

Lichen genus *Lecanora* Ach. (lichenized Ascomycota) from Arunachal Pradesh, India

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ABSTRACT

Singh P., Singh K. P. & Bhatt A. B. 2015. Lichen genus *Lecanora* Ach. (lichenized Ascomycota) from Arunachal Pradesh, India. *Geophytology* 45(2): 127-138.

The paper records the occurrence of 19 species of *Lecanora* from Arunachal Pradesh and part of the Himalaya biodiversity hotspot region in north-eastern India. Of these, *Lecanora subjaponica* L. Lü & H. Y. Wang is a new record for India and 13 species marked with an asterisk (*) are new reports for the state of Arunachal Pradesh. A key to the species and distinguishing characters are provided to facilitate the identification of species.

Key-words: *Lecanora*, lichens, new record, taxonomy, Himalaya.

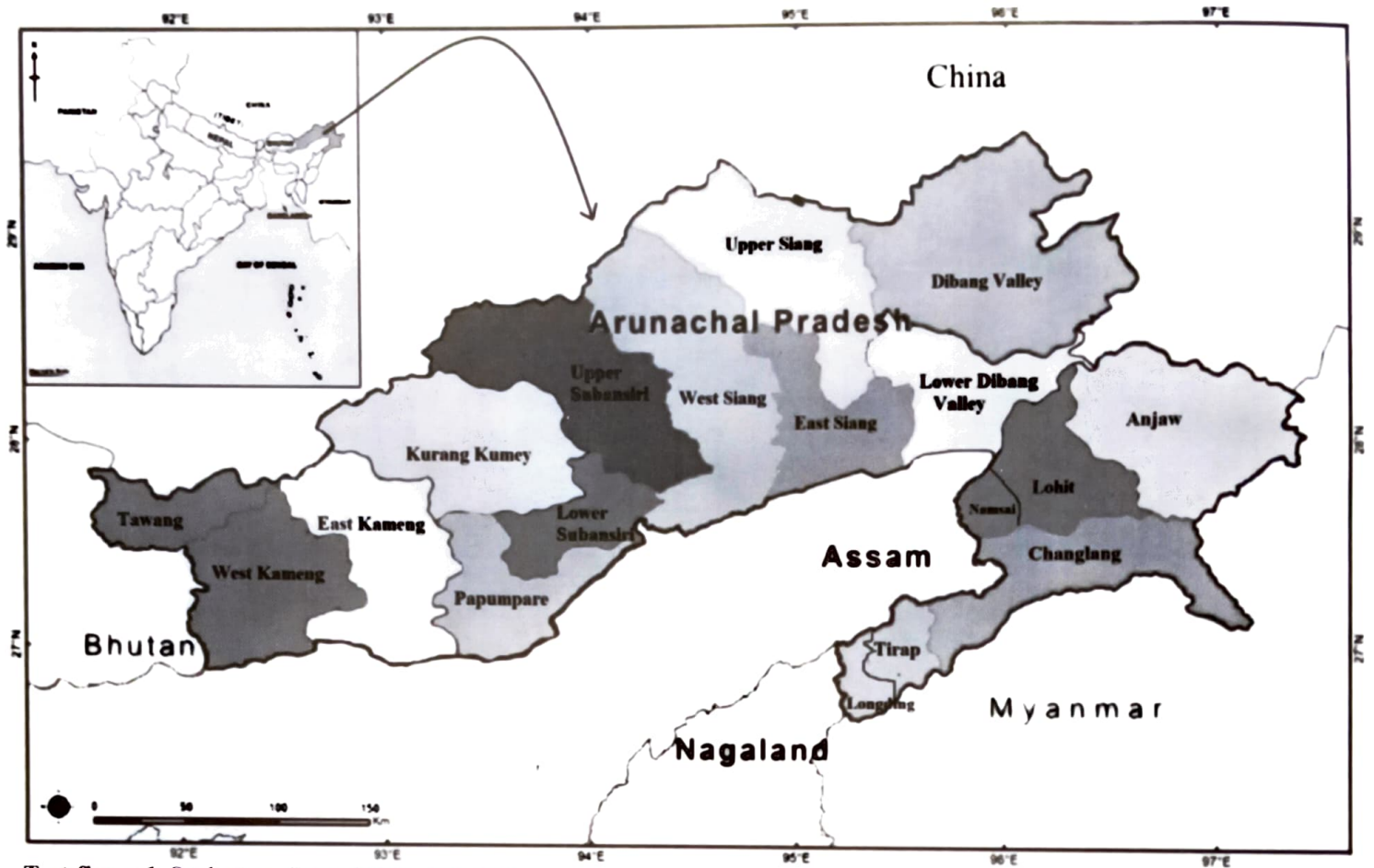
INTRODUCTION

The genus *Lecanora* belonging to family Lecanoraceae (Lumbsch & Huhndorf 2010) is represented by c. 800 species worldwide (Kirk et al. 2008). Of these, 87 species are known from India (Singh & Sinha 2010, Papong et al. 2012, Joseph & Sinha 2013). The genus distributed in tropical, subtropical and temperate regions is characterized by its crustose or placodioid thallus with lecanorine apothecia; different types of amphithecia; usually pigmented epihymenium with or without crystals; hyaline to dark brown hypothecium; *Lecanora*-type of asci with simple, colourless ascospores and presence of secondary metabolites. Arunachal Pradesh (Text-figure 1), the part of the Himalaya biodiversity hotspot region (Mittermeier et al. 2005) situated in the north-eastern region of India, is quite rich and diverse in its lichen flora and several interesting results have been published (Ahti et al. 2002, Dubey et al. 2010, Singh &

Swarnlatha 2011, Upreti et al. 2011, Singh & Singh 2012a, b, Singh et al. 2013). While investigating further collections from Arunachal Pradesh, 19 species of *Lecanora* have been identified through the consultation of various publications (Brodo 1984, Lumbsch et al. 1996, Upreti & Chatterjee 1997, Upreti 1998, Guderley & Lumbsch 1999, Lumbsch & Elix 2004, Ryan et al. 2004, Nayaka et al. 2006, Papong & Lumbsch 2011) as there is no world revision of the genus. Of these identified species, *L. subjaponica* L. Lü & H. Y. Wang, is a new record for India and described. 13 species marked with an asterisk (*) are new reports for the state of Arunachal Pradesh. Key and characteristic features of all the species are provided herewith to facilitate the identification of taxa.

MATERIAL AND METHODS

Specimens collected from Arunachal Pradesh, deposited in the herbaria at Botanical Survey of India,



Text-figure 1. Study area, Arunachal Pradesh, India.

Shillong (ASSAM) and Allahabad (BSA) were investigated. Morphological observations were made using a stereomicroscope (Nikon SMZ 1500). Thin hand-cut sections of thalli and ascomata were mounted in water, 10% KOH, and Lugol's iodine solution. All anatomical measurements were made in water mounts and examined under a compound microscope (Digi 2, Nikon Eclipse 50i). Lichen substances were identified by thin layer chromatography (TLC) in solvent A (180 Toluene: 60 dioxane: 8 acetic acid) following White & James (1985). All the specimens were identified with the help of protologue, and descriptions available in the literature as mentioned above.

KEY TO SPECIES OF *LECANORA* IN ARUNACHAL PRADESH

- | | |
|---|---------------------------|
| 1. Saxicolous | 2 |
| 1. Corticolous | 5 |
| 2. Apothecia aspicilioid (remain immersed in the thallus);
apothecial disc red-brown to brown | 16. <i>L. subimmersa</i> |
| 2. Apothecia sessile | 3 |
| 3. Hypothecium dark brown; apothecial disc black | 8. <i>L. hensenniae</i> |
| 3. Hypothecium hyaline | 4 |
| 4. Thallus containing zeorin | 14. <i>L. streimanii</i> |
| 4. Thallus containing usnic acid | 19. <i>L. wilsonii</i> |
| 5. Asci 32-spored | 17. <i>L. subjaponica</i> |
| 5. Asci 8-spored | 6 |
| 6. Thallus sorediate | 9. <i>L. impudens</i> |
| 6. Thallus esorediate | 7 |
| 7. Hypothecium yellowish brown to reddish brown | 8 |
| 7. Hypothecium hyaline to pale yellow | 10 |
| 8. Apothecial disc black; epihymenium <i>gangaleoides</i> -
type (egranular olive-green pigmented, pigments
changing to green in K) | 6. <i>L. fimbriatula</i> |
| 8. Apothecial disc red to dark brown | 9 |
| 9. Epihymenium <i>glabrata</i> -type (egranular, pigments
insoluble in K) | 5. <i>L. concilianda</i> |

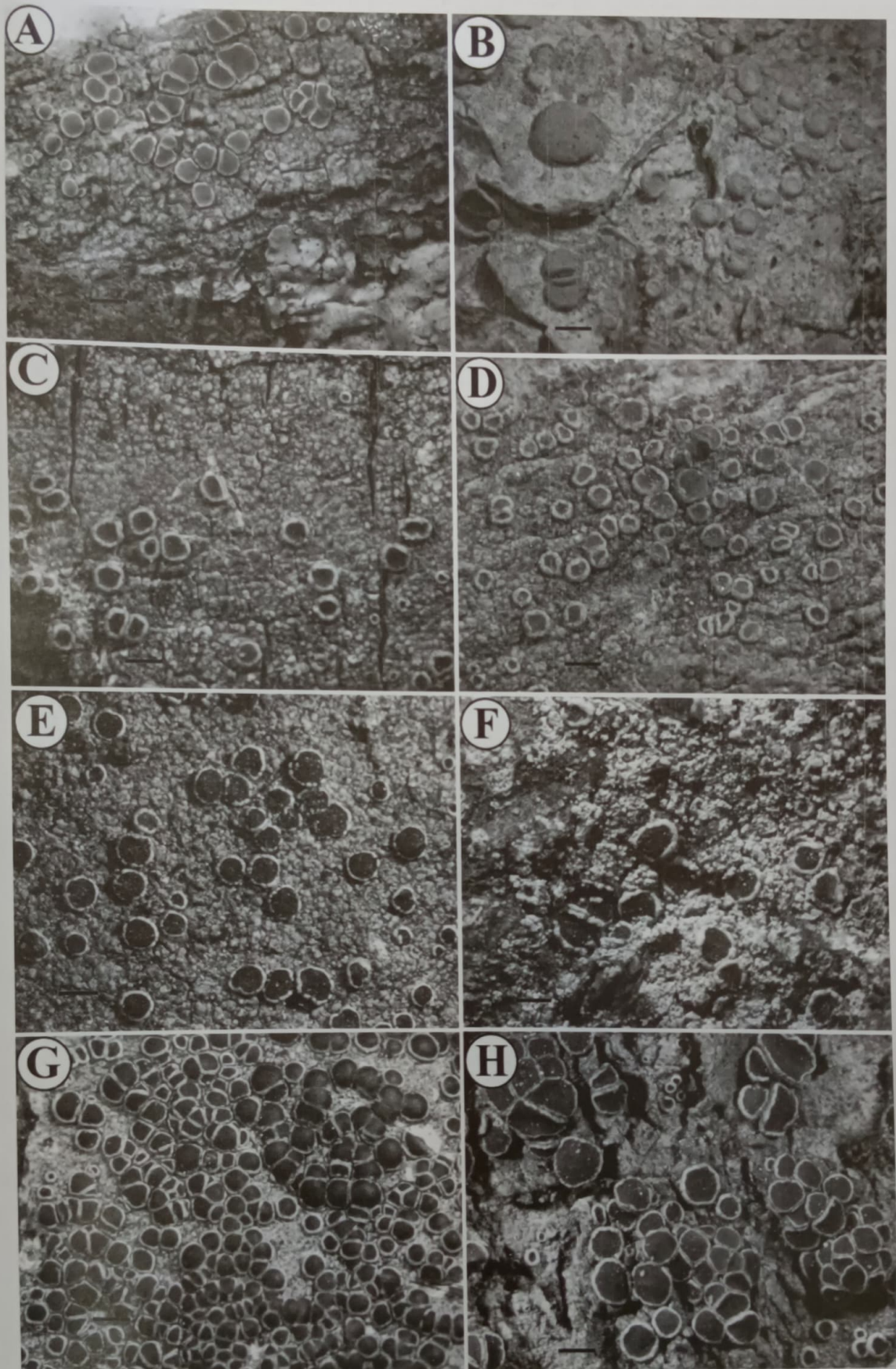


Plate 1

A-H. Habit. A. *Lecanora achroa*. B. *Lecanora albella*. C. *Lecanora austrointumescens*. D. *Lecanora helva*. E. *Lecanora hensenniae*. F. *Lecanora impudens*. G. *Lecanora imshaugii*. H. *Lecanora rugosella*. Bars = 1mm.

9. Epihymenium *chlarotera*-type (granular, pigments soluble in K) 12. *L. phaeocardia*
10. Thallus containing hypoprotocetraric acid
..... 10. *L. imshaugii*
10. Thallus lacking hypoprotocetraric acid 11
11. Discs whitish grey pruinose, flesh-coloured to pinkish 12
11. Discs epruinose, orange, red-brown to brownish black 13
12. Amphithecium *allophana*-type (with only small crystals); thallus containing protocetraric acid
..... 3. *L. albella*
12. Amphithecium *pulicaris*-type (with large crystals); thallus containing atranorin, zeorin and unknown substance 15. *L. subalbellina*
13. Amphithecium *melacarpella*-type (with small and large crystals) 14
13. Amphithecium *pulicaris*-type (with large crystals) 15
14. Thallus containing usnic acid
..... 4. *L. austrointumescens*
14. Thallus containing zeorin and chodatol
..... 18. *L. tropica*
15. Epihymenium *glabrata*-type (egranular, pigments soluble in K) 16
15. Epihymenium *chlarotera*-type (granular, pigments soluble in K) 17
16. Thallus containing arthothelin (C+ orange)
..... 2. *L. alba*
16. Thallus lacking arthothelin
..... 11. *L. perplexa*
17. Thallus containing 2'-O- methylperlatolic acid 18
17. Thallus containing gangaleoidin and usnic acid 13. *L. rugosella*
18. Thallus containing usnic acid 1. *L. achroa*
18. Thallus lacking usnic acid 7. *L. helva*

RESULTS

Nineteen species of *Lecanora* recorded from Arunachal Pradesh are briefly dealt below.

1. **Lecanora achroa* Nyl. in Cromb.,
J. Bot. 14: 263. 1876.

Plate 1, figure A

Remarks: *Lecanora achroa* is characterized by its orange brown apothecial disc with slightly whitish grey pruinose or epruinose, *pulicaris*-type amphithecium, *chlarotera*-type epihymenium and presence of atranorin, 2'-O-methylperlatolic and usnic acids. Morphologically, it closely resembles *L. helva* and *L. lerprosa*, but both later species differ in chemistry. Corticolous. In India, it is distributed in Himachal Pradesh, Manipur, Sikkim, Uttar Pradesh and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, West Kameng district, Simipam forest, alt. 1200-1500 m, K. P. Singh 9872 (ASSAM).

2. *Lecanora alba* Lumbsch, Bryologist 98: 565.
1995.

Remarks: *Lecanora alba* is characterized by its red brown to brown apothecial disc, *pulicaris*-type amphithecium, *glabrata*-type epihymenium and presence of atranorin, arthothelin and usnic acids. Morphologically and chemically, it is similar to *L. interjecta* but latter species differs in having *pulicaris*-type epihymenium and paler apothecial disc. Corticolous. In India, it is distributed in Himachal Pradesh, Uttarakhand and common in Arunachal Pradesh.

Specimens examined: Arunachal Pradesh, Lower Dibang Valley district, Mehao Wildlife Sanctuary, Diti hill, alt. c. 2700 m, K. P. Singh 385 C (BSA); Mehao Wildlife Sanctuary, Mayudia to Checkopani track, alt. c. 2050 m, K. P. Singh & P. K. Dixit 305A (BSA).

3. **Lecanora albella* (Pers.) Ach., Lichenogr.
Universalis: 369. 1810. *Lichen albellus* Pers., Ann.
Bot. (Usteri) 5: 18. 1794.

Plate 1, figure B

Remarks: *Lecanora albella* is characterized by the pinkish brown to pale brown with heavily greyish pruinose apothecial disc, thinner smooth, entire apothecial margin, *allophana*-type amphithecium, *pulicaris*-type epihymenium and presence of atranorin,

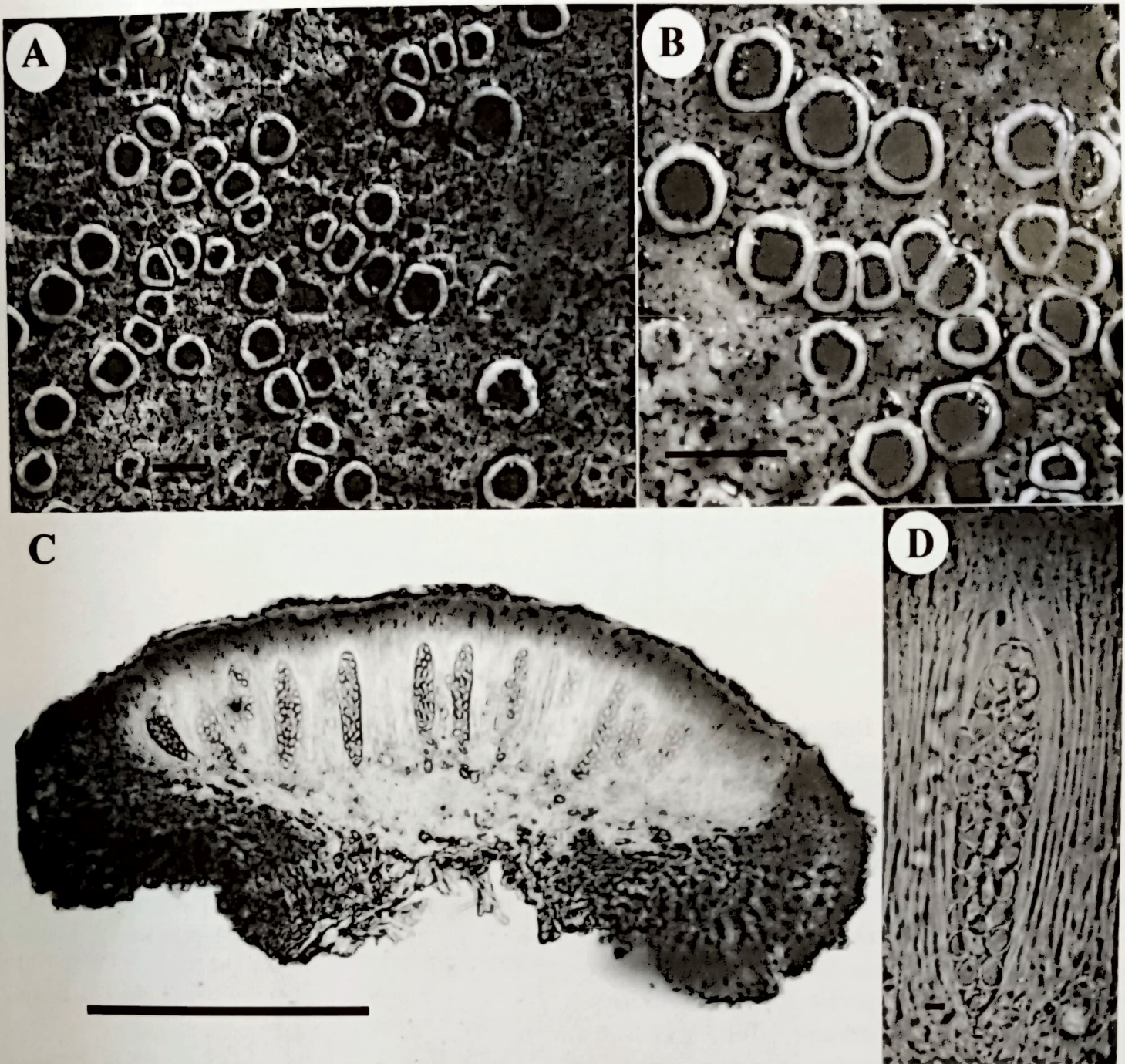


Plate 2

A-D. *Lecanora subjaponica*. A-B. Habit. C. Cross section of apothecium. D. Ascus with ascospores. Bars: A, B = 2 mm, C = 200 μ m, D = 5 μ m.

chloroatranorin and protocetraric acid. Morphologically, it closely resembles *L. caesiorubella*, but later species has usually larger apothecia with thick and flexuose margin. Corticolous. In India, it is distributed in Himachal Pradesh, Karnataka, Kerala, Tamil Nadu and Uttarakhand and scarce in Arunachal Pradesh.

Specimens examined: Arunachal Pradesh, Anjaw district, Hotspring-Jachup foot, alt. 3200-3650 m, Singh 7836, 7835 (ASSAM).

4. **Lecanora austrointumescens* Lumbsch & Elix, Mycotaxon 67: 393. 1998.

Plate 1, figure C

Remarks: This species is characterized by its red brown to brown apothecial disc, flexuose margin often becoming soredate, *melacarpella*-type amphithecium, *chlarotera*-type epihymenium and presence of atranorin and usnic acid. Morphologically, it resembles *L. achroa*, which has 2'-*O*-methylperlatolic acid. Corticolous. In

India, it is distributed in Himachal Pradesh, Sikkim, Uttar Pradesh and Uttarakhand and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, East Kameng district, Ramda forest, alt. c. 1250 m, K. P. Singh 9980 (ASSAM).

5. *Lecanora concilianda* Vain., Étud. Lich. Brésil 1: 85. 1890.

Remarks: *Lecanora concilianda* is characterized by its yellowish brown apothecial disc, *melacarpella*-type amphithecium, *glabrata*-type epihymenium and presence of 2'-*O*-methylperlatolic acid. Anatomically, it closely resembles *L. coronulans*, which has red brown to dark brown apothecial disc and different chemistry. Corticolous. In India, it is distributed in Himachal Pradesh, Sikkim and Uttarakhand and scarce in Arunachal Pradesh.

Specimens examined: Arunachal Pradesh, West Kameng district, Simipam forest, on bark, alt. 1500-1250 m, K. P. Singh 9882, 9875 (ASSAM).

6. *Lecanora fimbriatula* Stirt., Proc. Roy. Soc. Glasgow 11: 311. 1879.

Remarks: It is characterized by the black apothecial disc, *melacarpella*-type amphithecium, *gangaleoides*-type epihymenium, pale brown to red brown hypothecium and presence of atranorin chloroatranorin and 2'-*O*-methylperlatolic acid. This species is close to the genus *Tephromela*, which is easily distinguished by the purple coloured hymenium. Corticolous. In India, it is distributed in Goa, Himachal Pradesh, Karnataka, Maharashtra, Sikkim, Tamil Nadu and Uttarakhand and common in Arunachal Pradesh.

Specimens examined: Arunachal Pradesh, Lohit district, Yatang-Koibong road, on bark, alt. 600-900 m, K. P. Singh 327, 321 (ASSAM); Dibang Valley district, Riyali Anini foot track, near 10 km, alt. c. 900 m, K. P. Singh 4773 (ASSAM); Simpian forest, alt. 500-1250 m, K. P. Singh 9879 (ASSAM).

7. *Lecanora helva* Stizenb., Ber. Thätigk. St. Gallischen Naturwiss. Ges. 1888/1889-218. 1890

Plate 1, figure D

Remarks: It is characterized by its small, orange to pale brown apothecial disc, *pulicaris*-type

amphithecium, *chlarotera*-type epihymenium, presence of atranorin and 2'-*O*-methylperlatolic acid. Morphologically, it resembles *L. achroa*, which has usnic acid and slightly larger ascospores. Corticolous. In India, it is distributed in Assam, Goa, Himachal Pradesh, Kerala, Madhya Pradesh, Maharashtra and Tamil Nadu and common in Arunachal Pradesh.

Specimens examined: Arunachal Pradesh, Lower Subansiri district, on way of Yazali to Hapoli, on bark, alt. c. 1600 m, K. P. Singh 10567, 10605, 10565 (ASSAM); Dibang Valley district, Riyali-Annini foot tract, near 10 km, alt. c. 900 m, K. P. Singh 4773 (ASSAM); West Kameng district, Simipam forest, alt. 1250-1500 m, K. P. Singh 9879 (ASSAM); Lower Dibang Valley district, Mehao Wildlife Sanctuary, Premayudia, alt. c. 1550 m, K. P. Singh & P. K. Dixit 359 B (BSA).

8. *Lecanora hensenniae* Vanska, Ann. Bot. Fenn. 23: 30. 1986

Plate 1, figure E

Remarks: *L. hensenniae* is characterized by its black apothecial disc, *melacarpella*-type amphithecium, *pulicaris*-type epihymenium, reddish-brown to dark brown hypothecium and presence of atranorin, chloroatranorin, zeorin and caperatic acid. In saxicolous habit and dark hypothecium, it closely resembles *L. atroanima*, which has *glabrata*-type of epihymenium. Saxicolous. In India, it is distributed in Madhya Pradesh and Uttarakhand and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, West Kameng district, near National Research Centre on Yak, on rock, alt. 1500-2300 m, K. P. Singh & G. Swarnlatha 4921 (BSA).

9. *Lecanora impudens* Degel., Svensk. Bot. Tidskr. 38: 50. 1944.

Plate 1, figure F

Remarks: *Lecanora impudens* is characterized by the sorediate thallus, reddish brown to dark brown apothecial disc, *allophana*-type amphithecium, *glabrata*-type epihymenium, hyaline hypothecium and presence of atranorin and zeorin. In sorediate morphotype, it closely resembles *L. leproplaca* which

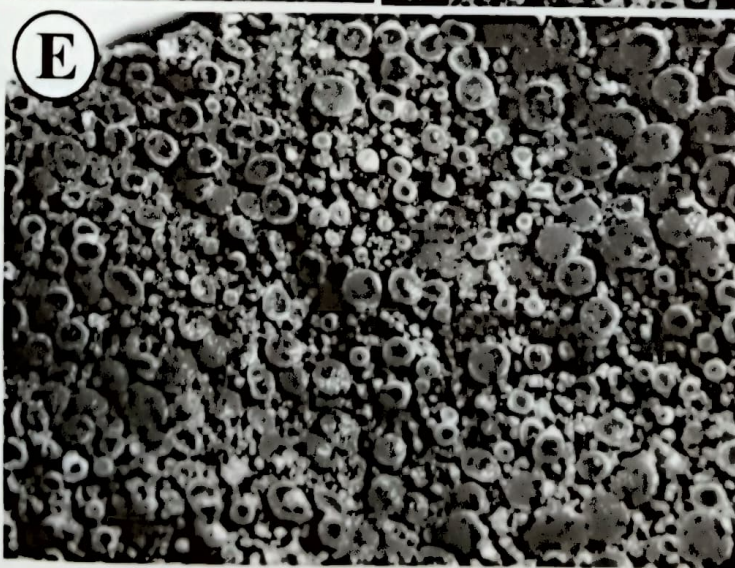
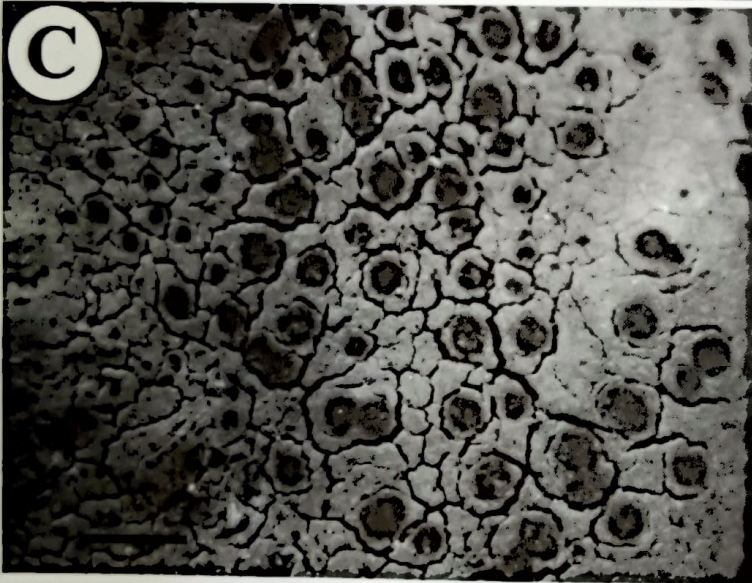
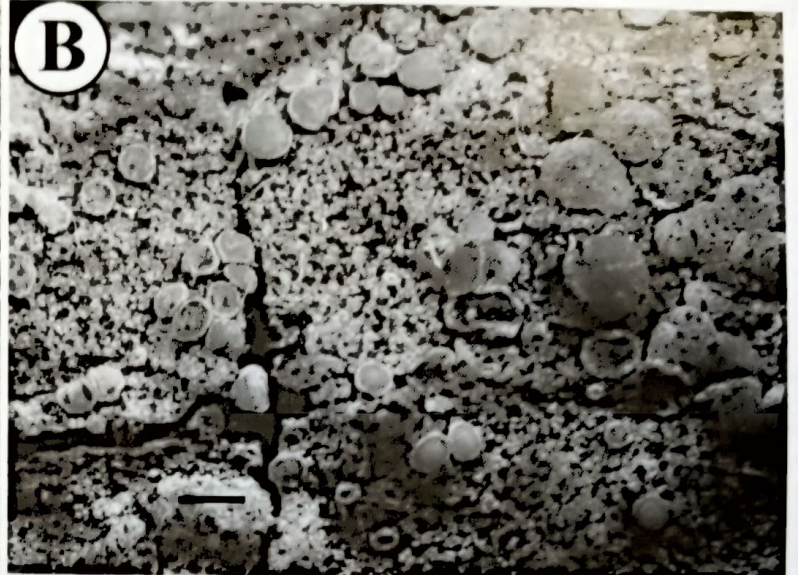


Plate 3

A-E. Habit. A. *Lecanora streimanii*. B. *Lecanora subalbellina*. C. *Lecanora subimmersa*. D. *Lecanora tropica*. E. *Lecanora wilsonii*. Bars = 1 mm.

has *pulicaris*-type of amphithecium. Corticolous. In India, it is distributed in Kerala, Madhya Pradesh and Uttarakhand and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, Lohit district, Hayuliang, Hayugam to Barpu foot track, on bark, alt. c. 1100 m, K. P. Singh 4411, 4389 (ASSAM).

10. **Lecanora imshaugii* Brodo, Nova Hedwigia 79: 63. 1984

Plate 1, figure G

Remarks: *Lecanora imshaugii* is characterized by its reddish brown apothecial disc, *allophana*-type amphithecium, *glabrata*-type epihymenium and presence of atranorin, zeorin and hypoprotocetraric acid. Morphologically and anatomically, it resembles *L. allophana*, which has strongly constricted apothecia and absence of zeorin. Corticolous. In India, it is distributed in Sikkim and Uttarakhand and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, Tirap district, Namdapha, Deban river, 0 mile camp, on bark, alt. 500-800 m, K. P. Singh 715 (ASSAM).

11. *Lecanora perplexa* Brodo, Beih. Nova Hedwigia 79: 148-150. 1984.

Remarks: This species is characterized by its granular to verruculose red brown apothecial disc, *pulicaris*-type amphithecium, *glabrata*-type epihymenium and presence of atranorin and zeorin. Morphologically, it resembles *L. subrugosa* which has different chemistry. Corticolous. In India, it is distributed in Assam, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh and Uttarakhand and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, Lohit district, Tezu, near Lohitpur Assam Rifles camp, on bark, alt. c. 200 m, K. P. Singh 4212 (ASSAM).

12. *Lecanora phaeocardia* Vain., Ann. Soc. Zool. Bot. Fenn. 1(3): 41. 1921.

Remarks: It is characterized by the red-brown apothecial disc, *melacarpella*-type amphithecium, *chlarotera*-type epihymenium, presence of atranorin, chloroatranorin, unknown secalonic acid derivative

(minor). Morphologically, it resembles *L. coronulans* and *L. tropica*, but both the later species has *glabrata*-type of epihymenium and hyaline hypothecium. Corticolous. In India, it is distributed in Uttarakhand and West Bengal-hills and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, Lower Dibang Valley district, Mehao Wildlife Sanctuary, Diti hill, on bark, alt. 2500-2750 m, K. P. Singh & P. K. Dixit 388A (BSA).

13. **Lecanora rugosella* Zahlbr., Cat. Lich. Univ. 5: 524. 1928.

Plate 1, figure H

Remarks: This species is characterized by its pale brown to brown apothecial discs, *pulicaris*-type amphithecium, *chlarotera*-type epihymenium and presence of atranorin and gangaleoidin as secondary metabolites. Morphologically, it closely resembles *L. chlarotera* which has verrucose apothecial margin. Corticolous. In India, it is distributed in Himachal Pradesh, Jammu and Kashmir, Madhya Pradesh, Orissa, Sikkim, Tamil Nadu, Uttarakhand and West Bengal-hills and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, West Kameng district, Dirang valley, near apple garden, on bark, alt. c. 2125 m, K. P. Singh & G Swarnlatha 4969 (BSA).

14. **Lecanora streimanii* Lumbsch, J. Hattori Bot. Lab. 77: 135. 1994.

Plate 3, figure A

Remarks: This species is characterised by its sessile, pale brown to dark brown epruinose apothecia, *pulicaris*-type amphithecium, *glabrata*-type epihymenium and presence of atranorin and zeorin. Morphologically, it resembles *L. fuscococcinea* which has *melacarpella*-type amphithecium and presence of chodatol as secondary metabolites. Saxicolous. In India, it is distributed in Uttarakhand and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, Lower Dibang Valley district, Mehao Wildlife Sanctuary, Roing Mini Zoo, on rock, alt. c. 500 m, K. P. Singh & P. K. Dixit 522A (BSA).

Table 1. Details of habitat and altitudinal preference along with distribution of *Lecanora* spp. in 9 districts of Arunachal Pradesh and in the world.

Species	Habitat	Altitude	Distribution in different districts									Distribution in the World	
			West Kameng	East Kameng	Lower Subansiri	Upper Subansiri	Lower Dibang Valley	U. Dibang Valley	Lohit	Anjaw	Tirap		
<i>L. achroa</i> Nyl.	C	1500-1200 m	+										New Zealand, Papua New Guinea and Thailand; Australia; Antarctica; Central, North and South America.
<i>L. alba</i> Lumbsch	C	2050-2700 m					+						Australia; Antarctica
<i>L. albella</i> (Pers.) Ach.	C	3200-3600 m									+		Bhutan, China, Indonesia, Nepal, Netherlands, Norway; temperate regions of the world.
<i>L. austrointumescens</i> Lumbsch & Elix	C	c. 1250 m		+									Australia
<i>L. concilianda</i> Vain.	C	1250-1500 m	+										Central and South America
<i>L. fimbriatula</i> Stirt.	C	600-900 m						+	+			+	Bhutan and Nepal
<i>L. helva</i> Stizenb.	C	c. 1600 m	+		+		+	+					Thailand; Sri Lanka; Australia; Africa, Central and South America
<i>L. hensenniae</i> Vanska	S	1500-2300 m	+										Brazil
<i>L. impudens</i> Degel.	C	c. 1100 m							+				Europe, North America
<i>L. imshaugii</i> Brodo	C	600-800 m										+	Japan and Korea; North America
<i>L. perplexa</i> Brodo	C	c. 200 m							+				Canada, Nepal
<i>L. phaeocardia</i> Vain.	C	2500-2750 m						+					Australia; Indonesia and Thailand
<i>L. rugosella</i> Zahlbr.	C	c. 2125 m	+										Sri Lanka; Europe, North America
<i>L. streimanii</i> Lumbsch	S	c. 500 m						+					Nepal and Papua New Guinea; Australia
<i>L. subalbellina</i> Vain.	C	c. 1600 m			+								Central and South America
<i>L. subimmersa</i> (Fée) Vain.	S	600-800 m				+							Nepal and Thailand; Australia; Central and South America
<i>L. subjaponica</i> L. Lü & H. Y. Wang	C	c. 2250 m						+					China
<i>L. tropica</i> Zahlbr.	C	c. 2100 m				+							Nepal, Papua New Guinea and Thailand, Japan; Sri Lanka; Australia; tropical America
<i>L. wilsonii</i> Mull Arg.	S	1500-1550 m						+					Australia, Bolivia

15. **Lecanora subalbellina* Vain., Acta Soc. Fauna Flora Fenn. 7: 78. 1890.

Plate 3, figure B

Remarks: This species is characterized by its whitish grey pruinose apothecial disc, *pulicaris*-type amphithecium, *chlarotera*-type epihymenium and presence of atranorin, zeorin and unknown substance. Morphologically, it resembles *L. flavidomarginata*, which contains usnic acid in addition to atranorin and zeorin. Corticolous. In India, it is distributed in Tamil Nadu and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, Lower

Subansiri district, Hapoli-Ziro road, on bark, alt. c. 1600 m, K. P. Singh 449 (ASSAM).

16. **Lecanora subimmersa* (Fée) Vain. Étude Lich. Brésil 1: 98. 1890. *Lecidea subimmersa* Fée, Bull. Soc. Bot. France 20: 315. 1873.

Plate 3, figure C

Remarks: *Lecanora subimmersa* is easily distinguished from the other *Lecanora* species by its saxicolous habit, aspicilioid ascomata with red-brown to brown apothecia, *glabrata*-type epihymenium and presence of atranorin, chloroatranorin and zeorin. In chemistry, it also resembles *L. subimmergens*, which

has much emergent apothecia. Saxicolous. In India, it is distributed in Himachal Pradesh, Madhya Pradesh, Karnataka, Orissa, Tamil Nadu and Uttarakhand and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, Upper Subansiri district, Taliha, Subansiri road, in river bed, on rock, alt. 600–800 m. K. P. Singh 10524 (ASSAM).

17. *Lecanora subjaponica* L. Lü & H. Y. Wang, *Lichenologist* 44: 465. 2012.

Plate 2, figures A–D

Description: Thallus corticolous, crustose, suborbicular to irregular in outline, greyish brown to yellowish-grey, rough to cracked or slightly verruculose, 4–6 cm across, 80–110 µm thick; prothallus indistinct; photobiont green *Trebouxia*; algal cells 8–10 µm across. Apothecia are numerous, lecanorine, sessile, rounded, constricted at base, 0.5–1.6 mm diam.; disc reddish brown to dark brown, concave to plane, shiny, epruinose; margin usually paler than the thallus, whitish grey, rather thick, persistent, smooth, entire to occasionally flexuose; amphithecial cortex distinct, hyaline, 50–75 µm thick, basally not expanded; amphithecium containing numerous small crystals (*campestris*-type) soluble in K, 80–115 µm thick; epihymenium reddish brown, 10–12 (–14) µm high, without granules; hymenium hyaline, 50–62.5 µm high, I+ blue; paraphyses simple, 1–1.5 µm thick; tips slightly thickened, 1.8–2.6 µm thick, not pigmented; subhymenium hyaline, 8–10 µm high; hypothecium hyaline, 25–35 µm high; asci 32-spored, clavate, 85–95×23–25 µm; ascospores colourless, simple, ellipsoid, 8–10 × 4.8–5.5 µm.

Chemistry: Thallus K+ yellow, C–, KC–, P–, UV–. TLC – atranorin and zeorin (major).

Remarks: *Lecanora subjaponica* is characterized by its epruinose reddish brown to brown apothecial disc, *campestris*-type amphithecium, non granulose epihymenium, 32-spored asci and presence of atranorin and zeorin. In multi-spored asci condition, it closely resembles *L. japonica* and *L. loekoessii*. *Lecanora japonica* has (8–) 16-spored asci and atranorin only, while *L. loekoessii* contains (12–) 16-spored asci, a granulose (*pulicaris*-type) epihymenium

and usnic and norstictic acids in addition to atranorin and zeorin. *Lecanora subpraesistens* Nayaka, another multi-spored species from Western Himalaya differs from *L. subjaponica* in having *pulicaris*-type amphithecium and *glabrata*-type epihymenium. Earlier this species was reported from neighbouring country China and now shows extended distribution to India. It is known from a single collection and found growing on the bark of a tree in open shady place in cool temperate area which receives snow falls during winter months.

Specimen examined: Arunachal Pradesh, Lower Dibang Valley district, Mayudia, on bark, alt. c. 2250 m, K. P. Singh & P. K. Dixit 439B (ASSAM).

18. **Lecanora tropica* Zahlbr., *Cat. Lich. Univ.* 5:589. 1928.

Plate 3, figure D

Remarks: *Lecanora tropica* is characterized by its dark red brown apothecial disc, *melacarpella*-type amphithecium, *glabrata*-type epihymenium and presence of atranorin, chodatol, zeorin, demethylchodatol, chloroatranorin and thiophanic acid. In apothecial morphology, it resembles *L. argentata*, but later species differs in chemistry by having gangaleoidin. It somewhat also resembles *L. ecoronata* which has a ±entire apothecial margin and lacks chodatol chemosyndrome. Corticolous. In India, it is distributed in Himachal Pradesh, Karnataka, Madhya Pradesh, Odisha, Sikkim, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal-plains and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, Lower Subansiri district, near Kimin, on bark, alt. c. 2100 m, K. P. Singh 5069 (ASSAM).

19. **Lecanora wilsonii* Müll. Arg., *Bull. Herb. Boissier* 1: 39. 1893.

Plate 3, figure E

Remarks: This species is characterised by its reddish brown apothecia, *melacarpella*-type amphithecium, *glabrata*-type epihymenium and presences of atranorin and usnic acid. Morphologically and anatomically, it resembles *L. fuscococcinea* which has zeorin and chodatol as secondary metabolites. Saxicolous. In India, it is distributed in Himachal

Pradesh and scarce in Arunachal Pradesh.

Specimen examined: Arunachal Pradesh, Lower Dibang Valley district, Mehao Wildlife Sanctuary, 4 km from Checkopani to Mayudia, alt. 1500-1550 m, on rock, K. P. Singh & P. K. Dixit 359A (BSA).

DISCUSSION

Lecanora is a widespread and common genus in Arunachal Pradesh. Most of the species are corticolous (c. 84%), growing on the bark of trees or branches. 4 species grow on the rocks. Majority of the species prefer to grow in rain forests between 200 and 1800 m in tropical and subtropical regions while species like *Lecanora alba*, *L. albella* and *L. phaeocardia* are found in temperate regions between 1800 and 3600 m altitude. *L. hensenniae* prefers to grow in subtropical and sub temperate regions (between 1500 and 2300 m). Only *L. subjaponica*, a new record for India bears multi-spored asci while remaining species contain eight-spored asci. Among these *Lecanora* species, *L. austointumescens*, *L. fimbriatula*, *L. phaeocardia*

L. streimanii and *L. subjaponica* occur in eastern paleotropics and remaining species show pantropical distribution. Out of 7 north-eastern state of India, Arunachal Pradesh shows maximum species diversity of *Lecanora*, followed by Manipur, Assam, Nagaland, Meghalaya, Mizoram and Tripura with 17, 13, 5, 1, 1 and nil species respectively (Singh & Sinha 2010, Sanayaima Devi et al. 2013, Sinha et al. 2013, Daimari et al. 2014). This indicates that many states in north-eastern region are underexplored or unexplored and thus require thorough exploration for *Lecanora* species. The distribution of *Lecanora* species in different districts (Table 1) shows the occurrence of maximum number of 5 species in West Kameng and Lower Debang Valley districts because of varied topographic and suitable climatic conditions and suggests further explorations in other districts of the state. The secondary metabolites (Table 2) present in *Lecanora* spp. are interesting and may be evaluated for antibacterial and antifungal activities. *Lecanora* spp. from Arunachal

Table 2. Details of colour reactions and secondary metabolites present in *Lecanora* spp. of Arunachal Pradesh.

Species	Colour test reactions							Secondary metabolites											
	K	C	KC	P	Atr	Meth	Usn	Chl	Cap	Cho	Dem	Arth	Gan	Pro	Hyp	Zeo	Sec	Thi	
<i>L. achroa</i> Nyl.	+	-	-	-	+	+	+												
<i>L. alba</i> Lumbsch	+	+	+	+	+		+					+							
<i>L. albella</i> (Pers.) Ach.	+	-	-	+	+			+						+					
<i>L. austointumescens</i> Lumbsch & Elix	+	-	-	+	+		+												
<i>L. concilianda</i> Vain.	+	-	-	-	+	+													
<i>L. fimbriatula</i> Stirt.	+	-	-	-	+	+		+											
<i>L. helva</i> Stizenb.	+	-	-	+	+	+													
<i>L. hensenniae</i> Vanska	+	-	-	+	+			+	+										+
<i>L. impudens</i> Degel.	+	-	-		+														+
<i>L. imshaugii</i> Brodo	+	-	-	-	+										+				+
<i>L. perplexa</i> Brodo	+	-	-	+	+														+
<i>L. phaeocardia</i> Vain.	+	-	-	+	+			+											+
<i>L. rugosella</i> Zahlbr.	+	-	-	-	+								+						
<i>L. streimanii</i> Lumbsch	+	-	-	-	+														+
<i>L. subalbellina</i> Vain.	+	-	-	+	+														
<i>L. subimmersa</i> (Fée) Vain.	+	-	-	-	+			+											+
<i>L. subjaponica</i> L. Lü & H. Y. Wang	+	-	-	-	+														+
<i>L. tropica</i> Zahlbr.	+	-	-	-	+			+											+
<i>L. wilsonii</i> Mull Arg.	+	-	-	+	+		+												+

Atr = Atranorin, Chl = Chloroatranorin, Zeo = Zeorin, Usn = Usnic acid, Gan = Gangaleoidin, Meth = 2'-O-methylperlatolic acid, Arth = Arthothelin, Pro = Protocetraric acid, Hyp = Hypoprotocetraric acid, Cap = Caperatic acid, Sec = Secalonic acid, Cho = Chodatol, Deme = Demethylchodatol, Thi = Thiophanic acid

Pradesh show close affinities with the lecanoroid flora of tropical South-East Asian countries (Thailand, Indo-China and Indonesia), Australia, Bhutan, Japan and Nepal and also has some elements common with peninsular India and Sri Lanka (Table 1). The present study will form baseline information for future lichen studies in the state. The lichens being sensitive to microclimatic conditions can be used as biomonitors keeping in view of anthropogenic disturbances in the state.

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