



Research article

New distributional records in lichen family *Graphidaceae* for Andhra Pradesh, India

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[Accepted: 22 September 2017]

Abstract: The present paper reports 15 lichen taxa viz. *Chapsa leprocarpoides*, *Diploschistes scruposus*, *Fissurina capsulata*, *F. cingalina*, *F. comparimuralis*, *F. egena*, *Glyphis cicatricosa*, *Graphis cincta*, *G. crebra*, *G. duplicata*, *G. furcata*, *G. handelii*, *G. leptocarpa*, *G. lineola* and *Thecaria austroindica* of family *Graphidaceae* for the first time from Andhra Pradesh. Out of which, genera *Chapsa*, *Fissurina* and *Thecaria* are recorded for the first time from the state. The brief description and updated distribution are provided for all the taxa studied.

Keywords: Taxonomy - *Graphidaceae* - Thelotremoid - New addition - Rayalaseema forest.

[Cite as: Mohabe S, Anjali DB, Reddy AM, Pandhava G & Nayaka S (2017) New distributional records in lichen family *Graphidaceae* for Andhra Pradesh, India. *Tropical Plant Research* 4(3): 383–390]

INTRODUCTION

The lichen family *Graphidaceae* is well known for its tropical and subtropical distribution in the world. The family was monographed by Staiger (2002) which has been recently reclassified on the basis of molecular phylogeny (Plata *et al.* 2012, Lücking *et al.* 2017). At present *Graphidaceae* is the largest family comprising of 2,161 species in the world and 406 species in India (Singh & Sinha 2010). In the last five years, several taxa under the family have been described from the various regions of India (Chitale *et al.* 2011, Sharma *et al.* 2012, Joshi *et al.* 2012, Singh & Singh 2014, Mohabe *et al.* 2015, 2016a). Some of the studies especially focused to know the diversity of the family within the different states of the country (Gupta & Sinha 2012, Singh & Singh 2015). In recent lichenological investigations on Rayalaseema region of Andhra Pradesh, Anantapur, Chittoor and YSR districts additions have been made in lichen diversity of the region (Anjali *et al.* 2013, Mohabe *et al.* 2016b, 2017). So far seven species viz. *Diorygma junghuhnii* (Mont. & Bosch) Kalb & *al.*, *D. kurnoolensis* Mohabe, Nayaka & Reddy, *Diploschistes scruposus* (Schreb.) Norman, *D. actinostomus* (Pers. ex Ach.) Zahlbr., *Graphis neeladriensis* Mohabe, Anjali & Nayaka, *G. plumierae* Vain. and *G. subalbostrigata* Lücking are known from the state under *Graphidaceae*. The present investigation on *Graphidaceae* lichens reports new distributional records as well as addition to the diversity of *Graphidaceae* within Rayalaseema forests of Andhra Pradesh.

MATERIALS AND METHODS

A total of 54 samples of *Graphidaceae* lichens were segregated from Herbarium Department of Botany, Yogi Vemana University, Kadapa, Andhra Pradesh. The lichens were mostly observed on tree barks, which were collected from Tirumala hills, Talakona mango orchards and Shikaram between altitudes ranges of 500 to 1000 m in Chittoor and Kurnool district respectively. These collections were made by the authors during 2012–2014. The morphological features of lichen thallus and lirellae (ascomata) were observed under Leica S8AP0 stereo-zoom microscope. 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). Light microscope of Leica DM500 was used for anatomical investigation of lirellae. All the measurements of anatomical structures were taken in water and K while Lugol's iodine solution was used especially for

hymenium, ascus and ascospores observation. The lichen substances were identified with Thin Layer Chromatography in solvent system 'A' following White & James (1985) and Orange *et al.* (2001). The other literatures were followed for identification includes Makhija & Adawadkar (2007), Lücking *et al.* (2009) Sharma *et al.* (2012), Joshi *et al.* (2012), Lücking *et al.* (2017) was consulted for nomenclature and classification.

RESULTS

Taxonomic details and Indian distribution of endemic lichens of Graphidaceae in Andhra Pradesh, India

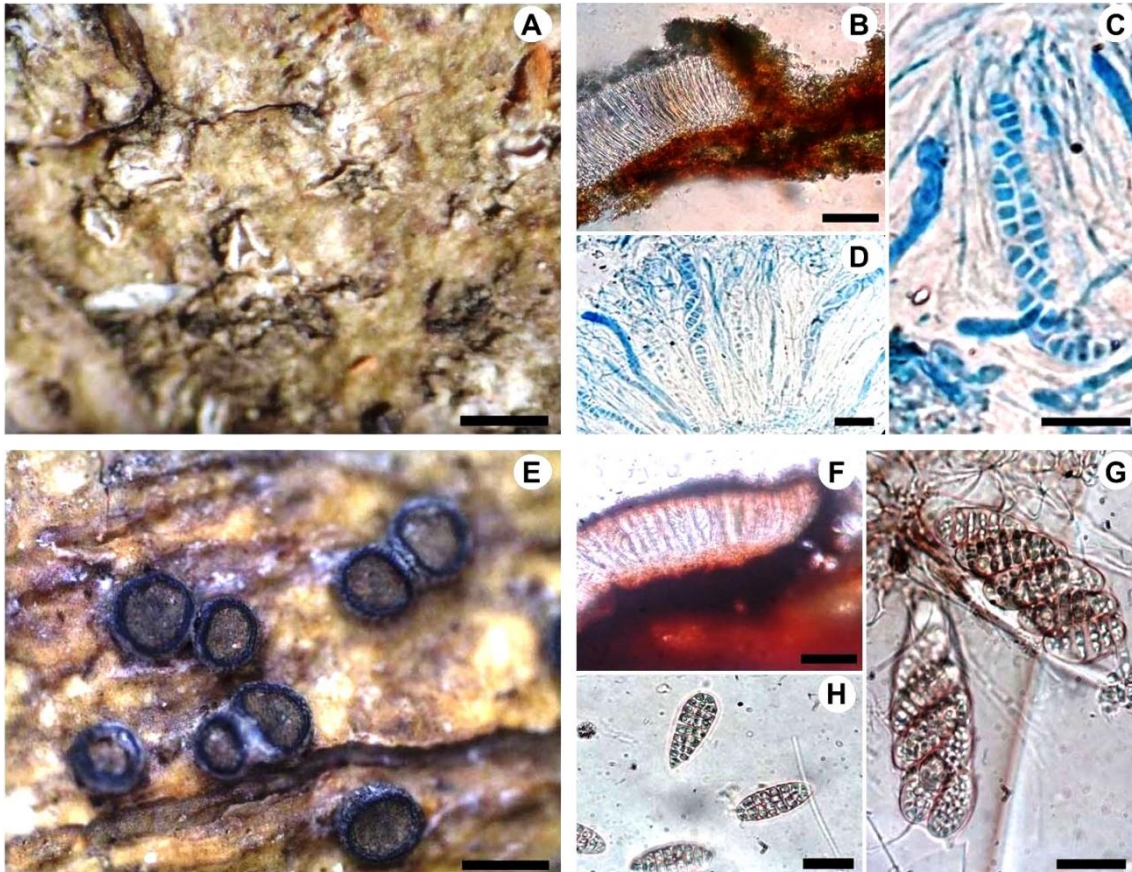


Figure 1. Endemic lichens of *Graphidaceae* in Andhra Pradesh, India: (A–D), *Fissurina capsulata* Makhija & Adaw. [A, Habit (Scale: 0.5 mm); B, V.s. of lirellae (Scale: 50 µm); C–D, Ascospores within ascus in lectophenol cotton blue (Scale: 25 µm)]; (E–H), *Thecaria austroindica* (D. D. Awasthi & Upreti) K. P. Singh & G.P Sinha [E, Habit (Scale: 0.5 mm); F, V.s. of apothecia showing completely carbonized exciple (Scale: 100 µm); G, Ascus with 8-spored ascospores (Scale: 25 µm), H, Brown muriform ascospores (Scale: 25 µm)].

1. *Fissurina capsulata* Makhija & Adaw., Lichenologist 39(2): 171. 2007. (Figs. 1A–D)

This corticolous species is characterized by yellowish brown, thin, ecorticated thallus; simple to branched, 0.5–1.0 mm long ascomata, margin with swollen tissue; yellowish brown exciple; clear hyaline hymenium; 8-spored ascus; hyaline, transversely 3–5-septate, $11\text{--}16 \times 4\text{--}5 \mu\text{m}$, halonate ascospores and lacking lichen substances.

Distribution in India: The species is endemic to India and it was earlier reported from Tamil Nadu (Singh & Sinha 2010).

Specimen examined: Andhra Pradesh, Chittoor district, Talakona, on bark of *Mangifera indica*, 539 m, 16.03.2013, ADB & SM 3638 (YVUH); Kurnool district, Shikaram, 7 km before Srisailam, on bark, 745 m, 12.01.2013, SM & KSR 3001 (YVUH).

2. *Thecaria austroindica* (D. D. Awasthi & Upreti) K. P. Singh & G.P Sinha, Indian Lichens: An Annotated Checklist, 242, 2010. (Figs. 1E–H)

This corticolous species is characterized by epiphloedal, buff yellow to brownish, evanescent, smooth to cracked thallus; rounded to elongate or oval, scattered, emergent, 0.2–0.5 mm apothecia; margin thin, concolorous with thallus; entire, slightly irregular towards outside, divergent labia covered with thalline

layer; brown black, pruinose, dusty, open, concave disc; completely carbonized exciple; hyaline, inspersed hymenium; 2–8 spored ascus; brown, muriform, transversely 4–8 septate, longitudinally 1–3 septate, I+ red brown ascospores; lacking lichen substances.

Distribution in India: The species is endemic to India and it was earlier reported from Arunachal Pradesh, Assam, Karnataka, Manipur and Odhisa (Singh & Sinha 2010, Devi *et al.* 2015).

Specimens examined: Andhra Pradesh, Chittoor district, Tirumala hills, on bark, 917 m, 06.02.2013, *ADB & SM* 3251 (YVUH); Tirumala hills, Dharmagiri, on bark, 937m, 07.02.2013, *SM & ADB* 3435 (YVUH); Shilathoranam, on bark of roadside tree, 973 m, 07.02.2013, *ADB & SM* 3331 3251, 3332, 3298, 3318, 3340 (YVUH); on bark, 958 m, 05.07.2014, *SM & ADB* 4059, 4051 (YVUH); Neeladri range, viewpoint, on bark, 06.07.2014, *SM & ADB* 4160, 4168 (YVUH); Starting of Tirumala hills, upside, on bark, 917 m, 06.02.2013, *ADB & SM* 3242 (YVUH).

Taxonomic details and Indian distribution of new lichen records of Graphidaceae for Eastern Ghats

3. *Fissurina egena* (Nyl.) Nyl. Staiger, Biblioth. Lichenol. 85: 136. 2002. (Figs. 2A–C)

This corticolous species is characterized by greenish brown to olive brown, smooth to cracked, sometimes verruculose thallus; 0.5–1.5 mm long, immersed, simple to furcate, straight to flexuous, irregularly branched, ascomata surrounded by white roof like structure; epruinose, slit like disc; entire, non-carbonized, convergent exciple; hyaline, clear, I– hymenium; indistinct, hyaline hypothecium; immature ascus and ascospores; simple paraphyses and lacking lichens substances.

Distribution in India: It was earlier known from West-Bengal (Jagadeesh *et al.* 2006).

Specimen examined: Andhra Pradesh, Kurnool district, Shikaram, 7 km before Srisailam, on bark, 745 m, 12.01.2013, *SM & KSR* 3014 (YVUH).

4. *Graphis crebra* Vain. Hedwigia 38: 256. 1899. (Figs. 2D–G)

This corticolous species is characterized by smooth to cracked, whitish grey, 3–5 cm, corticated thallus; white medulla, with large crystals at the base of exciple; indistinct to brownish prothallus; lirellate ascomata erumpent, short to elongate, 0.5–2.0 mm long, 0.1–0.5 mm wide, branched, with lateral thalline margin; entire, black, epruinose labia, exposed disc with white pruina; laterally carbonized 14–25 µm thick exciple; pale brown, 12–17 µm thick epihymenium; hyaline, inspersed, 85–173 wide, 68–95 µm high, I– hymenium; hyaline, 17–35 µm high hypothecium; hyaline, transversely 4–9-septate, 16–33 × 4–10 µm ascospores and contains norstictic acid.

Distribution in India: It was earlier reported from West-Bengal (Jagadeesh *et al.* 2012).

Specimens examined: Andhra Pradesh, Chittoor district, Talakona, on bark of *Mangifera indica*, 539 m, 16.03.2013, *ADB & SM* 3645, 3749 (YVUH); Tirumala hills, Neeladri range, on bark, 06.07.2014, *SM & ADB* 4074 (YVUH).

5. *Graphis furcata* Fée, Essai Crypt. Ecorc.: 40. 1824. (Figs. 2H–K)

This corticolous species is characterized by whitish grey, rough to cracked, ecorticated thallus with black prothallus; short to elongate, erumpent, 0.1–0.2 mm long, 0.2–0.3 mm wide lirellate ascomata, simple to partially branched with acute ends, flexuous lirellae laterally covered by the thallus; concealed disc; entire, often thinly white-pruinose labia; laterally carbonized exciple; clear, hyaline hymenium; 8-spored ascus; hyaline, ellipsoid to fusiform, transversely 5–11 septate, 22–38 × 8–9 µm ascospores and thallus lacking lichen substances.

Distribution in India: It was earlier reported from Andaman & Nicobar Islands and Meghalaya (Singh & Sinha 2010, Singh & Singh 2015).

Specimens examined: Andhra Pradesh, Chittoor district, Tirumala hills, Dharmagiri, on bark, 937 m, 07.02.2013, *SM & ADB* 3427, 3442 (YVUH); Shilathoranam, on bark, 937 m, 07.02.2013, *SM & ADB* 3315 (YVUH).

6. *Graphis leptocarpa* Fée, Essai Crypt. Exot. 36: 1825. (Figs. 2L–O)

This crustose corticolous species is characterized by whitish grey, rough to cracked, 2 cm across thallus with indistinct prothallus; lirellate ascomata erumpent, short and sparsely branched 0.5–1.0 mm long, 0.01–0.05 mm wide, with acute ends, with lateral thalline margin, slit like disc; entire, epruinose labia; laterally carbonized, 19–48 µm thick exciple; greyish brown, 18–28 µm epihymenium; hyaline, inspersed, 73–106 µm high, I– hymenium; hyaline, 29–56 µm hypothecium; hyaline, 53–66 × 12–19 µm, 8-spored ascus;

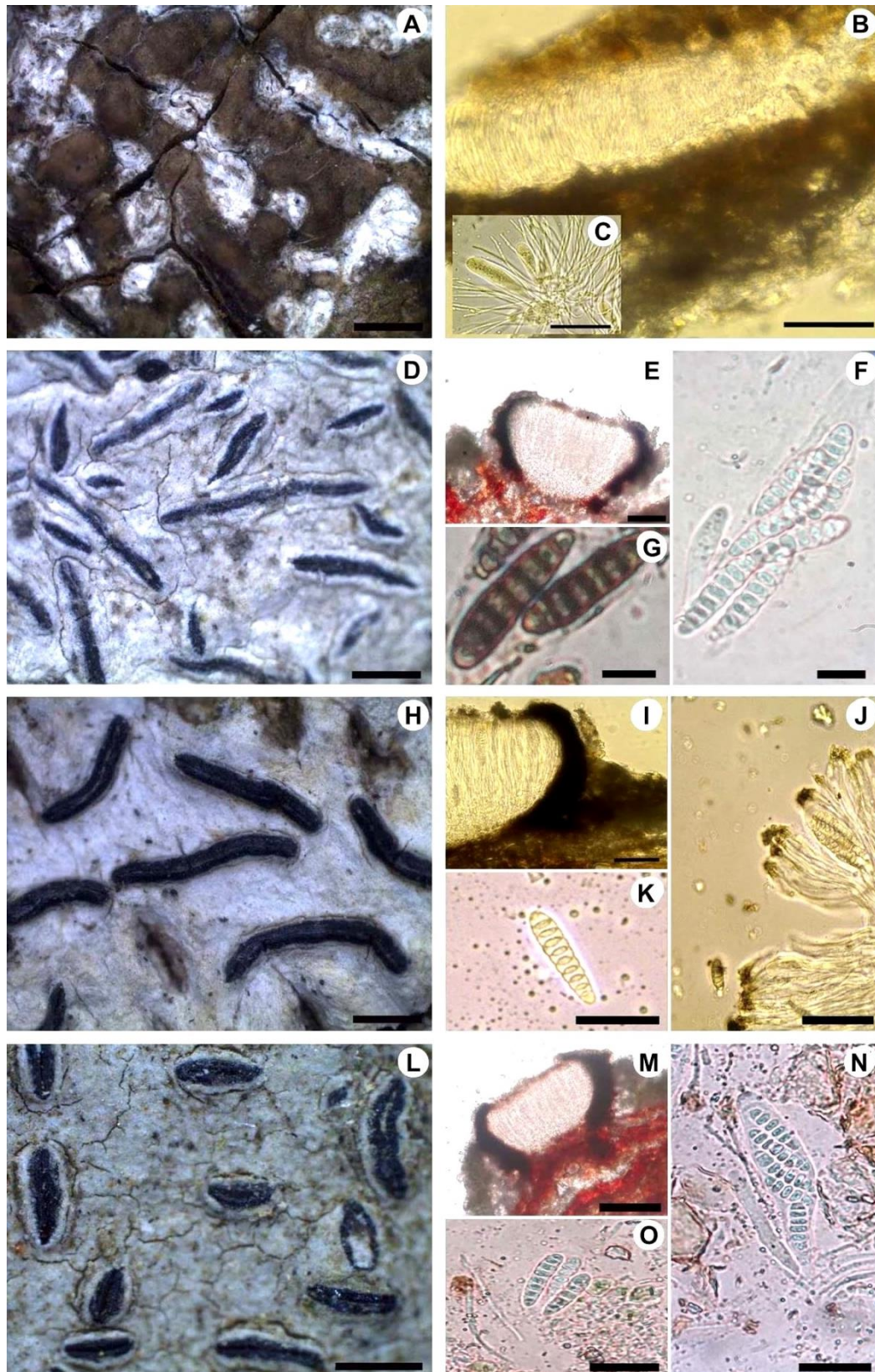


Figure 2. New records for Eastern Ghats: (A–C), *Fissurina egena* (Nyl.) Nyl. [A, Habit (Scale: 0.5 mm); B, Clear hymenium (Scale: 50 µm); C, Ascus (Scale: 50 µm)]; (D–G), *Graphis crebra* Vain. [D, Habit (Scale: 0.5 mm); E, Impersed hymenium with lateral carbonization (Scale: 50 µm); F, Ascospores in K (Scale: 10 µm); G, Ascospores in I (Scale: 10 µm)]; (H–K), *Graphis furcata* Fée [H, Habit (Scale: 0.5 mm); I, Clear hymenium with entire labia and lateral thalline margin (Scale: 50 µm); J, Ascus with ascospores and pyraphyses (Scale: 50 µm.); K, Ascospore (Scale: 25 µm)]; (L–O), *Graphis leptocarpa* Fée [L, Habit (Scale: 0.5 mm); M, Entire labia with lateral thalline margin (Scale: 50 µm); N, Ascospores within ascus in K (Scale: 25 µm); O, ascospores in K (Scale: 25 µm)].

colourless, transversely 7–11-septate, $27\text{--}32 \times 6\text{--}7 \mu\text{m}$ ascospores; paraphyses 1.6–3.8 μm thick, contains stictic and constictic acid.

Distribution in India: It was earlier reported from Assam, Jammu & Kashmir (Daimari *et al.* 2014, Goni & Sharma 2015).

Specimen examined: Andhra Pradesh, Chittoor district, Talakona, before jungle thrills, on bark of *Mangifera indica*, 539 m, 16.03.2013, ADB & SM 3743 (YVUH).

Taxonomic details and Indian distribution new lichen records of Graphidaceae for Andhra Pradesh

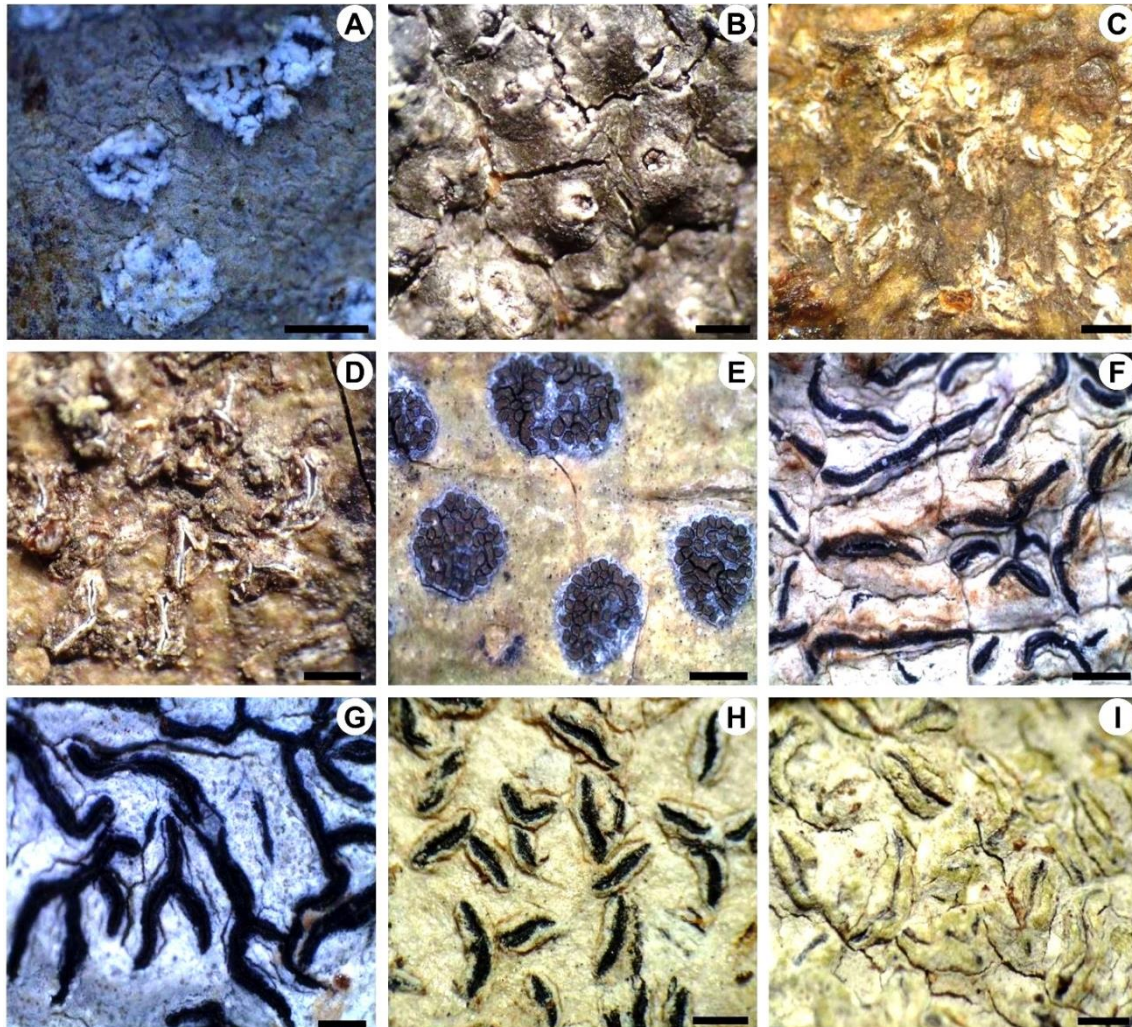


Figure 3. New records for Andhra Pradesh: **A**, *Chapsa leprocarpoides* (Hale) Cáceres & Lüking (Scales: 0.5 mm); **B**, *Diploschistes scruposus* (Schreb.) Norman (Scales: 0.5 mm); **C**, *Fissurina cingalina* (Nyl.) Staiger (Scale: 0.1 mm); **D**, *Fissurina comparimuralis* Staiger (Scale: 0.1 mm); **E**, *Glyphis cicatricosa* Ach. (Scales: 0.5 mm); **F**, *Graphis cincta* (Pers.) Aptroot (Scales: 0.5 mm); **G**, *Graphis duplicata* Ach. (Scales: 0.2 mm); **H**, *Graphis handelii* Zahlbr. (Scales: 0.5 mm); **I**, *Graphis lineola* Ach. (Scales: 0.5 mm).

7. *Chapsa leprocarpoides* (Hale) Cáceres & Lüking, Libri Bot. 22: 52, 2007. (Fig. 3A)

This species is characterized by corticolous habitat, pale olive to fawn coloured, ecorticate thallus; immersed to semi-immersed, rounded to angular, flesh coloured, 0.05–0.2 mm apothecia; pruinose disc and low uneven to lobed margins; a free, pale to brownish or hyaline proper exciple; 2–4 spored, $40\text{--}60 \times 20\text{--}30 \mu\text{m}$ ascus; hyaline muriform, oval-ellipsoidal, $20\text{--}25 \times 10\text{--}15 \mu\text{m}$ ascospores and lacking lichen substances.

Distribution in India: It was earlier reported from Karnataka (Joshi *et al.* 2012).

Specimen examined: Andhra Pradesh, Chittoor district, Japali Anjaneya Swamy Temple, on bark, 746.5 m, 13.06.2012, SN & AMR 1819 (YVUH).

8. *Diploschistes scruposus* (Schreb.) Norman, Nyt Mag. Naturvidensk. 7: 232, 1853. (Fig. 3B)

This is a saxicolous species characterized by greenish grey to brown, rimose-areolate to cracked, upto 3 cm across, epruinose thallus; thin to thick, 0.5–1.5 mm areolae, plane to subconvex at ostiolar region;

urceolate, subimmersed to sessile, 0.5–1.0 mm, slightly pruinose ascomata; dark brown, concave disc; hyaline hymenium; cylindriclavate asci; brown, muriform, ellipsoid, 26–38 × 11–19 µm, transversely 4–7, vertically 1–3 septate ascospores with longitudinal septa and contains diploschistesic, lecanoric and orsellinic acid.

Distribution in India: It was earlier reported from Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh, Maharashtra, Meghalaya, Sikkim, Tamil Nadu, Uttarakhand, West Bengal (Singh & Sinha 2010).

Specimen examined: Andhra Pradesh, Chittoor district, Tirumala hills, starting point, top of the hill, on rock, 917 m, 06.02.2013, *ADB & SM* 3176 (YVUH).

9. *Fissurina cingalina* (Nyl.) Staiger, *Biblioth. Lichenol.* 85: 128, 2002. (**Fig. 3C**)

This corticolous species is characterized by greenish grey to greenish brown, smooth to cracked, glossy thallus delimited by black hypothallus; 1.0–2.5 mm long, branched, immersed, terminally acute lirelline ascomata; epruinose, slit like disc; entire, non-carbonized, convergent exciple; hyaline, clear, I– hymenium; indistinct, hyaline hypothecium; 8-spored ascus; hyaline, muriform, transversely 6–9, vertically 2–3 septate, 25–30 × 9–16 µm, halonate ascospores; simple paraphyses and lacking lichen substances.

Distribution in India: It was earlier reported from Kerala, Maharashtra, Manipur and Tamil Nadu (Singh & Sinha 2010, Singh & Singh 2015).

Specimens examined: Andhra Pradesh, Chittoor district, Talakona, on bark of *Mangifera indica*, 539 m, 16.03.2013, *ADB & SM* 3699, 3709 (YVUH); Shilathoranam, on roadside tree bark, 958 m, 05.07.2014, *ADB & SM* 4030 (YVUH).

10. *Fissurina comparimuralis* Staiger. *Biblioth. Lichenol.* 85: 134, 2002. (**Fig. 3D**)

This corticolous species is characterized by yellowish to dark brown, slightly verruculose to cracked, slightly glossy thallus; delimited by thin black hypothallus; 0.3–1.0 mm long, simple to irregularly branched, curved, immersed, terminally acute lirelline, ascomata with slightly raised thalline margin; immersed, slit-like disc; entire, non-carbonized, orange, convergent exciple; hyaline, clear, I– hymenium; indistinct hypothecium; simple paraphyses; 8-spored asci; hyaline, submuriform, transversely 5–6 and longitudinally 1–2-septate, 21–24 × 5–8 µm, halonate, I+ weak blue ascospores and lacking lichen substances.

Distribution in India: It was earlier known from Kerala (Sharma *et al.* 2012).

Specimen examined: Andhra Pradesh, Chittoor district, Talakona, on bark of *Mangifera indica*, 539 m, 16.03.2013, *ADB & SM* 3638 (YVUH); Kurnool district, Shikaram, 7 km before Srisailam, on bark, 745 m, 12.01.2013, *SM & KSR* 3013 (YVUH).

11. *Glyphis cicatricosa* Ach. *Syn. Meth. Lich.*: 107. 1814. (**Fig. 3E**)

This corticolous species is characterized by greenish to yellowish grey or yellowish brown, smooth thallus; irregular lirellate apothecia embedded in carbonaceous stroma; dark brown, concave disc; hyaline, clear, 65–125 µm high hymenium, simple paraphyses; 8-spored ascus; transversely 5–10 septate, halonate, I+ blue, 25–65 × 8–12 µm ascospores with rounded lumina, lacking lichen substances.

Distribution in India: It was earlier reported from Andaman & Nicobar Islands, Goa, Karnataka, Kerala, Sikkim, Tamil Nadu, West Bengal, Manipur, Meghalaya and Nagaland (Singh & Sinha 2010, Singh & Singh 2015).

Specimens examined: Andhra Pradesh, Chittoor district, Tirumala hills, Dharmagiri, on bark, 937 m, 07.02.2013, *SM & ADB* 3440 (YVUH); on road side tree bark, 958 m, 05.07.2014, *ADB & SM* 4035, 4045, 4029, 4033 (YVUH); Shilathoranam, on bark, 937 m, 07.02.2013, *SM & ADB* 3318, 3332 (YVUH); Srivari padalu, on bark, 1076 m, 07.02.2013, *ADB & SM* 3526, 3535 (YVUH).

12. *Graphis cincta* (Pers.) Aptroot in A.W. Archer, *Fl. Australia* 57: 651. 2009. (**Fig. 3F**)

This corticolous species is characterized by thin, smooth, whitish grey thallus; lirellate, 0.1–0.3 mm wide, 0.2–1.2 mm long ascomata; epruinose, slit like disc; epruinose, entire labia, sometimes broad at apex; laterally carbonised, 19–44 µm thick exciple; distinct, brown to dark brown, 15–20 µm thick epihymenium; interspersed with oil globules, 56–79 µm high hymenium; hyaline, 19–22 µm high hypothecium; hyaline, clavate, 59–79 × 5–10 µm, 8-spored ascus; hyaline, transversely 4–8-septate, 20–25 × 4–8 µm, I+ blue ascospores and contains norstictic acid.

Distribution in India: It was earlier reported from Arunachal Pradesh, Goa, Karnataka, Kerala, Maharashtra, Manipur, Meghalaya, Nagaland and Tamil Nadu (Singh & Sinha 2010, Singh & Singh 2015).

Specimens examined: Andhra Pradesh, Chittoor district, Tirumala hills, Dharmagiri, on the way, on bark, 937 m, 07.02.2013, ADB & SM 3422 (YVUH); Shilathoranam, on bark of road side tree, 958 m, 05.07.2014, SM & ADB 4029 (YVUH).

13. *Graphis duplicata* Ach. Syn. Meth. Lich.: 81. 1814. (Fig. 3G)

This corticolous species is characterized by greyish white, smooth to rough, corticated thallus with brown to black prothallus; lirellate ascomata, erumpent to prominent, 0.2–1.0 mm long, 0.05–0.1 mm wide, with indistinct to basal thalline margin, elongate and irregularly branched, striate labia; laterally carbonized exciple; clear hymenium; hyaline, transversely 7–11-septate, 13–42 × 5–8 µm ascospores and lacking lichen substances.

Distribution in India: It was earlier reported from Arunachal Pradesh, Karnataka, Kerala, Maharashtra, Manipur, Meghalaya, Nagaland, Tamil Nadu and Uttarakhand (Singh & Sinha 2010, Singh & Singh 2015).

Specimens examined: Andhra Pradesh, Chittoor district, Thamballapalli, near Shiva temple, on bark, 900 m, 05.01.2013, SM & AMR 2833, 2834 (YVUH).

14. *Graphis handelii* Zahlbr. in Hand.-Mazz., Symb. Sin. 3: 39 & 40. 1930. (Fig. 3H)

This corticolous species is characterized by greyish white, smooth to cracked or areolate, corticated thallus; lirellate apothecia erumpent, short to elongate and sparsely to irregularly branched, with lateral thalline margin; epruinose, exposed disc; entire labia; laterally carbonized exciple; hyaline, interspersed hymenium; clavate, 8-spored ascus, transversely 5–11-septate, 16–46 × 5–10 µm ascospores and contains norstictic acid.

Distribution in India: It was earlier reported from Manipur, Meghalaya and West Bengal (Singh & Sinha 2010, Singh & Singh 2015).

Specimen examined: Andhra Pradesh, Chittoor district, Tirumala hills, Kousthubham Cottage, 859 m, 06.02.2013, ADB & SM 3159 (YVUH).

15. *Graphis lineola* Ach. Lichenogr. Universalis: 264. 1810. (Fig. 3I)

This corticolous species is characterized by greenish grey to yellowish green, rough to cracked, lirellate apothecia erumpent, with lateral to complete thalline margin; concealed disc; entire, epruinose labia; laterally carbonized exciple; interspersed hymenium; 8-spored ascus; hyaline, transversely 5–11-septate, 22–42 × 6–9 µm ascospores and lacking lichen substances.

Distribution in India: It was earlier reported from Arunachal Pradesh, Jammu & Kashmir, Karnataka, Manipur, Tamil Nadu, Uttarakhand, Uttar Pradesh and West Bengal–hills (Singh & Sinha 2010, Goni & Sharma 2015, Devi *et al.* 2015, Gupta & Sinha 2016).

Specimen examined: Andhra Pradesh, Chittoor district, Tirumala hills, Kousthubham cottage, on bark, 859 m, 06.02.2013, ADB & SM 3172, 3162 (YVUH).

CONCLUSION

At present *Graphidaceae* is the third largest family in Andhra Pradesh with 22 species under 7 genera which is followed by families *Physciaceae* and *Parmeliaceae* (Mohabe 2016a). Among these *Fissurina capsulata* Makhija & Adaw. and *Thecaria austroindica* (D. D. Awasthi & Upreti) K. P. Singh & G.P Sinha recorded as endemic to India. The study also recorded four species viz. *Fissurina egena* (Nyl.) Nyl., *Graphis crebra* Vain., *G. furcata* Fée and *G. leptocarpa* Fée are found first time from southern part (Eastern Ghats) of India. Further, the present study on lichen diversity of Andhra Pradesh would represent 167 species, while Chittoor district alone has 92 species. The available information on Graphidaceous lichens will helpful as base line records to lichen flora of Andhra Pradesh and can be used for biomonitoring studies in future.

ACKNOWLEDGEMENTS

The first author is very grateful to University Grant Commission, New Delhi (F./PDFSS-2015-17-MAD-12168) and Department of Science & Technology, New Delhi and CSIR, New Delhi (Letter No. 60(0100)/11/EMR - II, 2012 for financial assistance; the Director and Dr. D.K. Upreti, Chief Scientist, CSIR-National Botanical Research Institute, Lucknow for providing infrastructure facilities of Lichenology Laboratory for lichens identification; Mr. K. Suresh Raju for helping in lichen collection and to the Forest official of Andhra

Pradesh to permit for sample collections.

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