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# The lichen genus *Endocarpon* from India

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&

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## RÉSUMÉ

SINGH, A. & D. K. UPRETI (1984). *Endocarpon*, genre lichénique des Indes. *Candollea* 39: 539-548. En anglais, résumé français.

Cet article est une contribution écologique et taxonomique à propos de six espèces d'*Endocarpon*, soient: *E. nanum*, *E. nigro-zonatum*, *E. pallidum*, *E. pusillum*, *E. rosettum* et *E. subrosettum*, présents en Inde. Seul *E. pusillum*, une espèce courante et répandue a été signalée précédemment dans le sub-continent indien. *E. pallidum* est une espèce tempérée nouvelle pour la flore lichénique de l'Inde, tandis que les autres sont des espèces nouvelles.

## ABSTRACT

SINGH, A. & D. K. UPRETI (1984). The lichen genus *Endocarpon* from India. *Candollea* 39: 539-548. In English, French abstract.

The paper presents the ecological and taxonomic account of six species of *Endocarpon*, viz., *E. nanum*, *E. nigro-zonatum*, *E. pallidum*, *E. pusillum*, *E. rosettum* and *E. subrosettum*, represented in India. Only *E. pusillum*, a common and widespread species has earlier been reported from the Indian subcontinent. *E. pallidum*, a temperate species is new record for the Indian lichen flora, and the rest are new species.

## Introduction

It is strange to note that only one species, out of about seventy, comprising genus *Endocarpon* is known to occur in the Indian subcontinent. *Endocarpon pusillum* (Anzi) Hedw., an ubiquitous species has been reported by SMITH (1931) and CHOPRA (1934) from Gujranwala, Pakistan, by BHATIA (1957) from Plains of Punjab and Himalayan tracts on hard soil over lime plaster, by PATWARDHAN & al. (1977) from Purander Fort, South-Western India, and by SINGH & SETHI (1978) from Delhi. Poor reporting (not necessarily poor representation) of the genus from this vast region may be attributed to the much less attention paid to the exploration of microlichens in India than it deserves. Moreover, the collection of material of this genus is rendered difficult due to various factors discussed later in this work.

The paper deals with the ecology and collection aspect of *Endocarpon* as well as taxonomic account of its six species from India.

## Ecology

The ever increasing demand on land for cultivation and habitation by the continuous growth of human population since time immemorial has gradually converted the once heavily forested and moist region of the extensive North Indian Plain into a semi-arid zone. This region, where most of the *Endocarpon* population seems to thrive, stands ± devoid of all the original forest

cover and its climate is characterized by high temperature during the major part of the year and insufficient amount of rainfall, restricted to the limited period of three months, called the rainy season. Under such climatic conditions the alkaline lime and cement plaster (pH value 7.85-9.4) of walls and roofs of buildings erected by human beings for various purposes provide suitable substratum for the taxa of *Endocarpon*. This calcareous substratum, that is exposed to scorching summer sun and hot, dry westerly winds creating dessicating conditions is unsuitable for the growth of most of the plants. It, however, invites the lime-loving cryptogamic plant community, that comprises a few blue-green algae, e.g., *Chroococcus*, *Gloeocapsa*, *Scytonema*, etc., a green alga, *Pleurococcus* sp., some fungal mycelia, several lichen taxa belonging to genera *Endocarpon*, *Arthopyrenia*, *Peltula*, *Bacidia* and family Pyrenopsidaceae, a few mosses, such as, species of *Physcomitrium* and *Physcomitriolopsis*. Sometimes a fern, *Actiniopteris* and many species of angiosperms colonise this substratum, especially in the uncared for or abandoned buildings. These plants secure a foothold in cracks and crevices developed in the substratum as time passes (BALAPURE & SRIVASTAVA, 1964). This angiospermic plant community may, in real sense, not be called as lime-loving one, as most of its species thrive equally well or even better on other substrata.

The thallophytic and bryophytic plant species growing on this substratum seem to enjoy only a short period of active life, starting with the first shower of rainy season and generally terminating at the advent of the following dry season. The mosses dry up but as soon as these seemingly dead plants receive moisture, revive themselves and attain bright green colour. The same seems true for the algal species. In case of *Endocarpon*, the squamules of the thallus assume their natural colour and size after absorbing water. In this condition only, the lichen patches pertaining to this genus are quite discernible and can be collected. The thallus dries up when the rainy season is over. Intermittent prolonged dry spells during rainy season revert the thallus into dry state. The thallus, generally grey to brown or blackish in colour, then gets totally merged with the substratum or with the surrounding dry cryptogamic vegetation. Occasional rains outside the rainy season and the night dew and fog during winters are the main source of moisture that tides over the lean period. Although, this reduced quantum of moisture seems sufficient for the subsistence of the lichen, yet is not enough to reveal the presence of the thallus on the substratum. The lichen thus remains undetected by the observer.

It is interesting to note that patches of *Endocarpon*, and also of *Arthopyrenia*, *Peltula*, and *Bacidia* grow invariably on the upper horizontal face of cornices, parapet or boundary walls or on the terraces. This may be for the reason that the horizontal face of buildings receives direct sunlight, and moisture from the atmosphere. Other cryptogams, such as, taxa of Pyrenopsidaceae, algae, mosses, etc., thrive well on the vertical face also.

Another factor important for the growth of lichens in general is the amount of pollution in the atmosphere, which has come to be known as the deciding element in controlling the lichen vegetation of an area. Its increased quantum is responsible for creating unfavourable conditions for lichen growth, resulting in decreased or unhealthy-looking lichen vegetation. In urban areas the mushroom growth of industrial complexes, coupled with excessive automobile transport activity has adversely affected the growth of lichens, especially in and around large cities. Observations made in this regard at Lucknow may be illustrative for all other cities in dry areas of India. The city of Lucknow, that could boast of a lichen flora consisting of a moderate number of species about twenty years ago, stands now devoid of almost all of its corticolous species. Large scale felling of trees for the purpose of developing new colonies and for widening of roads is another factor contributing its fair share for this loss. The lichen species thriving on lime or cement plaster of walls and roofs of buildings have, on the other hand, not only remained unaffected by atmospheric pollution and change of climatic conditions of the city but have shown marked tendency for an increase in their population. It is because of the invasion by these lichens on the largely increased substratum area provided by continuous building activity. This anomaly can be explained in the light of the observations of LEBLANC & RAO (1973), who have shown the significance of substratum on the metabolism of lichens. They mention that lichens growing on alkaline substrate are protected from the ill effect of acidic gases that form considerable part of pollutants of the atmosphere. In this regard, they (LEBLANC & RAO, 1973) state, "...such a substrate in SO<sub>2</sub> polluted environment may represent a special niche which though physically exposed to pollution, possess an in-built chemical protection from it".

### Collection

The lichens, in general, are perennial plants and remain fruiting throughout the year. The collector, for this reason, avoids venturing collection during inconvenient rainy season. The *Endocarpon* species thus escape observation and remain largely uncollected. In addition, the collection of species of this genus is further rendered difficult as no house owner agrees to remove a chunk of plaster from walls of his building as these lichens can only be collected along with the substratum. From historical monuments, that are most favourable habitats for the taxa of *Endocarpon*, the question of collection hardly arises as they are protected buildings.

These lichens, though finding favour from the urban climatic conditions, are sometimes in danger of loss of some rare or uncommon taxa. Scrapping and white washing of walls cause their removal from the substratum. Demolition of old structures is another cause for their loss, as had been in case of *Endocarpon nigro-zonatum*. This species, described as new in this paper was collected on two different dates from the littered broken pieces of lime plaster from the boundary wall of a local hotel at the time of its demolition. With this wall, the taxon also seems to have been lost as it could not subsequently be collected even from any of the nearby buildings.

### Taxonomic account

**Endocarpon** Hedw., Descript. et Adumbr. Muscor. Frond., 2: 56. 1789.

Thallus minutely foliose, squamulose or occasionally almost crustose, both sides or only upper side paraplectenchymatously corticate, phycobiont layer consisting of compactly arranged mycobiont as well as phycobiont (green alga) components, medulla consisting of lax hyphae. Perithecia generally immersed, ostioles indistinct to prominent, like a protuberance, excipuloid tissue paraplectenchymatous, blackish, perithecial cavity with hymenial phycobiont, in its upper part and at ostiole lined with dense, simple periphyses, paraphyses gelatinized, asci 1-6-spored (only 2-spored in all the species described here), spores brown, multi-celled muriform.

### Key to the Indian species

1. Thallus squamulose, mature squamules up to 1.0 mm across, not rosette-forming, 1-2-carpous.....	2
1a. Thallus squamulose to subfoliose, mature squamules 2.0-7.0 mm across, ± rosette-forming, sometimes lobulate, multicarpous .....	5
2. Under side pale .....	1. <b>E. nanum</b>
2a. Under side black .....	3
3. Thallus with a distinct narrow to broad zone of black hypothallus	2. <b>E. nigro-zonatum</b>
3a. Thallus without hypothallus .....	4
4. Squamules loosely attached to substratum, imbricate, ascending .....	3. <b>E. pallidum</b>
4a. Squamules closely adnate to substratum, not imbricate or ascending.	4. <b>E. pusillum</b>
5. Squamule under side pale, 1-30-carpous, up to 7.0 mm across .....	5. <b>E. rosettum</b>
5a. Squamule under side black, 1-6-(15)-carpous, up to 2.5 mm across	6. <b>E. subrosettum</b>

#### 1. **E. nanum** A. Singh & Upreti, spec. nova

Thallus squamulosus, squama dispersa, adnata, parva, 0.2-0.7 mm diam., rotundata vel interdum irregularia ambita, plana vel leviter concava, fulva, subitus fulvus, 1-carpa; perithecia immersa, ostiola prominentia, crassa-nigra-marginata; asci 2-spori; sporae fuscae, oblongo-ellipsoidae, leviter constrictae ad medium, murali divisae, cellulis in 9-11 serie transversalis dispositis, 33-42  $\mu$ m longae, 13-20  $\mu$ m crassae.

**Holotype:** India; U.P., Lucknow, on lime plaster of wall, 4th August, 1963, *Singh* 97597 (LWG) (Figs. 1 and 7).

Thallus squamulose, up to 2.0 cm across, hypothallus indistinct; squamules scattered, 0.2-0.7 mm across, 100-200  $\mu\text{m}$  thick, adnate, round to irregular in outline, plain to slightly concave, yellowish-brown when dry, greenish-grey to brownish when wet, K-, C-, KC-, P-, margin entire to sometimes crenate, under side whitish to yellowish-brown; upper cortex 3-6 cells thick, 25-45  $\mu\text{m}$ ; phycobiont layer 50-80  $\mu\text{m}$  thick, algal cells 5-8  $\mu\text{m}$  in diameter; medulla 25-30  $\mu\text{m}$  thick; lower cortex 2-4 cells thick, 20-30  $\mu\text{m}$ .

Perithecia 1 per squamule, immersed, globose, up to 0.25 mm in diameter, only ostiole protruding out as a prominent black-rimmed opening; excipuloid tissue 4-6 cell-layered, 25-50  $\mu\text{m}$  thick; perithecial cavity 100-200  $\mu\text{m}$  high, 150-200  $\mu\text{m}$  broad; nucleus I + blue; hymenial alga spherical, 2-4  $\mu\text{m}$  in diameter; asci clavate, 2-spored, 50-90  $\times$  15-22  $\mu\text{m}$ ; spores brown, oblong-ellipsoid, slightly constricted in the middle, multi-celled muriform, cells arranged in 9-11 transverse tiers, with 3-5 cells in each, 33-42  $\times$  13-20  $\mu\text{m}$ .

**Remarks.** — *Endocarpon nanum* is characterized by the thallus consisting of scattered, adnate, 1-carpous, by and large small squamules with pale under side and  $\pm$  thick black-rimmed ostioles protruding out prominently from the thalline surface. The specific epithet is attributed to the generally small-sized squamules.

This taxon resembles *Endocarpon tenellum*, *E. sorediatum* and *E. johnstonii* in general appearance, but *E. tenellum* has black under side, *E. sorediatum* has sorediate thallus and in *E. johnstonii* the squamules are imbricate and spores hyaline.

Additional specimens examined: M.P., Satna district, Raigaon, on lime plaster of wall, July, 1983, *Singh* s.n. (LWG); U.P., Lucknow district, Lucknow, on lime plaster of wall, 10th November, 1960, *Singh* 74655 (LWG), 4th August, 1963, *Singh* 79598 (LWG), Malishabad, on lime plaster of wall, *Singh* s.n. (LWG).

## 2. *E. nigro-zonatum* A. Singh & Upreti, spec. nova

Thallus squamulosus, areolatus, hypothallus nigrus; squama adnata, rotundata, polygamia vel irregularia ambita, plana vell interdum leviter concava, fusca, subtus nigra, 1(-2)-carpa; perithecia immersa sed area circa ostiola emergenta, convexa et nigra, ostiola pallida vel indistincta; asci 2-spori; sporae murali-divisae, fuscae, oblongo-ellipsoideae, haud constrictae ad medium, cellulis in 8-12 serie transversalis dispositis, 28-42  $\mu\text{m}$  longae, 14-20  $\mu\text{m}$  crassae.

**Holotype:** India; U.P., Lucknow, on lime plaster of boundary wall (now demolished) of Carlton Hotel, 10th November, 1960, *Singh* 74603 (LWG) (Figs. 2, 8 and 9).

Thallus squamulose, round to irregular in outline, up to 3.0 mm across, with a black hypothallus extending beyond the squamulose area as a narrow to a broad zone; squamules scattered (in young lichen patches) or grouped together, forming  $\pm$  continuous areolate crustose patches, up to 1.0 mm across, 110-117  $\mu\text{m}$  thick, roundish, polygonal or irregular in outline with crenate margin, plain to slightly concave, but the fertile ones slightly convex, dark brown when dry, light brown when wet, with darker brown to blackish narrow marginal zone, K-, C-, KC-, P-, under side black; upper cortex 4-6 cells thick, 20-40  $\mu\text{m}$ ; phycobiont layer 35-50  $\mu\text{m}$  thick, algal cells 5-10  $\mu\text{m}$  in diameter; medulla 15-30  $\mu\text{m}$  thick; lower cortex 2-4 cells thick, 17-20  $\mu\text{m}$ , dark coloured in its lower part.

Perithecia 1(-2) per squamule, immersed, globose to somewhat depressed, up to 0.25 mm in diameter, generally a small black area around ostiole emerging like a prominent protuberance, ostioles like pale dots or indistinct; excipuloid tissue 4-6 cell-layered, 10-13  $\mu\text{m}$  thick; perithecial cavity 100-150  $\mu\text{m}$  high, 130-200  $\mu\text{m}$  broad; nucleus I-; hymenial alga spherical, 2-4  $\mu\text{m}$  in diameter; asci clavate, 2-spored, 50-60  $\times$  12-15  $\mu\text{m}$ ; spores brown, oblong-ellipsoid, not constricted in the middle, multi-celled muriform, cells arranged in 8-12 transverse tiers, with 3-5 cells in each, 28-42  $\times$  14-20  $\mu\text{m}$ .

**Remarks.** — *Endocarpon nigro-zonatum* is characterized by areolate, squamulose thallus with prominent black hypothallus expanding beyond the thalline crust (specific epithet attributed to this character), and squamules with polygonal to irregular outline, 1(-2) carpos condition and black under side.

This species resembles *Endocarpon pusillum*, but the thallus of the latter is devoid of any visible hypothallus.

Additional specimens examined: same locality as that of the type, 4th December, 1960, *Singh 74621* pro parte (LWG).

**3. E. pallidum** Ach., Lich. Univ., p. 301. 1810 (Figs. 3 and 10).

Thallus squamulose, irregular in outline, up to 7.0 cm across; squamules scattered or crowded or imbricate or overlapping or forming  $\pm$  terraced crust, loosely attached to substratum, up to 1.0 mm across, 70-140  $\mu\text{m}$  thick, roundish, linear or irregular in outline, plain to slightly concave, brownish-grey to yellowish-brown when dry, greenish-grey to greenish-brown when wet, K-, C-, KC-, P-, margin entire to crenate, sometimes ascending, under side black; upper cortex 3-5 cells thick, 30-42  $\mu\text{m}$ , phycobiont layer 40-60  $\mu\text{m}$  thick, algal cells 5-9  $\mu\text{m}$  in diameter, medulla 30-55  $\mu\text{m}$  thick, lower cortex 2-4 cells thick, 10-20  $\mu\text{m}$ .

Perithecia 1-5 per squamule, globose, up to 0.25 mm in diameter, immersed, ostioles somewhat papillate; excipuloid tissue 6-8 cell-layered, 20-50  $\mu\text{m}$  thick; perithecial cavity 100-300  $\mu\text{m}$  high, 190-285  $\mu\text{m}$  broad; nucleus I-; hymenial alga spherical, 2-4  $\mu\text{m}$  in diameter; asci clavate, 2-spored, 70-100  $\times$  15-17  $\mu\text{m}$ ; spores brown, oblong-ellipsoid, not constricted in the middle, multi-celled muriform, cells arranged in 8-14 transverse tiers, with 2-3 cells in each, 38-57  $\times$  18-25  $\mu\text{m}$ .

*Remarks.* — *Endocarpon pallidum* is recognized by imbricate, loosely attached squamules that may be overlapping or ascending and are with black under side.

This species is close to *Endocarpon petrolepidum*, but the latter has thickish, lobulatae squamules and I + reaction of the nucleus. *E. pallidum* is distributed in temperate regions of the world and is a new record for the Indian flora.

Specimens examined: India; U.P., Rae Bareli district, Pithan, on lime plaster of old wall, 19th July, 1963, *Singh 97569, 97570, 97571* (LWG); 4th August, 1963, *Singh 97572, 97581* (LWG); on brick, 17th September 1963, *Singh 97599* (LWG).

**4. E. pusillum** Hedw., Descript. et Adumbr. Muscor. Frond., 2: 56. 1789 (Figs. 4 and 11).

Thallus squamulose, irregular in outline, up to 3.0 cm across; squamules scattered or sometimes crowded and forming crust, closely adnate to substratum, up to 1.0 mm across, 80-140  $\mu\text{m}$  thick, round to irregular in outline, plain to slightly concave, fertile ones convex, brownish to olive green, K-, C-, KC-, P-, margin entire to crenate, slightly raised, lower side black; upper cortex 3-6 cells thick, 10-35  $\mu\text{m}$ ; phycobiont layer 30-60  $\mu\text{m}$  thick, algal cells 5-7  $\mu\text{m}$  in diameter; medulla 15-30  $\mu\text{m}$  thick; lower cortex 2-4 cells thick, 10-25  $\mu\text{m}$ , blackish in its lower part.

Perithecia 1-2 per squamule, globose, up to 0.25 mm in diameter, immersed, but generally a small black area around ostiole emerging like a  $\pm$  prominent protuberance, ostioles pale dot-like or indistinct; excipuloid tissue 3-6 celled, 10-30  $\mu\text{m}$  thick; perithecial cavity 150-200  $\mu\text{m}$  high, 200-300  $\mu\text{m}$  broad; nucleus I-; hymenial alga spherical, 2-4  $\mu\text{m}$  in diameter; asci clavate, 2-spored, 50-60  $\times$  14-18  $\mu\text{m}$ ; spores brown, oblong-ellipsoid, not constricted in the middle, multi-celled muriform, cells arranged in 7-10 transverse tiers, with 3-5 cells in each, 29-45  $\times$  12-20  $\mu\text{m}$ .

*Remarks.* — *Endocarpon pusillum* is a common species throughout India and is distinguished by the presence of scattered to crowded, closely adnate, 1-2-carpous squamules.

This species is similar to *Endocarpon pallidum*, but the thallus in the latter is represented by the aggregation of squamules that are loosely attached to the substratum and are imbricate, ascending and sometimes overlapping.

Specimens examined: India; U.P., Lucknow district, Lucknow, on lime plaster of old wall, 4th August, 1963, *Saxena 97597* (LWG); 20th October, 1963, *Singh 97604, 97606* (LWG); on brick, 25th August, 1961, *Singh 74606* pr. p. (LWG); Malihabad, on lime plaster of old wall, 17th August, 1961, *Singh 74605* (LWG); Rae Bareli district, Pithan, on lime plaster of old wall, 19th July, 1963, *Singh 74654*, 17th September, 1963, *Singh 97596* (LWG).

**5. E. rosettum** A. Singh & Upreti, spec. nova

Thallus squamulosus, squama subfoliosa, aggregata, interdum imbricata, lax apta, rosettea ambita, margo lobulata, subitus pallidus, multicarpa; perithecia immersa, ostiola plana; asci

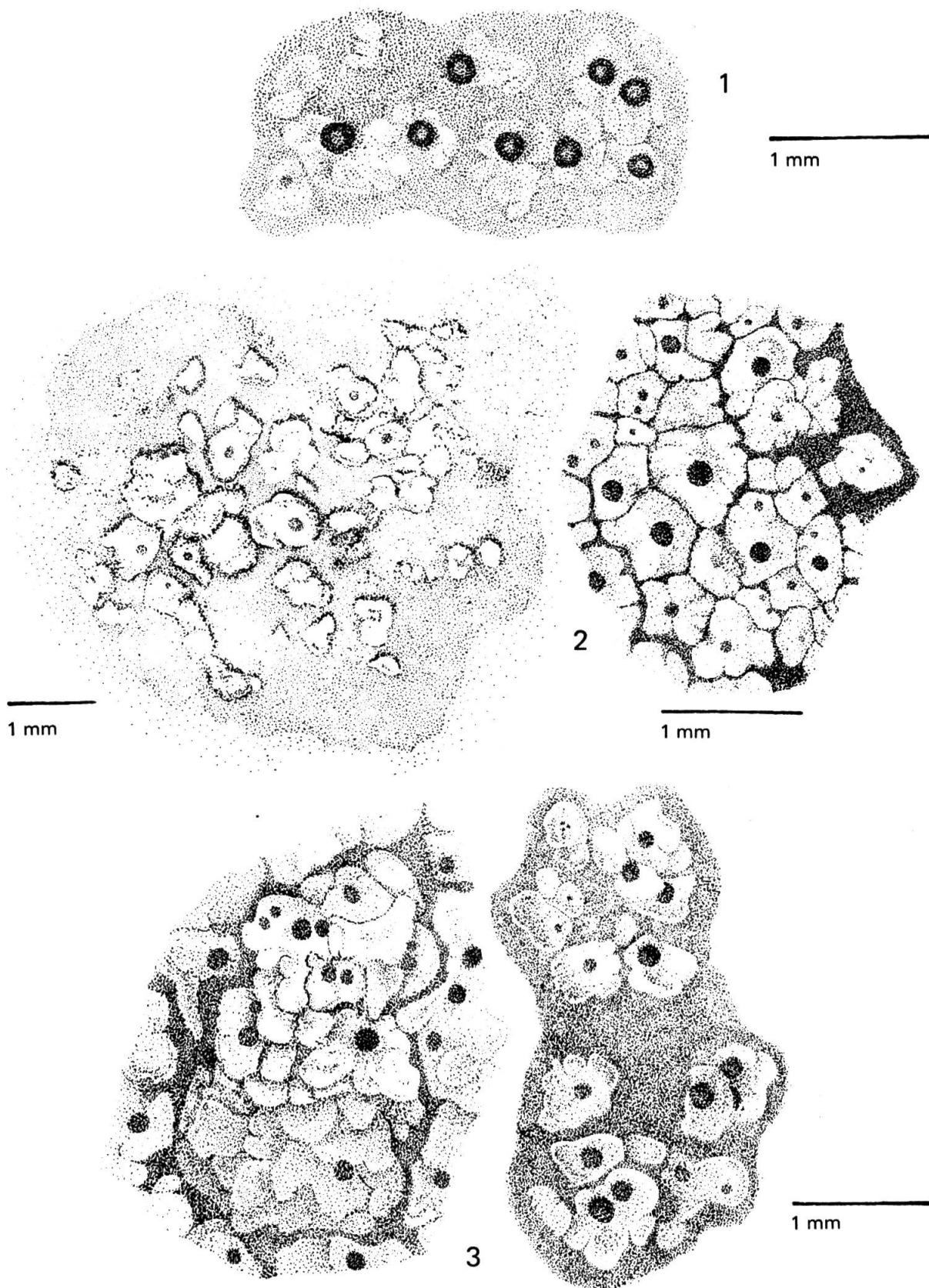


Fig. 1. — *Endocarpon nanum* (habit).

Fig. 2. — *E. nigro-zonatum* (habit).

Fig. 3. — *E. pallidum* (habit).

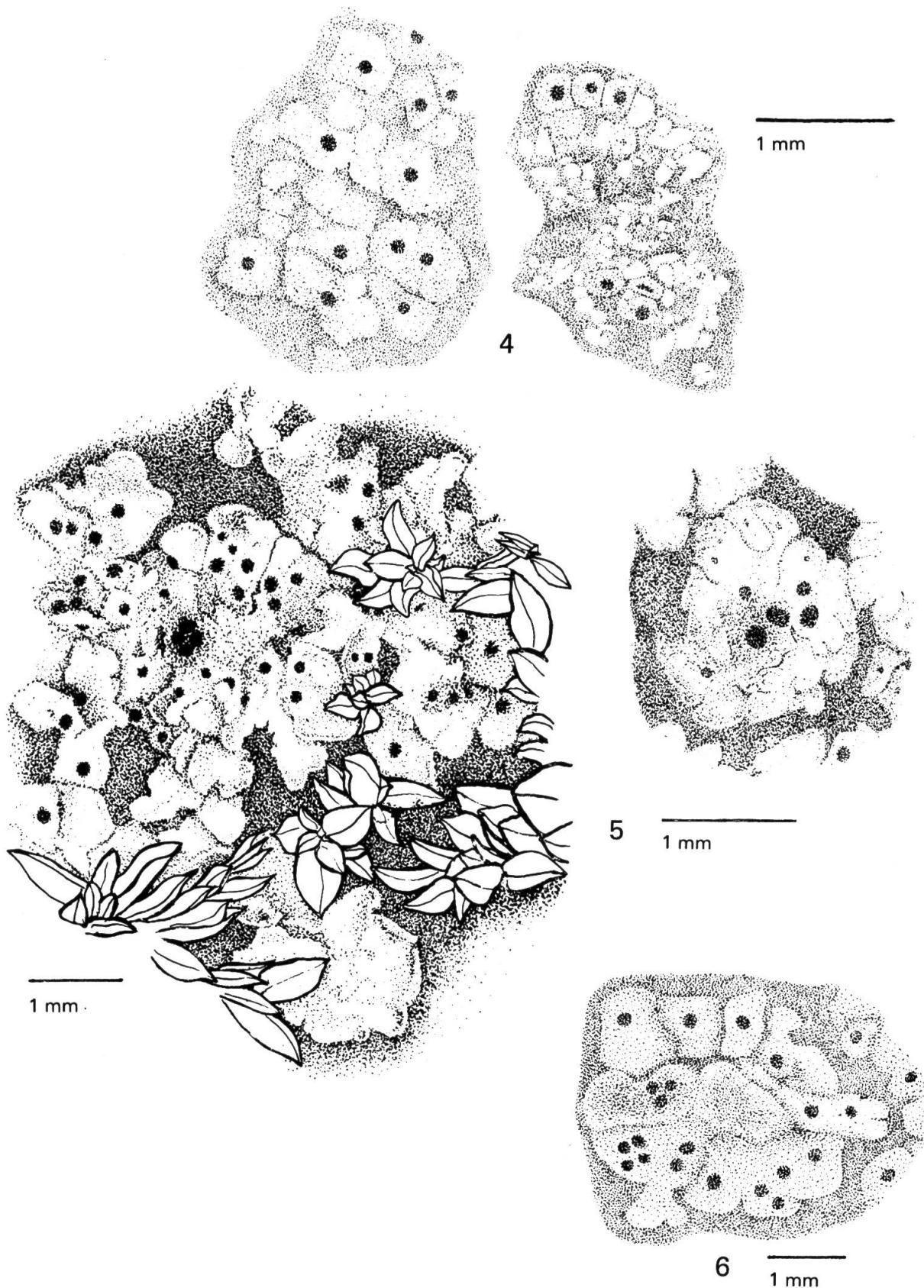
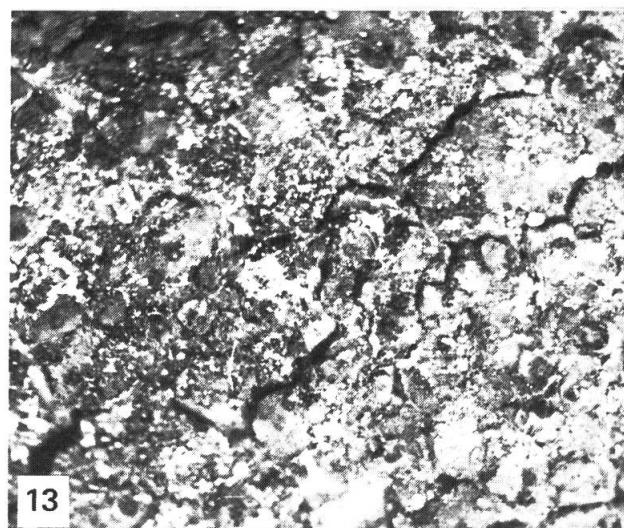
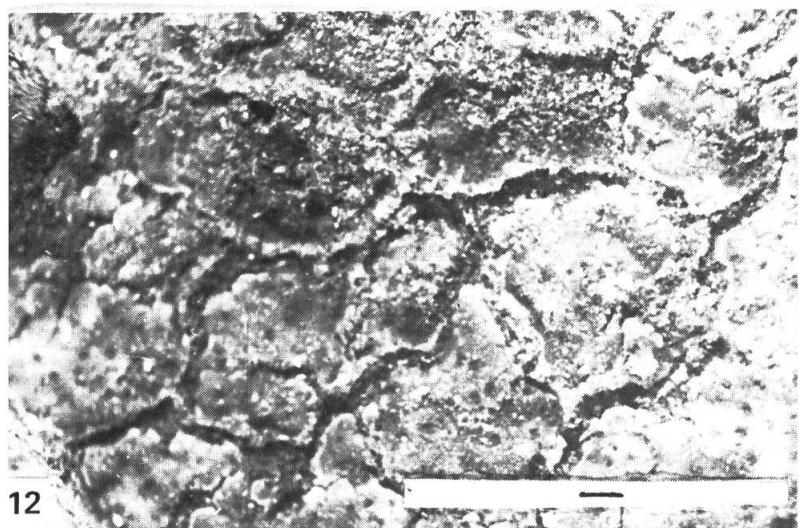
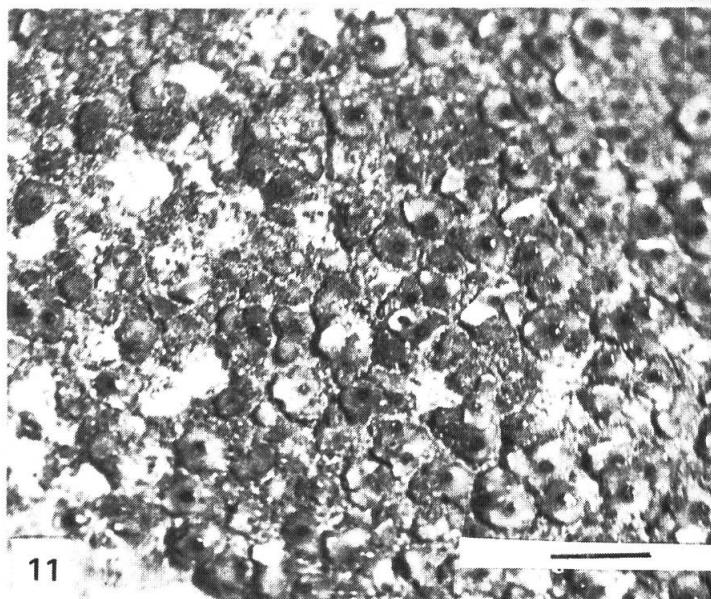
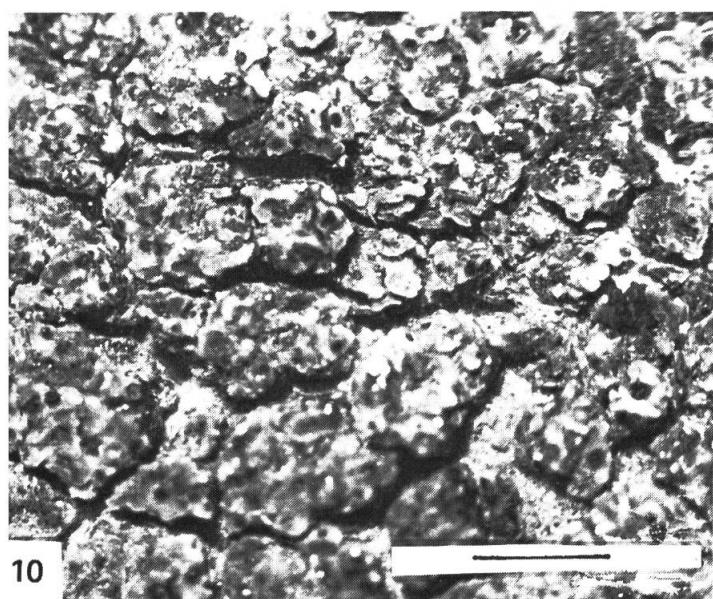
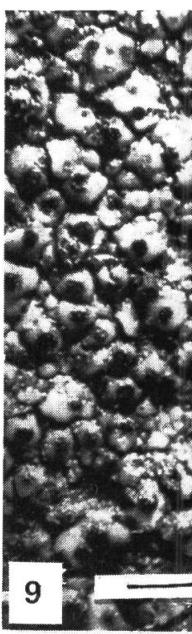
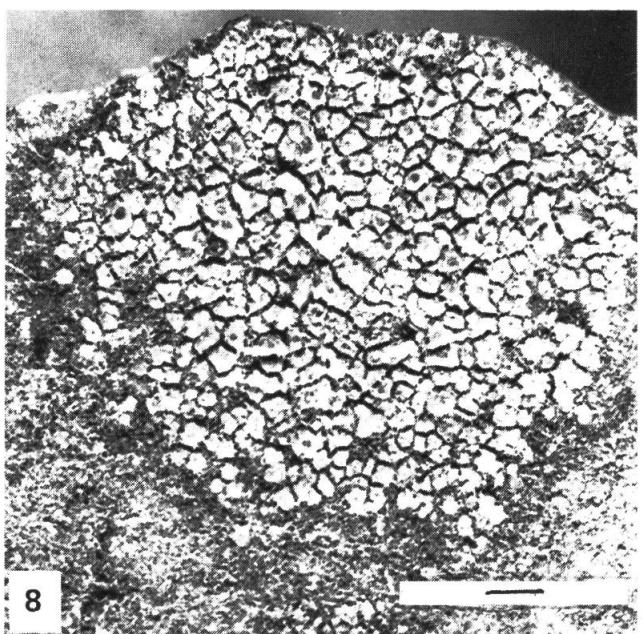
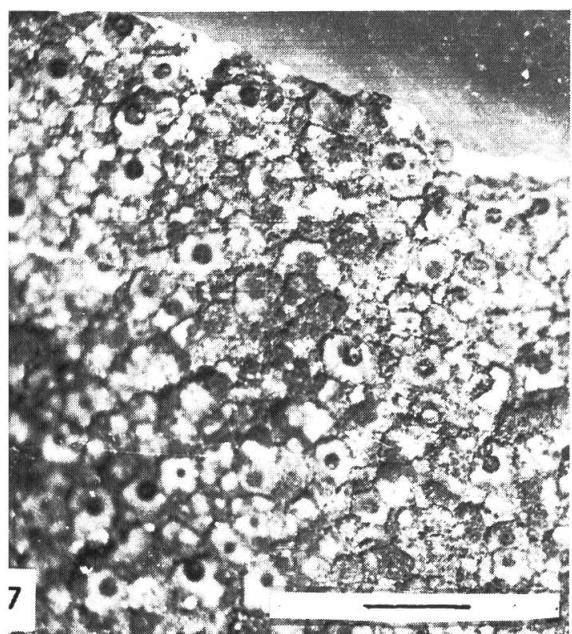


Fig. 4. — *Endocarpon pusillum* (habit).

Fig. 5. — *E. rosettum* (habit).

Fig. 6. — *E. subrosettum* (habit).



2-spori; sporae fuscae, oblongo-ellipsoidae, haud constrictae ad medium, murali divisae, cellulis in 7-10 serie transversalis dispositis, 35-45  $\mu\text{m}$  longae, 12-21  $\mu\text{m}$  crassae.

**Holotype:** India; U.P., Lucknow, on lime plaster of wall, 4th August, 1963, *Singh* 97587 (LWG) (Figs. 5 and 12).

Thallus squamulose, forming extensive patches; squamules crowded, sometimes imbricate, loosely attached to the substratum, 0.5-7.0 mm across, 80-155  $\mu\text{m}$  thick, round to irregular in outline and the fully developed ones forming rosettes, plain to slightly concave, olive-grey when dry, yellow-brown to dark greenish-brown when wet, K-, C-, KC-, P-, margin crenate to lobulate, whitish, lobules up to 0.6 mm broad and sometimes ascending, under side pale; upper cortex 3-6 cells thick, 20-45  $\mu\text{m}$ ; phycobiont layer 45-65  $\mu\text{m}$  thick, algal cells 3-7  $\mu\text{m}$  in diameter; medulla 30-50  $\mu\text{m}$  thick; lower cortex 2-4 cells thick, 10-25  $\mu\text{m}$ .

Perithecia numerous (up to 30) per squamule, globose, up to 0.25 mm in diameter, immersed, ostioles round punctate, brown, plain to slightly protruded from thalline surface; excipuloid tissue 4-6 cell-layered, 25-50  $\mu\text{m}$  thick; perithecial cavity 100-300  $\mu\text{m}$  high, 145-200  $\mu\text{m}$  broad; nucleus I-; hymenial alga spherical, 3-6  $\mu\text{m}$  in diameter; asci clavate, 2-spored, 60-80  $\times$  15-20  $\mu\text{m}$ ; spores brown, oblong-ellipsoid, not constricted in the middle, multi-celled muriform, cells arranged in 7-10 transverse tiers, with 2-3 cells in each, 35-45  $\times$  12-21  $\mu\text{m}$ .

**Remarks.** — *Endocarpon rosettum* is characterized by loosely attached, lobulate to rosette-forming, polycarpous squamules with pale under side.

The taxon referred to as *E. pusillum* by SINGH & SETHI (1978) from Delhi, as is evident from the description and illustration of the plant, is actually *E. rosettum*.

*E. rosettum* resembles with *Endocarpon helmsianum* and *E. tortuosum*, but unlike *E. rosettum*, the former possesses long black rhizinae on under side of the squamule, and the latter species has a tortuous (twisted) thallus and larger spores, measuring 45-61  $\times$  18-27  $\mu\text{m}$ .

Additional specimens examined: India; U.P., Lucknow, on lime plaster of old wall, 4th August, 1963, *Singh* 97575 (LWG); 4th August, 1963, *Saxena* 97578 (LWG).

## 6. *E. subrosettum* A Singh & Upreti, spec. nova

Subsimilis *Endocarpon rosettum*, sed squama minora et subtus nigra.

**Holotype:** India; U.P., Sitapur district, Mahmudabad, on lime plaster of old wall, 14th August, 1967, *Singh* s.n. (LWG) (Figs. 6 and 13).

Thallus squamulose, irregular in outline, up to 5.0 cm across; squamules crowded or sometimes imbricate,  $\pm$  adnate, up to 2.5 mm across, 80-140  $\mu\text{m}$  thick, round to irregular in outline, plain to slightly concave or convex, olive-grey when dry, greenish-grey when wet, K-, C-, KC-, P-, margin crenate to lobulate, lobules whitish, 0.4 mm broad, sometimes ascending, under side black; upper cortex 3-6 cells thick, 15-30  $\mu\text{m}$ ; phycobiont layer 30-60  $\mu\text{m}$  thick, algal cells 5-8  $\mu\text{m}$  in diameter; medulla indistinct; lower cortex 2-4 cells thick, 15-20  $\mu\text{m}$ , black at its lower part.

Perithecia 1-6(-15) per squamule, globose, up to 0.25 mm in diameter, immersed, ostioles round, black punctate, plain; excipuloid tissue 4-6 cell-layered, 20-35  $\mu\text{m}$  thick; perithecial cavity 150-250  $\mu\text{m}$  high, 100-200  $\mu\text{m}$  broad; nucleus I + blue; hymenial alga spherical, 3-6  $\mu\text{m}$  in diameter; asci clavate, 2-spored, 60-80  $\times$  12-18  $\mu\text{m}$ ; spores brown, oblong-ellipsoid, not constricted in the middle, multi-celled muriform, cells arranged in 7-10 transverse tiers, with 2-3 cells in each, 30-40  $\times$  12-14  $\mu\text{m}$ .

Fig. 7. — *Endocarpon nanum* (habit).

Figs. 8-9. — *E. nigro-zonatum* (habit).

Fig. 10. — *E. pallidum* (habit).

Fig. 11. — *E. pusillum* (habit).

Fig. 12. — *E. rosettum* (habit).

Fig. 13. — *E. subrosettum* (habit).

Scale: 1.0 mm.

*Remarks.* — *Endocarpon subrosettum* resembles *E. rosettum*, but the squamules of the former are smaller and have black under side.

Additional specimens examined: India; U.P., Chamoli district, Guptakashi, alt. 1200 m, on rock, 12th September, 1975, *Singh & Ranjan 106828* (LWG).

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