

# New Addition of Twenty Lichen Species to the Flora of Odisha: A Report

Ramakanta Mishra<sup>1</sup>, Pradeep Kumar Chand<sup>1</sup> and Kunja Bihari Satapathy<sup>2,\*</sup>

<sup>1</sup>Department of Botany, Utkal University, Vani Vihar, Bhubaneswar, Odisha, INDIA.

<sup>2</sup>School of Applied Sciences, Centurion University of Technology and Management, Bhubaneswar, Odisha, INDIA.

Submission Date: 04-06-2021; Revision Date: 25-07-2021; Accepted Date: 02-08-2021

## ABSTRACT

Panchadhara Hill range is one of the distinguished forest ranges of Odisha highly enriched with a large number of angiospermic flora. The present paper reports the occurrence of 20 species of crustose lichens for the first time in the state of Odisha while exploring the lichen diversity of the area. A morpho-taxonomic note together with habitat and distribution of all the newly reported lichen species is provided. The newly recorded lichen taxa belong to 14 genera such as *Amandinea*, *Arthothelium*, *Arthopyrenia*, *Baculifera*, *Buellia*, *Cococarpia*, *Collema*, *Cratiria*, *Cryptothecia*, *Dimelaena*, *Fissurina*, *Graphis*, *Herpothallon* and *Pyxine* and 6 families including Arthoniaceae, Arthopyreniaceae, Caliciaceae, Coccocarpiaceae, Collemataceae, and Graphidaceae. The specimens were collected from different substrata such as bark and twigs from the forests of the hill range and the identification of lichen species was done by critically studying their morphology, anatomy and chemistry. The newly reported lichen taxa included *Amandinea punctata* (Hoffm.) Coppins and Scheid., *Arthopyrenia grisea* (Schleich. ex Schaer.) Korber, *Arthopyrenia minor* R.C. Harris, *Arthothelium abnorme* (Ach.) Muell. Arg., *Baculifera cutisii* (Tuck.) Marb., *Buellia aethalea* (Ach.) Th., *Buellia disciformis* (Fr.) Mudd., *Cococarpia erythroxyli* (Spreng.) Swinscow and Krog, *Collema nigrescens* Degel, *Collema pulcellum* var. *subnigrescens* (Muell. Arg.) Degel., *Collema subflaccidum* Degel, *Cratiria obscurior* (Stirt.) Marbach and Kalb, *Cryptothecia striata* G. Thor, *Dimelaena tenius* (Muell. Arg.) H. Mayrhofer and Wippel, *Graphis lineola* Ach., *Fissurina comparimuralis* Staig., *Graphis pseudoserpens* Chaves, Lucking and Umana, *Herpothallon granulare* (Sipman) Aptroot and Lücking, *Pyxine petricola* Nyl. and *Pyxine solediata* (Ach.) Mont. which were found to be an addition to lichen flora of Odisha. It is evident from the present study that Panchadhara Hill Range has a rich diversity of lichen flora. Since many of these lichen species are likely to be endemic to the special habitats of this region, they are most vulnerable to extinction and it is extremely important to document the existing lichen vegetation and to study the effect of biotic pressures on it.

**Key words:** Lichens, Flora, New records, Panchadhara, Odisha.

## Correspondence:

**Dr. Kunja Bihari Satapathy,**

School of Applied Sciences, Centurion University of Technology and Management, Bhubaneswar-752050, Odisha, INDIA.

Phone no: +91-9861126749

Email: kbs\_bot@rediffmail.com

## INTRODUCTION

The 'Panchadhara Hill range' situated between 20° 24' North latitude and 85° 21' East longitudes with an average elevation varying between 550 m to 1070 m. The survey area has the highest temperature of about 46°C and lowest temperature of about 8°C with an average rainfall

of about 1415 mm. This hill range has a dry deciduous type forest with *Shorea robusta* and *Diospyros melanoxylon* of frequent occurrence. In this forest, the ratio of Sal is less as compared to that in the north Indian moist deciduous forest with an optimum frequency of 10% of the total vegetation. The other co-dominant tree species included *Dalbergia sissoo*, *Bombax ceiba*, *Butea monosperma*, *Tectona grandis*, and *Cleistanthus collinus*. Shrubs, such as *Cipadessa baccifera*, *Helicteres isora*, *Rotheca serrata*, *Vitex negundo* were frequently observed in this region which provided a suitable habitat for the growth of many species of lichens with a wide spread diversity. During the present investigation a unique attempt was made

### SCAN QR CODE TO VIEW ONLINE



www.ajbls.com

DOI:  
10.5530/ajbls.2021.10.51

with an objective to explore the lichen diversity of the hill range under study although exhaustive floristic inventory in the area were done by earlier workers.<sup>[1,2]</sup>

## MATERIALS AND METHODS

Extensive field tours were conducted at regular intervals during 2016-2018 in the study area in order to locate the occurrence of various lichen species before they were digitally photographed in their natural habitats in association with their respective hosts. The lichen specimens were collected using standard field survey techniques and reference specimens were brought to the laboratory for their morphological characterization and taxonomic analysis. Ecological notes regarding substrate, forms and abundance were recorded on field. All the prescribed procedures such as anatomical and chemical investigations were conducted towards confirmation of the identity of the collected samples. The species were identified with the help of relevant literature<sup>[3]</sup> and the taxa were confirmed in consultation with the Herbarium Unit in the Lichenological Laboratory, National Botanical Research Institute (NBRI), Lucknow (India). All the voucher specimens were deposited in the herbarium of Lichenological Laboratory at NBRI, Lucknow.

## RESULTS AND DISCUSSION

During the present investigation a total number of 65 species of lichens were collected and documented which belong to 36 numbers of genera included under 30 families. Graphidaceae was found to be the most dominant family represented by 8 genera followed by Caliciaceae with 5 genera. The analysis of the inventory data revealed 20 newly recorded lichen species namely *Amandinea punctata* (Hoffm.) Coppins and Scheid., *Arthopyrenia grisea* (Schleich. ex Schaer.) Korber, *Arthopyrenia minor* R.C. Harris, *Arthobelium abnorme* (Ach.) Muell. Arg., *Baculifera cutisii* (Tuck.) Marb., *Buellia aethalea* (Ach.) Th., *Buellia disciformis* (Fr.) Mudd, *Cococarpia erythroxyli* (Spreng.) Swinscow and Krog, *Collema nigrescens* Degel, *Collema pulcellum* var. *subnigrescens* (Muell. Arg.) Degel., *Collema subflaccidum* Degel, *Cratiria obscurior* (Stirt.) Marbach and Kalb, *Cryptothecia striata* G. Thor, *Dimelaena tenuis* (Muell. Arg.) H. Mayrhofer and Wippel, *Graphis lineola* Ach., *Fissurina comparimuralis* Staig., *Graphis pseudoserpens* Chaves, Lucking and Umana, *Herpothallon granulare* (Sipman) Aptroot and Lücking, *Pyxine petricola* Nyl., *Pyxine sorediata* (Ach.) Mont. which were not reported earlier from any part of the Odisha State since they did not match with any species recorded in the earlier flora of the region.<sup>[4,5]</sup> The details of the new records of the lichen species are enumerated below.

## Enumeration

***Amandinea punctata*** (Hoffm.) Coppins and Scheid., Lichenol. 25: 343.1993. Type: *s.l.*, *fide* F. Bungartz, A. Nordin and U. Grube, Lichen Fl. Great. Sonor. Des. Reg. 3: 163. 2007. [CALICIAEAE]

**Vernacular name(s):** Tiny button lichen (E); Bindu Gartikaa (O).

**Thallus:** Crustose or inapparent, uninterrupted to poorly verruculose, 1-6 cm wide; lack of prothallus **upper surface:** cinereous, flavido-cinereous, prasino-cinereous to cinero-phaeoic, soredia absent; upper cortex 10–16 µm thick **Apothecia:** 0.2-0.7 mm wide, lecideine, scarcely plunged to epedicellate; disc nigrescent, flat to poorly convex, epruinose; proper margin narrow. **proper exciple:** 14-20 µm thick, K–; exterior region dark phaeoic to nigrescent, scarcely darker than the hypothecium; interior region pale phaeoic **epihymenium:** 4-9 µm thick, dark phaeoic, dark prasino-phaeoic or phaeo-nigrus, K–. **hymenium:** 58-82 µm thick, inconspicuously interspersed, but scantily dispersed oleo droplets are found in the lower part **hypothecium:** 80-100 µm thick, flavo-phaeoic, medium phaeoic or dark phaeoic **paraphyses:** 1.6-2.0 µm wide, simple to furcate or cladulate; apices 4-6 µm wide, with dark phaeoic pileus **asci:** eight spored. **ascospores:** *Buellia*-type, uniseptate, olive-prasinus to olive-phaeoic or olive-cinereous, ellipsoidal, 7-20 × 4-9 µm, ± slightly campylar; torus lacking; exterior spore wall leioc to poorly ornamented **Pycnidia:** nigrescent, 0.07-0.10 mm wide, phaeoic **conidia:** 13-20 × 0.4-1.0 µm. **Spot test:** Thallus K–, C–, P–, UV–. **Secondary metabolites:** none detected. (Figure 1A)

**Substrate and ecology:** Bark and twigs of plants found in primary and secondary forests.

**World distribution:** Australia, Europe, North and South America, Asia and Africa.

**Indian distribution:** Himachal Pradesh, Jammu and Kashmir, Madhya Pradesh and Manipur.

**Specimens examined:** Odisha - Angul, Pallahada, Durgapur, Dhandatopha and Madhapur on the bark of *Senna siamea*, *Syzygium cumini*, dt. 19.01.2018, 20.1.2018 RM, 18-033317, 19-033326, 20-033329.

***Arthopyrenia grisea*** (Schleich. ex Schaer.) Korber Syst. Lich. Germ.: 369. 1855. [ARTHOPYRENIACEAE]

**Vernacular name(s):** Dhusara Ghrootabeja (O).

**Thallus:** corticolous, crustose, laevis to coarse, nitid, luteo-canescens, endophloeodal **photobiont:** present, chlorophycean algae *Trentepohlia* **Ascomata:** perithecial, perithecia nigrescent, unitary or 2-3 in groups, sunken to scarcely emergent, flat to moderately conical, ensheathed by corticiform layer, 0.05 - 0.13 mm diam **ostiole region:** carbonaceous, naked, ostiole apical

**exciple:** laterally expanding, phaeoic above, pale, gracilis or inconspicuous at base, 10-27  $\mu\text{m}$  thick **hamathecium:** conical to globular, pellucid, I-, 205-228 175-190  $\mu\text{m}$  across **paraphyses:** ramified and anastomosing **asci:** fissitunicate – bitunicate, octo spored, clavate to cylindrical, 60-80 16-18  $\mu\text{m}$  **ascospores:** pellucid, transversely uni-bi(-tri) septate, oblong-ellipsoid, 15-20 5-7  $\mu\text{m}$  **Spot tests:** thallus K-, C-, KC-, P-. **Secondary metabolites:** absent. (Figure 1B)

**Substrate and ecology:** Bark, trunks, branches, and twigs of both native and introduced trees; typically in semi-shaded to shaded and esheltered habitats.

**World distribution:** Asia, Europe and Arctic region of the world.

**Indian distribution:** Andhra Pradesh and Uttar Pradesh.

**Specimens examined:** Odisha - Angul, Pallahada, Durgapur, Dhandatopha, and Madhapur on the bark of *Diospyros melanoxylon* and *Madhuca indica* dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033334, 19-033343 and 19-033366.

**Arthopyrenia minor:** R.C. Harris in Tucker and Harris Bryol. 83(1): 7. 1980. Type: Florida, *n.v* [ARTHOPYRENIACEAE]

**Vernacular name(s):** Khudra Ghrootabeeja (O).

**Thallus:** crustose, endophloeodal, leucoish to phaeo-cinereous, effuse, laevigate, rimose-areolate **photobiont:** present, chlorophycean algae *Trentepohlia* **Ascomata:** perithecial, carbonaceous, unitary, or occasionally bi-tri in groups, semispherical to subglobular or conical, superficial to semi-plunged, 0.22-0.7 x 0.14-0.27mm **ostiolar region:** nudus, ostiole apical, inconspicuous, leucoish; wall interrupted beneath the hymenium, clypeate, 64-115  $\mu\text{m}$  thick laterally, K+ porraceous **exciple:** phaeoic above, pale, psilic and inevident beneath, 31-55  $\mu\text{m}$  thick **hamathecium:** pellucid, I-, 291 x 395  $\mu\text{m}$  across **hymenium:** achromate, not sprinkled with oleic globules, I- **pseudoparaphyses:** cladate and anastomosing, 1-1.7  $\mu\text{m}$  thick **asci:** moderately ellipsoidal to cylindrical, bitunicate, octospored, 60-76 x 10-18  $\mu\text{m}$  **ascospores:** uniseriate to lowly biseriate, achromate (rarely pale phaeoic at maturity), ovatiform or to ellipsoid, transversely uniseptate, with big upper locule, compressed at septum, 12-18 x 4.5-6.5  $\mu\text{m}$ ; wall of the ascospores leioic, unornamented **Spot tests:** thallus K-, C-, KC-, P-. **Secondary metabolites:** absent. (Figure 1C)

**Substrate and ecology:** Bark, trunks, branches, and twigs of both native and introduced trees; typically in semi-shaded to shaded and esheltered habitats.

**World distribution:** Asia, Europe and Arctic region of the world.

**Indian distribution:** Andhra Pradesh and Uttar Pradesh.

**Specimens examined:** Odisha - Angul, Pallahada, Purunagarh, and Jilinda, on the bark of *Diospyros melanoxylon* and *Mangifera indica* dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033305, 19-033313 and 19-033321.

**Arthothelium abnorme** (Ach.) Müll. Arg., Fl. Regensb. 63: 287. 1880. (ARTHONIACEAE)

**Vernacular name(s):** Ghrutashrungi (O).

**Thallus:** crustose, endophloeodal, asymmetrical, 1-7 cm across, pale candid, leuco-cinereous, cinero-fuscus to cinereous, leioic, uninterrupted, frequently nitid, effuse or delineated by a nigrescent line, ecorticate **photobiont:** a chlorophycean alga, *Trentepohlia*, cells 5-15  $\mu\text{m}$  across **Ascomata:** arthonioid, plunged to hemi-plunged, circinate to elongate, forked, asterik to subasterik or asymmetrical, 0.4-1.4 mm long, 0.3-0.6 mm wide, 64-96  $\mu\text{m}$  high **disc:** dark phaeoic to nigrescent or ferruginose, campestrial, epruinose. **epithecium:** phaeoic to dark phaeoic or rubiginose, 9-26  $\mu\text{m}$  thick, K- **hymenium:** achromate, 34-66  $\mu\text{m}$  high, I+ deep caeruleus **hypothecium:** achromate to fusco-flavus or pale phaeoic, 19-28  $\mu\text{m}$  thick, K-, I+ deep caeruleus **paraphyses:** copiously ramified and anastomosing, firmly coherent, 1-1.7  $\mu\text{m}$  thick; tips highly cladate, anastomosing, consistent, moderately grossus, dark phaeoic to rubiginose walled, with deep phaeoic apical caps **asci:** subglobulate to obovoid, bitunicate, octospored, 47-63 x 32-45  $\mu\text{m}$  **ascospores:** achromate, ellipsoid, muricate, with six-nine transverse septa and uni-tetra vertical septa, devoid of a bigger apical cell, 16-26 x 7-14  $\mu\text{m}$  **Pycnidia:** semi-spherical to subglobular, merulius, 64-150 x 64-120  $\mu\text{m}$  **conidia:** achromate, simple, virgate, 3-6 x 1.3  $\mu\text{m}$ . **Spot tests:** Thallus K-, C-, KC-, P-, I-. **Secondary metabolites:** not found. (Figure 1D)

**Substrate and ecology:** On barks and trunks of various trees.

**World distribution:** Asia, Africa, Australia and America.

**Indian distribution:** Assam, Karnataka, Maharashtra, Manipur, Tamil Nadu, Uttar Pradesh and West Bengal.

**Specimens examined:** Odisha - Angul, Kaniha, on the bark of *Syzygium cumini*, dt. 19.01.2018 RM, 18-033334.

**Baculifera cutisii** (Tuck.) Marb. Biblioth. Lichenol. 74: 119. 2000. [CALICIACEAE]

**Vernacular name(s):** Shakhadharee (O).

**Thallus:** crustose, rimose to rimose-verruculose, gracillius,  $\pm$ uninterrupted. **prothallus:** lacking or delineated the thallus as a nigrescent outline where many different thalli congregate **surface:** cinero-albus to atro-cinereous,

dull, phenocorticate, devoid of pruina and soredia. **medulla:** candid, devoid of calcium oxalate ( $H_2SO_4$ -) **Apothecia:** lecideine; 0.2-0.5 mm in diam., quickly sessile **margin:** carbonaceous, crassus, occasionally persistent, generally excluded with age, occasionally with a thalline veil when elevating from the thallus **disc:** carbonaceous, epruinose, flat, quickly becoming convex **proper exciple:** dispersa-type, interior excipular hyphae prominent, not diminished, pigmented, prosoplectenchymatous (textura oblita), spreading from the deep rubro-phaeoc hypothecium (leptoclinoides brown, textura intricata), exterior excipular hyphae pumilo-celled, cells angular, conspicuously bulgy (textura angularis) and  $\pm$ carbonized with variable amounts of a phaeoc pigment (cf. elachista-brown,  $HNO_3$ -) **epihyemium:** brunneis, pigmentation continuous with the exterior exciple ( $HNO_3$ -) **hymenium:** vitreous, not interspersed with oleic globules, but moderate oleic globules from a poorly interspersed subhymenium **paraphyses:** simple to scarcely ramified, apically bulgy, with a phaeoc pigment operculum (cf. elachista-brown). **asci:** clavate, *Bacidia*-type, octo-spored. **ascospores:** quickly phaeoc, uni-septate, rarely with two subsidiary false septa, tenuiformly ellipsoid, occasionally constricted with age, with acute terminations, often crispulus, (14-)18.5-[21.5]-24.5(27)  $\times$  (5.2-) 6.5-[7.5]-8.8(-10.5)  $\mu m$  **proper septum:** becoming quickly but only temporarily crassus during spore ontogeny, lateral wall inevidently crassus ( $\pm$ *Callispora*-type) **ornamentation:** lowly pannuceus (visible without DIC) **Pycnidia:** occasionally observed, urceolar to globular, unilocular; ontogeny shows resemblance to the *Umbilicaria*-type **conidiogenous cells:** generally terminal, occasionally also intercalary (cf. conidiophore-type V) **conidia:** elongate-irrigate, straight, 5.2-10.5  $\times$  0.4-1  $\mu m$  **Spot tests:** K+ flavid to aurantio-rubrus (acicular crystals observed with the compound microscope), P- to poorly flavus, C- **fluorescence:** UV-(pale) **iodine reaction:** medulla inamyloid **Secondary metabolites:** majorly norstictic acid, little amount of atranorin, dissectic, and stictic acid. (Figure 1E)

**Substrate and ecology:** Only found on bark or wood of deciduous forests.

**World distribution:** Scanty data available, although frequent at oceanic lowland region in the eastern and southeastern USA, Australia, Europe.

**Indian distribution:** Jammu and Kashmir, Madhya Pradesh, Manipur and Tamil Nadu.

**Specimen examined:** Odisha - Angul, Pallahada, Purunagarh, and Jilinda, on bark of *Ficus racemosa* dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033314, 20-033319 and 21-033306.

**Buellia aethalea** (Ach.) Th. Fr., Lichenogr. Scand. (Upsal.) 2: 604. 1874. Type: UK. ENG. Durham Co., 548469 N, 18349 W, ca. 67 m [orig. label data: 'Anglia, Durham'], *Harriman s.n.* (H-Ach 66), lectotype selected by Fouc. et al. 2002; UPS-Ach!, isolectotype; S, isotype). [CALICIACEAE]

**Vernacular name(s):** Disc lichens, Button lichens (E); Krusha Gandadharee (O).

**Thallus:** crustose, areolate, gracillis,  $\pm$ uninterrupted **prothallus:** conspicuous, merulius, generally operculating the thallus and developing between the areoles (forming a hypothallus) **surface:** generally canescent to pale phaeoc, occasionally atro-cinereus, dull, phenocorticate, devoid of soredia and pruina. **medulla:** candid, devoid of calcium oxalate ( $H_2SO_4$ -) **Apothecia:** lecideine, 0.1-0.5 mm in diam., remaining plunged, not becoming epedicellate, angular to asymmetrically circular ("comma"-shaped), prominently in the medial portion of an areole. **margin:** nigrescent, inconspicuous, reduced **disc:** carbonaceous, epruinose, flat, not becoming convex with age **proper exciple:** tenuiform, weakly differentiated, *aethalea*-type, interior excipular hyphae tenuiform, pellucid, prosoplectenchymatous (textura oblita), frequently reduced, shows resemblance in structure and orientation to the paraphyses, transient with the pellucid hypothecium (pigment may or may not be present in textura intricata), exterior excipular hyphae parallel, scarcely bulgy (textura oblita) and generally highly carbonized with variable amounts of phaeoc and aeruginose pigments (cf. elachista-brown and cinereorufa-green,  $HNO_3$ + violeus) **epihyemium:** brunneis, pigmentation continuous with the exterior exciple ( $HNO_3$ + violeus) **hymenium:** pellucid, not interspersed with oleic globules **paraphyses:** simple to scarcely cladate, apically turgid, with a phaeoc pigment pileus (cf. elachista-brown) **asci:** clavate, *Bacidia*-type, octo-spored **ascospores:** quickly phaeoc, uni-septate, broadly ellipsoid, compressed with age, with obtuse ends, not campylar, 11.5-[12.8]-14.2(-18)  $\times$  (5-)7.5-[8.2]-8.9(-10)  $\mu m$  **proper septum:** tenuiform, not thickened during spore ontogeny (*Buellia*-type). **ornamentation:** lowly pannuceus **Pycnidia:** infrequent, urceolar to globular, unilocular; ontogeny shows resemblance to the *Umbilicaria*-type **conidiogenous cells:** generally terminal, occasionally also intercalary (cf. conidiophore-type V) **conidia:** irrigate, 5-5.5  $\times$  1  $\mu m$  **Spot tests:** thallus and medulla K+ luteus to rubicund (crystals), P+ luteus, C-, KC-, CK- **fluorescence:** UV- (merulius) **iodine reaction:** medulla inamyloid. **Secondary metabolites:** shows presence of norstictic and connorstictic acids. (Figure 1F)

**Substrate and ecology:** Epilithic, on different siliceous (HCl-) rock substrates.

**World distribution:** Europe, North America, Australasia.

**Indian distribution:** Himachal Pradesh, Manipur, Tamil Nadu, Uttarakhand

**Specimens examined:** Odisha - Angul, Binikei, dt. 18.01.2018 RM, 19-033324.

**Buellia disciformis** (Fr.) Mudd, A Man. Brit. Lich.: 216.1861. var. **disciformis** (Fr.) Mudd Type: Fries 215A [centre specimen]; lecto: UPS, *fide* Kalb and Elix, Mycot. 68: 478 .1998. [CALICIACEAE]

**Vernacular name(s):** Disc lichens, Button lichens (E); Bimba Gandadharee (O).

**Thallus:** crustose, plunged to superficial, 3-5 cm wide, crepitus to crepito-areolate, psilic to slightly crassus,  $\pm$ continuous **prothallus:** wanting or confined the thallus as a nigrescent outline where various dissimilar thalli meet **surface:** pale candid to cinero-candid, dull, leioic to poorly verrucose, phenocorticate, soredia and pruina absent **medulla:** leucoish, wanting calcium oxalate ( $\text{CaC}_2\text{O}_4$ ) **Apothecia:** very often found, lecideine; 0.3-1.5 mm in diam., shortly stalked **margin:** merulious, crassus,  $\pm$ persistent, occasionally excluded with age, sometimes with a thalline envelope when arise from the thallus **disc:** carbonaceous, pruina lacking, flat, sometimes becoming convex **proper exciple:** dispersa-type, interior excipular hyphae conspicuous, not diminished, pigmented, prosoplectenchymatous, spreading from the deep rubro-phaeolic hypothecium, exterior excipular hyphae with parvocell, cells angular, conspicuously bulgy and  $\pm$ nigrescent with diverse amounts of a phaeo pigment (cf. *Elachista*-brown,  $\text{HNO}_3$ ) **epihyemenium:** 10-16  $\mu\text{m}$  thick, phaeolic to prasino-phaeolic, K- **hymenium:** pellucid, 100-120  $\mu\text{m}$  thick firmly interspersed with oleic droplets **hypothecium:** 120-170  $\mu\text{m}$  thick, deep phaeolic, lowly paler than the exciple **paraphyses:** simple to slightly cladate, apically turgid, with a phaeo pigment pileus (cf. *elachista*-brown) **asci:** club shaped, *Bacidia*-type, octo spored **ascospores:** very shortly turn phaeolic, uniseptate, rarely with two subsidiary pseudo septa, angusto-ellipsoid, generally uncompressed, with acute termination, occasionally pumilo- campylos,  $12-29 \times 7-10 \mu\text{m}$  **proper septum:** tenuiculate, not thickening, but juvenile spores frequently with a  $\pm$ crassus endospore during spore ontogeny **lateral wall:**  $\pm$ crassus (*Callispora*-type). **ornamentation:** inconspicuous in DIC **Pycnidia:** uncommon, globular, unilocular; ontogeny resembles to the *Umbilicaria*-type. **conidiogenous cells:** generally in termination point, occasionally also intercalary (cf. conidiophore-type V) **conidia:** virgate,  $2.5-6.5 \times 0.5-1.2 \mu\text{m}$ . **Spot tests:** K+ flavid, P+,

C- flavid **fluorescence:** UV- (pale) **iodine reaction:** medulla inamyloid **Secondary metabolites:** atranorin, fulgidin in higher amount fulgoicin and norfulgoicin. placodiolic acid, isousnic acid, brialmontin 1 and 2, glyrophoric acid, norstictic acid, 5-O-methylhiassic acid, and traces of 4,5-di-O-methylhiassic acid trace amount. (Figure 2A)

**Substrate and ecology:** On bark of trees, also on wood.

**World distribution:** Europe, Asia, Macaronesia, North America and the Pacific Islands.

**Indian distribution:** Arunachal Pradesh, Himachal Pradesh, Maharastra, Manipur, Tamil Nadu, Uttar Pradesh, and West Bengal Hills.

**Specimens examined:** Odisha - Angul, Pallahada, Chhendipada, Athmallik, Bamur, Pampasar, and Jilinda, on the bark of *Shorea robusta*, *Gmelina arborea* dt. 18.01.2018, 19.01.2018, 20.01.2018 RM, 18-033339, 18-033329, 19-033322, 19-033345 and 20-033316.

**Bulbothrix meizospora** (Nyl.) Hale, Phytol. 28(5): 480. 1974. Type: Ind. Nilgher. Montains, Watt *s.n.* (H-NYL 35107!). [PARMELIACEAE]

**Vernacular name(s):** Renu Kandakeshee (O).

**Thallus:** foliose, scarsely irregular laciniate to lowly laciniate up to 4-7.5 cm diam., lowly coriaceous to scarsely membranaceous, corticolous (rarely saxicolous or terricolous) **upper cortex:** 14-21  $\mu\text{m}$  thick, leioic and continuous at juvenile parts, becoming rugose and irregularly rimose at mature parts; devoid of laminal ciliary bulbs. adventitious marginal lacinulae lacking to sparse on mature parts, pumilus,  $0.3-0.9 \times \text{ca. } 0.2-0.4 \text{ mm}$ , flat, simple; apices truncate; under side conchomous with the lower marginal zone **algal layer:** 24-35  $\mu\text{m}$  thick **medulla:** candid, 84-110  $\mu\text{m}$  thick, lower cortex 14-21  $\mu\text{m}$  thick **laciniae:** asymmetrically to almost anisotomically dichotomously cladate, 1.5-6.2 mm wide, contiguous to scarsely imbricate, becoming glutate at the center,  $\pm$ adnate and adpressed, with plane to scarsely involute, subcircinate to subtruncate or occasionally truncate apices **margins:** plane to scarsely involute, crenate to or asymmetrical, entire, infrequently sublacinulate; axils ovate to asymmetrical. **maculae:** poor, punctulate, laminal or in the amphithecium, generally common but difficult to see on darker specimens **cilia:** carbonaceous, with or without simple or double apices, pumilus and gibbus downwards,  $0.04-0.30 (-0.70) \times 0.02-0.06 \text{ mm}$ , with hemi-immersed to emergent bulbate bases  $0.9-0.30 \text{ mm}$  wide (these partially expanded or rarely lacking), often xeric and becoming reniform at the axils, sparse along the margins but more abundant at the crenae and axils, spaced  $0.04-0.16 \text{ mm}$  from each to rarely contiguous,

solitary or in parvulus clusters, becoming lacking at the apices and nearby parts of the laciniae. esorediate, eisidiate and epustulate **lower cortex:** nigrescent, rarely atro-phaeolic at the transition from the margins to the center, poorly nitid to opaque, leioic to rugose, sparsely rhizinate **marginal zone:** carbonaceous and inevident from the center to phaeolic or atro-phaeolic and attenuate, 0.5-4.0 mm wide, opaque to slightly nitid, lenis to rugose, poorly papillate, sparsely rhizinate at the transition to the center **rhizinae:** merulius, infrequently atro-phaeolic close to the margins, initially simple to occasionally furcate, devoid of basal or displaced bulbs, 0.9-0.40 (-0.72) × ca. 0.05 mm, generally numerous but varying from sparse to abundant at some parts or proximal to the margins, evenly distributed **Apothecia:** urceolate to concave or lowly concave, partly becoming rimose and plicate when matured, adnate to sparsely pedicelate, 0.7-6.3 mm diam., laminal to lowly marginal, ecoronate **margin:** plicate at maturity, adnate to subpedicelate, 0.7-6.3 mm diam., laminal to submarginal, ecoronate, leioic **amphitecia:** lenis becoming subrugose, lacking ornamentations. **disc:** light to atro-phaeolic, epruinose, imperforate **epithecium:** 9-21 µm high **hymenium:** 49-79 µm high **subhymenium:** 14-38 µm high. **asci:** lecanoralean, tholus crassus, amyloid with widening axial body towards the apex (*Lecanora*-, *Parmelia*-, *Rinodina*- types etc., ca octosporous **ascospores:** simple, ellipsoid to ovate or circinate, (9) 13-18 (-23) × (6.5-) 9.5-11.5 (-14.5) µm **epispore:** (0.4-) 1.1-1.7 µm **Pycnidia:** abundant, laminal to lowly marginal, immerse, with carbonaceous ostioles **Conidia:** baciliform to poorly or prominently bifusiform (3.0-) 5.5-9.0 × 0.78 µm. **Secondary metabolites:** upper cortical part bears atranorin and chloroatranorin; medullary part harbours salazinic acid (major) and consalazinic acid (minor). (Figure 2B)

**Substrate and ecology:** Bark, cork, plant surfaces like trunks, branches, siliceous and acidic rocks.

**World distribution:** Africa, Asia tropical, South and Central America.

**Indian distribution:** Arunachal Pradesh, Himachal Pradesh, Meghalaya, Nagaland, Sikkim, Tamil Nadu and Uttarakhand

**Specimen examined:** Odisha - Angul, Pallahada, Purunagarh, and Jilinda, on the bark of *Shorea robusta* dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033307, 19-033319 and 19-033334.

**Cryptothecia striata** G.Thor Bryol. 31: 278.1991. Type: Holotype S, Thor 2200 On bark: Florida [ARTHONIA-CEAE]

**Vernacular name(s):** Wreath lichen (E); Oormi Gudhadhane (O).

**Thallus:** corticolous, occasionally saxicolous, delineated by a prominent byssoid prothallus of candid, radiating hyphae, surface gossypinus, ecorticate, chloro-cinereus to cinero- albus, with storage beige, esorediate **medulla:** candid, densely filled with teeny-weeny, achromate granules and scarce calcium oxalate crystals (insoluble in KOH, forming achromate, acicular crystals in 25% H<sub>2</sub>SO<sub>4</sub>) **Ascomata:** developing in the thallus centre as parvulus, byssoid dots that soon mingle into prominently radiating striae, occasionally not forming striae, but mingling into copious pustular outgrowths (unauthentic soredia) **asci:** bitunicate, fissitunicate, approximately pyriform to globose, with a pumils stalk, a sparsely thickened wall (ca. 4-6 µm) and crassus tholus with tiny ocular chamber, individual asci asymmetrically scattered, isolated to laxly aggregated, not closely aggregating, intertwined by few, IK+ viola-caeruleus paraphysoids, rarely ensheathed by diffuse brunneis pigment, not carbonized **ascospores:** pellucid, K-, ovoid to oblong, rarely crispulus, muriform, with campylar septa, (46-)55-70(-80) × (19-) 23-29(-37) µm, one(two) per ascus. **Conidiomata:** not found. **Spot tests:** P-, K-, C+ puniceus, KC+ puniceus; UV- (pallid-prasinus); medulla ILugol's+ deep caeruleus. **Secondary metabolites:** gyrophoric and/or lecanoric acid, traces of atranorin. (Figure 2C)

**Substrate and ecology:** Especially in the humid and upper transition region, occasionally also in the xeric zone, native to introduced tree species, typically in eshaded and sheltered habitats.

**World distribution:** Cosmopolitan, whole European countries, Galapagos and Ecuador.

**Indian distribution:** Assam and Uttar Pradesh.

**Specimens examined:** Odisha - Angul, Pallahada, Kaniha, Jilinda on the bark of *Mangifera indica* and *Artocarpus heterophyllus* dt. 18.01.2018, 19.1.2018 RM, 18-033348, 18-033369.

**Coccocarpia erythroxyli** (Spreng.) Swins. and Krog Norw. J. Bot. 23: 254.1976. Type: Guadal. 1818, Martius *s.n.*; lecto: TO, *fide* Swins. and Krog *op. cit.* 256. [COC-COCARPIACEAE]

**Vernacular name(s):** Lahu Ukunaphalaa (O).

**Thallus:** foliose, ± rotund, 2-9 (-15) cm wide, plumbo-cinereus to luteo-cinereus, infrequently endivii-merulius. adnate to weakly adnate, concentric rings may or may not be present, lobate **lobes:** flabelliform or cuneiform, 1-4 (-7) mm wide, contiguous to imbricate or conspicuously discrete, older parts lobulate and poorly ramified **apices:** orbicular and deflexed, wider than inner parts

of the lobes, generally slashed **upper surface**: pale cinereous to dark caeruleo-cinereous when dry, darker when wet, laevigatus, generally glossy, occasionally scabridulous, epruinose, seldom with concentric, crispulate crest, not isidiate, but frequently with small circinate, laminal or marginal subsidiary lobules in medial parts of the thallus occasionally **upper cortex**: candid or pallid, 11-20  $\mu\text{m}$  thick, bearing an epicortex **cortex**: pellucid to carbonaceous, 11-20  $\mu\text{m}$  thick **medulla**: candid or pallid, lax, 30-60  $\mu\text{m}$  thick **lower surface**: generally pale phaeoic but occasionally dark phaeoic to nigrescent, glabrous, rhizinate; **rhizines**: candid, light to dark phaeoic or carbonaceous, scanty to innumerable, rarely forming a thick hypothallus **Apothecia**: prominent, laminal, asymmetrically orbicular, 1-5 (-9) mm wide, adnate or epedicellate **margin**: graciliform, only conspicuous in juvenile apothecia, seldom leucotrichous, especially trichome or hair towards base of apothecia and cryptic when visualised from the above side **disc**: erythro-phaeoic to nigrescent, plane to strictly convex. **exciple**: pellucid or light phaeoic, up to 200  $\mu\text{m}$  thick but operculate by disc **epihymenium**: pale phaeoic or phaeoic or nigrescent, 4-9  $\mu\text{m}$  thick **hymenium**: achromate, 40-60  $\mu\text{m}$  high **paraphyses**:  $\pm$  ramified, septate, apically capitate **subhymenium**: pale phaeoic to almost merulius, up to 100  $\mu\text{m}$  thick. **asci**: tenui-clavate, octosporous. **ascospores**: narrowly to broadly spindle shaped to ellipsoid, pellucid, simple, generally with bi-oleo droplets, 6-15 x 3-6  $\mu\text{m}$  **Pycnidia**: laminal or marginal, plunged or astalked, ostiole merulius **Conidia**: bacillioid, 2-5 x 1  $\mu\text{m}$  **Spot tests**: all negative **Secondary metabolites**: none detected. (Figure 2D)

**Substrate and ecology**: On rocks and tree trunks in dry deciduous forests.

**World distribution**: Pantropical and subtropical with a few outlying temperate to arctic localities.

**Indian distribution**: Andaman and Nicobar Islands, Arunachal Pradesh, Assam, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Nagaland, Sikkim, Tamil Nadu, Uttarakhand and West Bengal.

**Specimens examined**: Odisha - Pallahada, Chhendipada, Athmallik, Bamur, Jilinda and Pampasar on the bark of *Syzygium caryophyllifolium* dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033322, 20-033317 and 21-033332.

**Collema pulchellum** var. **subnigrescens** (Muell. Arg.) Degel. Symb. Bot. Upsal. 20(no. 2): 173 1974. [COLLEMATACEAE]

**Vernacular name(s)**: Jelly lichen (E); Krushna Lehika (O).

**Thallus**: foliose, corticolous, up to 10 cm across, atro cinero-prasinus to nigrescent olivo-prasinus, laxly to firmly attached, homoimerous **lobes**: orbicular to irregular, 3-8 mm wide, 65-165  $\mu\text{m}$  thick **surface**: upper surface pustulate, heavily and longitudinally plicate rugose to deeply ridged; lower surface moderately paler than the upper, attached by haptera, isidia absent **photobiont**: a blue-green alga *Nostoc*, cells 3-4.8  $\mu\text{m}$  wide **Ascomata**: apothecia, lecanorine, infrequent, laminal, concolours with the thallus, gracilis, lenis, moderately stalked, 0.5-1.2 mm diam **disc**: rubro-phaeoic to roseus-aurantiate convex, epruinose **thalline exciple**: with algal cells, 27-78  $\mu\text{m}$  thick, devoid of pseudocortex **proper exciple**: euparaplectenchymatous, continuing beneath hypothecium **epithecium**: pale phaeoic, 15-20  $\mu\text{m}$  thick, K- **hymenium**: vitreous, 55-70  $\mu\text{m}$  high, 1+ caeruleus **subhymenium**: pellucid, 32-46  $\mu\text{m}$  thick **hypothecium**: pellucid to pallid, 78-135  $\mu\text{m}$  thick, K- **paraphyses**: simple, 1.5-2  $\mu\text{m}$  thick; tips furcated, bulgy, with aurantiate pigments **asci**: clavate, bitunicate, octo-spored, 55-67 x 15-18  $\mu\text{m}$  **ascospores**: biseriata, achromate, fusiform, straight to crispulus, penta-hexa septate, 25-35 x 4.5-7  $\mu\text{m}$  **Spot tests**: Thallus K-, C-, KC-, P-. **Secondary metabolites**: no lichen substances detected or very less amount of calycin and vulpinic acid present. (Figure 2E)

**Substrate and ecology**: On acidic bark and rarely on rocks.

**World distribution**: Tropical and temperate regions of Asia, Tropical Africa, Europe and America.

**Indian distribution**: Maharashtra, Manipur, Nagaland, Tamil Nadu, Uttar Pradesh, Uttaranchal and West Bengal.

**Specimen examined**: Odisha - Angul, Pallahada, Chhendipada, Athmallik, Bamur, Jilinda and Pampasar on the bark of *Mangifera indica* dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033324, 19-033326 and 20-033333.

**Collema subflacidum** Degel., Symbol. Botan. Upsal. 20(2): 140.1974. Type: Togue Pond Camps (near Mt Katah.), Maine, U.S.A., 1 Nov. 1939, *G. Degelius*; holo: herb Degel., *n.v.*, *fide* G. Degel., Symb. Bot. Upsal. 20(2): 140.1974. [COLLEMATACEAE]

**Vernacular name(s)**: Jelly lichen (E); Ruchi Lehika (O).

**Thallus**: foliose, medial to big, 4-6 cm wide, psilic, membranaceous, laxly attached, widely and  $\pm$  keenly lobate **lobes**: 0.4-1.5(-3.5) cm wide, psilic, 74-100  $\mu\text{m}$  thick when soggy, non tumidous, scanty,  $\pm$  circinate, frequently bluntly ascending,  $\pm$  imbricate, not or inconspicuously plicate **upper surface**: leioic to occasionally littlebit pustulate, atro olivo-prasinus, nigrescent, dull, pruina absent **isidia**: copious, dense, frequently evenly expanding over the lobes, occasionally covering centre

of thallus, laminal, simple, globular, ca. 0.04-0.1 mm wide, becoming parvo-teretiform and rarely ramified with age **lower surface**: generally scantily paler than the upper surface **Apothecia**: uncommon, laminal, epedicellate with constricted base, 1.4(-2.6) mm wide **disc**: plane to moderately convex, pale or dark rubrus, generally unshiny, leioic, pruina lacking or rarely pruina present when mature **thalline margin**: leioic, inconspicuous, generally with grossus pseudocortex especially at lower portion **proper exciple**: graciliform, subparaplectenchymatous to euthyplectenchymatous, occasionally parvocellular, euparaplectenchymatous **hymenium**: pellucid, 80-135  $\mu\text{m}$  tall **asci**: tenuiformly claviform, octosporous **ascospores**: pellucid, angustiformly spindle shaped to widely aciculate, (four)six-eight celled, 40-62(-65)  $\times$  (3-)4-7  $\mu\text{m}$  **Pycnidia**: plunged, laminal, pale. **Conidia**: virgate or with scarcely turgid ends, (3.5)4-(6)  $\times$  1-1.4(1.9)  $\mu\text{m}$ . **Spot tests**: all -ve. **Secondary metabolites**: unknown. (Figure 2F).

**Substrate and ecology**: On basic bark in approximately soggy, shady places, also on rock.

**World distribution**: North America, Europe, Asia, Africa, India, Hawaii, and Australasia.

**Indian distribution**: Himachal Pradesh, Jammu and Kashmir, Nagaland, Tamil Nadu and Uttar Pradesh.

**Specimen examined**: Odisha -Angul, Pallahada, Chhendipada, Athmallik, Bamur, Jilinda and Pampasar on the bark of *Anogeissus acuminata* dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033307, 19-033328 and 20-03338.

**Cratiria obscurior** (Stirt.) Marb. and Kalb, in B.Marb., Biblioth. Lichenol. 74: 186. 2000. Type: Fassif. Qld, 9 Dec. 1878, F.M. Bailey 236: holo: BM. Illust: B.Marb., *op. cit.* 191. [CALICIACEAE]

**Vernacular name(s)**: Basin/ Mug lichen (E); Karotika (O).

**Thallus**: crustose, poorly to conspicuously verruculose, slightly rimose to areolate, 1.4-4.0 cm wide; prothallus carbonaceous **upper surface**: leucoish, leuco-cinereous, cinereous to flavo- cinereous;; upper cortex 14-26  $\mu\text{m}$  thick, epicortex absent; lower cortex 20-40  $\mu\text{m}$  thick **Apothecia**: 0.5-1.0 mm wide, epedicellate, often crowded and  $\pm$ contorted; margin conspicuous, persistent, broad to slightly broad; disc nigrescent, epruinose, poorly concave to flat or poorly convex **excipulum**: 50-80  $\mu\text{m}$  thick, peripheral and interior parts dark phaeoic and paler in the middle part which is open beneath, K+ flavid then rubric forming acicular crystals. **epihymenium**: 6-9  $\mu\text{m}$  thick, erythro-phaeoic to dark phaeoic, K- **hymenium**: 70-90  $\mu\text{m}$  thick, achromate, not interspersed or may be in a small amount; scattered

paraphyses rarely with granules restricted to the external zone of the paraphyses or amalgamating in the lower portion of the hymenium **hypothecium**: 70-120  $\mu\text{m}$  thick, dark phaeoic to nigrescent, carbonaceous **paraphyses**: 1.4-2.0  $\mu\text{m}$  thick, oil globules visible occasionally; apices 3.0-4.7  $\mu\text{m}$  wide, with phaeoic pileus **asci**: eight spored **ascospores**: prasino-phaeoic to phaeoic, uniseptate, 11-19  $\times$  5-9  $\mu\text{m}$ , with prominent apical and medial wall thickenings; outer wall scarcely adorned. **Pycnidia**: merulius, ca. 0.1 mm wide; conidia virgatus, 4.4-5.6  $\times$  ca. 1.3  $\mu\text{m}$ . **Spot tests**: Thallus K+ flavid then rufus C-, P+ flavo-aurantiate **Secondary metabolites**: atranorin in major or trace quantity, norstictic acid in major and connorstictic acid in minor quantity. (Figure 3A).

**Substrate and ecology**: Bark of dry and moist deciduous forests.

**World distribution**: Australia, Africa, Asia, Central and South America and the Hawaiian Islands.

**Indian distribution**: Andhra Pradesh, Assam, Bihar, Kerala, Madhya Pradesh, Tamil Nadu, Uttarakhand and West Bengal.

**Specimens examined**: Odisha - Angul, Kaniha on the bark of *Diospyros melanoxylon* 18.01.2018 RM, 19-033306.

**Dimelaena tenuis** (Müell.-Arg.) H.Mayr. and Wip. in H. Mayr. M.Matzer, A.Wip. and Elix, Mycot. 58: 304.1996. Type: Fax. Brazil, June 1880, *J.I. Puiggari 1200*; lecto: G n.v., *fide* H. Mayr. M. Matzer, A.Wip. and J.A. Elix, *loc. cit.* (CALICIACEAE)

**Vernacular name(s)**: Krusha Dwikrishnaa (O).

**Thallus**: crustose, psilic, areolate; margin of plicate-diverging lobes. **lobes**: elongate; lacking a prothallus **upper surface**: pale to dark phaeoic, leioic and lustrous **Apothecia**: 0.1-0.5 mm wide, adnate, beginningly lecanorine, becoming biatorine or lecideine **disc**: nigrescent,  $\pm$ flat to poorly convex; thalline exciple to 45-50  $\mu\text{m}$  thick, concolorous with the thallus, scarcely developed, frequently incomplete or excluded, becoming lecideine with exjuvenscence, nigrescent and carbonaceous, 25-50  $\mu\text{m}$  wide **epihymenium**: 7-14  $\mu\text{m}$ , crassus, dark phaeoic, K-, N-. **hymenium**: 48-82  $\mu\text{m}$  thick **hypothecium**: 58-100  $\mu\text{m}$ , crassus, achromate to pale phaeoic **paraphyses**: 1.4-2.0  $\mu\text{m}$  wide beneath; apical cells turgid to 3.4-4.0  $\mu\text{m}$  wide, forming a phaeoic pileus **ascospores**: more or less ellipsoidal, 8-14  $\times$  4.4-8.0  $\mu\text{m}$ , occasionally aseptate **Pycnidia**: globular; conidia 4-8  $\times$  1.2  $\mu\text{m}$  **Spot tests**: Medulla K-, C+ rubrus, P- **Secondary metabolites**: 5-O-methylhiassic acid [major], gyrophoric acid [minor], hiassic acid [trace], lecanoric acid [minor], 4-O-methylhiassic acid [trace],



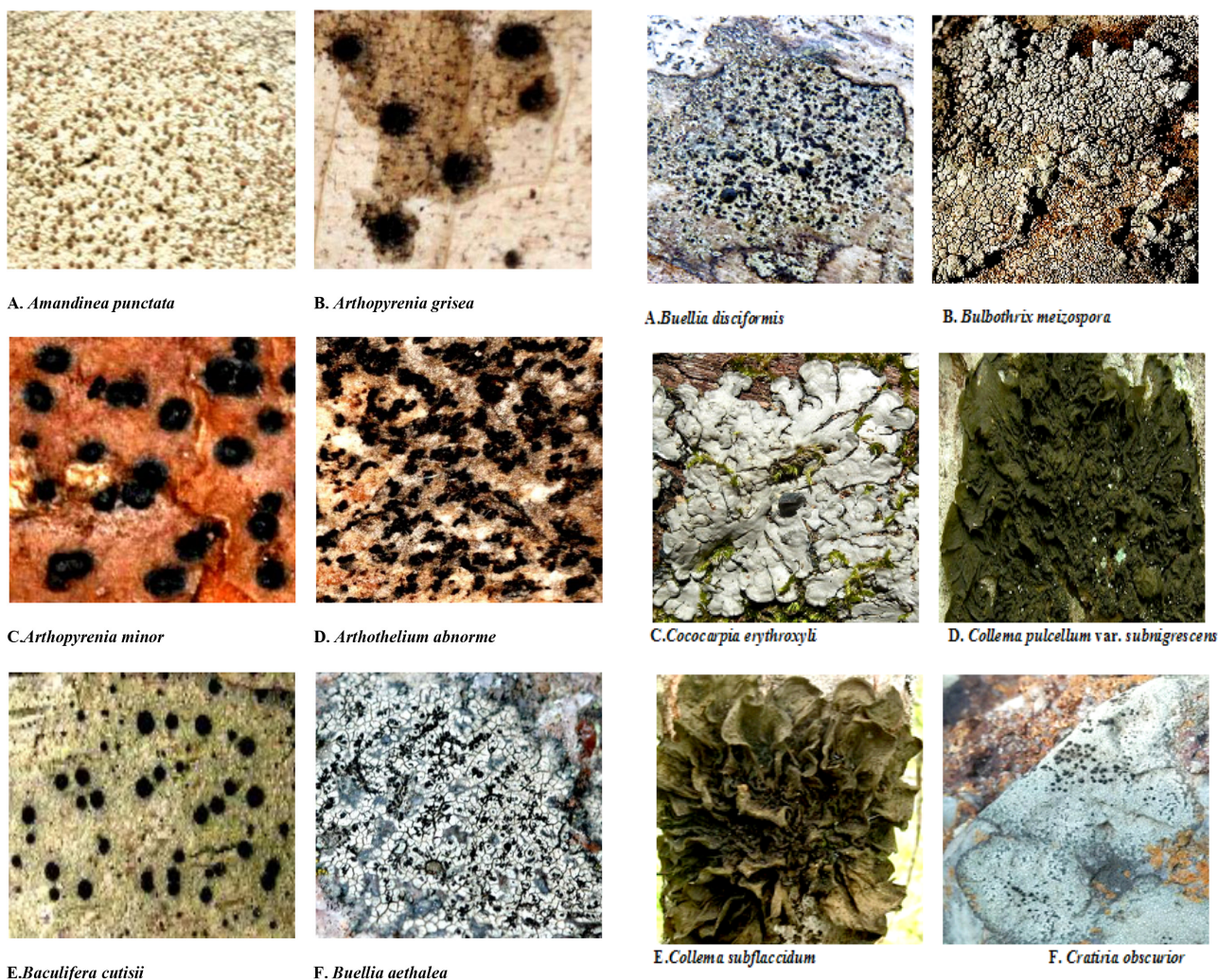


Figure 1: Photograph of the apothecia of *Amandinea punctata*, *Arthopyrenia grisea*, *Arthopyrenia minor*, *Arthothelium abnorme*, *Baculifera cutisii*, *Buellia aethalea*.

5-O-acetylhiassic acid [minor or trace], minutellic acid [minor]. (Figure 3B).

**Substrate and ecology:** Found on siliceous rocks and xeric sclerophyllous forest.

**World distribution:** Africa, South America, Papua New Guinea and New Caledonia.

**Indian distribution:** Only from Uttar Pradesh.

**Specimens examined:** Odisha - Angul, Pallahada, Purunagarh, and Jilinda, on rock dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033302, 20-033304 and 21-033303.

**Fissurina comparimuralis** Staig. Biblioth. Lichenol. 85: 134. 2002. [GRAPHIDACEAE]

**Vernacular name(s):** Fissure lichen (E); Rubisa (O).

**Thallus:** corticolous, crustose, luteo-phaeoic to cinero-phaeoic, leioic **Apothecia:** lirellae irregularly dispersed, immersed to superficial, delicate, simple to ramified,



Figure 2: Photograph of the apothecia of *Buellia disciformis*, *Cococarpia erythroxyli*, *Collema nigrescens*, *Collema pulcellum var subnigrescens*, *Collema subflaccidum*, *Cratiria obscurior*.

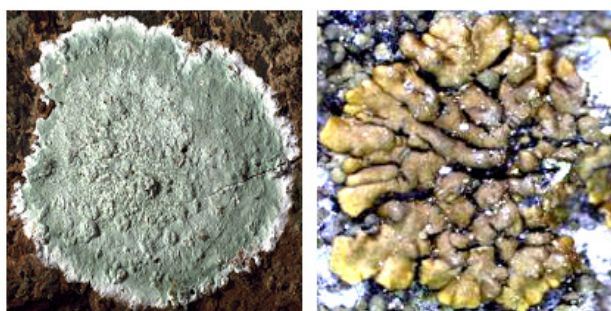
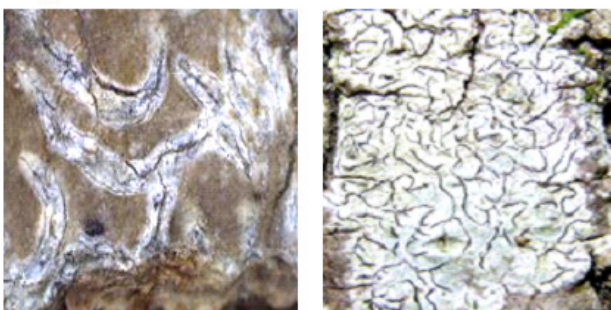
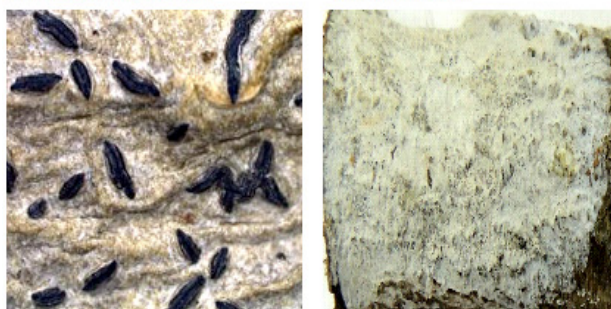
campylar to flexuose, 1.5-2.5 mm long **margin:** candid, plane, broad, operculating the disc **disc:** slit like **exciple:** pale, apically brunneis, not-carbonized, 12 - 22  $\mu$ m thick. **hymenium:** pellucid, 92-125  $\mu$ m thick **hypo-thecium:** pellucid, 13-25  $\mu$ m thick **asci:** eight spored, clavate **ascospores:** submuriform, broadly ellipsoidal to oval, transversely tri septate, vertically uniseptate, 21.4 - 23.5 x 8.5-11.6  $\mu$ m **Spot tests:** Thallus K-, C-, KC-, P-.

**Secondary metabolites:** none detected. (Figure 3C) **Substrate and ecology:** On bark, cork, plant surface, trunks, branches, twigs, in humid, submontane or montane forests.

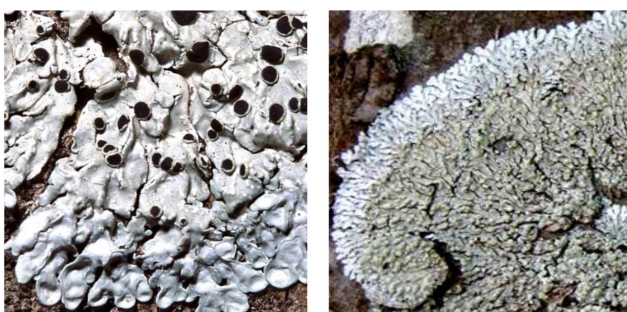
**World distribution:** Eurasia, South and Central America, Philippines and Japan.

**Indian distribution:** Only from Uttar Pradesh.

**Specimen examined:** Odisha - Angul, Pallahada, Purunagarh, and Jilinda, on the bark of *Shorea robusta*

A. *Cryptothecia striata*B. *Dimelaena tenuis*C. *Fissurina comparimuralis*D. *Graphis lineola*E. *Graphis pseudoserpens*F. *Herpothallon granulare*

**Figure 3: Photograph of the apothecia of *Cryptothecia striata*, *Dimelaena tenuis*, *Graphis lineola*, *Fissurina comparimuralis*, *Graphis pseudoserpens*, *Herpothallon granulare*.**

A. *Pyxine petricola* Nyl.B. *Pyxine sorediata*

**Figure 4: Photograph of the apothecia of *Pyxine petricola* and *Pyxine sorediata*.**

dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033315, 19-033336 and 20-033323.

**Graphis lineola** Ach., Lichenogr. Univ.: 264.1810. Type: West Ind., loc. Ign., *O. Swartzii* s.n.; holo: H-ACH 584 n.n., fide Staiger 2002. (GRAPHIDACEAE)

**Vernacular name(s):** Sama Lekhashree (O).

**Thallus:** crustose, episubstratal, continuous to slightly diffuse, rimose. **surface:** cinereus, chloro- cinereus, luteo-albus (ivory, off-white, creamy), specific structure absent, morphological substructures like areoles, lobes, branches etc. present on the upper surface, leioic, flat, granular, 25-85  $\mu\text{m}$  thick **cortex:** present, generally consists of  $\pm$ periclinal hyphae. **medulla:** candid, frequently with grandiform crystals **photobionts:** primary one *Trentepohlia*, a chlorophycean alga, secondary one absent **Ascomata:** apothecial, lirellate, frequently flexuous and ramified, abundant, crowded, stalked, subsessile, subimmersed, adnate, emergent, simple, 0.5-1.0 mm long, 0.2-0.4 mm wide, apparently ensheathed by the thalline margin, nigrescent **hypothecium:** pellucid **paraphyses:** parallel,  $1 \times 1.5 \mu\text{m}$  **hymenium:** vitreous, 100-122  $\mu\text{m}$  thick, inspersed **epihymenium:** luteus, if dull then buff **epithecium:** pellucid **asci:** claviform, I-, apex thickened with  $\pm$ conspicuous ocular chamber (*Graphis*-type), mono-octo spored. unitunicate **ascospores:** hyaline, median, eight per ascus,  $25-38 \times 7-8 \mu\text{m}$ , transversely septate, submuriform or muriform, 6-10 locular, I+ caeruleus **Spot tests:** Thallus K-, C-, KC-, P-. **Secondary metabolites:** none detected. (Figure 3D)

**Substrate and ecology:** Bark, cork, plant surface, trunks, branches, twigs, in humid, submontane or montane forests.

**World distribution:** Eurasia, South and Central America, Philippines and Japan.

**Indian distribution:** Arunachal Pradesh, Assam, Karnataka, Manipur, Tamil Nadu, Uttarakhand and West Bengal.

**Specimen examined:** Odisha - Angul, Pallahada, Purunagarh, and Jilinda, on the bark of *Diospyros melanoxylon* dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 18-033305, 19-033311 and 20-033321.

**Graphis pseudoserpens** Chaves, Lucking and Umana Fieldiana, Bot. 38(1549):101. 2008. [GRAPHIDACEAE]

**Vernacular name(s):** Kutasarpi Lekhashree (O).

**Thallus:** corticolous, crustose, luteus to luteo-phaeoc **Apothecia:** lirellate, emergent, simple, straight, thalline margin evident, 0.2-1.8  $\mu\text{m}$  long **disc:** nigrescent, epruinose **exciple:** apically to laterally carbonized, convergent, 18 - 36  $\mu\text{m}$  thick; labia with tri-tetra striate **epihymenium:** pale phaeoc **hymenium:** clear, pellucid, 38-95  $\mu\text{m}$  thick **hypothecium:** clear, 18-33  $\mu\text{m}$  thick. **asci:** clavate, 67- 99 x 26 - 44  $\mu\text{m}$  **ascospores:** perspicuous, muriform, 20.5 - 44.0 x 12.7- 24.5  $\mu\text{m}$ . **Spot tests:** Thallus K-, C-, KC-, P-. **Secondary metabolites:** no chemicals detected. (Figure 3E)

**Substrate and ecology:** Bark, cork, plant surface, trunks, branches, twigs, in humid, submontane or montane forests.

**World distribution:** Eurasia, South and Central America, Philippines and Japan.

**Indian distribution:** Only known from Uttar Pradesh.

**Specimen examined:** Odisha - Angul, Pallahada, Purunagarh, and Jilinda, on the bark of *Plumeria rubra*, dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033301, 19-033308 and 20-033325.

**Herpothallon granulare** (Sipman) Aptroot and Lucking in Aptroot, Thor, Lucking, Elix and Chaves, Biblioth. Lichenol. 99: 43.2009. Type: Holotype B, Sipman 45838 on trunk of tree: Singapore. [ARTHONIACEAE]

**Vernacular name(s):** Creep lichen (E); Srupa pinda (O).

**Thallus:** corticolous, occasionally foliicolous, delineated by a broad prothallus of laxly radiating fibrous strands of candid hyphae; surface chloro-cinereous to dull prasinus, with storage becoming paler, ecorticate, entire thallus of crasso fibrous strands of laxly plexus hyphae, frequently ensheathed in roughly granular pseudisidia **medulla:** improperly differentiated, inconspicuous, with hyphae operculated by achromate to pale brunneis granules, devoid of calcium oxalate crystals (not forming achromate, acicular crystals in 25% H<sub>2</sub>SO<sub>4</sub>) **Asci and pycnidia:** not observed. **Spot tests:** P-, K-, C-, KC-, UV-. **Secondary metabolites:** perlatolic acid. (Figure 3F)

**Substrate and ecology:** On a wide variety of both native and introduced trees; typically in semi-shaded to shaded and esheltered habitats.

**World distribution:** Pantropical to tropical areas of the world.

**Indian distribution:** Andaman Island, Assam and Uttar Pradesh.

**Specimens examined:** Odisha - Angul, Pallahada, Kaniha, Jilinda on the bark of *Diospyros melanoxylon* dt. 18.01.2018, 19.1.2018 RM, 18-033352, 18-033358.

**Pyxine petricola** Nyl., in J.M. Cromb. J. Bot. Brit. and Foreign 14: 263.1876. Type: Rodrig. island, 9<sup>th</sup> December. 1874, *I.B. Balfour 2391* (Trans. of Venus Exped.); holo: BM *n.v.* [CALICIACEAE]

**Vernacular name(s):** Box lichen (E); Shila Samputika (O).

**Thallus:** foliose, ± laxly appressed, 3- 6cm in diam, subdichotomously lobed **lobes:** plane, generally conspicuously concave towards tips of the lobe, all over occasionally convex, 0.6-1.2 mm wide **upper surface:** cinereous, prasino-canescens, approximately leucoish or stramineous. **pseudocyphellae:** scarce, laminal and marginal, generally limited to the surrounding portion

of the lobes, occasionally reticulately confluent **pruina:** blotchy, occasionally punctiform, frequently nitid; lack of soralia, isidia and polysidiangia **medulla:** completely leucoish **lower surface:** carbonaceous in middle, paler towards tips of the lobe **rhizines:** ± glutate, nigrescent, furcated **Apothecia:** *Cocoes*-type, occurs frequently, laminal, 0.4-1.5 mm wide **disc:** merulius, epruinose **internal stipe:** prominent, upper portion roseus or aurantio-rubrus, occasionally candid, lower portion leucoish **ascospores:** uniseptate, phaeoic, 15-19 × 4-7.5 μm **Pycnidia:** immersed **Conidia:** virgate, 2.5-4 × 1 μm **Spot tests:** upper cortical portion K-, C-, KC-, P-; upper and lower medullary portion K-, C-, KC-, P-; internal stipe of apothecia K+ blackish purple or purple, C-, KC-, P-; lower part K-, C-, KC-, P-. **Secondary metabolites:** upper cortex with lichexanthone; medulla with some triterpenes in trace amount. (Figure 4A)

**Substrate and ecology:** On bark, wood and acidic rock.

**World distribution:** Asia, Africa, South America, Hawaiian Islands and Micronesia.

**Indian distribution:** Assam, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra and Tamil Nadu.

**Specimens examined:** Odisha - Angul, Pallahada, Purunagarh, and Jilinda, on the bark of *Shorea robusta* dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033309, 20-033315 and 21-033307.

**Pyxine soreidiata** (Ach.) Mont., in Sagra, Hist. Phys. Polit. et natur. de l'isle de Cuba, Bot. Pl. Cell. 2:188.1842. Type: America septentr., *Mühlenb.*; lecto: H-ACH 378 *n.v.*, *vide* R. Moberg, Symb. Bot. Upsal. 34(1): 287.2004; isolecto: S, UPS *n.v.* (CALICIACEAE)

**Vernacular name(s):** Box lichen (E); Renu Samputika (O).

**Thallus:** foliose, laxly appressed, 4-8 cm in diam, subdichotomously lobate. **lobes:** projecting from a single point, contiguous to imbricate, plane or moderately concave, 0.5-1.5 mm wide, suborbicular at the apices **upper surface:** pale rarus, phaeo-rarus, plumbus or caeruleo-rarus **pseudocyphellae:** conspicuous along the margin of the lobe, occasionally ravopruinose and reticulately confluent **pruina:** punctulate on the surrounding parts of the lobes, edactylate and eisidiate **soredia:** very common, granular, occasionally farinose, primarily in marginal, rimose, then in laminal, in rotund soralia, occasionally ancilarily with a cortex and then reproducing polysidiangia; isidia and polysidiangia are of false category pale leucoish or canescens **medulla:** upper part citroflavus, ochraceous to aurantio-flavus **lower surface:** merulius in centrally, paler towards

the tips of the lobe **rhizines**: ± crowded, merulius to merulo-caeruleus, furcately dissect **Apothecia**: uncommon, *obscurascens*-type, laminal, 0.4-1.5 mm wide. **disc**: nigrescent, epruinose **internal stipe**: conspicuous, upper portion merulo-aurantiate, lower portion candid **ascospores**: uniseptate, phaeoic, 13-19 × 5-8 µm **Pycnidia**: plunged **Conidia**: virgate, 3-5 × 1 µm. **Spot tests**: upper cortex K+ flavid or K-, C-, KC-, P- or P+ pallid; upper and lower medullary part K-, C-, KC-, P-. internal stipe's upper portion K+ rubrus, C-, KC+ purpureus, P-; lower part K-, C-, KC-, P-. **Secondary metabolites**: upper cortex atranorin (trace concentration); chloroatranorin (minor), medullary portion with unidentified terpenes (major) and unknown pigment (minor).

**Substrate and ecology**: On bark and rock of primary and secondary forests. (Figure 4B)

**World distribution**: North America, Europe, Africa, Nepal, India, Japan and Australia.

**Indian distribution**: Arunachal Pradesh, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Manipur, Nagaland, Sikkim, Tamil Nadu, Uttarakhand, and West Bengal Hills

**Specimens examined**: Odisha - Angul, Pallahada, Purunagarh, and Jilinda, on the bark of *Diospyros melanoxylon* and *Mangifera indica* dt. 18.01.2018, 19.1.2018, 20.1.2018 RM, 19-033305, 19-033313 and 19-033321

## CONCLUSION

It is evident from the present study that Panchadhara Hill Range has a rich diversity of lichens. While going through the relevant published literature<sup>[4-9]</sup> and screening work at NBRI Herbarium unit and the Herbarium of BSI, Allahabad (India) no reports are available on the occurrence, distribution and habitat of these enumerated lichen species and it is thus claimed as new records for the state of Odisha. The hill range under study and the surrounding forest areas can provide an opportunity to study the impact of urbanization on these lichen communities. Several indicator communities can be identified from the reported lichen flora besides the detailed studies in this hill range on various regeneration may be a baseline for future biomonitoring studies. Since many of these lichen species are likely to be endemic to the special habitats of this region, they are most vulnerable to extinction and it is extremely important to document the existing lichen vegetation and to study the effect of biotic pressures on it. The increasing pressure for fuel wood and grazing are serious threats to their diversity. Since lichen flora is sensitive to even mild disturbance in their habitat they need special protection as an immediate conservation measure. In view of their

role as pioneer species in a habitat, as indicator taxa and complex biological symbionts, it is urgently necessary that steps are to be taken to conserve the diversity of these species characteristic and endemic to these areas.

## ACKNOWLEDGEMENT

The authors wish to express their gratitude to Dr. D.K. Upreti (Emeritus Scientist, CSIR-National Botanical Research Institute, Lucknow) for providing necessary laboratory facilities and support during course of the investigation. Financial assistance in the form of BSR- fellowship (RFSMS).to the first author by the University Grants Commission (UGC) is also deeply acknowledged.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## ABBREVIATIONS

**cm**: Centimetre; **mm**: Milimetre; **µm**; Micrometre.

## SUMMARY

An extensive survey on natural resources in Angul district of Odisha conducted during 2016-2018 could reveal the existence of twenty species of crustose and foliose lichen, which were found to be new record for the state of Odisha. Systematic study on the morphotaxonomic feature of the newly reported lichen enabled to include them under 14 genera and 6 families such as *Amandinea*, *Arthobelium*, *Arthopyrenia*, *Baculifera*, *Buellia*, *Cococarpia*, *Collema*, *Cratiria*, *Cryptothecia*, *Dimelaena*, *Fissurina*, *Graphis*, *Herpothallon* and *Pycnina* and Arthoniaceae, Arthopyreniaceae, Caliciaceae, Coccocarpiaceae, Collemataceae, Graphidaceae respectively. The result of the present study indicated that the Panchadhara hill range in the study area constitute a rich biota of lichen which were not earlier reported by any worker. Further study on the newly reported species could be of immense important in view of their secondary metabolites of pharmacological and nutraceutical importance.

## REFERENCES

- Haines HH. The Botany of Bihar and Orissa, Vol. I-VI. London: printed by Adlard and sold by agents for Indian Official Publications 1921-25.
- Saxena HO, Bramham M. The flora of Orissa, Vol.I-IV. Regional Research Laboratory, (CSIR). Bhubaneswar and Orissa forest Development Corporation Ltd. 1994-1996.
- Awasthi DD. A Key to the microlichens of India, Nepal and Sri Lanka. Biblioth Lichenol. 2007;40:1-337.
- Nayak S. Diversity of lichen flora of Odisha, India- A review. Stud Fungi. 2016;1(1):114-24. doi: 10.5943/sif/1/1/11.

5. Mishra R, Chand PK, Satapathy KB. Some new additions to the lichen flora of Odisha. *Plant Arch.* 2020;20(1):1979-86.
6. Singh KP, Kumar K. A note on the lichens from Similipal Biosphere Reserve. *Ind J For.* 2012;35(3):383-90.
7. Singh KP, Sinha GP. Indian lichens: annotated checklist. *Bot Surv India, Kolkata.* 2010.
8. Upreti DK. Lichen on *Shorea robusta* in Jharsuguda district of Orissa, India, *Fl. and Fa.* 1996;2(2):159-61.
9. Nayak SK, Mohapatra A, Chand PK, Satapathy KB. A report on Diversity of lichen flora in Kapilash reserve forest of Dhenkanal district in Odisha, India. P.G. Department of Botany, Utkal University, Bhubaneswar Odisha, 2015, pp 65.

**Cite this article:** Mishra R, Chand PK and Satapathy KB. New Addition of Twenty Lichen Species to the Flora of Odisha: A Report. *Asian J Biol Life Sci.* 2021;10(2):378-90.