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**DIVERSITY AND DISTRIBUTION OF LICHENS IN YSR DISTRICT,
ANDHRA PRADESH WITH SEVERAL NEW ADDITIONS**

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ABSTRACT

The lichen mycota of ecologically interesting and biodiversity rich YSR district located in Rayalaseema region of Andhra Pradesh is extensively explored. The study revealed the occurrence of 46 species of lichens from 14 localities. Out of total 28 species are recorded for the first time from the state and the list also included 8 taxa endemic to India. A total of 9 species recorded from Siddavatam fort is the first ever record of lichens from any historical monuments in Andhra Pradesh. Among the different growth forms, the crustose lichens exhibited the maximum diversity with 21 species followed by 14 species of foliose, 10 squamulose and a single species of leprose form. The saxicolous (both growing on rocks and lime-plaster of monument) species exhibited the maximum diversity represented by 31 species followed by 15 corticolous species. The members of dominant lichen families Physciaceae and Parmeliaceae showed their diversity with 14 and eight species under 6 and 3 genus respectively. Within the YSR district the forests of Guvvala Cheruvu Hills are rich in lichen diversity.

Key Words: Biodiversity, Rayalaseema, Kadapa, Cuddapah, Eastern Ghats, South India

INTRODUCTION

It is now well established that Eastern Ghats region of India has remarkable lichen diversity, but so far inadequately explored (Nayaka *et al.*, 2013). Further, our cursory studies in the state of Andhra Pradesh indicated the existence of interesting lichen mycota (Reddy *et al.*, 2011), which encouraged us to take up a detailed lichen study in the region. Aim of the study is to document and bring out complete checklist of lichens for Andhra Pradesh. For this purpose district wise lichen survey is being under taken and here the results of ecologically interesting and biodiversity rich YSR district are presented.

YSR (= Yeduguri Sandinti Rajasekara Reddy) district is one the four districts of politically demarcated Rayalaseema region in Andhra Pradesh and it is formerly known as Kadapa or Cuddapah district. The district is situated within 13°.43' and 15°.14' Northern latitude and 77°.55' and 79°.29' Eastern longitude. The total geographical area of the district is 15,379 km². Major forest areas of the district comprise dry deciduous and scrub-spiny forests. The Red Sanders (*Pterocarpous santalinus* Linn. f.), an endemic and endangered tree species of medicinal and aesthetic importance is available only in this area. The district is ecologically interesting due to the presence of three prominent hill ranges Nallamalais, Seshachalam and Erramalais, which provide range of habitats and wide altitudinal gradient for the growth of plants. Seshachalam Biosphere Reserve is set up in Chittoor and YSR district recorded 50 species of butterflies (Guptha *et al.*, 2012), while 52 species of Herpetofauna and 30 Ichthyofauna are recorded from Thumalapalli uranium mining site in the YSR district (Reddy *et al.*, 2013a, b). Pullaiah *et al.*, (2007) of the opinion that wild vegetation of YSR district is rich and fascinating with large number of curious, botanically interesting, exquisite, economically important, rare, endangered, threatened and endemic plants. Reddy *et al.*, (2012) recorded 710 species of wild flowering plants from the district which included 356 species that can be utilized as ornamentals. The region is rich in medicinal plants and Maheswari *et al.*, (2012) recorded 144 species which included floristic elements such as *Couroupita guianensis* Aubl.,

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Dichrostachys cinerea (L.) Wight & Arn., *Gmelina asiatica* L. *Helicteres isora* L., *Shorea tumbuggaia* Roxb., *Thespesia populnea* (Linn.) Sol. and *Vitex negundo* L. Various tribes inhabiting in the hilly areas use these plant in their ethnic medicine (Reddy et al., 2007, 2011). Basha et al., (2011) documented 15 plant species which are widely used by the Yanadis tribes of Mamandur for medicines, fibre, gum, resins, oils, latex and dye. Some of the research group is now involved in the phytochemical analysis of these medicinal plants (Reddy et al., 1995). Above studies indicates that YSR district has good diversity of higher plants, however studies on lower plants, especially on lichens are meagre. Savithamma and Saradvathi (2008) mentioned occurrence of plenty of algae, bryophytes and pteridophytes in marshy areas of Mamandur forest of the region. Nayaka et al., (2013) while discussing about lichen diversity of Eastern Ghats mentioned two species of lichens from the YSR district, i.e. *Parmotrema nilgherrense* (Nyl.) Hale from Guvvala Cheruvu Hills, and *Pyxine petricola* Nyl. from Kadapa. This is the only record of lichen available for the YSR district. Therefore a detailed lichens exploration is undertaken in the district.

MATERIALS AND METHODS

The present study is based on 200 lichen specimens collected during the 2011 and 2012 from 14 localities of YSR district in Rayalaseema region of Andhra Pradesh (Fig. 1) i.e. Chitvel, Gandhi, Guvvala Cheruvu hill (Fig. 2A), Paideipalem, Palakonda hill (Fig. 2B), Pincha, Polathala, Pulivendula Ghat, Rapur, Rayachoti, Sibyala forest, Sanipai, Siddavatam fort (Fig. 2C), Sundupalli, Thumalapalli Uranium mining site. The lichens were growing over tree trunks, exposed rocks, lime plaster and on monument. The morphological features of lichen thallus and ascomata were observed under Magnüs MS 24/13 stereomicroscope.

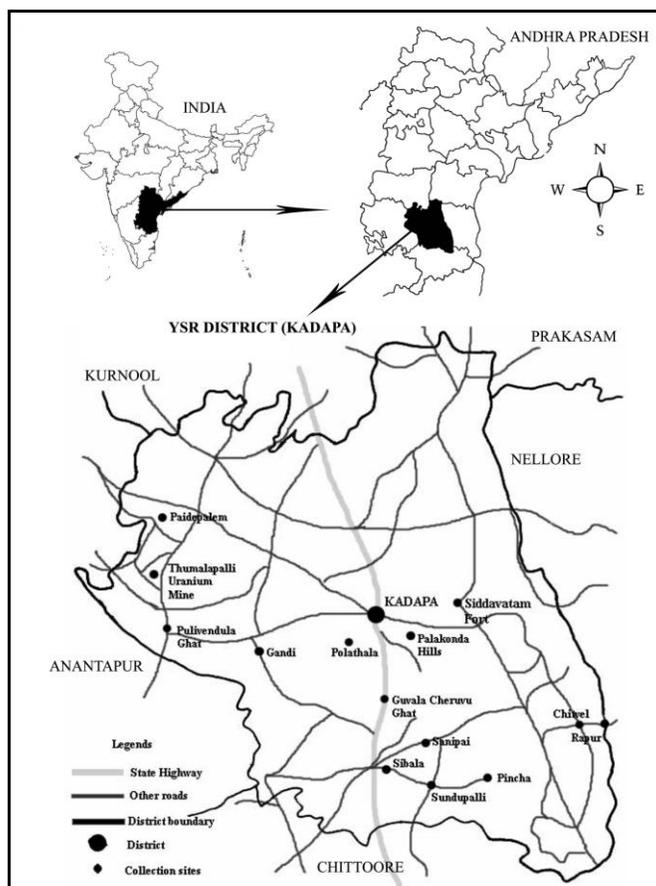


Figure 1: Map showing lichen explored areas of YSR district, Andhra Pradesh

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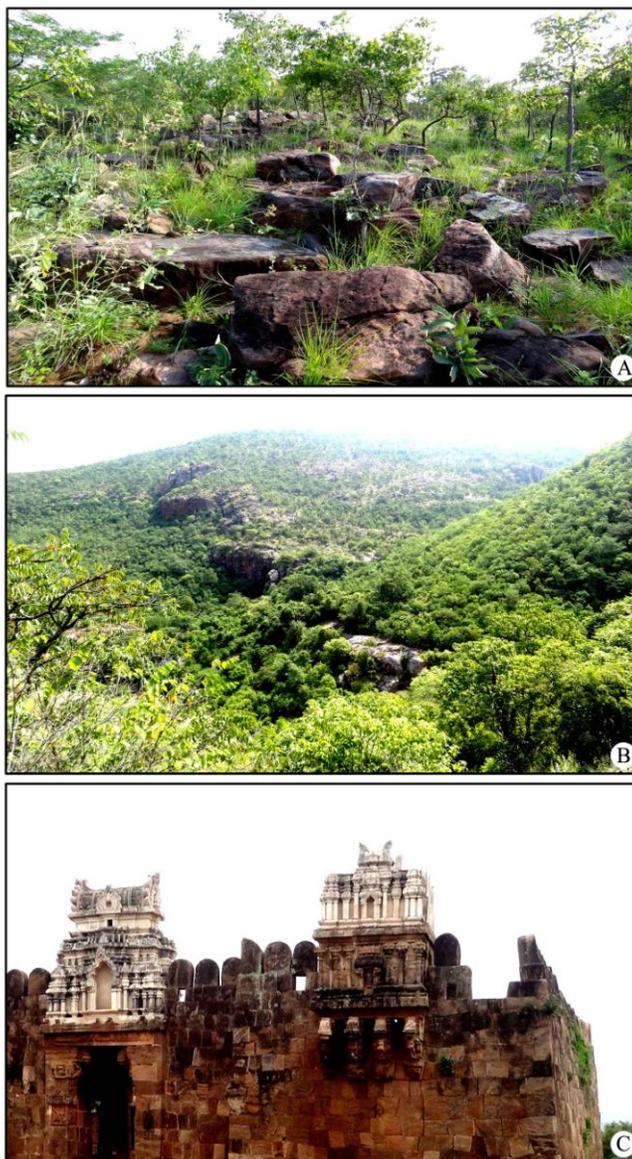


Figure 2: A. Rocky outcrop in at Guvala Cheruvu Ghat providing excellent habitat for saxicolous lichens, B. Beautiful view of Palakonda hills showing scrub-spiny forest and rocky ridges, C. Siddavatam fort from which 9 calcicolous lichens were collected, which is the first ever record of lichens from any monuments of Andhra Pradesh

Spot test for colour reaction were carried out by 10% aqueous solution of potassium hydroxide (K), Steiner's stable para-phenylenediamine solution (PD) and calcium hypochlorite solution (C). For anatomical investigation of fruiting bodies light microscope of ZEISS Axiostar plus was used. All the measurements of anatomical structures were taken in water and 10% aqueous solution of K. The lichen substances were identified with Thin Layer Chromatography in solvent system 'A' following White and James (1985) and Orange *et al.*, (2001). The following literatures were consulted for identification of lichen samples; Awasthi (1991, 2007), Divakar and Upreti (2005), Joshi (2008), Khare (2012), Mayrhofer (1996), Nayaka (2005), and Laundon (1981). The nomenclature and classification of lichens were updated following Lumbsch and Huhndorf (2007). All the genus and species are arranged alphabetically within

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the each family. Identified specimens were labelled, documented, digitalized. The specimens were preserved in the herbarium of Department of Botany, Yogi Vemana University, Kadapa, Andhra Pradesh.

RESULTS AND DISCUSSION

The district has rich diversity of lichens represented by 46 species belonging to 17 genera under 10 families. Out of the total 28 species are new records for the state of Andhra Pradesh. Among the different growth forms, the crustose lichens exhibit the maximum diversity with 21 (46%) species followed by 14 (30%) species of foliose, 10 (22%) squamulose and a single (2%) species of leprose (Fig. 3).

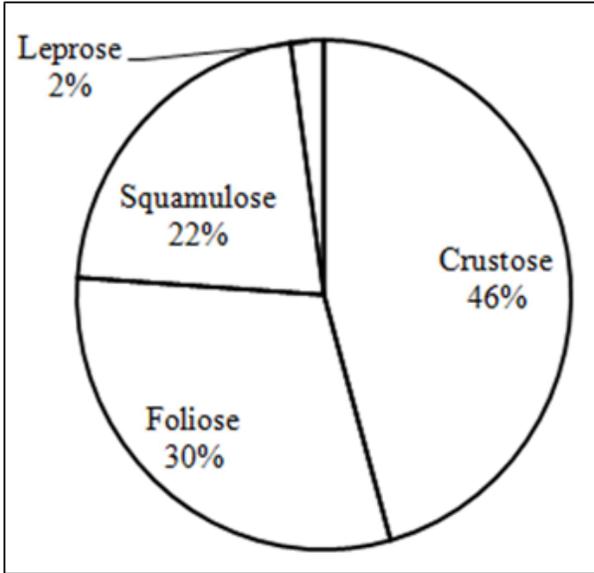


Figure 3: Proportion of various growth forms represented in YSR district

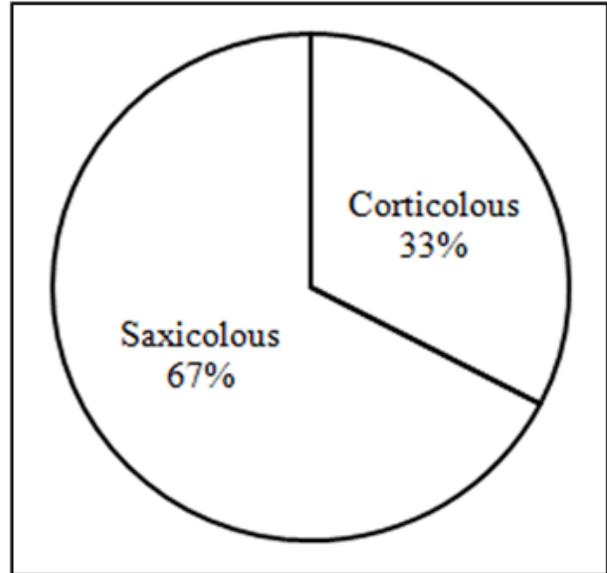


Figure 4: Habitat preference of lichens in YSR district

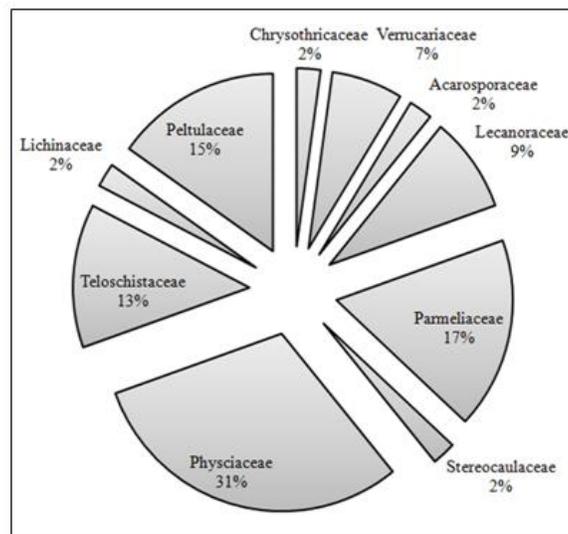


Figure 5: Representation of different lichen families in YSR district

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The saxicolous (growing on rocks, lime-plaster and monuments) species of lichens exhibited the maximum diversity represented by 31 (67%) species followed by 15 (33%) corticolous (growing on bark of trees) species (Fig. 4). *Caloplaca cinnabarina* (Ach.) Zahlbr., *Pyxine petricola* var. *pallida* Swinscow & Krog, are the most dominant species in the district represented from 8 and 7 localities followed by *Peltula placodizans* (Zahlbr.) Wetmore, and *Caloplaca tropica* Y. Joshi & Upreti occurring in 5 localities each. The genus *Peltula* and *Caloplaca* are the most dominant genera in the district represented by 7 and 6 species followed by *Buellia* and *Parmotrema* with 5 species each. The members of lichen family Physciaceae and Parmeliaceae showed maximum diversity with 14 (31%) and 8 (17%) species under 6 and 3 genus respectively followed by Peltulaceae & Teloschistaceae with 7 (15%) and 6 (13%) species under the single genus each. Other families represented in the district include Lecanoraceae, Verrucareaceae with 4 (9%), and 3 (7%) species respectively followed by Acarosporaceae, Stereocaulaceae, Chrysothricaceae, Lichinaceae with single (2%) species each (Fig. 5). The Guvvala Cheruvu forests exhibited the maximum diversity of lichens represented by 18 species followed by Palakonda hills and Polathala with 14 species each, while Thumalapalli Uranium mining site and Pulivendula Ghat represented 13 and 12 species respectively. A total of 9 species of lichens were recorded from Siddavatam Fort and it is the first ever record of lichens from any historical monuments in Andhra Pradesh. Other localities in the district have poor diversity of lichens ranging from 1 to 4 species (Fig. 6). Probable reasons for the poor diversity of lichens in these areas may be low altitude, dry forest areas, high temperature, low moisture and frequent human interference.

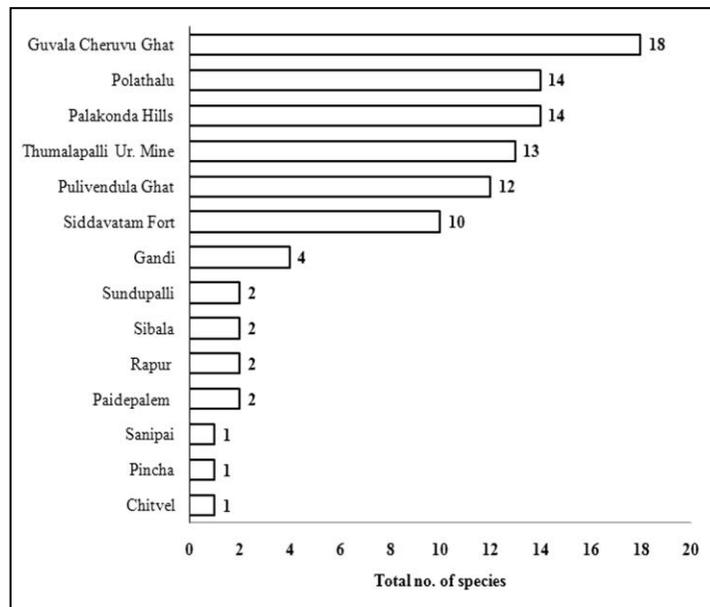


Figure 6: Lichen diversity in different localities of YSR district

The lichen communities in YSR district exhibited a typical tropical mycota with dominance of Physciaceae and Parmeliaceae members those have tolerance to longer dry period and require exposed areas for their growth. It is interesting to note that unlike any other forested areas YSR district has maximum number of lichens growing over rock which also included 9 species growing on lime plaster of a monument. The lichen taxa on Siddavatam fort represented mostly calcicolous species (*Caloplaca cinnabarina* (Ach.) Zahlbr., *C. subpoliotera* Y. Joshi & Upreti, *C. tropica* Y. Joshi & Upreti, *Endocarpon rosettum* Ajay Singh & Upreti, *E. subrosettum* Ajay Singh & Upreti, *Lepraria coriensis* (Hue) Sipman, *Phylliscum indicum* Upreti) as observed on monuments of Uttar Pradesh (Nayaka et al., 2013) and Madhya Pradesh (Bajpai et al., 2008). It is interesting to note that the Siddavatam monument did not host any species of *Peltula* in contrast to our observations made elsewhere (Uttar Pradesh and Madhya

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Pradesh); however the species of this genus were frequently encountered in other parts of the district. A corticolous species of *Peltula* (*P. corticola* Büdel & R. Sant.) was collected from *Azadirachta indica* L. tree growing near the Siddavattam fort.

Table: 1. Lichens of YSR district in Andhra Pradesh

S. No	Family/Species Name	GF	Habit	No. of Localities													
				1	2	3	4	5	6	7	8	9	10	11	12	13	14
Chrysothricaceae																	
1	<i>Chrysothrix candelaris</i> (L.) J.R. Laundon*	Cr	C	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Verrucariaceae																	
2	<i>Endocarpon rosettum</i> Ajay Singh & Upreti*#	Sq	S	-	-	-	-	-	-	-	-	-	-	-	-	+	-
3	<i>E. subrosettum</i> Ajay Singh & Upreti*#	Sq	S	-	-	-	-	-	-	-	-	-	-	-	-	+	-
4	<i>Staurothele fissa</i> (Taylor) Zwackh*	Cr	S	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Acarosporaceae																	
5	<i>Acarospora</i> sp.	Cr	S	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Lecanoraceae																	
6	<i>Lecanora achora</i> Ach.	Cr	C	-	-	+	-	-	-	-	+	-	-	-	-	-	-
7	<i>L. alba</i> Lumbsch*	Cr	C	-	-	-	-	-	-	-	+	-	-	-	-	-	-
8	<i>L. albescens</i> (Hoffm.) Flk.*	Cr	S	-	-	+	-	-	-	-	-	-	-	-	-	-	-
9	<i>Lecidella</i> sp.	Cr	S	-	-	+	-	-	-	-	-	-	-	-	-	-	+
Parmeliaceae																	
10	<i>Bulbothrix sensibilis</i> (J. Steiner & Zahlbr.) Hale*	Fl	C	-	-	-	-	+	-	-	-	-	-	-	-	-	-
11	<i>Parmotrema andinum</i> (Müll. Arg.) Hale	Fl	C	-	-	-	+	+	-	-	-	-	-	-	-	+	-
12	<i>P. austrosinense</i> (Zahlbr.) Hale	Fl	C	-	-	-	-	+	-	-	-	-	-	-	-	-	-
13	<i>P. nilgherrense</i> (Nyl.) Hale	Fl	C	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	<i>P. mesotropum</i> (Müll. Arg.) Hale	Fl	C	-	-	-	-	-	-	-	-	-	+	-	-	-	-
15	<i>P. praesorediosum</i> (Nyl.) Hale	Fl	C	-	-	-	+	-	-	-	-	-	+	-	+	-	-
16	<i>Xanthoparmelia pseudocongensis</i> Hale	Fl	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	<i>X. coreana</i> (Gyeln.) Hale*	Fl	S	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Stereocaulaceae																	
18	<i>Lepraria coriensis</i> (Hue) Sipman*	LP	S	+	-	-	-	-	-	-	+	-	-	-	-	+	-
Physciaceae																	
19	<i>Buellia</i> sp.	Cr	S	-	-	+	-	-	-	-	-	+	-	-	-	-	-
20	<i>B. disciformis</i> (Fr.) Mudd.*	Cr	C	-	-	+	-	-	-	-	-	-	-	-	-	-	-
21	<i>B. maculata</i> Bungartz in Bungartz & Nash*	Cr	S	-	-	-	-	-	-	-	-	+	-	-	-	-	+
22	<i>B. nilghiriensis</i> S.R. Singh & D.D. Awasthi *#	Cr	S	-	-	+	-	+	-	-	-	-	-	-	-	-	-
24	<i>B. substigmaea</i> S.R. Singh & D.D. Awasthi*#	Cr	S	-	-	+	-	+	-	-	+	-	-	-	-	-	+
25	<i>Dimelaena</i> sp.	Sq	S	-	-	+	-	-	-	-	-	-	-	-	-	-	-
26	<i>Dirinaria applanata</i> (Fée) D.D. Awasthi	Fl	C	-	-	+	-	-	-	-	-	-	-	-	-	-	-
27	<i>Physcia abuensis</i> D.D. Awasthi & S.R. Singh*#	Fl	S	-	-	-	-	-	-	+	+	-	-	-	-	-	+
28	<i>Pyxine petricola</i> var. <i>petricola</i> Nyl.	Fl	S	-	-	+	-	-	-	-	-	-	-	-	-	-	+
29	<i>P. petricola</i> var. <i>pallida</i> Swinscow & Krog*	Fl	S	-	+	+	-	+	-	-	+	-	+	-	+	-	+
30	<i>P. philippina</i> Vain*	Fl	C	-	-	-	-	+	-	-	-	-	-	-	-	-	-
31	<i>Rinodina</i> sp.	Cr	S	-	-	-	-	-	-	-	+	-	-	-	-	-	+
32	<i>R. oxydata</i> (Massl.) Massal.*	Cr	S	-	-	-	-	+	-	+	-	-	-	-	+	-	-
33	<i>R. sophodes</i> (Ach.) A. Massal.*	Cr	C	-	-	+	-	+	-	+	-	-	-	-	-	-	-
Teloschistaceae																	
34	<i>Caloplaca</i> sp.	Cr	C	-	-	+	-	-	-	-	-	-	-	-	-	-	-

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35	<i>C. chalybaea</i> (Fr.) Müll. Arg.*	Cr	S	-	+	-	-	-	-	-	-	-	-	-	-	-	-
36	<i>C. cinnabarina</i> (Ach.) Zahlbr.	Cr	S	-	+	+	-	+	+	-	+	-	+	-	+	-	+
37	<i>C. cupulifera</i> (Vain.) Zahlbr.	Cr	S	-	-	+	-	+	-	+	-	-	-	-	-	-	-
38	<i>C. subpoliotera</i> Y. Joshi & Upreti*#	Cr	S	-	-	-	-	+	-	-	-	-	-	-	+	-	+
39	<i>C. tropica</i> Y. Joshi & Upreti*#	Cr	S	-	+	+	-	-	-	-	+	-	-	-	+	-	+
Lichinaceae																	
39	<i>Phylliscum indicum</i> Upreti*#	Sq	S	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Peltulaceae																	
40	<i>Peltula corticola</i> Büdel & R. Sant.*	Fl	C	-	-	-	-	-	-	-	-	-	-	-	+	-	-
41	<i>P. euploca</i> (Ach.) Poelt*	Sq	S	-	-	-	-	-	-	+	-	-	-	-	-	-	+
42	<i>P. farinosa</i> Büdel	Sq	S	-	-	-	-	-	-	+	-	-	-	-	-	-	-
43	<i>P. obscurans</i> (Nyl.) Gyeln*.	Sq	S	-	-	-	-	+	-	+	-	-	-	-	-	-	+
44	<i>P. patellata</i> (Bagl.) Swinscow & Krog*	Sq	S	-	-	+	-	-	-	+	-	-	-	-	-	-	+
45	<i>P. placodizans</i> (Zahlbr.) Wetmore*	Sq	S	-	-	+	-	+	-	+	+	-	-	-	-	-	+
46	<i>P. zahlbrucknerii</i> (Hasse) Wetmore*	Sq	S	-	-	-	-	-	-	-	+	-	-	-	-	-	-

Note: GF = Growth Forms, Cr = Crustose, Fl = Foliose, Sq = Squamulose, LP = Leprose, C = Corticolous, S = Saxicolous; (+) = Present, (-) = Absent, (*) = New additions, (#) = Endemic to India; Localities: 1. Chitvel, 2. Gandi, 3. Guvalacheruvu Ghat, 4. Paidaipalem, 5. Palakonda hill, 6. Pincha, 7. Polathalu, 8. Pulivendula Ghat, 9. Rapur, 10. Rayachoti, Sibala Forest, 11. Sanipai, 12. Siddavatam fort, 13. Sundupalli, 14. Thumalapalli Uranium Mine

The occurrence of 13 species in Thumalapalli Uranium mining site is useful information in terms of Environment Impact Assessment. As mentioned earlier Reddy *et al.*, (2013a, b) reported 52 species of Herpetofauna and 30 species of Ichthyofauna from the same site. Lichens being more sensitive to air pollution, microclimatic changes and being better accumulator of heavy metals, they can act as better indicators of environmental changes in the area. However, a detailed study in this perspective is needed utilizing lichens.

The study also recorded 8 endemic lichen species (Sing and Sinha, 2010), among them *Physcia abuensis* D.D. Awasthi & S.R. Singh, was earlier restricted to its type locality Mt. Abu in Rajasthan. The endemic species also included two neoendemics (recently described) *Caloplaca subpoliotera* Y. Joshi & Upreti, and *Caloplaca tropica* Y. Joshi & Upreti. It is interesting note that most of the endemic species reported here are once reported from north India indicating inadequacy of lichen exploration in the country.

Conclusion

The present study clearly indicates the presence of high lichen diversity in the YSR district. The study also included some of the interesting specimens, partially identified up to genus level (*Acarospora*, *Buellia*, *Caloplaca*, *Dimelaena*, *Lecidella*, and *Rinodina*) and they are either new to science or new records for India. Their detailed identification is still in progress in consultation with protologue, type specimens and expert's personals. It can be noted while generating the baseline data on lichens of Andhra Pradesh Reddy *et al.*, (2011) listed 43 species of lichens with 12 new additions to the state. Later on Nayaka *et al.*, (2013) added 26 species to the list and recently, Mohabe *et al.*, (2013) added another 10 new additions to the state of Andhra Pradesh. After the addition of 28 species to the list of lichens of Andhra Pradesh the final tally would be 107 species. The present data on lichens from the district will be useful for future biomonitoring studies especially in the areas with high anthropogenic disturbances in the district. The study also indicates the need for taking up regional or district wise studies for better understanding the distribution of lichens.

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