, dark to black margined; isidia laminal, cylindrical, simple to coralloid branched, up to 1 mm high; lower surface pale brown, moderately rhizinate up to the margin; rhizines simple to rarely furcate, ca. 1 mm long. Apothecia sessile, 2-4 mm diam.; thalline exciple isidiate; spores ellipsoid, 15-17 x 8-10 μm . Chemistry: Cortex K + yellow; medulla K-, C-, KC-, P-; atranorin, protolichesterinic and an unidentified fatty acid present.

It commonly grows on trees in open places.

Distribution: India (Himachal Pradesh, Kerala, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Japan, Taiwan, Thailand.

Specimens examined: East Sikkim: Gangtok, Tashi view point, alt. 1900 m, Sinha 103. Gangtok, near Burtuk, Sinha 96. Premlakha, along the bank of Hunde river, alt. 2000 m, Sinha 945.

2. *Parmelinopsis horrescens* (Taylor) Elix & Hale, Mycotaxon 29:242. 1987.
Parmelia horrescens Taylor in Mackay, Fl. Hibern. 2:144. 1836. -*Parmelina horrescens* (Taylor) Hale, Phytologia 28: 482. 1974.-*Parmelia dissecta* Nyl., Flora 65:451.1882; Awasthi, Biol. Mem. 1:170.1976.

Thallus closely adnate, whitish to mineral greyish, 2-5 cm across; lobes sublinear, \pm dichotomously branched, imbricate, 0.5-2 mm wide; margin crenate, often lobulate; cilia evenly dispersed, ca. 0.5 mm long; upper surface shiny, emaculate; isidia laminal, dense, cylindrical, simple to branched, apically short ciliate or spinulate, in part becoming procumbent; lower surface black; rhizines

simple. Apothecia rare, sessile, 2-3 mm diam.; thalline exciple isidiate; spores 16-18 x 10-12 μm . Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ rose red, P-; gyrophoric acid, atranorin and unknown 'horrescens' present.

It sparsely grows on tree trunks and on rocks in subtropical regions.

Distribution: India (Meghalaya, Nagaland, Sikkim, Tamil Nadu and Uttaranchal), Japan, Philippines; pantemperate and montane pantropical regions.

Specimen examined: East Sikkim: Gangtok, Rumtek and Tumin, Chatterjee & Divakar s. n. (LWG).

27. *Parmotrema* Massal.

Thallus foliose, dorsiventral, heteromerous, lobate; lobes broad, rotund; margin entire or crenate, ciliate or eciliate; upper surface smooth or rugose, wrinkled, isidia, soredia and maculae present or absent; lower surface black or brown with a characteristic pale brown or white mottled rhizinate marginal zone; upper cortex palisade plectenchymatous, with a pored epicortex; photobiont green, *Trebouxia*; medulla white or sometimes yellow; lower cortex brown to black, palisade plectenchymatous. Apothecia usually substipitate or stalked; disc perforate or eperforate; thalline exciple smooth or rugose; asci 8-spored; spores colourless, simple, oval-ellipsoid; paraphyses simple. Conidia sublageniform or filiform.

About 220 species in the world; 39 species in India and 9 species in Sikkim.

Key to the species

- 1a. Thallus isidiate or sorediate 2
- 1b. Thallus lacking isidia and soredia; apothecia
large, perforate 3. ***P. nilgherrense***
- 2a. Thallus isidiate or isidia bursting into soredia 3
- 2b. Thallus sorediate, soredia not developed from isidia 5
- 3a. Lobes ciliate 2. ***P. mellissii***
- 3b. Lobes eciliate 4
- 4a. Medulla C+ pink, P-; lecanoric acid present 9. ***P. tinctorum***
- 4b. Medulla C-, KC+ pink, P+ yellow-orange;
protocetraric acid present 7. ***P. saccatilobum***
- 5a. Lobes ciliate 6

- 5b. Lobes eciliate 4. **P. praesorediosum**
- 6a. Medulla C+ pink; gyrophoric acid present. 8. **P. sanctae-angelii**
- 6b. Medulla C-; gyrophoric acid absent 7
- 7a. Upper surface of lobes densely maculate; sorediate lobes involute or revolute 8
- 7b. Upper surface of lobes emaculate; sorediate lobes revolute; soredia farinose 6. **P. rampoddense**
- 8a. Lower surface margin dark brown; sorediate lobes involute; α -collatolic acid present 5. **P. pseudonilgherrense**
- 8b. Lower surface margin ivory to pale grey; sorediate lobes revolute; protolichesterinic acid present 1. **P. hababianum**

1. Parmotrema hababianum (Gyelnik) Hale, *Phytologia* 28: 336. 1974. -*Parmelia hababiana* Gyelnik, *Feddes Repert. Sp. Nov.* 29:288. 1931; Hale, *Contr. U. S. Nat. Herb.* 36:325. 1965; Awasthi, *Biol. Mem.* 1:211. 1976.

Thallus loosely adnate, pale grey, mineral grey to pale brown, 6-8 cm across; lobes rotund, 5-12 mm wide; margin sparsely ciliate; upper surface smooth, emaculate to faintly maculate; soralia marginal to submarginal, soraliate lobes revolute; medulla white; lower surface brown to brown black in central part, sparsely minutely rhizinate-papillate, marginal part erhizinate, ivory, light brownish or mottled, smooth and shining. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ reddish, P-; atranorin, and protolichesterinic acid present.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Kerala, Manipur, Orissa, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Nepal; widely distributed in pantropical regions.

Specimen examined: East Sikkim: Pakyong, Chatterjee & Divakar 20-77151/B (LWG).

2. Parmotrema mellissii (Dodge) Hale, *Phytologia* 28: 337. 1974. -*Parmelia mellissii* Dodge, *Ann. Mo. Bot. Gdn.* 46: 134. 1959; Hale, *Contr. U.S. Nat. Herb.* 36: 297. 1965; Awasthi, *Biol. Mem.* 1: 213. 1976.

Thallus loosely attached, mineral grey to grey, 3-5 cm across; lobes rotund, 4-10 mm wide; margin slightly ascending, crenate to dissected; cilia 3-4 mm long; upper surface smooth, emaculate, minutely reticulately cracked in older parts; isidia marginal to submarginal, simple to coralloid; soredia develop from isidioid outgrowths, granular; lower surface black, rugose to minutely wrinkled, sparsely rhizinate in groups, dark brown to brown black or mottled; rhizines simple to rarely furcated, 1-2 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ reddish, P-; atranorin, α -collatolic acid, alectoronic acid and skyrin present.

It sparsely grows on boulders in open places.

Distribution: India (Kerala, Nagaland, Sikkim, Tamil Nadu and West Bengal), Japan and tropical parts of the world with northward extension up to United States.

Specimens examined: *East Sikkim:* On way between Premlakha-Tenjibir foot track, alt. 2000 m, Sinha 900. *West Sikkim:* Kacheopalri lake surrounding forest, alt. 1828 m, Roy 1749.

3. *Parmotrema nilgherrense* (Nyl.) Hale, Phytologia 28: 338. 1974. -*Parmelia nilgherrensis* Nyl., Flora 52: 291. 1869; Hale, Contr. U. S. Nat. Herb. 36: 333. 1965; Awasthi, Biol. Mem. 1: 214. 1976.

Thallus loosely attached, thick coriaceous, mineral grey to ashy grey, 10-20 cm across; lobes plane to convoluted, rotund, 6-20 mm wide; margin ascending, imbricate, entire to broadly crenate-dentate, ciliate; cilia simple to furcated, 1-3 mm long; upper surface smooth, sometimes rugose, dull to shining, densely maculate, isidia and soredia absent; medulla white; lower surface black, minutely wrinkled, sparsely rhizinate in groups in central part; rhizines slender or thick, simple, 1-3 mm long. Apothecia common, up to 20 mm diam., stipitate; margin crenate or broadly lacerated, involute; thalline exciple distinctly rugose, maculate; spores 15-30 x 10-21 μ m. Pycnidia submarginal, immersed, sometimes producing a protrusion on lower side; conidia 9-18 x 0.5 μ m. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ pink, P-, atranorin, alectoronic and α -collatolic acids present.

It commonly grows on upper portion of trees in dense forests in temperate forests.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Kerala, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal); Africa and Asia.

Specimens examined: *North Sikkim:* Tholung-Kissong foot track, alt. 2475-2700 m. Sinha 587, 626.

4. *Parmotrema praesorediosum* (Nyl.) Hale, Phytologia 28: 338. 1974. -*Parmelia praesorediosa* Nyl., Sert. Lich. Trop. Labuan Singapore :18. 1891; Hale, Contr. U.S. Nat. Herb. 36: 258. 1965; Awasthi, Biol. Mem. 1: 215. 1976.

Thallus adnate, yellowish grey to dark grey, 3-8 cm across, \pm suborbicular; lobes subrotund to rotund, 4-10(-15) mm wide; margin ascending, sinuous, imbricate, eciliate; upper surface smooth, minutely cracked-reticulate in older parts, emaculate; soralia marginal to rarely submarginal, linear or crescent-shaped; soredia granular; medulla white; lower surface black, minutely wrinkled; sparsely rhizinate in central part, brown to white mottled; rhizines simple, ca. 1 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranorin and protopraesorediosic acid present.

The species commonly grows on trees and boulders in open places.

Distribution: India (Andhra Pradesh, Assam, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Nagaland, Orissa, Rajasthan, Sikkim, Uttaranchal, Uttar Pradesh and West Bengal). Pantropical.

Specimens examined: West Sikkim: Nayabazar-Soreng road, ca 5 km point, alt. 800-900 m, Sinha 15, Tashiding Monastrey surroundings, alt. 1600 m, Sinha 313.

5. ***Parmotrema pseudonilgherrense*** (Asah.) Hale, Mycotaxon 5:441. 1977. *Parmelia pseudonilgherrensis* Asah., J. Jap. Bot. 29: 370. 1954; Hale, Contr. U.S. Nat. Herb. 36: 337. 1965; Awasthi, Biol. Mem. 1: 216. 1976.

Thallus loosely attached, coriaceous, 5-8 cm across, ashy grey to dark grey, especially in central part; lobes rotund, 7-12 mm wide, margins \pm ascending, imbricate, sinuous, ciliate; cilia 1.5-2.5 mm long, simple, rarely forked; upper surface smooth, densely white maculate; soralia on apices of dentations in central part of thallus, becoming confluent, linear and sinuous; sorediate lobes involuted, soredia granular, older soralia turning blackish; medulla white; lower surface smooth to minutely wrinkled, black, shining, sparsely rhizinate in groups in central part; dark tan to dark brown, shining. Apothecia rare, sessile, 2.5 mm diam.; thalline exciple rough, maculate; asci and spore immature. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ reddish, P-; atranorin, alectoronic acid and α -collatolic acid present.

It sparsely grows on shrubs at higher elevations.

Distribution: India (Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Sikkim, Tamil Nadu and Uttaranchal), Africa and Eastern Asia.

Specimen examined: East Sikkim: Thegu, alt. 3700 m, Sinha 1378 B.

6. ***Parmotrema rampoddense*** (Nyl.) Hale, Phytologia 28: 338. 1974. *Parmelia rampoddensis* Nyl., Acta Soc. Sci. Fenn. 26(10): 7. 1900; Hale, Contr. U.S. Nat. Herb. 36: 304. 1965; Awasthi, Biol. Mem. 1: 217. 1976.

Thallus loosely attached, glaucous grey to grey, 8-10 cm across; lobes rotund, 6-13 mm wide; margin subsascending imbricate, sinuous, entire, ciliate; cilia simple to furcated, conspicuous, 2-3 mm long; upper surface smooth, dull, emaculate, rugulose and cracked in older parts, sorediate, sorediate lobes revolute; soralia marginal, linear, \pm continuous; soredia farinose; medulla white; lower surface black, prominently wrinkled, sparsely rhizinate, margin brown; rhizines in patches, simple to rarely squarrose, 1-1.5 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ rose, P-; atranorin and alectoronic acid present.

It commonly grows on trees in open places.

Distribution: India (Madhya Pradesh, Manipur, Nagaland, Sikkim, Tamil Nadu and Uttaranchal). Pantropical.

Specimens examined: East Sikkim: On way between Chhanglangpong village and Aritar, alt. 1500 m, Sinha 526. *West Sikkim:* Along down stream of Narkhola-Karchi, alt. 2000-1700 m, Sinha 425.

7. *Parmotrema saccatilobum* (Taylor) Hale, *Phytologia* 28: 339. 1974. -*Parmelia saccatiloba* Taylor in Hook., *Lond. J. Bot.* 6: 174. 1874; Hale, *Contr. U.S. Nat. Herb.* 36: 262. 1965; Awasthi, *Biol. Mem.* 1: 219. 1976.

Thallus loosely attached, mineral grey to grey, 5-7 cm across; lobes rotund, subirregularly branched, convolute, 4-8 mm wide; margin entire, sometimes crenate, eciliate; upper surface smooth, dull, emaculate, cracked in older part; isidia laminal, simple; granular to filiform, rarely branched, ca. 1 mm long; medulla white; lower surface black, wrinkled, sparsely rhizinate, margin brown; rhizines sparse, simple, ca. 1 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ reddish, P+ orange; atranorin and protocetraric acid present.

It sparsely grows on trees and on boulders at lower elevations in open places.

Distribution: India (Andaman Islands, Assam, Goa, Kerala, Nagaland, Sikkim, Uttaranchal and West Bengal), Singapore, Taiwan; South Pacific regions and Australia.

Specimen examined: South Sikkim: Jorethang-Namchi road, at 5 km point, alt. 550-600 m, Sinha 1.

8. *Parmotrema sanctae-angelii* (Lynge) Hale, *Phytologia* 28: 339. 1974. *Parmelia sancti-angelii* Lynge, *Ark. Bot.* 13: 35. 1914; Hale, *Contr. U.S. Nat. Herb.* 36:306. 1965; Awasthi, *Biol. Mem.* 1: 220. 1976.

Thallus loosely attached, glaucous white, grey to dark grey, coriaceous, 8-12 cm across; lobes rotund, 6-12 mm wide; margin \pm ascending, imbricate, entire to crenate, ciliate; cilia simple to furcated, 2-4 mm long; upper surface plane, emaculate, cracked in older parts, sorediate lobes often involuted; soralia marginal, sometimes submarginal young soralia farinose, older ones granulose and blackish; medulla white; lower surface black, minutely wrinkled, sparsely rhizinate in the central part, margin brown to white mottled; rhizines simple to squarrosely branched, 1-3 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C+ rose, KC+ red, P-; atranorin, gyrophoric acid and skyrin present.

It commonly grows on trees, boulders and often on ground with mosses in almost all the localities except alpine zone.

Distribution: India (Andhra Pradesh, Kerala, Madhya Pradesh, Manipur, Meghalaya, Nagaland, Rajasthan, Sikkim, Tamil Nadu, Uttaranchal and West Bengal). Pantropical.

Specimens examined: South Sikkim: Namchi-Old Damthang road, alt. 1700-2000 m, Sinha 30. Namchi-Mamle route, alt. 1550 m, Sinha 195. Sumbuk-kartikey village

area, alt. 900-1050 m, Sinha 8. *West Sikkim*: Sombaria, Forest Rest House compound, alt. 1700 m, Sinha 1295. Soreng, alt. 1800-2000 m, P. Singh 64.

9. *Parmotrema tinctorum* (Despr. ex Nyl.) Hale, *Phytologia* 28: 339. 1974. *Parmella tinctorum* Despr. ex Nyl., *Flora* 55: 547. 1872; Hale, *Contr. U.S. Nat. Herb.* 36: 264. 1965; Awasthi, *Biol. Mem.* 1: 223. 1976. (Fig. 54)

Thallus ± loosely attached, in orbicular or suborbicular patches, glaucous grey, greyish white to grey, 6-15 cm across; lobes rotund 8-20 mm wide; margin entire, ciliate; upper surface smooth, dull, plane, emaculate, somewhat longitudinally folded in marginal region; isidia laminal, sparse to abundant, granular to filiform or becoming coralloid branched and rarely somewhat flattened microphylline, up to 1.5 mm long; medulla white; lower surface black, margin brown; rhizines sparse in central part only. Apothecia absent in the specimens examined. Chemistry: Cortex K+ yellow; medulla K-, C+ red, KC+ red, P-; atranorin and lecanoric acid present.

It commonly grows on trees and boulders in open places.

Distribution: Widely distributed in India (Arunachal Pradesh, Assam, Bihar, Jammu & Kashmir, Madhya Pradesh, Maharashtra, Manipur, Nagaland, Sikkim, Tamil Nadu, Uttaranchal, Uttar Pradesh and West Bengal), tropical and temperate regions of the world.

Specimens examined: *East Sikkim*: On way between Chhalangpong-Aritar village, alt. 1500 m, Sinha 524. *North Sikkim*: Bey surroundings, alt. 1600 m, Sinha 570. *South Sikkim*: Sumbuk-kartikey village area, alt. 950-1050 m, Sinha 7. Namchi-Old Damthang road, alt. 1700-2000 m, Sinha 31. *West Sikkim*: Nayabazar-Soreng road, alt. 800-900 m, Sinha 16. Soreng, 1800-2000 m, P. Singh 62. Pelling, alt. 2300 m, P. Singh 79. Tashiding Monastrey surroundings, alt. 1600 m, Sinha 153.

28. *Platismatia* W. Culb. & C. Culb.

Thallus foliose, dorsiventral, heteromerous, rosette forming or wide spreading, lobate; lobes 3-25 mm wide, margin often ascending, wavy, sometimes crisped; upper and lower surfaces with a well developed paraplectenchymatous cortex; upper surface with punctiform pseudocyphellae; photobiont green, *Trebouxia*; lower surface pale or black with a few, scattered rhizines. Apothecia very rare, marginal or submarginal; disc brown, often perforate; asci 8- spored; spores colourless, simple, ellipsoid or subglobose, (3.5-)5-8(-10) × 3-5 µm. Pycnidia marginal, immersed or absent; conidia cylindrical, not swollen at apices. Atranorin present.

A genus of ca. 11 species with highest concentration of species in northern Asia and western North America. The single Indian species is known from Sikkim only.

Platismatia erosa W. Culb. & C. Culb., Contr. U. S. Nat. Herb. 34: 526. 1968.

(Fig. 55)

Thallus ± loosely attached, ashy grey, tinged with brown, 8-25 cm across; lobes broadly rounded, 5-20 mm wide; margin rounded to weakly crenate; upper surface broadly reticulately ridged and veined, crests of ridges often darkening and pseudocyphellate with minute pores and often bearing isidial scars resembling pseudocyphellae; isidia usually infrequent, short, stout or simple and usually confined to the ridges or thallus cracks but becoming coralloid and well developed at the margin of lobes; lower surface jet black, punctate, marginal zone light brown or tan; rhizines few, simple or fasciculate, confined to older parts. Apothecia and pycnidia not seen. Chemistry: Cortex K-, medulla K-, C-, KC- P-; atranorin, caperatic acid and an unknown yellow pigment present.

It grows abundantly in temperate and subalpine zone of Sikkim on trees as well as on boulders.

Distribution: India (Sikkim), China, Japan, Nepal, Philippines, Taiwan and Vietnam.

Specimens examined: East Sikkim: Kupup, north border side, alt. 4100-4200 m, Sinha 1511. Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1472. North Sikkim: Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1068. Theu La-Jakthang way, alt. 4600-3400 m, Sinha 1711. West Sikkim: Near Bakhim, alt. 2500-2700 m, Sinha 716. On way between Dzongri-Tangsing foot track, alt. 3900-3500 m, Sinha 816. Phedang-Dzongri foot track, alt. 3900-4000 m, Sinha 230.

29. *Punctelia* Krog

Thallus foliose, dorsiventral, heteromerous; lobes rounded, rarely sublinear, canaliculate, commonly pseudocyphellate; pseudocyphellae suborbicular without a perforate polysaccharide covering; upper cortex paraplectenchymatous; photobiont green, *Trebouxia*; medulla white; lower surface pale, tan, brown or black, rhizinate; rhizines simple, not reaching beyond margins. Apothecia laminal or submarginal; margin entire; disc rarely perforate; asci 8-spored; spores colourless, simple, ellipsoid, 10-27 x (5-)8-18 µm. Pycnidia laminal or rarely marginal; conidia unciform, filiform or bifusiform. Atranorin present in cortex.

About 31 species in the world; 4 species in India and 2 in Sikkim.

Key to the species

- 1a. Thallus isidiate; lecanoric acid present 2. *P. rudecta*
 1b. Thallus sorediate; gyrophoric acid present 1. *P. borrieri*

1. ***Punctelia borrieri*** (Smith) Krog, Nord. J. Bot. 2:291. 1982. -*Lichen borrieri* Smith in Smith & Sowerby, Engl. Bot. 25: 1780. 1807. -*Parmelia borrieri* (Smith) Turn., Trans. Linn. Soc. London 9:148. 1808; Awasthi, Biol. Mem. 1:166. 1976.

Thallus loosely adnate, 5-8 cm across, bluish grey; lobes broad, rounded, somewhat dissected, often crowded, 2-5 mm wide; margin ascending, sinuous; upper surface smooth to rough, wrinkled centrally, white pseudocyphellate; pseudocyphellae small, punctiform, distinct at margins, becoming sorediate centrally; soralia derived from pseudocyphellae, clustered at centre, sometimes marginal, confluent; soredia fine, white to grey white; lower surface black, marginal area pale brown to brown black, rhizinate; rhizines sparse to dense in central part, marginal area sometimes erhizinate, black or pale brown. Apothecia not seen. Chemistry: Thallus K + yellow; medulla K-, C + red, KC + red, P-; gyrophoric acid and atranorin present.

It sparsely grows on boulders in temperate areas.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Tamil Nadu and Uttaranchal). Cosmopolitan.

Specimen examined: East Sikkim: Thegu, alt. ca. 3700 m, Sinha 1377.

2. *Punctelia rudecta* (Ach.) Krog, Nord. J. Bot. 2:291. 1982, -*Parmelia rudecta* Ach., Syn. Lich. :197. 1814; Awasthi, Biol. Mem.1:189. 1976.

Thallus ± loosely attached, spreading, crisp, fragile, yellowish grey, 3-5 cm across; lobes subrotund, 3-6 mm wide; margin suberect, crenate dentate; upper surface smooth, shining, reticulately rugulose near margins; pseudocyphellae laminal, elliptical to rounded; isidia laminal, also develop around pseudocyphellae, cylindrical, rarely branched, ca. 0.5 mm long; lower surface brown, rhizinate with a pale brown naked marginal zone; rhizines pale, dense, ca. 1 mm long. Apothecia not seen. Chemistry: Cortex K + yellow; medulla K-, C + rose, KC + red, P-; atranorin and lecanoric acid present.

It sparsely grows on trees as well as on boulders in open places in temperate regions.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Kerala, Nagaland, Sikkim, Tamil Nadu and Uttaranchal); widely distributed in temperate regions of the world.

Specimens examined: North Sikkim: Bey surroundings, alt. 1600 m, Sinha 567. Zema -I, alt. 2750 m, Sinha 1513. West Sikkim: Karchi village surroundings, alt. 2000 m, Sinha 433.

30. *Rhizoplaca* Zopf

Thallus foliose, heteromerous, umbilicate to squamulose, corticated on both surfaces; upper surface yellow green; rhizines and pseudocyphellae absent; upper cortex prosoplectenchymatous, with non pored epicortex; photobiont a green alga. Apothecia laminal, sunken to sessile, lecanorine, eperforate; asci 8 -spored, with distinct amyloid tholus; spores colourless, simple, ellipsoid, 8-13 x 4-7.5 µm.

Pycnidia laminal, immersed; conidia filiform, curved, 20 - 25 x 1 µm. Usnic acid present.

A cosmopolitan, saxicolous genus of 4 species occurring on all continents except Australia; 3 species in India and 2 in Sikkim.

Key to the species

- 1a. Apothecial disc light red; usnic and placodiolic acids present 1. **R. chrysoleuca**
 1b. Apothecial disc bluish; only usnic acid present 2. **R. melanophthalma**

1. **Rhizoplaca chrysoleuca** (Smith) Zopf, Justus Liebig's 340:291. 1905. -*Lichen chrysoleucus* Smith, Trans. Linn. Soc. London 1:82. 1791. -*Lecanora rubina* (Vill.) Ach., Lich. univ. :412. 1810. (Fig. 56)

Thallus foliose, umbilicate, often closely crowded and then almost columnar and appearing dwarf fruticose, deeply lobed, whitish green to light yellow-green, up to about 3 cm wide, often with a finely mealy upper surface. Apothecia sessile to almost stalked, up to about 5 mm diam., usually smaller; disc light red to pale yellowish, pruinose; spores simple, colourless, 6-12 x 3-6 µm. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; usnic and placodiolic acids present.

It commonly grows on nitrophilous boulders in open alpine areas up to snow zone.

Distribution: India (Jammu & Kashmir and Uttaranchal), Nepal and alpine areas in Europe.

Specimens examined: North Sikkim: Sebu La base camp, east side, alt. 4960 m, Sinha 1237. Near Thangu bridge on Muguthang foot track, alt. 3900 m, Sinha 1163. Yomesamdong, Tembawa river valley, alt. 4750 m, Sinha 1270 A and 1270 B.

2. **Rhizoplaca melanophthalma** (Ram.) Leuck. & Poelt, Nova Hedwigia 28:72. 1977. -*Lichen melanophthalma* Ram. in Lam. & DC., Fl. fr. ed.3, 2:377. 1805.

Thallus monophyllous to thickly crowded bullate, yellowish grey, 2-3 cm across; lobes up to 1.5 mm wide, rounded in peripheral part, black rimmed, inside contiguous; surface epruinose. Apothecia broadly protruding, numerous, crowded, margin crenate, involute, (0.5-)1-1.5(-2) mm across; disc bluish, pruinose; spores simple, colourless, 8-11 x 4-5 µm. Chemistry: Cortex K-, P-; medulla K-, C-, KC-, P+ yellow; usnic acid present.

A single specimen collected from nitrophilous rock in dry alpine area of North Sikkim.

Distribution: India (Western Himalaya); alpine areas in Europe.

Specimen examined: North Sikkim: Chholhamu, alt. 5600 m, U. Lachungpa 1623.



Fig. 55. *Platismatia erosa*. **Fig. 56.** *Rhizoplaca chrysoleuca*. **Fig. 57.** *Rimelia reticulata*. **Fig. 58.** *Tuckneraria ahtii*.

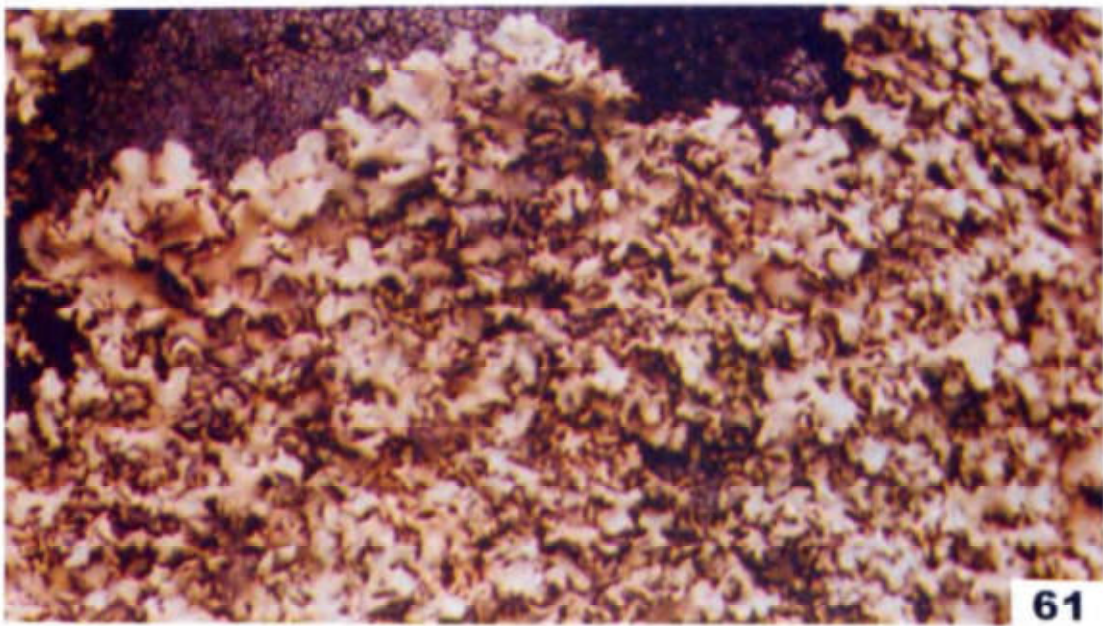
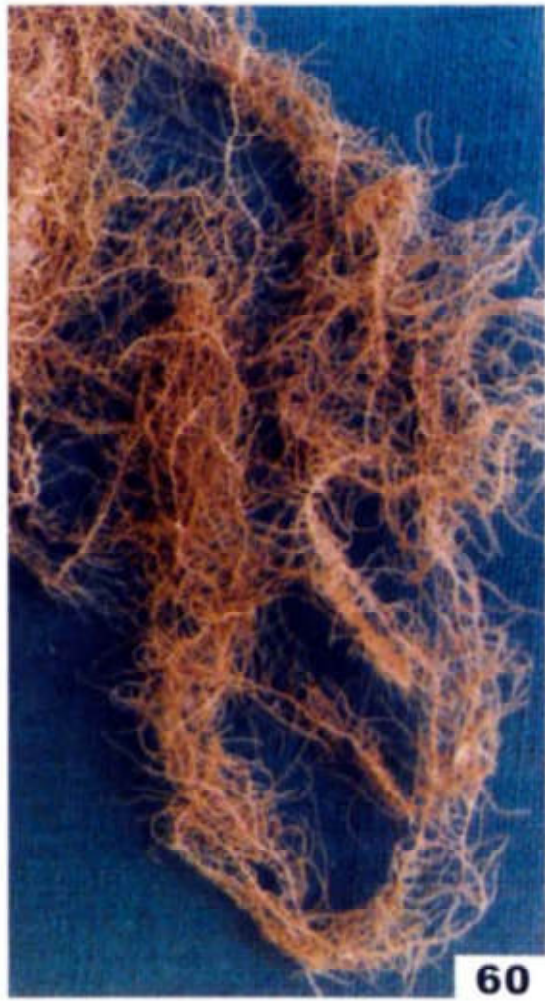
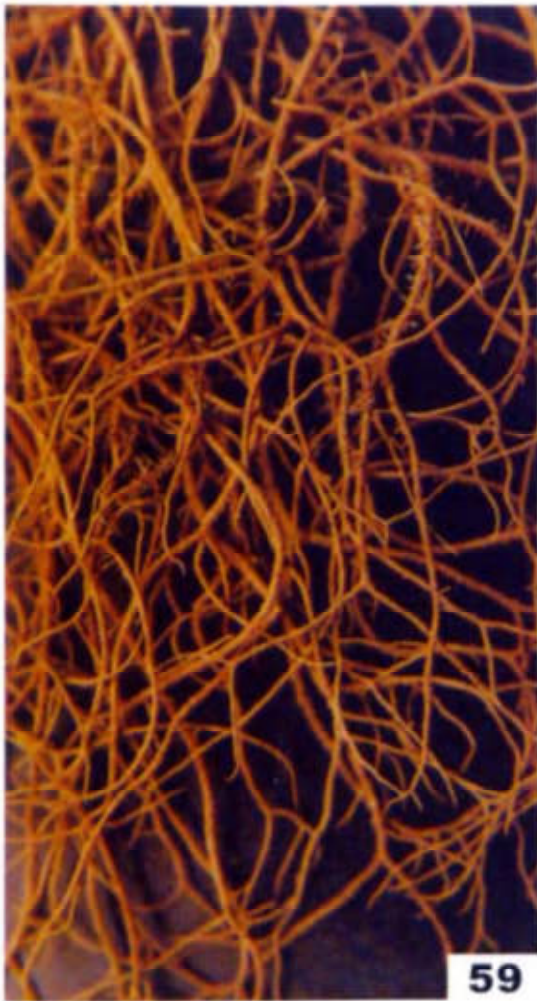


Fig. 59. *Usnea baileyi*. **Fig. 60.** *U. longissima*. **Fig. 61.** *Xanthoparmelia somloensis*.

31. Rimelia Hale & A. Fletcher

Thallus foliose, loosely adnate to adnate, pale grey to dark grey or grey green, 4-20 cm across; lobes flat, broad, 3-30 mm wide, often marginally lacinate; margin ciliate; cilia sparse to dense, simple or sparingly branched, not bulbate, black; upper surface smooth to rugose, finely maculate, with or without soredia and dactyls, lacking pseudocyphellae and isidia; maculae forming an intricate network and fissuring in to reticulate cracks; soredia when present, developing laminally or marginally; upper cortex vaulted paraplectenchymatous, with \pm uniformly pored epicortex; medulla white; lower surface glossy, black, rhizinate; lobe margins brown, with or without rhizines, rhizinate margins occasionally papillate; rhizines moderately dense to dense, simple to irregularly squarrosely branched, black. Apothecia laminal, subpedicellate to pedicellate; disc eventually perforate, rarely eperforate; asci 8-spored; spores colourless, simple, ellipsoidal, 10-18 x 6-11 μm . Pycnidia laminal, immersed, punctiform; conidia bacilliform or filiform, 9-16 x 1.5 μm . Atranorin and chloroatranorin present.

Rimelia a segregate of *Parmelia* Ach. s. lat., with 17 species in the world; 2 species in India and 1 in Sikkim.

Rimelia reticulata (Taylor) Hale & A. Flechter, Bryologist 93: 28. 1990. -*Parmelia reticulata* Taylor in Mackay, Fl. Hibern. 2: 148. 1836; Awasthi, Biol. Mem. 1: 217. 1976. -*Parmotrema reticulatum* (Taylor) M. Choisy, Bull. Mens. Soc. Linn. Lyon 21: 175. 1952. (Fig. 57)

Thallus loosely to closely attached or sometimes almost adnate, mineral grey to grey, 6-12 cm across; lobes subrotund, subirregularly branched, discrete to imbricate, 3-10 mm wide, laterally in central part of thallus often with shortly dentate to dichotomously divided \pm elongated lobes or finger like lacinules; margin ascending; cilia 1-2 mm long, sparse to dense; upper surface dull, smooth, with distinct to subdistinct reticulate maculae, often reticulately fissured or cracked in older parts, sorediate lobes sometimes involute; soralia marginal or \pm capitate at the tips of narrow finger like lacinules; lower surface black, usually densely rhizinate up to the margin, sometimes the sorediate elongated lacinules pale brown to yellow brown in the marginal region and the rhizines are sparse to absent; rhizines simple to squarrosely branched, sometimes rhizines and rhizinal papillae interspersed. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow turning red, C-, KC-, P+ orange-red; atranorin, salacinic acid and consalacinic acid present.

It commonly grows on boulders and trees in almost all places except alpine zone in open places.

Distribution: India (Arunachal Pradesh, Assam, Himalchal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Manipur, Meghalaya, Nagaland,

Sikkim, Tamil Nadu, Uttaranchal and West Bengal); widely distributed in pantemperate and pantropical zones and tropical parts of the world.

Specimens examined: *East Sikkim:* Gangtok, near Burtuk, Sinha 97. On way between South Regu-Picrae forest, alt. 1900 m, Sinha 506. Thegu, alt. 3700 m, Sinha 1378. *North Sikkim :* Bey surroundings, alt. 1600 m, Sinha 568. *South Sikkim:* Namchi-Damthang road, 2 km point, alt. 1800 m, Sinha 20. *West Sikkim:* Tashiding Monastrey surroundings, alt. 1400-1600 m, Sinha 155. Soreng, alt. 1800-2000 m, P. Singh 65. Yoksum, 1900 m, Sinha 685.

32. *Tuckermannopsis* Gyelnik

Thallus foliose to subfruticose, thin; lobes elongate, margin ciliate; upper surface pale olive grey to olive brown; upper cortex paraplectenchymatous, with non pored epicortex; lower surface smooth, lacking pseudocyphellae; rhizines sparse, simple. Apothecia marginal, nephromoid, eperforate; asci 8-spored, cylindrical, 25-40 x 8-15 μm ; spores globose, 3.5-5 x 3.5-5 μm . Pycnidia marginal, emergent, conidia bifusiform, 6 x 1 μm . Atranorin present in cortex.

A genus of ca. 11 species from the northern hemisphere with centres of speciation in north – eastern Asia and North America; 2 species known from India as well as from Sikkim.

Key to the species

- 1a. Thallus yellowish brown; lobes 2-4 mm wide, marginally sorediate 1. *T. chlorophylla*
- 1b. Thallus olive brown or ashy brown; lobes 1-2.5 mm wide, lacking soredia 2. *T. sepincola*

1. ***Tuckermannopsis chlorophylla*** (Willd.) Hale, Bryologist 90: 164. 1987. *Lichen chlorophylla* Willd. in Humb., Fl. Frib. Spec. :20. 1793. -*Cetraria chlorophylla* (Willd.) Vainio, Acta Soc. Fauna Fl. Fenn. 13:7. 1896; Awasthi, Bull. Bot. Surv. India 24(1-4): 7. 1982.

Thallus foliose, loosely appressed, yellowish brown, 2-3 cm across; lobes radiating, 2-4 mm wide, \pm concave; margin ascending, undulate, lacking black fibrils; upper surface smooth; soredia marginal, whitish farinose to grey granular; pseudocyphellae absent; medulla white; lower surface pale brown with short rhizines in the central region, remaining part erhizinate and \pm wrinkled. Chemistry: Cortex K+ yellowish; medulla K-, C-, KC-, P-; protolichesterinic acid present.

It sparsely grows on small trees or shrubs in moist conditions in temperate to subalpine regions.

Distribution: India (Sikkim, Uttaranchal and West Bengal), temperate areas of South America and New Zealand.

Specimen examined: North Sikkim: Theu La to Jakthang way, alt. 4600-3400 m, Sinha 1709. *West Sikkim:* Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 231 B.

2. **Tuckermannopsis sepincola** (Ehrh.) Hale, *Bryologist* 90:164. 1987. -*Lichen sepincola* Ehrh., *Hannover Mag.* 21:203. 1783. -*Cetraria sepincola* (Ehrh.) Ach., *Meth. Lich.* :297. 1803.

Thallus 1-1.7 cm across, orbicular, olive brown or ashy brown; lobes radiating, irregularly incised or rounded, 1-2.5 mm wide; upper surface smooth, dull; lower surface pale brown, weakly wrinkled; rhizines pale, simple, scattered. Apothecia abundant, submarginal, 1-3 mm across; disc red brown, shining, epruinose; spores simple, ellipsoid, 5.3-6.4 x 4-5 μ m. Pycnidia numerous; conidia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; protolichesterinic acid present.

It sparsely grows on *Rhododendron* shrubs in high temperate and alpine areas.

Distribution : India (Sikkim), Japan; Europe, N. America.

Specimen examined: North Sikkim: Theu La base camp, south side, alt. 4500 m, Sinha 1682.

33. **Tuckneraria** Randlane & A. Thell

Thallus foliose, \pm loosely attached to the substratum, up to 7 cm across; lobes elongate or rounded with ascending margins and numerous marginal cilia; upper surface smooth or only slightly rugose, light yellow, yellowish-green or yellowish grey, with or without marginal soredia; lower surface whitish, light to dark brown or black, with white or light brown, small and plain pseudocyphellae; rhizines simple, sometimes long and numerous; both cortices paraplectenchymatous, cortical hyphae strongly gelatinized. Apothecia marginal, rounded or reniform, up to 10 mm diam.; disc brown; asci 8-spored, clavate, 30-50 x 10-14 μ m; spores \pm uniseriately arranged, colourless, simple, globose-subglobose, 5-7 x 4-5 μ m. Pycnidia marginal or emergent on projections, occasionally laminal on both surfaces; conidia bifusiform, 4-5 x 1-1.5 μ m. Usnic acid present in cortex.

A genus of 4 species, growing on deciduous and coniferous trees mainly in eastern and south eastern Asia; 2 species in India as well as in Sikkim.

Key to the species

- 1a. Lobes 5-12 mm wide, lacking soredia 1. **T. ahtii**
 1b. Lobes 2-5 mm wide, marginally sorediate 2. **T. laureri**

1. **Tuckneraria ahtii** Randlane & Saag, *Acta Bot. Fenn.* 150: 147. 1994; Randlane, Saag & Obermayer, *Mycotaxon* 80: 420. 2001. (Fig. 58)

Thallus loosely attached, horizontally spreading, yellowish green. 5-10 cm across, thick coriaceous; lobes rounded to elongate, convolute, 5-12(-14) mm wide; margin rotund to crenate with dense or sparse black pycnidial fibrils and occasional pale brown cilia; upper surface smooth to faintly rugose in central part; lower surface light to dark brown or almost black in central parts, reticulate lamellate; pseudocyphellae white or light brown, usually develop on smooth surface; rhizines sparse in patches in central part, brown, simple, 1.5-3 mm long. Apothecia marginal, reniform up to 8x5 mm; disc brown; spores subglobose, 6-7 x 5-6 μm . Chemistry: Cortex and medulla K-, C-, KC-, P-; caperatic and protolichesterinic acids present.

It commonly grows in temperate regions on upper portion of tree branches.

Distribution: Bhutan, China and Nepal. It is a new record for India.

Specimens examined: East Sikkim: Rechala surroundings, alt. 2700-2900 m, Sinha 1002 & 1003 A. North Sikkim: Tholung-Kissong track, alt. 2475-2700 m, Sinha 586, 588. West Sikkim: On way between Thangsing-Phedang track, alt. 3500 m, Sinha 867. Yoksum-Tsoka foot track, 1800-3050 m, Sinha 202 A.

2. *Tuckneraria laureri* (Krempelh.) Randle & Thell, Acta. Bot. Fenn. 150: 149. 1994; Randle, Saag & Obermayer. Mycotaxon 80:420. 2001. -*Cetraria laureri* Krempelh., Flora 34:673. 1851; Awasthi, Bull. Bot. Surv. India 24 (1-4):11. 1982. -*Nephromopsis laureri* (Krempelh.) Kurok., J. Jap. Bot. 66:156. 1991.

Thallus irregularly to dichotomously divided, yellowish grey, ca. 5 cm across; lobes imbricate, 2-5 mm wide; margin undulate, rounded to weakly crenate, with minute black fibrils; upper surface involute, smooth to scrobiculate; soredia marginal, discontinuous, farinose to granular, intermittently present between minute fibrils; medulla white; lower surface pale brown or concolorous with upper surface, slightly rugose and white pseudocyphellate; rhizines sparse, concolorous with upper surface, ca. 1 mm long. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; lichesterinic, protolichesterinic and usnic acids present.

It sparsely grows on exposed boulders in temperate regions.

Distribution: India (Sikkim and Uttaranchal), Bhutan, China, Japan, Mongolia, Nepal, Russia; Central Europe and South America.

Specimens examined: North Sikkim: Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1067. Tholung, Gumpa surrounding forest, alt. 2500 m, Sinha 623. West Sikkim: Near Bakhim, alt 2500-2700 m, Sinha 706. Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 238 A. Thangsing-Lampokhari foot track, 3 km point, alt. 3500 m, Sinha 851.

34. *Usnea* Adans.

Thallus fruticose, erect to longly pendent or decumbent, in most species attached by a compact basal holdfast, dichotomously to sympodially branched

or filamentous, yellowish, pale- greenish to brownish; main branches \pm terete and rigid, angular, articulate inflated or flexuose; lateral branchlets dense or sparse, \pm terete; papillae, tubercles, isidia, soredia and pseudocyphellae present or absent; cortex single or double layered, \pm prosoplectenchymatous; photobiont green, *Trebouxia*; central axis solid or hollow. Apothecia lecanorine, lateral or subterminal but appearing terminal and geniculate; margin ciliate; disc rounded, plane or slightly concave, caesiopruinose; asci 8 -spored; spores colourless, simple, ellipsoid; paraphyses simple. Usnic acid present in cortex.

About 600 species in the world; 55 species in India and 25 species in Sikkim.

Key to the species

- 1a. Central axis hollow; periaxial medulla pigmented red 2. **U. baileyi**
 1b. Central axis solid 2
 2a. Branching dichotomous or filamentous 3
 2b. Branching sympodial or subsympodial 6
 3a. Branching dichotomous; branches articulate-inflated 9. **U. himalayana**
 3b. Branching filamentous; branches terete, not inflated ... 4
 4a. Cortex of branches completely evanescent, pulverulent or partially evanescent 5
 4b. Cortex of branches persistent, smooth to cracked areolate, lacking soredia 11. **U. montis-fuji**
 5a. Central axis I+ blue; cortex evanescent and pulverulent throughout 10. **U. longissima**
 5b. Central axis I-; branches generally with cortex, sometimes evanescent 16. **U. pectinata**
 6a. Cortex or medulla pigmented 7
 6b. Cortex or medulla lacking pigments 9
 7a. Cortex pigmented; soredia absent 8
 7b. Medulla pigmented; soredia present 7. **U. fragilis**
 8a. Branching subsympodial; cortex palisade like; barbatic, diffractic and salacinic acids present 15. **U. pangiana**
 8b. Branching sympodial; cortex prosoplectenchymatous; stictic acid complex present 19. **U. rubicunda**

- 9a. Thallus pseudocyphellate 10
- 9b. Thallus lacking pseudocyphellae 17
- 10a. Thallus isidiate 11
- 10b. Thallus lacking isidia 12
- 11a. Surface papillate; pseudocyphellae elevated on
tubercles 12. **U. nepalensis**
- 11b. Surface lacking papillae; pseudocyphellae not elevated
on tubercles 25. **U. undulata**
- 12a. Cortex double layered 13
- 12b. Cortex single layered 16
- 13a. Medulla K+ red; salacinic acid present 14
- 13b. Medulla K-; salacinic acid absent 24. **U. thomsonii**
- 14a. Thallus yellowish brown; usnic and
salacinic acids present 23. **U. subsordida**
- 14b. Thallus grey brown to brown black; usnic, salacinic
and barbatic acids present 15
- 15a. Lateral branchlets uniform in size; pseudocyphellae on
apices of tubercles 13. **U. norkettii**
- 15b. Lateral branchlets unequal in size; pseudocyphellae
plane to slightly raised, not on tubercles 18. **U. robusta**
- 16a. Thallus yellow brown; branches \pm inflated, surface
waxy in appearance 20. **U. sordida**
- 16b. Thallus brown to brown- black; branches not inflated,
not waxy in appearance 21. **U. splendens**
- 17a. Thallus isidiate and /or sorediate 18
- 17b. Thallus lacking isidia and soredia 22
- 18a. Thallus sorediate or sorediate-isidiate 19
- 18b. Thallus isidiate, lacking soredia 20
- 19a. Thallus reddish brown, soredia apical in young branches,
major branches isidiate and papillate 8. **U. galbinifera**
- 19b. Thallus grey to yellowish brown; branches initially
sorediate, soredia later become isidiate 22. **U. subfloridiana**

- 20a. Thallus articulate and inflated;
stictic acid complex present 3. **U. bismolliuscula**
- 20b. Thallus not articulate and inflated 21
- 21a. Thallus decumbent to pendulous; branches more or
less convergent; lateral branchlets absent 1. **U. aciculifera**
- 21b. Thallus erect; branches divergent; lateral branchlets
sparse to dense 6. **U. eumitrioides**
- 22a. Cortex double layered 17. **U. pseudosinensis**
- 22b. Cortex single layered 23
- 23a. Thallus yellow to yellow brown; branches inflated 14. **U. orientalis**
- 23b. Thallus pale brown to dark brown; branches not
inflated 24
- 24a. Medulla lax; papillae concolorous to surface, rounded;
salacinic and norstictic acids present 4. **U. cineraria**
- 24b. Medulla dense; papillae raised with paler apices;
barbatic, salacinic and alectorialic acids present 5. **U. dendritica**

1. **Usnea aciculifera** Vainio, Bot. Mag. Tokyo 35: 45. 1921; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst. :322. 1936-38; G. Awasthi, Journ. Hattori Bot. Lab. 61: 363. 1986.

Thallus decumbent to pendulous, up to 12 cm long, yellow brown to brown-blackish near base, branching subsympodial; branches terete, 0.25-0.75 mm diam., convergent or running parallel to other branches, tapering apically; lateral branchlets sparse in apical region only; surface smooth to minutely verruculose, transversely cracked; isidia simple, filiform, whitish, occurring solitary or in groups on surface or on verrucae; cortex colourless, palisade like; medulla dense; central axis colourless, solid. Apothecia not seen. Chemistry: Medulla K+ yellow-red, C-KC-, P+ yellow; usnic acid and stictic acid complex present.

It sparsely grows on trees at lower elevations in open places.

Distribution: India (Arunachal Pradesh, Manipur, Nagaland, Sikkim, Uttaranchal and West Bengal), China, Japan and Nepal.

Earlier record: Sikkim: Gangtok, Pamianchi and Yoksum (Asahina, 1966).

2. **Usnea baileyi** (Stirton) Zahlbr., Denkschr. Akad. Wiss. Wien, Math. Nat. Cl. 83: 182. 1909; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst. : 63. 1936-38; G. Awasthi, Journ. Hattori Bot. Lab. 61: 346. 1986. —*Eumitria baileyi* Stirton, Scott. Nat. 6:100. 1881. (Fig. 59)

Thallus suberect to pendulous, 10-20 cm long, pale grey to greyish brown, basal part sometimes blackish, branching sympodial; branches terete, 1-1.8 mm diam., lateral branchlets sparse; surface smooth to cracked; papillae concolorous with the thallus or whitish at tips, dense on main branches, sparse on lateral branchlets; pseudocyphellae white, oblong or rounded on smooth surface or slightly raised; isidia dense or sparse, simple, produced directly on the cortex as well as on the pseudocyphellae; medulla pigmented red; central axis hollow. Sterile. Chemistry: Medulla K-, C-, KC-, P-; usnic, norstictic, salacinic acids and a yellow unidentified substance present.

It commonly grows on trees and on boulders along roadsides in subtropical and temperate regions.

Distribution: India (Arunachal Pradesh, Kerala, Manipur, Meghalaya, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Nepal; South East Asia, Australia, Africa and Central America.

Specimens examined: *East Sikkim:* On way between Chhalangpong-Aritar village, alt. 1500 m, Sinha 521. North Regu, near Chhuba village, alt. 1000-1300 m, Sinha 972. *South Sikkim:* Namchi-Old Damthang road, alt. 1700-2000 m, Sinha 35. Temi Tea Estate, alt. 1300 m, Sinha 54A. *West Sikkim:* On way between Labdang-Pokharidanda, alt. 2000 m, Sinha 489. Soreng, alt. 1800-2000 m, P. Singh 70. Pemayangtse, alt. 2075 m, Sinha 172. Tashiding Monastery surroundings, alt. 1600 m, Sinha, 310. Karchi Reserve Forest, alt. 2100-2400 m, Sinha 400.

3. *Usnea bismolliuscula* Zahlbr., Cat. lich. univ. 6:542. 1930; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst.:451. 1936-38; G Awasthi, Journ. Hattori Bot. Lab. 61:366. 1986.

Thallus decumbent, ca. 7 cm long, grey green; branching sympodial; branches up to 1.5 mm diam., terete, tapering, articulate and inflated; lateral branchlets absent or sparse in upper part; surface smooth to foveolate; isidia more or less dense, white, filiform, occur in groups or on general surface leaving rough scars when detached; cortex palisade like; medulla arachnoid; axis solid, white. Sterile. Chemistry: Cortex K-; medulla K+ yellow to red, C-, KC-, P+ yellow; usnic acid and stictic acid complex present.

It sparsely grows on tree branches in open places at lower elevations.

Distribution: India (Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Tamil Nadu and West Bengal), Japan and Deutsche Neuguinea.

Specimen examined: *East Sikkim:* North Regu, near Chhuba village, alt. 1000-1300 m, Sinha 973.

4. *Usnea cineraria* Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst. 618. 1936-38; G Awasthi, Journ. Hattori Bot. Lab. 61: 367. 1986.

Thallus erect, 5-7 cm tall, rigid, pale- brown to dark brown; branching sympodial; branches divergent, 0.5-1.75 mm diam., slightly irregular in outline, flexuose; lateral branchlets dense towards apical region, \pm perpendicular, simple to branched, flexuose; surface dull, densely papillate; papillae concolorous to thallus, convex to elongated; cortex single layered, palisade like; medulla lax; central axis solid, white. Apothecia 2-7 mm diam.; disc caesiopruinose; margin ciliate; thalline exciple reticulately rugose and papillate; spores 10-13 x 6-8.5 μ m. Chemistry: Medulla K+ yellow-red; C-, KC-, P+ yellow; usnic, norstictic and salacinic acids present.

It sparsely grows on trees in open moist places.

Distribution: India (Arunachal Pradesh, Meghalaya and Sikkim).

Specimens examined: East Sikkim: Rechala surroundings, alt. 2700-2900 m, Sinha 1005. North Sikkim: Bey surroundings, alt. 1600 m, Sinha 579. Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 618. West Sikkim: Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 199.

5. **Usnea dendritica** Stirton, Scott. Nat. 6: 296. 1882; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst. :617. 1936 - 38; G. Awasthi, Journ. Hattori Bot. Lab. 61: 369. 1986.

Thallus erect, ca. 5 cm tall, greenish brown to blackish brown; branching sympodial; branches terete, 0.5-1.5 mm diam., tapering apically; lateral branchlets sparse in basal region, dense in apical region, sometimes appear like short spinules; surface dull, annularly cracked, papillate; papillae dense, prominent, concolorous with the thallus with paler tips; cortex pale, single layered, palisade like; medulla dense; central axis brownish, pigmented, solid. Apothecia terminal 2-5 mm diam.; margin densely ciliate; thalline exciple smooth, rarely ciliate; disc flat to concave, greyish, caesiopruinose; spores 12 x 8 μ m. Chemistry: Medulla K+ yellow-red, C-, KC-, P+ yellow; usnic, alectorialic and salacinic acids present.

It sparsely grows on trees in open moist places.

Distribution: India (Arunachal Pradesh, Meghalaya, Nagaland, Sikkim and West Bengal), Burma and Nepal.

Specimen examined: West Sikkim: Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 198.

6. **Usnea eumitrioides** Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst. 322. 1936 - 38; G. Awasthi, Journ. Hattori Bot. Lab. 61: 370. 1986.

Thallus erect, 5-7 cm tall, yellowish brown; branching sympodial; branchlets terete, slightly divergent, 0.2-1 mm diam., tapering apically; lateral branchlets dense in basal region, absent in apical part; surface smooth to minutely papillate; papillae sparse in basal region, concolorous with the thallus; pseudocypbellae

very small, effigurate, white, not raised; isidia white, filiform, dense, occurring singly or in groups in apical region, sparse to absent in basal region; cortex colourless to pale; medulla dense; central axis solid, pale ochraceous. Apothecia not seen. Chemistry: Medulla K+ yellow; C-, KC-, P-; usnic acid and stictic acid complex present.

It sparsely grows on trees at lower elevations.

Distribution: India (Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), China, Philippines and Taiwan.

Specimens examined: *East Sikkim:* Near Phadamchen, on Lingtam-Phadamchen road, alt. 1800 m, Sinha 877. *West Sikkim:* On way between Narkhola-Karchi village, alt. 2100-1850 m, Sinha 366.

7. *Usnea fragilis* Stirton, Scott. Nat. 6: 297, 1882; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst.:355, 1936-38; G. Awasthi, Journ. Hattori Bot. Lab. 61: 371, 1986.

Thallus erect to subpendulous, 7-10 cm long, usually fragile, greenish-grey to yellowish green; branching sympodial; branches terete, 0.5-1 mm diam., tapering apically, sometimes appearing blunt due to breaking of apical part; lateral branchlets sparse or dense; surface annularly cracked, fissured and rugose in basal part, rough, irregularly tuberculate and pseudocyphellate; pseudocyphellae apical, white, dense, raised, becoming soresiate, sometimes pseudo isidia develop from soresia; cortex colourless; medulla \pm dense, red pigmented; central axis solid, colourless. Apothecia absent in the specimens examined. Chemistry: Medulla K-, C-, KC-, P-; usnic and barbatic acids present.

It commonly grows on trees and rarely on rocks in open places in subtropical to temperate regions.

Distribution: India (Arunachal Pradesh, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal) and South-East Asian countries.

Specimen examined: *West Sikkim:* Soreng, alt. 1800-2000 m, P. Singh 71.

8. *Usnea glabrifera* Asah., J. Jap. Bot. 38:257, 1963; G. Awasthi, Journ. Hattori Bot. Lab. 61:372, 1986.

Thallus erect, 6-10 cm tall, brown to reddish brown; branching subsympodial; branches ca. 2 mm diam., simple, sometimes branched; surface minutely papillate; papillae soon becoming soresiate, then isidiate; isidia minute, white, dense, in addition rounded white soralia in terminal region of branches; medulla arachnoid; axis solid. Apothecia absent. Chemistry: Medulla K+ red, C-, KC-, P+ yellow-red; galbinic, norstictic, salacinic and usnic acids present.

Distribution: India (Meghalaya and Sikkim). Malaysia.

Specimens examined: *North Sikkim:* Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1047. Theu La to Jakthang way, alt. 4600-3400 m, Sinha 1726.

9. *Usnea himalayana* C. Bab., Hook. J. Bot. 4: 243. 1852; G. Awasthi, Journ. Hattori Bot. Lab. 61: 348. 1986. -*Usnea dichotoma* Fr., Syst. orb. 1: 282. 1825; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst. :130. 1936-38. -*Usnea flexilis* Stirton, Scott. Nat. 6: 106. 1881; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst. :126. 1936 - 38.

Thallus soft, pendulous, 10-20 cm long, pale green to greyish green; branching dichotomous, divergent; branches terete, articulate, inflated, 0.4-2 mm diam., tapering apically; lateral branchlets absent, surface annularly cracked, irregularly compressed and foveolate; pseudocyphellae white to yellowish, plane to slightly raised, orbicular to linear elongate or effigurate; cortex colourless, palisade like; medulla arachnoid; central axis solid, colourless. Apothecia absent. Chemistry: Medulla K+ yellow-red, C-, KC-, P+ yellow; central axis I-; usnic acid and stictic acid complex present.

It commonly grows on trees in open forest in subtropical-temperate region.

Distribution: India (Himachal Pradesh, Kerala, Manipur, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal); South East Asia and Africa.

Specimens examined: East Sikkim: Pangolakha scrub, alt. 2900 m, Sinha 934. Rechala surroundings, alt. 2700-2900 m, Sinha 1006. North Sikkim: Lachung, river side forest, alt. 2650 m, Sinha 1127. Tholong-Kissong foot track, 2475-2700 m, Sinha 612. South Sikkim: Damthang-Tendong 6 km foot track, alt. 2000-2650 m, Sinha 122. Namchi-Mamle route, alt. 1550-1750 m, Sinha 113. West Sikkim: Near Bakhim, alt. 2500-2700 m, Sinha 719.

10. *Usnea longissima* Ach., Lich. univ. :626 . 1810; Mot., Lich. Gen. *Usnea* Stud., Mongr. Pars Syst.: 423. 1936-38; G. Awasthi, Journ. Hattori Bot. Lab. 61: 357. 1986. (Fig. 60)

Thallus pendulous, up to 50 cm long, greyish green, sometimes intermittently black, attachment point not seen; branching filamentous; branches 0.3-0.7 mm diam., somewhat thickened to flattened at dichotomy, sometimes flattened and fasciculate for a short distance; cortex mostly evanescent in filamentous branches and surface represented by pulverulent to whitish powdery mass, rarely surface somewhat irregular, smooth and with cortex, lateral branchlets dense, perpendicular, flexuose, much variable in length and branching; cortex persistent, annularly cracked near the base, smooth and continuous upwards, sometimes densely verruculose, sorediate; soredia white, sometimes soredia delimited and slightly depressed; medulla dense; axis solid, I+ blue. Apothecia not seen. Chemistry: Medulla K+ yellowish, C-, KC-, P-; usnic and barbatic acids present.

G. Awasthi (1986) reported 7 strains from India out of which Stain II, IV and V occur in Sikkim. However, the present investigation shows the presence of strain II only. It abundantly grows on trees and shrubs in temperate-alpine regions of Sikkim.

Distribution: India (Arunachal Pradesh, Assam, Himachal Pradesh, Sikkim, Uttaranchal and West Bengal); widely distributed in temperate-alpine parts throughout the world.

Specimens examined: *East Sikkim:* Near Meimenchu Check Post, alt. 3700 m, Sinha 1406. Tamsey, alt. 3000-3500 m, P. Singh 680. *North Sikkim:* Chungthang, alt. 2450 m, Sastry 672. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1046. Thangu, along Teesta bank, alt. 3800 m, Sinha 1152. Thangu, Chepta valley, alt. 3900 m, Sinha 1646. Yumthang, along river side forest, alt. 3530 m, Sinha 1079. *West Sikkim:* Phedhang-Dzongri, 3 km foot track, alt 3900-4025 m, Sinha 248.

11. *Usnea montis-fuji* Mot., Lich. Gen *Usnea* Stud. Mongr. Pars Syst.: 420. 1936-38; G Awasthi, Journ. Hattori Bot. Lab. 61: 361. 1986.

Thallus pendulous, up to 60 cm long, greyish green, intermittently blackish in some, basal attachment not seen; branching filamentous; filamentous branches round to compressed at places, up to 1 mm diam., somewhat contorted, slightly tapering; cortex present, smooth, continuous to areolate; lateral branchlets dense, flexuose, annularly cracked in cortex; surface verruculose; verrucae minute, white, orbicular; medulla dense; axis solid, red-brown, 1+ light bluish turning vinose red. Apothecia not seen. Chemistry: Medulla K+ yellow, C-, KC-, P-; usnic and salacinic acids present.

It commonly grows on trees and shrubs in temperate regions of Sikkim in open moist places.

Distribution: India (Sikkim and West Bengal), China, Japan and Nepal.

Specimens examined: *East Sikkim:* Tamsey, P. Singh 681. *North Sikkim:* Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 612 A. *West Sikkim:* Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 188.

12. *Usnea nepalensis* Awasthi ex G Awasthi, Journ. Hattori Bot. Lab. 61: 376. 1986.

Thallus procumbent, ca. 8 cm long, brown black near base, yellow-brown apically; branching subsympodial; branchlets terete, up to 2 mm diam. near base, secondary branches ca. 1 mm diam., gradually tapering; lateral branchlets ± dense near basal region, sparse to absent towards apical region, surface cracked at places, verrucose-tuberculate; papillae dense, minute, concolorous with surface, sparse in younger branches; pseudocyphellae elevated on tubercles, white, rounded, sometimes effigurate, dense in young branches; isidia directly on cortex as well as on pseudocyphellae, in groups; medulla dense; axis solid, white I-. Apothecia absent in specimens examined. Chemistry: Cortex and medulla K-, C-, KC-, P-; usnic acid present.

The species sparsely grows on trees in temperate regions of Sikkim.

Distribution: India (Sikkim and Uttaranchal), Nepal.

Specimens examined: *North Sikkim:* Tingbong, near Kusum village, alt. 1400 m, Sinha 645. *West Sikkim:* Karchi Reserve Forest, 2000-2400 m, Sinha 405. On way between Narkhola-Karchi village, alt. 2000-2400 m, Sinha 403.

13. *Usnea norkettii* G Awasthi, Journ. Hattori Bot. Lab. 61:377. 1986.

Thallus erect to procumbent, 10-15 cm long, greyish brown to dark brown; branching isotomic dichotomous, later becoming sympodial; main branches articulated and inflated, up to 3 mm diam.; lateral branchlets sparse to dense, simple to branched, rather slender and uniform in size; surface sparsely and minutely papillate; papillae rounded or slightly elongated, concolorous to surface, becoming tuberculate and apically white pseudocypheolate; cortex double layered; medulla arachnoid; central axis solid, colourless, I-. Apothecia ca. 1 cm across, finally becoming terminal, geniculate; disc concave to plane, caesiopruinose; margin ciliate; thalline exciple smooth; spores 10-14 x 8-10 μ m. Chemistry: Medulla K+ yellow turning red, C-, KC-, P+ deep yellow; usnic, barbatic and salacinic acids present.

It sparsely grows on tree trunks in lower temperate areas.

Distribution: Nepal. It is a new record for India.

Specimen examined: *South Sikkim:* Damthang, Termi Tea Estate, Upreti & Chatterjee 01-26698, 01-26691/A (LWG).

14. *Usnea orientalis* Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst. :547. 1936-38; G Awasthi, Journ. Hattori Bot. Lab. 61: 377. 1986.

Thallus erect to decumbent, 4-8 cm long, greenish grey to yellowish, basal region dark grey to brownish; branching sympodial; branches terete, somewhat irregularly swollen, articulate, inflated, up to 2.5 mm diam., tapering apically; lateral branchlets dense throughout thallus; surface densely papillate; papillae minute, concolorous with the surface, sometimes with whitish tips; medulla arachnoid; central axis solid, colourless. Apothecia common, 2-8 mm diam.; margin ciliate; thalline exciple rugose, papillate, ciliate; disc flat at maturity, caesiopruinose; spores 10 x 7 μ m. Chemistry: Medulla K+ yellow to red, C-, KC-, P+ yellow; usnic and salacinic acids present.

It commonly grows on trees and boulders in open moist places in subtropical and temperate areas.

Distribution: India (Arunachal Pradesh, Manipur, Nagaland, Sikkim and Uttaranchal), Bhutan and Nepal.

Specimens examined: *East Sikkim:* On way between South Regu-Picrae forest, alt. 1900 m, Sinha 508. *North Sikkim:* Thangu, along Teesta bank, alt. 3800 m,

Sinha 1151. *South Sikkim*: On Damthang-Tendong 6 km foot track, alt. 2000-2650 m, Sinha 121. *West Sikkim*: Along down stream of Narkhola to Karchi, alt. 2000-1700 m, Sinha 418.

15. *Usnea pangiana* Stirton, Scott. Nat. 7: 77. 1883; Mot., Lich. Gen. *Usnea* Stud. Mongr. Pars Syst.: 350. 1936-38; G Awasthi, Journ. Hattori Bot. Lab. 61: 378. 1986.

Thallus pendulous, 10-15 cm long, pale yellow to grey brown; branching subsympodial; branchlets terete, running parallel to slightly divergent, 0.3-1 mm diam., tapering and flexuose apically; lateral branchlets sparse to dense; surface annularly cracked, minutely papillate to verruculose; pseudocyphellae white, irregular, sparse to dense, producing isidia; isidia white, filiform, usually borne on pseudocyphellae, sometimes occur on surface; cortex colourless to pigmented brown; medulla dense; central axis solid, colourless to pigmented brown. Apothecia not seen in the specimens examined. Chemistry: Medulla K+ yellow, C-, KC-, P+ yellow; usnic, barbatic, diffractic and salacinic acids present.

It commonly grows on trees in open places.

Distribution: India (Meghalaya, Nagaland, Sikkim, Uttaranchal and West Bengal). Distributed in Himalayan region only.

Specimens examined: *East Sikkim*: On way between Chhalongpong-Aritar, alt. 1500 m, Sinha 520. *South Sikkim*: Namchi-Old Damthang road, alt. 1700-2000 m, Sinha 23, 34. *West Sikkim*: Karchi Reserve Forest, alt. 2000-2400 m, Sinha 404. Soreng, P. Singh 68.

16. *Usnea pectinata* Taylor in Hook., Lond. J. Bot. 6:191. 1847; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst :422. 1936-38; G Awasthi, Journ. Hattori Bot. Lab. 61:361. 1986.

Thallus pendulous, 20-30 cm long, yellowish grey; branching filamentous; branches ca. 0.5 mm diam., terete, tapering; lateral branchlets dense, perpendicular, straight to flexuose, simple to dichotomously branched; surface smooth to annularly cracked, areolate; cortex sometimes evanescent; attachment point of branches and branchlets characteristically cracked; cortex colourless; medulla dense; central axis solid, I-. Apothecia not seen. Chemistry: Medulla K+ yellow to red, C-, KC-, P+ yellow; usnic acid and stictic acid complex present.

It sparsely grows on tree trunks in subtropical areas.

Distribution: India (Arunachal Pradesh, Nagaland, Manipur and Sikkim) and eastwards up to Thailand.

Specimen examined: *East Sikkim*: Tumin, Upreti & Chatterjee 01-26603 (LWG).

17. *Usnea pseudosinensis* Asah. in Hara, Fl. Eastern Himalaya, Lichenes :600. 1966; G Awasthi, Journ. Hattori Bot. Lab. 61:381. 1986.

Thallus erect, *ca.* 10 cm tall, yellow brown to brown, initial branching sympodial, main branches irregularly inflated and articulate, up to 3 mm diam., tapering, sometimes cortex annularly cracked; lateral branchlets dense, surface densely papillate; papillae round to irregular in outline, concolorous to thallus or darker; pseudocyphellae absent, but lateral branchlet gets cracked and appear pseudocyphellate; medulla arachnoid; axis solid. Apothecia up to 1.5 cm diam.; margin ciliate; thalline exciple smooth to papillate, often ciliate; disc caesiopruinose; spores 10-14 x 6-8 μ m. Chemistry: Medulla K-, C-, KC-, P- or P+ yellowish; barbatic, psoromic and usnic acids present.

Distribution: India (Sikkim and West Bengal) and Nepal.

Earlier record: Asahina (1966).

18. *Usnea robusta* Stirton., Scott. Nat. 6: 295. 1882; Mot., Lich. Gen *Usnea* Stud. Mongr., Pars. Syst.: 615. 1936-38. G. Awasthi, Journ. Hattori Bot. Lab. 61: 381. 1986.

Thallus erect to suberect, *ca.* 10 cm tall, dark brown to brown black; branching sympodial; branches terete, divergent, up to 2 mm diam., slightly tapering, lateral branchlets dense; surface sometimes annularly cracked in main branches; papillae dense, concolorous to cortex; pseudocyphellae white, punctate to elongate, sometimes effigurate, plane to slightly raised; cortex double layered, outer layer palisade - like; medulla dense; axis solid. Apothecia up to 1.5 cm diam.; margin ciliate; thalline exciple smooth to papillate; disc caesiopruinose; spores 10-12 x 8-10 μ m. Chemistry: Medulla K+ yellow to red, C-, KC-, P-; barbatic, salacinic and usnic acids present.

It commonly grows on tree trunks in temperate and lower alpine areas.

Distribution: India (Sikkim and West Bengal) and Nepal.

Specimens examined: East Sikkim: Between Premlakha-Tenjabir forest, alt. 2000 m, Sinha 905, 906. Rechala surroundings, alt. 2700-2900 m, Sinha 1004. West sikkim: Tashiding Monastery surroundings, alt. 1600-1700 m, Sinha 152.

19. *Usnea rubicunda* Stirton, Scott. Nat. 6: 102. 1881; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pras Syst. :339. 1936 - 38. G. Awasthi, Journ. Hattori Bot. Lab. 61. 382. 1986.

Thallus erect to procumbent, 4-8 cm long, reddish brown near base, yellowish brown upwards; branching subsympodial; branches terete, up to 1.5 mm diam., tapering apically, apices dichotomously divided; lateral branchlets sparse; surface annularly cracked in basal region; pseudocyphellae dense, white to pale, producing isidia; isidia white to pale greenish, develop on pseudocyphellae and on branchlets, occur in groups; cortex pigmented red; medulla dense; central axis solid, brownish. Apothecia not seen. Chemistry: Medulla K+ yellow, C-, KC-, P+yellow; usnic acid and stictic acid complex present.

It commonly grows on trees and on rocks in open places.

Distribution: India (Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Nepal, Australia and England.

Specimens examined: *North Sikkim:* Near Lachung, on road side, alt. 2500 m, Sinha 1024. *West Sikkim:* Karchi Reserve Forest, alt. 2000-2400 m, Sinha 401.

20. *Usnea sordida* Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst. :69. 1936-38; G Awasthi, Journ. Hattori. Bot. Lab. 61: 384. 1986.

Thallus erect to procumbent, ca. 7 cm long, pale greyish; branching sympodial; branches articulate, inflated, up to 2 mm diam., tapering apically; lateral branchlets sparse; surface waxy in appearance, annularly cracked; papillae concolorous with the thallus; pseudocyphellae white, raised, rounded to oblong; medulla lax; central axis solid, white. Apothecia not seen. Chemistry: Medulla K+ yellow, C-, KC-, P-; usnic and salacinic acids present.

It commonly grows on trees in temperate-alpine regions in open places.

Distribution: India (North Western Himalaya, Sikkim and West Bengal). Himalaya.

Specimens examined: *West Sikkim:* Karchi Reserve forest, alt. 2000-2400 m, Sinha 402. Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 247. Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 197.

21. *Usnea splendens* Stirton, Scott. Nat. 6: 296. 1882; Mot. Lich. Gen. *Usnea* Stud. Mongr. Pars Syst.: 615. 1936-38; G Awasthi, Journ. Hattori Bot. Lab. 61: 385. 1986.

Thallus erect, 5-9 cm tall, greyish brown to brown black; branching dichotomous to sympodial; branches up to 2 mm diam., tapering, cortex annularly cracked at intervals; lateral branchlets dense; surface densely papillate; papillae minute, convex, concolorous with branches; pseudocyphellae white, minute, rounded, scattered; medulla arachnoid; central axis solid. Apothecia common, 3-6 mm diam.; margin ciliate; thalline exciple slightly rugose at maturity, ciliate; spores 9-12 x 8-10 μ m. Chemistry: Medulla K+ yellow, C-, KC-, P-; usnic and salacinic acids present.

The taxon grows commonly on trees and boulders in open moist places in temperate to alpine regions.

Distribution: India (Arunachal Pradesh, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Nepal.

Specimens examined: *East Sikkim:* Tamsey, alt. 3000-3500 m, P. Singh 678. *West Sikkim:* Along down stream of Narkhola-Karchi, alt. 2000-1700 m, Sinha 419. Karchi Reserve forest, alt. 2000-2400 m, Sinha 399. Tsoka-Phedang foot track, alt. 3050-3900 m, Sinha 222. Yoksum-Tsoka foot track, alt. 1800-3050 m. Sinha 196.

22. *Usnea subfloridiana* Stirton, Scott. Nat. 6:294. 1882; G Awasthi, Journ. Hattori Bot. Lab. 61:387. 1986.

Thallus ± erect, 4.5-6 cm tall, greyish, basal part blackish; branching subsympodial to sympodial; branches up to 1.5 mm diam.; lateral branchlets ± uniform in size, simple to branched, divergent in lower part, convergent in apical region; surface papillate; papillae minute, numerous, concolorous to thallus, sorediate and isidiate; soralia excavate, round to oblong; isidia often developing on soralia as well as directly on cortex, leaving white scars when detached; medulla arachnoid; axis solid. Sterile. Chemistry: Cortex K-; medulla K+ reddish, C-, KC-, P+ yellowish; usnic and salacinic acids present.

It sparsely grows on ground in alpine areas.

Distribution: India (Himachal Pradesh, Jammu & Kashmir and Uttaranchal); Europe.

Specimen examined: East Sikkim: Kupup, around Bethang lake, alt. 4100 m, Sinha 1444.

23. *Usnea subsordida* Stirton, Procd. Phil. Soc. Glasgow 11:310. 1879; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst.:532. 1936-38; G Awasthi, Journ. Hattori Bot. Lab. 61:389. 1986.

Thallus ± erect, 5-10 cm tall, greyish in major part, brownish black near base; branching sympodial; branches ca. 2 mm diam., articulate and inflated, tapering; lateral branchlets sparse to dense of unequal sizes; surface dull, matt, densely papillate, sparsely pseudocyphellate; pseudocyphellae white, point like or elongate, raised; cortex double layered, outer palisade like, inner prosoplectenchymatous; medulla arachnoid; axis solid, white. Apothecia up to 8 mm diam.; margin ciliate; thalline exciple smooth; disc caesiopruinose; spores 10-12 x 6(-8) µm. Chemistry: Cortex K-; medulla K+ reddish, C-, KC-, P-; salacinic and usnic acids present.

It sparsely grows on trees as well as on boulders in temperate areas.

Distribution: India (Himachal Pradesh, Nagaland, Tamil Nadu, Uttaranchal and West Bengal) and Nepal.

Specimens examined: East Sikkim: Pangolakha scrub, alt. 2900 m, Sinha 935. North Sikkim: Zema -I, alt. 2750 m, Sinha 1522.

24. *Usnea thomsonii* Stirton, Scott. Nat. 6:107. 1881; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst. :615. 1936-38; G Awasthi, Journ. Hattori Bot. Lab. 61:390. 1986.

Thallus erect, 5-10 cm tall, greyish brown; basal disc blackish; branching sympodial, main branches up to 3 mm diam., slightly tapering, stiff, divergent, sometimes appearing articulate and inflated; lateral branchlets moderate to dense,

apices often blackish; surface smooth, sometimes annularly cracked, densely papillate; papillae concolorous with surface, rounded to slightly raised and elongate; pseudocyphellae white, elongate and raised; cortex double layered, outer layer palisade like, inner layer prosoplectenchymatous; medulla dense; central axis solid, colourless. Apothecia terminal, 6-10 mm diam.; thalline exciple smooth; spores 12-16 x 10-12 μm . Chemistry: Medulla K-, C-, KC-, P-; alectorialic and usnic acids present.

Distribution: India (Arunachal Pradesh, Nagaland, Sikkim, Uttaranchal and West Bengal) and Nepal.

Specimen examined: East Sikkim: Pangolakha scrub, alt. 2900 m, Sinha 933.

25. *Usnea undulata* Stirton, Scott. Nat. 6: 104. 1881; Mot., Lich. Gen. *Usnea* Stud. Monogr. Pars Syst. :517. 1936-38; G. Awasthi, Journ. Hattori Bot. Lab. 61: 391. 1986.

Thallus erect to pendulous *ca.* 9 cm long, greyish brown, basal region blackish; branching sympodial to sybsympodial; branches terete, slightly divergent, up to 1.5 mm diam., tapering apically; lateral branchlets dense; surface pseudocyphellate; pseudocyphellae white; isidia concolorous with the surface, filiform, intermixed with lateral branchlets; cortex single layered; medulla dense; central axis solid, colourless. Apothecia not seen. Chemistry: Medulla K+ yellow to red, C-, KC-, P-; usnic and salacinic acids present.

It commonly grows on trees in open places in subtropical regions.

Distribution: India (Karnataka, Kerala, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal); South & East Africa.

Specimens examined: North Sikkim: Nampruk village, along river side, alt. 1200 m, Sinha 653. South Sikkim: Temi Tea Estate, alt. 1300 m, Sinha 54. West Sikkim: Labdang forest, alt. 1900-2000 m, Sinha 472. Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 246. Soreng, alt. 1800-2000 m, P. Singh 69.

35. *Vulpicidia* Mattson & M.J. Lai

Thallus foliose to subfruticose, yellowish brown, corticolous or terricolous, lobate; lobe margin undulate, lacking cilia; upper surface lacking pseudocyphellae; upper cortex paraplectenchymatous with non pored epicortex; lower surface rhizinate. Apothecia submarginal or laminal, eperforate; asci 8-spored; spores globose to subspherical, 6-9 x 4-6 μm . Pycnidia marginal or laminal, on projections; conidia sublageniform or fusiform, 7 x 1 μm . Usnic acid alongwith pinastric and vulpinic acids present.

A genus of 6 species segregated from *Cetraria*, occurs in the arctic, boreal and temperate regions of northern hemisphere; 1 species in India as well as in Sikkim.

Vulpicidia pinastri (Scop.) Mattson & M. J. Lai, Mycotaxon 46: 425-428. 1993. - *Lichen pinastri* Scop., Fl. Carniol., ed.2, 2:382. 1772. - *Cetraria pinastri* (Scop.) S. Gray, Nat. Arra. Br. Pl. 1: 432. 1821; Awasthi, Bull. Bot. Surv. India 24(1-4):14. 1982.

Thallus foliose, loosely appressed to the substratum, pale yellow to yellow grey, 1-2 cm across; lobes narrow, imbricate, 1-4 mm wide; margin undulate; upper surface smooth, with marginal yellow soralia, occasionally spreading to submarginal parts; soredia farinose, yellow; medulla yellow; lower surface greyish to brownish, lamellose rugose with dark brown, 1-1.2 mm long rhizines. Apothecia numerous, marginal to submarginal, 1-3(-4) mm diam.; margin weakly crenulate, sorediate; disc concave, dark brown, shiny; spores 10-12 x 8 μm . Chemistry: Cortex and medulla K-, C-, KC-, P-; usnic, vulpinic and pinastric acids present.

Only sterile specimens were reported from India (Awasthi, 1982), however, during the present investigations the lone specimen collected is fertile and it has slightly larger spores. The other taxon *V. juniperina* (L.) Mattson & M. J. Lai, known from adjacent China resembles the present species in having numerous apothecia but the former lacks soredia and has abundant black, stalked pycnidia. It sparsely grows on twigs of small *Betula* shrubs at 4000 m altitude in moist place.

Distribution: India (Uttaranchal), China, Japan, Russia; Europe, North America.

Specimen examined: East Sikkim: Kupup, north border side, 4000 m, Sinha 1498. North Sikkim: Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1632.

36. *Xanthoparmelia* (Vainio) Hale

Thallus foliose, very tightly to loosely adnate, saxicolous or free growing on soil, 1-20 cm across, yellowish green; lobes subirregular to sublinear or linear, 0.1-10 mm wide, plane or convoluted, irregularly to dichotomously branched, margin sometimes black rimmed, separate to imbricate; upper surface continuous and emaculate, white maculate, or effigurate maculate, smooth to transversely cracked and rugose with age; medulla white or partly or wholly pigmented; lower surface plane or canaliculate, pale brown to black, sparsely to densely rhizinate; rarely erhizinate; rhizines simple to sparingly branched, 0.1-2 mm long. Apothecia adnate to substipitate, 1-20 mm diam.; disc usually plane, eperforate, brown; asci 8-spored; spores simple, ellipsoid, colourless, 6-13 x 4-8 μm . Pycnidia immersed; conidia bifusiform, 4-8 μm long, rarely cylindrical, 5-14 μm long. Usnic acid always present in upper cortex.

A genus of about 500 species with centre of speciation in South Africa and Australia; 13 species in India and 3 in Sikkim.

Key to the species

- 1a. Thallus isidiate; norstictic and salacinic acids present 2
 1b. Thallus lacking isidia; salacinic acid present 2. **X. somloensis**
 2a. Thallus loosely adnate; lobes 2-4 mm wide, subirregular;
 isidia not dark tipped 3. **X. tinctina**
 2b. Thallus closely adnate; lobes 0.5-1.5 mm wide, sublinear;
 isidia dark tipped 1. **X. antleriformis**

1. Xanthoparmelia antleriformis (Elix) Elix, & Johnston in Elix, Johnston & Armstrong, Bull. Brit. Mus. (Nat. Hist.) Bot., ser. 15:194. 1986; Hale, Smithson. Contr. Bot. 74:70. 1990; Divakar & Upreti, Nova Hedwigia 75:509. 2002. -*Parmelia antleriformis* Elix, Aust. J. Bot. 29:349. 1981.

Thallus closely adnate, yellowish green, blackening in part, 3-5 cm across; lobes sublinear, 0.3-1.5 mm wide, contiguous to imbricate, apices subrotund, black rimmed; upper surface continuous, emaculate, shiny near periphery; isidia dense, subglobose to cylindrical, up to 1 mm high, tips blackening, becoming densely coralloid branched with age; medulla white; lower surface pale brown, darker towards tips, sparsely rhizinate; rhizines pale brown, simple, ca. 0.5 mm long. Apothecia and pycnidia not seen. Chemistry: Cortex K-; medulla K+ yellow-red, C-, KC-, P+ orange; salacinic, consalacinic, usnic acids and norstictic acid (in trace) present.

It sparsely grows on boulders in dry alpine area of North Sikkim.

Distribution: India (Sikkim), Australia, Argentina and South Africa.

Specimen examined: North Sikkim: Midway between Thangu-Lashar, alt. 4300 m, Sinha 1169.

2. Xanthoparmelia somloensis (Gyelnik) Hale in Ahti, Brodo & Noble, Mycotaxon 28:96. 1987; Divakar & Upreti, Nova Hedwigia 75:518. 2002. - *Parmelia somloensis* Gyelnik, Feddes Repert. Spec. Nov. Reg. Veg. 29: 156. 1931.

(Fig. 61)

Thallus ± loosely attached, usually cushion forming, yellow to yellowish grey, 5-8(-10) cm across; lobes sublinear, subdichotomously branched, ± contiguous, 1.5-2(-3) mm wide, margin subrotund, brown tinged, with numerous dichotomously branched secondary lobules developing from centre; upper surface smooth, plane to convex, shiny, emaculate; lower surface pale brown in central part, dark brown to tan near periphery, pale to rugose, canaliculate in secondary lobules; rhizines pale brown, up to the margin, simple to rarely furcated, 0.5-1 mm long. Apothecia and pycnidia not seen. Chemistry: Cortex K + yellowish; medulla K+ yellow turning red, C-, KC-, P + orange-red; consalacinic, salacinic and usnic acids present.

It sparsely grows on exposed boulders in dry alpine area of Llonakh valley.

Distribution: India (Himachal Pradesh, Jammu & Kashmir and Uttaranchal) China, Japan, Korea, Mongolia, Pakistan; Europe, North America.

Specimens examined: North Sikkim: Llonakh valley, Muguthang, alt. 4500 m, Sinha 1662, 1667.

3. *Xanthoparmelia tinctina* (Maheu & Gillet) Hale, *Phytologia* 28:489, 1974; Divakar & Upreti, *Nova Hedwigia* 75:520, 2002. -*Parmelia tinctina* Maheu & Gillet, *Bull. Soc. Bot. Fr.* 72:860, 1925; Awasthi, *Indian J. Forestry* 4(3):199, 1981.

(Fig. 62)

Thallus loosely adnate, dull yellowish green, 5-8 cm across; lobes subirregular, 2-4 mm wide, contiguous to imbricate, subapically rotund, subascending at margin; upper surface continuous, emaculate, dull in centre, shiny near periphery; isidia laminal, moderate to dense, globular to cylindrical to somewhat coralloid branched, pale tipped; medulla white; lower surface plane, black with a brown zone at the tips, moderately rhizinate; rhizines brown to black, simple, coarse, ca. 0.5 mm long. Apothecia and pycnidia not seen. Chemistry: Thallus K + yellowish; medulla K + red, C-, KC-, P + orange; consalacinic, salacinic and usnic acids present.

The species sparsely grows on exposed boulders in dry alpine area of Llonakh valley.

Distribution: India (Himachal Pradesh and Uttaranchal), Algeria, Bulgaria, France, Greece, Hungary, Italy, Morocco, Pakistan, Portugal, Rumania, Spain, Sweden, U.S.S.R., Yugoslavia.

Specimens examined: North Sikkim: Llonakh valley, Muguthang, alt. 4500 m, Sinha 1557, 1663.

RAMALINACEAE

Ramalina Ach.

Thallus fruticose, erect to pendent from a restricted or spreading holdfast, heteromerous, stramineous to pale grey green; branching dichotomous, subdichotomous or irregular; branches markedly compressed, canaliculate, broadly channelled or strap-shaped, often subterete and hooked apically; upper and lower surfaces distinct or indistinct, usually longitudinally ridged, occasionally with fenestrations; pseudocyphellae common, linear elongate or punctiform; soralia frequent, often developing from pseudocyphellae; cortex uneven, prosoplectenchymatous; chondroid tissue uneven; photobiont green, trebouxoid; medulla rarely dense and opaque, usually laxly arachnoid, sometimes completely absent when the branches are hollow. Apothecia lecanorine, sometimes spurred; asci 8-spored; spores colourless, 1-septate, broadly ellipsoid or kidney-shaped; paraphyses simple. Pycnidia present or absent; conidia bacilliform, colourless.

About 200 species known from temperate and subtropical regions of the world; 24 species from India and 7 species from Sikkim.

Key to the species

- 1a. Thallus hollow in medulla 2
 1b. Thallus solid, not hollow in medulla 3
 2a. Medulla hollow throughout the thallus; soredia
 absent; evernic acid present 3. **R. himalayensis**
 2b. Medulla hollow only in parts; soredia present; sekikaic
 acid aggregate present 4. **R. roesleri**
 3a. Branches palmate -lobed, sword -shaped 6. **R. sinensis**
 3b. Branches narrow - flattened, strap -shaped 4
 4a. Pseudocyphellae raised on tubercles 1. **R. africana**
 4b. Pseudocyphellae not raised on tubercles 5
 5a. Thallus sorediate, sterile 6
 5b. Thallus lacking soredia, fertile 2. **R. conduplicans**
 6a. Soredia dense, only usnic acid present 7. **R. taitensis**
 6b. Soredia sparse; usnic acid with sekikaic and
 homosekikaic acids present 5. **R. shinanoana**

1. **Ramalina africana** (Stein) Dodge, Nova Hedwigia 38: 56. 1971. -*Ramalina rigida* (Pers.) Ach. var. *africana* Stein, Jahresber Schles. Gesell. Vaterl. Cultur. 66:137. 1888.

Thallus ± erect, stramineous or greenish grey, ca. 4.5 cm tall, densely branched with short secondary branchlets; branches solid, up to 2.5 mm wide, bilateral, flat or canaliculate; surface ± rugose and ridged; pseudocyphellae usually abundant on lower surface, rarely on upper surface, laminal to marginal, punctiform, raised on tubercles; soralia absent. Apothecia common, marginal or lateral, spurred, 1.5-3.5 mm diam.; thalline exciple wrinkled, usually pseudocyphellate; margin entire; spores 12-14 x 5-7 µm. Chemistry: Cortex and medulla K-, C-, KC-, P-; homosekikaic, sekikaic and usnic acids present.

It commonly grows on trees and shrubs in open places.

Distribution: India (Nagaland, Manipur and Tamil Nadu), East Africa.

Specimens examined: *East Sikkim:* On way between South Regu and Picrae forest, alt. 1900 m, Sinha 507. Thegu, alt. 3700 m, Sinha 1387. *North Sikkim:* Zema -I, alt. 2750 m, Sinha 1525 (det. H. Kashiwadani). *West Sikkim:* Near Bakhim, alt. 2500-2700 m, Sinha 726. Yoksum, near Old Gumpa, alt. 1900 m, Sinha 700, 701.

2. **Ramalina conduplicans** Vainio, Annal. Soc. Zool. Bot. Fenn. 1(3): 35. 1921; Zahlbr., Cat. lich. univ. 6:453. 1930; Kashiwadani, Bull. Nat. Mus., ser. B, 12:92-93. 1986; G. Pant & Awasthi, Indian J. Forestry 26(3):303. 2003. – *Ramalina farinacea* (L.) Ach. subsp. *subcomplanata* Nyl., Bull. Soc. Linn. Normandie, ser. 2, 4:134. 1870.

Thallus subpendulous, stramineous grey, 5-7 cm long; branches 0.3-1.4 mm wide, irregularly branched; lateral branchlets moderate, tapering; surfaces separable in to upper and lower; upper surface ± smooth, laminally to submarginally pseudocyphellate; lower surface channelled, lacking pseudocyphellae, lighter than upper surface; pseudocyphellae usually ellipsoid, not elevated on tubercles; soredia absent; medulla arachnoid. Apothecia lateral, up to 1.2 mm diam.; disc plane to convex, brownish, pruinose; spores 14-18 x 4.5-6.5 µm. Chemistry: Medulla K-, C-, KC-, P-; homosekikaic, sekikaic and usnic acids present.

It commonly grows on trees in subtropical regions.

Distribution: India (temperate himalaya, Arunachal Pradesh, Himachal Pradesh and Uttaranchal), China, Bhutan, Japan, Nepal.

Specimens examined: *East Sikkim:* Between Premlakha-Tenjabir foot track, alt. 2000 m, Sinha 907. Singhanebans village surroundings, alt. 2200 m, Sinha 954. South Regu, Talkharka, alt. 1800 m, Sinha 974 (det. H. Kashiwadani). *North Sikkim:* Bey surroundings, alt. 1600 m, Sinha 580. Lachen, along road side, alt. 2710 m, Sinha 1138. Pentong village surroundings, alt. 1700 m, Sinha 635. *South Sikkim:* Namchi-Mamle route, alt. 1550-1750 m, Sinha 109. Namchi-Old Damthang road, alt. 1700-2000 m, Sinha 36. *West Sikkim:* On way between Labdang-Pokharidanda, alt. 2000 m, Sinha 490. On way between Narkhola-Karchi village, alt. 2100-1850 m, Sinha 361. Tashiding Monastery surroundings, alt. 1600-1700 m, Sinha 151. Sombaria Forest Rest House compound, alt. 1700 m, Sinha 1287, 1288. Soreng, alt. 1800-2000 m, P. Singh 73 B. Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1322.

3. **Ramalina himalayensis** Räsänen, Arch. Soc. Zool. Bot. Fenn. 'Vanamo' 5(1):26. 1950; G. Pant & Awasthi, Indian J. Forestry 26(3):306. 2003.

Thallus erect, yellow to brownish yellow, 1-1.5 cm tall; branching irregular; branches cylindrical to subcylindrical, compact, inflated, imperforate, 1-1.5 mm diam., pseudocyphellate; branchlets digitate; chondroid tissue thin, cracked; medulla yellowish, hollow. Apothecia scattered, lateral to terminal, 1-3 mm diam.; disc convex, caesiopruinose; spores 10-13(-16) x 3-6 µm. Chemistry: Cortex and medulla K-, C-, KC-, P-; evernic acid present.

The species is reported to grow on rocks in temperate and alpine areas.

Distribution: India (Sikkim, Uttaranchal, West Bengal hills). Endemic in the Himalayas.

Earlier record: Sikkim: Migothang (Asahina, 1966).

4. *Ramalina roesleri* (Hochst. ex Schaerer) Hue, Rev. Bot. 6:151. 1887; G. Pant & Awasthi, Indian J. Forestry 26(3):310. 2003. -*R. farinacea* var. *roesleri* Hochst. ex Schaerer, Enum. Critic. Lich. Eur.:9.1850.

Thallus fruticose, erect to subpendulous, loosely tufted, yellowish green, often with reddish tinge, up to 5 cm long; branching subdichotomous; branches flat, 0.5-1.5 mm wide, inseparable in to upper and lower surfaces; branchlets dense, often repeatedly branched with finely divided apices ending into hooked terete branchlets; surfaces \pm shining, striated, sparsely fenestrated, sorediate; soralia terminal to subterminal, punctiform to rounded; medulla hollow in parts. Sterile. Chemistry: Medulla K-, C-, KC-, P-; sekikaic acid aggregate present.

It commonly grows on trees as well as on boulders in moist places.

Distribution: India (Himachal Pradesh, Nagaland and South Indian hills), Japan, Finland and Sweden.

Specimens examined: East Sikkim: Near Meimenchu Memorial Check Post, alt. 3700 m, Sinha 1404. North Sikkim: Tholung-Kissong 5 km foot track, alt. 2475-2700 m, Sinha 619. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1051. West Sikkim: Between Tsoka-Dzongri foot track, alt. 3500-4000 m, Sinha 747.

5. *Ramalina shinanoana* Kashiwadani, Bull. Nat. Sci. Mus. Tokyo, ser. B, 12(4):12. 1986; Sinha, Bull. Bot. Surv. India 45(1-4):222. 2003. (Fig. 63)

Thallus \pm erect to subpendulous, yellowish grey, 3-4 cm long, shrubby branches growing from a narrow holdfast; branches solid, dichotomous to irregularly branched, with finely dissected branchlets ending in nodules; nodules 0.8-1 mm wide; surface smooth with rare ellipsoid pseudocypheae which often turn into soralia; soredia laminal to subterminal; medulla loose. Apothecia not seen. Chemistry: Medulla K-, C-, KC-, P-; homosekikaic, sekikaic, 4-o-methylnorhomosekikaic and usnic acids present.

It commonly grows on tree trunks in subtropical to temperate areas.

Distribution : India (Sikkim), China, Japan.

Specimens examined: East Sikkim: Rechala surroundings, alt. 2700-2900 m, Sinha 1009. North Sikkim: Near Lachung, on road side, alt. 2500 m, Sinha 1027. Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1640. Tingbong, near Kusum village, alt. 1400 m, Sinha 638. South Sikkim: Namchi-Damthang road, at 2 km point, alt. 1800 m, Sinha 25, 26. West Sikkim: On way between Labdang-Pokharidanda, alt. 2000 m, Sinha 491 (det. H. Kashiwadani). Along downstream

of Narkhola-Karchi forest, alt. 2000-1700 m, Sinha 417. Pelling, alt. 2300 m, P. Singh 84. Soreng, alt. 1800-2000 m, P. Singh 66.

6. **Ramalina sinensis** Jatta, *Nouv. Giorn. Bot. Ital.* 9:462. 1902; G. Pant & Awasthi, *Indian J. Forestry* 26(3):311, 2003. (Fig. 64)

Thallus erect to subpendulous, firmly attached, pale grey to greenish grey, 5-7 cm long; branching lateral; main branches flattened, strap-shaped to palmate, with variable width; secondary branches lateral, elongate to multifid as extension of margins; upper surface uneven, longitudinally and partly reticulately wrinkled, foveolate, fenestrated; lower surface paler than upper surface, with longitudinal ridges, ecorticate between ridges; medulla loose. Apothecia lateral, terminal to subterminal, rarely laminal, 2-4 mm diam.; margin entire, usually undulate at maturity; thalline exciple wrinkled; disc concave to flat, greyish to brownish, pruinose; spores 10-12 x 5-6 μm . Chemistry: Medulla K-, C-, KC-, P-; usnic acid present.

It commonly grows on upper portion of trees in dense moist forest in subtropical and temperate region.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Nagaland and Uttaranchal), China, Japan, Nepal, Pakistan and in Fennoscandia region

Specimens examined: East Sikkim: Rechala surroundings, alt. 2700-2900 m, Sinha 1010. North Sikkim: Lachung, river side forest, alt. 2650 m, Sinha 1126.

7. **Ramalina taitensis** Nyl., *Bull. Soc. Linn. Normandie*, ser.2, 4:21. 1870; G. Pant & Awasthi, *Indian J. Forestry* 26(3):314, 2003.

Thallus loosely tufted, pale grey, 3-5 cm long; branches 0.5-1 mm wide with numerous apically tapering branchlets; surface \pm smooth, inseparable in to upper and lower, flat to canaliculate; pseudocyphellae submarginal, punctiform, later becomes sorediate; soralia rounded to irregular; soredia \pm granular; chondroid tissue cracked; medulla loose, not hollow. Apothecia not seen. Chemistry: Medulla K-, C-, KC-, P-; usnic acid present.

It commonly grows on boulders in moist and shady places in lower temperate areas.

Distribution: India (West Bengal), French Polynesia.

Specimens examined: North Sikkim: Lachen, Gumpa side forest, alt. 2700 m, Sinha 1552 West Sikkim: Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1321.



Fig. 62. *Xanthoparmelia tinctina*. **Fig. 63.** *Ramalina shinanoana*. **Fig. 64.** *R. sinensis*. **Fig. 65.** *Heterodermia boryi*.



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Fig. 66. *Heterodermia chondroidea*. **Fig. 67.** *H. dactyliza*. **Fig. 68.** *H. diademata*. **Fig. 69.** *H. dissecta*.

PHYSICIACEAE

1. *Dirinaria* (Tuck.) Clem.

Thallus foliose, dorsiventral, heteromerous, \pm closely adpressed to the substratum; lobes adglutinated and confluent centrally, slightly disjunct and truncate at periphery, apices confluent and flabellate; upper surface plane to concave, centripetally plicate rugose; thallus corticated on both sides; upper cortex paraplectenchymatous; photobiont green, *Trebouxia*; medulla colourless to pale; lower cortex brownish, prosoplectenchymatous; rhizines lacking or small black precursors of rhizines sparsely present. Apothecia lecanorine, sessile to constricted at base without retrorse hairs; epitheium K-; hymenium I+ blue; asci 8-spored; spores brown to dark brown, ellipsoid, transversely 2-celled, thick walled, Physcia type; paraphyses sparingly branched in the tip region. Atroronin always present.

About 26 species known from tropical and subtropical regions of the world; 6 species in India and 4 in Sikkim.

Key to the species

- 1a. Thallus isidiate and or sorediate; apothecia not seen ... 2
- 1b. Thallus lacking isidia and soredia; fertile 3. **D. confluens**
- 2a. Thallus distinctly sorediate, isidia lacking 3
- 2b. Thallus first simple to coralloid branched isidiate, eventually becoming crateriform sorediate 1. **D. aegialita**
- 3a. Divaricatic acid present; lobe apices flabellate 2. **D. applanata**
- 3b. Divaricatic acid absent; lobe apices not flabellate 4. **D. consimilis**

1. ***Dirinaria aegialita*** (Afz.) Moore, Bryologist 71:248. 1968; Awasthi, Bibliotheca Lichenol. 2:64. 1975. -*Parmelia aegialita* Afz. in Ach., Meth. Lich. :191. 1803. -*Physcia aegialita* Nyl., Ann. Sci. Nat. Bot., ser. 4, 15:43. 1861.

Thallus glaucous white to glaucous grey, adpressed, growing in suborbicular patches, 5-8 cm across; lobes radiating, subdichotomously divided or irregularly multifid, 0.5-1.5 mm wide, rounded to retuse or flabellate at apices, apices \pm ascending, discrete at periphery, centripetally confluent and eventually subcrustaceous verrucose in central part; upper surface epruinose or rarely pruinose at the apices; isidia first develop as minute protuberances which often become coralloid branched, ultimately turn in to crateriform structure and sorediate; soredia coarse, granular; lower surface black, lacking rhizines. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranorin and divaricatic acid present.

It sparsely grows on tree trunks in open places in subtropical areas.

Distribution: India (Sikkim and Tamil Nadu); distributed widely in pantropical parts (mostly oceanic) of Asia, Africa, S. America and Pacific regions.

Specimen examined: South Sikkim: Namchi-Jorethang road, Upreti & Chatterjee 01-219554/B (LWG).

2. *Dirinaria applanata* (Fée) Awasthi in Awasthi & Agarwal, J. Indian Bot. Soc. 49:135. 1970; Awasthi, Bibliotheca Lichenol. 2:78. 1975. -*Parmelia applanata* Fée, Essai Crypt. : 126. tab. 32, fig. 2. 1824. -*Physcia applanata* Zahlbr., Cat. lich. univ. 7:581. 1931.

Thallus glaucous grey, 3-5 cm across in suborbicular or orbicular patches, almost adglutinated; lobes irregularly divided, 0.7-1.2 mm wide, contiguous, with rounded flabellate apices, usually confluent from the peripheral region and centripetally longitudinally plicate-rugose to subcrustaceous; upper surface densely pruinose towards peripheral region; soralia laminal, on the convexities of plicate thallus, rounded; soredia farinose; lower surface black. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranorin and divaricatic acid present.

It sparsely grows on tree trunks in subtropical-temperate regions.

Distribution : India (Maharashtra, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal); widely distributed in tropical and subtropical regions of the world.

Specimens examined: East Sikkim: Gangtok, Tashi view point, 1900 m, Jagadeesh Ram 1774 A. South Sikkim: Jorethang, Chatterjee & Divakar 20-77103 (LWG).

3. *Dirinaria confluens* (Fr.) Awasthi, Bibliotheca Lichenol. 2: 28. 1975. *Parmelia confluens* Fr., Syst. orb. 1:284. 1825.

Thallus glaucous grey, closely adnate, growing in suborbicular patches, 3-5 cm across; lobes radiating, subdichotomously divided, 1-1.5 mm wide, rounded flabellate at apices, centrally distinctly plicate rugose; upper surface weakly pruinose; medulla white; lower surface black, apices pale brown, precursor of rhizines sparsely present. Apothecia constricted at base, ca. 1 mm diam.; margin entire; disc black, slightly convex, faintly pruinose; spores 18-22 x 4-8 μ m. Chemistry: Cortex K+ yellow; medulla K-, C-, KC, P-; atranorin and divaricatic acid present.

It sparsely grows on trees in open places between 1000-1500 m altitudes.

Distribution: India (Maharashtra, Nagaland, Tamil Nadu, Uttar Pradesh and West Bengal); widely distributed in tropical and subtropical regions of the world.

Specimens examined: East Sikkim: North Regu, near Chhuba village, alt. 1000-1300 m, Sinha 963. On way between Chhalongpong-Aritar, alt. 1500 m, Sinha 534.

4. *Dirinaria consimilis* (Stirton) Awasthi in Awasthi & Agarwal, J. Indian Bot. Soc. 49: 135. 1970; Awasthi, Bibliotheca Lichenol 2: 91. 1975. -*Physcia consimilis* Stirton, Proc. Phil. Soc. Glasgow 11: 310. 1879.

Thallus glaucous grey, closely adpressed, orbicular, 3-5 cm across; lobes radiating, imbricate to confluent at the periphery, subpinnately divided, centripetally somewhat longitudinally plicate rugose to subverrucose, 0.5-1 mm wide; upper surface slightly pruinose in peripheral part; soralia capitate, develop as small verrucae, later bursts open to produce farinose soredia; medulla white; lower surface black with narrow pale margin at apices, precursor of rhizines present. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranorin and sekikaic acid present.

It commonly grows on trees as well as on boulders in open places.

Distribution: India (Himachal Pradesh, Manipur, Nagaland, Tamil Nadu, Uttaranchal and West Bengal); tropical regions of Africa and Asia.

Specimens examined: *East Sikkim:* On way between Chhalongpong & Aritar, alt. 1500 m, Sinha 533. North Regu, near Chhuba village, alt. 1000-1300 m, Sinha 961. *North Sikkim:* On way between Lachung to Yumthang, L.K. Rai 1349. *South Sikkim:* Sumbuk-kartikey village, alt. 950-1050 m, Sinha 12. Jorethang, P. Singh 61. *West Sikkim:* Nayabazar-Soreng road, 800-900 m, Sinha 19; Tashiding Forest Rest House compound, alt. 1450 m, Sinha 499.

2. *Heterodermia* Trevisan *em* Poelt.

Thallus foliose, dorsiventral, heteromerous, appressed, marginally ascendent, rosetiform or ribbon like and pendulous, whitish grey to greenish grey, lobate; lobes linear elongate, linear cuneate or spatulate; margin entire or notched at tips, lobulate or without lobules; upper surface plane to convex, pruinose or epruinose, cilia, isidia, soredia and squamules present or absent; upper cortex fibrous, composed of longitudinally thick walled conglutinate hyphae; photobiont green, *Trebouxia*; medulla white or pigmented; lower surface corticate or ecorticate, white or ochraceous, sometimes sorediate, rhizinate; rhizines marginal, concolorous with the thallus or blackish, simple to fruticose branched. Apothecia when present adnate or substipitate, subterminal or terminal; thalline exciple I+ blue or I-; disc brown, blackish to ashy grey, pruinose or epruinose; hymenium colourless; spores brown, ellipsoid, transversely 2-celled, thick walled. *Physcia* type with or without sporoblastidia.

A cosmopolitan genus with about 92 species in the world; 36 species in India; 25 species in Sikkim.

Key to the species

- 1a. Thallus appressed; lower surface of lobes corticate or ecorticate 2

- 1b. Thallus suberect or ribbon like; lower surface ecorticate .. 17
- 2a. Lower surface of lobes corticate 3
- 2b. Lower surface of lobes ecorticate 12
- 3a. Thallus isidiate or sorediate 4
- 3b. Thallus lacking isidia and soredia 7
- 4a. Thallus isidiate, isidia marginal, later becoming
sorediose 9. **H. dissecta**
- 4b. Thallus sorediate 5
- 5a. Medulla K+ reddish; norstictic and
salacinic acids present 21. **H. pseudospeciosa**
- 5b. Medulla K+ yellow; norstictic and salacinic acids absent . 6
- 6a. Spores less than 30 μm long; lobes short, flexuose;
apothecia margin sorediate 25. **H. tremulans**
- 6b. Spores more than 30 μm long; lobes linear-elongate;
apothecia margin crenate or lacinulate 23. **H. speciosa**
- 7a. Lower surface pigmented yellow to ochraceous 8
- 7b. Lower surface lacking pigment 9
- 8a. Medulla K+ red, P+ deep yellow; unknown anthraquinone
present 1. **H. albidiflava**
- 8b. Medulla K+ purple, P-; anthraquinone absent 10. **H. firmula**
- 9a. Thallus lobes very narrow, 0.5-1 mm wide, brownish
grey; lobe apices pruinose 5. **H. chondroidea**
- 9b. Thallus lobes otherwise, not pruinose 10
- 10a. Medulla K+ yellow-red, P+ yellow; salacinic and
norstictic acids present 11
- 10b. Medulla K+ yellow, P-; salacinic and norstictic acids
absent 8. **H. diademata**
- 11a. Lobes 0.5-1 mm wide; spores 36-40 x 16 μm 2. **H. angustiloba**
- 11b. Lobes 1-2 mm wide, spores 18-30 x 9-12 μm 22. **H. rubescens**
- 12a. Thallus sorediate 13
- 12b. Thgallus lacking soredia and isidia 15

- 13a. Lower surface pigmented, K+ purple 18. **H. obscurata**
- 13b. Lower surface lacking pigment, K+ yellow or
K+ yellow to red 14
- 14a. Lower surface K+ yellow to red; salacinic acid present 12. **H. hypocaesia**
- 14b. Lower surface K+ yellow; salacinic acid absent 15. **H. japonica**
- 15a. Thallus with numerous squamules along lobe margins 17. **H. microphylla**
- 15b. Thallus lacking squamules along lobe margins 16
- 16a. Thallus rigid, greyish black; lobes 0.7-1 mm wide 7. **H. dactyliza**
- 16b. Thallus rather delicate, whitish grey to grey brownish;
lobes 0.5-2 mm wide 24. **H. togashii**
- 17a. Thallus rosulate, lobes spatulate 19
- 17b. Thallus linear, ribbon like, loosely interwoven with black
marginal rhizines along margin 18
- 18a. Medulla pigmented yellow, pigment K- 16. **H. lutescens**
- 18b. Medulla not pigmented 4. **H. boryi**
- 19a. Upper surface of lobes ciliate 20
- 19b. Upper surface of lobes lacking cilia 21
- 20a. Upper surface of lobes with whitish cilia all over 6. **H. comosa**
- 20b. Upper surface of lobes with black spinules in apical part .. 14. **H. indica**
- 21a. Medulla P+ yellow; norstictic and salacinic acids present 22
- 21b. Medulla P- or P+ pale yellow; norstictic and salacinic
acids absent 24
- 22a. Thalline exciple I+ violet 23
- 22b. Thalline exciple I- 20. **H. podocarpa**
- 23a. Thallus lobes flat, up to 3 mm wide; lower surface
often orange to red tinged 3. **H. awasthii**
- 23b. Thallus lobes convex on upper surface, up to 2 mm wide;
lower surface white 11. **H. himalayensis**
- 24a. Marginal lobules ciliate; spores with 1-2 sporoblastidia ... 13. **H. incana**
- 24b. Marginal lobules lacking cilia; spores with numerous
sporoblastidia 19. **H. pellucida**

1. **Heterodermia albidiflava** (Kurok.) Awasthi, Geophytology 3:113. 1973.
Anaptychia albidiflava Kurok., Nova Hedwigia 6:42. 1962.

Thallus ± loosely appressed, whitish grey, 5-7 cm across; lobes sublinear, repeatedly branched, 1-2 mm wide, apices white pruinose; upper surface convex; medulla yellow; lower surface corticated, brownish, rhizinate; rhizines concolorous with lower surface, up to 1.5 mm long. Apothecia common, sessile to substipitate, 1.5-2.5 mm diam.; margin crenulate to lacinulate; disc dark brown to blackish; spores 25-30 x 12-16 µm. Chemistry: Cortex K+ yellow; medulla K+ red, C-, KC-, P+ deep yellow; atranorin, zeorin and anthraquinone present.

It sparsely grows in subtropical and temperate areas on trees as well as on boulders.

Distribution : India (Himachal Pradesh, Madhya Pradesh, Sikkim and West Bengal), Endemic.

Specimen examined: East Sikkim: Gangtok, near Bhusuk, 20-77189, 20-77110 (LWG).

2. **Heterodermia angustiloba** (Müll. Arg.) Awasthi, Geophytology 3: 113. 1973.
-Physcia speciosa var. *angustiloba* Müll. Arg., Flora 66: 78. 1883. *-Anaptychia angustiloba* (Müll. Arg.) Kurok., Nova Hedwigia 6: 39. 1962.

Thallus closely appressed, whitish grey, 3-4 cm across, lobes repeatedly dichotomously to trichotomously branched, short and narrow, 0.5-1 mm wide, usually discrete at periphery; upper surface smooth, epruinose; medulla white; lower surface corticate, concolorous with the thallus or sordid brown towards cortex; rhizines marginal, concolorous with the thallus, irregularly branched, 1-2 mm long. Apothecia crowded, 0.7-1.3 mm diam., margin crenate, lobulate; disc blackish brown, slightly pruinose; spores 36-40 x 16 µm. Chemistry: Cortex K+ yellow; medulla K+ yellow turning red, C-, KC-, P+ yellow; atranorin, zeorin, norstictic and salacinic acids and an unidentified substance present.

It sparsely grows on boulders in open moist places.

Distribution: India (Himachal Pradesh), China, Japan, Nepal and Australia.

Specimen examined: West Sikkim : Along down stream of Narkhola to Karchi, alt. 2000-1700 m, Sinha 426.

3. **Heterodermia awasthii** (Kurok.) Awasthi, Geophytology 3: 113. 1973:
Anaptychia awasthii Kurok., Nova Hedwigia 6: 88. 1962.

Thallus loosely attached, whitish grey, ca. 5 cm across; lobes linear-elongate, dichotomously to irregularly branched, imbricate, ascending, 1.5-3 mm wide; upper surface smooth, convex; medulla white; lower surface ecorticate, white, concave, minutely nervose; rhizines marginal, concolorous with thallus, blackening

at tips, simple to branched, 2-3 mm long. Apothecia numerous, terminal, pedicellate, 2-4 mm diam.; margin lobulate, ciliate; disc concave to plane, ashy grey to brownish, pruinose; thalline exciple l+ blue; spores 40-48 x 16-21 μ m, 1-3 sporoblastidia present in each locule. Chemistry: Cortex K+ yellow; medulla K+ yellow to reddish, C-, KC-, P+ yellow; atranorin, zeorin, salacinic and norstictic acids present.

It sparsely grows on trees as well as on road side boulders in open places.

Distribution: India (Nagaland, Sikkim, Uttaranchal and West Bengal) and Myanmar.

Specimen examined: South Sikkim: Namchi-Mamle route, alt. 1550-1750 m, Sinha 108.

4. **Heterodermia boryi** (Fée) K. Singh & S. Singh, Geophytology 6: 33. 1976. *Borrera boryi* Fée, Essai Crypt., : 52, tab. 2, Fig. 23. 1824.-*Anaptychia neoleucomalaena* Kurok., J. Jap. Bot. 36: 51. 1961; Kurok, Nova Hedwigia 6: 77. 1962. (Fig. 65)

Thallus loosely attached, mineral grey, 3-7 cm across; lobes dichotomously branched, ascending, revolute 0.5-2 mm wide; upper surface smooth; medulla white, thin; lower surface ecorticate, subapically sorediate like, canaliculate, arachnoid, white to yellow red; rhizines marginal, black, simple to branched, 5-8 mm long. Sterile. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P-; atranorin and zeorin present.

Distribution: India (Himalayas, Kerala and Tamil Nadu); widely distributed in tropical and temperate regions of the world.

Selected specimens examined: East Sikkim: Gangtok, Tashi view point, alt. 2000 m, Sinha 100. Near Mulkhark lake around W.B. border, alt. 2200-2300 m, Sinha 540. Pangolakha scrub, alt. 2900 m, Sinha 917. On way between Premlakha-Tenjahir foot track, alt. 2000 m, Sinha 902. Rechala surroundings, alt. 2700-2900 m, Sinha 1017. On way between South Regu and Picrae forest, alt. 1900 m, Sinha 504. North Sikkim: Lachen, Gumpa side forest, alt. 2700 m, Sinha 1541. Near Lachung, along road side, alt. 2500 m, Sinha 1036. Pentong village surroundings, alt. 1500 m, Sinha 637. Between Phuni-Yakche, alt. 3000 m, Sinha 1098. Tholung, Gumpa surroundings, alt. 2500 m, Sinha 630. Zema -I, alt. 2750 m, Sinha 1529. South Sikkim: On Damthang-Tendong 6 km foot track, alt. 2000-2650 m, Sinha 127. West Sikkim: Near Bakhim, alt. 2500-2700 m, Sinha 717. Dzongri, alt. 4000 m, Sinha 785. Hilley-Varshay 1 km foot track, alt. 2250 m, Sinha 1303. Karchi Reserve forest, alt. 2000-2400 m, Sinha 393. Sombaria, Forest Rest House compound, alt. 1700 m, Sinha 1284. Thangsing-Lampokhari 3 km foot track, alt. 3500 m, Sinha 849.

5. **Heterodermia chondroidea** Web. & Awasthi, Bryologist 74:181. 1971; Sinha, Bull. Bot. Surv. India 45(1-4):222. 2003. (Fig. 66)

Thallus strongly adnate, occurring in small rosettes, brownish grey to blackish, *ca.* 2.5 cm across; lobes narrowly linear, 0.5-1 mm wide, imbricate, apices slightly expanded, pruinose with rounded, lateral microphylline lobes; surface convex, dull; lower surface corticated, dark brown, sparingly rhizinate; rhizines simple to irregularly branched, not squarrose, *ca.* 0.5 mm long. Apothecia and pycnidia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranorin present.

It sparsely grows on boulders in cold desert areas.

Distribution: India (Sikkim), Nepal and Rocky mountains in North America.

Specimen examined: North Sikkim: Llonakh valley, Muguthang, alt. 4500 m, Sinha 1572 (det. T. L. Esslinger).

6. *Heterodermia comosa* (Eschw.) Follm. & Redon, Willdenovia 6: 446. 1972. - *Parmelia comosa* Eschw. in Martius, Icon. Pl. Crypt. 1: 26. 1828. - *Anaptychia comosa* (Eschw.) Massal., Mem. Lichenogr.: 39. 1853; Kurok., Nova Hedwigia 6: 103. 1962.

Thallus occurring in small scattered patches, whitish grey, 3-5 cm across, attached to the substratum centrally; lobes paddle-shaped or spatulate, ascending, suberect, apices rotund, 2-4 mm wide; upper surface uneven, convex, sparsely to densely ciliate; cilia white, laminal and marginal, 2-4 mm long; lower surface ecorticate, white, sometimes brownish in older parts, sorediate; soredia apical or subapical. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P-; lower surface pigment K-; atranorin, zeorin and an unidentified substance present.

It commonly grows on twigs of trees in shady places.

Distribution: India (Nagaland, Sikkim, West Bengal and temperate Himalaya); widely distributed in temperate regions of America, Asia and East Africa.

Specimen examined: West Sikkim: Tashiding-Yoksum road, near Chongrung village, alt. 1500 m, Sinha 301.

7. *Heterodermia dactyliza* (Nyl.) Swinscow & Krog, Lichenologist 8: 117. 1976. - *Physcia speciosa* var. *dactyliza* Nyl., Syn. Lich. 1: 417. 1860. - *Anaptychia dactyliza* (Nyl.) Zahlbr. in Skottsbo. Nat. Hist. Juan Fernan. 2: 404. 1924; Kurok., Nova Hedwigia 6: 64. 1962. (Fig. 67)

Thallus rigid, occurring in small orbicular patches, dark greyish to blackish, *ca.* 3 cm across; lobes linear elongate, repeatedly dichotomously branched, imbricate in central part, discrete at periphery, 0.7-1 mm wide; upper surface convex, epruinose; medulla white; lower surface ecorticate, whitish to sordid brown, marginally densely rhizinate; rhizines digitately to fruticoseously branched, black, concolorous with the thallus at base, 1-2 mm long. Apothecia not seen.

Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P-; atranorin and zeorin present.

It sparsely grows on boulders in open alpine areas.

Distribution: India (Eastern Himalaya); South America and Africa.

Specimens examined: *North Sikkim:* On way between Lasher and G.S.I. Old Camp Hut, alt. 4400 m, Sinha 1196. Near Thangu bridge, on Muguthang road, alt. 3900 m, Sinha 1165.

8. *Heterodermia diademata* (Taylor) Awasthi. *Geophytology* 3: 113. 1973.
Parmelia diademata Taylor, *J. Bot. London* 6: 165. 1847. -*Anaptychia diademata* (Taylor) Kurok., *Nova Hedwigia* 6: 28. 1962; *Journ. Hattori Bot. Lab.* 37: 596. 1973.
(Fig. 68)

Thallus usually loosely attached, greyish white, 10-20 cm across; lobes dichotomously to irregularly branched, sometimes lobulate, minutely notched, 0.5-2 mm wide; upper surface plane, epruinose; medulla white; lower surface corticate, white to brownish; rhizines sparse, greyish or brown black towards apices, simple to irregularly branched, 1-3 mm long. Apothecia common, laminal, subsessile, 1-5 mm diam.; margin entire, crenulate to lobulate; disc brown to blackish brown, flat to slightly convex; thalline exciple smooth; spores 20-30 x 8-15 μ m, sporoblastidia absent. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P+ yellow or P-; atranorin and zeorin present.

It commonly grows on tree trunks and on boulders between tropical and temperate regions.

Distribution: India (Manipur, Meghalaya, Nagaland, Sikkim, Uttaranchal and West Bengal); tropical and temperate regions of the World.

Selected specimens examined: *East Sikkim:* Pangolakha scrub, alt. 2900 m, Sinha 916. Between Premlakha-Tenjibir forest, alt. 2000 m, Sinha 903. Rechala surroundings, alt. 2700-2900 m, Sinha 1015. North Regu, near Chhubba village, alt. 1000-1300 m, Sinha 962. *North Sikkim:* On way between Lachung to Yumthang, L.K.Rai 1346. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1059. *South Sikkim:* Jorethang-Namchi road, at 5 km point, alt. 650 m, Sinha 6. Namchi-Mamle route, alt. 1550-1750 m, Sinha 112. Sumbuk-kartikey village area, alt. 950-1050 m, Sinha 9. *West Sikkim:* Dzungri, alt. 4000 m, Sinha 766. Hilley-Varshey 1 km foot track, alt. 2250 m, Sinha 304. On way between Labdang-Pokharidanda foot track, alt. 2000 m, Sinha 492. Naya Bazar-Soreng road, at 5 km point, alt. 900 m, Sinha 18. Pemayangtse Monastery surroundings, alt. 2075 m, Sinha 169. Sombaria, near Forest Rest House compound, alt. 1750 m, Sinha 1300. Tashiding-Yoksum road, near Chongrung village, alt. 1500 m, Sinha 295. Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1342.

9. **Heterodermia dissecta** (Kurok.) Awasthi, *Geophytology* 3: 113. 1973.
Anaptychia dissecta Kurok., *J. Jap. Bot.* 34: 182. 1959; *Nova Hedwigia* 6: 38. 1962.
 (Fig. 69)

Thallus loosely appressed, whitish grey, 6-8 cm across; lobes repeatedly dichotomously branched, imbricate centrally, discrete at periphery, minutely notched, 1-2 mm wide, lobulate; upper surface smooth, epruinose; microphyllous lobules and isidia marginal, dense in central part, rarely submarginal, suberect, appearing thickly isidiate; medulla white; lower surface corticate, greyish brown; marginal rhizines black, simple, remaining greyish, simple to irregularly branched, 1-2 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow to reddish, C-, KC-, P+ yellow to orange; atranorin, zeorin, salacinic acid, norstictic acid and an unknown substance present.

It sparsely grows on mossy rocks in open places along the roadsides.

Distribution: India (widely distributed in tropical and temperate himalaya, Manipur, Nagaland and West Bengal) and Japan.

Specimens examined: *North Sikkim:* Near Lachung, on roadside, alt. 2500 m, Sinha 1039. *West Sikkim:* Labdang village surroundings, alt. 1850 m, Sinha 479.

10. **Heterodermia firmula** (Nyl.) Trevisan, *Atti. Soc. Ital. Sci. Nat.* 11: 615. 1868.
-Physcia firmula Nyl., *Syn. Lich.* 1: 418. 1860; *Zahlbr., Cat. lich. univ.* 7: 618. 1931.
-Anaptychia firmula (Nyl.) Dodge & Awasthi in Awasthi, *J. Indian Bot. Soc.* 39: 423. 1960; Kurok., *Nova Hedwigia* 6: 40. 1962.
 (Fig. 70)

Thallus loosely or firmly attached, occur in suborbicular patches, greenish grey to mineral grey, 5-8 cm across; lobes irregularly branched, discrete at periphery, imbricate in the central region, narrow, 0.4-1 mm wide; upper surface plane, epruinose; medulla yellow to ochraceous; lower surface corticate, whitish along margin, brownish in the central part; rhizines concolorous with the thallus, irregularly branched, small, ca. 1 mm long. Apothecia numerous, 1-3 mm diam.; margin entire in early stage, later becoming crenulate and irregular at maturity; disc dark brown, concave, slightly pruinose in older apothecia; spores 20-30 x 9-12 μ m. Chemistry: Cortex K+ yellow; medulla K+ purple, C-, KC-, P+ purple; zeorin and an unidentified substance present.

It sparsely grows on exposed boulders and on trees in open places.

Distribution: India (Himachal Pradesh, Madhya Pradesh, Manipur, Nagaland, Sikkim, Uttaranchal and West Bengal) and south west China.

Specimens examined: *East Sikkim:* Near Mulkhark lake around W.B. border, alt. 2200-2300 m, Sinha 539. *West Sikkim:* Yoksum, near Old Gumpa, alt. 1900 m, Sinha 702.

11. **Heterodermia himalayensis** (Awasthi) Awasthi, *Geophytology* 3: 113. 1973.
-Anaptychia himalayensis Awasthi, *Proc. Indian Acad. Sci.* 45 B: 13. 1957;
 Kurok., *Nova Hedwigia* 6: 87. 1962.
 (Fig. 71)

Thallus attached centrally to the substratum, whitish grey, 3-4 cm across; lobes short, imbricate, subascending towards apices, 0.5-1.5 mm wide; upper surface plane to convex, smooth, pruinose along lobe apices; medulla white; lower surface ecorticate, slightly canaliculate, whitish grey, arachnoid; rhizines marginal, concolorous with the surface, sometimes with black tips, irregularly branched, 1-3 mm long. Sterile. Chemistry: Cortex K+ yellow; medulla K+ yellow to red, C-, KC-, P+ yellow-orange; atranorin, zeorin, norstictic and salacinic acids present.

It sparsely grows on boulders in open places.

Distribution: India (Manipur, Nagaland, Sikkim, Uttaranchal and West Bengal). Endemic.

Specimen examined: West Sikkim: Tashiding Monastery surroundings, alt. 1600 m, Sinha 319.

12. *Heterodermia hypocaesia* (Yasuda) Awasthi, Geophytology 3: 113. 1973.
Anaptychia hypocaesia Yasuda in Räsänen, J. Jap. Bot. 16: 139. 1940; Kurok., Nova Hedwigia 6: 57. 1962.

Thallus loosely attached, forming extensive colonies, greyish white, 3-6 cm across; lobes subdigitately branched, slightly ascending towards apices, 1-1.5 mm wide, minutely notched at tips; upper surface plane to somewhat concave, pruinose towards apices; soredia develop at the tips of short lateral branches, granular; lower surface ecorticate, arachnoid, blackish towards centre, white to ochraceous towards periphery; rhizines black, marginal, simple to squarrosely branched, ca. 2 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow to red, C-, KC-, P+ yellow; atranorin, zeorin and salacinic acid present.

It commonly grows on moss covered boulders in open moist places.

Distribution: India (Himachal Pradesh, Madhya Pradesh, Manipur, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Hawaii, Indonesia, Japan and Philippines.

Selected specimens examined: East Sikkim: Gangtok, Tashi view point, alt. 2000 m, Sinha 105 A. North Regu, near Chhubba village, alt. 1000-1300 m, Sinha 965. North Sikkim: Bey surroundings, alt. 1600 m, Sinha 560. Lachung, river side forest, alt. 2650 m, Sinha 1118. Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 614. South Sikkim: Temi Tea Estate, alt. 1300 m, Sinha 51. West Sikkim: Labdang village surroundings, alt. 1850 m, Sinha 480. On way between Narkhola-Kholak harka forest, alt. 2000-2200 m, Sinha 373. Near Karchi village, alt. 2100 m, Sinha 346. Tashiding Monastery surroundings, alt. 1600 m, Sinha 148, 318. Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 254.

13. *Heterodermia incana* (Stirton) Awasthi, Geophytology 3: 113. 1973. -*Physcia incana* Stirton, Proc. Phil. Soc. Glasgow 11: 322. 1879. -*Anaptychia incana* (Stirton) Zahlbr., Cat. lich. univ. 7: 727. 1931; Kurok., Nova Hedwigia 6: 92. 1962.

(Fig. 72)

Thallus attached centrally to the substratum, occurring in small patches, whitish grey, 3-5 cm across; lobes dichotomously to irregularly branched, ascending, 1.5-3 mm wide; upper surface smooth, convex, epruinose; medulla white; lower surface ecorticate, concave, white, minutely nervose; rhizines marginal, concolorous with the surface or blackish, squarrosely branched, 2-3 mm long. Apothecia numerous, subterminal, pedicellate, 2-4 mm diam.; margin crenate to lobulate, lobule margins ciliate; disc grey brown, pruinose; thalline exciple I+ violet; spores 30-48 x 18-20 μ m, 1-2 sporoblastidia present in each locule. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P+ pale yellow; atranorin and zeorin present.

Distribution: India (Himachal Pradesh, Nagaland, Sikkim, Tamil Nadu and West Bengal), Indonesia, Nepal, Sri Lanka, Taiwan and Thailand.

Specimens examined: *East Sikkim:* Near Mulkhark lake area around W.B. border, alt. 2200-2300 m, Sinha 537. Between Premlakha-Tenjabir forest, alt. 2000 m, Sinha 904. Thegu, alt. 3700 m, Sinha 1381. *North Sikkim:* Bey surroundings, alt. 1600 m, Sinha 562. *South Sikkim:* Namchi-Old Damthang road, alt. 1700-2000 m, Sinha 41. *West Sikkim:* Labdang village surroundings, alt. 1850 m, Sinha 483. On way between Narkhola-Karchi village, alt. 2100-1850 m, Sinha 375. Yoksum, near old Gumpa, alt. 900 m, Sinha 704. Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1344 A.

14. *Heterodermia indica* (H. Magn.) Awasthi, Geophytology 3: 114. 1973. *Anaptychia indica* H. Magn. in Awasthi, J. Indian Bot. Soc. 39: 439. 1960; Kurok., Nova Hedwigia 6: 102. 1962.

Thallus rosulate, affixed centrally to the substratum, whitish grey, ca. 3 cm across; lobes ascending, irregularly branched, subimbricate, 1-1.5 mm wide; upper surface convex, \pm smooth, irregularly branched, blackish cilia present in submarginal area; medulla white; lower surface ecorticate, white, concave, nervose, densely rhizinate; rhizines marginal, grey to brownish black, densely squarrosely branched, ca. 2 mm long. Apothecia not developed. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P+ yellow; atranorin and zeorin present.

It sparsely grows on twigs and on boulders in open moist places.

Distribution: India (Nagaland and West Bengal). Endemic.

Specimens examined: *West Sikkim:* Karchi Reserve Forest, alt. 2000-2400 m, Sinha 397. Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1344 B.

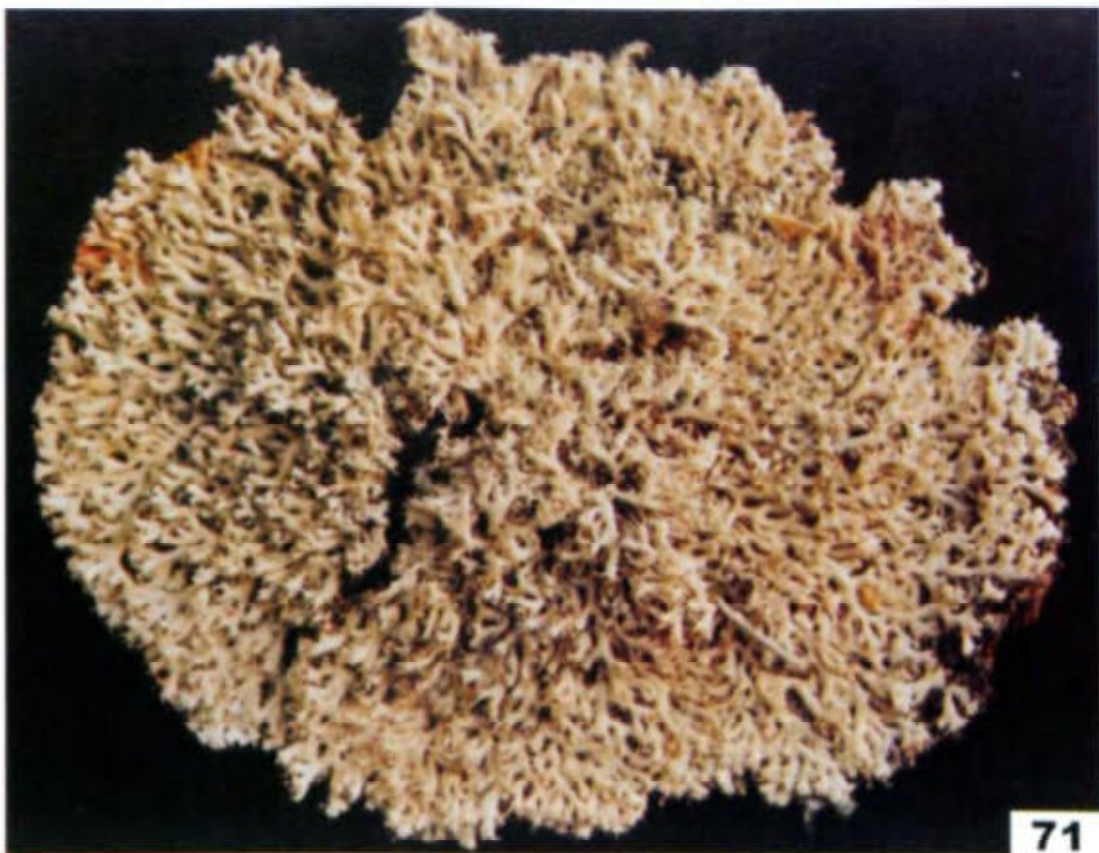


Fig. 70. *Heterodermia firmula*. **Fig. 71.** *H. himalayensis*.



Fig. 72. *Heterodermia incana*. **Fig. 73.** *H. japonica*. **Fig. 74.** *H. lutescens*.
Fig. 75. *H. togashii*.

15. *Heterodermia japonica* (Sato) Swinscow & Krog, *Lichenologist* 8:122. 1976. -*Anaptychia dendritica* var. *japonica* Sato, *J. Jap. Bot.* 12:427. 1936 -*Anaptychia japonica* (Sato) Kurok., *J. Jap. Bot.* 35:353. 1960; Kurok., *Nova Hedwigia* 6:58. 1962. (Fig. 73)

Thallus greyish white, 5-8 cm across; lobes \pm subdigitately branched, sublinear elongate, contiguous or imbricate, 0.7-1.5 mm wide; upper surface plane to somewhat convex, usually slightly pruinose towards the apices, with capitate soralia on lateral branches; lower surface ecorticate, whitish; rhizines marginal, black, simple to squarrosely branched, 1-2 mm long. Apothecia absent in specimens examined. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P-; atranorin and zeorin present.

It sparsely grows on exposed rocks in temperate areas.

Distribution: India (Madhya Pradesh, Manipur and West Bengal), Japan; Africa.

Specimens examined: North Sikkim: Lachen, Gumpa side forest, alt. 2700 m, Sinha 1538, 1539.

16. *Heterodermia lutescens* (Kurok.) Follm., *Philippia* 2: 73. 1974. -*Anaptychia lutescens* Kurok., *J. Jap. Bot.* 36: 54. 1961; *Nova Hedwigia* 6: 79. 1962.

(Fig. 74)

Thallus loosely spread, whitish grey, 4-6 cm across; lobes linear elongate, dichotomously branched, ascending, 1-1.5 mm wide; upper surface smooth; medulla white; lower surface ecorticate, plane to canaliculate, partially yellow pigmented, pigment K-, sorediate subapically; rhizines marginal, simple, black with greyish or blackish basal region, 4-7 mm long. Sterile. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P-; atranorin, zeorin and an unidentified pigment present.

It sparsely grows on trees as well as on boulders in open places.

Distribution: India (Arunachal Pradesh and Nagaland); widely distributed in tropical and subtropical regions of the world.

Specimens examined: East Sikkim: Near Phadamchen, alt. 1800 m, Sinha 880. West Sikkim: Labdang forest, alt. 1900-2000 m, Sinha 468; Tashiding Monastery surroundings, alt. 1600 m, Sinha 316.

17. *Heterodermia microphylla* (Kurok.) Skorepa, *Bryologist* 75:490. 1972. *Anaptychia hypoleuca* var. *microphylla* Kurok., *J. Jap. Bot.* 34:123. 1959. -*Anaptychia microphylla* (Kurok.) Kurok., *Nova Hedwigia* 6:44. 1962.

Thallus greyish brown, 3-7 cm across; lobes linear elongate, dichotomously to irregularly branched, 0.5-2 mm wide; upper surface smooth, with numerous squamules; lower surface ecorticate, rhizinate; rhizines simple, 0.5-1 mm long.

Apothecia sessile, 2-3 mm diam.; margin entire, lobate; thalline exciple with numerous squamules; disc black, convex, epruinose; spores 35-39 x 16-19 μ m. Chemistry: Cortex K+ light yellow; medulla K-, or K+ pale yellow, C-, KC-, P-; atranorin and zeorin present.

It sparsely grows on trees in subtropical areas.

Distribution : India (Uttaranchal). Japan; Africa and America.

Specimen examined: East Sikkim: Tumin, Upreti & Chatterjee s.n. (LWG).

18. *Heterodermia obscurata* (Nyl.) Trevisan, Nuov. Giorn. Bot. Ital. 1:114. 1869. - *Physcia obscurata* Nyl., Acta Soc. Sci. Fenn. 7: 440. 1863. - *Anaptychia obscurata* (Nyl.) Vainio, Acta Soc. Fauna Fl. Fenn. 7: 137. 1890; Kurok., Nova Hedwigia 6: 49. 1962.

Thallus loosely attached, occurring in orbicular patches, mineral grey, 5-8 cm across; lobes dichotomously to irregularly branched, minutely notched at apices, discrete at periphery, 1-2 mm wide; upper surface plane to convex, smooth, epruinose; soralia labriform, occur on the tips of lateral recurved branchlets; lower surface ecorticate, arachnoid, ochraceous orange in the middle and brownish yellow towards periphery, K+ purple; rhizines black, marginal, simple to squarrosely branched, ca. 2 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow; C-, KC-, P+ pale yellow or P-; pigmented lower surface K+ purple; atranorin, zeorin and an unidentified pigment present.

It commonly grows on boulders in subtropical-temperate areas.

Distribution: India (Himachal Pradesh, Manipur, Nagaland, Sikkim, Uttaranchal); widely distributed in tropical and temperate regions of the world.

Specimens examined: East Sikkim : On way between Chhalongpong and Aritar, alt. 1500 m, Sinha 532. North Sikkim: Near Lachung, along road side, alt. 2500 m, Sinha 1037. South Sikkim: Damthang-Tendong 6 km foot track, alt. 2000-2650 m. Sinha 135. Namchi-Old Damthang road, alt. 1700-2000 m, Sinha 40. West Sikkim: Near Bakhim, alt. 2500-2700 m, Sinha 718.

19. *Heterodermia pellucida* (Awasthi) Awasthi, Geophytology 3: 114. 1973. *Anaptychia pellucida* Awasthi, Proc. Indian Acad. Sci. 45B: 136. 1957; Kurok., Nova Hedwigia 6: 93. 1962.

Thallus greyish or greenish white, darkening near centre, 3-4 cm across, in rosulate patches; lobes ascending, dichotomously or irregularly branched, 2-4.5 mm wide; upper surface convex or plane; lower surface ecorticate, white, arachnoid; rhizines marginal, rarely laminal, concolorous with the surface, often darkening towards the apices, fruticose branched, 2-3 mm long. Apothecia laminal at first, later becoming terminal at maturity, subpedicellate, 1-4 mm diam.; margin crenate, eciliate; disc blackish brown, epruinose; thalline exciple irregularly

thickened, I+ violet; spores 40-70 x 22-26 μm , locules with numerous sporoblastidia. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P- or P+ faintly yellow; atranorin and zeorin present.

It sparsely grows on boulders in temperate areas.

Distribution: India (Sikkim and West Bengal), China, Nepal.

Specimens examined: West Sikkim: Thangsing-Lampokhari 3 km foot track, alt. 3500 m, Sinha 848, 854.

20. *Heterodermia podocarpa* (Bél.) Awasthi, *Geophytology* 3: 114. 1973. *Parmelia podocarpa* Bél., *Vog. Ind. Orient. Bot. II. Crypt.* 122. Pl. e, fig. 1. 1840. - *Anaptychia podocarpa* (Bél.) Massal., *Atti. I. R. Inst. Venet.*, ser. 3, 5: 249, pl. 13, fig. 1. 1860; Kurok., *Nova Hedwigia* 6: 86. 1962.

Thallus growing in rosulate patches, attached to the substratum basally, greyish white, 3-5 cm across; lobes short, imbricate, irregularly branched, 0.5-3 mm wide, ascending towards apices; upper surface \pm smooth; lower surface ecorticate, arachnoid, white, \pm canaliculate; rhizines simple to irregularly branched, \pm concolorous with the surface, 1-2 mm long. Apothecia pedicellate, 1-4 mm diam.; margin crenate or lacinulate, eciliate; disc brown to dark brown, pruinose; thalline exciple irregularly thickened, I+ blue; spores 35-50 x 15-22 μm , 3-4 sporoblastidia present in each locule. Chemistry: Cortex K+ yellow; medulla K+ yellow-reddish, C-, KC-, P+ yellow; atranorin, zeorin, norstictic acid and salacinic acid present.

It commonly grows on tree trunks and boulders in open places.

Distribution: India (Sikkim, Uttaranchal and West Bengal), Nepal; Asia, North America.

Specimens examined: South Sikkim: Temi Tea Estate, alt. 1300 m, Sinha 52. West Sikkim: Kongri village forest, alt. 2000 m, Sinha 327. Along down stream of Narkhola to Karchi, alt. 2000-1700 m, Sinha 421.

21. *Heterodermia pseudospeciosa* (Kurok.) W. Culb., *Bryologist* 69: 484. 1966. - *Anaptychia pseudospeciosa* Kurok., *J. Jap. Bot.* 34: 176. 1959; *Nova Hedwigia* 6: 25. 1962.

Thallus loosely appressed, growing in orbicular patches, greyish white, 5-8 cm across; lobes repeatedly dichotomously branched, imbricate in the centre, discrete at periphery, 1-1.5 mm wide, minutely notched, marginally subascending; upper surface plane, glabrous, sorediate; soralia capitate or linear, apical or on lateral lobules; soredia granular; medulla white; lower surface corticate, white, brownish towards centre; rhizines sparse, concolorous with the thallus or blackish, squarrosely branched, 1-2 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow to red, C-, KC-, P+ yellow; atranorin, norstictic acid, salacinic acid and zeorin present.

It commonly grows on boulders and on trees in open places.

Distribution: India (Manipur, Nagaland, Uttaranchal and West Bengal), Japan, Taiwan; East Africa and South America.

Specimens examined: *East Sikkim:* Gangtok, BSI complex, on *Alnus nepalensis*, Sinha 1363. Near Mulkharka lake around West Bengal border, alt. 2200-2300 m, Sinha 538. On way between Talkharka-lower Rechala, alt. 2000-2200 m, Sinha 981. *North Sikkim:* Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 615. *West Sikkim:* Along down stream of Narkhola to Karchi, alt. 2000-1700 m, Sinha 427. Pemayangtse Monastery surroundings, alt. 2075 m, Sinha 170. Yoksum, near old Gumpa, alt. 1900 m, Sinha 703 A.

22. *Heterodermia rubescens* (Räsänen) Awasthi, *Geophytology* 3: 114. 1973. *Anaptychia hypoleuca* f. *rubescens* Räsänen, *Arch. Soc. Zool. Bot. 'Vanano'* 5: 27. 1950. -*Anaptychia rubescens* (Räsänen) Kurok., *Nova Hedwigia* 6: 31. 1962.

Thallus loosely attached, mineral grey, often reddish due to decomposition of salacinic acid, up to 15 cm across; lobes dichotomously to irregularly branched, imbricate in centre, discrete at periphery, 1-2 mm wide; upper surface plane to slightly convex, epruinose; medulla white; lower surface corticate, white to brownish; rhizines concolorous with surface, with dark brown apices, irregularly branched, 1-3 mm long. Apothecia common 1-4 mm diam.; margin entire, crenate to lobulate at maturity; disc dark brown, plane to concave, faintly pruinose; spores 18-30 x 9-12 μ m. Chemistry: Cortex K+ yellow; medulla K+ yellow-reddish, C-, KC-, P+ yellow; atranorin, norstictic acid, salacinic acid and zeorin present.

It commonly grows on boulders in open places.

Distribution: India (Himachal Pradesh, Manipur, Nagaland, Sikkim, Uttaranchal and West Bengal). Endemic.

Specimens examined: *East Sikkim:* Near Phadamchen, on Phadamchen-Lingtam road, alt. 1800 m, Sinha 879 A. *North Sikkim:* Bey surroundings, alt. 1600 m, Sinha 563. *West Sikkim:* Kacheopalri lake surroundings, alt. 1850 m, Sinha 277.

23. *Heterodermia speciosa* (Wulfen) Trevisan, *Atti Soc. Ital. Sci. Nat. Milano* 11:614. 1868. *Lichen speciosus* Wulfen in Jacq., *Coll. Bot.* 3:119. 1789. *Anaptychia speciosa* (Wulfen) Massal., *Mem. Lichenogr.*:36. 1853; Kurok., *Nova Hedwigia* 6:24. 1962. -*Parmelia speciosa* (Wulfen) Ach., *Meth. Lich.*:198. 1803. -*Physcia speciosa* (Wulfen) Nyl., *Prod. Lich. Gall. Soc. Linn. Bord.*:307. 1857.

Thallus adpressed, in suborbicular patches, greyish white, 5-8 cm across; lobes subdichotomously to pinnately branched, sometimes imbricate marginally, linear elongate, 0.5-1.5 mm wide, minutely notched; upper surface plane, smooth, epruinose; soredia capitate at the tips of short lateral branches; lower surface corticate, white, sordid brown in centre; rhizines sparse, concolorous with surface,

slightly darker at apices, simple to irregularly branched, 0.5-1(-1.5) mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P-; atranorin and zeorin present.

It sparsely grows on rocks in higher reaches of North Sikkim.

Distribution: India (Himachal Pradesh, Madhya Pradesh, Tamil Nadu, Uttaranchal and West Bengal); Europe.

Specimens examined: North Sikkim: Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1649. Theu La to Jakthang way, alt. 4600-3400 m, Sinha 1724.

24. *Heterodermia togashii* (Kurok.) Awasthi, *Geophytology* 3: 114. 1973.
Anaptychia togashii Kurok., *Nova Hedwigia* 6: 68. 1962. (Fig. 74)

Thallus adpressed, occurring in ± suborbicular patches, mineral greyish, 6-10 cm across; lobes irregularly branched, 0.5-2 mm wide; upper surface ± smooth; lower surface ecorticate, white; rhizines dense along margins, branched, concolorous with surface, tips brownish to blackish, 1-2 mm long. Apothecia sessile, 2-8 mm diam.; margin lacinulate, ciliate, lacinules 1-3 mm long, ecorticate beneath; disc brownish; thalline exciple smooth, I+ blue; spores 30-42 x 16-20 µm. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P- or P+ faint yellow; atranorin and zeorin present.

It commonly grows on tree trunks and on boulders in open places.

Distribution: India (Himachal Pradesh and Sikkim). Endemic.

Specimens examined: East Sikkim: Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1466. Near Meimenchu Memorial Check Post, alt. 3700 m, Sinha 1412. Rechala surroundings, alt. 2700-2900 m, Sinha 1016. *West Sikkim:* Dzongri, alt. 4000 m, Sinha 784.

25. *Heterodermia tremulans* (Müll. Arg.) W. Culb., *Bryologist* 69: 485. 1966.
Physcia hypoleuca var. *tremulans* Müll. Arg., *Flora* 63: 277. 1880. -*Anaptychia pseudospeciosa* var. *tremulans* (Müll. Arg.) Kurok., *Nova Hedwigia* 6: 26. 1962.

Thallus loosely attached, growing in irregular patches, mineral greyish, 3-6 cm across; lobes dichotomously branched, short, flexuose, imbricate in centre, discrete at periphery, minutely notched, 0.7-1.5 mm wide; upper surface plane; soredia capitate or linear, present apically on lobes, producing granular soredia; medulla white; lower surface corticate, white, brownish towards centre; rhizines sparse, concolorous with the surface to blackish, irregularly branched, 1-2 mm long. Apothecia rare, 1-3 mm diam.; margin crenate to lacinulate; spores 26-32 x 12-14 µm. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P- or P+ yellowish; atranorin and zeorin present.

Distribution: India (Madhya Pradesh, Nagaland, Sikkim and Uttaranchal), Bhutan, Brazil, China, Hawaii, Japan, Manchuria, Mexico and Saghalien.

Earlier report: Asahina (1966).

3. *Phaeophyscia* Moberg

Thallus foliose and lobate, \pm loosely appressed to the substratum, dorsiventral, greyish brown, lobe margin eciliate; upper surface flat to concave, epruinose; medulla white to orange red; lower surface black or dark brown, rhizinate; rhizines black, simple, dense, sometimes projecting beyond the margin; upper and lower cortices paraplectenchymatous. Apothecia lecanorine, laminal, \pm sessile, mostly with rhizines at base (corona); disc brown to black; hymenium colourless; hypothecium colourless; asci 8-spored; spores brown, thick-walled, 1-septate, *Physcia* or *Pachysporia* type; paraphyses branched towards apices. Pycnidia laminal, immersed; conidia ellipsoid, less than 4 μ m long. Atranorin absent, skyrin or zeorin present or absent.

About 22 species known from the world; 11 species in India and 6 in Sikkim.

Key to the species

- 1a. Thallus sorediate 2
- 1b. Thallus lacking soredia 3
- 2a. Thallus up to 3 cm across; lobes up to 1 mm wide, pale grey to dark brown; soredia submarginal, capitate 5. ***P. orbicularis***
- 2b. Thallus larger, 5-8 cm across; lobes 2-4 mm wide, ashy grey to greyish brown; soredia laminal to submarginal, pustulate to capitate 4. ***P. hispidula***
- 3a. Medulla orange red 4
- 3b. Medulla white 6
- 4a. Lobes 2-3 mm wide, greyish brown 6. ***P. pyrrophora***
- 4b. Lobes narrower, up to 1 mm wide 5
- 5a. Apothecia with basal corona, margin entire to crenulate-lobulate; spores *Pachysporia* type 3. ***P. endococcinodes***
- 5b. Apothecia without basal corona, margin entire; spores *Physcia* type 2. ***P. endococcina***
- 6a. Thallus closely adnate; lobes 0.5-1 mm wide; apothecia 0.5-0.7(-1) mm diam., lacking basal corona 1. ***P. decolor***
- 6b. Thallus loosely attached; lobes 2-4 mm wide; apothecia up to 3 mm diam., with basal corona 4. ***P. hispidula***

1. **Phacophyscia decolor** (Kashiwadani) Essl., Mycotaxon 7:299. 1978. -*Physcia decolor* Kashiwadani, Ginkgoana 3:42. 1975; Sinha, Bull. Bot. Surv. India 45(1-4):222. 2003.

Thallus closely adnate, in suborbicular patches, dark brown to blackish, 4-5 cm across; lobes repeatedly dichotomously or irregularly branched, imbricate, 0.5-1 mm wide; upper surface smooth, epruinose; medulla white; lower surface brown-black; rhizines black, simple to branched, 1-1.5 mm long. Apothecia few, scattered, sessile, 0.5-0.8(-1) mm diam., without basal hairs; margin concolorous with surface, lobate; disc concave, brown black, epruinose; spores *Physcia* type, 18-21 x 7-14 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; zeorin present.

It sparsely grows on thick soil coverings on boulders in dry alpine areas.

Distribution: India (Sikkim), Japan; Europe and N. America.

Specimen examined: North Sikkim: Llonakh valley, Muguthang, alt. 4500 m. Sinha 1561 (det. T. L. Esslinger).

2. **Phaeophyscia endococcina** (Körber) Moberg, Symb. Bot. Upsal. 22(1): 35.1977. -*Parmelia endococcina* Körber, Parerga Lichenologica : 36. 1865.

Thallus closely adnate to the substratum, brownish grey, 2.5-3.5 cm across in orbicular patches; lobes subdichotomously to irregularly branched, crowded, imbricate up to the margin, ca. 1 mm wide; upper surface smooth, convex, epruinose, isidia and soredia absent; medulla orange in lower half; rhizines blackish, ca. 0.5 mm long. Apothecia numerous, constricted at the base, without basal hairs or corona; margin concolorous with the surface, entire; disc flat, brown-black, epruinose; spores *Physcia* type with apical thickening, 24-33 x 10-12 μ m. Chemistry: Cortex K-; medulla K+ purple violet, C-, KC-, P-; skyrin and zeorin present.

The species sparsely occur in temperate regions on tree trunks in open places.

Distribution: India, (Himachal Pradesh, Madhya Pradesh and Uttaranchal), Nepal; Europe and North America.

Specimens examined: West Sikkim: On way between Narkhola-Karchi village, 2100-1850 m, Sinha 375. Pemayangtse Monastery surroundings, alt. 2075 m, Sinha 167.

3. **Phaeophyscia endococcinodes** (Poelt) Essl., Mycotaxon 7: 301.1978. -*Physcia endococcinodes* Poelt, Khumbu Himal 6: 77. 1974. (Fig. 76)

Thallus closely adnate, brownish grey, occurring in small 2-3 cm across circular patches; lobes radiating, subdichotomously branched, imbricate centrally, ca. 0.5 mm wide, apices entire to minutely notched; upper surface smooth, flat or

convex; medulla red; rhizines *ca.* 0.5 mm long, blackish. Apothecia many 1(-2) mm diam., with basal corona; margin concolorous with the surface, entire to crenulate lobulate; disc flat, brown black, epruinose; spores *Pachysporia* type, (20-)22-26(-30) x 8-12 μ m. Chemistry: Cortex K-; medulla K+ purple violet, C-, KC-, P-; skyrin and zeorin present.

The species commonly grows on boulders in open moist places of temperate areas.

Distribution: India (Madhya Pradesh, Manipur, Nagaland and Uttaranchal); East Africa and North America.

Specimens examined: *North Sikkim:* Lachen, Gumpa side forest, alt. 2700 m, Sinha 1548. Near Lachung, alt. 2500 m, Sinha 1038. Zema -I, along road side boulders, alt. 2750 m, Sinha 1528. *West Sikkim:* Thangsing-Samiti surroundings, alt. 3700 m, Sinha 830.

4. *Phaeophyscia hispidula* (Ach.) Essl., *Mycotaxon* 7(2): 305. 1978. -*Parmelia hispidula* Ach., *Lich. univ.*: 468. 1810. *Physcia hispidula* (Ach.) Frey, *Ber. Sch. Weiz. Bot. Ges.* 73: 474. 1963

Thallus loosely attached, ashy grey to greyish brown, 5-8 cm across; lobes irregularly branched, discrete or imbricate centrally, broader and concave marginally, 2-4 mm wide; upper surface dull, epruinose, sorediate or esorediate; soredia when present, laminal to submarginal, pustulate to capitate; medulla white; rhizines dense, black, conspicuous from above, 1-3 mm long. Apothecia usually rare, constricted at base with basal hairs or corona, up to 3 mm diam.; margin thick, entire or crenulate; disc dull or shining, brown black, flat; spores *Physcia* type, 20-25 x 8-9 μ m. Pycnidia black; conidia 3-4 x 1 μ m. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; no lichen substances present.

It commonly grows in subtropical-temperate regions on boulders as well as on tree trunks in open moist places.

Distribution: India (Himachal Pradesh, Madhya Pradesh, Manipur, Nagaland, South India and Uttaranchal); tropical regions of the world.

Specimens examined: *East Sikkim:* Gangtok, C.P.W.D. complex, on stone walls, alt. 1500 m, Sinha 1423. *North Sikkim:* Bey surroundings, alt. 1600 m, Sinha 561. Lachen, along road side, alt. 2700 m, Sinha 1135, 1136. Near Lachung, along road side, alt. 2500 m, Sinha 1035. *West Sikkim:* On way between Narkhola and Karchi village, alt. 1800-2100 m, Sinha 355, 368, 413, 422. Tashiding Monastery surroundings, alt. 1600 m, Sinha 317.

5. *Phaeophyscia orbicularis* (Neck.) Moberg, *Symb. Bot. Upsal.* 22(1):44. 1977. -*Lichen orbicularis* Neck., *Deliciae Gallo -Belgicae* :509. 1768. -*Physcia orbicularis* Poetsch in Poetsch & Schiederm, *System Aufzählung Samenlos. Pflanzen.* :247. 1872.

Thallus loosely attached, growing in small orbicular patches, pale grey to dark brown, ca. 3 cm across; lobes radiating, discrete, rarely overlapping, subdichotomously branched, up to 1 mm wide; upper surface plane, emaculate, epruinose; soralia laminal to submarginal; soredia maculiform or capitate, granular, white to dark brown; medulla white; lower surface black with paler margin, rhizinate; rhizines black, ca. 1 mm long, occasionally projecting beyond margin; upper and lower cortex paraplectenchymatous. Apothecia not seen. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; no lichen substances present.

It sparsely grows on tree trunks in temperate areas.

Distribution : India (Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Manipur, Nagaland and Uttaranchal), Fennoscandia region, New Zealand and United States of America.

Specimen examined: North Sikkim: Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1629.

6. *Phaeophyscia pyrrhophora* (Poelt) Awasthi & Joshi, Ind. Mycol. Res. 16(2):278, 1978. -*Physcia pyrrhophora* Poelt, Khumbu Himal 6:84, 1974.

Thallus closely attached, growing in \pm orbicular patches, brownish grey, 3-6 cm across; lobes sublinear, irregularly branched, 2-3 mm wide, apices dissected; upper surface plane to concave, smooth, epruinose; rhizines black, often projecting beyond lower margin. Apothecia common, 1-3 mm diam., with rhizines at base; margin entire to lobulate; disc dark brownish, flat to convex, epruinose; spores *Pachysporia* type, 18-36 x 9-14 μ m. Chemistry: Cortex K-; medulla K+ red-violet, C-, KC-, P-; skyrin present.

It commonly grows on tree trunks in subtropical areas,

Distribution: India (Madhya Pradesh, Manipur, Nagaland, Sikkim and Uttaranchal), Japan and Nepal.

Specimen examined : East Sikkim : Tumin, Chatterjee & Divakar 20-77084/B (LWG).

4. *Physcia* (Schreber) Michaux

Thallus foliose, whitish grey to dark grey, more or less loosely appressed to the substratum, lobate; lobes irregularly branched, ascending in apical parts; upper surface sometimes with a white pruina, isidia and soredia present or absent; medulla white; lower surface white to pale brown with whitish to dark brown sparse rhizines; upper cortex paraplectenchymatous; photobiont green, *Trebouxia*; lower cortex prosoplectenchymatous or rarely paraplectenchymatous. Apothecia lecanorine, laminal, sessile or short stalked; disc brown to black, sometimes with a white pruina; epithecium K-; hymenium I+ blue; hypothecium colourless to pale; asci 8 -spored; spores brown, 2 -celled, thick -walled, *Physcia*

or *Pachysporia* type; paraphyses branched, thickened and brown towards apices. Pycnidia immersed except for the blackened tips; conidia subcylindrical, more than 4 μ m long. Atranorin always present in the cortex, often also with zeorin or other terpenoids.

A cosmopolitan genus usually distributed in temperate regions of the world. About 19 species known from India and 5 species from Sikkim.

Key to the species

- 1a. Thallus sorediate 2
 1b. Thallus lacking soredia or isidia; lobes with
 subrotund apices 2. ***P. dilatata***
 2a. Soredia marginal or apical 3
 2b. Soredia laminal 4
 3a. Medulla K+ yellow 3. ***P. dimidiata***
 3b. Medulla K- 4. ***P. tribacia***
 4a. Upper surface white maculate 1. ***P. caesia***
 4b. Upper surface emaculate 5. ***P. tribacoides***

1. *Physcia caesia* (Hoffm.) Frnkr., Naturhist. Topogr. Regensburg 2: 250. 1839; Kashiwadani, Ginkgoana 3: 26. 1975; Moberg, Symb. Bot. Upsal. 22(1): 64. 1977. - *Lichen caesius* Hoffm., Enum. Lich.: 65, tab.12, fig. 1. 1788. (Fig. 77)

Thallus closely adpressed, mostly orbicular in outline, whitish grey, 3-5 cm across, lobes radiating, convex to concave, imbricate, overlapping in centre, usually discrete at periphery, eciliate, rounded at tips, 1-1.5 mm wide; upper surface densely white maculate, epruinose; soralia marginal on short lobes, lip-shaped or orbicular, soredia farinose; medulla white; rhizines simple to furcated, brown black, ca. 1 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K- or K+ pale, C-, KC-, P-; atranorin, zeorin present.

It commonly grows in temperate-alpine regions on exposed boulders.

Distribution: India (Himachal Pradesh, Manipur and Nagaland), Japan. East Africa; Europe, North America and Antarctica.

Specimens examined: *North Sikkim:* Theu La base camp, south side, alt. 4500 m, Sinha 1679. Yomesamdong, Hot Spring surroundings, alt. 4530 m, Sinha 1253. *West Sikkim:* On way between Dzongri-Thangsing, alt. 3900-3500 m, Sinha 796. On way between Thangsing-Samiti foot track, alt. 3700 m, Sinha 840.

2. *Physcia dilatata* Nyl., Syn. Lich. 1: 423. 1860; Moberg, Nord. J. Bot. 6(6): 855. 1986.

Thallus loosely attached, orbicular to irregular in outline, whitish grey to grey, 3-5 cm across; lobes imbricate, sinuate lobate, apically subrotund, margin slightly incised, up to 5 mm wide; upper surface heavily rugose in older parts, smooth in apical region, faintly pruinose; medulla white; rhizines grey to dark grey, simple, 1-2 mm long. Apothecia many, crowded, constricted at base, 1-2.5 mm diam.; margin thick, entire; disc flat to concave, blackish brown, epruinose; thalline exciple pruinose; spores *Phycia* type, 26-32 x 10-12 μ m. Pycnidia common; conidia 4 x 1 μ m. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P-; atranorin and zeorin present.

It commonly grows in subtropical-temperate regions on tree trunks in shady places.

Distribution: India (Himachal Pradesh, Manipur, Nagaland and Uttaranchal) and tropical East Africa.

Specimens examined: West Sikkim: Karchi village surroundings, alt. 2000 m, Sinha 450. On way between Narkhola and Karchi village, alt. 2100-1800 m, Sinha 350. Sombaria, Forest Rest House compound, alt. 1700 m, Sinha 1291.

3. *Phycia dimidiata* (Aronld) Nyl. in Hue, Rev. Botan. 5:9. 1886-87. -*Parmelia pulverulenta* var. *dimidiata* Aronld, Flora 47:594. 1864.

Thallus \pm closely adnate, greyish white, 2-3 cm across; lobes convex, pinnately branched, 0.5-1 mm wide; upper surface plane, pruinose; soralia marginal or apical; soredia granular; medulla yellowish; lower surface dusty white; rhizines sparse, up to 1 mm long; upper cortex paraplectenchymatous, lower cortex prosoplectenchymatous. Apothecia not seen. Chemistry : Cortex K+ yellowish; medulla K+ yellow, C-, KC-, P+ pale yellow; atranorin present.

It sparsely grows on trees in subtropical areas.

Distribution: India (Himachal Pradesh, Madhya Pradesh and Sikkim); Europe and Mediterranean region.

Specimen examined: East Sikkim: Pakyong, Chatterjee & Divakar 20-77113 (LWG).

4. *Phycia tribacia* (Ach.) Nyl., Flora 57:48. 1874; Awasthi, J. Ind. Bot. Soc. 39(1); 11.1960. -*Lecanora tribacia* Ach., Lich. univ. :415. 1810.

Thallus orbicular to irregular, whitish grey, 1-3 cm across; lobes dichotomously or irregularly branched, broadened near apices, 1-2 mm wide; upper surface plane or \pm convex; soralia marginal; soredia coarsely granular; medulla white; lower surface white to grey or brownish; rhizines sparse, pale, up to 1.5 cm long; upper and lower cortex paraplectenchymatous with rounded cells. Apothecia and pycnidia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC-, P-; atranorin, zeorin and leucotylin present.

It sparsely grows on tree trunks as well as on rocky outcrops in subtropical areas.

Distribution : India (Himachal Pradesh, Madhya Pradesh, Sikkim and Tamil Nadu), Japan, Nepal, East Africa, Europe and North America.

Specimen examined: East Sikkim: Pakyong, Chatterjee & Divakar 20-77088 (LWG).

5. ***Physcia tribacoides*** Nyl., Flora 57:307, 1874; Kashiwadani, Ginkgoana 3:38, 1975.

Thallus closely adpressed, occurring in orbicular patches, whitish grey, 3-4 cm across; lobes dichotomously branched, imbricate centrally. 0.8-1.2 mm wide; upper surface \pm convex, emaculate, epruinose; soralia large, laminal, whitish grey, capitate; medulla white; lower surface pale brownish, moderately rhizinate; rhizines simple to branched, greyish, 0.5-1 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K+ yellow, C-, KC-, P-; atranorin and zeorin present.

It sparsely grows on boulders in temperate areas.

Distribution: India (Himachal Pradesh, Manipur, Nagaland and Tamil Nadu), Japan; Europe and North America.

Specimen examined: North Sikkim: Theu La to Jakthang way, alt. 4600-3400 m, Sinha 1723.

5. ***Physconia*** Poelt

Thallus foliose, loosely attached, grey brown to dark brown, usually with a whitish pruina, lobate, lobe margin ciliate; upper cortex thick, scleroplectenchymatous or paraplectenchymatous; lower cortex prosoplectenchymatous, black and distinct or whitish and indistinct, rarely absent. Apothecia lecanorine, often with lobules on the margin; asci 8-spored; spores brown, 1-septate, uniformly thick walled 'Physconia type' usually more than 27 μ m long and 15 μ m wide; paraphyses brown and thickened at apices. Pycnidia \pm immersed; conidia subcylindrical, 4-7 x 1-2 μ m. Atranorin absent, several unknown lichen substances reported.

A genus primarily separated from *Physcia* by the absence of apical thickening in the spores and their thick and broad septum and by absence of atranorin in the thallus. It is represented by ca. 15 species in the world; 3 species in India and 2 in Sikkim.

Key to the species

- 1a. Thallus sorediate 1. ***P. detersa***
 1b. Thallus lacking soredia 2. ***P. muscigena***



Fig. 76. *Phaeophyscia endococcinodes*. **Fig. 77.** *Physcia caesia*. **Fig. 78.** *Pyxine subcinerea*. **Fig. 79.** *Peltigera polydactyla*.

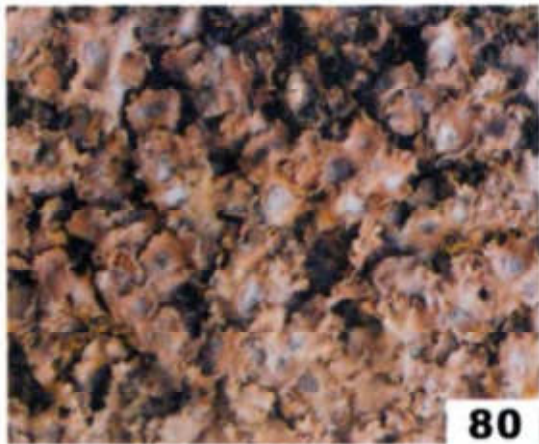


Fig. 80. *Solorina crocea*. **Fig. 81.** *Lobaria retigera*. **Fig. 82.** *Pseudocyphellaria aurata*. **Fig. 83.** *P. clathrata*.

1. *Physconia detersa* (Nyl.) Poelt, Nova Hedwigia 9:30. 1965. -*Parmelia pulverulenta* var. *detersa* Nyl., Syn. Lich. 1:420. 1860. -*Physcia detersa* (Nyl.) Nyl., Flora 52:332. 1869; Awasthi, Journ. Indian Bot. Soc. 39(1):11. 1960.

Thallus adpressed, in suborbicular patches, grey brown to dark brown, up to 4 cm across; lobes elongated, appressed, up to 1.3 mm wide, usually distinctly separated; upper surface smooth, concave from the above, densely white to blue white pruinose in peripheral parts; soredia marginal, coarse; lower surface black up to the tip; rhizines black, squarrose; upper cortex scleroplectenchymatous; medulla white; lower cortex prosoplectenchymatous. Apothecia and conidia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It sparsely grows on tree trunks in temperate areas.

Distribution: India (Himachal Pradesh and Jammu & Kashmir); Europe and N. America.

Specimen examined: North Sikkim: Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1630.

2. *Physconia muscigena* (Ach.) Poelt, Nova Hedwigia 9:30.1965. -*Parmelia muscigena* Ach., Lich. univ. :472. 1810. -*Physcia muscigena* (Ach.) Nyl., Mem. Soc. Imp. Sci. Nat. Cherbourg 5:107.1857; Awasthi, Journ. Indian Bot. Soc. 39(1):14.1960.

Thallus loosely attached, dark brown to slate grey, 3-5 cm across; lobes 1-2 mm wide at margin, more narrower towards centre, margin ascending; upper surface with dense whitish pruina; lower surface black except narrow brown margin; rhizines black, ca. 1 mm long, squarrosely branched; thallus 136-150 μ m thick; upper cortex paraplectenchymatous; medulla white; lower cortex brown, prosoplectenchymatous. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It commonly grows among mosses directly on ground or amongst moss covered rocks in alpine areas of North Sikkim.

Distribution: India (Himachal Pradesh, Jammu & Kashmir and Uttaranchal), temperate regions of N. hemisphere.

Specimen examined: North Sikkim: I.lonakh valley, Muguthang, alt. 4500 m, Sinha 1562 (det. T. L. Esslinger).

6. *Pyxine* Fr.

Thallus foliose, corticolous or saxicolous, loosely to closely adpressed to the substratum, glaucous grey to greyish; lobes radiating, subdichotomously to irregularly branched, discrete at periphery; upper surface apically to subapically pruinose, maculate; pseudocyphallae usually marginal, sometimes laminal or

absent; soredia and isidia present or absent; medulla white, yellow or red; lower surface black; rhizines black; upper cortex pale greyish, paraplectenchymatous; photobiont green, *Trebouxia*; lower cortex black, prosoplectenchymatous. Apothecia laminal, lecanorine, lecideine in appearance; margin black, entire; epithecium brown, K+ purple-violet; hypothecium brown, K+ red; asci 8-spored; spores brown, transversely 2-celled, thick walled, *Physeia* type; paraphyses branched or furcated apically.

About 35 species known from the world; 23 species in India and 3 species in Sikkim

Key to the species

- 1a. Thallus isidiate 1. ***P. retirugella***
 1b. Thallus sorediate 2
 2a. Thallus UV+; soredia yellowish 3. ***P. subcinerea***
 2b. Thallus UV-; soredia whitish grey to bluish 2. ***P. sorediata***

1. *Pyxine retirugella* Nyl., Ann. Sci. Nat. Bot. ser. 4 (11): 240. 1859-*Pyxine consocians* Vainio, Philipp. J. Sci., Sect. S, 8: 109. 1913; Awasthi, Phytomorph. 30: 370. 1980.

Thallus ± closely adpressed, greyish, 3-6 cm across; lobes radiating, imbricate, confluent, 1-1.5 mm wide, margin incised; upper surface plane, maculate; maculae linear to reticulate, marginal to laminal, sometimes develop into pseudocyphellae; isidia marginal to laminal, apically bursting into crateriform structure with granular soredia; medulla white, stramineous to orange at some places; rhizines black, squarrosely branched, ca. 1 mm long. Apothecia sparse, constricted at base, ca. 1 mm diam.; margin prominent in young apothecia, later excluded; disc convex, brown black, epruinose; hypothecium brown black, lenticular, internal stipe colourless, K-; spores 12-16 x 7-8 µm. Chemistry: Cortex K+ yellow, UV-; medulla K+ yellow to red, C-, KC-, P+ orange; atranorin, norstictic acid and terpenes present.

It commonly grows on boulders in exposed places along roadside in subtropical areas.

Distribution: India (Andaman Islands, Manipur, Nagaland and Sikkim), Philippines; Australia & East Africa.

Specimens examined: West Sikkim: Sombaria, near Forest Rest House, alt. 1750 m, Sinha 1301, 1302.

2. *Pyxine sorediata* (Ach.) Mont. in Sagra, Hist. Cuba Bot. 9: 188. 1842; Awasthi, Phytomorph. 30: 378. 1980. -*Lecidea sorediata* Ach., Syn. Lich. :54. 1814.

Thallus closely adpressed, ashy grey, *ca.* 5 cm across; lobes radiating, compact, imbricate in central part, discrete at periphery, 1-1.5 mm wide, margin incised; upper surface smooth, plane to concave; pseudocyphellae white, marginal; soralia marginal, develop in pseudocyphellae region, later spreading on the lamina, orbicular to concrescent, whitish grey to bluish grey; soredia granular to powdery; medulla yellow; rhizines squarrosely branched, 1-2 mm long. Apothecia not seen. Chemistry: Cortex K-, UV-; medulla K-, C-, KC-, P-; terpenes present.

It sparsely grows on trees in open and shady places.

Distribution: India (Manipur, Nagaland, Tamil Nadu and West Bengal); widely distributed throughout the world in tropical and subtemperate regions.

Specimen examined: North Sikkim: Lachung to Yumthang, L.K. Rai 1348.

3. *Pyxine subcinerea* Stirton, Trans. Proc. N.Z. Inst. 30: 397. 1898; Awasthi, Phytomorph. 30: 379. 1980. (Fig. 78)

Thallus closely to loosely adpressed, occurring in orbicular to irregular patches, whitish grey, 5-10 cm across; lobes radiating, imbricate, 1-2 mm wide, margin ascending; upper surface plane to concave; soralia orbicular to irregular, marginal, later spread on the lamina; soredia whitish, granular; pseudocyphellae marginal; medulla yellow; rhizines simple to branched, *ca.* 1 mm long. Apothecia not seen. Chemistry: Cortex K-, UV+ yellow; medulla K-, C-, KC-, P-; lichexanthone and terpenes present.

It commonly grows on trees in open places between 600-1300 m elevations.

Distribution: India (Himachal Pradesh, Madhya Pradesh, Manipur, Nagaland, Uttaranchal and West Bengal); subtropical and warm temperate regions of the world.

Specimens examined: East Sikkim: North Regu, near Chhubba village, alt. 1000-1300 m, Sinha 96. South Sikkim: Jorethang-Namchi road, alt. 650 m, Sinha 4, 5.

PELTIGERACEAE

1. *Peltigera* Willd.

Thallus foliose, dorsiventral, heteromerous, forming compact to very wide spreading rosettes; lobes rounded or \pm elongate, discrete, contiguous or overlapping; upper surface smooth to scrobiculate, tomentose or etomentose, bluish, brownish or reddish brown, corticate; cortex colourless to pale brownish, paraplectenchymatous, many layered, composed of isodiametric or vertically elongated cells; photobiont blue green *Nostoc* or green *Protococcus*; medulla white, loosely interwoven; lower surface ecorticated, veined; rhizines simple to fasciculate or fibrillose. Apothecia hemiangiocarpic, saddle-shaped, flattened or

oval, marginal to submarginal, horizontal or on vertical ascending lobules; margin sometimes reflexed; disc red brown or brown black, epruinose; exciple indistinct at base, marginally paraplectenchymatous, composed of isodiametric to vertically elongated cells; asci 8-spored; spores colourless or brown, fusiform or acicular, transversely 3-9-septate; parphyses simple.

About 300 species widely distributed at higher elevations in tropical and temperate zone of the world; 17 species in India and 10 in Sikkim.

Key to the species

- 1a. Thallus sorediate 2. **P. collina**
 1b. Thallus lacking soredia 2
 2a. Thallus isidiate or with squamules 9. **P. praetextata**
 2b. Thallus lacking isidia and squamules 3
 3a. Upper surface tomentose, at least in upper margin 4
 3b. Upper surface lacking tomentum 6
 4a. Lobes with frilled margin; veins on lower surface
 parallelly arranged 10. **P. rufescens**
 4b. Lobes and veins on lower surface otherwise 5
 5a. Veins flattened; rhizines simple to fasciculate 1. **P. canina**
 5b. Veins raised; rhizines fibrillose, finely penicillate 7. **P. membranacea**
 6a. Apothecia horizontal; spores fusiform, 3-septate 4. **P. horizontalis**
 6b. Apothecia vertical; spores acicular, more than
 3-septate 7
 7a. Thallus lower surface veined; veins usually black
 or brown black 8
 7b. Thallus lower surface not veined 6. **P. malacea**
 8a. Rhizines simple, usually more than 5 mm long 9
 8b. Rhizines fasciculate, less than 5 mm long 8. **P. polydactyla**
 9a. Rhizines sparse, up to 10 mm long 3. **P. dolichorrhiza**
 9b. Rhizines dense, confluent, 5-8 mm long 5. **P. macra**

1. **Peltigera canina** (L.) Willd., Fl. Berol. Prod.:347. 1787; Awasthi & Joshi, Kavaka 10: 49. 1982. -*Lichen caninus* L., Sp. Pl. : 1149. 1753.

Thallus loosely attached, irregularly spreading, 5-8 cm across; lobes irregularly branched, apices broader, 5-15 mm wide, greenish grey when wet, brownish grey when dry; margin crenate, wavy, recurved in apical region, sometimes cracked, dull or shiny, epruinose, marginally tomentose; lower surface forming a net work of white to pale brown \pm flattened veins and pale brown large interspaces; rhizines simple to fasciculate, pale brown to greyish black, 1-5 mm long. Apothecia brown, singly on extended lobules, 2-6 mm diam.; margin creamish brown, minutely crenate; disc reddish brown to dark brown, slightly convex to longitudinally reflexed; spores acicular, transversely 3-5 -seporate, 35-72 x 3-4 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It commonly grows in moist places on ground as well as on mossy boulders.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal); widely distributed in Bhutan, Japan, Nepal, Europe and North America.

Specimens examined: *East Sikkim:* Gangtok, near Burtuk, alt. 1700 m, Sinha 90. Near Mulkhark lake around West Bengal border, alt. 2200-2300 m, Sinha 553. *North Sikkim:* Lachen, Gumpa side forest, alt. 2700 m, Sinha 1545. Lachung, along road side, alt. 2500 m, Sinha 1034. Near Zema -I, alt. 2750 m, Sinha 1520. *West Sikkim:* Near Kongri village, alt. 2000 m, Sinha 324. Labdang forest, alt. 1900-2000 m Sinha 458.

2. ***Peltigera collina*** (Ach.) Schrader, J. Bot. 1:78. 1801; Awasthi & Joshi, Kavaka 10:51.1982. -*Lichen collinus* Ach., Lich. suec. Prodr. :162. 1798.

Thallus loosely or closely attached, 7-9 cm across, growing in orbicular patches, brown to chestnut brown; lobes imbricate, flat, 5-10 mm wide, curled and crisped at margins; upper surface smooth, epruinose, etomentose; soralia marginal or submarginal, in rounded masses; soredia granular, grey; lower surface with indistinct brown to dark brown veins, interspaces yellowish white, cottony; rhizines 1-2.5 mm long, dark brown to blackish, fasciculate or fibrillose. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; tenuiorin, zeorin and unidentified substances present.

It sparsely grows in temperate areas on rotting logs and on rocks in open moist places.

Distribution: India (Tamil Nadu); circumpolar, but common in coastal areas of Europe and N. America.

Specimens examined: *North Sikkim:* Theu La base camp, south side, along river bed, alt. 4500 m, Sinha 1706. *West Sikkim:* Near Bakhim, alt. 2700 m, Sinha 269.

3. *Peltigera dolichorrhiza* (Nyl.) Nyl., Lich. Nova Zealand :43. 1888; Awasthi & Joshi, Kavaka 10: 51. 1982. -*Peltigera polydactyla* var. *dolichorrhiza* Nyl., Syn. Lich. 1: 327. 1860.

Thallus loosely attached, growing in large irregular patches, pale brown to brownish black, 10-25 cm across; lobes elongated with broad apices, discrete, imbricate, 5-25 mm wide; margin wavy to crisped, sinuous, lobulate; upper surface \pm scrobiculate, tomentose, dull; lower surface pale brown to brown, veins distinctly reticulate, slightly raised with large interspaces; rhizines dark brown to blackish, sparse to dense, simple, 3-10 mm long. Apothecia numerous, vertical, borne singly or in pairs or in groups on extended lobules, oblong, 3-4 x 2.5-3 mm; margin pale brown, minutely crenate; disc reddish brown to blackish, convex to reflexed; spores acicular, transversely 5-8 -septate, 40-90 x 3-4 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; tenuiorin and dolichorrhizin present.

It commonly grows on ground and boulders mainly along the streams in the temperate areas.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Jammu & Kashmir, Meghalaya, Nagaland, Sikkim, Uttaranchal and West Bengal), Bhutan, Japan and plaeotropical regions of the world.

Specimens examined: East Sikkim: On way between South Regu-Picrae forest, alt. 1900 m, Sinha 502. North Sikkim: Tholung-Kissong way, alt. 2475-2700 m Sinha 617.

4. *Peltigera horizontalis* (Huds.) Baumg., Fl. Lips. :562. 1790; Awasthi & Joshi, Kavaka 10:53. 1982. -*Lichen horizontalis* Huds., Fl. Angl.:543. 1762.

Thallus loosely adnate, greenish grey when wet, brownish grey when dry, up to 10 cm across; lobes flat, thick, discrete to imbricate, 5-25 mm wide, margin wavy, usually ascending; upper surface smooth, shining, epruinose, tomentose; lower surface with broad flat veins forming an almost confluent tomentum; veins brown to black; interspaces small, pale brown; rhizines sparse, black, fasciculate, up to 5 mm long. Apothecia horizontal, at the edges of lobes or on short extended lobules, rounded, 3-6 mm across, margin crenate; disc reddish brown to dark brown; spores fusiform, transversely 3 -septate, 25-38 x 3.5-6 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; tenuiorin, zeorin and other unknown substances present.

It sparsely grows on soil, among mosses and over rocks in subtropical areas.

Distribution : India (Himachal Pradesh, Jammu & Kashmir, Sikkim and Uttaranchal); Europe and America.

Specimen examined: East Sikkim: Gangtok, Baluakhani, Chatterjee & Divakar 20-77013 (LWG).

5. **Peltigera macra** Vainio, Phillip. J. Sci. Sect. C, 8(2):114. 1913; Awasthi & Joshi, Kavaka 10:55. 1982.

Thallus closely adpressed, pale brown to brown, up to 3 cm across; lobes flat, discrete, 5-10 mm wide, margin entire to wavy; upper surface smooth, epruinose, etomentose; lower surface pale brown to brown with concolorous reticulate veins at margin, veins brownish black, diffused in central part; rhizines simple, dense, confluent, 5-8 mm long, sometimes penicillate. Apothecia vertical, on extended lobules, rounded, 2-4 mm across; disc reddish brown; spores acicular, usually curved, transversely 5-7 -septate, 43-72 x 5 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; tenuiorin, dolichorrhizin and an unidentified substance present.

It sparsely grows on soil in subtropical areas.

Distribution : India (Meghalaya and Sikkim), Philippines.

Specimen examined: East Sikkim: Gangtok, near Bhusuk, Upreti & Chatterjee 01-26627(LWG).

6. **Peltigera malacea** (Ach.) Funck, Krypt. Gew. 33: 5. 1827; Awasthi & Joshi, Kavaka 10: 55. 1982. -*Peltidea malacea* Ach., Syn. Lich.: 240. 1814.

Thallus loosely attached, rigid, brownish, ca. 5 cm across; lobes flat, discrete, 6-12 mm wide; margin wavy, sometimes inrolled; upper surface dull to shining towards centre, irregularly cracked, etomentose, marginally slightly pruinose; lower surface brown to brown black, veins absent or indistinct; rhizines sparse, fasciculate, 2-8 mm long. Apothecia vertical, borne on extended lobules, rounded to oblong, 2-5 x 2-3 mm; margin \pm entire, sinuous; disc reddish brown to brown, epruinose; spores acicular, transversely 4-6 -septate, 45-70 x 3-6 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; tenuiorin and unidentified substances present.

It sparsely grows on ground in moist places in temperate regions.

Distribution: India (Himachal Pradesh, Sikkim and West Bengal), Japan, Nepal; temperate Europe, North America.

Specimens examined: East Sikkim: Gangtok, Tashi view point surroundings, alt. 2000 m, Sinha 96. West Sikkim: On way between Narkhola-Kholak harka forest, alt. 2000-2200 m, Sinha 416.

7. **Peltigera membranacea** (Ach.) Nyl., Bull. Soc. Linn. Normandie, ser. 4, 1: 74. 1887. Awasthi & Joshi, Kavaka 10: 57. 1982. -*Peltidea canina* var. *membranacea* Ach., Lich. univ. : 518. 1810.

Thallus loosely attached, spreading, pale brown to brownish, up to 10 cm across; lobes \pm discrete to imbricate, flat, 20-30 mm wide, margin entire, sinuous, often ascending; upper surface slightly arachnoid tomentose towards margin,

weakly scrobiculate, shining at the central part, epruinose; lower surface pale brown, veins reticulately elevated, brown in the central part, indistinct in the marginal region due to dense fuzzy growth of rhizines; rhizines 2-8 mm long, simple. Apothecia on extended ascending lobules, rounded, 4-6 mm, often reflexed; margin pale, crenulate, thin; disc reddish brown to dark brown; spores acicular, transversely 5-7-septate, 35-60 x 3-4 μm . Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It sparsely grows on the ground in moist shady places.

Distribution: India (Sikkim, Uttaranchal and West Bengal), Japan, New Zealand; Europe, North & Central America.

Specimens examined: South Sikkim: Jorethang, alt. 600 m, Sinha 60. West Sikkim: Tashiding Monastery surroundings, alt. 1600 m, Sinha 320.

8. *Peltigera polydactyla* (Neck.) Hoffm., *Descr. adumb. Lich.* 1: 19. 1790; Awasthi & Joshi, *Kavaka* 10: 58. 1982. -*Lichen polydactylon* Neck., *Meth. Musc.* :85. 1771.

Key to the varieties

- 1a. Upper surface pruinose; pruina found as spots or extensive on lamina 8.2. var. **pruinosa**
 1b. Upper surface epruinose 8.1. var. **polydactyla**

8.1. var. *polydactyla* (Fig. 79)

Thallus \pm closely attached, thick, coriaceous, irregularly spreading, greyish brown to brown, ca. 12 cm across; lobes flat, rotund to sub-rotund, discrete, 6-25 mm wide; margin crenate to wavy, rarely revolute; upper surface often fissured, etomentose, epruinose; lower surface with broad, flat, brown black veins, distinctly reticulate in younger parts and diffused in older parts, interspaces small; rhizines short, sparse, fasciculate, up to 5 mm long. Apothecia vertical, borne in groups of 2-7 on narrow erect lobules, oval to oblong, 3-7 x 2-4 mm, young apothecia revolute, later longitudinally reflexed; margin thin, entire, sinuous; disc pale brown to dark brown; spores acicular, straight to curved, transversely 5-9 septate, 35-90 x 3-5 μm . Chemistry: Cortex and medulla K-, C-, KC-, P-; tenuiorin, dolichorrhizin and 2 unidentified substances present.

It commonly grows on ground, over mossy boulders in moist places.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Meghalaya, Sikkim, Uttaranchal and West Bengal). Cosmopolitan.

Specimens examined: South Sikkim: Namchi-Old Damthang road, alt. 1700-2000 m, Sinha 45. West Sikkim: Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 181, 182.

8.2. var. pruinosa Gyelnik, Magy. Bot Lap. 25: 253. 1926; Awasthi & Joshi, Kavaka 10: 59. 1982.

The var. *pruinosa* differs from var. *polydactyla* in presence of scattered pruinosity on upper surface which may be found as spots or extensive. Chemically both the varieties are identical.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Sikkim, Uttaranchal and West Bengal), Japan, Nepal.

Specimen examined: South Sikkim: Teri Tea Estate, alt. 1300 m, Sinha 47.

9. Peltigera praetextata (Flörke) Vainio, Termeszetr. Fuz. 22:306. 1899; Awasthi & Joshi, Kavaka 10:59. 1982. -*Peltigera ulorrhiza* var. *praetextata* Flörke in Sommerf., Suppl. Fl. Lapon.:123. 1826.

Thallus loosely adnate, spreading, greyish brown, ca. 5 cm across; lobes 5-15 mm wide, discrete, flat, margin crenate to wavy; upper surface smooth, marginally tomentose; isidia marginal or along the margin of cracks, squamuliform, up to 1 mm; lower surface pale brown, veins indistinctly reticulate; rhizines simple, 2-4 mm long. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It sparsely grows on mossy rocks in open moist places of temperate areas.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Nagaland and Uttaranchal), Japan; Europe and America.

Specimen examined: North Sikkim: Lachen, Gumpa side forest, alt. 2700 m, Sinha 1546 A.

10. Peltigera rufescens (Weis.) Humb., Fl. Frib. Spec. :2. 1793; Awasthi & Joshi, Kavaka 10:60. 1982. -*Lichen caninus* var. *rufescens* Weis., Plant. Crypt. Fl. Goetting :79. 1770.

Thallus loosely adnate, growing in irregular patches, pale brown to brownish, 5-8 cm across; lobes flat, discrete, up to 10 mm wide, margin wavy, crisp, crenate to frilled, reflexed or deflexed; upper surface smooth to rough, distinctly tomentose in apical part and on fertile lobes, tomentose part appearing arachnoid or areolate; lower surface pale brown, with dense, ± parallel anastomosing veins; rhizines simple, up to 3.5 mm long. Apothecia vertical on extended lobules, rounded, up to 6 mm across; disc reddish brown; spores acicular, transversely 5-7 -septate, 45-61 x 3-5 µm. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It sparsely grows on mossy rocks in temperate areas.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Nagaland and Uttaranchal). Cosmopolitan.

Specimen examined: West Sikkim: Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1323.

2. *Solorina* Ach.

Thallus foliose, dorsiventral, heteromerous, wide spreading or in rosettes, lobate; lobes rounded, margin slightly raised; upper surface smooth to scabrid, matt or slightly shining, green grey, \pm bright green when wet; photobiont green, *Coccomyxa*, in a continuous layer below upper cortex; internal or external blue grey cephalodia containing *Nostoc* also present; lower surface tomentose and obscurely veined. Apothecia rounded, irregularly scattered, impressed to \pm deeply immersed on the upper surface; disc dark red-brown, slightly to very deeply concave; thalline exciple absent; asci clavate, 2-8 -spored; spores brown, ellipsoid to fusiform, 1 -septate, surface ornamented or \pm warted.

A genus of ca. 10 species in the world; 3 species in India and 2 species in Sikkim.

Key to the species

- 1a. Lower surface bright orange; asci 8-spored;
spores 32-50(-60) x 13-17 μ m 1. *S. crocea*
- 1b. Lower surface white or pale; asci 4-spored;
spores 25-35 x 9-18 μ m 2. *S. saccata*

1. ***Solorina crocea*** (L.) Ach., Lich. univ.:149.1810. -*Lichen croceus* L., Sp. Pl.: 1149. 1753. (Fig. 80)

Thallus growing in extensive orbicular patches, olive green when wet, brown when dry, ca. 15 cm across; lobes rounded, 3.5-5 mm wide; margin weakly indented, raised, subapically pruinose, rather scabrid; cephalodia internal in ovoid colonies above lower surface; medulla white; lower surface bright orange, tomentose with a reticulum of brown veins. Apothecia frequent, dark brown, deeply sunk in depression in upper surface, oblong to round, plane, up to 5 mm diam.; asci 8 -spored; spores 32-50(-60) x 13-17 μ m. Chemistry: Cortex and medulla K+ purple, C-, KC-, P-; solorinic acid present.

It sparsely grows on mossy rocks in moist places in temperate areas.

Distribution: India (Himachal Pradesh and Sikkim), Japan, New Zealand; Europe, North America.

Specimen examined: North Sikkim: Tholung-Kissong foot track, Sinha 600.

2. ***Solorina saccata*** (L.) Ach., Kgl. Vetensk. Akad. Nya Handl.:228. 1808. -*Lichen saccatus* L., Flor. Suec., ed. 2:419. 1755.

Thallus spreading, bright green when wet, pale grey when dry, 6-10 cm across; lobes rounded, 4-8 mm wide, margin entire wavy, naked to densely white pruinose; cephalodia internal, scattered below photobiont layer; lower surface white or pale, densely tomentose, indistinctly veined; asci 4-spored; spores 25-

35 x 9-18 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It sparsely grows on soil in temperate and lower alpine areas.

Distribution: India (Sikkim, Tamil Nadu and Uttaranchal), Japan; Europe, North America.

Specimen examined: East Sikkim: Chhangu, Chatterjee & Divakar 20-77124 (LWG).

LOBARIACEAE

1. *Lobaria* (Schreber) Hoffm.

Thallus foliose, dorsiventral, heteromerous, irregularly spreading; lobes branched, the apices rounded or truncate, often incised; upper surface smooth, flat or scrobiculate, often with prominent depressions with a network of ridges; isidia or lobules present or absent; upper and lower cortici well differentiated, paraplectenchymatous; photobiont blue green, *Nostoc* or *Scytonema* or green *Trebouxia*; medulla white; lower surface pale brown to blackish, tomentose, rhizinate, cyphellae or pseudocyphellae absent. Apothecia hemiangiocarpic, lecanorine, laminal, subpedicellate, constricted at base, disc reddish brown, eperforate; hymenium 1+ blue; asci 8 -spored; spores colourless to pale brown, acicular or fusiform, transversely 2-7 -septate; paraphyses simple. Pycnidia immersed in thallii; conidia rod -shaped.

About 80 species in the world; 11 species in India and 5 in Sikkim.

Key to the species

- 1a. Thallus \pm smooth; photobiont green; tomenta diffuse 1. **L. discolor**
 1b. Thallus scrobiculate; photobiont blue green; tomenta
 not diffuse, in a network fashion 2.
 2a. Thallus isidiate 3.
 2b. Thallus lacking isidia 4.
 3a. Medulla K+ yellow to red, P+ yellow 2. **L. isidiosa**
 3b. Medulla K-, P- 5. **L. retigera**
 4a. Medulla K+ yellow to red, P+ yellow.....4. **L. pseudopulmonaria**
 4b. Medulla K-, P- 3. **L. kurokawae**

1. ***Lobaria discolor*** (Bory) Hue, Nouv. Arch. Mus. Hist. Nat., ser. 4, 3: 23. 1901; Yoshimura, Journ. Hattori Bot. Lab. 34: 263. 1971; Joshi & Awasthi, Biol. Mem. 7:168. 1982. -*Sticta discolor* Bory in Delise, Hist. Lich. Sticta: 136. 1882.

Thallus loosely attached, pale brown, ca 4 cm across; lobes rotundate, lacinate, 3-8 mm wide; margin entire to crenulate, ascending; upper surface plane to concave, smooth, shining; photobiont green; medulla white; lower surface pale brown at the margin, dark brown towards centre, tomentose, rhizinate; tomenta diffused, present only in older part, concolorous with lower surface; rhizines sparse, dark brown, ca. 2 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ red, P-; gyrorphoric acid present.

It sparsely grows on trees in open moist places.

Distribution: India (Arunachal Pradesh, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), Nepal, Indonesia, Madagascar; tropical America and tropical Asia.

Specimens examined: North Sikkim: Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1053. West Sikkim: Tashiding-Yoksum road, near Chongrung village, Sinha 303.

2. **Lobaria isidiosa** (Müll. Arg.) Vainio, Philipp. J. Sci. 8(C): 129. 1913; Yoshimura, Journ. Hattori Bot. Lab. 34: 295. 1971; Joshi & Awasthi, Biol. Mem. 7: 169. 1982. – *Stictina retigera* f. *isidiosa* Müll. Arg., Flora 65:300. 1882. – *Lobarina awasthiana* Räsänen, Arch. Soc. Zool. Bot. 'Vanamo' 5(1):28. 1950. – *Lobaria awasthiana* (Räsänen) Awasthi, Nova Hedwigia 17:72. 1965.

Thallus loosely attached, brown, 8-14 cm across; lobes divaricately to irregularly branched, up to 10 mm wide; upper surface scrobiculate; isidia submarginal to laminal, restricted on ridges, granular to cylindrical, simple to coralloid branched; photobiont blue green; medulla white; lower surface brown to black in grooves, pale brown on convexities, densely tomentose and rhizinate; tomenta veined type, bluish black, rhizines simple to branched, up to 5 mm long. Apothecia not seen. Chemistry: Cortex K-; medulla K+ red, C-, KC-, P+ yellow; norstictic acid and triterpenoids present.

It commonly grows on trees as well as on boulders in moist parts of temperate areas.

Distribution: India (Nagaland, Sikkim, Uttaranchal and West Bengal), Eastern Asia, Tropical America and Borbon Islands.

Specimens examined: North Sikkim: Bey surroundings, alt. 1600 m, Sinha 578. Tingbong, near Kusum village, alt. 1400 m, Sinha 643. Near Namprik village, alt. 1200 m, Sinha 662. South Sikkim: Damthang-Tendong foot track, 2000-2600 m, Sinha 128. West Sikkim: Labdang villagae surroundings, alt. 1850 m, Sinha 478. Labdang-Pokharidanda foot track, alt. 2000 m, Sinha 487.

3. **Lobaria kurokawae** Yoshimura, Journ. Hattori Bot. Lab. 34: 297. 1971; Joshi & Awasthi, Biol. Mem. 7: 169. 1982.

Thallus large, loosely attached, brown to brownish black, up to 30 cm across; lobes subdichotomously to irregularly branched, truncate, 8-25 mm wide; margin = rotund; upper surface scrobiculate, reticulately ridged; photobiont a blue green alga; medulla white; lower surface brown black to black; tomentum and rhizines netted type; rhizines black, branched, up to 3 mm long. Apothecia not seen. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; triterpenoids present.

It commonly grows on lower portion of trees as well as on ground along with mosses in temperate and sub alpine regions.

Distribution: India (Manipur, Nagaland, Sikkim, Uttaranchal and West Bengal), China, Japan, Nepal, Taiwan.

Specimens examined: *East Sikkim:* Near Mulkhark lake around West Bengal border, alt. 2200-2300 m, Sinha 546. *North Sikkim:* Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 613. *West Sikkim:* Tsoka-Phedang foot track, alt. 3050-3900 m, Sinha 228. Yoksum-Tsoka foot track, 1800-3050 m, Sinha 187.

4. *Lobaria pseudopulmonaria* Gyelnik, Acta Fauna Flora, Univers. ser. 2, 1(5-6): 6. 1933; Yoshimura, Journ. Hattori. Bot. Lab. 34: 291, 1971; Joshi & Awasthi, Biol. Mem. 7: 171, 1982.

Thallus large, loosely attached, brown to dark brown, 10-40 cm across; lobes divaricately to irregularly branched, apices truncate, 10-30 mm wide; upper surface scrobiculate, reticulately ridged; photobiont a blue green alga; medulla white; lower surface brown to black in grooves, pale brown on convexities, densely tomentose, sparsely rhizinate; rhizines black, simple to branched up to 2 mm long. Apothecia constricted at base, present on ridges in marginal to sub marginal region, 1.5-3.5 mm diam; margin entire; thalline exciple verruculose, connate with parathecium; disc flat to slightly convex; spores transversely 1-3 -septate, 24-35 x 7-9 μ m. Chemistry: Cortex K-; medulla K+ yellow-red, C-, KC-, P+ yellow-orange; constictic, norstictic, stictic acids and triterpenoids present.

It commonly grows on lower portion of trees especially on *Rhododendron* as well as on ground in moist places in temperate - sub alpine zone.

Distribution: India (Arunachal Pradesh, Manipur, Nagaland, Sikkim, Uttaranchal and West Bengal), Japan, Malaysia, Nepal, Taiwan, Alaska and New Guinea.

Specimens examined: *East Sikkim:* Near Mulkhark lake around West Bengal border, alt. 2200-2300 m, Sinha 547. *West Sikkim:* Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 241. Tsoka-Phedang foot track, alt. 3500-3900 m, Sinha 229. Karchi Reserve Forests, alt. 2100-2400 m, Sinha 392.

5. *Lobaria retigera* (Bory) Trevisan, Lichenotheca Veneta :75. 1869; Yoshimura, Journ. Hattori Bot. Lab. 34: 298. 1971; Joshi & Awasthi, Biol. Mem. 7: 172. 1982 - *Lichen retigera* Bory, Voyag. Princip. Iles Mers-d' Afrique 3: 101. 1804. (Fig. 81)

Thallus loosely attached, pale brown to dark brown, 5-20 cm across; lobes irregularly branched, imbricate, truncate, 10-25 mm wide; apices rotund; upper surface scrobiculate, reticulately ridged; isidia dense, usually distributed on reticulate ridges or along the cracks, simple to globular, cylindrical to coralloid branched, sometimes isidial tips ciliate; photobiont a blue green alga; medulla white; lower surface dark brown to black in grooves, pale brown on convexities, tomentose, rhizinate; tomenta netted type; rhizines simple or squarrose, pale brown to bluish, 1-2 mm long. Apothecia not seen. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; triterpenes present.

It commonly grows on tree trunks, on boulders as well as on grounds in moist open and humid places of subtropical and temperate areas..

Distribution: India (Arunachal Pradesh, Assam, Himachal Pradesh, Manipur, Meghalaya, Sikkim, Tamil Nadu, Uttaranchal and West Bengal), tropical and subtropical regions of Bhutan, Japan, Nepal, South Africa, Australia and North America.

Specimens examined: *East Sikkim:* Mulkhark lake around West Bengal border, alt. 2200-2300 m, Sinha 545. *North Sikkim:* Tholung-Kissong foot track, alt. 2400-2700 m, Sinha 606. *West Sikkim:* Tashiding-Yoksum road, near Chongrung village, alt. 1500 m, Sinha 299. Tashiding Monastery surroundings, alt. 1600 m, Sinha 156. Pemayangtse Monastery surroundings, alt. 2075 m, Sinha 174. Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 186. Karchi Reserve Forest, alt. 2100-2400 m, Sinha 391.

2. *Pseudocyphellaria* Vainio

Thallus foliose, dorsiventral, heteromerous, lobate, spreading, ± rosette forming or irregularly branched, loosely attached; lobes rounded or truncate, variously indented, often ascending at margins; corticated on both surfaces; cortici paraplectenchymatous; upper surface smooth or wrinkled, ± scabrid or hairy, often deeply or shallowly foveolate, with or without pseudocyphellae, isidia or soredia; photobiont green, *Dictyochloropsis* or *Chlorella* like or blue green *Nostoc*; medulla white or yellow; lower surface usually tomentose, dotted with scattered pseudocyphellae; pseudocyphellae white or yellow; immersed in tomenta or raised, conical, rounded to irregular. Apothecia hemiangiocarpic, emergent, sessile to pedicellate, laminal or marginal; thalline exciple well developed; asci 8 -spored; spores colourless or brown, polarilocular to transversely 3 -septate. Pycnidia very rare; conidia bacilliform.

About 200 species in the world predominantly in the southern hemisphere, particularly in temperate and rain forest areas; 5 species in India and 2 species in Sikkim.

Key to the species

- 1a. Photobiont blue green, thallus sorediate 1. **P. aurata**
 1b. Photobiont green; thallus lacking soredia 2. **P. clathrata**

1. **Pseudocyphellaria aurata** (Ach.) Vainio, *Etud. Lich. Bresil* 1: 183. 1890; Joshi & Awasthi, *Biol. Mem.* 7: 174. 1982. -*Sticta aurata* Ach., *Meth. Lich.*: 277. 1803.
 (Fig. 82)

Thallus \pm loosely attached, ochraceous brown, ca. 4 cm across, coriaceous, irregularly spreading; lobes irregularly branched, imbricate, discrete at periphery, 2-6 mm wide; margin slightly thickened below, broadly rounded to incised, sinuous, subascending, pubescent, irregularly pseudocyphellate-sorediate; upper surface dull, smooth to minutely reticulate foveolate; soralia yellow, confluent along pseudocyphellate margin; soredia granular to farinose; photobiont blue green; medulla yellow; lower surface pale brown to ochraceous brown, greyish centrally; tomentose; pseudocyphellae yellow, \pm rounded, 0.1- 0.3 mm diam., sometimes raised in marginal area, sunken towards centre; tomentum pale brown to greyish, 0.1-0.3 mm long. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; calycin and pulvinic dilactone present.

It sparsely grows on tree branches in subtropical areas.

Distribution: India (Manipur, Nagaland, Sikkim and Tamil Nadu). Cosmopolitan.

Specimen examined: North Sikkim: Nampruk village, along river side, Sinha 660.

2. **Pseudocyphellaria clathrata** (De Not.) Malme, *Ark. Bot.* 26A(14): 9. 1934.
Sticta clathrata De Not., *Osserv. Sticta* : 10. 1851. (Fig. 83)

Thallus centrally attached to the substratum, coriaceous, irregularly spreading, ochraceous brown, 3-4 cm across; lobes irregularly branched, imbricate-discrete at periphery, 1-4 mm wide; margin rounded to incised, pubescent, sparsely pseudocyphellate; upper surface dull, smooth to shallowly reticulate foveolate; photobiont a green alga; medulla yellow; lower surface pale to ochraceous, tomentose; pseudocyphellae yellow, \pm rounded, 0.2-0.3 mm diam., sunken, rarely raised; tomentum pale brown to greyish, dense, 0.1-0.4 mm long. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; calycin, pulvinic acid and pulvinic dilactone present.

It sparsely grows on trees in subtropical areas.

Distribution: India (Nagaland and Sikkim), Argentina, Brazil, Colombia, Dominican Republics, Ecuador, Guatemala, Honduras, Jamaica, Kenya, Madagascar, Malaysia, Mauritius, Mexico, Paraguay, Peru, Philippines, South Africa, Tanzania, Uganda, Uruguay, Venezuela and Zimbabwe.

Specimen examined: North Sikkim: Near Nampruk village, alt. 1200 m, Sinha 970.

3. *Sticta* (Schreber) Ach.

Thallus foliose, dorsiventral, heteromerous, loosely attached, corticated on both surfaces, single to multilobed, spreading or stipitate; lobes dichotomously branched to broad, rounded, irregular; upper surface smooth, wrinkled or ridged, scabrid or tomentose; isidia and soredia present or absent; pseudocyphellae absent; medulla white; endotrophic cephalodia present or absent; photobiont green, *Trebouxia* or *Myremica* or blue green *Nostoc*; lower surface pale to dark grey, glabrous or tomentose, cyphellae always present. Apothecia hemiangiocarpic, laminal or marginal, sessile to pedicellate; thalline exciple well developed; asci 8-spored; spores colourless, acicular to fusiform, 1-9-septate; paraphyses simple; conidia bacilliform or ampulliform.

About 200 species distributed in tropical to temperate regions of the world; 13 species in India and 8 species in Sikkim.

Key to the species

- 1a. Photobiont green; upper surface yellowish grey 2
 1b. Photobiont blue green; upper surface grey brown 4
 2a. Upper surface tomentose; medulla KC- 5. ***S. platyphylloides***
 2b. Upper surface etomentose; medulla KC+ red, gyropohric acid present 3
 3a. Thallus lacinate with marginal squamuliform isidia 6. ***S. praetextata***
 3b. Thallus with rounded lobes, lacking isidia or squamules 3. ***S. nylanderiana***
 4a. Thallus stipitate or substipitate 5
 4b. Thallus not stipitate 7
 5a. Thallus isidiate 6
 5b. Thallus lacking isidia 8. ***Sticta* species**
 6a. Lobes linear; isidia marginal 1. ***S. cyphellulata***
 6b. Lobes rounded; isidia submarginal to laminal 4. ***S. orbicularis***
 7a. Thallus sorediate 2. ***S. limbata***
 7b. Thallus isidiate 7 ***S. weigelii***

1. ***Sticta cyphellulata*** (Müll. Arg.) Hue, Nouv. Arch. Mus. Hist. Nat., ser. 4, 3:99. 1901; Joshi & Awasthi, Biol. Mem. 7: 179. 1982. -*Stictina cyphellulata* Müll. Arg., Flora 65: 301. 1822. (Fig. 84)

Thallus stipitate, firmly attached by holdfast, greyish brown, 3-4.5 cm tall; lobes linear, dichotomously branched, narrow at base, broader at tips, 5-13 mm wide; margin rounded, minutely crenate, wavy; upper surface smooth, dull, concave at least in basal portion; isidia marginal to submarginal, granular to cylindrical, coralloid branched; photobiont blue green alga; lower surface brown, brownish grey towards centre, erhizinate, densely tomentose; cyphellae flask shaped, up to 1 mm diam.; tomenta dark brownish, 0.1-0.4 mm long. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It sparsely grows on trees in shady places in temperate - subtropical regions.

Distribution: India (Kerala, Nagaland, Sikkim and Tamil Nadu), Australia, Malaysia, Queensland and Caledonia.

Specimen examined: West Sikkim: On way between Narkhola-Karchi village, alt 2100-1850 m, Sinha 370.

2. ***Sticta limbata*** (Smith) Ach., Meth. Lich.: 280. 1803; Joshi & Awasthi, Biol. Mem. 7: 181. 1982. -*Lichen limbatus* Smith in Smith & Sowerby, Engl. Bot. 16: 1104. 1803.

Thallus non stipitate, ± closely attached, rounded to irregular, brown grey to olive brown, ca. 6 cm across; lobes 2-15 mm wide; margin entire to minutely crenate, sometimes slightly ascending; upper surface dull, smooth or wrinkled, marginally sorediate; soredia in linear soralia, granular to isidia like; photobiont blue green alga; lower surface dark brown towards centre, light brown at margin, ± uniformly densely tomentose; cyphellae small, scattered, pale, flat. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It sparsely grows on trees in subtropical areas.

Distribution: India (Manipur, Meghalaya, Sikkim, Tamil Nadu and Uttaranchal). Cosmopolitan.

Specimen examined: North Sikkim: Near Lingzea village, alt. 1500 m, Sinha 647.

3. ***Sticta nylanderiana*** Zahlbr., Cat. lich. univ. 3: 356. 1925; Joshi & Awasthi, Biol. Mem. 7: 183. 1982. (Fig. 85)

Thallus ± loosely attached, thick, coriaceous, irregularly spreading, yellowish grey to grey, 10-25 cm across; lobes 3-20 mm wide; margin rounded, entire to broadly crenate; upper surface dull, smooth to rugose, etomentose; photobiont green; lower surface pale brown to dark brown; cyphellae saucer-shaped, 0.5-1.5 mm diam.; tomenta pale brown to dark brown, 0.1-0.6 mm long; rhizines sparse, pale brown to dark brown, 2-5 mm long. Apothecia laminal to submarginal, sessile to pedicellate, 2-8 mm diam., margin entire to crenate; thalline exciple granulose;

spores acicular, transversely 3-7 -septate, 30-95 x 5-8 μ m. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ pink, P-; arnanorin and gyrophoric acid present.

It commonly grows on tree buttresses as well as on mossy grounds in moist places in temperate region.

Distribution: India (Himachal Pradesh, Manipur, Nagaland, Sikkim and Uttaranchal), Bhutan, Nepal and S. E. China.

Specimens examined: *East Sikkim:* Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1478. *North Sikkim:* Jakthang-Zema -II foot track, alt. 3200-2800 m, Sinha 1740. Lachen, Gumpa side forest, alt. 2700 m, Sinha 1534. Near Lachung, along road side, alt. 2500 m, Sinha 1032. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1052. Theu La-Jakthang foot track, alt. 4600-3400 m, Sinha 1731. Yumthang, along river side forest, alt. 3530 m, Sinha 1082. *West Sikkim:* On way between Dzongri-Thangsing foot track, alt. 3900-3500 m, Sinha 818. On way between Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 192.

4. *Sticta orbicularis* (A. Br.) Hue, *Annls. Jard. Bot. Buitens* 17: 193. 1901; Joshi & Awasthi., *Biol. Mem.* 7:183. 1892. -*Sticta filicina* var. *orbicularis* A. Br. in Mey & Flotow, *Nova Acta Acad. Leopoldin. Carolin. suppl.* 19: 215. 1843.

Thallus substipitate, loosely attached to the substratum, pale brown to dark brown, ca. 3 cm across; lobes rounded apically, 5-8 mm wide; margin entire, undulate; upper surface smooth, often cracked; isidia marginal to submarginal, also present along cracks, simple to branched, glomuliferous to terete; photobiont a blue green alga; lower surface brown to greyish brown; cyphellae cup-shaped, up to 1 mm diam.; tomenta dense, greyish, 0.3-0.5 mm long; rhizines simple, greyish, 1-2 mm long. Apothecia not seen. Chemistry: Cortex and medulla K, C-, KC-, P-; no lichen substances present.

It sparsely grows on trees in open places in subtropical areas.

Distribution: India (Kerala, Nagaland, Sikkim and Tamil Nadu), Borbon Island and Northern Asia.

Specimen examined: *South Sikkim:* Temi Tea Estate, alt. 1300 m, Sinha 55.

5. *Sticta platyphylloides* Nyl., *Bull. Soc. Bot. Fr.* 34: 22. 1887; Joshi & Awasthi, *Biol. Mem.* 7: 184. 1982.

Thallus loosely attached, irregularly spreading, thick, coriaceous, sinuate lobate to lacinate lobate, yellowish grey, up to 15 cm across; lobes 2-15 mm wide; margin rounded to incised; upper surface smooth to rugose, sometimes foveolate, persistent tomenta present in marginal part; photobiont a green alga; lower surface pale brown in marginal area, dark brown centrally; cyphellae saucer-shaped, 0.5-1.5 mm diam.; tomenta dense, pale brown, up to 1 mm long; rhizines sparse, blackish ca. 2 mm long. Apothecia marginal to submarginal, pedicellate, 1-3 mm

diam.; margin entire to crenate; thalline exciple granulose, tomentose; spores acicular, transversely 3 or more -septate, 45-65 x 5-8 μ m. Chemistry: Cortex K-; medulla K-, C-, KC-, P-; no lichen substances present.

It commonly grows on tree buttresses as well as on mossy grounds in moist places.

Distribution: India (Arunachal Pradesh, Himachal Pradesh, Manipur, Nagaland, Sikkim, Uttaranchal and West Bengal), China and Nepal.

Specimens examined: North Sikkim: Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1660. Tholung-Kissong foot track, alt 2475-2700 m, Sinha 599.

6. ***Sticta praetextata*** (Räsänen) Awasthi in Awasthi & Joshi, Biol. Mem. 7:185. 1982. -*Sticta platyphylla* var. *praetextata* Räsänen, Arch. Soc. Zool. Bot. 'Vanamo' 6(2):84. 1952.

Thallus loosely attached, irregularly branched, sinuate lobate, yellowish grey, 6-10 cm across; lobes 5-15 mm wide, margin repeatedly branched, lacinate to squamuliform, ascending; upper surface coriaceous, tomentose, squamuliform isidiate marginally; photobiont a green alga; lower surface brown, cyphellae saucer-shaped; rhizines sparse, simple, up to 1.5 mm long. Apothecia not seen. Chemistry: Cortex K+ yellow; medulla K-, C-, KC+ pink, P-; gyrophoric acid and an unidentified substance present.

It sparsely grows on lower parts of tree trunks in open moist places in temperate areas.

Distribution: India (Arunachal Pradesh, Himachal Pradesh and Uttaranchal), Nepal.

Specimens examined: West Sikkim: Hilley-Varshey foot track, alt. 2250 m, Sinha 1311. Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1324.

7. ***Sticta weigellii*** (Ach.) Vainio, Acta Soc. Fauna Fl. Fenn. 7:189. 1890. Joshi & Awasthi, Biol. Mem. 7: 186. 1982. -*Sticta damaecornis* β *weigellii* Ach., Lich. univ. :446. 1810.

Thallus \pm loosely attached, irregularly spreading, greyish brown, 5-10 cm across; lobes variable, broad and rounded to lacinate, 3-10 mm wide; margin entire to slightly notched, incised, wavy to dissected, sometimes ciliate in axils; upper surface smooth, rugose in older parts, sometimes cracked; isidia mainly marginal to submarginal, often develop along the cracks, granular to cylindrical, simple to coralloid branched; photobiont a blue green alga; lower surface pale brown at periphery, greyish black towards centre, sparsely rhizinate, cyphellae cup-shaped, up to 0.5 mm diam.; tomenta pale to greyish black, up to 0.5 mm long. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It commonly grows on trees, boulders as well as on ground in open places in subtropical areas.

Distribution: India (Assam, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu and Uttaranchal); tropical and subtropical regions of the world.

Specimen examined: North Sikkim: Tingbong, near Kusum village, alt. 1400 m, Sinha 642.

8. *Sticta* species

Thallus stipitate, 4-6 cm tall, firmly attached to the substratum by a basal holdfast and long rhizines, greyish brown to pale brown, 2-3 mm diam.; lobes repeatedly dichotomously branched, 3-14 mm wide; margin entire, wavy; upper surface concave, smooth; photobiont blue green alga; lower surface pale brown at periphery, dark brown towards centre, rhizinate at stipitate base only; cyphellae cup-shaped, ca. 0.5 mm diam.; tomenta sparse, 0.1-0.2 mm long. Apothecia marginal, sessile, 1-2.5 mm diam.; margin entire, brownish; thalline exciple ± indistinct, minutely rugulose; disc dark brown, slightly concave; spores fusiform, transversely 3-septate, 30-50 x 7-10 µm. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It sparsely grows on trees in moist open shady places in temperate areas. It closely resembles *S. cyphellulata* (Müll. Arg.) Hue, which is an isidiate taxon.

Specimen examined: West Sikkim: Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 192.

NEPHROMATACEAE

Nephroma Ach.,

Thallus foliose, dorsiventral, heteromerous, greenish brown or brown, lobate, corticate on both surfaces; upper and lower cortex paraplectenchymatous, many layered, composed of isodiametric cells; photobiont a green *Coccomyxa* or a blue green *Nostoc*; medulla of loose hyphae; lower surface glabrous, pubescent or tomentose. Apothecia immersed on lower surface at tips of lobes; disc light brown to dark brown; exciple colourless to light brown; hymenium colourless; asci 8 spored; spores light brown, transversely 3-septate; paraphyses simple.

About 30 species known from the subtropical to temperate regions of the world; 6 species in India and 4 species in Sikkim.

Key to the species

- | | |
|---|------------------------|
| 1a. Upper surface of lobes tomentose | 3. <i>N. nakaoi</i> |
| 1b. Upper surface smooth | 2 |
| 2a. Isidia coralloid, present along ridges and margins
in clusters | 2. <i>N. isidiosum</i> |

- 2b. Isidia marginal, flat to squamuliform 3
 3a. Spores oblong to fusiform, 18-25 x 4-8 μm 1. **N. helveticum**
 3b. Spores cylindrical, 30-40 x 3-5 μm 4. **N. sikkimensis**

1. **Nephroma helveticum** Ach., Lich. univ. : 523. 1810. (Fig. 86)

Thallus loosely attached, brown or greenish brown, suborbicular to spreading, 3-6 cm across; lobes irregularly branched; imbricate or discrete, 3-8 mm wide, margin with indentations, broad lobules or small teeth, 0.2-0.3 mm long, notably with ascending tips, upper surface glabrous, wrinkled, often foveolate, shining, squamulose, tips pubescent on back of apothecia; isidia and squamules usually marginal, flattened; medulla white to pale brownish; lower surface black to dark brown, tomentose. Apothecia rounded to oblong, 2-6 mm diam.; margin often fringed; spores oblong to fusiform, 18-25 x 4-8 μm . Chemistry: Cortex and medulla K-, C-, KC-, P-.

It commonly grows on tree trunks and twigs in moist open places.

Distribution: India (Manipur, Nagaland, Tamil Nadu and Uttaranchal).
Cosmopolitan.

Specimens examined: *East Sikkim:* Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1454. *North Sikkim:* Lachen, Gumpa side forest, alt. 2700 m, Sinha 1543. On way between Lashar and G.S.I. Old Camp Hut, alt. 4400 m, Sinha 1203. *West Sikkim:* On way between Phedang-Dzongri foot track, alt. 3900-4025 m, Sinha 258; Tashiding Monastery surroundings, alt. 1600 m, Sinha 307. Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1327.

2. **Nephroma isidiosum** (Nyl.) Gyelnik, Ann. Crypt. Exot. 4: 126. 1932.
Nephromium tomentosum var. *isidiosum* Nyl., Notis. Sallsk. Faun. Fl. Fenn. Forh. ser. II, 8: 180. 1866.

Thallus loosely attached, brown, in irregular patches, 2-4 cm across; lobes broad, imbricate, ca 5 mm wide, not notably ascending; margin entire to subcrenulate; upper surface even, smooth to slightly scabrid, \pm shining, with many clusters of coralloid to flattened isidia on the lamina as well as along margins; medulla white; lower surface covered with dense, short, dark brown tomentum and scattered coarse rhizines. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-.

It sparsely grows on trees in moist places in temperate regions.

Distribution: India (Uttaranchal), Nepal, Siberia; America and Europe.

Specimens examined: *East Sikkim:* Kupup, V.S.Sharma & M. Ranjan 76702 (LWG). *West Sikkim:* Pemayangtse Monastery surroundings, alt. 2075 m, Sinha 168.

3. **Nephroma nakaoui** Asah. in H. Kihara, Fauna & Flora Nepal Himalaya. Lichenes 1: 45. 1955; Sinha in Mukerji *et.al.* (eds.), Biol. Lich. : 213.1999.

Thallus loosely attached, brown, in irregular patches of 3-4 cm; lobes imbricate, *ca.* 3 cm long, 3-6 mm wide, margin dissceted; upper surface thinly to densely pubescent tomentose throughout; isidia terete to squamuliform or thinly distributed on general surface and along margins; medulla white; lower surface brown, tomentose. Apothecia oblong, 4-7 mm diam.; margin \pm entire; spores fusiform, transversely 3-septate, 19-21 x 6 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-.

It sparsely grows on *Rhododendron* branches in open moist places at about 3500 m.

Distribution : India (Sikkim), Nepal.

Specimens examined: West Sikkim: Thangsing-Lampokhari foot track, at 3 km point, alt. 3500 m, Sinha 847A and 861.

4. **Nephroma sikkimense** Asah. J. Jap. Bot. 38 (7): 193. 1963.

Thallus dirty brown, up to 10 cm across; lobes 1-3 cm long, 0.5-1 cm wide, unequally branched with short dentate to broader margin; upper surface opaque, smooth; isidia marginal, 0.4 mm long, 0.15 mm diam., flat, squamuliform to spine like, fragile, often breaking; lower surface whitish to pale yellow, tomentose up to margin; tomentum dark brown to blackish. Apothecia on back side of apical lobes, dorsal receptacle serobiculate-rugose, pubescent, usually isidiate; margin dentate-fimbriate; disc up to 10 mm long, 12 mm wide, dark violaceous; spores pale at maturity, cylindrical, 30-40 x 3-5 μ m, 3-septate, parallelly arranged within ascus. Pycnidia not seen. Chemistry: Cortex K-, C-; medulla K-, C+ vanishing red, KC+ red, P-.

The species is described from Dzungri-Olothang and Dzungri-Gamothang area of West Sikkim. It is known only by type collection. A thorough search in and around the vicinity of type locality was made, but it could not be collected. Detailed description of Asahina (*l.c.*) is provided here for ready reference.

Distribution : India (Sikkim). Endemic.

PANNARIACEAE

Erioderma Fée

Thallus foliose, small, lobate, dorsiventral, heteromerous, attached to the substratum by clump of rhizines; upper surface \pm hairy or tomentose; tomentum white or yellowish or brownish buff; photobiont blue green *Scytonema*; lower surface white or yellowish brown, strongly tomentose; rhizines black, often in thick separate clumps or tufts. Apothecia \pm marginal, sessile or subpedicellate with thalline margin; asci 8-spored; spores colourless, simple, ellipsoid or elongate

fusiform. Pycnidia marginal, brown or black; conidia cylindrical, septate, *Sticta* type.

A genus of about 22 species best developed in tropics; 1 species in India as well as in Sikkim.

Erioderma meiocarpum Nyl., Syn. Lich. 2:47. t. 9, fig. 33. 1863; Zahlbr., Cat. lich. univ. 3:279. 1925; Awasthi, Journ. Hattori. Bot. Lab. 65:231. 1988.

(Fig. 87)

Thallus yellowish grey to grey brown, occurring in small orbicular patches, ca. 4 cm across; lobes rounded, 4-6 mm wide, margin crenate; upper surface tomentose; lower surface ecorticate, yellowish-white tomentose, margin etomentose. Apothecia marginal, subpedicellate, 2.5-7 mm across, young ones distinctly tomentose at margin; disc convex at maturity, dark brown; spores ellipsoid, 10-11.5 x 8-9 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

The species sparsely grows on tree buttresses in high temperate areas.

Distribution: India (Tamil Nadu); Africa.

Specimen examined: North Sikkim: On way between Jakthang- Zema -II foot track, alt. 3400-2800 m, Sinha 1744.

COCOCARPIACEAE

Coccocarpia Pers.

Thallus foliose, dorsiventral, heteromerous, \pm orbicular in outline, whitish-grey or lead-grey to brownish, lobate; lobes flattened, usually broadly flabellate or cuneate with round apices and deflexed margins, rarely linear; upper surface \pm glossy, smooth or with transverse concentric rings, isidia present or absent; pseudocypheflae and soredia absent; photobiont blue green, *Scytonema*; medulla usually white; lower surface creamish to blackish, densely rhizinate; rhizines simple, \pm entangled, whitish, brownish or black, sometimes forming a dense hypothallus; both upper and lower surfaces corticated, composed of 2-3 layers of rectangular cells. Apothecia biatorine, adnate, rarely sessile, \pm irregular in outline, without a prominent proper margin; asci 8 -spored; spores colourless, simple, globose to fusiform, usually with oil droplets; paraphyses simple to sparsely branched. Pycnidia laminal or marginal, immersed or sessile, brownish or black, conidia rod -shaped, up to 5 μ m long.

About 21 species distributed in tropical and sub-tropical regions of the world; 4 species in India and 3 species in Sikkim.

Key to the species

- 1a. Thallus isidiate 2
 1b. Thallus lacking isidia 1. *C. erythroxyli*
 2a. Isidia terete, globular to cylindrical 2. *C. palmicola*
 2b. Isidia flattened, microphylline 3. *C. pellita*

1. *Coccocarpia erythroxyli* (Sprengel) Swinscow & Krog, *Norw. J. Bot.* 23: 256. 1976; Arvidsson, *Opera Bot.* 67: 57. 1982; Awasthi, *Kavaka* 13: 83. 1985. -*Lecidea erythroxyli* Sprengel, *Vetensk. Acad. Nya Handl.* 1:47. 1820.

Thallus occurring in irregular or orbicular patches, usually \pm loosely attached, whitish grey, lead grey or brownish grey, 5-10 cm across; lobes \pm imbricate, rarely somewhat discrete, broadly flabellate, 2-8 mm wide; margin usually incised, lobulate and weakly branched; upper surface glossy, matt, smooth to minutely wrinkled, sometimes with concentric rings; medulla white, rarely brownish in part; lower surface brown to blackish; rhizines blackish, *ca.* 1 mm long. Apothecia common, scattered or crowded, sometimes fusing to form irregular aggregates, adnate or slightly raised over the surface of lobes by white hairs projecting from the base of apothecia, 1-5 mm diam.; margin rarely visible as a pale line; thalline exciple indistinct; disc plane to strongly convex, brownish red to blackish; spores fusiform, 8-12 x 3-5 μ m. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present. It commonly grows on boulders as well as on tree trunks in subtropical and temperate regions.

Distribution: India (Assam, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Nagaland, Sikkim, Tamil Nadu and West Bengal). Cosmopolitan.

Specimens examined: *East Sikkim:* Thegu, alt. 3700 m, Sinha 1385. *West Sikkim:* On way between Dzongri-Thangsing, alt. 3900-3500 m, Sinha 798. Pemayangtse Monastery surroundings, alt. 2075 m, Sinha 165. Thangsing-Samiti foot track, alt. 3700 m, Sinha 831.

2. *Coccocarpia palmicola* (Sprengel) Arvidsson & D. Galloway, *Bot. Notiser* 132: 242. 1979; Arvidsson, *Opera Bot.* 67: 72. 1982; Awasthi, *Kavaka* 13: 84. 1985. -*Lecidea palmicola* Sprengel, *Vetensk. Acad. Nya Handl.* 1: 46. 1820.

(Fig. 88)

Thallus growing in irregular patches, loosely to closely attached, whitish grey to lead - grey, 3-7 cm across; lobes imbricate or adjacent, rarely somewhat discrete, usually broadly flabellate or cuneate, 2-7 mm wide; margin usually incised, lobulate or weakly branched, deflexed, secondary lobes often present, more rarely also tertiary lobes; upper surface glossy, matt, smooth to minutely wrinkled, usually with concentric rings; isidia laminal, sparse to dense,

concolorous with surface or darker, terete, globular to cylindrical, simple to rarely branched, up to 1 mm long; medulla white; lower surface brown to blackish; rhizines greenish, ca. 0.5-1 mm long. Apothecia absent. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It commonly grows on trees, rocks and mossy ground in sub-tropical and temperate regions.

Distribution: India (Assam, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Sikkim, Tamil Nadu and Uttaranchal), Bhutan; tropical and subtropical regions of the world.

Specimens examined: *South Sikkim:* Namchi-Old Damthang road, alt. 1700-2000 m, Sinha 44. Temi Tea Estate, alt. 1300 m, Sinha 55A. *West Sikkim:* Geyzing, alt. 2100 m, P. Singh 80. Pemayangtse Monastery surroundings, alt. 2075 m, Sinha 166. Tashiding Monastery surroundings, alt. 1600-1700 m. Sinha 159.

3. *Coccocarpia pellita* (Ach.) Müll. Arg. em R. Sant., Symb. Bot. Upsal. 12(1):420. 1952; Arvidsson, Opera Bot. 67:76. 1982; Awasthi, Kavaka 13:86. 1985. -*Parmelia pellita* Ach., Lich. univ.:468. 1810.

Thallus growing in irregular patches, loosely attached, lead grey, 3-5 cm across; lobes 3-7 mm wide, imbricate, broadly flabellate or with almost rounded apices; upper surface glossy, matt, smooth to minutely wrinkled, with concentric rings, epruinose, lobulate in older parts; isidia laminal to marginal, dense, flattened, microphylline; lower surface blackish; rhizines up to 1 mm long, blackish. Apothecia not seen. Chemistry: Cortex and medulla K-, C-, KC-, P-; no lichen substances present.

It sparsely grows on rocks and on ground in open moist places.

Distribution : India (Himachal Pradesh, Kerala, Madhya Pradesh, Manipur, Meghalaya, Nagaland, Tamil Nadu and Uttaranchal). Pantropical.

Specimens examined : *North Sikkim :* Near Lngzea village, alt. 1500 m, Sinha 648. *West Sikkim :* Near Karchi village, alt. 2100 m, Sinha 339, 340.

COLLEMATACEAE

1. *Collema* Web. ex Wigg.

Thallus mainly foliose, rarely subcrustose or subfruticose, gelatinous, homoiomerous, ecorticated or with a pseudocortex, often swollen when wet, olive green to blackish green; lobes orbicular or elongated, imbricate; upper surface smooth to rough or distinctly ridged, sometimes fenestrated; isidia and pustules present or absent; photobiont blue green, *Nostoc*; lower surface generally paler than upper surface, rhizines and hapters absent. Apothecia with an outer thalline and inner proper exciple; proper exciple euparaplectenchymatous, subparaplectenchymatous or euthyplectenchymatous; asci 8-spored; spores

colourless, transversely septate to muriform, usually fusiform or acicular; paraphyses simple.

About 80 species in the world; 34 species in India and 5 in Sikkim.

Key to the species

- 1a. Thallus isidiate 3
 1b. Thallus lacking isidia 2
 2a. Upper surface of thallus smooth; pseudocortex present
 in thalline exciple 4. **C. japonicum**
 2b. Upper surface longitudinally deeply ridged; thalline
 exciple non cellular 5. **C. pulcellum**
 var. **subnigrescens**
 3a. Isidia squamuliform 1. **C. flaccidum**
 3b. Isidia not squamuliform 4.
 4a. Thallus uniformly smooth, lacking ridges and pustules;
 apothecia margin red 3. **C. hookeri**
 4b. Thallus striate, ridged and pustulate; apothecia
 when present, margin not red 2. **C. furfuraceum**

1. **Collema flaccidum** (Ach.) Ach., lich. univ. :647. 1810; Degelius, Symb. Bot. Upsal. 13(2): 384, 1954 & 20(2): 142, 1974; Akhtar & Awasthi, Biol. Mem. 5: 20. 1980. -*Lichen flaccidus* Ach., K. Vet. Acad. Nya. Hand. :14. 1795.

Thallus foliose, closely to loosely attached, bluish grey, ca. 5 cm across; lobes orbicular, up to 7 mm wide, ca. 120 μ m thick, few vertical hyphae present in cross section; margin entire to isidiate; upper surface smooth, folded; isidia globular to squamuliform, dense on the ridges as well as on general surface up to margin, 0.1-0.3 mm diam; lower surface paler than upper surface. Apothecia not seen.

It sparsely grows on trees in moist open places.

Distribution: India (Himachal Pradesh and Jammu & Kashmir); Africa and North America.

Specimen examined: North Sikkim: Bey surroundings, alt. 1600 m, Sinha 564.

2. **Collema furfuraceum** (Arnold) Du Rietz, Ark. Bot. 22 A, 1(3): 3. 1929; Degelius, Symb. Bot. Upsal. 13(2): 443. 1954 and 20(2): 178. 1974; Akhtar & Awasthi, Biol. Mem. 5: 21. 1980. -*Synechoblastus nigrescens* f. *furfuraceum* Arnold, Flora 64: 115. 1881.

Thallus foliose, closely attached, membranaceous, dark olive green, ca. 4.5 cm across; lobes rounded, imbricate, 5-10 mm wide, few vertical hyphae found

between the two cortices; margin entire, folded, not swollen; upper surface strongly ridged; isidia generally present on ridges, pustulate, globular to teretiform; lower surface pale green, rhizines and hapters absent. Apothecia not seen.

It sparsely grows on trees in open moist places in temperate areas.

Distribution: India (Nagaland and Uttaranchal), Japan; Africa, North America and Europe.

Specimen examined: West Sikkim: Karchi village surroundings, alt. 2000 m, Sinha 451.

3. *Collema hookeri* Degelius, Symb. Bot. Upsal. 20(2): 155. 1974.

Thallus foliose, loosely or firmly adnate, thin, membranaceous, \pm olive green, ca. 5 cm across, deeply and broadly lobate or not lobate; lobes few, rounded or somewhat extended, \pm imbricate, usually 5-15 mm wide, with few vertical hyphae found between two cortices; margin \pm entire and sometimes bent downwards, never swollen, sparsely and broadly lobulate; upper surface smooth to irregularly ridged, matt or in part a little glossy; isidia sparse to dense, laminal, rarely marginal, \pm glabrous when young, later teretiform or somewhat flattened, simple or branched; lower surface paler; rhizines or hapters absent. Apothecia numerous, laminal, 1-1.5 mm diam.; disc plane to little convex, dark red, epruinose; thalline margin \pm smooth, persistent; thalline exciple with pseudocortex, brownish, made of several layers of thick walled cells; proper exciple euthyplectenchymatous, thin, ca. 30 μ m thick, rarely subparaplectenchymatous or euparaplectenchymatous in part, I-; spores ellipsoid to fusiform, 6-celled, rarely submuriform, colourless, (26-)32-43 x 8.5(-10.5) μ m.

The species is only known from the type locality *i.e.* Lachen (North Sikkim) at ca. 12000 ft.

Distribution: India (Sikkim). Endemic.

Earlier record: Sikkim, Lachen (Degelius, *l.c.*).

4. *Collema japonicum* (Müll. Arg.) Hue, Nouv. Arch. Mus., ser. 3, 10:220. 1898; Degelius, Symb. Bot. Upsal. 20(2):126. 1974; Akhtar & Awasthi, Biol. Mem. 5:22. 1980. –*Synechoblastus japonicus* Müll. Arg., Flora 53:17. 1880.

Thallus foliose, lead grey to black and indistinctly pustulate when dry, distinctly pustulate when wet; lobes orbicular, contiguous, 1-1.5 cm wide, 75-90 μ m thick; upper surface smooth. Apothecia 0.5-1 mm across; thalline exciple smooth, excluded at maturity, 40-60 μ m thick, pseudocortex 2-3 cell-layered; proper exciple euparaplectenchymatous, 5-7 cell-layered; spores fusiform or acicular, transversely 4-5(-6)-septate, 24-41 x 6-8 μ m.

It commonly grows on tree trunks in temperate areas.

Distribution : India (Sikkim and West Bengal), Eastern Asia, Australia and Oceania.

Specimen examined: East Sikkim : Tumin, Upreti & Chatterjee 01-26622 (LWG).

5. *Collema pulcellum* Ach. var. *subnigrescens* (Müll. Arg.) Degelius, Symb. Bot. Upsal. 20(2):173. 1974; Akhtar & Awasthi, Biol. Mem. 5: 23. 1980. *Synechoblastus flaccidus* var. *subnigrescens* Müll. Arg., Proc. R. Soc. Edinburgh 4: 456. 1882.

Thallus foliose, loosely to closely attached, ca. 8 cm across, dark greyish green to blackish olive green; lobes orbicular, 3-12 mm wide; margin entire, folded irregularly; upper surface heavily and longitudinally deeply ridged; lower surface concolorous to upper surface or slightly paler. Apothecia numerous, 0.5-1.5 mm diam.; thalline exciple smooth, non cellular throughout; proper exciple euparaplectenchymatous; spores fusiform, transversely 4-8 -septate, straight or slightly curved, 30-52 x 4-6 µm.

It sparsely grows on exposed boulders in open moist places.

Distribution: India (Madhya Pradesh, Maharashtra, Manipur, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttaranchal and West Bengal).

Specimen examined: West Sikkim: Near Bakhim, alt. 2700 m, Sinha 273.

2. *Leptogium* (Ach.) Gray

Thallus foliose, rarely crustose, squamulose or subfruticose, homoiomerous, gelatinous, lead grey to bluish or suffuse brown, paraplectenchymatously corticated on both surfaces or on only upper surface, inner part of thallus with loosely interwoven hyphae or rarely paraplectenchymatous throughout; lobes flattened, orbicular to elongate, crowded or congested and subascendent; margin entire to lacerate, crenate or isidiate; upper surface smooth, wrinkled-plicate, undulate or lobulate or isidiate; photobiont blue green, *Nostoc*; lower surface smooth or glabrous or tomentose; tomentum hyphae free to anastomosing, composed of cylindrical cells or rarely with spherical cells. Apothecia emergent, adnate, sessile or pedicellate; thalline and proper exciple cellular or not; asci (4-)8 -spored; spores colourless, transversely septate or muriform; paraphyses simple.

About 150 species in the world; 42 species in India and 13 in Sikkim.

Key to the species

- 1a. Thallus tomentose 2
 1b. Thallus lacking tomentum 10
 2a. Thallus isidiate 3

- 2b. Thallus lacking isidia 6
- 3a. Thallus surface distinctly wrinkled 4
- 3b. Thallus smooth on upper surface 5
- 4a. Tomentum bluish black; thallus dark brown 2. **L. asiaticum**
- 4b. Tomentum whitish to pale brown; thallus bluish 10. **L. papillosum**
- 5a. Thallus bluish grey to dark grey; isidia coralloid
branched 5. **L. burnetiae**
- 5b. Thallus dark brown to brown black, isidia
usually granular 12. **L. saturninum**
- 6a. White trichomes present on thalline exciple 7
- 6b. Trichomes absent on thalline exciple 9
- 7a. Thallus bluish grey; trichomes sparse on exciple 1. **L. arisanense**
- 7b. Thallus grey brown, olivaceous to brown black;
trichomes dense on exciple 8
- 8a. Apothecia substipitate; thalline exciple with short
trichomes 3. **L. askotense**
- 8b. Apothecia sessile, constricted at base; thalline
exciple with robust and dense trichomes 13. **L. trichophorum**
- 9a. Apothecia with up to 5 mm long tubular stalk; disc
as wide as stalk 6. **L. delavayi**
- 9b. Apothecial stalk short, constricted, not tubular; disc
wider than stalk 11. **L. pedicellatum**
- 10a. Thallus isidiate 7. **L. denticulatum**
- 10b. Thallus lacking isidia 11
- 11a. Apothecia stipitate on short tubular stalk 9. **L. indicum**
- 11b. Apothecia sessile or basally constricted 12
- 12a. Pycnidia abundant, embedded in marginal and
submarginal part of lobes 8. **L. gelatinosum**
- 12b. Pycnidia absent 4. **L. azureum**

1. **Leptogium arisanense** Asah., J. Jap. Bot. 12:252. 1936; Awasthi & Akhtar, Norw. J. Bot. 24:62. 1977.

Thallus foliose, loosely attached, flat, up to 5 cm across, bluish grey in dry condition, olivaceous green, semitransparent and swollen when wet; lobes

discrete, 6-13 mm wide; margin entire, wavy; upper surface rough, irregularly minutely wrinkled, marginal part with few white hairs; lower surface densely tomentose; tomentum pale brown to dark brown or blackish, blue at base, up to 0.5 mm long, composed of cylindrical cells. Apothecia not seen.

It sparsely grows on tree trunks in moist subtropical areas.

Distribution: India (Manipur and Sikkim and West Bengal), Taiwan; Eastern Asia.

Specimens examined: *East Sikkim:* Gangtok, Hanuman tok, Chatterjee & Divakar 20-77032 (LWG). *North Sikkim:* Tingbong, Near Kusum village, alt. 1400 m, Sinha 644.

2. *Leptogium asiaticum* P. M. Jørg., *Herzogia* 2:466. 1973.

Thallus foliose, loosely adnate, ca. 5 cm across, lead grey to blackened; lobes oblong to elongate, ± imbricate, flat to slightly concave or gently undulate, 2-5 mm wide; margin entire to sinuate, often recurved to loosely revolute; upper surface ± matt, wrinkled; isidia granular; lower surface ± more densely wrinkled, with uniform tomentum comprising numerous tight bundles of whitish to bluish hairs, ca. 1.5 mm long, containing thelophoric acid, tomentum cells cylindric. Apothecia and pycnidia not seen.

It sparsely grows on lower part of tree trunks in subtropical areas in open places.

Distribution: India (Manipur and Sikkim), Nepal; Africa and Australia.

Specimen examined: *East Sikkim:* Rumtek, Chatterjee & Divakar 20-77057/A.

3. *Leptogium askotense* Awasthi in Awasthi & Akhtar, *Norw. J. Bot.* 24:63. 1977.

Thallus foliose, spreading, loosely attached, blackish grey to dark brown when dry, dark olivaceous green, translucent, swollen, glossy when wet, 3-5 cm across; lobes orbicular, 5-15 mm wide; margin wavy, flat to slightly ascending; upper surface dull, wrinkled, wrinkles more prominent when wet; lower surface paler than upper surface; tomentum pale brown, 0.5-0.7 mm long, cells cylindrical. Apothecia common, submarginal, subpedicellate to pedicellate, 1-4 mm across; pedicel tubular; disc concave to plane, epruinose, reddish brown; thalline exciple thick, wrinkled with minute white hyphal hairs densely distributed; proper exciple euparaplectenchymatous; spores submuriform to muriform, ellipsoid with acute ends, 25-40 x 10-15 µm.

It commonly grows on tree trunks in subtropical to temperate areas.

Distribution: India (Uttaranchal, Sikkim and West Bengal). Endemic in Himalaya.

Specimen examined: *East Sikkim:* Gangtok, Tashi view point, Upreti & Chatterjee 01-217566 (LWG).

4. **Leptogium azureum** (Swartz) Mont. in Web. & Benth., Hist. Nat. Canar. 3: 129. 1840; Awasthi & Akhtar, Geophytology 8: 194. 1979. -*Lichen azureus* Swartz in Ach., Lich. succ. Prodr. :137. 1798.

Thallus foliose, loosely attached, ca. 5 cm across, lead grey to dark grey when dry, dark olive green when wet; lobes orbicular to somewhat elongate, 2-7 mm wide, ± imbricate centrally, apices rounded; margin entire to lobulate, flat to rarely ascending; upper surface smooth, shining; lower surface concolorous with upper surface, dull, tomentose. Apothecia scattered, laminal to submarginal, constricted at base, 0.5-1.5 mm diam.; margin cream-coloured, entire; disc concave, dark red-brown, epruinose; thalline exciple ± smooth, concolorous with surface, composed of isodiametric or elongated cells; proper exciple euparaplectenchymatous at margin only, cells elongated; spores muriform, ellipsoid with beak like ends, 20-24 x 8-10 µm.

It sparsely grows on exposed rocks in temperate regions.

Distribution: India (Madhya Pradesh, Maharashtra, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttaranchal and West Bengal); tropical and subtropical regions of the world.

Specimens examined: North Sikkim : Bey surroundings, alt. 1600 m, Sinha 582. South Sikkim: Namchi-Old Damthang road, alt. 1700-2000 m, Sinha 38. West Sikkim: Near Baktim, alt. 2700 m, Sinha 274.

5. **Leptogium burnetiae** Dodge, Nova Hedwigia 12: 120. 1964; Awasthi & Akhtar, Norw. J. Bot. 24: 65. 1977.

Thallus foliose, loosely attached, 2-4 cm across, bluish grey when dry, dark olive green, non glossy, slightly swollen when wet; lobes orbicular to elongate, 5-10 mm wide; margin entire, flat to ascending, revolute; upper surface smooth, rough, dull; isidia laminal, concolorous with upper surface, solid, globular to coralloid branched; lower surface paler than upper surface, densely tomentose; tomenta white to pale brown, 0.3-0.5 mm long, tomenta cells cylindrical, 6-14 x 4-8 µm. Apothecia not seen.

It sparsely grows on trees in temperate regions in open moist places.

Distribution: India (Himachal Pradesh, Madhya Pradesh, Maharashtra, Manipur, Nagaland, Tamil Nadu, Uttaranchal and West Bengal), Bhutan; Eastern Asia, Africa and New World.

Specimen examined: East Sikkim: Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1461. Near Mulkhark lake around West Bengal border, alt. 2200-2300 m, Sinha 549, 550. Rechala surroundings, alt. 2900 m. Sinha 1012. West Sikkim: Karchi Reserve Forest, alt. 2000-2400 m, Sinha 394, 395. On way between Narkhola-Karchi village, alt. 2100-1850 m, Sinha 354.

6. **Leptogium delavayi** Hue, Bull. Soc. Bot. France 36:25. 1889; Awasthi & Akhtar, Norw. J. Bot. 24:66. 1977.

Thallus foliose, loosely attached, dark grey when dry, olivaceous grey, translucent when wet, ca. 5 cm across; lobes orbicular, sometimes elongate, 3-21 mm wide, central lobes narrow, 3-5 mm wide; margin entire, revolute or involute; upper surface smooth, dull, weakly wrinkled; lower surface densely tomentose; tomentum white to pale brown, up to 1 mm long, cells cylindrical. Apothecia common, submarginal to laminal, 2-4 mm across, distinctly pedicellate; pedicel tubular, smooth, with minute white hyphal hairs; disc concave to plane, reddish brown; thalline exciple thin, entire, continuous with the pedicel; proper exciple euparaplectenchymatous; spores muriform, ellipsoid with acute ends, 20-35 x 7-14 μm .

It commonly grows on trees in moist places in subtropical areas.

Distribution: India (Nagaland, Sikkim, Uttaranchal and West Bengal) and other Asian countries.

Specimen examined: East Sikkim: Gangtok, near Bhusuk, Upreti & Chatterjee 01-26623, 01-26636 (LWG).

7. **Leptogium denticulatum** Nyl., Ann. Sci. Nat. Bot., ser. 5, 7: 302. 1867; Awasthi & Akhtar, Geophytology 8: 196. 1979.

Thallus foliose, loosely to closely attached, 3-5 cm across, lead grey when dry, olivaceous green, slightly swollen when wet; lobes 2-5 mm wide, young lobes suberect, superposing the older ones, discrete; margin entire to lobulate or isidiate; upper surface smooth; isidia concolorous with surface, laminal and marginal both, primarily globular, soon becoming squamuliform; lower surface paler, smooth, etomentose. Apothecia rare, laminal, shortly stipitate, 0.5-1.5 mm diam.; disc reddish brown, concave to convex; thalline exciple concolorous with surface, entire, smooth; proper exciple euparaplectenchymatous at the margin, indistinct at centre; spores ellipsoid, muriform, slightly acute at ends, 16-20 x 6-8 μm .

It commonly grows on exposed boulders as well as on trees in open places.

Distribution: India (Kerala, Madhya Pradesh, Maharashtra, Manipur, Nagaland, Tamil Nadu and West Bengal) and New World tropics.

Specimens examined: East Sikkim: North Regu, near Chhubba village, alt. 1000-1300 m, Sinha 966. North Sikkim: Lachung, river side forest, alt. 2650 m, Sinha 1124. Namprik village surroundings, alt. 1200 m, Sinha 664. South Sikkim: Namchi-Mamle route, alt. 1150-1750 m, Sinha 117. Temi Tea Estate, alt. 1300 m, Sinha 53. West Sikkim: Tashiding Monastery surroundings, alt. 1600 m, Sinha 321. Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 190.

8. *Leptogium gelatinosum* (With.) J. R. Laundon, *Lichenologist* 16: 219-220, 1984. -*Lichen gelatinosus* With., *Bot. Arr. Veg. Gr. Br.* :710. 1776. -*Lichen sinuatus* Huds., *Fl. Angel.*, ed 2, 2: 535. 1778. -*Leptogium sinuatum* (Huds.) Massal., *Mem. Lichenogr.* :88: 1853; Sierk, *Bryologist* 67: 285. 1964; Awasthi & Akhtar, *Geophytology* 8: 202. 1979.

Thallus foliose, loosely attached, cushion -shaped, 3-6 cm across, dark grey to bluish grey when dry, olivaceous green, swollen when wet; lobes orbicular or elongate, 1-5 mm wide, overlapping and erect to semi erect; margin entire to irregularly cut to lobulate, plane or folded, usually pycnidiate, upper surface rough, occasionally irregularly wrinkled; lower surface concolorous with upper surface, smooth to rough. Apothecia not seen. Pycnidia abundant, embedded in marginal and submarginal part of lobe; conidia straight to slightly curved, 3-6 x 1 μ m.

It commonly grows on trees as well as on boulders in open places.

Distribution: India (Kerala, Tamil Nadu and West Bengal); America, Asia and Europe.

Specimens examined: South Sikkim: Jorethang-Namchi road, 5 km point, alt. 550 m, Sinha 2. North Sikkim: Near Lingzea village, alt. 1500 m, Sinha 650. Nampruk village, along river side, alt. 1200 m, Sinha 663. West Sikkim: Kacheoplari lake surroundings, alt. 1850 m, Sinha 279. On way between Narkhola-Karchi village, alt. 2100-1850 m, Sinha 353. Pelling, alt. 2300 m, P. Singh 83. Yoksum, near old Gumpa, alt. 1900 m, Sinha 693 & 694.

9. *Leptogium indicum* Awasthi & Akhtar, *Geophytology* 8:197. 1979.

Thallus foliose, loosely adnate, ca. 7 cm across, lead grey when dry, olive green, swollen when wet, irregularly lobate; lobes orbicular, (2-)5-10 mm wide; margin ascending, wavy, with brownish apothecial initials; upper surface rough; lower surface rough, tomentose. Apothecia common, dense, laminal to submarginal, pedicellate, stalk as wide as disc, 1-2.5 mm diam.; disc \pm plane, epruinose, red brown; thalline exciple longitudinally wrinkled; spores muriform, 18-25 x 12-15 μ m.

It sparsely grows on tree trunks in moist open places.

Distribution : India (Maharashtra and Rajasthan). Endemic.

Specimen examined : North Sikkim : Bey surroundings, alt. 1600 m, Sinha 581.

10. *Leptogium papillosum* (B. de Lesd.) Dodge, *Ann. Miss. Bot. Gard.* 20:418, 422. 1933; Awasthi & Akhtar, *Norw. J. Bot.* 24:67. 1977. -*Leptogium hildenbrandii* var. *papillosum* B. de Lesd., *Lich. Mexico*:30. 1914.

Thallus foliose, loosely attached, 3-5 cm across, lead grey when dry, olivaceous green, translucent when wet; lobes rounded, 3-6 mm wide, discrete

to confluent; margin entire to wavy; upper surface rough, wrinkled; isidia laminal, globular, solid; lower surface paler than upper surface, densely tomentose; tomentum white to pale brown, up to 1 mm long, hyphae of tomentum free. Apothecia not seen.

It sparsely grows on mossy rocks in temperate areas.

Distribution : India (Himachal Pradesh and Tamil Nadu); Central America.

Specimen examined: North Sikkim: Thangu, Chepta valley surroundings, alt. 3900 m, Sinha 1635.

11. *Leptogium pedicellatum* P.M. Jørg., *Herzogia* 3: 448. 1975; Awasthi & Akhtar, *Norw. J. Bot.* 24: 68. 1977. (Fig. 89)

Thallus foliose, loosely attached, 3-8 cm across, greenish blue when dry, dark olivaceous green, translucent, slightly glossy and not much swollen when wet, lobes 5-15 mm wide, broadly orbicular, discrete to somewhat contiguous in older parts; margin entire, \pm undulate, flat to ascending or rarely involute; upper surface smooth; lower surface paler than upper surface, densely tomentose; tomentum up to 1 mm long, hyphae of tomentum free. Apothecia laminal to submarginal, 1-4 mm diam., usually pedicellate; pedicel 0.5-1.5 mm high, smooth to wrinkled; disc concave to convex, smooth, reddish brown; thalline exciple entire, smooth; spores ellipsoid, muriform, 31-38 x (7-)10-14(-17) μ m, usually with beak like ends.

It commonly grows on trees along with mosses or on boulders in open places of temperate region.

Distribution: India (Himachal Pradesh, Sikkim, Uttaranchal and West Bengal), China and Japan.

Specimens examined: East Sikkim: Near Mulkhark lake, around West Bengal border, alt. 2200-2300 m, Sinha 548. Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1460. Rechala surroundings, alt. 2700-2900 m, Sinha 1011. Pangolakha scrub, alt. 2900 m, Sinha 927. North Sikkim: Lachen, Gumpa side forest, alt. 2700 m, Sinha 1549. On way between Phuni-Yakche, alt. 3000 m, Sinha 1093. West Sikkim: On Yoksum-Tsoka foot track, alt. 1800-3050 m, Sinha 190, 191.

12. *Leptogium saturninum* (Dickson) Nyl., *Acta. Soc. Linn. Bordeaux* 21: 272. 1856; Sierk, *Bryologist* 67: 268. 1964; Awasthi & Akhtar, *Norw. J. Bot.* 24: 69. 1977. -*Lichen saturninus* Dickson, *Fasc. Pl. Crypt. Brit.* 2: 21. 1790.

Thallus foliose, loosely attached, 4-8 cm across, brownish black to olivaceous black when dry, olive green to dark olive green, translucent and much swollen when wet; lobes orbicular, 5-12 mm wide, spreading, discrete to confluent in the central part; margin entire to occasionally irregularly cut or isidiate, flat to ascending; upper surface smooth to rough, weakly wrinkled, wrinkles disappear

when wet; isidia sparse to dense, laminal or marginal, granular to rarely coralloid, concolorous with surface or somewhat darker; lower surface paler than upper surface, densely tomentose; tomentum pale brown to colourless, 0.2-0.6 mm long, hyphae of tomentum free. Apothecia not seen.

It commonly grows on trees, boulders as well as on soil in temperate zone.

Distribution: India (Assam, Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh and Uttaranchal); temperate regions of the world.

Specimens examined: *North Sikkim:* Lachung river side forest, alt. 2650 m, Sinha 1125. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1057. Thangu, along Teesta bank, alt. 3800 m, Sinha 1154. Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 605. *West Sikkim:* Dzongri, alt. 4000 m, Sinha 786. Thangsing-Samiti foot track, 3 km point, alt. 3700 m, Sinha 841. Yoksum, near old Gumpa, alt. 1900 m, Sinha 692.

13. *Leptogium trichophorum* Müll. Arg., Flora 72: 505. 1889; Awasthi & Akhtar, Norw. J. Bot. 24: 70. 1977.

Thallus foliose, loosely attached, 5-10 cm across, grey brown to brown black in dry condition, dark olivaceous green, translucent glossy, much swollen when wet; lobes orbicular, 5-12 mm wide, discrete, sometimes confluent in older parts; margin entire, flat to ascending, upper surface distinctly wrinkled, dull, wrinkles more prominent in older lobes, white trichomes of hyphal bundles often found on young lobes; lower surface densely tomentose, tomentum pale brown, 0.2-1 mm long, cells cylindrical. Apothecia common, submarginal to laminal, sessile, constricted at base, 0.5-2 mm diam.; thalline exciple with dense trichomes in young apothecia, older ones with or without trichomes; disc reddish brown, plane to concave, epruinose; proper exciple euparaplectenchymatous; spores muriform, ellipsoid with acute ends, 20-26 x 10-12 μ m.

It commonly grows on trees as well as on boulders in moist open places.

Distribution: India (Himachal Pradesh, Manipur, Meghalaya, Nagaland, Uttaranchal and West Bengal) and Eastern Asia.

Specimens examined: *East Sikkim:* Near Lower Zuluk, alt. 2300 m, Sinha 882. On way between Premlakha-Tenjibir foot track, alt. 2000 m, Sinha 901. On way between Talkharka-Lower Rechala, alt. 2000-2200 m, Sinha 986. *North Sikkim:* Lachen, Gumpa side forest, alt. 2700 m Sinha 1549 A. Singbha Rhododendron Sanctuary, alt. 3350 m, Sinha 1058. *South Sikkim:* On Damthang-Tendong foot track, alt. 2000-2650 m, Sinha 123. *West Sikkim:* Tashiding Monastery surroundings, alt. 1600 m, Sinha 154. Near Bakhim, alt. 2500-2700 m, Sinha 735.

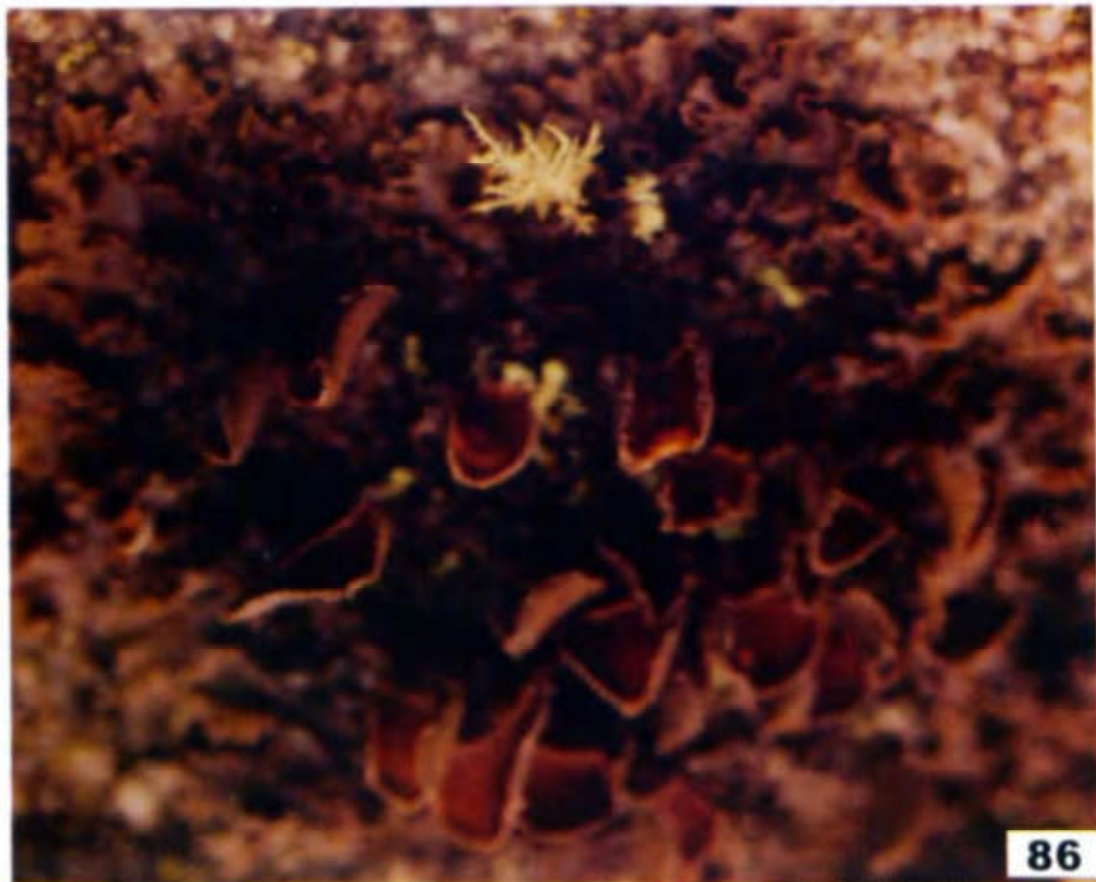


Fig. 84. *Sticta cyphellulata*. **Fig. 85.** *S. nylanderiana*. **Fig. 86.** *Nephroma helveticum*.



Fig. 87. *Erioderma meiocarpum*. Fig. 88. *Coccocarpia palmicola*. Fig. 89. *Leptogium pedicellatum*.

TELOSCHISTACEAE**Xanthoria (Fr.) Th. Fr.**

Thallus foliose, lobate, dorsiventral, heteromerous, orbicular, ± rosette forming to spreading, loosely to closely attached; upper surface corticate, bright yellowish orange or orange red (K+ purple -parietin), smooth or wrinkled, matt or shining; photobiont green, *Trebouxia*; medulla white; lower surface corticate, white or pale brownish, sparingly rhizinate; rhizines simple, pale. Apothecia lecanorine, sessile to subpedicellate; disc plane or concave, yellow, orange or orange red, epruinose; asci 8 -spored; spores colourless, polarilocular. Pycnidia laminal, immersed in ± prominent warts.

A genus with about 15 species widely distributed in the world; 5 species in India and 2 in Sikkim.

Key to the species

1a. Thallus laminally granular isidiate or isidiate sorediate 2. **X. sorediata**

1b. Thallus lacking isidia or soredia 1. **X. elegans**

1. **Xanthoria elegans** (Link) Th. Fr., Lich. Arctoi: 69. 1860; Awasthi, Procd. Indian Acad. Sci. (Pl. Sci.) 96(3):229. 1986. -*Lichen elegans* Link, Annal. Naturg. Gottingen 1: 37. 1791. (Fig. 90)

Thallus rosette forming to irregularly spreading, closely appressed, often eroding in parts, orange red, ca. 4 cm across; lobes radiating, partly imbricate and loosely attached, convex, sparingly branched, ca. 1 mm wide; margin crenate to subsinuous; upper surface smooth, matt, wrinkled. Apothecia laminal, if present numerous, ca 1 mm diam.; margin persistent, concolorous with surface; disc red; epithecium K+ purple; spores 12-16 x 5-8 µm. Chemistry: Thallus K+ purple, C-, KC-, P-; parietin present.

It commonly grows on boulders in alpine regions.

Distribution: India (Himachal Pradesh, Jammu & Kashmir, Sikkim and Uttaranchal); widely distributed in upper temperate, alpine to frigid zones all over the world.

Specimens examined: North Sikkim: Chholhamu plateau, U. Lachungpa 683, 1622. Lasher, alt. 4500 m, Sinha 1190. Llonakh valley, Muguthang, alt. 4500 m, Sinha 1559, 1563 A. Yomesamdong, Tembawa river valley, alt. 4750 m, Sinha 1273.

2. **Xanthoria sorediata** (Vainio) Poelt, Mitt. Bot. Staatssamml. Munchen 11:29. 1954; Awasthi, Procd. Indian Acad. Sci. (Pl. Sci.) 96(3):230. 1986. -*Lecanora elegans* var. *sorediata* Vainio, Meddel. Soc. Faun. Fl. Fenn. 6:143. 1881.

Thallus suborbicular to irregularly appressed, orange brown to reddish orange brown, 3-4 cm across; lobes radiating, sparingly branched, partly imbricate, up to 0.8 mm wide, apices often polyfid; upper surface plane or convex, dull, with laminal granular isidia, sometimes becoming sorediate later. Apothecia crowded in centre, up to 1 mm diam.; spores $12 \times 4 \mu\text{m}$. Chemistry: Thallus K+ purple, C-, KC-, P-; parietin present.

It sparsely grows on exposed boulders in alpine deserts.

Distribution: India (Himachal Pradesh and Uttaranchal); widely distributed in temperate-alpine regions of Europe.

Specimen examined: North Sikkim : Lonakh valley, Muguthang, alt. 4500 m, Sinha 1579.

UMBILICARIACEAE

1. *Lasallia* Mérat

Thallus foliose, monophyllous, plate like, dorsiventral, heteromerous, attached by a stout, \pm central umbilicus; upper surface dorsally densely pustulate; upper cortex paraplectenchymatous; photobiont chlorococcoid; lower cortex scleroplectenchymatous; lower surface with broad, excavate depressions corresponding to pustules on the upper surface, without rhizines. Apothecia sessile or + stalked, lecideine; disc black, flat, smooth to roughened; asci 1(-2) spored; spores muriform, pale to dark brown. Pycnidia immersed, with + pale brown wall; conidia bacilliform.

Lasallia comprises about 12 species widely distributed in the world; 3 species in India and 1 in Sikkim.

***Lasallia pustulata* (L.) Mérat**, Nouv. Fl. Env. Paris, ed. 2, 1:202. 1821; Llano, Monogr. Lich. Fam. Umbilicariaceae :30. 1950. -*Lichen pustulatus* L., Sp. Pl.:1150. 1753. (Fig. 91)

Thallus dull black-brown, scabrid pruinose, 1.5-3.5 cm across; upper surface with numerous, crowded, conspicuous, convex, oval pustules, especially towards the centre of thallus, flattening towards the margin which become \pm eroded and lacerated, rarely fenestrate; isidia laminal, scattered to densely crowded, coralloid branched; lower surface grey to brown, black in central part, roughened, irregularly pitted. Sterile. Chemistry: Cortex K-; medulla K-, C+ red, KC + red, P-; UV-; gyrophoric acid present.

It sparsely grows on exposed boulders in alpine areas.

Distribution: India (Himalaya, Nagaland); temperate zones of Asia, America and Europe.

Specimens examined: North Sikkim: On mid way between Thangu-Lashar, alt. 4300 m, Sinha 1173. Sebu La base camp, east side, alt. 4960 m, Sinha 1241 B.

2. *Umbilicaria* Hoffm.

Thallus foliose, mono- or poly- phyllous, dorsiventral, attached at a single point by a central or excentric umbilicus, soft, pliable and somewhat leathery when wet, brittle when dry; upper surface pale grey brown to black, smooth to warty areolate, sometimes folded or reticulate ridged with a raised central area, margin sinuous, entire or incised, pustules absent; isidia and soredia occasionally present; upper cortex at times overlain by an amorphous zone; photobiont chlorococcoid; medulla loose or compact, not always clearly differentiated from lower cortex; lower surface smooth or warty-areolate, sometimes pitted, black or pale brown-pink; rhizines present or absent, not attaching thallus. Apothecia \pm convex, mostly gyrose, occasionally smooth with a central, protruding button of sterile tissue, thalline exciple absent; asci 8 -spored, elongate clavate, thick walled, apical dome 1+ blue, spores ellipsoid, simple and colourless or muriform, becoming brown; pycnidia uni- or multiloculate; conidia shortly cylindrical; thallospores present in non isidiate, non sorediate, rarely in fruiting species, originating from lower cortex or on rhizines, single celled or of several cells.

About 45 species widely distributed in the world, 15 species in India and 9 species in Sikkim.

Key to the Species

- | | |
|--|-------------------------|
| 1a. Thallus microphyllous, up to 4 mm wide | 5. <i>U. nanella</i> |
| 1b. Thallus broad lobed, more than 4 mm wide | 2 |
| 2a. Thallus with phyllocladia | 6. <i>U. thamnoides</i> |
| 2b. Thallus lacking phyllocladia | 3 |
| 3a. Lower surface rhizinate | 4 |
| 3b. Lower surface lacking rhizines | 10 |
| 4a. Margin of thallus ciliate | 5 |
| 4b. Margin of thallus lacking cilia | 6 |
| 5a. Thallus monophyllous; lower surface grey white | 2. <i>U. cylindrica</i> |
| 5b. Thallus usually polyphyllous; lower surface
brown-black | 4. <i>U. indica</i> |
| 6a. Lower surface pink brown, marginal part greyish;
rhizines concolorous | 8. <i>U. virginis</i> |
| 6b. Lower surface black, rhizines concolorous | 7 |

- 7a. Apothecia sunken in thallus 8
 7b. Apothecia sessile to stalked 9
 8a. Thallus 2-4 cm across; cortex C-, medulla C+ pink;
 lower surface with kinky hair; fine richly branched
 rhizines 9. **U. yunnana**
 8b. Thallus 3-8 cm across; C+ pink, medulla C-;
 lower surface with thin simple rhizines 1. **U. badia**
 9a. Rhizines cylindrical only; thallus usually polyphyllous 4. **U. indica**
 9b. Rhizines both cylindrical and lump like; thallus
 monophyllous 7. **U. vellea**
 10a. Thallus margin ciliate 2. **U. cylindrica**
 10b. Thallus margin lacking cilia 3. **U. decussata**

1. **Umbilicaria badia** Frey, Ber. Schweiz. Bot. Gesellsch. 59: 453. 1949; Poelt, Khumbu Himal 6(3): 416. 1977.

Thallus monophyllous, 2-4 cm across, irregularly lobed to entire, rounded, greyish to pale brown, ± centrally umbilicate, umbo not prominent; surface dull smooth to weakly rugose in central part; medulla white; lower surface black, ± plane with numerous, simple, thin rhizines. Apothecia immersed, crowded, small 0.2-0.8 mm diam.; disc black, gyrose, plane, papillate; spores colourless, simple, ellipsoid, 16-19 x 16-12 µm. Chemistry: Cortex C + pink; medulla K -, C-, KC-, P-; gyrophoric acid present.

It sparsely grows on boulders in temperate regions.

Distribution: India (Uttaranchal and West Bengal), Nepal.

Specimen examined: West Sikkim: Varshey Rhododendron Sanctuary, alt. 2700-2750 m, Sinha 1337.

2. **Umbilicaria cylindrica** (L.) Delise in Duby, Bot. Gall. 2: 595. 1830. -*Lichen cylindricus* L., Sp. Pl. : 1144. 1753. -*Gyrophora cylindrica* Ach., Meth. Lich.: 107. 1803.

Thallus monophyllous, dark grey, 1.5-3 cm across, raised and somewhat curled with irregular outline; margin crenate to torn or cleft, thin, ± perforated, with occasional marginal cilia; upper surface dull, smooth or wrinkled, central part slightly ridged, folded and ± white pruinose; lower surface rather smooth, grey white, with sparse rhizines towards margin, remaining part ± erhizinate. Apothecia immature. Chemistry: Medulla K+ reddish, C-, KC-, P- or P+ orange; norstictic acid present.

It sparsely grows on rocks in exposed and well lit sites.

Distribution: India (Himalaya); Europe, Arctic, North America, Australia, New Zealand.

Specimen examined: East Sikkim: Kupup, around Bethang lake, alt. 4100 m, Sinha 1448.

3. Umbilicaria decussata (Vill.) Zahlbr., Cat. lich. univ. 8: 490. 1942. -*Lichen decussatus* Vill., Hist. pl. Dauph. 3: 964, pl. 55. 1789.

Thallus monophyllus, light to dark grey, 1.5-2.5 cm across, coriaceous, rigid, umbo peaked to elevated; margin round with straight sharp tears or deeper incisions; surface dull, umbo region coarsely granulose, pruinose, rugi strongly formed, elevated, reticulating or in alveolar pattern, decreasing in size towards periphery, occasionally perforate; lower surface blackish with a grey or light brown narrow peripheral zone, crhizinate. Apothecia ca 1 mm diam., black, adnate, button like; disc flat, dark brown; spores colourless, simple, 8-10 x 4-6 μ m. Chemistry: Medulla K-, C-, KC-, P-; no lichen substances present.

It sparsely grows on exposed boulders in alpine areas.

Distribution: India (Himalaya). Cosmopolitan.

Specimen examined: East Sikkim: Yomesamdong, Tembawa river valley, alt. 4750 m, Sinha 1264.

4. Umbilicaria indica Frey, Bericht. Schweiz. Bot. 59: 456. 1949; Poelt, Khumbu Himal 6(3): 420. 1977. -*Gyrophora himalayensis* Räsänen, Arch. Soc. Zool. Bot. Fenn. 'Vanamo' 5(1):25. 1951. (Fig. 92)

Thallus usually polyphyllous, dark brown to blackish, 3-6 cm across, attached by a central umbilicus; lobes rounded (1.5-)3-22 mm wide; margin usually entire, subascending to flat, ciliate; upper surface dull, smooth to rugose; medulla white; lower surface black, densely rhizinate; rhizines black, usually projecting beyond margins, furcate to irregularly branched or bump like, 0.5-1 mm long. Apothecia common, laminal, densely ciliate around base and margin, up to 2 mm diam.; margin black, irregular; disc flat to convex, black, gyrose; spores colourless, simple, 15-24 x 7-12 μ m. Chemistry: Medulla K-, C+ pink, KC+ red, P-; gyrophoric acid present.

It is one of the most common lichen above 3000 m altitudes, growing on almost every boulder but more commonly near wet places along rivers and streams.

Distribution: India (Nagaland, Sikkim, Uttaranchal and West Bengal, Western Himalaya), China, Nepal.

Selected specimens examined: East Sikkim: Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1486. Kupup, around Bethang lake, alt. 4100 m, Sinha 1449. West Sikkim: Dzongri, alt. 4025 m, Sinha 264 B.

5. **Umbilicaria nanella** Frey & Poelt, *Kumbhu Himal* 6(3):425. 1977; Sinha, *Bull. Bot. Surv. India* 45(1-4):223. 2003.

Thallus microphylline, monophyllous, grey to blackish, 2-4 mm across, with lateral umbilicus; margin rounded or irregular with numerous marginal rhizinoid, 1-1.5 mm long branched cilia; upper surface grey to white pruinose; medulla white; lower surface brown black; rhizines thick, marginal, black, 1-2 mm long. Apothecia sessile, angular, *ca.* 1 mm diam.; disc black, gyrose; asci and spores not formed in specimen examined. Chemistry: Medulla K-, C+ pink, KC-, P-; gyrophoric acid present.

It sparsely grows on exposed rocks in dry alpine region.

Distribution: India (Sikkim), China, Nepal.

Specimen examined: North Sikkim: Llonakh valley, Chhaber lake below Luna La, alt. 4600 m, Sinha 1588 A.

6. **Umbilicaria thamnodes** Hue, *Nouv. Arch. Mus.* 4(2):121. 1900; Poelt, *Khumbu Himal*. 6(3): 428. 1977.

Thallus monophyllous to polyphyllous, 4-6 cm across, grey brown to brown, attached by a \pm central umbilicus; lobes rounded, 10-27 mm wide; margin \pm entire to crenate, undulating, sometimes reflexed, lacking cilia; upper surface dull, smooth, flattened lobules appearing as scales, with wart like structure bearing phyllocladia, general surface with numerous blackish embedded spots throughout; lower surface black, granulose, with dense rhizines; rhizines blackish, sparsely irregularly branched, up to 1.5 mm long. Sterile. Chemistry: Medulla K-, C+ pink, KC+ red, P-; gyrophoric acid present.

It sparsely grows on boulders in moist exposed alpine areas.

Distribution: India (Sikkim), China, Nepal.

Specimen examined: West Sikkim: Dzungri, alt. 4025 m, Sinha 264 A.

7. **Umbilicaria vellea** (L.) Ach., *Vetensk. -Akad. Nya Handl.* 15:101. 1794; Krog & Swinscow, *Nord. J. Bot.* 6:84. 1984. -*Lichen velleus* L., *Sp. Pl.* :1150. 1753.

Thallus monophyllous, 3.5-6 cm across, creamish buff to pale grey, rigid to membranous, orbicular, umbo moderately elevated or absent; margin entire to \pm deeply incised, crenate; upper surface undulate, \pm folded, smooth to scabrid, areolate papillate, perforated or torn with rhizines from lower surface appearing as dark clumps; medulla white; lower surface black, occasionally brownish at margins, coarsely papillate-rhizinate; rhizines long and thick but swollen on the base caused by covering with black thalloconidia and or mixed with stubby ones

covered with thalloconidia. Apothecia not seen. Chemistry: Medulla K-, C+ pink, KC+ red, P-; gyrophoric acid present.

It commonly grows on moist boulders in temperate and alpine areas.

Distribution: India (Himalaya). Cosmopolitan.

Specimens examined: East Sikkim: Meimenchu lake surroundings, alt. 3200-3500 m, Sinha 1487, 1488. Thangu, alt. 3700 m, Sinha 1382. North Sikkim: On way between Lachung-Yumthang, alt. 3000 m, Sinha 1350. West Sikkim: On way between Dzongri-Thangsing, alt. 3900-3500 m, Sinha 799.

8. *Umbilicaria virginis* Schaerer, Biblioth. Univ. Geneve 36: 153. 1841; Poelt, Khumbu Himal 6(3): 431. 1977.

Thallus monophyllous, rarely appearing polyphyllous due to deep cut up to umbilicus point, pinkish buff, 1.5-4 cm across, coriaceous, undulating, weakly crenate, somewhat repand margin; margin crenate to incised or torn, umbilicus lateral, not produced; upper surface powdery, cracked in part, dull, with few scattered rhizinal lumps; medulla white; lower surface pale ochraceous, densely rhizinate; rhizines abundant, dark grey, much divided, ca. 1 mm long, frequently extending beyond the margins. Apothecia common, scattered over thallus but most abundant peripherally, 0.5-1.5(-2) mm diam., black, with central sterile button not always visible on the exterior, sessile or stipitate; margin entire; disc black, plane to concave; spores colourless, simple, ellipsoid to rounded, 11-20 x 6-8 μ m. Chemistry: Medulla K-, C+ pink or C-, KC+ red, P-; gyrophoric acid present.

It sparsely grows on exposed boulders in wet alpine areas.

Distribution: India (Western Himalaya, Sikkim), China; widely distributed in Western Hemisphere.

Specimens examined: North Sikkim: Sebu La base camp, east side, alt. 4960 m, Sinha 1226, 1244.

9. *Umbilicaria yunnana* (Nyl.) Hue, Nouv. Arch. Mus. 4(12):117. 1900; Poelt, Khumbu Himal 6(3): 432. 1977. -*Gyrophora yunnana* Nyl., Bull. Soc. Bot. France 34:23. 1887. (Fig. 93)

Thallus monophyllous, slightly lobed, pale greyish, 3.5-8 cm across, irregularly outlined; margin slightly lacerated but not deeply lobed; upper surface undulating with soft folds over umbo, dull, smooth to minutely rugose, shallowly foveolate; medulla white; lower surface brown black with discoid depression below apothecia, with kinky hair fine and richly branched rhizines which project dorsally through cracks or over margins. Apothecia many, depressed, all over the lamina, 1-2 mm diam., usually angular to oblong; disc gyrose, black; spores colourless,

simple, ellipsoid, 16-20 x 6-12 μ m. Chemistry: Medulla K-, C+ pink, KC+ red, P-; gyrophoric acid present.

It commonly grows on exposed boulders as well as on tree trunks in temperate region.

Distribution: India (Eastern Himalaya, Sikkim), China and Nepal.

Specimens examined: North Sikkim: Lachen, along road side, alt. 2710 m, Sinha 1137. Lachung, river side forest, alt. 2650 m, Sinha 1119. On way between Phuni-Yakche, alt. 3000 m, Sinha 1087. On way between Rabong-Chhaten, alt. 2350 m, on *Carpinus* trunk, Sinha 1131. Tholung-Kissong foot track, alt. 2475-2700 m, Sinha 602, 603. Yumthang, river side forest, alt. 3530 m, Sinha 1071 B.

LICHENS OF UNCERTAIN AFFINITY

Leprocaulon Nyl. ex Lamy

Thallus small, slender, cartilagenous, \pm terete, simple or branched, crowded, erect or intricate, pseudopodetia leprose sorediate, irregularly lumpy rotulose or minutely verrucose, surface glabrous or slightly arachnoid tomentose, sometimes \pm decumbent and dorsiventral; primary thallus absent or minutely verrucose, or powdery dissolute. Cephalodia, apothecia and pycnidia absent. Photobiont green, *Trebouxia*.

A genus of imperfect lichens with 7 species in the world; 2 species in India and Sikkim which are only chemically separable.

Key to the species

- 1a. Physodalic and protocetraric acids present 1. *L. arbuscula*
 1b. Thamnic and squamatic acid present 2. *L. pseudoarbuscula*

1. ***Leprocaulon arbuscula*** (Nyl.) Nyl., Lich. ins. guin.: 8. 1899; Lamb & Ward, Journ. Hattori Bot. Lab. 38:516. 1974. -*Stereocaulon arbuscula* Nyl., Syn. Lich. 1: 258. 1860.

Pseudopodetia in small tufts, dendroid with dorsiventral distichous branches, soft and fragile, up to 2.5 cm tall, 0.4 mm thick; upper branches much finer, to 0.15 mm thick, whitish, glaucous greyish, or white, matt, tomentose, main branches glabrous, terminal branchlets very fine, coralloid; phyllocladial granules on terminal branchlets, scarce or absent on ventral side, softly pulverulent, often dissolving into smaller granules; photobiont in irregular groups on surface of pseudopodetia and in powdery granules, loosely enveloped with hyphae. Chemistry: Pseudopodetia K+ brownish or K-, P+ orange red to miniate red; atranorin and protocetraric acid present; physodalic acid present (strain -II) or absent (strain - I).

Both strain I and strain II are known from Dzongri area of West Sikkim (*l.c.* Lamb & Ward). No specimen pertaining to this species was found during the present investigation.

Distribution: India (Sikkim), China, Japan, Nepal; Colombia, Cuba, New Zealand and U.S.A..

2. ***Leprocaulon pseudoarbuscula*** (Asah.) Lamb & Ward, Journ. Hattori Bot. Lab. 38: 533. 1974. -*Stereocaulon pseudoarbuscula* Asah., J. Jap. Bot. 19: 282, 1943.

The species is morphologically and anatomically identical to the preceding *L. arbuscula* (Nyl.) Nyl. It differs chemically from the former by presence of thamnolic, squamatic, baecomycesic and barbatic acids.

The taxon is reported from Bakhim area of West Sikkim (*l.c.* Lamb & Ward). No specimen pertaining to this was found during the present investigation.

Siphula Fr.

Thallus fruticose, erect, sparingly branched, whitish, compressed to ± terete, often crowded, thick or thin, often fragile, on soil or among moss, anchored with a ± well developed rooting system; roots terete, dendroid, simple to branched; cortex pseudoparenchymatous; photobiont chlorococcoid; medulla compact, hyphae ± longitudinally aligned. Apothecia and pycnidia not known.

A cosmopolitan genus of *ca.* 40 species characteristics of peaty soils and acid bark in temperate and wet alpine regions. Only a single species is known from Sikkim Himalayan region in India.

Siphula ceratites (Wahlenb.) Fr., Lich. Eur. : 406. 1831. -*Baeomyces ceratites* Wahlenb., Fl. Lappon.:459. 1812. (Fig. 94)

Thallus forming compact tufts, 2.5-3 cm tall, scattered in small patches; branches up to 2 mm diam., chalk white to pale greyish, sparingly branched, ± cylindrical, longitudinally plicate or furrowed, particularly towards a rooting base, smooth, ± rugose or scabrid pruinose, solid; apices rounded, not markedly tapered. Chemistry: Cortex K + yellow, C + yellow brown, KC + yellow-orange, P -; medulla UV + violet-glaucous; siphulin present.

It grows on soil in alpine areas. Small thallus of *Thamnolia vermicularis* show some morphological resemblance with this species, but the former has pitted apices, hollow branches and different chemistry.

Distribution: India (Sikkim and West Bengal), Nepal and alpine regions of the world.

Specimen examined: East Sikkim: Kupup, north border side, alt. 4100-4200 m, Sinha 1493.



90



91



92

Fig. 90. *Xanthoria elegans*. **Fig. 91.** *Lasallia pustulata*. **Fig. 92.** *Umbilicaria indica*.

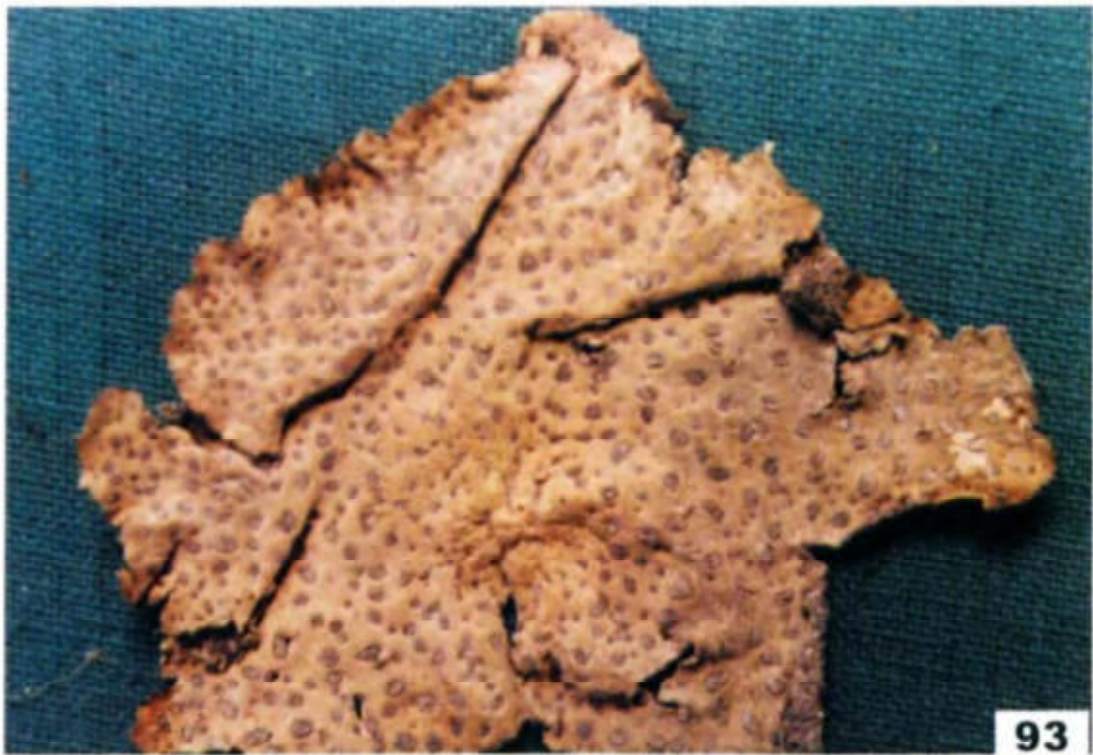


Fig. 93. *Umbilicaria yunnana*. **Fig. 94.** *Siphula ceratites*. **Fig. 95.** *Thamnolia vermicularis*.

Thamnolia Ach. *ex* Schaerer

Thallus fruticose, prostrate or decumbent, not or sparingly branched; branches cylindrical, base usually dying; cortex paraplectenchymatous, of longitudinally oriented hyphae; photobiont trebouxioid; medulla thin, of longitudinally oriented hyphae, the interior hollow. Apothecia and pycnidia unknown.

A genus with 2 species (often considered only one), with an extraordinary world wide distribution; both known from India and 1 from Sikkim.

Thamnolia vermicularis (Swartz) Ach. *ex* Schaer., Enum. lich. eur.: 243, 1850.
Lichen vermicularis Swartz, Meth. Musc.: 37, 1781. (Fig. 95)

Thallus prostrate to erect podetia worm like stems, simple or forked, tapering, terete, appearing flattened or compressed particularly at furcating point, 2-4.5 cm long, 1.5-2 mm wide at base, milky white; surface smooth, matt, isidia and soredia absent. Sterile. Chemistry: Cortex K+ yellow, P+ orange; medulla K+ pale or K-, C-, KC-, P+ orange or P-; thamnolic acid present.

A subalpine to alpine region taxon grows profusely on ground in moist situation.

Distribution: India (Sikkim and Western Himalaya). Cosmopolitan.

Specimens examined: North Sikkim: Sebu La, alt. 5400 m, U. Lachungpa 684, Sinha 96. West Sikkim: Dzungri, alt. 4000 m, Sinha 761. On way between Dzungri-Thangsing, alt. 3900-3500 m, Sinha 810.

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INDEX

<i>Abies</i> Miller	6, 100, 102
<i>densa</i> Griffith ex Parker	8, 10
<i>Acer</i> L.	6, 10
<i>campbelli</i> Hook. f. & Thomson	10
Acroscyphus Lév.	10, 22, 24
sphaerophoroides Lév.	12, 13, 14, 24 , 25
<i>Aglata lawii</i> (Wight) Ramamoorthy	7
<i>Alangium chinense</i> (Lour.) Harms.	7
<i>Albizia</i> Durazzini	
<i>gamblei</i> Prain	7
<i>odoratissima</i> (L. f.) Benth.	7
<i>procera</i> (Roxb.) Benth.	7
Alectoria Ach	23, 61
<i>bicolor</i> (Ehrh.) Nyl.	73
<i>confusa</i> Awasthi	74
<i>himalayana</i> Mot.	74
ochroleuca (Hoffm.) Massal.	12, 14, 59, 61
<i>perspinosa</i> Bystrek	76
<i>sulcata</i> (Lév.) Nyl.	63
<i>tenuis</i> Dahl	76
<i>virens</i> Taylor	64
ALECTORIACEAE	61
<i>Allocetraria</i> Kurok. & M. J. Lai	18, 67
ambigua (C. Bab.) Kurok. & M. J. Lai	12, 60, 67
<i>cucullata</i> (Béllardi) Randlane & Saag	94
denticulata (Hue) A. Thell & Randlane	60, 67 68
flavonigrescens A. Thell & Randlane	12, 60, 67, 68
globulans (Nyl.) A. Thell & Randlane	60, 67 68
stracheyi (C. Bab.) Kurok. & M. J. Lai	11, 13, 67, 69 , 70
<i>potaninii</i> (Oxner) Randlane & Saag	69
<i>Alnus nepalensis</i> D. Don	7, 66, 105, 118, 188
<i>Alstonia</i> R. Br.	
<i>neerifolia</i> D. Don	7
<i>scholaris</i> (L.) R. Br.	7

Anaptychia

<i>albidiflava</i> Kurok.	176
<i>angustiloba</i> (Müll. Arg.) Kurok.	176
<i>awasthii</i> Kurok.	176
<i>comosa</i> (Eschw.) Massal.	178
<i>dactyliza</i> (Nyl.) Zahlbr.	178
<i>dendritica</i> var. <i>japonica</i> Sato	185
<i>diademata</i> (Taylor) Kurok.	179
<i>dissecta</i> Kurok.	180
<i>firmula</i> (Nyl.) Dodge & Awasthi	180
<i>himalayensis</i> Awasthi	180
<i>hypocaesia</i> Yasuda	181
<i>hypoleuca</i> var. <i>microphylla</i> Kurok.	185
f. <i>rubescens</i> Räsänen	188
<i>incana</i> (Stirton) Zahlbr.	182
<i>indica</i> H. Magn.	182
<i>japonica</i> (Sato) Kurok.	185
<i>lutescens</i> Kurok.	185
<i>microphylla</i> (Kurok.) Kurok.	185
<i>neoleucomalaena</i> Kurok.	177
<i>obscurata</i> (Nyl.) Vainio	186
<i>pellucida</i> Awasthi	186
<i>podocarpa</i> (Bél.) Massal.	187
<i>pseudospeciosa</i> Kurok.	187
var. <i>tremulans</i> (Müll. Arg.) Kurok.	189
<i>rubescens</i> (Räsänen) Kurok.	188
<i>speciosa</i> (Wulfen) Massal.	188
<i>togashii</i> Kurok.	189
Anzia Stizenb.	20, 64
physoidea Smith	12, 13, 64
ANZIACEAE	64
Arctoparmelia Hale	18, 72
subcentrifuga (Oxner) Hale	14, 72
ARTHONIACEAE	7
<i>Bauhinia purpurea</i> Benth.	7
Baeomyces Pers.	21, 27
<i>ceratites</i> Wahlenb.	244
pachypus Nyl.	10, 25, 27
<i>pocillum</i> Ach.	43

<i>roseus</i> Pers.	28
BAEOMYCETACEAE	27
<i>Berberis</i> L.	10, 114
<i>Betula</i> L.	162
BIATORACEAE	65
<i>Bischofia javanica</i> Blume	7
<i>Bombax ceiba</i> L.	7
<i>Borreria boryi</i> Féc	177
<i>Bryopogon jubatum</i> var. <i>nitidum</i> Th. Fr.	75
Bryoria Brodo & D. Hawksw.	9, 10, 23, 72
<i>bicolor</i> (Ehrh.) Brodo & D. Hawksw.	13, 73
<i>confusa</i> (Awasthi) Brodo & D. Hawksw.	13, 73, 74
<i>himalayana</i> (Mot.) Brodo & D. Hawksw.	10, 73, 74
<i>implexa</i> (Hoffm.) Brodo & D. Hawksw.	13, 14, 73, 75
<i>levis</i> Awasthi	12, 73, 75
<i>nitidula</i> (Th.Fr.) Brodo & D. Hawksw.	12, 73, 75
<i>perspinosa</i> (Bystrek) Brodo & D. Hawksw.	13, 73, 76
<i>tenuis</i> (Dahl) Brodo & D. Hawksw.	14, 73, 76
Bulbothrix Hale	15, 77
<i>isidiza</i> (Nyl.) Hale	7, 70, 77
<i>meizospora</i> (Nyl.) Hale	13, 77, 78
<i>setschwanensis</i> (Zahlbr.) Hale	13, 77, 78
CALICIACEAE	7, 24
<i>Callicarpa arborea</i> Roxb.	7
Candelaria Massal.	15, 65
<i>concolor</i> (Dickson) Arnold	12, 66
<i>fibrosa</i> Müll. Arg. f. <i>indica</i> Hue	66
<i>indica</i> (Hue) Vainio	66
CANDELARIACEAE	65
Canomaculina Flix & Hale	16, 79
<i>subsumpta</i> (Nyl.) Elix	79
<i>subtinctoria</i> (Zahlbr.) Elix	13, 70, 79, 80

Canoparmelia Elix & Hale	19, 80
aptata (Krempelh.) Elix & Hale	81
texana (Tuck.) Elix & Hale	81
<i>Capitularia amaurocraea</i> Flörke	33
<i>Castanopsis</i> (D. Don) Spach.	6
<i>indica</i> (Roxb.) Miq.	7
<i>Cenomyce</i>	
<i>chlorophaea</i> Flörke	35
<i>gracilis</i> var. <i>cetrariiformis</i> Delise	37
<i>scabriuscula</i> Delise	35
Cetraria Ach.	22, 24, 67, 82, 89, 161
<i>ambigua</i> C. Bab.	67
<i>chlorophylla</i> (Willd.) Vainio	145
<i>cucullata</i> (Béllardi) Ach.	94
<i>everniella</i> (Nyl.) Krempelh.	69
<i>hepatizon</i> (Ach.) Vainio	113
<i>isidioidea</i> (Räsänen) Awasthi	121
<i>islandica</i> (L.) Ach.	11, 13, 14, 70, 82, 83
<i>japonica</i> Zahlbr.	88
laevigata Rassad.	82, 83
<i>laureri</i> Krempelh.	147
<i>leucostigma</i> Lév.	121
melaloma (Nyl.) Krempelh.	11, 13, 82, 83
muricata (Ach.) Eckfeldt	70, 82, 84
<i>nephromoides</i> (Nyl.) Awasthi	122
nigricans Nyl.	12, 82, 84
<i>pallescens</i> Schaerer	122
<i>pallida</i> Awasthi	83
<i>pinastri</i> (Scop.) S. Gray	162
<i>potaninii</i> Oxner	69
<i>rhytidocarpa</i> Mont. & v. d. Bosch	89
<i>sanguinea</i> Schaerer	89
<i>sepincola</i> (Ehrh.) Ach.	146
<i>sikkimensis</i> Räsänen	121
<i>stracheyi</i> C. Bah	123
<i>wallichiana</i> (Taylor) Müll. Arg.	122
var. <i>isidioidea</i> Räsänen	121
<i>Cetrariastrum vexans</i> Zahlbr. ex W. Culb. & C. Culb.	93
<i>Cetrariopsis wallichiana</i> (Taylor) Kurok.	122

Cetrelia W. Culb. & C. Culb.	18, 85
braunsiana (Müll. Arg.) W. Culb. & C. Culb.	10, 13, 85, 86
cetrarioides (Delise ex Duby) W. Culb. & C. Culb.	13, 71, 85, 86
collata (Nyl.) W. Culb. & C. Culb.	13, 86, 87
delavayana W. Culb. & C. Culb.	86, 87
japonica (Zahlbr.) W. Culb. & C. Culb.	85, 88
olivetorum (Nyl.) W. Culb. & C. Culb.	13, 85, 88
pseudolivetorum (Asah.) W. Culb. & C. Culb.	85, 86, 88
sanguinea (Schaerer) W. Culb. & C. Culb.	14, 86, 89
Cetrellopsis M. J. Lai	17, 18, 89
rhytidocarpa (Mont. & v. d. Bosch) M. J. Lai	13, 89
Chlorea <i>cladonioides</i> Nyl.	112
<i>flexuosa</i> Nyl.	112
Chlorella spp.	212
Chukrasia <i>tabularis</i> A. Juss.	7
Cladia Nyl.	24, 28
aggregata (Swartz) Nyl.	11, 13, 25, 28
Cladonia P. Browne	12, 21, 23, 24, 28, 41
amourocraea (Flörke) Schaerer	12, 26, 32, 33
<i>applanata</i> Räsänen	36
arbuscula (Wallroth) Hale & W. Culb.	14, 26, 32, 33
awasthiana Ahti & Upreti	31, 34
borealis S. Stenroos	12, 30, 34
cartilaginea Müll. Arg.	31, 34
chlorophaea (Flörke) Sprengel	13, 26, 30, 35
coccifera (L.) Willd.	12, 13, 30, 36
<i>coccocarpa</i> (Nyl.) Evans	50
<i>coniocraea</i> (Flörke) Sprengel	37
corniculata Ahti & Kashiwadani	31, 36
corymbescens Nyl. ex Leighton	33, 37
crispata (Ach.) Flotow var. cetrariformis (Delise) Vainio	33, 37
<i>delavayi</i> des Abb.	32, 38
fenestralis Nuno	26, 32, 38
fruticulosa Krempelh.	30, 39
furcata (Huds.) Schrader	10, 32, 39
kaneweskii Oxner	14, 30, 40, 46
laili S. Stenroos	30, 40, 46
luteoalba Wehldon & A. Wilson	13, 30, 41

<i>macilenta</i> Hoffm.	29, 41, 46
<i>macroptera</i> Räsänen	32, 42, 46
<i>mongolica</i> Ahti	13, 32, 42, 47
<i>ochroclora</i> Flörke	31, 43
<i>pocillum</i> (Ach.) Grognot	30, 43, 47
<i>pytirea</i> (Flörke) Fr.	44
<i>pyxidata</i> (L.) Hoffm.	12, 31, 44
<i>ramulosa</i> (With.) J.R. Laundon	12, 31, 32, 37, 44
<i>rangiferina</i> (L.) Wigg.	11, 32, 45, 47
<i>scabriuscula</i> (Delise) Nyl.	7, 32, 45
<i>singhii</i> Ahti et Dixit	13, 31, 48
<i>squamosa</i> Hoffm.	10, 33, 48
<i>subulata</i> (L.) Wigg.	14, 31, 49
<i>transcedens</i> Vainio var. <i>yunnana</i> Vainio	50
<i>yunnana</i> (Vainio) des Abb. ex J.C. Wei & Y. M. Jiang	13, 30, 47, 50
CLADONIACEAE	12, 28
Coccocarpia Pers.	18, 221
<i>erythroxyli</i> (Sprengel) Swinscow & Krog	10, 12, 222
<i>palmicola</i> (Sprengel) Arvidsson & D. Galloway	13, 222, 235
<i>pellita</i> (Ach.) Müll. Arg. em R. Sant.	223
COCCOCARPIACEAE	221
<i>Coccomyxa</i> spp.	208, 218
<i>Coelocaulon muricatus</i> (Ach.) J. R. Laundon	84
Collema Web. ex Wigg.	20, 223
<i>flaccidum</i> (Ach.) Ach.	14, 224
<i>furfuraceum</i> (Aronld) Du Reitz	224
<i>hookeri</i> Degel.	12, 224, 225
<i>japonicum</i> (Müll. Arg.) Hue	14, 224, 225
<i>pulcellum</i> Ach. var. <i>subnigrescens</i> (Müll. Arg.) Degel.	224, 226
COLLEMATACEAE	12, 223
<i>Cornicularia sulcata</i> Lév.	63
<i>Cotoneaster</i> L.	6, 10
<i>Cryptomeria japonica</i> (L.f.) D. Don	66
<i>Cystococcus</i> spp.	27
Dibaeis Clements	21, 27
<i>baeomyces</i> (L.f.) Rambold & Hertel	28

<i>Dictyochloropsis</i> spp.	212
Dirinaria (Tuck.) Clem.	7, 19, 21, 171
<i>aegialita</i> (Afz.) Moore	171
<i>applanata</i> (Fée) Awasthi	171, 172
<i>confluens</i> (Fr.) Awasthi	171, 172
<i>consimilis</i> (Stirton) Awasthi	171, 173
<i>Duabanga grandiflora</i> (Roxb. ex DC.) Walp	7
<i>Engelhardia spicata</i> Blume	10
Erioderma Fée	17, 20, 220
<i>meiocarpum</i> Nyl.	13, 221, 235
<i>Erythrina arborescens</i> Roxb.	7
<i>Eugenia kurzii</i> Duthie	7
<i>Eumitria baileyi</i> Stirton	150
<i>Eurya cerasifolia</i> (D. Don) Kobuski	7
Evernia Ach.	22, 90
<i>mesomorpha</i> Nyl.	71, 90
<i>stracheyi</i> C. Bab.	69
Everniastrum Hale ex Sipman	16, 21, 91
<i>cirrhatum</i> (Fr.) Hale ex Sipman	10, 13, 71, 91, 93
<i>nepalense</i> (Taylor) Hale ex Sipman	7, 11, 13, 91, 92, 93
<i>vexans</i> (Zahlbr. ex W. Culb. & C. Culb.) Hale ex Sipman	10, 13, 71, 91, 93
<i>Exbucklandia populnea</i> (R. Br. ex Griffith) R. W. Brown	10
<i>Ficus</i> L.	
<i>auriculata</i> Lour.	7
<i>hirta</i> Vahl	7
<i>semicordata</i> J. E. Smith	7
Flavocetraria Karnefelt & A. Thell	21, 93
<i>cucullata</i> (Béllardi) Karnefelt & A. Thell	13, 94
Flavoparmelia Hale	18, 94
<i>caperata</i> (L.) Hale	95, 96
Flavopunctelia (Krog) Hale	18, 95
<i>flaventior</i> (Stirton) Hale	13, 95

GRAPHIDACEAE	7
Gymnoderma Nyl.	21, 50
coccocarpum Nyl.	13, 50
<i>Gynocordia odorata</i> R. Br.	7
<i>Gyrophora</i>	
<i>cylindrica</i> Ach.	239
<i>himalayensis</i> Räsänen	240
<i>yunnana</i> Nyl.	242
<i>Haldina cordifolia</i> (Roxb.) Ridsdale	7
<i>Helicia nilagirica</i> Bedd.	7
Heterodermia Trevisan <i>em</i> Poelt	12, 16, 19, 20, 22, 173
albidiflava (Kurok.) Awasthi	13, 174, 176
angustiloba (Müll. Arg.) Awasthi	174, 176
awasthii (Kurok.) Awasthi	13, 175, 176
boryi (Fée) K. Singh & S. Singh	10, 13, 169, 175, 177
chondroidea Web. & Awasthi	12, 170, 174, 177
comosa (Eschw.) Follm. & Redon	175, 178
dactyliza (Nyl.) Swinscow & Krog	170, 175, 178
diademata (Taylor) Awasthi	7, 11, 170, 174, 179
dissecta (Kurok.) Awasthi	170, 174, 180
firmula (Nyl.) Trevisan	13, 174, 180, 183
himalayensis (Awasthi) Awasthi	175, 180, 183
hypocaesia (Yasuda) Awasthi	175, 181
incana (Stirton) Awasthi	175, 182, 184
indica (H. Magn.) Awasthi	12, 175, 182
japonica (Sato) Swinscow & Krog	175, 184, 185
leutescens (Kurok.) Follm.	13, 175, 184, 185
microphylla (Kurok.) Skorepa	175, 185
obscurata (Nyl.) Trevisan	175, 186
pellucida (Awasthi) Awasthi	175, 186
podocarpa (Bél.) Awasthi	14, 175, 187
pseudospeciosa (Kurok.) W. Culb.	14, 174, 187
rubescens (Räsänen) Awasthi	174, 188
speciosa (Wulfen) Trevisan	14, 174, 188
togashii (Kurok.) Awasthi	12, 175, 184, 189
tremulans (Müll. Arg.) W. Culb.	13, 174, 189

Hypogymnia (Nyl.) Nyl.	20, 98
<i>alpina</i> Awasthi	13, 99
<i>enteromorpha</i> (Ach.) Nyl.	14, 99
<i>hypotrypa</i> (Nyl.) Rassad.	10, 13, 96, 98, 99 , 100
<i>physodes</i> (L.) Nyl.	13, 98, 100
<i>pseudohypotrypa</i> (Asah.) A. Singh	13, 98, 100
<i>sikkimensis</i> Sinha & Elix	12, 98, 101
<i>thomsoniana</i> (Müll. Arg.) Awasthi	12, 96, 99, 101
<i>vittata</i> (Ach.) Gasilicn	13, 98, 102
<i>zeylanica</i> (R. Sant.) Awasthi & K. Singh	101
Hypotrachyna (Vainio) Hale	12, 16, 19, 102
<i>adducta</i> (Nyl.) Hale	104
<i>aurulenta</i> (Tuck.) Krog & Swinscow	117
<i>bostrychodes</i> (Zahlbr.) Hale	109
<i>crenata</i> (Kurok.) Hale	13, 103, 104
<i>dactylifera</i> (Vainio) Hale	103, 105
<i>exsecta</i> (Taylor) Hale	13, 103, 105
<i>flexilis</i> (Kurok.) Hale	104, 106
<i>formosana</i> (Zahlbr.) Hale	109
<i>imbricatula</i> (Zahlbr.) Hale	103, 106
<i>incognita</i> (Kurok.) Hale	103, 107
<i>infirmata</i> (Kurok.) Hale	13, 103, 107
<i>koyaensis</i> (Asah.) Hale	14, 97, 103, 108
<i>massartii</i> (Hue) Hale	109
<i>neodissecta</i> (Hale) Hale	103, 108
<i>neosingularis</i> Divakar, Upreti & Elix	12, 104, 108
<i>osseoalba</i> (Vainio) Park & Hale	103, 109
<i>physciodes</i> (Nyl.) Hale	104, 109
<i>radiculata</i> (Kurok.) Elix	103, 110
<i>rigidula</i> (Kurok.) Hale	12, 103, 110
<i>scytodes</i> (Kurok.) Hale	109
<i>scytophylla</i> (Kurok.) Hale	97, 104, 111
<i>sinuosa</i> (Smith) Hale	103, 111
ICMADOPHILACEAE	27
<i>Juglans regia</i> L.	10
<i>Juniperus</i> L.	6, 10, 34
<i>Lagerstromia parviflora</i> Roxb.	7
<i>Larix griffithiana</i> Carriers	6, 10

Lasallia Mérat	15, 237
pustulata (L.) Mérat	14, 237, 245
<i>Lecanora</i>	
<i>elegans</i> var. <i>sorediata</i> Vainio	236
<i>rubina</i> (Vill.) Ach.	141
<i>tribacia</i> Ach.	195
LECANORACEAE	7
<i>Lecidea</i>	
<i>corallina</i> Eschw.	65
<i>erythroxyli</i> Sprengel	222
<i>pulmicola</i> Sprengel.	222
<i>sorediata</i> Ach.	200
Leprocaulon Nyl. ex Lamb	241
arbuscula (Nyl.) Nyl.	13, 14, 21, 243
pseudoarbuscula (Asah.) Lamb & Ward	243, 244
Leptogium (Ach.) Gray	12, 20, 226
arisanense Asah.	227
asiaticum P.M. Jørg.	227, 228
askotense Awasthi	12, 227, 228
azureum (Swartz) Mont.	227, 229
burnetiae Dodge	7, 227, 229
delavayi Hue	227, 230
denticulatum Nyl.	7, 227, 230
gelatinosum (With.) J. R. Laundon	227, 231
<i>hildenbrandi</i> var. <i>papillosum</i> B. de Lesd.	231
indicum Awasthi & Akhtar	227, 231
papillosum (B. de Lesd.) Dodge	227, 231
pedicellatum P. M. Jørg.	14, 227, 232, 235
saturninum (Dickson) Nyl.	227, 232
<i>sinuatum</i> (Huds.) Massal.	231
trichophorum Müll. Arg.	227, 233
Lethariella (Mot.) Krog	10, 23, 112
cladonioides (Nyl.) Krog	11, 12, 13, 97, 112
<i>Lichen</i>	
<i>agregatus</i> Swartz	28
<i>azureus</i> Swartz	229
<i>baeomyces</i> L. f.	28
<i>bicolor</i> Ehrh.	73

<i>borreri</i> Smith	139
<i>caesius</i> Hoffm.	194
<i>caninus</i> L.	202
<i>var. rufescens</i> Weis.	207
<i>caperatus</i> L.	95
<i>chlorophylla</i> Willd.	145
<i>chrysoleucus</i> Smith	141
<i>cocciferus</i> L.	36
<i>collinus</i> Ach.	203
<i>concolor</i> Dickson	66
<i>croceus</i> L.	208
<i>cucullatus</i> Bellardi	94
<i>cylindricus</i> L.	239
<i>decussatus</i> Vill.	240
<i>elegans</i> Link	246
<i>flaccidus</i> Ach.	224
<i>furcatus</i> Huds.	39
<i>gelatinosus</i> With.	231
<i>hepatizon</i> Ach.	113
<i>horizontalis</i> Huds.	204
<i>islandicus</i> L.	83
<i>limbatus</i> Smith	215
<i>melanophthalma</i> Ram.	141
<i>muricatus</i> Ach.	84
<i>olivaceous</i> L.	114
<i>orbicularis</i> Neck.	192
<i>physodes</i> L.	100
<i>pinastri</i> Scop.	162
<i>polydactylon</i> Neck.	206
<i>pustulatus</i> L.	237
<i>pyxidatus</i> L.	44
<i>ramulosus</i> With.	44
<i>rangiferinus</i> L.	45
<i>retigera</i> Bory	211
<i>saccatus</i> L.	208
<i>saturninus</i> Dickson	232
<i>saxatilis</i> L.	126
<i>sepincola</i> Ehrh.	146
<i>sinuatus</i> Huds.	231
<i>sinuosus</i> Smith	111
<i>speciosus</i> Wulfen	188

<i>stygius</i> L.	115
<i>subulatus</i> L.	49
<i>tiliaceus</i> Hoffm.	130
<i>velleus</i> L.	241
<i>vermicularis</i> Swartz	247
<i>Lithocarpus pachyphylla</i> (Kurz) Rehder	10
Lobaria (Schreber) Hoffm.	20, 21, 209
<i>awasthiana</i> (Räsänen) Awasthi	210
discolor (Bory) Hue	209
<i>isidiosa</i> (Müll. Arg.) Vainio	13, 14, 209, 210
<i>kurokawae</i> Yoshimura	10, 13, 209, 210
<i>pseudopulmonaria</i> Gyelnik	10, 11, 14, 209, 211
<i>retigera</i> (Bory) Trevisan	7, 13, 82, 209, 211
<i>terebrata</i> Hoffm.	115
LOBARIACEAE	12, 209
<i>Lobarina awasthiana</i> Räsänen	210
<i>Lonicera</i> L.	10
<i>Mucaranga denticulata</i> (Blume) Muell. Arg.	7
<i>Malus sikkimensis</i> (Wenz) Koehne	10
<i>Mangifera sylvatica</i> Roxb.	7
Melanelia Essl.	17, 113
<i>hepatizon</i> (Ach.) A. Thell	12, 113
<i>microglabra</i> Divakar, Upreti, Sinha & Elix	97, 113, 114
<i>olivacea</i> (L.) Essl.	12, 113, 114
<i>poeltii</i> Essl.	12, 113, 114
<i>stygia</i> (L.) Essl.	10, 13, 14, 113, 115
Menegazzia Massal.	20, 115, 128
<i>terebrata</i> (Hoffm.) Massal.	10, 115
<i>Michelia</i> L.	6
<i>velutina</i> DC.	7
Myelochroa (Asah.) Elix & Hale	16, 116
<i>aurulenta</i> (Tuck.) Elix & Hale	13, 116, 117
<i>irrugans</i> (Nyl.) Elix & Hale	13, 117
<i>metarevoluta</i> (Asah.) Elix & Hale	14, 116, 118
<i>perisidians</i> (Nyl.) Elix & Hale	116, 119
<i>sikkimensis</i> Divakar, Upreti, Sinha & Elix	119, 128
<i>xantholepis</i> (Mont. & v. d. Bosch) Elix & Hale	7, 119, 128

<i>Moyremica</i> spp.	214
<i>Myricaria</i> Desvaux	10
Nephroma Ach.	10, 17, 218
<i>helveticum</i> Ach.	219 , 234
<i>isidiosum</i> (Nyl.) Gyelnik	13, 218, 219
<i>nakaoui</i> Asah.	11, 13, 218, 220
<i>sikkimense</i> Asah.	12, 220
NEPHROMATACEAE	218
<i>Nephromium tomentosum</i> var. <i>isidiosum</i> Nyl.	219
Nephromopsis Müll. Arg.	17, 22, 120
<i>ectocarpisma</i> (Hue). Gyelnik	122
<i>isidioidea</i> (Räsänen) Randle & Saag	12, 120, 121
<i>laureri</i> (Krempelh.) Kurok.	147
<i>leucostigma</i> (Lév.) Awasthi	11, 12, 13, 120, 121
<i>nephromoides</i> (Nyl.) Ahti & Randle	121, 122
<i>pallescens</i> (Schaerer) Park	10, 120, 122
<i>rhytidocarpa</i> (Mont. & v. d. Bosch) Zahlbr.	90
<i>stracheyi</i> (C. Bab.) Müll. Arg.	10, 120, 123
<i>stracheyi</i> f. <i>ectocarpisma</i> Hue	122
<i>Nostoc</i> spp.	51, 52, 53, 54, 55, 56, 57, 58, 201, 209, 212, 214, 218, 223, 226
Oropogon Th. Fr.	24, 62
<i>formasanus</i> Asah.	12, 13, 59, 62
PANNARIACEAE	220
Parmelaria Awasthi	16, 123
<i>subthomsonii</i> Awasthi	12, 13, 123, 124
<i>thomsonii</i> (Stirton) Awasthi	10, 11, 12, 13, 123, 124 , 128
Parmelia Ach.	18, 99, 124
<i>adaugescens</i> Nyl.	10, 125
<i>adducta</i> Nyl.	104
<i>aegialita</i> Afz.	171
<i>anuleriformis</i> Elix	163
<i>applanata</i> Fée	172
<i>aptata</i> Krempelh.	81
<i>aurulenta</i> Tuck.	117
<i>borreri</i> (Smith) Turn.	139
<i>bostrychodes</i> Zahlbr.	109
<i>braunsiana</i> Müll. Arg.	86

<i>caperata</i> (L.) Ach.	95
<i>cirrhata</i> Fr.	91
<i>comosa</i> Eschw.	178
<i>confluens</i> Fr.	172
<i>crenata</i> Kurok.	104
<i>dactylifera</i> Vainio	105
<i>diademata</i> Taylor	179
<i>dissecta</i> Nyl.	132
<i>endococcina</i> Körber	191
<i>enteromorpha</i> Ach.	99
<i>expallida</i> Kurok.	132
<i>exsecta</i> Taylor	105
<i>flaventior</i> Stirton	95
<i>flexilis</i> Kurok.	106
<i>formosana</i> Zahlbr.	109
<i>hababiana</i> Gyelnik	134
<i>hispidula</i> Ach.	192
<i>homogenes</i> Nyl.	117
<i>horrescens</i> Taylor	132
<i>hypotrypa</i> Nyl.	99
<i>imbricatula</i> Zahlbr.	106
<i>incognita</i> Kurok.	107
<i>infirma</i> Kurok	107
<i>irrugans</i> Nyl.	117
<i>isidiza</i> Nyl.	77
<i>koyaensis</i> Asah.	108
<i>massartii</i> Hue	109
meiophora Nyl.	13, 125, 126
<i>meizospora</i> (Nyl.) Nyl.	78
<i>mellissii</i> Dodge	134
<i>metarevoluta</i> Asah.	118
<i>muscigena</i> Ach.	199
<i>neodissecta</i> Hale	108
<i>nepalensis</i> Taylor	92
<i>nilgherrensis</i> Nyl.	135
<i>olivacea</i> (L.) Ach.	114
<i>olivetorum</i> Nyl.	88
<i>osseoalba</i> Vainio	109
<i>pellita</i> Ach.	223
<i>perisidians</i> Nyl.	119
<i>perlata</i> var. <i>cetrarioides</i> Delise ex Duby	86

<i>physcioides</i> Nyl.	109
<i>physodes</i> (L.) Ach.	100
var. <i>vittata</i> Ach.	102
<i>podocarpa</i> Bél.	187
<i>praesorediosa</i> Nyl.	135
<i>pseudohypotrypa</i> Asah. ex Nuno	100
<i>pseudolivetorum</i> Asah.	88
<i>pseudomarmariza</i> Awasthi	125
<i>pseudonilgherrensis</i> Asah.	136
<i>pulverulenta</i> var. <i>dimidiata</i> Aronld	195
var. <i>detersa</i> Nyl.	199
<i>radiculata</i> Kurok.	110
<i>rampoddensis</i> Nyl.	136
<i>reticulata</i> Taylor	144
<i>rigidula</i> Kurok.	110
<i>rudecta</i> Ach.	140
<i>saccatiloba</i> Taylor	137
<i>sancti-angelii</i> Lynge	137
saxatilis Ach.	13, 125, 126
<i>scytodes</i> Kurok.	109
<i>scytophylla</i> Kurok.	111
<i>setschwanensis</i> Zahlbr.	78
<i>sinuosa</i> (Smith) Ach.	111
<i>somloensis</i> Gyelnik	163
<i>speciosa</i> (Wulfen) Ach.	188
squarrosa Hale	14, 125, 126
<i>stygia</i> (L.) Ach.	115
<i>subaurulenta</i> Nyl.	117
<i>subcentrifuga</i> Oxner	72
<i>subsumpta</i> Nyl.	79
<i>subtinctoria</i> Zahlbr.	80
sulcata Taylor	13, 125, 127 , 129
<i>texana</i> Tuck.	81
<i>thomsoniana</i> Müll. Arg.	101
<i>thomsonii</i> (Stirton) C. Culb.	124
<i>tiliacea</i> (Hoffm.) Ach.	130
var. <i>meizospora</i> Nyl.	78
<i>tinctina</i> Maheu & Gillet	164
<i>tinctorum</i> Desprt. ex Nyl.	138
<i>vexans</i> Zahlbr.	93
<i>wallichiana</i> Taylor	131
<i>xantholepis</i> Mont. & v. d. Bosch	119

PARMELIACEAE	12, 67
Parmelina Hale	17, 116, 127, 130, 132
<i>aurulenta</i> (Tuck.) Hale	117
<i>expallida</i> (Kurok.) Hale	132
<i>horrescens</i> (Taylor) Hale	132
<i>irrugans</i> (Nyl.) Hale	117
<i>metarevoluta</i> (Asah.) Hale	118
<i>perisidians</i> (Nyl.) Hale	119
<i>subaurulenta</i> (Nyl.) Hale	117
tiliacea (Hoffm.) Hale	13, 130
<i>wallichiana</i> (Taylor) Hale	131
<i>xantholepis</i> (Mont. & v. d. Bosch) Hale	119
Parmelinella Elix & Hale	16, 130
<i>wallichiana</i> (Taylor) Elix & Hale	7, 129, 131
Parmelinopsis Elix & Hale	17, 131, 132
<i>expallida</i> (Kurok.) Elix & Hale	129, 132
<i>horrescens</i> (Taylor) Elix & Hale	132
Parmotrema Massal.	7, 16, 19, 133
hababianum (Gyelnik) Hale	134
mellissii (Dodge) Hale	133, 134
nilgherrense (Nyl.) Hale	10, 133, 135
praesorediosum (Nyl.) Hale	13, 134, 135
pseudonilgherrense (Asah.) Hale	134, 136
rampoddense (Nyl.) Hale	13, 134, 136
<i>reticulatum</i> (Taylor) M. Choisy	144
saccatilobum (Taylor) Hale	133, 137
sanctae-angelii (Lynge) Hale	7, 134, 137
<i>subtinctorium</i> (Zahlbr.) Hale	80
tinctorum (Despr. ex Nyl.) Hale	7, 129, 133, 138
<i>Patellaria foliacea</i> var. <i>arbuscula</i> Wallroth	33
<i>Peltidea canina</i> var. <i>membranacea</i> Ach.	205
<i>malacea</i> Ach.	205
Peltigera Willd.	12, 19, 201
<i>canina</i> (L.) Willd.	10, 202
<i>collina</i> (Ach.) Schrader	203
dolichorrhiza (Nyl.) Nyl.	7, 13, 202, 204
<i>horizontalis</i> (Huds.) Baumg.	14, 202, 204
<i>macra</i> Vainio	202, 205

<i>malacea</i> (Ach.) Funck	202, 205
<i>membranacea</i> (Ach.) Nyl.	14, 202, 205
<i>polydactyla</i> (Neck.) Hoffm.	11, 12, 197, 202, 206
var. <i>polydactyla</i>	206, 207
var. <i>pruinosa</i> Gyelnik	206, 207
var. <i>dolichorrhiza</i> Nyl.	204
<i>praetextata</i> (Flörke) Vainio	202, 207
<i>rufescens</i> (Weis.) Humb.	12, 202, 207
<i>ulorrhiza</i> var. <i>praetextata</i> Flörke	207
PELTIGERACEAE	12, 201
PERTUSARIACEAE	7
Phacophyscia Moberg	16, 17, 190
<i>decolor</i> (Kashiwadani) Essl.	14, 190, 191
<i>endococcina</i> (Körber) Moberg	190, 191
<i>endococcinodes</i> (Poelt) Essl.	190, 191, 197
<i>hispidula</i> (Ach.) Essl.	190, 192
<i>orbicularis</i> (Neck.) Moberg	190, 192
<i>pyrrhophora</i> (Poelt) Awasthi & Joshi	13, 190, 193
<i>Phyllanthus emblica</i> L.	7
Phyllopsora Müll. Arg.	21, 65
<i>corallina</i> (Eschw.) Müll. Arg.	13, 65
Physcia (Schreber) Michaux	19, 193
<i>aegialita</i> Nyl.	171
<i>applanata</i> Zahlbr.	172
<i>caesia</i> (Hoffm.) Fűrnr.	11, 14, 194, 197
<i>consimilis</i> Stirton	173
<i>decolor</i> Kashiwadani	191
<i>detersa</i> (Nyl.) Nyl.	199
<i>dilatata</i> Nyl.	11, 194
<i>dimidiata</i> (Aronld) Nyl.	13, 14, 194, 195
<i>endococcinodes</i> Poelt	191
<i>firmula</i> Nyl.	180
<i>hispidula</i> (Ach.) Frey	192
<i>hypoleuca</i> var. <i>tremulans</i> Müll. Arg.	189
<i>incana</i> Stirton	182
<i>muscigena</i> (Ach.) Nyl.	199
<i>obscurata</i> Nyl.	186
<i>orbicularis</i> Poetsch	192

<i>pyrrhophora</i> Poelt	193
<i>speciosa</i> (Wulfen) Nyl.	188
var. <i>angustiloba</i> Müll. Arg.	176
var. <i>dactyliza</i> Nyl.	178
tribacia (Ach.) Nyl.	194, 195
tribacoides Nyl.	194, 196
PHYSICIACEAE	12, 171
Physconia Poelt	17, 196
detersa (Nyl.) Poelt	13, 196, 199
muscigena (Ach.) Poelt	13, 196, 199
<i>Picea spinulosa</i> (Griffith) Henry	10
<i>Pins</i> L.	107
Platismatia W. Culb. & C. Culb.	18, 138 , 142
erosa W. Culb. & C. Culb.	10, 12, 13, 139
<i>Platysma</i>	
<i>collatum</i> Nyl.	87
<i>everniellum</i> Nyl.	69
<i>globulans</i> Nyl.	68
<i>melalomum</i> Nyl.	83
<i>nephromoides</i> Nyl.	122
<i>pallescens</i> (Schaerer) Nyl.	122
<i>thomsonii</i> Stirton	124
<i>Populus ciliata</i> Royle	10
<i>Protococcus</i> spp.	65, 201
<i>Prunus nepalensis</i> Koch	10
Pseudocyphellaria Vainio	20, 212
aurata (Ach.) Vainio	7, 12, 198, 213
clathrata (De Not.) Malme	198, 213
<i>Pseudoparmelia</i> Lyngé	80
<i>aptata</i> (Krempelh.) Hale	81
<i>caperata</i> (L.) Hale	95
<i>texana</i> (Tuck.) Hale	81
Punctelia Krog	18, 139
borreri (Smith) Krog	12, 139
rudecta (Ach.) Krog	10, 139, 140
PYRENULACEAE	7

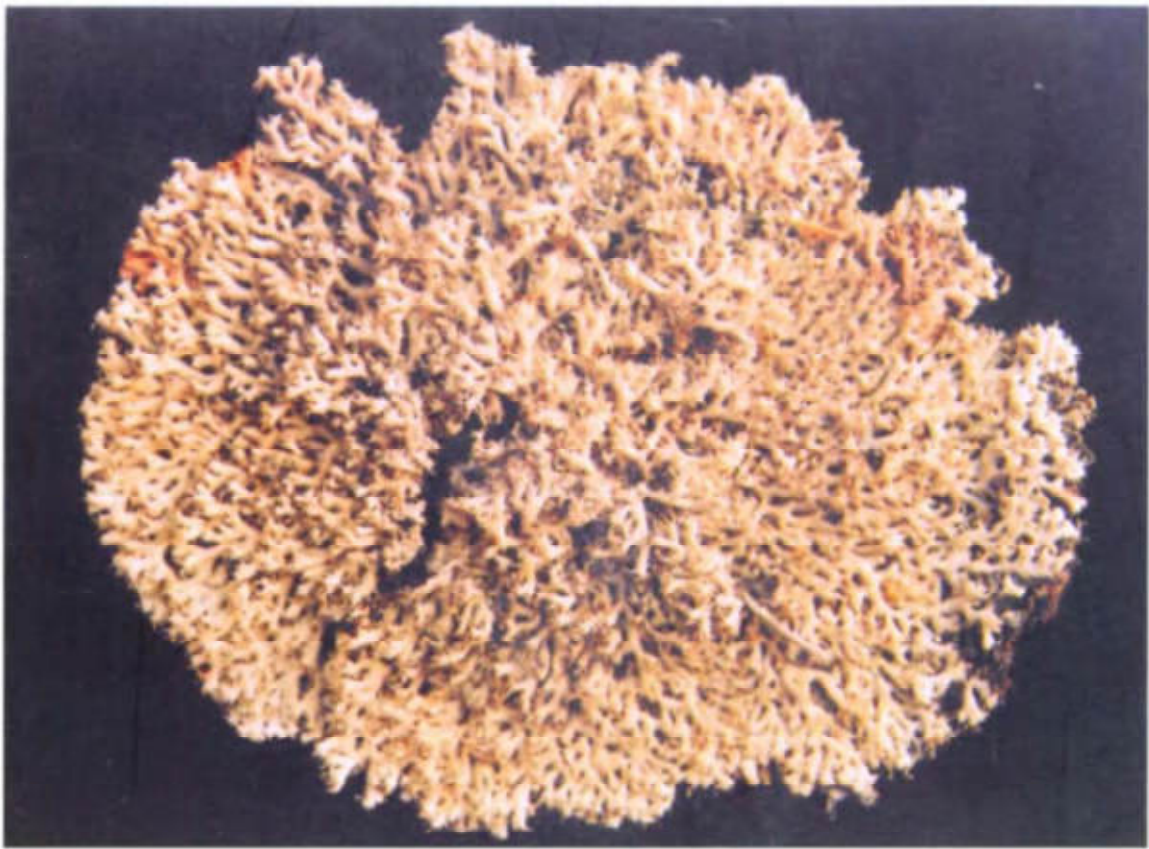
Pyxine Fr.	19, 7, 18, 199
<i>consocians</i> Vainio	200
retirguella Nyl.	200
sorediata (Ach.) Mont.	13, 200
subcinerea Stirton	197, 201
<i>Quercus</i> L.	6
<i>glauca</i> Thunb.	10
Ramalina Ach.	22, 23, 24, 164
africana (Stein) Dodge	165
conduplicans Vainio	13, 165, 166
<i>farinacea</i> (L.) Ach. subsp. <i>subcomplanata</i> Nyl.	166
var. <i>roesleri</i> Hochst. ex Schaerer	167
himalayaensis Räsänen	13, 165, 166
<i>rigida</i> (Pers.) Ach. var. <i>africana</i> Stein	165
roesleri (Hochst. ex Schaerer) Hue	13, 165, 167
shinanoana Kashiwadani	14, 165, 167 , 169
sinensis Jatta	13, 165, 168 , 169
taitensis Nyl.	165, 168
RAMALINACEAE	164
<i>Rhizocarpom</i> Ramond ex DC.	10
Rhizoplaca Zopf	15, 140
chrysoleuca (Smith) Zopf	14, 141 , 142
melanophthalma (Ram.) Leuck. & Poelt	141
<i>Rhododendron</i> L.	6, 9, 10, 34, 64, 99, 100, 102, 220
Rimelia Hale & A. Fletcher	16, 144
reticulata (Taylor) Hale & A. Fletcher	7, 13, 142, 144
<i>Rimeliella subtinctoria</i> (Zahlbr.) Kurok.	80
<i>Salix</i> L.	6, 10
<i>Saurauja napaulensis</i> DC.	7
<i>Scytonema</i> spp.	51, 56, 61, 209, 220, 221
<i>Shorea robusta</i> Gaertn. f.	7
Siphula Fr.	23, 244
ceratites (Wahlenb.) Fr.	13, 244 , 246
Solorina Ach.	20, 208
crocea (L.) Ach.	12, 198, 208
saccata (L.) Ach.	208

<i>Sorbus</i> L.	10
Stereocaulon (Schreber) Hoffm.	12, 51
<i>alpinum</i> Laur. ex Funck	14, 52, 59
<i>arbuscula</i> Nyl.	243
<i>botryophorum</i> Müll. Arg.	53
<i>coniophyllum</i> Lamb	11, 14, 52, 53
<i>foliolosum</i> Nyl.	52, 53
var. <i>botryophorum</i> (Müll. Arg.) Lamb	53
var. <i>strictum</i> (C. Bab.) Lamb	11, 53, 54, 59
<i>glareosum</i> (Savicz) Magn.	12, 51, 54
<i>himalayense</i> Awasthi & Lamb	11, 13, 52, 55
<i>macrocephalum</i> Müll. Arg.	11, 13, 52, 55
<i>massartianum</i> Hue	11, 52, 56
<i>myriocarpum</i> Th. Fr.	13, 51, 56
<i>paradoxum</i> Lamb	10, 52, 57
<i>piluliferum</i> Th. Fr.	7, 10, 51, 57
<i>pomiferum</i> Duvign.	7, 10, 52, 58
<i>pseudoarbuscula</i> Asah.	244
<i>ramulosum</i> var. <i>strictum</i> C. Bab.	54
<i>togashii</i> Lamb	52, 58
<i>tomentosum</i> f. <i>glareosum</i> Savicz	54
STEREOCAULACEAE	12, 22, 51
Sticta (Schreber) Ach.	20, 214
<i>aurata</i> Ach.	213
<i>clathrata</i> De Not.	213
<i>cyphellulata</i> (Müll. Arg.) Hue	214, 234
<i>damaecornis</i> â <i>weigeli</i> Ach.	217
<i>discolor</i> Bory	209
<i>filicina</i> var. <i>orbicularis</i> A. Br.	216
<i>limbata</i> (Smith) Ach.	215
<i>nylanderiana</i> Zahlbr.	10, 11, 215, 234
<i>orbicularis</i> (A. Br.) Hue	216
<i>platyphylla</i> var. <i>praetextata</i> Räsänen	217
<i>platyphylloides</i> Nyl.	216
<i>praetextata</i> (Räsänen) Awasthi	13, 217
<i>wallichiana</i> Taylor	122
<i>weigeli</i> (Ach.) Vainio	10, 217
<i>species</i>	214, 218

<i>Stictina</i>	
<i>cyphellulata</i> Müll. Arg.	214
<i>retigera</i> f. <i>isidiosa</i> Müll. Arg.	210
<i>Stigonema</i> spp.	51
Sulcaria Bystrek	23, 63
<i>sulcata</i> (Lév.) Bystrek ex Brodo & D. Hawksw.	10, 13, 60, 63
<i>virens</i> (Taylor) Bystrek ex Brodo & D. Hawksw.	10, 13, 60, 63, 64
<i>Synechoblastus</i>	
<i>flaccidus</i> var. <i>subnigrescens</i> Müll. Arg.	226
<i>nigrescens</i> f. <i>furfuraceum</i> Aronld	224
<i>japonicus</i> Müll. Arg.	225
<i>Talauma hodgsonii</i> Hook. f. & Thomson	7
<i>Terminalia</i> L.	
<i>alata</i> Heyne 23Roth.	7
<i>bellirica</i> (Gaertn.) Roxb.	7
<i>chebula</i> Retz.	7
<i>myriocarpa</i> Heurek & Mueller	7
TELOSCHISTACEAE	236
Thamnotia Ach. ex Schaerer	10, 24, 247
<i>vermicularis</i> (Swartz) Ach. ex Schaerer	11, 12, 244, 246, 247
<i>Trebouxia</i> spp.	29, 85, 91, 102, 123, 125, 133, 138, 139, 148, 171, 173, 193, 200, 209, 214
<i>Tsuga dumosa</i> (D. Don) Eichler	10
Tuckermannopsis Gyelnik	16, 22, 145
<i>chlorophylla</i> (Willd.) Hale	145
<i>hepatizon</i> (Ach.) Kurok.	113
<i>sepincola</i> (Ehrh.) Hale	14, 145, 146
Tuckneraria Randlane & A. Thell	146
<i>ahtii</i> Randlane & Saag	12, 142, 146
<i>laureri</i> (Krempelh.) Randlane & Saag	13, 14, 146, 147
Umbilicaria Hoffm.	11, 15, 238
<i>badia</i> Frey	239
<i>cylindrica</i> (L.) Delise	14, 238, 239
<i>decussata</i> (Vill.) Zahlbr.	239, 240
<i>indica</i> Frey	10, 11, 238, 239, 240, 245

nanella Frey & Poelt	13, 238, 241
thamnodes Hue	238, 241
vellea (L.) Ach.	10, 12, 239, 241
virginis Schaerer	13, 238, 242
yunnana (Nyl.) Hue	10, 13, 239, 242 , 246
UMBILICARIACEAE	12, 237
Usnea Adans	7, 10, 12, 23, 147
aciculifera Vainio	14, 150
baileyi (Stirton) Zahlbr.	7, 143, 148, 150
bismolliuscula Zahlbr.	14, 151
cineraria Mot.	150, 151
dendritica Stirton	150, 152
<i>dichotoma</i> Fr.	154
eumitrioides Mot.	13, 150, 152
<i>flexilis</i> Stirton	154
fragilis Stirton	148, 153
galbinifera Asah.	149, 153
himalayana C. Bab.	10, 148, 154
<i>hookeri</i> Mot.	112
<i>implexa</i> Hoffm.	75
longissima Ach.	8, 10, 11, 13, 143, 148, 154
montis fuji Mot.	10, 13, 148, 155
nepalensis Awasthi & G. Awasthi	10, 149, 155
norkettii G. Awasthi	12, 13, 149, 156
<i>ochroleuca</i> Hoffm.	61
orientalis Mot.	7, 150, 156
pangiana Stirton	13, 148, 157
pectinata Taylor	13, 148, 157
pseudosinensis Asah.	150, 157
robusta Stirton	13, 149, 158
rubicunda Stirton	148, 158
sordida Mot.	12, 149, 159
splendens Stirton	149, 159
subfloridiana Stirton	13, 14, 149, 160
subsordida Stirton	149, 160
thomsonii Stirton	10, 149, 160
undulata Stirton	149, 161
Viburnum L.	10
Vulpicidia Mattson & M. J. Lai	17, 161

<i>juniperina</i> (L.) Mattson & M. J. Lai	162
pinastri (Scop.) Mattson & M.J. Lai	13, 14, 162
Xanthoparmelia (Vainio) Hale	18, 162
<i>antleriformis</i> (Elix) Elix <i>et al.</i>	163
<i>somloensis</i> (Gyelnik) Hale	61, 143, 163
<i>subcentrifuga</i> (Oxner) Hale	72
<i>tinctina</i> (Maheu & Gillet) Hale	13, 163, 164 , 169
Xanthoria (Fr.) Th. Fr.	10, 15, 236
<i>elegans</i> (Link) Th. Fr.	236 , 245
<i>sorediata</i> (Vainio) Poelt	13, 14, 236



ISBN : 81-8177-011-0