

# THE LICHEN GENUS *PYRENULA* FROM ANDAMAN ISLANDS, INDIA

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## Abstract

Twenty-one species of the genus *Pyrenula* from Andaman Islands are described. Except three, all the species are new records for the lichen flora of these islands. Eight species are new. They are *Pyrenula andamanica*, *P. elegans*, *P. kurzii*, *P. longislandica*, *P. nuda*, *P. oculata*, *P. submastophora* and *P. subrizalensis*.

## Introduction

The lush green tropical forests of Andaman islands, perhaps one of the richest in plant wealth in the world, have been fascinating for botanical studies. The senior author had an opportunity to collect lichens in 1961 from these islands. This paper is based on the investigations of part of this collection, lodged at LWG as well as on Kurz's collection lodged at CAL and H.

Nylander (1873) from the collection of Kurz at H described five species of *Pyrenula* from Andaman Islands, which are *P. aspistea* (Afz.) Ach. (syn. *Verrucaria aspistea* Afz.), *P. mastophora* (Nyl.) Müll. Arg. (Syn. *Verrucaria mastophora* Nyl.), *P. mastophoriza* (Nyl.) Zahlbr. (syn. *Verrucaria mastophoriza* Nyl.), *P. nitida* (Weig.) Ach. (syn. *Verrucaria nitida* Schrad), and *P. subnitidella* (Nyl) Müll Arg. (syn. *Verrucaria subnitidella* Nyl.). The specimen of *P. mastophora*, however, shows characters that are at variance with those of the species it is assigned. It has been designated as the holotype of *Pyrenula oculata* A. Singh & Upreti, a new species. The specimen of *P. nitida* could not be traced out at H. Some unidentified material of this genus collected by kurz has been traced out at CAL. The results of its investigation also are incorporated here.

The paper deals with 21 species of *Pyrenula* from Andaman Islands. Spore types have been employed to classify different species into separate groups, as suggested by Malme (1929). These types are based on the number, shape and orientation of chambers in the spore. Malme (1929) recognized three basic spore types, which within themselves show good deal of variation. It is felt that this system can be enlarged and modified in light of the study of broader based material. While making an attempt in this direction, we have limited ourselves in describing only those spore types (five in number) that we have observed in the included species.

The five spore-types thus encountered in the Andaman material are as follows :

1. *Pyrenula approximans*—type (Text-fig. 23)—It is characterized by lens-shaped or often almost cubical or round middle chambers, and with a more or less longitudinal orientation of apical chambers rendering the spore-apical-wall thin or even causing it to appear as papillate.

*Species represented*—*P. kurzii*.

2. *Pyrenula brunnea*—type (Text-fig. 24)—It has lens-shaped, rarely hemispherical to  $\pm$  spherical spore-chambers and thick wall at both ends.

*Species represented*—*P. mamillana*.

3. *Pyrenula cayennensis*—type (Text-fig. 25)—Spores are strongly oval or almost sphaerical. Middle spore-chambers are strongly lens-shaped, rarely almost spherical and the apical ones are usually much smaller, sphaerical or transversely oriented. Very thin-walled at both ends.

*Species represented*—*P. andamanica*, *P. cayennensis*, *P. mastophoriza*, and *P. lamprocarpa*.

4. *Pyrenula mastophora*-type (Text-fig. 26 a-e)—Spores are oblong-ellipsoid. Middle spore-chambers  $\pm$  rhomboid or somewhat rounded and the apical ones are rhomboid or triangular with the base of the triangle facing the spore-end, or sometimes slightly elongated longitudinally, resulting in thick-walled spore apices.

*Species represented* : *P. albella*, *P. aspistea*, *P. deplanata*, *P. elegans*, *P. gibberosa*, *P. longislantica*, *P. minor*, *P. subaggregata*, *P. submastophora*, *P. subnitida*, *P. subnitidella*, *P. subrizalensis*, and *P. velata*.

5. *Pyrenula subducta*-type (Text-fig. 27)—Spores oblong-ellipsoid. Middle spore-chambers rounded and apical ones  $\pm$  triangular, with their base facing the spore apex (similar to part of *P. mastophora*-type). All the chambers are, nevertheless, somewhat strongly papillate at the side that faces the adjacent chamber or chambers. Spores thick-walled at ends.

*Species represented*—*P. oculata*.

Apart from the spore types, other characters, such as, shape and size of ascocarp, shape of perithecium, presence of columella, reaction of I with nucleus, presence or absence of oil globules in the nucleus and sometimes thalline characters have been employed in the study of different species.

### Key to Species

- |  |                            |
|--|----------------------------|
| 1a. Spores <i>P. subducta</i> -type  | 15. <i>P. oculata</i>      |
| 1b. Spores not <i>P. subducta</i> -type  |                            |
| 2a. Spores <i>P. approximans</i> -type   | 8. <i>P. kurzii</i>        |
| 2b. Spores not <i>P. approximans</i> -type   |                            |
| 3a. Spores <i>P. brunnea</i> -type   | 11. <i>P. mamillana</i>    |
| 3b. Spores not <i>P. brunnea</i> -type   |                            |
| 4a. Spores <i>P. cayennensis</i> -type   |                            |
| 5a. Nucleus I+blue   |                            |
| 6a. Perithecium not spreading, sometimes columellate, nucleus without oil globules | 2. <i>P. andamanica</i>    |
| 6b. Perithecium spreading, eolumellate, nucleus with oil globules                  | 4. <i>P. cayennensis</i>   |
| 5b. Nucleus I—   |                            |
| 7a. Thallus undulate + areolate, white to whitish grey                             | 9. <i>P. lamprocarpa</i>   |
| 7b. Thallus rugose-verrucose, yellow to dark yellow                                | 12. <i>P. mastophoriza</i> |
| 4b. Spores <i>P. mastophora</i> -type  |                            |
| 8a. Ascocarps columellate  |                            |
| 9a. Perithecium broadly spreading, columella                                       |                            |

- sometimes present, nucleus with abundant oil globules
- 9b. Perithecium not spreading, columella always present, nucleus without oil globules
- 8b. Ascocarps eolumellate
- 10a. Spores 20  $\mu\text{m}$  or longer (in *P. longislandica* 19-25  $\mu\text{m}$  long)
- 11a. Ascocarps invariably immersed completely in the thallus
- 11b. Ascocarps emerging when mature
- 12a. Ascocarps not verruca-forming, perithecium spreading laterally
- 12b. Ascocarps verrucae forming, perithecium not spreading laterally
- 10b. Spores less than 20  $\mu\text{m}$  long (in *P. aspistea* 17-22  $\mu\text{m}$  long)
- 13a. Perithecium not spreading
- 14a. Thallus verrucose (verruca not associated with ascocarps)
- 14b. Thallus smooth
- 15a. Ascocarps sometimes single, but generally a few to numerous coalescing without forming stroma (all conditions present in the same specimen)
- 15b. Ascocarps generally single
- 13b. Perithecium spreading
- 16a. Ascocarps naked
- 17a. Spores 17-22  $\mu\text{m}$  long
- 17b. Spores 14-16  $\mu\text{m}$  long
- 16b. Ascocarps covered with corticiform layer of thallus
- 18a. Thallus areolate
- 18b. Thallus not areolate
- 19a. Thallus white
- 19b. Thallus yellow to brownish
- 20a. Ascocarps  $\pm$  flat to slightly coniodepressed or depressed convex
- 20b. Ascocarps distinctly convex to conio-hemispherical
6. *P. elegans*
17. *P. submastophora*
7. *P. gibberosa*
10. *P. longislandica*
18. *P. subnitida*
20. *P. subrizalenis*
16. *P. subaggregata*
19. *P. subnitidella*
3. *P. aspistea*
14. *P. nuda*
13. *P. minor*
1. *P. albella*
5. *P. deplanata*
21. *P. velata*

1. *Pyrenula albella* Müll. Arg., *Flora*, **65** : 400. 1882.

(Plate 1, Fig. 1; Text-figs. 1 & 26)

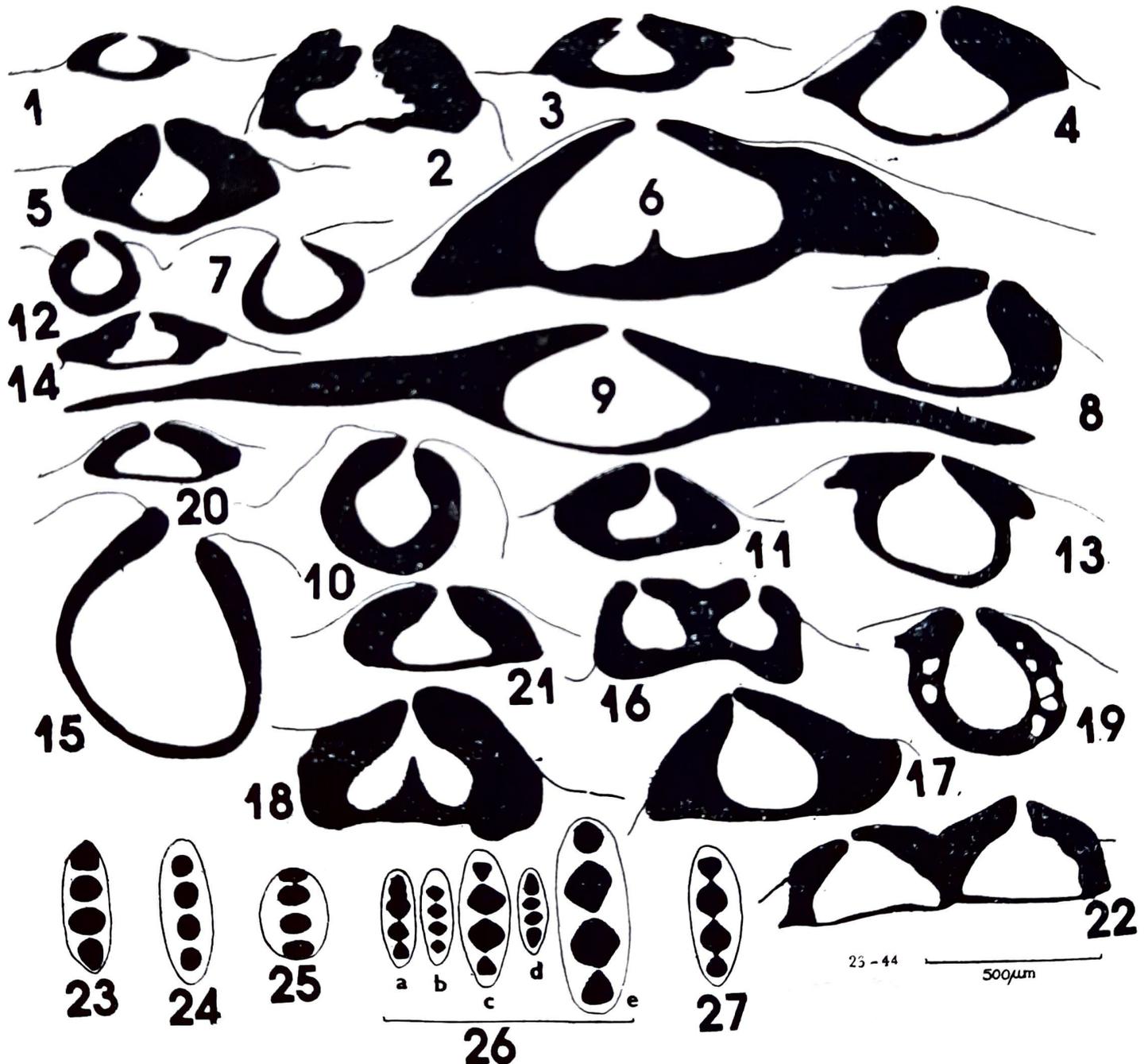
Thallus endophloedal, white, rough, hypothallus indistinct.

Ascocarps solitary, 0.2-0.5 mm in diameter, 100-200  $\mu\text{m}$  high, semi-immersed, depressed convex, covered with corticiform layer of thallus, whitish to dull black, ostioles indistinct; perithecium black and carbonaceous, slightly spreading; nucleus I+vinose

red, without oil globules; paraphysoid threads simple; asci clavate, 8-spored,  $62-65 \times 15-18 \mu\text{m}$ ; spores biseriate in ascus, locules *P. mastophora*-type, oblong-ellipsoid,  $14-17.8-9 \mu\text{m}$ .

*Remarks*—The species is distinguished by white thallus with convex-depressed to conical ascocarps. It is close to *P. glabriuscula* Vainio but the latter has completely immersed ascocarps.

*Specimen examined*—South Andaman Island, Wimberlygunj, on *Hevea brasiliensis* bark, 16.4.1961, Singh 88235 (LWG).



Text-figure 1—23. (Vertical section of ascocarps) : 1. *P. albella*; 2. *P. anadamanica*; 3. *P. aspistea*; 4. *P. cyennensis*; 5. *P. deplanata*; 6. *P. elegans*; 7. *P. gibberosa*; 8. *P. kurzii*; 9. *P. mamillana*; 10. *P. mastophoriza*; 11. *P. minor*; 12. *P. subaggregata*; 13. *P. longislandica*; 14. *P. nuda*; 15. *P. oculata*; 16. *P. subaggregata*; 17. *P. lamprocarpa*; 18. *P. submastophora*; 19. *P. subnitida*; 20. *P. subnitidella*; 21. *P. subrizalensis*; 22. *P. velata*. 23-27 (Spore types; not to scale) : 23. *Pyrenula approximans*-type; 24. *P. brunnea*-type; 25. *P. cayennensis*-type; 26. *P. mastophora*-type; 27. *P. subducata*-type.

2. *P. andamanica* A. Singh & Upreti sp. nov.

Thallus endophloedus. Ascocarpia solitaria vel 2-5 aggregata lineria, 0.6-1.0 mm diam., strata thallina non-algiferata velata, ostiola umbilicata; perithecium fuliginosum, columellatum; asci 8-spori; sporae oblongo-ellipsoidae, *P. cayennensis*-formae, 13-20  $\mu$ m longae, 9-14  $\mu$ m crassae.

*Holotype*—India, South Andaman Island, Mount Harriet, on bark of *Cocos* sp. 25-3-1961, Singh 67683 (LWG). (Plate 1, Fig 2; Text-figs. 2 & 25).

Thallus endophloedal brown to smoke-brown, smooth, hypothallus indistinct.

Ascocarps solitay or 2-5 linearly coalesing, 0.6-1.0 mm in diameter, 300-450  $\mu$ m high, globose, covered with corticiform layer of thallus, with rough to slightly undulate surface, dull black, ostioles prominently umbilicate, whitish; perithecium black and carbonaceous with colourless crystals, globose, not spreading laterally, columella sometimes arising from the base; nucleus I+bluish, without oil globules; pavaphysiod threads simple; asci cylindrical, 8-spored, 80-120  $\times$  12-13  $\mu$ m; spores uniseriately arranged in ascus, locules *P. cayennensis*-type ellipsoid, 13-20  $\times$  9-14  $\mu$ m.

*Remarks*—Similar to *Pyrenula laevigata* (Pers.) Arn. in possession of columella and in *P. cayennensis*-type of spores but the ascocarps in the latter are smaller, measuring 0.3-0.5 mm in diameter.

Known from the type collection only.

3. *P. aspistea* (Afz. ex Ach.) Ach., *Ges. Naturf. Freunde Berlin. Mag.*, 6 : 17, 1814.-*Verrucaria aspistea* Afz. ex Ach. *Method. Lich.* : 121, 1803.

(Plate 1, Fig. 3; Text-figs 3 & 26e).

Thallus endophloedal, buff to yellow-brown, smooth, hypothallus indistinct.

Ascocarps solitary or 2-3 coalesing, 0.2-0.6 mm in diameter, 100-150  $\mu$ m high, convex-conical, naked, black, nitidous, ostioles slightly umbilicate; perithecium black and carbonaceous, conical, slightly spreading laterally, nucleus I-, without oil globules; paraphysoid threads simple; asci clavate, 8-spored, 65-77  $\times$  18-22  $\mu$ m; spores uniseriate in ascus, locules *P. mastophora*-type, oblong-ellipsoid, 17-22  $\times$  9-10  $\mu$ m.

*Remarks*—The species is distinguished by smooth, buff-yellow thallus and with convex-conical, naked, black and nitidous ascocarps. It is similar to *P. velata* Müll Arg. but ascocarps in the latter are covered with corticiform layer of thallus and spores are small (12-16  $\mu$ m long). The specimen of Kurz at H is not traceable.

*Specimens examined*—Middle Andaman group, Lond Island, 27.3.1961, Singh 89449 (LWG); Middle Andaman Island, Parlobjig, 30.3.1961, Singh 79810 (LWG).

4. *P. cayennensis* Müll. Arg., *Flora*, 67 : 662. 1884.

(Plate 1, Fig. 4; Text-figs. 4 & 25).

Thallus endophloedal, yellow-brown to brownish, smooth to rough, hypothallus indistinct.

Ascocarps solitary or 2-3 grouped, 0.3-0.8 mm in diameter, 150-250  $\mu$ m high, convex to somewhat depressed conical, covered with corticiform layer of thallus and black, naked around ostioles, black and nitidous, ostioles plain; perithecium black and carbonaceous, globose, slightly spreading laterally; nucleus I $\pm$ blue, with oil globules, paraphysoid threads simple; asci clavate to cylindrical, 8-spored, 60-80  $\times$  11-15  $\mu$ m; spores uni- or biseriately arranged in ascus, locules *P. cayennensis*-type, ellipsoid to oval, 10-15  $\times$  8-11  $\mu$ m.

*Remarks*—It is similar to *P. velata* in outward appearance but the spores in the former are *P. cayennensis*-type whereas in *P. velata* they are *P. mastophora*-type.

*Specimens examined*—South Andaman Island, Port Blair, on *Mangifera indica* bark, 22.3.1961, Singh 78810/A, 78871, 78822 (LWG), Mount Harriet, 25.3.1961, Singh 67632, 67645/B, 67645/D (LWG), Kurz 4168 (CAL), Middle Andaman group, Long Island, on *Coccos* sp., 4.4.1961, Singh 52970 (LWG).

5. *P. deplanata* Müll. Arg., *Engler Bot. Jb.*, 6 : 411, 1885.

(Plate 1, Fig. 5; Text-figs. 5 & 26d).

Thallus endophloedal, light brown to brown, nitidous, smooth or undulate, hypothallus like a black surrounding line.

Ascocarps solitary or 2-3 aggregated, 0.6-0.8 mm in diameter, 150-250  $\mu\text{m}$  high,  $\pm$  flat to conico-depressed or depressed-convex, covered with corticiform layer of thallus, dull black, ostioles umbilicate, prominent; perithecium black and carbonaceous, slightly spreading laterally; nucleus I-, without oil globules; paraphysoid threads simple; asci clavate, 8-spored, 68-80  $\times$  10-14  $\mu\text{m}$ ; spores uni- or biseriate in ascus, locules *P. mastophora*-type, oblong-ellipsoid, 16-19  $\times$  7-9  $\mu\text{m}$ .

*Remarks*—*P. deplanata* is similar to *P. marginata* (Hepp) Hook., but the ascocarps in the latter are larger (1.7-2.0 mm diameter).

*Specimens examined*—Baratang Island; Nilambur and Jarwa creak, 22.4.1961, Singh 79732 (LWG); Middle Island, Pariobjig, 30.3.1961, Singh 79874 (LWG).

6. *P. elegans* A. Singh & Upreti sp. nov.

Thallus epiphloedus, nitidulus. Ascocarpia solitaria, conica vel depresso-conica, strata thallina non-algifera obducta, perithecium fuliginosum, laterali multo expansum, interdum columellatum; nucleus I-, oleoso-inspersus, asci 8-sporei, cylindrici; sporae *P. mastophora*-formae, 16-22  $\mu\text{m}$  longae, 7-9  $\mu\text{m}$  crassae.

*Holotype*—India; Andaman Islands, Middle Andaman Island, Parlobjig, 30.3.1961, Singh 79816 (LWG).

(Plate 1, Fig. 6 : Text-figs. 6 & 26b).

Thallus epiphloedal, greenish-yellow to golden-yellow, shining, hypothallus indistinct.

Ascocarps solitary, up to 1.0 mm in diameter, 300-500  $\mu\text{m}$  high, conical or conico-depressed, covered with corticiform layer of thallus, dull black, ostioles indistinct, plain, perithecium black & carbonaceous, conico-globose, broadly spreading laterally, sometimes a small slender central columella arising from bottom; nucleus I-, with abundant oil globules; paraphysoid threads simple; asci cylindrical, 8-spored, 90-120  $\times$  10-12  $\mu\text{m}$ ; spores uniseriate in ascus, locules *P. mastophora*-type, oblong-ellipsoid to ellipsoid, 16-22  $\times$  7-9  $\mu\text{m}$ .

*Remarks*—In ascocarp size, *P. elegans* is close to *P. albida* but in the latter they are naked. The spores too are slightly larger (20-22  $\mu\text{m}$  long) in the latter. It also resembles *P. castanca* (Eschw.) Müll. Arg. in ascocarp shape, but they are larger in this species i.e. (0.75 - ) 1-2 (-2.5) mm in diameter, which soon become naked and are commonly umbonate.

Known from the type collection only.

7. *P. gibberosa* Vainio, Cat. Welwitsch Afric. Plants: 454. 1901.

(Plate 1, Fig. 7 ; Text-figs. 7 & 26c).

Thallus endophloedal, greenish to olive green, shining, slightly verrucose (verruca always associated with ascocarps), hypothallus indistinct.

Ascocarps abundant, verruca-forming, one in each verruca, 0.3-0.5 mm in diameter, 200-280  $\mu\text{m}$  high, globose, completely immersed in thalline verruca or a small upper part around ostiole covered with corticiform layer of thallus, and dull black, ostioles distinct, plain, whitish; perithecium black & carbonaceous, with abundant colourless crystals, globose, not spreading laterally; nucleus I-, without oil globules; paraphysoid threads simple; asci clavate, 8-spored, 97-112  $\times$  22-28  $\mu\text{m}$ ; spores biseriate in ascus, locules *P. mastophora*-type, fusiform to oblong-ellipsoid, 23-32  $\times$  9-13  $\mu\text{m}$ .

*Remarks*—It is close to *P. parvula* Müll. Arg. but in the latter the ascocarps are more exposed and the thallus is not verrucose.

*Specimen examined*—Middle Andaman group, Long Island, 4.4.1961, Singh 52983 (LWG).

8. *P. Kurzii* A. Singh & Upreti sp. nov.

Thallus endophloedus, ochraceus, nitidous, verrucolous,  $\pm$  areolatus. Verrucula thallina, 1-6-carpa. Ascocarpia 0.5-1.0 mm diam., immersa, aut parte superiora nuda, nigra et nitida; perithecium fuliginosum, conico-semiglobosum; nucleus I-, oleoso-inspersus; asci 8-sporei; sporae *P. approximans*-formae, oblongo-ellipsoideae vel fusiformae, 35-50  $\mu\text{m}$  longae, 13-18  $\mu\text{m}$  crassae.

*Holotype*—India; South Andaman Island, Mt. Harriat, Kurz 4143 (CAL).

(Plate 1, Fig. 8; Text-figs. 8 & 23).

Thallus endophloedal, yellow-ochre, smooth, verruculose-areolate, hypothallus indistinct.

Ascocarps 0.5-1.0 mm in diameter, 200-400  $\mu\text{m}$  high, conical-semiglobose, completely embedded in verrucae or up to upper one third part naked, black and nitidous, ostioles whitish, slightly umbilicate; perithecium black and carbonaceous, conical-semiglobose, not spreading laterally; nucleus I-, with oil globules; paraphysoid threads simple; asci cylindrical, 8-spored, 190-210  $\times$  20-25  $\mu\text{m}$ ; spores uni- or biseriate in ascus, locules *P. approximans*-type, oblong-ellipsoid, fusiform, 35-50  $\times$  13-18  $\mu\text{m}$ .

*Remarks*—*P. kurzii* resembles *P. approximans* (Krmph.) Müll Arg. in spore type but the latter is characterized by continuous, smooth thallus, semiglobose, naked, dull black, 0.4-0.6 mm diameter ascocarps, nucleus without oil globules and spores 20-26  $\times$  9-11  $\mu\text{m}$  (smaller than those of *P. kurzii*). Another species *P. rizalensis* Vainio shows close similarity to *P. kurzii* in many characters but differs in possession of different types of spores that have smaller cell chambers and thick septa between them. Moreover, the nucleus in *P. rizalensis* is without oil globules.

Known from the type collection only.

9. *P. lamprocarpa* Müll. Arg., Bull. Soc. Bot. Belgique 30 : 94-1891.

(Plate 2, Fig. 17 : Text-figs. 17 & 25).

Thallus endophloedal, white to whitish-grey, undulate,  $\pm$  areolate, hypothallus like black border line.

Ascocarps solitary or 2-3 aggregated, 0.4-0.8 mm in diameter, 200-500  $\mu\text{m}$  high,

hemispherical, covered with corticiform layer of thallus, whitish to dull black, ostioles indistinct, but sometimes indistinctly mamillate; perithecium black and carbonaceous globose; nucleus I-, without oil globules; paraphysoid threads simple; asci cylindrical, 8-spored,  $90-120 \times 11-15 \mu\text{m}$ ; spores uniseriate in ascus, locules *P. cayennensis*-type, oblong-oval,  $14-17 \times 9-10 \mu\text{m}$ .

*Remarks*—*P. lamprocarpa* is similar in all respects to *P. glabrescens* Vainio except that the apical spore-cells are prominently mamillate in the latter. It also resembles *P. albella* Müll. Arg. but in this species ascocarps are smaller and spores are *P. mastophora*-type, other two species, viz. *P. affinis* Malme and *P. finitima* Müll. Arg. showing affinity to *P. lamprocarpa* possess ascocarps that are naked.

*Specimen examined*—South Andaman, Mt. Harriat, Kurz 4157 (CAL).

10. *P. longislandica* A. Singh & Upreti sp. nov.

Thallus endophloedus, evanescent, laevigatus, zona angusta fuscuscentus pro parte limitatus. Ascocarpia solitaria vel 2-3 confluentia, 0.5-1.0 mm diam., immersa vel emergentia, thallina non-algifera obducta aut nuda, perithecium fuliginosum; laterali expansum, asci 8-spore, sporae, *P. mastophora*-formae, 19-25  $\mu\text{m}$  longae, 9-12  $\mu\text{m}$  crassae.

*Holotype*—India, Andaman Islands, Long Island, 27.3.1966, Singh 67697 (LWG). (Plate 2, Fig. 14; Text-figs 13 & 26d).

Thallus endophloedal, evanescent, smooth, with partly surrounding narrow brownish zone.

Ascocarps solitary or 2-3 aggregated, 0.5-1.0 mm diameter, 300-400  $\mu\text{m}$  high, completely immersed in thallus or emerging, the latter ones covered with corticiform layer of thallus or naked, dull black to black & nitidous, ostioles indistinct; perithecium black and carbonaceous, laterally spreading; nucleus I-, without oil globules; paraphysoid threads simple; asci cylindrical to narrowly clavate, 8-spored,  $130-190 \times 16-19 \mu\text{m}$ ; spores uniseriate in ascus, locules *P. mastophora*-type, ellipsoid,  $19-25 \times 9-12 \mu\text{m}$ .

*Remarks*—It is similar to *Pyrenula commixta* Malme but the nucleus of the latter is provided with abundant oil globules. Another species *P. subcremea* Malme resembling *P. longislandia*, has globose perithedium and a nucleus with abundant oil globules.

Known from the type collection only.

11. *P. mamillana* (Ach.) Trevisan, Consp. Verr. : 13.1860-*Verrucaria mamillana* Ach., Method. Lich. : 120-1803.

(Plate 1, Fig. 9 ; Text-figs. 9 & 24).

Thallus endophloedal, buff to yellow-brown, smooth, hypothallus like black surrounding line.

Ascocarps solitary, 1.0-2.5 (3.0) mm in diameter, 300-400  $\mu\text{m}$  high,  $\pm$  flat, convex to conico-depressed, naked, basal portion spreading, covered with corticiform layer of thallus, dull black, ostioles plain to mamillate-papillate; perithecium black & carbonaceous with colourless crystals, conico-depressed, spreading laterally; nucleus I-, with abundant oil globules; paraphysoid threads simple; asci cylindrical, 8-spored,  $100-140 \times 12-14 \mu\text{m}$ ; spores uniseriate in ascus, locules *P. brunnea*-type, oblong-ellipsoid,  $17-20 \times 7-9 \mu\text{m}$ .

*Remarks*—*P. mamillana* is similar to *P. marginata* (Hepp) Hook. but ostioles in the latter are not mammilate-papillate.

*Specimens examined*—South Andaman Island, Mt. Harriat, 25.3.1961, Singh 67645/A (LWG); Port Blair, 20.3.1961, Singh 68998 (LWG); Middle Andaman group. Long Island, 27.3.1961, Singh 89445 (LWG).

12. *P. mastophoriza* (Nyl.) Zahlbr., Catal. lich. Univ. 1 : 439. 1922.-*Verrucaria mastophoriza* Nyl., Bull. Soc. Linn. Normand., Ser. 2, 7 : 180, 1873.

(Plate 1, Fig. 10; Text-figs. 10, 25).

*Lectotype*—Ins. Andaman, 1867, Kurz 65 (H-Nyl) No. 1215.-annotated as *Verrucaria mastophoriza* Nyl.

Thallus endophloedal, yellow to dark yellow, rugose-verruculose, black hypothallus line present.

Ascocarps 0.3-0.6 mm in diameter, 300-500  $\mu\text{m}$  high, globose, completely embedded in thalline verrucae or sometimes area around ostioles naked, black and nitidous, ostioles slightly umbilicate; perithecium black and carbonaceous, globose; nucleus I-, without oil globules; paraphysoid threads simple; asci clavate, 8-spored, 75-110  $\times$  12-14  $\mu\text{m}$ , spores uniseriate or rarely biseriate in ascus, locules *P. cayennensis*-type, oblong-oval, 12-17  $\times$  7-9  $\mu\text{m}$ .

*Remarks*—This species is distinguished by rugose thallus and verrucae-forming, mostly immersed ascocarps and oblong-oval spores. *P. mastophoriza* resembles *P. mastophora* but the basic difference between the two lies in their spore types, which in the former are *P. cayennensis*-type, whereas in the latter they are of *P. mastophora*-type.

Known from the type collection only.

13. *P. minor* Fée, Essi Cryptog. Écoreoffic: 70. 1824.

(Plate 1, Fig. 11; Text-figs. 11, 26d).

Thallus endophloedal, viridi-glaucous, areolate, hypothallus indistinct.

Ascocarps solitary, 0.3-0.4 mm in diameter, 100-150  $\mu\text{m}$  high, hemispherical to globose, covered with corticiform layer of thallus, dull black, ostioles indistinct, plain; perithecium black & carbonaceous, globose, slightly spreading laterally; nucleus I-, without oil globules; paraphysoid threads simple; asci narrowly clavate, 8-spored, 60-90  $\times$  10-12  $\mu\text{m}$ ; spores biseriate in ascus, locules *P. mastophora*-type, ellipsoid, 12-18  $\times$  5-6  $\mu\text{m}$ .

*Remarks*—It is close to *P. aspistea*, but in the latter ascocarps are naked and the thallus is buff to yellow-brown.

*Specimen examined*—South Andaman Island, T. L. D. Range, 14.4.1961, Singh 88225 (LWG).

14. *P. nuda* A. Singh & Upreti sp. nov.

Thallus endophloedus, cinereous, bubalineus vel ochraceous, linea nigra limitatus. Ascocarpia solitaria vel 3-5 aggregata, 0.25-0.6 mm diam, depresso-convexa, nuda, nitida; perithecium fuliginosum, laterali expansum, nucleus I-, haud oleoso-inspersus; asci 8-sporei; sporae fuscae, fusiformae vel oblongo-ellipsoidae, *P. mastophora*-formae, 14-16  $\mu\text{m}$  longae, 5-6  $\mu\text{m}$  crassae.

*Holotype*—India; Middle Andaman Island, Parlobjig, Singh 79810 (LWG).  
(Plate 2, Fig. 13; Text-figs. 14, 26d).

Thallus endophloedal, ash-coloured to buff or ochre, smooth, surrounded by black line.

Ascocarps solitary or 3-5 aggregated, 0.25-0.6 mm in diameter, 100-150  $\mu\text{m}$  high, depressed-convex, naked, black and nitidous, ostioles indistinct; perithecium black & carbonaceous, with crystals, spreading laterally; nucleus I-. without oil globules; paraphysoid threads simple; asci cylindrical, 8-spored 50-70  $\times$  9-12  $\mu\text{m}$ ; spores uni- or biseriate in ascus, locules *P. mastophora*-type, fusiform to oblong-ellipsoid, 14-16  $\times$  5-6  $\mu\text{m}$ .

*Remarks*—*P. nuda* resembles *Pyrenula aspistea* but spores in the latter are larger (17-22  $\mu\text{m}$  long). It also resembles *P. velata* in appearance but the ascocarps in this species are covered with corticiform layer of thallus and the perithecium is not spreading laterally.

*Additional specimen examined*—Same locality as the type. Singh 79875.

15. *P. oculata* A. Singh & Upreti sp. nov.

Thallus epiphloedus, ocharaceus vel flavido-fuscescentus, laevigatus vel sparsa verruculosus, obscurus pseudocyphellatus, verruca thallina monocarpa, oculata. Ascocarpia, ca. 0.5 mm diam., immersa in verruca thallina, parte minuta superiora starta thallina non-algifera obducta, ostioli indistinctis; perithecium fuliginosum, nucleus I-, oleosinpersus, asci clavati, 8-sporei; fuscae, 3-septatae, *Pyrenula subducta*-formae, 27-45  $\mu\text{m}$  longae, 15-18  $\mu\text{m}$  crassae.

*Holotype*—India; Ins. Andaman, (no precise locality), 1867, Kurz 7 (H-Nyl) No. 1212-annotated as *Verrucaria mastophora* Nyl.

(Plate 2, Fig. 15; Text-figs. 15, 27).

Thallus epiphloedal, ochre to yellow-brown, smooth, indistinctly pseudocyphellate, sparsely verruculose, verruca oculata and always associated with ascocarp formation, 1-carpous, hypothallus indistinct.

Ascocarps ca. 0.5 in diameter, 400-650  $\mu\text{m}$  high, globose, completely embedded in thalline verrucae, only a small part around ostiole visible as depressed, blackish,  $\pm$ round area, covered with corticiform layer of thallus, ostioles indistinct; perithecium black & carbonaceous, globose, not spreading laterally; nucleus I-, with oil globules; paraphysoid threads simple; asci clavate, 8-spored, 160-200  $\times$  20-25  $\mu\text{m}$ ; spores uni- or biseriate in ascus, locules *P. subducta*-type, oblong-ellipsoid, 27-45  $\times$  15-18  $\mu\text{m}$ .

*Remarks*—*Pyrenula oculata* differs from *P. mastophora* to which species it was assigned in possessing oculate condition of thalline verrucae and in the spore type. *P. oculata* shows similarity to *P. introducta* in verruculose thallus and in spore type but the verruca in the latter are non-oculate and nucleus is without oil globules. *P. subducta* (Nyl.) Müll Avg. with which species its spores resemble, is characterised by naked ascocarps.

Known from the type collection only.

16. *P. subaggregata* (Nyl.) Müll. Arg., *Engler Bot. Jb.*, 6 : 410. 1885—*Verrucaria aggregata* Nyl. Expos. syn. Pyrenocarp. 44, 1858.

(Plate 2, Figs. 12, 16; Text-figs. 12, 16, 26).

Thallus endo- or epiphloedal, whitish, yellow-ochre, greenish, smooth, hypothallus like a black surrounding line or indistinct.

Ascocarps sometimes solitary but generally a few to numerous aggregated (all condition found in the same specimen), 0.3-0.4 mm in diameter, 100-300  $\mu\text{m}$  high,  $\pm$ globose, immersed or emerging, convex to hemispherical, covered with corticiform layer of thallus or naked, dull black or nitidous, ostioles indistinct plain; perithecium black and carbonaceous, globose, not spreading laterally; nucleus I-, without oil globules; para-

physoid threads simple; asci cylindrical, 8-spored,  $70-95 \times 7-10 \mu\text{m}$ ; spores uni- or biserial in ascus, locules *P. mastophora*-type, oblong-ellipsoid to fusiform,  $14-18 \times 6-10 \mu\text{m}$ .

*Remarks*—It is close to *P. subdissidens* Vainio but the latter has smaller spores measuring  $13-15 \times 5-6 \mu\text{m}$  and also has white thallus. Vainio (1918) instituted *P. subdissidens*, the description of which tallies with *P. subaggregata* and the former may represent the same taxon as the latter, but the merger should await the study the comparison of the relevant types.

*Specimens examined*—South Andaman Island, Port Blair, on *Mangifera indica*, 22.3.1961, Singh 6 988/A, 68992, 78827, 78811 (LWG); Wimberly Gunj, on *Hevea brasiliensis*, 16.4.1961, Singh 88236 (LWG); Middle Andaman Island, Parlobjig, 30.3.1961, Singh 79869 (LWG); Long Island, 27.3.1961, Singh 89402 (LWG).

17. *P. submastophora* A. Singh & Upreti sp. nov.

Thallus endophloedus, ochraceous vel flavido-fuscescentus, areolatus, Ascocarpia solitaria vel 3-6 aggregata, hemispherica vel globosa; perithecium fuliginosum, columellatum; nucleus I-, haud oleoso-inspersus; asci 8-sporei, cylindrici. sporae, *P. mastophora*-formae,  $20-25 \mu\text{m}$  longae,  $8-9 \mu\text{m}$  crassae.

*Holotype*—India; South Andaman Island, Wimberly Gunj, on *Havea brasiliensis*, 14.4.1961, Singh 88246 (LWG).

(Plate 2, Fig. 18; Text-figs. 18 & 26e).

Thallus endophloedal, ochre to yellow-brown, areolate, hypothallus indistinct.

Ascocarps solitary or 3-6 aggregated, 0.8-1.2 mm in diameter,  $400-600 \mu\text{m}$  high, hemispherical to globose, covered with corticiform layer of thallus, dull black, with scattered thalline coloured patches over it, ostioles indistinct, plain; perithecium black & carbonaceous, with crystals, semiglobose, not spreading laterally, a central columella arising from bottom; nucleus I-, without oil globules; paraphysoid threads simple: asci cylindrical, 8-spored,  $100-120 \times 11-13 \mu\text{m}$ ; spores uniseriate in ascus, locules, *P. mastophora*-type, oblong-ellipsoid,  $20-25 \times 8-9 \mu\text{m}$ .

*Remarks*—*P. submastophora* is close to *P. mastophora*, which has  $\pm$  corresponding size of ascocarps and spores but in the latter ascocarps are ecolumellate.

Known from the type collection only.

18. *P. subnitida* (Nyl.) Müll. Arg., *Engler Bot. Jb.*, **6** : 413 1885-*Verrucaria subnitida* Nyl., *Flora*, **59** : 364, 1876.

(Plate 2, Fig. 19; Text-figs. 19 & 26e).

Thallus endophloedal, buff to yellow, smooth, hypothallus indistinct.

Ascocarps solitary, 0.6-1.0 mm in diameter,  $300-600 \mu\text{m}$  high, verruca-forming, hemispherical-globose, immersed to emerging, covered with corticiform layer of thallus or naked, dull black, ostioles indistinct, plain; perithecium black & carbonaceous, with colourless crystals, conico-globose, not spreading laterally; nucleus I-, without oil globules; paraphysoid threads simple; asci cylindrical, 8-spored,  $120-200 \times 16-25 \mu\text{m}$ ; spores mostly uniseriate or sometimes biserial in ascus, locules *P. mastophora*-type, oblong-ellipsoid,  $30-40 \times 10-18 \mu\text{m}$ .

*Remarks*—This species is distinguished by yellow or buff, shining thallus, 0.6-1.0 mm in diameter ascocarps,  $30-40 \times 10-18 \mu\text{m}$  spores. It is close to *P. nitidella* (Flk.) Müll.

Arg. and *P. nitida* (Ach.) Ach. but they have smaller spores, measuring 15-22(-27) × 6-8 (-10)  $\mu\text{m}$ .

*Specimens examined*—South Andaman Island, Southern fringe to Jirkatang range, 7.4.1961, Singh 52995 (LWG); Baratang Island, Between Nilambur and Jarwa Creak, 22.4.1961, Singh 79728 (LWG).

19. *P. subnitidella* (Nyl.) Müll. Arg., *Flora*, 66 : 247, 1883-*Verrucaria subnitidella* Nyl., *Bull. Soc. Linn. Normand. Ser. 2.* 7 : 179. 1873.

*Lectotype*—Ins. Andaman, Kurz 72 (H-Nyl) No. 1292 a & b- annotated as *Verrucaria subnitidella* Nyl.

(Plate 2, Fig. 20; Text-figs. 20 & 26b).

Thallus endophloedal, yellow-ochre, smooth, shining, hypothallus indistinct.

Ascocarps solitary or paired, 0.3-0.5 mm in diameter, 100-200  $\mu\text{m}$  high, convex, covered with corticiform layer of thallus, dull black, ostioles indistinct; perithecium black & carbonaceous, globose, not spreading laterally; nucleus I-, without oil globules; paraphysoid threads simples; asci cylindrical, 8-spored, 50-80 9-14  $\mu\text{m}$ ; spores mostly biserial in ascus, locules *P. mastophora*-type, oblong-ellipsoid, 14-17 × 5-7  $\mu\text{m}$ .

*Remarks*—*P. subnitidella* resembles *P. nitida*, in which ascocarps are commonly or partly embedded in thalline verrucae, whereas those in the former are not verruca forming.

Known from the type collection only.

20. *P. subrizalensis* A. Singh & Upreti sp. nov.

Thallus endophloedus, verruculose. Ascocarpia immersa vel emersa; perithecium fuliginosum; nucleus I-, haud oleoso-inspersus; asci 8-spore; sporae *P. brunnea*-formae, 14-16  $\mu\text{m}$  longae, 5-6  $\mu\text{m}$  crassae.

*Holotype*—India; Andaman Islands, Middle Andaman group, North Passage Island, 28.3.1961, Singh 89469 (LWG).

(Plate 2. Fig. 21; Text-figs. 21 & 26d).

Thallus endophloedal, yellow-brown, verruculose, verruca not associated with ascocarps, hypothallus indistinct.

Ascocarps solitary, or 2-5 aggregated, 0.5-0.8 mm in diameter, 200-350  $\mu\text{m}$  high, convex to conico-hemispherical, immersed in thallus or emerging, covered with corticiform layer of thallus or naked, dull black to black, ostioles indistinct, plain; perithecium black & carbonaceous, hemispherical to globose, not spreading laterally; nucleus I-, without oil globules; paraphysoid threads simple; asci cylindrical, 8-spored, 68-100 × 12-14  $\mu\text{m}$ ; spores uni- or biserial in ascus, locules *P. mastophora*-type, oblong-ellipsoid or fusiform, 14-16 × 5-6  $\mu\text{m}$ .

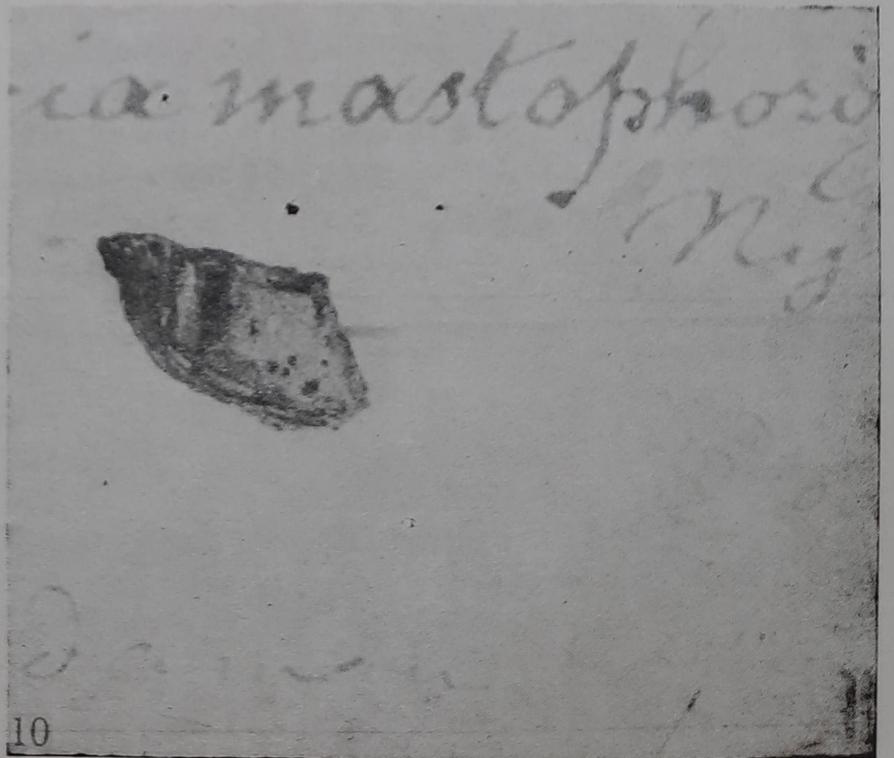
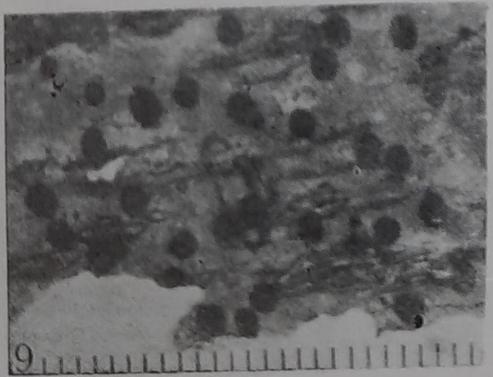
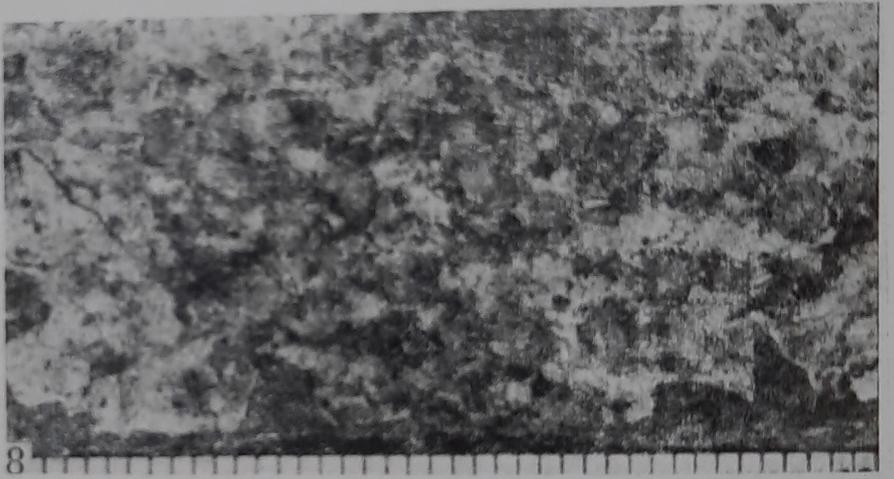
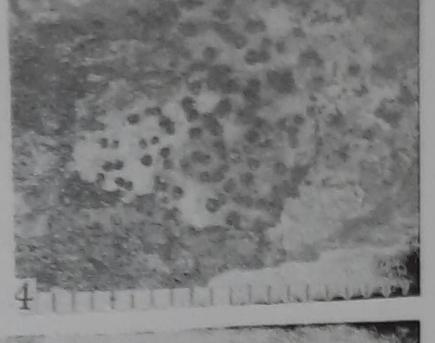
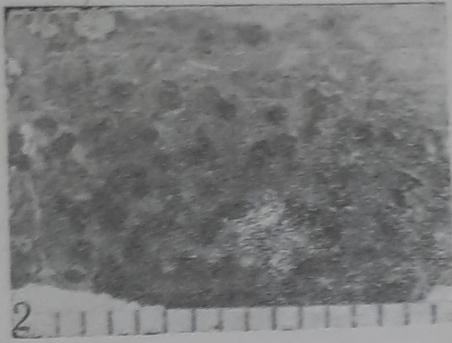
*Remarks*—*P. subrizalensis* is similar to *P. rizalensis* Vainio in verruculose condition of thallus and shape of ascocarps but the spores in the latter are much larger, measuring 30-40 × 14-15  $\mu\text{m}$ .

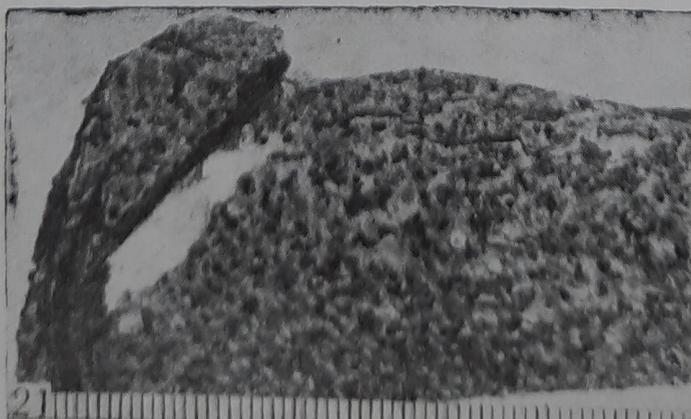
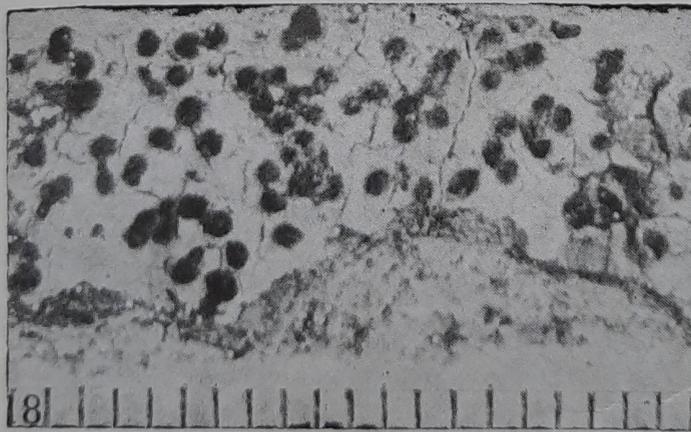
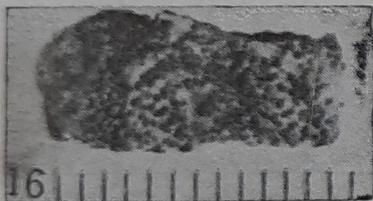
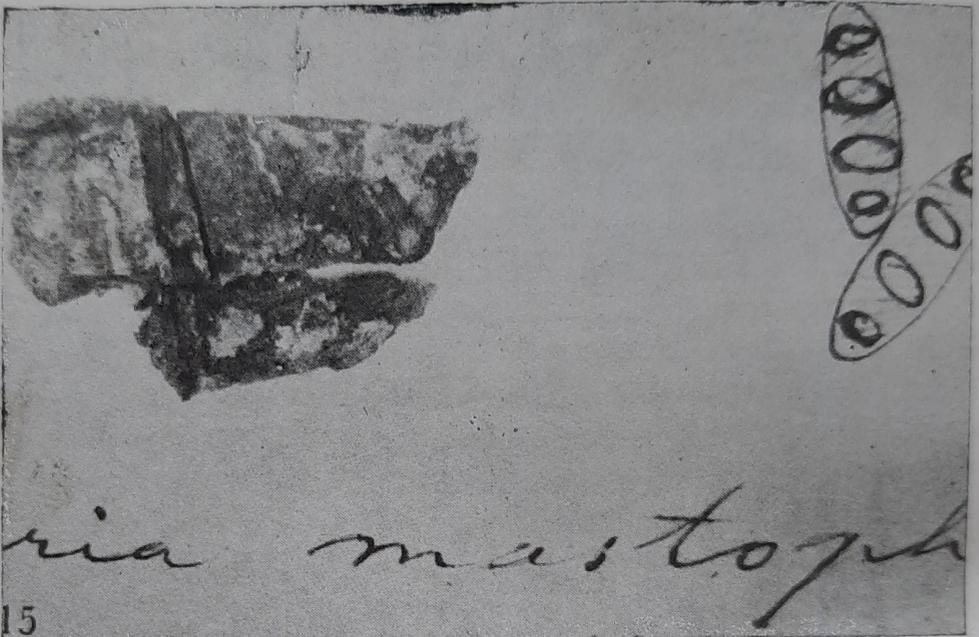
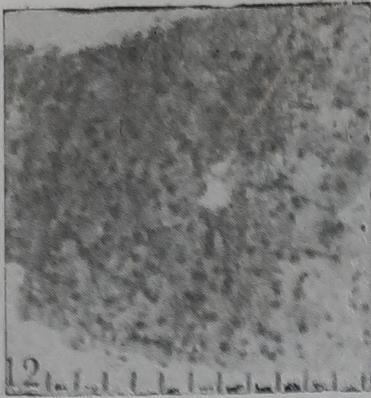
Known from the type collection only.

21. *P. velata* Müll. Arg. *Flora*, 67 : 661. 1884.

(Plate 2, Fig. 22; Text-figs. 22 & 26a,d)

Thallus endophloedal, yellow to yellow-brown, rough, hypothallus indistinct.





Ascomycetes solitary or 3-5 aggregated, 0.35-0.5 mm in diameter, 200-300  $\mu\text{m}$  high, naked, depressed-conico-hemispherical, covered with corticiform layer of thallus, dull black, ostioles indistinct, plain; perithecium black & carbonaceous, globose, slightly spreading laterally; nucleus I-, without oil globules; paraphysoid threads simple; asci cylindrical, 40-110  $\times$  8-17  $\mu\text{m}$ ; spores uni- or biseriate in ascus, locules *P. mastophora*-type, 12-22  $\times$  4-10  $\mu\text{m}$ .

*Remarks*—The taxon is characterized by the presence of 12-22  $\times$  4-10  $\mu\text{m}$  sized spores. It is close to *P. brunnea* Fée but the latter has *P. brunnea*-type of spores.

*Specimens examined*—Middle Andaman, Parlobjig, 31.3.1961, Singh 79897 (LWG); Bajalungta, 1.4.1961, Singh 52946 (LWG); Long Island, 27.3.1961, Singh 89444 (LWG).

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### Explanation of Plates

#### PLATE 1

1-11. (Habit : Scale 1 division = 1.0 mm) : 1. *Pyrenula albella*; 2. *P. andamanica*; 3. *P. aspistea*; 4. *P. cayennensis*; 5. *P. deplanata*; 6. *P. elegans*; 7. *P. gibberosa*; 8. *P. kurzii*; 9. *P. mamillana*; 10. *P. mastophora*.

#### PLATE 2

11-22 (Habit 1 division = 1.0 mm)

11. *P. minor*, 12. *P. subaggregata*; 13. *P. nuda*; 14. *P. longislandica*; 15. *P. oculata*; 16. *P. subaggregata*; 17. *P. lamprocarpa*, 18. *P. submastophora*; 19. *P. subnitida*; 20. *P. subnitidella*; 21. *P. subrizalensis*; 22. *P. velata*.