



Research article

Assessment of the lichen diversity from Koundinya wildlife sanctuary, Andhra Pradesh, India

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Abstract: The Present investigation revealed the occurrence of 69 species belonging to 36 genera and 21 families of lichens in Koundinya wildlife sanctuary. Out of which a saxicolous foliose lichen *Xanthoparmelia tuberculiformis* is reported as a new record to India and 6 species viz. *Arthonia collectiva*, *Arthonia subvelata*, *Dictyographa varians*, *Opegrapha astrea*, *Pyrenula gibberulosa* and *Verrucaria elaeomelaena* are new records to south India. While 6 species viz. *Buellia quartziana*, *Buellia substigmaea*, *Pyxine nilgiriensis*, *Physcia abuensis*, *Caloplaca subpoliotera*, and *Caloplaca tropica* are found as endemic to India. The sanctuary also comprises of 10 new distributional records to Andhra Pradesh as well as to the Chittoor district. Among the different growth forms, crustose lichens showed maximum diversity represented by 40 (58%) species followed by 23 (33%) of foliose, 3 (4%) of leprose, 2(3%) of squamulose and single species (2%) of fruticose lichen. The sanctuary showed the maximum diversity of corticolous lichens represented by 47 (64%) species followed by 24 (33%) saxicolous lichens out of these 2 (3%) species were found commonly both on bark and rock substrata. The member of the lichen family Caliciaceae exhibit the maximum diversity represented by 11 (16%) species under 5 genera. Among the 36 genera, *Lecanora* exhibits the maximum diversity represented by 6 species. The phorophytes, *Pongamia pinnata*, and *Premna tomentosa* bears the luxuriant growth of lichens represented by 9 species. Among the 14 different altitude gradients, 17 species each were recorded at the altitudes on 592 and 602 m. Two foliose lichens, *Dirinaria applanata* and *Pyxine petricola* var. *pallida* bear luxuriant growth on both bark (*Azadirachta indica*, *Premna tomentosa*, *Euphorbia antichoram*) and rock. The effort will lay the foundation for future bio-monitoring studies on lichens from this unique habitat of Koundinya wildlife sanctuary and will act as baseline data for Eastern Ghats of India.

Keywords: Eastern Ghats - Lichen taxonomy - New records - South India.

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INTRODUCTION

India has rich diversity of lichens comprising with 2,714 species (Sinha *et al.* 2018) and, few wildlife sanctuaries are available particularly with account of lichen diversity. Before one and half decade, Meghamalai wildlife sanctuary was explored in Tamil Nadu to generate baseline biodiversity information and to evaluate lichens conservation importance and were recorded 99 lichen species belonging to 39 genera and 22 families (Nayaka *et al.* 2001). Thereafter, an introductory observation was done on Bondla and Bhagwan Mahavir wildlife sanctuaries in Goa and recorded 21 species belonging to 9 genera under 8 families out of which 7 species were recorded from Bondla wildlife sanctuary (Nayaka *et al.* 2004). Later a large amount of lichen diversity presented with 99 species belonging to 43 genera and 25 families of which 21 species were new records for Cotigao wildlife sanctuary and 15 species were new to Goa. Also *Lepraria jacksonii* Tønsberg, a leprose lichen was reported as new to India (Pallavi *et al.* 2018). An ecological study was conducted in Mehao wildlife sanctuary of (Singh *et al.* 2004) Arunachal Pradesh to observe ecological diversity of lichens and calculated

Importance Value Index of 106 species under 39 genera and 17 families (Pinokiyo *et al.* 2008). In Karnataka, Bhadra wildlife sanctuary was documented with 67 macrolichens 85 microlichens and later 152 lichens were recorded by calculating ecological parameters (Vinayaka *et al.* 2011) and in continuation of these studies again 111 species were encountered belonging to 41 genera under 22 families from Shettihalli wildlife sanctuary in the same state (Vinayaka 2016). Nayaka *et al.* (2011) recorded 42 lichens from Katarniyaghat wildlife sanctuary in Uttar Pradesh while the maximum numbers of species (214) were reported from Govind wildlife sanctuary in Uttarakhand where lichen family Parmeliaceae exhibits its dominance with 45 species (Karakoti *et al.* 2014, Mishra *et al.* 2016). Goni *et al.* (2015) listed 356 species of lichens belonging to 35 families and 91 genera from Jammu and Kashmir. Ingle *et al.* (2016) identified 66 species belonging to 27 genera and 16 families from Mudumalai wildlife sanctuary and national park in Western Ghats of Tamil Nadu. Mishra *et al.* (2017) assessed lichen diversity in Bhima Shankar wildlife sanctuary and recorded 58 species of lichens belonging to 27 genera and 17 families of which 24 species were added as new to Maharashtra. Recently, Chander & Chandel (2019) enumerated a total number of 16 species belonging to each 14 genera and 14 families of lichens from Bara Bhangal region of Dhaultdar wildlife sanctuary in Himachal Pradesh. The studies on lichen diversity indicates that since a decade most of the wildlife sanctuaries were explored from Western Ghats of Southern India while, Eastern Ghats are unexplored or underexplored for lichens diversity particular in wildlife sanctuaries especially from Andhra Pradesh. Recently, Bhitarkanika wildlife sanctuary and national park were explored in Odisha and recorded 49 lichen species with 26 genera and 14 families (Panda *et al.* 2017).

From the past ten years, exploration of lichen diversity from the state of Andhra Pradesh has been made extensively from the districts such as YSR Kadapa, Chittoor and Anantapur districts of Rayalaseema forests represented (Anjali *et al.* 2013, Mohabe *et al.* 2016 & 2017) with a maximum diversity of 183 lichens belonging to 64 genera and 26 families with many new distributional records (Anjali 2016, Anjali *et al.* 2017) but lichens from Koundinya wildlife sanctuary (KWS) was uncharted therefore present study paved a way to provide information on lichens diversity of KWS including some new distributional records.

MATERIALS AND METHODS

The present investigation is based on more than 100 lichen specimens collected from Koundinya wildlife sanctuary (KWS) which includes two major localities *viz.* Kaigal Water Fall and Syam Village. The altitude range from 582 m to 678 m [Kaigal Water Fall - (582–617 m) & Syam Village - (596–678 m)] in Chittoor district of Andhra Pradesh (Fig. 1). KWS is located in a region where the Kolar plateau end slopes down the plains of the Tamil Nadu state consists of many valleys and Ghats. It was established in 1990 and has been covered 357.60 km² forests located in between 13°00.130' N 78° 03.842' E. There are two waterfalls, Kalyan Revu and Kaigal, located to North and West of Palamaner. These waterfalls are about 10 and 28 km away from Palamaner respectively in Chittoor district of Andhra Pradesh. The habitat of this Sanctuary is rugged with high hills and deep dales which are covered by Southern Tropical Dry Deciduous and Thorn forests with small ponds and tanks (Fig. 2). The sanctuary comprises 102 tree species that are being used for various purposes, such as fuel, medicine, timber and fodder (Rao *et al.* 2010). Some of the important flora consists of *Acacia* sp., *Albizia amara* (Roxb.) Boiv., *Azadirachta indica* A. Juss., *Euphorbia antiquorum* L., *Ficus* sp., *Lagerstroemia* sp., *Pongamia pinnata* (L.) Pierre, *Premna tomentosa* Willd., *Tamarindus indica* L., Bamboos and *Santalum album* L. Out of these trees, some of the species are host for lichen growth.

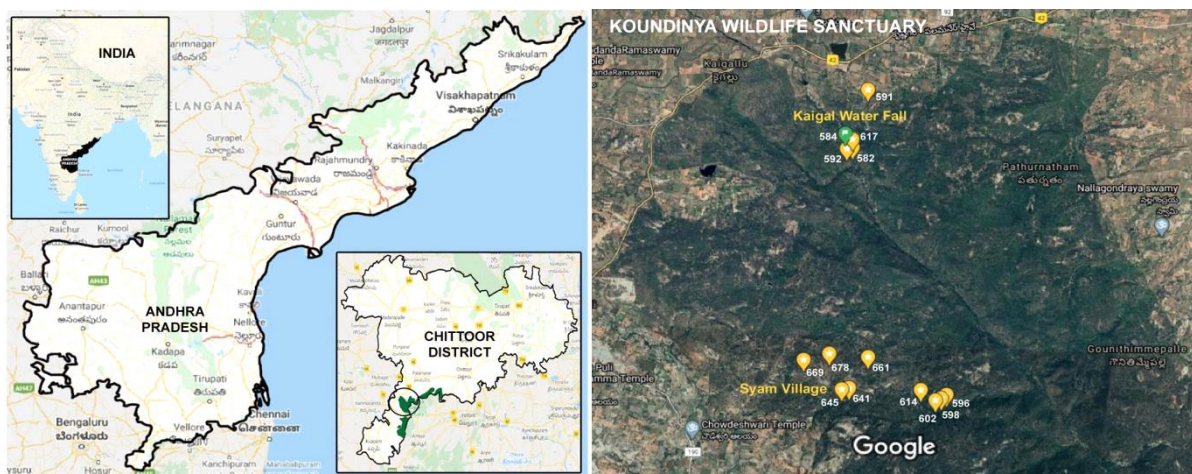


Figure 1. Map showing explored areas in Koundinya wildlife sanctuary from Chittoor district of Andhra Pradesh, India.



Figure 2. Tropical Dry Deciduous forests in Chittoor district: **A**, A beautiful view of Kaundinya wildlife sanctuary, Chittoor district; **B**, Kaigal Waterfalls; **C**, Rocky outcrops near at Syam Village.

The collections were made during March and April 2018 and all the collected specimens were properly labelled and deposited in the Lichen Herbarium, Department of Botany, Yogi Vemana University, Kadapa, Andhra Pradesh. In the sanctuary, both the localities Kaigal and Syam are randomly selected because earlier they were unexplored from Chittoor district even the range of Seshachalam Biosphere Reserve is well known for high lichen diversity comprising with 183 species (Anjali 2016). Also this wildlife sanctuary is one of the important habitat comprises of southern tropical dry deciduous and thorn forests including high hills and many vascular plants which supports growth of lichens. A stereomicroscope, Magnüs MS 24/13 was used for the observation of morphological features of lichen thallus including ascomata. Spot test for color reaction were carried out by 10% aqueous solution of Potassium Hydroxide (K), Steiner's stable *para*-phenylenediamine solution (PD) and calcium Hypochlorite solution (C). Anatomical structures of fruiting bodies were observed under light microscope of ZEISS Axiostar plus. All the measurements of anatomical structures were taken in water and 10% aqueous solution of K. The chemical components present in lichen samples were identified by www.tropicalplantresearch.com

Thin Layer Chromatography in solvent system ‘A’ following the procedures of White & James (1985) and Orange *et al.* (2001). Identification and classification of Lichens were done by following Anjali (2016), Awasthi (1991 & 2007), Mohabe (2016) and Lucking *et al.* (2017). All the genus and spp. are arranged alphabetically within each family.

RESULT AND DISCUSSION

The current study revealed the occurrence of 69 species belongs to 36 genera and 21 families of lichens. Out of which a foliose Saxicolous lichen *Xanthoparmelia tuberculiformis* Kurok is a New record to India (Singh & Sinha 2010) and other crustose lichens viz. *Arthonia collectiva* Stirt., *Arthonia subvelata* Nyl., *Dictyographa varians* (Mull. Arg.) Vain., *Opegrapha astrea* Tuck, *Pyrenula gibberulosa* (Mull.Arg.) Aptroot , *Verrucaria elaeomelaena* (A. Massal.) Arnold are new record to southern part of India (Pallavi *et al.* 2017, Singh & Sinha 2010, Mohabe *et al.* 2010, Nayaka *et al.* 2011) remaining 10 species are New additions to Andhra Pradesh as well as Chittoor district (Anjali *et al.* 2013, Anjali 2016, Mohabe *et al.* 2016 & 2017) and 6 species viz. *Buellia quartziana* S. R. Singh & D. D. Awasthi, *Buellia substigmaea* S.R. Singh & D.D. Awasthi, *Pyxine nilgiriensis* D. D. Awasthi, *Physcia abuensis* D. D. Awasthi & S. R. Singh, *Caloplaca subpoliotera* Y. Joshi & Upreti, and *Caloplaca tropica* Y. Joshi & Upreti found as endemic to India (Singh & Sinha 2010).

Among the different growth forms, crustose lichens showed maximum diversity represented by 40 (58%) species followed by 23 (33%) foliose, 3 (4%) leprose, 2(3%) squamulose and single species (2%) of fruticose lichen. This wildlife sanctuary showed the maximum diversity of corticolous lichens represented by 47 (64%) species followed by 24 (33%) saxicolous lichens out of these 2 (3%) species were found common both on bark and rock. The member of lichen family Caliciaceae exhibit the maximum diversity represented by 11 (16%) species under 5 genera followed by Parmeliaceae and Physciaceae with 8 (12%) species each under 4 genera, Lecanoraceae with 6 (9%) species, Opegraphaceae with 5 (7%) species, Teloschistaceae with 4 (6%) species, Arthoniaceae and Ramalinaceae with 4 (6%) species each, Verrucariaceae with 3 (4%) species, Graphidaceae, Chrysothricaceae, Peltulaceae, and Pyrenulaceae with 2 (3%) species each, while Lichinaceae, Candelariaceae, Collemataceae, Haematommataceae, Ochrolechiaceae, Porinaceae, Ramboldiaceae, Stereocaulaceae shows poor diversity of lichens each represented by single (1%) species. Among the 36 genera, *Lecanora* exhibits the maximum diversity represented by 6 species followed by 5 species of *Parmotrema*, 4 species each of *Arthonia* and *Pyxine*, 3 species each of *Heterodermia*, *Opegrapha*, *Physcia* and *Verrucaria*, 2 species each of *Bacidia*, *Buellia*, *Chrysothrix*, *Dirinaria*, *Peltula* and *Pyrenula* while maximum number of 19 genera represents poor diversity each with single species (Fig. 3). Among the different Phorophytes found in the Sanctuary, *Pongamia pinnata* and *Premna tomentosa*, bears the luxuriant growth of lichens represented by 9 species each followed by *Euphorbia antiquorum* and *Albizia amara* with 7 species each, *Strychnos nux-vomica* L. with 5 species, *Tamarindus indica* with 4 species, *Ziziphus* sp. with 2 species while *Azadirachta indica*, *Pavetta tomentosa* Roxb. ex Sm and *Tarenna asiatica* (L.) Kuntze ex K. Schum exhibit poor to scare growth of lichens with single species each while 9 species were observed on unidentified trees.

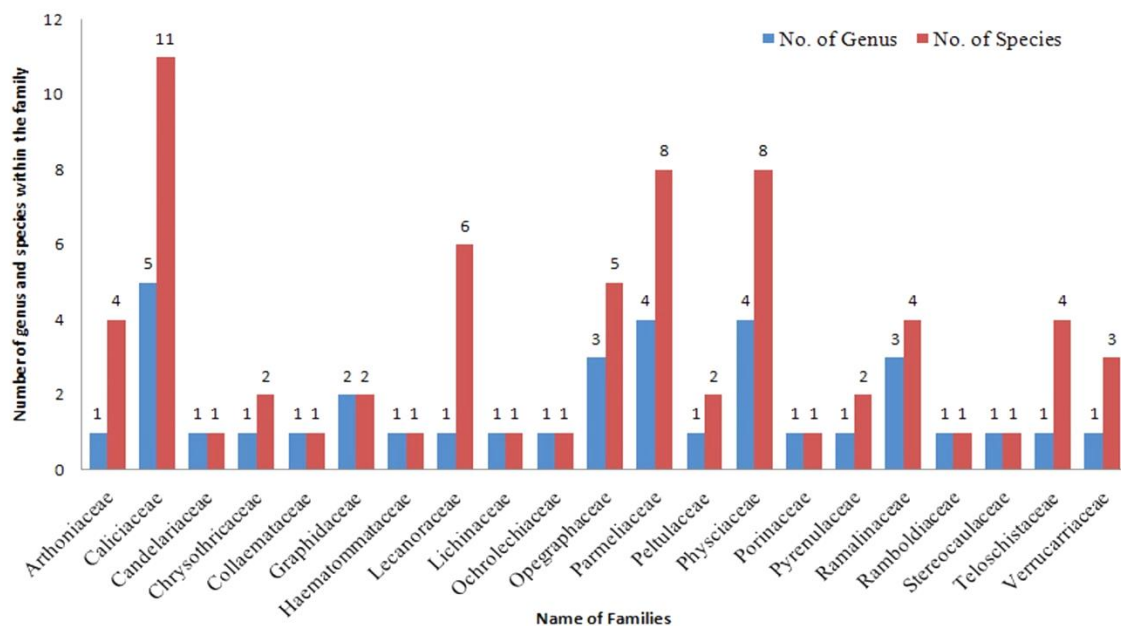


Figure 3. Representation of genus and species diversity within different lichen families. www.tropicalplantresearch.com

In this wildlife sanctuary Syam village shows maximum diversity of lichens represented by 46 species followed by Kaigal Water Fall represents 34 species out of which 11 species were found commonly in both the areas. Among the 14 altitudinal gradients between the 582–678 msl, the maximum diversity were recorded around the Kaigal water fall at an altitude ranges of 592 and 591 m represented by 17 and 10 species followed by 617 (5), 584 (6) and 582(4). Similarly, in Syam village maximum diversity were represented at an altitude ranges on 602 and 645 m with 17 and 14 species followed by 661 (13), 596 (9), 641 (5), 669 (5), 614 (3), 598 (3) and 678 with only single species. The area shows higher diversity in middle altitude and lower diversity in higher and lower altitudes. The altitude ranges in different areas with their lichen diversity in relation with number of species are provided in (Fig. 4). Koundinya wildlife sanctuary bear the luxuriant growth of two lichen species *Dirinaria applanata* (Fée) D.D. Awasthi and *Pyxine petricola* var. *pallida* Swinscow both on bark (*Azadirachta indica*, *Premna tomentosa* and *Euphorbia antichoram*) and rocks represented by 6 and 3 altitudinal gradient ranges followed by a saxicolous species *Lecanora subimmersa* (Fée) Vain and corticolous species *Opegrapha vulgata* (Ach.) Ach. (*Strychnos nux-vomica* and *Pongamia pinnata*) represented by 5 and 4 altitudinal gradient ranges. A complete list of identified species from KWS is provided in alphabetical order under the families with their distribution in Appendix I.

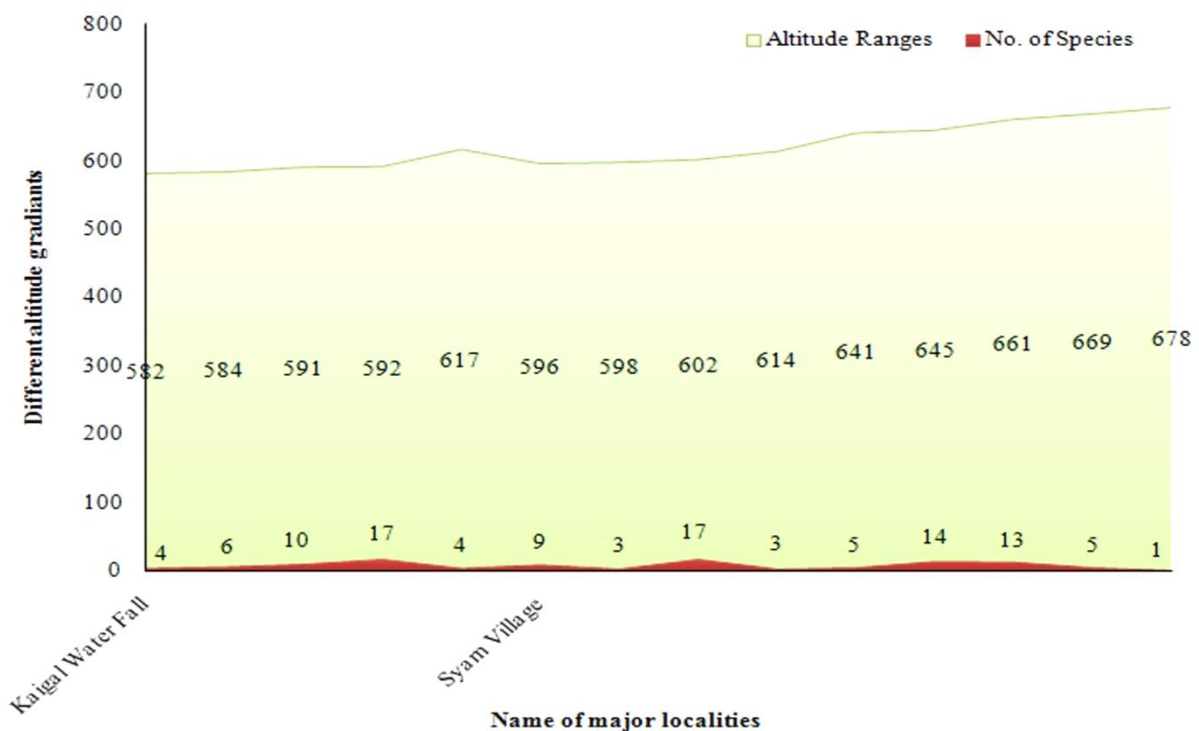


Figure 4. Diversity of lichens from different altitudinal ranges in Koundinya wildlife sanctuary.

New record to India

Xanthoparmelia tuberculiformis Kurok., J. Jap. Bot. 64(10): 291(1989).

[Fig. 5A-B]

Thallus saxicolous, foliose, closely adnate, yellowish green, dark in center, orbicular, upto 2 cm in diameter, heteromerous, upper cortex hyaline to greyish, 15–30 μ m thick, algal layer 30–70 μ m thick, lobes branched, sublinear, 0.3–1.0 mm wide, apices black margined, thallus isidiate, isidia sub-globose, simple or coralloid black tipped, 0.1 mm to 0.3 mm in long medulla white, 60–90 μ m thick, lower cortex brown to black 20–35 μ m thick, rhizines brown, 0.15 mm long, 20–35 μ m thick, apothecia absent.

Spot Test: Medulla K-, C-, KC- P+ orange red, TLC: fumarprotocetraric and protocetraric acids present.

Remarks: The species is morphologically resembling to *Xanthoparmelia keralensis* Hale having simple isidia and black lower side but latter the species differs by P+ orange to red medulla containing fumarprotocetraric acid and protocetraric acid.

Distribution: Earlier the species is reported from Japan, Korea and now the species is new record to India collected from Koundinya wildlife sanctuary which is a part of Eastern Ghats in India.

Specimen examined: India, Andhra Pradesh, Chittoor District, Koundinya Wildlife Sanctuary, Kaigal Water Fall, N 13° 03.918' E 078° 33.625', alt. 592 m, on rock, 02.03.2018, *Gangadhar Pandava, Satish Mohabe & A. Madhusudhana Reddy* 6741 (YVUH).

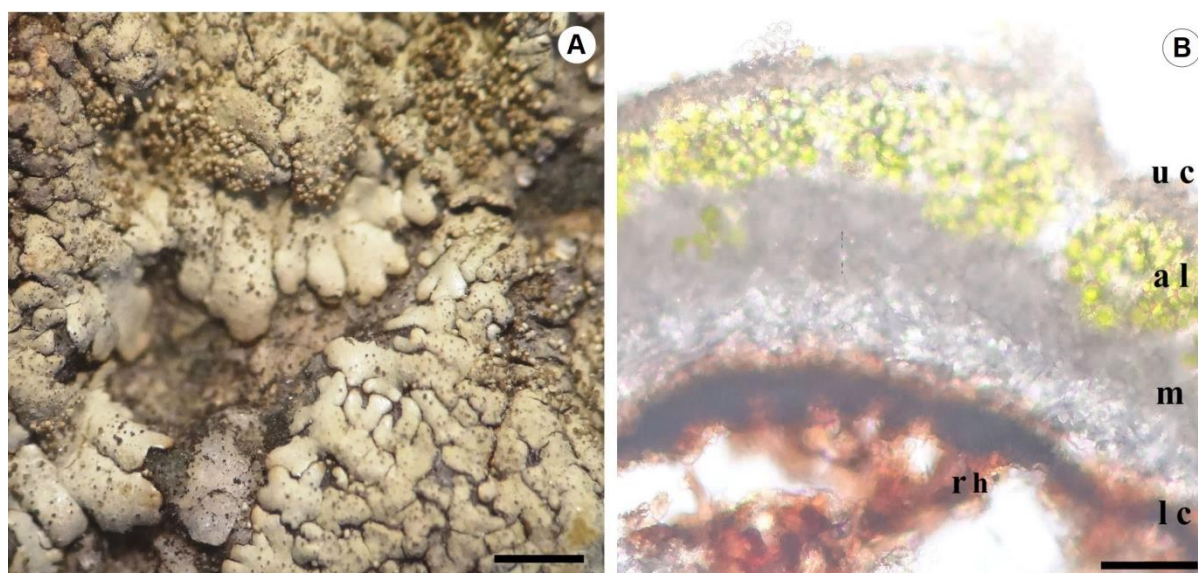


Figure 5. *Xanthoparmelia tuberculiformis* Kurok.: **A**, Habit of the thallus; **B**, V.S. of Thallus portion showing different layers (uc = upper cortex, al = algal layer, m = medulla, rh = rhizines). [Scale Bars: **A** = 1 mm, **B** = 50 µm]

New record to South India

Arthonia collectiva Stirt.

[Fig. 6A]

Specimen examined: India, Andhra Pradesh, Chittoor District, Syam, Kamgorudindu, N 13° 02.378' E 078° 33.324', alt. 669 m, on bark, 29.04.2018, *Gangadhar Pandava* 7070 (YVUH).

Distribution: Earlier the species is reported from Arunachal Pradesh and Assam and now the species is new record to South India.

Arthonia subvelata Nyl.

[Fig. 6B]

Specimen examined: India, Andhra Pradesh, Chittoor District, Syam, Majjigunta, N 13° 02.399' E 078° 33.778', alt. 661 m, on bark of *Ziziphus* sp., 29.04.2018, *Gangadhar Pandava* 7084 (YVUH).

Distribution: Earlier the species is reported from West Bengal-plains and now the species is new record to South India.

Dictyographa varians (Mull. Arg.) Vain.

[Fig. 6C]

Specimens examined: India, Andhra Pradesh, Chittoor District, Syam, Yerrakuppaleru, N 13° 02.083' E 078° 34.248', alt. 602 m, on bark of *Tarenna asiatica* (L.) Kuntz ex. K. Schum, 29.04.2018, *Gangadhar Pandava* 7134 & 7135 (YVUH).

Distribution: Earlier the species is reported from Gujarat and now the species is new record to South India.

Opegrapha astrea Tuck

[Fig. 6D]

Specimen examined: India, Andhra Pradesh, Chittoor District, Syam (Yerrakuppaleru), N 13° 02.123' E 078° 34.327', alt. 596 m, on bark of *Strychnos nux-vomica* L., 29.04.2018, *Gangadhar Pandava* 7177 (YVUH).

Distribution: Earlier the species is reported from Uttar Pradesh and now the species is new record to South India.

Pyrenula gibberulosa (Mull.Arg.) Aptroot

[Fig. 6E]

Specimen examined: India, Andhra Pradesh, Chittoor District, Syam, N 13° 02.172' E 078° 33.643', alt. 641 m, on bark of *Pongamia pinnata* (L.) Pierre, 02.03.2018, *Gangadhar Pandava*, *Satish Mohabe* & *A. Madhusudhana Reddy* 6839 (YVUH).

Distribution: Earlier the species is reported from Goa and now the species is a new record to South India.

Verrucaria elaeomelaena (A. Massal.) Arnold

[Fig. 6F]

Specimen examined: India, Andhra Pradesh, Chittoor District, Syam, Yerrakuppaleru, N 13° 02.083' E 078° 34.248', alt. 602 m, on rock, 29.04.2018, *Gangadhar Pandava* 7144 (YVUH).

Distribution: Earlier the species is reported from Manipur, Rajasthan and Madhya Pradesh and now the species is a new record to South India.

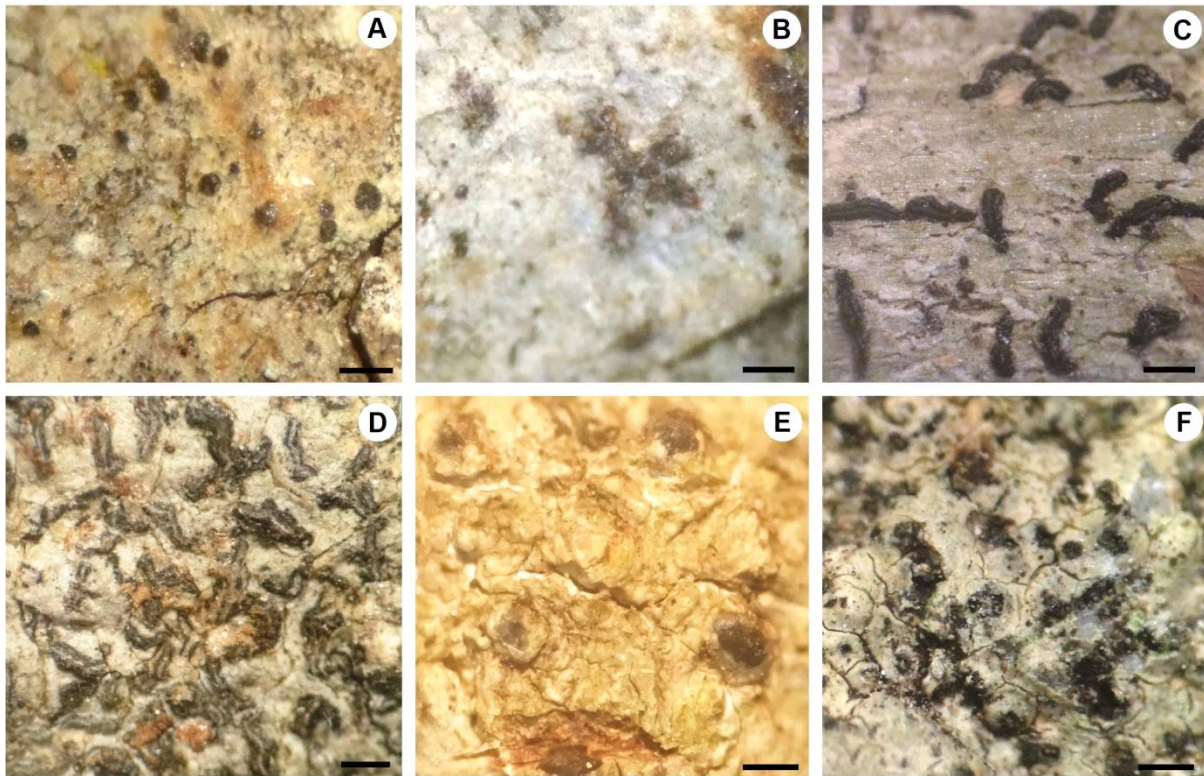


Figure 6. New distributional records to South India: **A**, *Arthonia collectiva* Stirt.; **B**, *A. subvellata* Nyl.; **C**, *Dictyographa varians* (Müll. Arg.) Vain; **D**, *Opegrapha astrea* Tuck; **E**, *Pyrenula gibberulosa* (Müll. Arg.) Aptroot; **F**, *Verrucaria elaeomelaena* (A. Massal.) Arnold.

Indian distribution of new additions from Andhra Pradesh (updated)

Arthonia catenatula Nyl.

Specimen examined: India, Andhra Pradesh, Chittoor District, Syam, Yerrakuppaleru, N 13° 02.123' E 078° 34.327', alt. 596 m, on bark of *Strychnos nux-vomica* L., 29.04.2018, *Gangadhar Pandava* 7179 (YVUH).

Distribution: Andaman & Nicobar Islands (Singh & Sinha 2010) and Andhra Pradesh.

Canoparmelia cinerascens (Lynge) Elix & Hale

Specimen examined: India, Andhra Pradesh, Chittoor District, Syam (Majjigunta), N 13° 02.399' E 078° 33.778', alt. 661 m, on bark, 29.04.2018, *Gangadhar Pandava* 7087 (YVUH).

Distribution: Andhra Pradesh, Kerala and Tamil Nadu

Chapsa leprocarpa (Nyl.) Frisch.

Specimen examined: India, Andhra Pradesh, Chittoor District, Syam, Yerrakuppaleru, N 13° 02.123' E 078° 34.327', alt. 596 m, on bark of *Strychnos nux-vomica* L., 29.04.2018, *Gangadhar Pandava* 7173 (YVUH).

Distribution: Andaman & Nicobar Islands, Andhra Pradesh, Karnataka, Uttarakhand.

Dirinaria papillulifera (Nyl.) D. D. Awasthi.

Specimens examined: India, Andhra Pradesh, Chittoor District, Syam, N 13° 02.172' E 078° 33.643', alt. 641 m, on bark of *Pongamia pinnata* (L.) Pierre, 02.03.2018, *Gangadhar Pandava*, *Satish Mohabe* & *A. Madhusudhana Reddy* 6839 & 6840 (YVUH).

Distribution: Assam, Andaman & Nicobar Islands, Andhra Pradesh, Karnataka, Orissa, Tamil Nadu, Uttar Pradesh, West Bengal - plains.

Ochrolechia pallescens (L.) A. Massal

Specimens examined: India, Andhra Pradesh, Chittoor District, Syam, Majjigunta, N 13° 02.399' E 078° 33.778', alt. 661 m, on bark, 29.04.2018, *Gangadhar Pandava* 7088, 7091 & 7093 (YVUH); India, Andhra Pradesh, Chittoor District, Syam, Majjigunta, N 13° 02.399' E 078° 33.778', alt. 661 m, on twigs, 29.04.2018, *Gangadhar Pandava* 7095 & 7097 (YVUH).

Distribution: Andhra Pradesh, Jammu & Kashmir, Karnataka, Manipur, Sikkim, Tamil Nadu and Uttarakhand.

Opegrapha cinerea Chavall.

Specimens examined: India, Andhra Pradesh, Chittoor District, Syam, N 13° 02.172' E 078° 33.643', alt. 641 m, on bark of *Pongamia pinnata* (L.) Pierre, 02.03.2018, Gangadhar Pandava, Satish Mohabe & A. Madhusudhana Reddy 6833, 6842, 6843 & 6846 (YVUH).

Distribution: Andaman & Nikobar Islands and Andhra Pradesh.

Opegrapha vulgata (Ach.) Ach.

Specimens examined: India, Andhra Pradesh, Chittoor District, Syam, N 13° 02.172' E 078° 33.643', alt. 641 m, on bark of *Pongamia pinnata* (L.) Pierre, 02.03.2018, Gangadhar Pandava, Satish Mohabe & A. Madhusudhana Reddy 6845 (YVUH); India, Andhra Pradesh, Chittoor District, Syam (Yerrakuppaleru), N 13° 02.123' E 078° 34.327', alt. 596 m, on bark of *Strychnos nux-vomica* L., 29.04.2018, Gangadhar Pandava 7175, 7176 & 7180 (YVUH).

Distribution: Andaman & Nikobar Islands, Andhra Pradesh, Assam, Karnaka, Tamil Nadu and West Bengal-plains.

Physcia aipola (Ehrh. ex Humb.) Furnr.

Specimen examined: India, Andhra Pradesh, Chittoor District, Kaigal, N 13° 04.351' E 078° 33.775', alt. 591 m, on bark of *Premna tomentosa* Willd., 02.03.2018, Gangadhar Pandava, Satish Mohabe & A. Madhusudhana Reddy 6708 (YVUH).

Distribution: Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir, Karnataka and Tamil Nadu.

Pyrenula immisa (Stirt.) Zahlbr.

Specimen examined: India, Andhra Pradesh, Chittoor District, Syam, N 13° 02.172' E 078° 33.643', alt. 641 m, on bark of *Pongamia pinnata* (L.) Pierre, 02.03.2018, Gangadhar Pandava, Satish Mohabe & A. Madhusudhana Reddy 6839 (YVUH); India, Andhra Pradesh, Chittoor District, Syam (Yerrakuppaleru), N 13° 02.123' E 078° 34.327', alt. 596 m, on bark of *Strychnos nux-vomica* L., 29.04.2018, Gangadhar Pandava 7177 (YVUH).

Distribution: Andhra Pradesh, Assam, Arunachal Pradesh, Goa, Himachal Pradesh, Karnataka, Kerala, Sikkim, Uttar Pradesh and West Bengal.

Pyxine nilgiriensis D. D. Awasthi.

Specimens examined: India, Andhra Pradesh, Chittoor District, Kaigal, N 13° 03.918' E 078° 33.625', alt. 592 m, on rock, 02.03.2018, Gangadhar Pandava, Satish Mohabe & A. Madhusudhana Reddy 6734 & 6736 (YVUH).

Distribution: Andhra Pradesh and Tamil Nadu.

CONCLUSION

In the State of Andhra Pradesh, Chittoor district is well known for lichen exploration work and high lichen diversity. Earlier, an appraisal of lichen biota was provided with 75 species belonging to 33 genera and 17 families from Chittoor district (Mohabe *et al.* 2016) later, Anjali (2016) concluded maximum lichen diversity represented by 160 species with 59 genera with 25 families. Despite lichens from Koundinya wildlife sanctuary were not recorded even single species therefore present study focused on to explore this area as a new locality in Andhra Pradesh to fill the gap of lichen diversity and now the wildlife sanctuary includes 17 species to Andhra Pradesh and out of these a new record *Xanthoparmelia tuberculiformis* Kurok is recorded for India. After this study, the lichen diversity of Andhra Pradesh will represent 217 species according to the published literatures and Chittoor district will reach with 177 species belonging to 61 Genera and 26 families which includes 2 generic records *Dictyographa* and *Alyxoria* and one family Lichinaceae first time from the Chittoor district. The wildlife sanctuary also includes some fruticose and foliose lichens which are medicinally important and earlier found from the Seshachalam Biosphere Reserve (Anjali *et al.* 2014, 2015, 2016). The possible reason for the higher diversity in Syam village includes 4 sub localities *viz.* Yerrakuppaleru, Kamgordindu, Majjigunta and Yelonerayi under forest cover with more number of trees (7) which supports the luxuriant growth of corticolous lichens. The Kaigal Water Fall is a tourist place which shows poor lichen diversity due to cutting of trees for fuel purpous. The continous anthropogenic activity harmed the subtle plants by crushing under the feet of people and animals especially those that grows on rocks such as saxicolous lichens. In this area a few trees (3) are found supporting the growth of lichen which is one of the reasons for the less lichen diversity. The study will lay

forward for future bio-monitoring studies on lichens from this unique habitat of Koundinya wildlife sanctuary and will act as baseline data for Eastern Ghats of India.

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Supporting information

Appendix I: List of identified lichens from Koundinya wildlife sanctuary of Andhra Pradesh, India.

Appendix I: List of identified lichens from Koundinya wildlife sanctuary of Andhra Pradesh, India.

S.N.	Family	GF	HBT	Localities														Specimens No.
				KWF					YAR			YEL	SYV		MAJ	KAM		
				582	584	591	592	617	596	598	602	614	641	645	661	669	678	
Arthoniaceae																		
1	<i>Arthonia catenatula</i> Nyl.*	Cr	C	-	-	-	-	-	+	-	-	-	-	-	-	-	-	7179
2	<i>A. collectiva</i> Stirt**	Cr	C	-	-	-	-	-	-	-	-	-	-	-	-	+	-	7070
3	<i>A. subvelata</i> Nyl.**	Cr	C	-	-	-	-	-	-	-	-	-	-	-	+	+	-	7078
4	<i>A. tumidula</i> (Ach.) Ach.	Cr	C	-	-	-	-	-	+	-	-	-	-	-	-	-	-	7177
Caliciaceae																		
5	<i>Buellia maculata</i> Tuck	Cr	S	-	-	-	-	-	-	-	-	-	-	+	-	-	-	6847
6	<i>B. quartziana</i> S. R. Singh & D.D. Awasthi#	Cr	S	-	-	-	+	-	-	-	-	-	-	-	-	-	-	6728
7	<i>B. substigma</i> S.R. Singh & D.D. Awasthi#	Cr	S	-	-	-	+	-	-	-	-	-	-	-	-	-	-	6751
8	<i>Cratiria obscurior</i> (Stirt.) Marbach & Kal.	Cr	S	-	-	-	+	-	-	-	-	-	+	-	-	-	-	6744
9	<i>Dirinaria applanata</i> (Fee) D.D. Awasthi	Fl	C, S	-	-	+	+	-	-	-	-	-	+	+	+	+	+	6732
10	<i>D. papulifera</i> (Nyl.) D.D. Awasthi*	Fl	C	-	-	-	-	-	-	-	-	-	+	-	-	-	-	6839
11	<i>Hafellia curtela</i> (Malme) Marbach	Cr	C	-	-	-	-	+	-	-	-	-	+	-	-	-	-	6829
12	<i>Pyxine cocoes</i> (Sw.) Nyl.	Fl	C	-	-	+	-	-	-	-	-	-	-	-	-	-	-	6706
13	<i>P. nilgiriensis</i> D. D. Awasthi*#	Fl	S	-	-	-	+	-	-	-	-	-	-	-	-	-	-	6734
14	<i>P. petricola</i> Nyl.	Fl	C	-	-	+	-	+	-	-	-	-	-	-	-	-	-	6829
15	<i>P. petricola</i> var. <i>pallida</i> Swinscow	Fl	C, S	-	+	+	-	-	-	-	-	+	-	+	-	-	-	6872
Candelariaceae																		
16	<i>Candelaria concolor</i> (Dicks.) Stein	Fl	C	-	-	-	-	-	-	-	-	-	-	-	+	-	-	7091
Chrysothricaceae																		
18	<i>Chrysothrix candelaris</i> (L.) J.R. Laundon	Lp	C	-	-	-	+	-	-	-	-	-	-	+	+	-	-	6809
19	<i>C. chlorina</i> (Ach.) J.R. Laundon	Lp	C	-	-	-	-	-	-	-	-	-	-	-	+	-	-	7096
Collaemataceae																		
20	<i>Collema subnigrescens</i> Degel	Fl	C	+	-	-	-	-	-	-	-	-	-	-	-	-	-	6684
Graphidaceae																		
21	<i>Graphis leptocarpa</i> Fée	Cr	C	-	-	-	-	-	+	-	+	+	-	-	+	-	-	7097
22	<i>Chapsa leprocarpa</i> (Nyl.) Frisch*	Cr	C	-	-	-	-	-	+	-	-	-	-	-	-	-	-	7173
Haematommataceae																		
23	<i>Haematomma puniceum</i> (Ach.) A. Massal.	Cr	C	-	-	+	-	-	-	-	-	-	-	-	-	-	-	6704
Lecanoraceae																		
24	<i>Lecanora achroa</i> Nyl.	Cr	C	-	-	-	-	+	-	-	-	-	-	-	-	-	-	6829
25	<i>L. alba</i> Lumbsch	Cr	C	-	-	-	+	-	-	-	-	-	-	-	-	-	-	6808

26	<i>L. interjecta</i> Müll. Arg.	Cr	C	-	-	-	-	+	-	-	-	-	-	-	-	-	-	6829
27	<i>L. leprosa</i> Fée	Cr	C	-	-	-	-	-	-	-	-	-	-	+	-	-	-	6829
28	<i>L. subimmersa</i> (Fée) Vain	Cr	S	+	-	-	-	-	+	+	+	+	-	+	-	-	-	6853
29	<i>L. tropica</i> Zahlbr.	Cr	C	-	-	-	-	-	-	-	-	-	-	+	-	-	-	6884
Lichinaceae																		
30	<i>Anema decipiens</i> (A. Massal.) Forssell	Cr	S	-	+	-	-	-	-	-	-	-	-	-	-	-	-	6690
Ochrolechiaceae																		
31	<i>Ochrolechia pallescens</i> (L.) A. Massal*	Cr	C	-	-	-	-	-	-	-	-	-	-	-	+	-	-	7088
Opegraphaceae																		
32	<i>Dictyographa varians</i> (Müll. Arg.) Vain**	Cr	C	-	-	-	-	-	-	-	+	-	-	-	-	-	-	7134
33	<i>Opegrapha astraea</i> Tuck.**	Cr	C	-	-	-	-	-	+	-	-	-	-	-	-	-	-	7177
34	<i>O. vulgata</i> (Ach.) Ach.*	Cr	C	-	-	-	-	-	+	-	+	-	+	+	-	-	-	7175
34	<i>O. cinerea</i> Chevall*	Cr	C	-	-	-	-	-	-	-	-	-	+	+	-	-	-	6848
35	<i>Alyxoria varia</i> Pers.	Cr	C	+	-	-	-	-	-	-	-	-	-	-	-	-	-	6817
Parmeliaceae																		
36	<i>Bulbothrix isidiza</i> (Nyl.) Hale	Fl	C	-	-	-	-	-	-	-	-	-	-	-	+	-	-	7088
37	<i>Canoparmelia cinerascens</i> (Lyngé) Elix & Hale*	Fl	C	-	-	-	-	-	-	-	-	-	-	-	+	-	-	7087
38	<i>Parmotrema austrosinense</i> (Zahlbr.) Hale	Fl	C	-	-	+	+	-	-	-	-	-	-	-	-	-	-	6772
39	<i>P. crinitoides</i> J. C Wei	Fl	C	-	-	-	-	-	-	-	+	-	-	-	-	-	-	7128
40	<i>P. mesotropum</i> (Mull. Arg.) Hale	Fl	C	-	-	-	+	-	-	-	-	-	-	-	+	-	-	6808
41	<i>P. praesorediosum</i> (Nyl.) Hale	Fl	C	-	-	-	+	-	-	-	-	-	-	-	+	+	-	6815
42	<i>P. tinctorum</i> (Despr. ex Nyl.) Hale	Fl	C	-	-	-	-	-	-	-	+	-	-	-	-	-	-	7125
43	<i>Xanthoparmelia tuberculiformis</i> Kurok.***	Fl	S	-	-	-	+	-	-	-	-	-	-	-	-	-	-	6741
Peltulaceae																		
44	<i>Peltula euploca</i> (Ach.) Poelt ex Pisut	Sq	S	-	+	-	-	-	-	-	-	-	-	-	-	-	-	6690
45	<i>P. placodizans</i> Zahlbr.	Sq	S	-	+	-	-	-	-	-	-	-	-	-	-	-	-	6690
Physciaceae																		
46	<i>Heterodermia albicans</i> (Pers.) Swinscow & Krog.	Fl	S	-	+	-	-	-	-	-	-	-	-	-	-	-	-	6871
47	<i>H. isidiophora</i> (Nyl.) D.D. Awasthi	Fl	C	-	-	-	-	-	-	-	+	-	-	-	-	-	-	7127
48	<i>H. pseudospeciosa</i> (Kurk.) W. L. Culb.	Fl	C	-	-	-	-	-	-	-	+	-	-	-	-	-	-	7128
49	<i>Hyperphyscia adglutinata</i> (Florke) H. Mayerhofer & Poelt	Fl	S	-	-	-	-	-	-	+	+	-	-	-	-	-	-	7147
50	<i>Physcia abuensis</i> D.D. Awasthi & S. R. Singh#	Fl	C	-	-	+	+	-	-	-	-	-	-	-	-	-	-	6708

51	<i>P. aipolia</i> (Ehrh. ex Humb.) Furnr.*	Fl	C	-	-	+	-	-	-	-	-	-	-	-	-	-	6708	
52	<i>P. tribacioides</i> Nyl.	Fl	C	-	-	+	+	-	-	-	-	-	-	-	-	-	6706	
53	<i>Rinodina oxydata</i> (A. Massal.) A. Massal.	Cr	S	-	-	-	-	-	-	-	+	-	-	-	-	-	7144	
Porinaceae																		
54	<i>Porina subinterstes</i> (Fée) Vain	Cr	S	-	-	-	-	-	+	-	+	-	-	-	-	-	7193	
Pyrenulaceae																		
55	<i>Pyrenula gibberulosa</i> (Müll.Arg.) Aptroot**	Cr	C	-	-	-	-	-	-	-	-	-	+	-	-	-	6839	
56	<i>P. immissa</i> (Stirt.) Zahlbr.*	Cr	C	-	-	-	-	-	+	-	+	-	-	-	-	-	7131	
Ramalinaceae																		
57	<i>Ramalina conduplicans</i> Vain.	Fr	C	-	-	+	-	-	-	-	-	-	-	-	-	-	6715	
58	<i>B. convexula</i> (Müll.Arg.) Zahlbr.	Cr	C	-	-	-	-	-	-	-	-	-	-	+	-	-	6884	
59	<i>B. incongruens</i> (Stirt.) Zahlbr.	Cr	C	-	-	-	-	-	-	-	+	-	-	+	-	-	7120	
60	<i>Lecania expallescens</i> (Nyl.) Oksner	Cr	S	-	-	-	-	-	-	-	-	-	-	+	-	-	6856	
Ramboldiaceae																		
61	<i>Ramboldia russula</i> (Ach.) Kalb.	Cr	C	-	-	-	-	-	-	-	-	-	-	-	+	+	-	7071
Stereocaulaceae																		
62	<i>Lepraria coriensis</i> (Hue) Sipman	Lp	S	-	-	-	+	-	-	-	-	-	-	-	-	-	6716	
Teloschistaceae																		
63	<i>Caloplaca bassiae</i> (Willd.ex Ach.) Zahlbr.	Cr	C	-	-	-	-	-	-	-	-	-	-	+	-	-	6880	
64	<i>C. cupulifera</i> (Vain.) Zahlbr.	Cr	S	+	-	-	+	-	-	+	-	-	-	-	-	-	6683	
65	<i>C. subpoliotera</i> Y. Joshi & Upreti#	Cr	S	-	+	-	+	-	-	-	+	-	-	-	-	-	6720	
66	<i>C. tropica</i> Y. Joshi & Upreti#	Cr	S	-	-	-	+	-	-	-	-	-	-	-	-	-	6736	
Verrucariaceae																		
67	<i>Verrucaria acrotella</i> Ach.	Cr	S	-	-	-	-	-	-	-	+	-	-	+	-	-	6856	
68	<i>V. elaeomelaena</i> (A. Massal.) Arnold**	Cr	S	-	-	-	-	-	-	-	+	-	-	-	-	-	7144	
69	<i>V. margacea</i> (Wahlenb.) Wahlenb.	Cr	S	-	-	-	-	-	-	-	+	-	-	-	-	-	7163	

Note: GF= Growth Forms, HBT= Habitat, Cr= Crustose, Fl= Foliose, Fr= Fruticose, Sq= Squamulose, LP= Leprose, C= Corticolous, S= Saxicolous; (+)= Present, (-)= Absent, (*)= New additions, (**)= New to South India, (***)= New to India, (#)= Endemic to India.

Localities: KWF= Kaigal Water Fall; YAR= Yarrakuppaleru; YEL= Yelonerayi; SYV= Syam Village; MAJ= Majjigunta; KAM= Kamgordindu.