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Keratinophilic Ascomycetes from central India

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Keratinophilic fungi form an important group of decomposer system active in all types of soil. During 1999 and 2002 soil survey was done in central India for keratinophilic fungi. Several ascomycetous fungi formed fruit bodies in the hair-baited plates indicating their presence in Central Indian soils. Fourteen species representing seven genera of ascomycetes with keratinolytic ability were obtained in the hair baits. The fungi encountered in the survey were *Amauroascus queenslandicus, Aphanoascus durus, A. reticulosporus, A. terreus, Arthroderma ciferri, A. gypsea, A. incurvata, Auxarthron conjugatum, A. umbrinum, Ctenomyces serratus, Gymnoascus citrinum, G. petallosporus,* and *Nanniziopsis vreesii.* The taxonomic details of fungi encountered were presented.

Key Words : Keratinophilic fungi, Central India, Ascomycetes

INTRODUCTION

Keratinophilic fungi form the biggest group of microbes that degrade the highly stable animal protein-keratin apart from bacteria and actinomycetes. (Sharma & Rajak, 2003). The degradation of keratin by keratinophilic fungi is primarily brought about by the release of proteolytic enzymes and sulphitolysis (Kunert, 1972). Central India has been subjected to several investigations during past several years for the presence of keratinophilic fungi in soil. However, a comprehensive data on their occurrence is still lacking. (Sharma, 2002) In the present investigation a survey has been done as a part of microbial diversity project to investigate the presence of keratinophilic fungi in Central Indian soils.

MATERIALS AND METHODS

Collections of soil and isolation of fungi

Soil specimens were collected from various districts of M.P. and Chattisgarh, in sealed polythene bags using sterile spatula and brought to the laboratory for processing. The hair-baiting procedure was used to isolate the keratinophilic fungi from soil. Briefly 10 g of soil was spread with a flame-sterilized spatula on sterile plastic Petri dishes. An aliquot of 5 ml of sterile distilled water (containing 2 mg choramphenicol ml^{-1}) was added to moisten the soil. Previously defatted horse/human hairs were distributed on the soil and the plate was incubated in dark at 28°C for one month, checking for fungal growth at weekly intervals. Once ascomata appear on the hair baited plate they were further transferred onto Sabouraud Dextrose Agar (SDA) using the micro-dilution drop-trail method described before (Sharma *et al.*, 2002).

Microscopic examination

Microscopic observations were made on lactophenol cotton blue mounts of ascomata using Nikon Eclipse E800 microscope at varying magnifications and microphotographs were taken with Nikon H-II camera attached to the microscope.

SEM analysis

Scanning electron microphotographs were taken by JEOL EM6100 unit. The dried ascomata were

placed onto aluminium or brass stubs with double sided adhesive tape. The ascomata were crushed with needle and finally sputter coated with Gold-Palladium mixture. The coated material was then visualized at low to medium vacuum at varying accelerating voltage and working distances. The microphotographs were taken by an iLFORD PAN 100 black and white photographic film.

RESULTS

The taxonomy of keratinophilic ascomycetes that were encountered during this investigation are as under :

Amauroascus aureus (Eidam) von Arx, *Persoonia,* **6** : 375, Fig. 40d, 1971.
= *Gymnoascus aureus* Eidam, *Ber. Bot. Sect. Schles. Ges.* **64** : 161, 1887.
= *Arachniotus aureus* (Eidam) Schroeter, *Kryopto-gamen Flora von Schlesiens* **3** : 210, 1893.

Ascomata on hair baited soil, white, cream to brownish, globose to sub-globose, small, 71-170 × 150-200 µm, discrete, delicate with little or no peridial hyphae, apparently asci and ascospores are held naked, rudimentary peridial hyphae. **Peridial hyphae** sparse, differentiated/undifferentiated, hyaline, subhyaline, few brownish, feebly asperulate. **Asci** subglobose, 6.4-8.82 × 7.4-12 µm, ascospores together when young,mature ascospores discrete, never in clusters. **Ascospores** globose, spherical, reticulate, hyaline to pale yellowish, 2.94 × 4.41 µm, diam.

Material examined : Slides prepared of ascomata obtained from soil No. S214, Burrow inside tree, Bandhavgarh, Umariya, MP, 16.6.2001, Leg-Rahul Sharma.

This species is first time being reported from Indian soils. Although, Dutta *et al.* (1963) had isolated two species of this genus, *Amauroascus echinulatus* (=*Pseudoarachniotus echinulatus* Dutta and Ghosh, 1963) and *A. reticulatus* (Kuehn & Goos) v. Arx, 1971 (=*Pseudoarachniotus reticulatus,* Kuehn & Goos, 1960) from soils of Orissa. But, both these species now no longer belong to *Amauroascus ; A. reticulatus* being transferred to *Mallochia* [*M. reticulata,* (Kuehn & Goos) Sole, Cano and Guarro, 2002] and *A. echinulatus* being excluded from Onygenaceae for being non-keratinolytic and in having prominent, blunt spines instead of puncta typical of *Amauroascus* (Currah, 1985). *Amauroascus* is currently represented by 10 species.

Amauroascus queenslandicus (Apinis & R. G. Rees) Sole, Cano & Guarro *Mycol. Res.* **106**(4) : 394, 2002
=*Apinisia queenslandica* Apinis and R.G. Rees, *Trans. Br. Myco. Soc.* **67** : 524, 1976.
= *Orromyces spiralis* B. Sur & G. R. Ghosh, *Kavaka* **12** : 63, 1985.
= *Brunneospora reticulata* Guarro & Punsola, *Persoonia* **13** : 387, 1987.
= *Uncinocarpus queenslandicus* (Apinis and R. G. Rees) Sigler, *Can. J. Bot.* **76** : 1632, 1998.
(Figs. 1 & 2)

Colony moderately expanding, 3.3 cm after 10 d (5 cm after 15 d) on SDA at 28°C, white, cottony, fluffy, slightly raised, not uniform, margin circular. Reverse-cream colored with brownish patches in center with pale green color, except margin where it is white.

Aleurioconidia 4.4-8.82 µm × 3.53-2.94 µm, smaller conidia longer, broader ones are shorter. **Ascomata** pale brownish to dark reddish brown, upto 800 µm including coiled peridial hyphae. **Peridial hyphae** extend approximately 100 µm from the ascospore mass, 2.94 µm thick, hyaline when young, reddish brown at maturity. **Ascus** globose to subglobose, 8-11.5 µm. **Ascospores**, oblate, or irregularly elliptical, round in polar view with reticulate surface visible even through LM, thick walled, reddish brown, 4-4.5 × 5-6 µm. The characteristic coiled peridial appendages and reddish brown thick walled ascospores are characteristics of the fungus and are easily recognizable.

Material examined : Culture K 230 was obtained from soil S230 Bandol, Balaghat, MP, 18.8.2001, Leg-MK Upadhyay; in other three samples permanent slides were prepared of ascomata obtained from soil S30 Sehora, Jabalpur, MP, 11.1.2002, Leg. Nipun Silawat; S224 Barghat, Balaghat, MP, 18.8.2001, Leg-MKU; S233 Balaghat, MP. 19.8.2001, Leg-MKU.

Sur & Ghosh (1985) once isolated the fungus when they erected a new genus *Orromyces spiralis* Sur and Ghosh. This is the second time that the fungus is being isolated from Indian soil and now its current name is *Amauroascus queenslandicus* (Apinis and Rees) Sole, Cano and Guarro, this new combination has been proposed on the basis of sequence analyses of ITS region of ribosomal DNA by Sole *et al.* (2002).

Aphanoascus durus (Zukal) Cano & Guarro, *Mycol. Res.* **94**(3) :, 355-377, 1990.
= *Gymnoascus durus* Zukal, *Ber. dt. bot. Ges.* **8** : 295, 1890.
= *Keratinophyton durum* (Zukal) Currah, *Mycotaxon,* **24** : 156, 1985.
= *Ascoclavatia dura* (Zukal) v. Arx, *Persoonia,* **13** : 178, 1986.
= *Anixiopsis biplanata* Gueho & de Vroey, *Can. J. Bot.* **64** : 2207, 1986. ana. *Chrysosporium* sp.

Ascomata on hair baited soil, dark brown, globose, spherical, 450-570 µm diam., little or no hyphae attached to surface. **Asci** 5.5-7.5 µm diam., globose, reddish brown, 8-spored. **Ascospores** reddish brown, oblate to broadly ellipsoid on equatorial view under LM, circular on polar view. The broad equatorial rim slightly visible when observed by slightly changing the focal length of LM.

Material examined : Slide of ascomata from hair baited soil No. S79, Chada Tribal Market, Amarkantak, MP, 2000, Leg RS.

The fungus is first time being recorded from Indian peninsula. It can easily be distinguished from its allied species (having disc shaped ascospores) by its broad equatorial rim and less acute equatorial apices which give a slight rhomboidal shape in LM. Cano & Guarro (1990) separate it from *A. terreus.*

Aphanoascus reticulosporus (Routien) Hubalek, *Acta. Scient. Nat. Brno,* Ser. **8** : 28, 1974. Cano & Guarro, *Mycol. Res.* **94**(3) : 370, 1990.
= *Anixiopsis reticulospora* Routien, *Mycologia* **59** : 476, 1967.
= *Anixiopsis fulvescens* (Cooke) se Vries var. *fulvescens* sensu *Mykosen* **12** : 119, 1968. de Vries, ana. *Chrysosporium sp.*
(Figs. 3, 4 & 5)

Ascomata on hair baited soil, pale brown to reddish brown, delicate, collapses instantly when placed onto lactophenol, 400-580 µm. **Asci** globose to subglobose, evanescent, thin wall visible when young, 8-8.8 × 9.5-11.5 µm. **Ascospores** spherical to oblate, reticulate, 3.5-5.25 µm. The ascomatal wall is pale brown in color composed of flattened angular cells.

Material examined : Slide of ascomata from hair baited soil No. S307, Slaughter house dump, Madar Tekri, Jabalpur, 13.2.2002, Leg-RS.

The species is first time being reported from Indian peninsula. The reticulate ascospores are clearly obvious from LM and resemble ascospores of *Auxarthron* sp. The asci have a thin covering, which is visible through Nomarski (interference contrast) microscope or observing them under LM by slightly changing the focal length of the microscope.

Aphanoascus terreus (Randhawa and Sandhu) Apinis *Mycopath. et Mycol. Appl.* **35** : 99, 1968 Cano & Guarro, *Mycol. Res.* **94**(3) : 370, 1990.
= *Keratinophyon terreum* Randhawa and Sandhu, *Sabouraudia* **3** : 253, 1964.
= *Anixiopsis terreus* (Randhawa & Sandhu) de Vroey & Recacochea, *Bull. Soc. Fr. Mycol. Med.* **6** : 209, 1977 ana. *Chrysosporium indicum* (Randhawa and Sandhu) Garg, 1966
(Figs. 6, 7 & 8)

Ascomata on hair baited soil, globose dark brown, often shining, 285-800 µm diam. **Asci** globose, 5.5-7 µm diam. **Ascospores**, 3-5.4 × 1.7-2 µm discoid, with very thin equatorial rim, small polar thickening (not clearly visible by LM), with or without few pits. Except polar thickening, ascospores surface pitted, reticulate.

Material examined : Slides of ascomata from hair baited soil No. S16, High school playground & cycle stand, Kauriya, Gadarwara, Jabalpur MP, 11.1.2000, Leg-RS; S34, St. Alloysius school, Jabalpur, MP, 20.11.1999, Leg-RS; S31, Defence theatre campus, 20.11.1999, Leg-RS; S71, Public place, Dindori, MP, 2000, Leg-RS; S78, Bus stand, Balaghat, MP, 2000, Leg-

RS; S117 Garbage, Amanala, Pariyat, Jabalpur, MP, 23.9.2002, Leg-RS; S317, Slaughterhouse dump, Madar Tekri, Jabalpur, MP, 13.2.2002, Leg-RS.

Randhawa and Sandhu (1964) first described the fungus from Indian soil with its type species *Keratinophyton terreum*. Cano & Guarro (1990) revised the genus and indicated that type description might have an error in ascospore measurements [i.e. 3.3-5×1.7-3.3 µm], since their isolates have larger ascospores [5-6 × 2.5-3.5 µm] (Cano & Guarro, 1990, pg 373) and similar difference has been noted by Gueho & de Vroey (1986).

We believe Randhawa & Sandhu's observations didn't had any mistake since our present material (see SEM Figs) also has smaller sized ascospores, which could mean that the tropical (Indian) isolates have ascospores somewhat smaller than the European (Spain) isolates without any difference in their structural pattern.

The fungus was first reported from India (Randhawa & Sandhu, 1964) and there were several reports of this fungus from the country (Gugnani *et al.*, 1971; Jain & Agarwal, 1977; Jain, 1983; Ghosh & Biswas, 1995; Govil, *et al.*, 2001).

Arthroderma ciferri Varsavsky and Ajello 1964 *Riv. Patol. Veg.* **4** : 358-359 Fig 1-6 Currah, 1985, *Mycotaxon*, **24** : 41. ana. *Trichophyton georgii* Varsavsky and Ajello opp cit. = *Chrysosporium georgii* (Varsavsky and Ajello) van Oorshot, 1980. **(Fig. 9)**

Ascomata on hair baited soil, globose to spherical, numerous, white to pale cream 350 µm diam, **Peridial hyphae** 4-6 × 6 µm, dumbbell shaped, symmetrical, curled ends tapering towards apices, occasional appendages, slender, smooth walled. **Ascospores** 1.5-2 × 2-3 µm. **Anamorph** conidia elongated, pyriform, subglobose, 1.75-2.2 × 4-5.5 µm.

Material examined : S92, Barber shop + public place Padmi crossing, Khargone, MP, 10.9.2000, Leg-RS.

The species is easily identified by its beaded structure of the peridial hyphae. The species is earlier reported from India *apud* Deshmukh & Agarwal (1998) but is not included in *Fungi of India* (Bilgrami *et al.*, 1991).

Arthroderma gypsea (Nannizzi) Stockdale *Sabouraudia* **3** : 119, Figs 1c, d; PL 1c, d, 1963 Currah, 1985, *Mycotaxon* **24** : 55.
= *Nannizia gypsea* (Nannizzi) Weitzman, McGinnis, Padhye and Ajello, *Mycotaxon* 1986, **25** : 505-518.
(Figs. 10 & 11)

Ascomata on hair baited soil, white to pale cream, pale brown, 215-357 × 614-785 µm with peridial hyphae. **Asci** globose, 8 spored, 6 µm diam. Pale yellow to cream. **Ascospores** oblate to ellipsoid, smooth, circular on polar view, compactly arranged in an ascus. **Peridial hyphae** asperulate thick walled, 3.58-4.5 µm diam., of ossiform cells 16.2-23.52 µm (thinner at the apical portion), dumbbell shaped with symmetrical to asymmetrical dumbbells. Peridial appendages coiled and upto 285 µm long.

Microconidia 1.4-1.76 × 4.4-5.88 µm, macroconidia 60 × 9.5 µm, 5 septate.

Material examined : Slides S215, Burrow soil, Bandhavgarh, Umariya, MP, 16.6. 2001, Leg-RS; S276, Barber shop near railway station, Betul, MP, 19.1.2002, Leg-RS; S277, barber shop near railway station, MP, Betul, MP, Leg-RS; S287, Public place, Sukhtava, 19.1.2002, MP, Leg-RS; S289, public place Itarsi, 19.1. 2002, Leg-RS.

The species is one of the most abundant and recently has been extensively studied from Madras soils (Ranganathan and Balajee, 2000).

Arthroderma incurvata Stockdale *Sabouraudia* **1** : 46-47, PL 1a-e, 1961.
= *Nannizia incurvata* (Nannizzi) Weitzman, McGinnis, Padhye and Ajello, *Mycotaxon* 1986, **25** : 505-518.

= *Nannizia gypsea* var. *incurvata* (Stockdale) 1964. **(Fig. 12)**

Ascomata on hair baited soil, white initially becoming pale tan to brownish, 258-500 × 357-642 µm. **Peridial hyphae** thick walled, asperulate, curving inwards towards the main axis, with prominent dumbbells, symmetrical and with coiled peridial appendages. **Asci** 4-5 µm diam, **Ascospores** are small smooth walled discoid, 1.5-2 × 2.2-2.5 µm. **Anamorph** 45 × 6.5 µm, 5 septate.

Material examined : Slide examined from soil S281, soil by the side of village hut, Kuppa, Hoshangabad, MP, 19.1.2002, Leg-RS; S291, village farm house near bus stand and public place, Babai, Hoshangabad, MP, Leg-RS.

It has been infrequently isolated from Indian soil (Mohapatra & Gugnani, 1964; Ranganathan and Balajee, 2000)

Auxarthron conjugatum (Kuehn) Orr and Kuehn *Can. J. Bot.* **41** : 1452-1453, Fig 22-23. 1963
= *Myxotrichum conjugatum* Kuehn, *Mycologia* **47** : 883, 1955.
= *Macronodua bifurcatus* Orr, *Mycotaxon* **5** : 284, 1977
= *Gymnoascus bifurcatus* (Orr) v. Arx, 1981, Page 132.
(Figs. 13 & 14)

Colony on SDA white initially, raised pale orange, circular, reverse dark orange with peripheral yellowish to colorless extreme periphery.

Ascomata on hair baited soil and culture, pale orange to yellow brown, spherical up to 500 µm, **Ascospores** hyaline to pale brown, oblate, punctations visible only through SEM. **Asci** ellipsoidal 4-6 µm. **Peridial hyphae**, yellowish brown, slightly asperulate, with prominent knuckle joints in LM. Apices acute, or uncinately branched or occasionally bifurcating at the apices. **Anamorph** hyaline to pale yellowish arthroconidia.

Material examined : Slides obtained of ascomata on hair baits and cultures, S217 : bat cave, Bandhavgarh National Park, MP, 16.6.2001, Leg-RS; S218; mango garden, Bandhavgarh, MP, 17.6.2001; Leg-RS.

The species was first time being isolated from Indian soils by Jain (1979).

Auxarthron umbrinum (Boudier) Orr and Plunkett *Can. J. Bot.* **41** : 1446-1449, Fig 9, 13-19, 1963.
= *Gymnoascus umbrinus* Boudier, *Bull. Soc. Mycol. Fr.* **8** : 43, 1892.
= *Myxotrichum brunneum* Rostrup, *Bot. Tidssk.* **19** : 206, 1895.
= *Auxarthron brunneum* (Rostrop) Orr and Kuehn, *Can. J. Bot.* **41** : 1446, 1963.
= *Gymnoascus subumbrinus* Smith, *Trans. Brit. Mycol. Soc.* **5** : 424, 1917.
= *Myxotricum emonsii* Kuehn, *Mycologia* **47** : 539, 1955.
= *Auxarthron thaxteri* (Kuehn) Orr, and Kuehn, *Mycologia* **63** : 200, 1971.

Colony 5 cm diam. on SDA at 28°C, 10 d, moderately fast growing, circular raised, cottony, with concentric rings, central portion with orangish spot. Reverse orange to yellow with concentric rings, central potion dark orange to red.

Ascomata on hair baited soil, dark brown to reddish brown, spherical, 200-450 µm. **Ascospores** yellow to pale brown, finally punctate not clearly visible by LM, oblate, 2-3.2 µm. **Asci** globose to subglobose up to 10 µm. **Peridial hyphae & appendages,** pale to reddish brown, asperulate to smooth towards the apical portion, rarely slightly uncinate, septate, knuckle joint upto 9-15 µm, appendages are dark towards the base and paler towards the apex. Pyriform, intercalary conidia as anamorph.

Material examined : Slides prepared from ascomata obtained from sample S171, animal burrow soil, Marwahi forest, Ambikapur, MP, 13.11.2000, Leg-RS; S218, mango garden, Bandhavgarh, M. P., 17.6.2001, Leg-Rs.

Isolated several times from India.

Ctenomyces serratus Eidam 1880 Cohn, *Beit. Biol. Pfl.* **3** : 274, 1880 PL XII Fig. 2. Em Benjamin *El Aliso* **3** : 307-311, 1956 PL V. Currah, 1985

Mycotaxon **24** : 51, Fig 2a, b 4a, b, c 6b, d. ana. *Chrysosporium* state of *Ctenomyces serratus.*
= *Myceliophthora* state of *Ctenomyces serratus* fide van Oorschot, 1980, *Stud. Mycol.* **20** : 1-89.
(Figs. 15, 16, 17 & 18)

Ascomata on hair baited soil, globose, dark brown at maturity, 250-450 µm diam. Peridial hyphae two types-inner ones form cleistoperidium containing asci and ascospores and outer thick walled peridial hyphae forms a mesh covering inner ascospore mass, from outer peridial mesh radiates characteristic comb shaped ctenoid appendages, up to 94 µm long from point of attachment, hooks/teeth 18.75 µm long. **Peridial appendages** thick walled, asperulate, become hard on drying and acts as springs helping the ascomata to jump and cling to the animal body when it comes in contact with some animal thus helping in spore dispersal. **Asci** globose, 4-6 µm diam. **Ascospores** lenticular, 3.45 µm (in polar view) flattened on one side and round on the other (hemispherical). **Conidia** are up to 9 µm lengthwise, verrucose, have atypical growth pattern on hair, cream colored on gross appearance on baits.

Material examined : Slide of ascomata from hair baited soil No. S156 Parsa, Ambikapur, CG, 11.11.2000, Leg-RS; S194 Bodh Ghati, Bastar, CG, 11.1.2001, Leg-RS.

The fungus is associated commonly with bird's feather or commonly isolated from habitats where birds are in plenty.

In India this fungus was infrequently isolated from such habitats. (Pugh, 1966; Deshmukh *et al.*, 2000). It was also isolated in 1981 by P.C. Jain from Sagar, MP, as a culture (CP-19) of this fungus happens to be deposited at the University of Alberta Mould Herbarium, Canada, UAMH/4429 *apud* Currah (1985).

Gymnoascus citrinus (Massee & Salmon) Sole, Cano, Pitarch, Stchigel & Guarro 2002 *Stud. In Mycol.* **47**: 142-152. Currah, 1985, *Mycotaxon* **24** : 73, Figs 13a, b, c 26a
= *Arachniotus citrinus* Massee and Salmon, *Ann. Bot.* **16** : 162, Fig 86 and 88, 1902.
= *Pseudoarachniotus citrinus* (Massee and Salmon) Kuehn, *Mycologia* **49** : 699, 1957.
= *Gymnascoideus citrina* (Massee and Salmon) Orr, Ghosh and Roy *Mycologia,* **69** : 126, Fig. 7, 1977.
(Figs. 19 & 20)

Colony 3 cm, circular, on SDA after 10 d at 28°C slow to moderately expanding. Central portion with raised threads of mycelium, rest colony with mostly submerged mycelium. Surface mycelium gives a gross yellow color to the colony. Reverse uncolored. **Ascomata** on hair baited soil, initially white turning bright yellow, on maturity turning pale brown on baits; in culture, pale brown, formed singly or in aggregates (scattered). 150-450 µm diam., globose with sparse peridial hyphae. **Peridial hyphae** more or less undifferentiated from vegetative hyphae, thin walled, pale brown to hyaline, 2.76 µm wide, septate. **Asci** 10-12.5 µm diam., globose, reddish brown. **Ascospores** ellipsoid, thick walled, 6-7 µm in polar view, 3.45 µm in equatorial view, reddish brown.

Material examined : Slide of ascomata from hair baited soil No. S293 Semri, Hoshangabad, MP, 20.1.2002, Leg-RS and its culture K293 isolated from the same soil sample.

Mainly Dr. G.R. Ghosh and her associates isolated this fungus in India on few occasions (Orr *et. al.*, 1977a) after being isolated for the first time for India by Rai and Mukerji (1961).

Gymnoascus petalosporus (Orr, Roy and Ghosh) von Arx, *Persoonia* **9** : 387, 1977. Sole *et al. Stud. in Mycol.* 2002 **47** : 141-152.
= ***Gymnoascoideus petalosporus*** Orr, Roy and Ghosh *Mycotaxon,* 1977, **5** : 460-461, Fig 1-20
(Figs. 21 & 22)

Colony 4 cm on SDA after 10 d at 28°C, moderately expanding, white, centrally raised, rest white knots at several places, Peripheral 1 cm region submerged. Mature colony, distinct outer ring, knots region & peripheral region turning brown, full of asci. **Ascomata** on hair baited soil and culture, discrete, formed of loosely arranged peridial hyphae. On hair baits reddish brown, globose, subglobose to irregu-

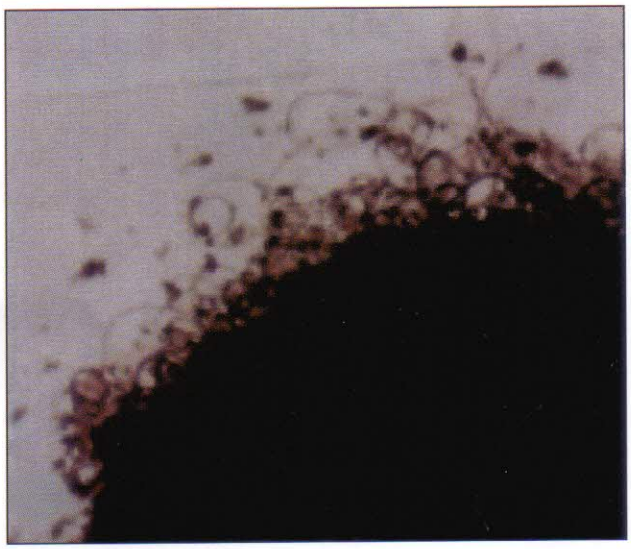

Fig. 1 : *Amauroascus queenslandicus*–Part of a mature ascoma covered with reddish brown coiled peridial hyphae. (X100)

Fig. 2 : *A. queenslandicus*–ascus with oblate, reticulate ascospores. (X1000)

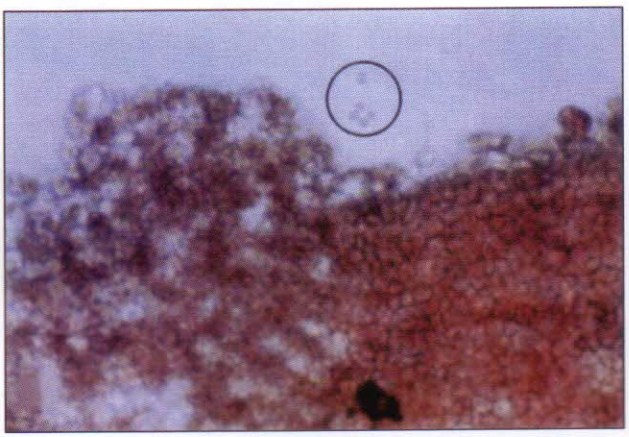

Fig. 3 : *Aphanoascus reticulosporus* – Crushed asoma with asci and ascospores (encircled area enlarged in Fig 19). (X100)

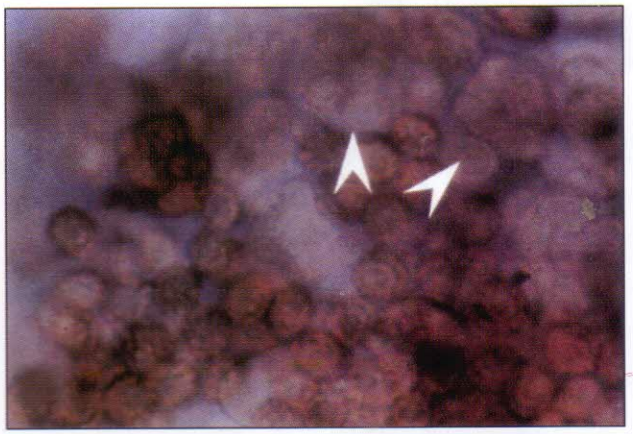

Fig. 4 : *A. reticulosporus* – subglobose asci (indicated by arrows) and ascospores. (X200)

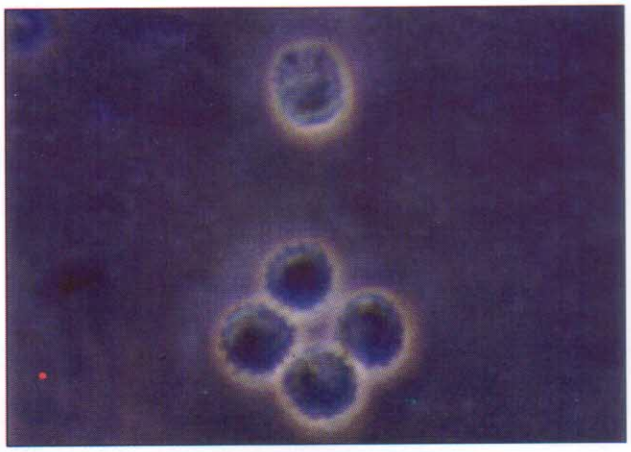

Fig. 5 : *A. reticulosporus* –reticulate ascospores clearly visible by phase contrast. (X400)

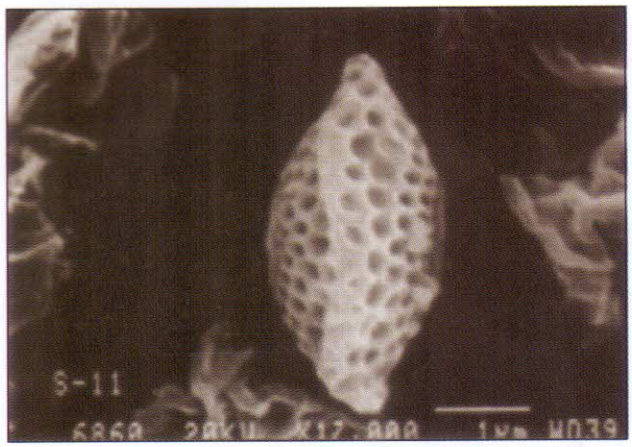

Fig. 6 : *A. terreus* – Equitorial view of ascospore showing equatiorial rim. (X12,000)

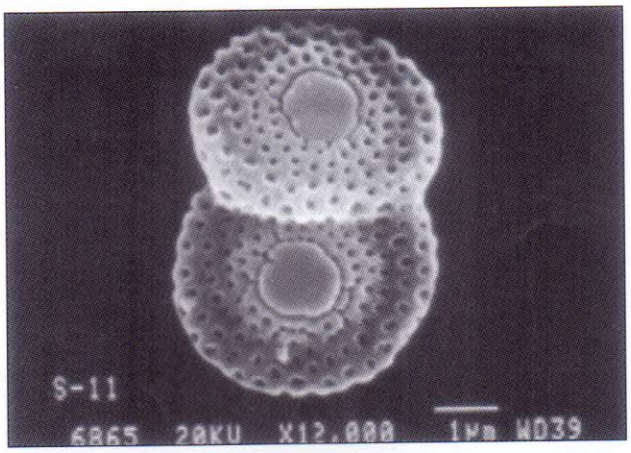

Fig. 7 : *A. terreus* –Polar view of ascospores with smooth polar thickening. (X12,000)

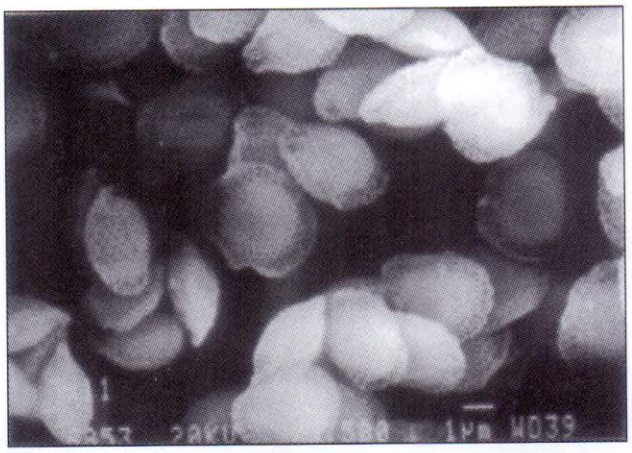

Fig. 8 : *A. terreus* – Ascospores in polar view. (X7,500)

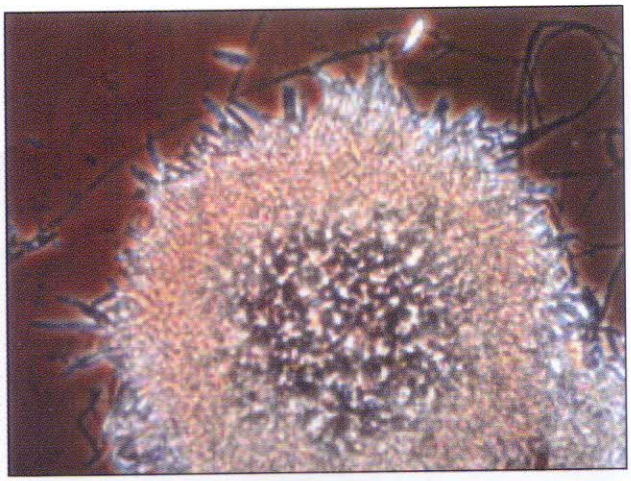

Fig. 9 : *Arthroderma ciferri* – ascoma with peripheral peridial hyphae covering the entire ascoma. (X100)

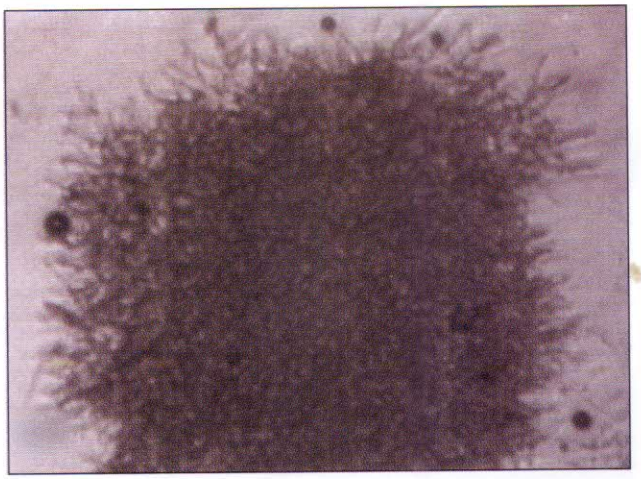

Fig. 10 : *A. gypsea* – Complete ascoma with radiating swollen ossiform cells of peridical hyphae. (X100)

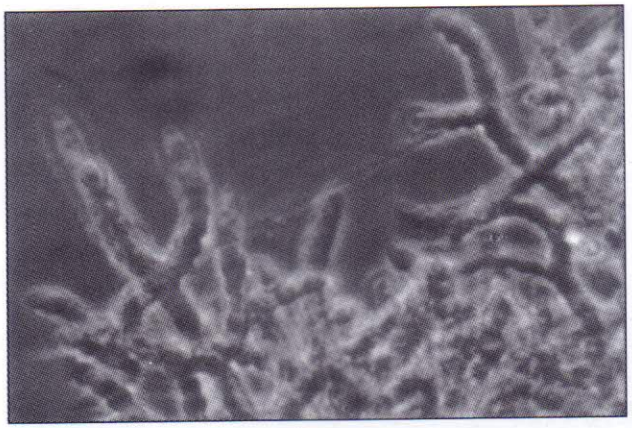

Fig. 11 : *A. gypsea* – Peridial hyphae with dumbbell shaped ossiform cells. (X400)

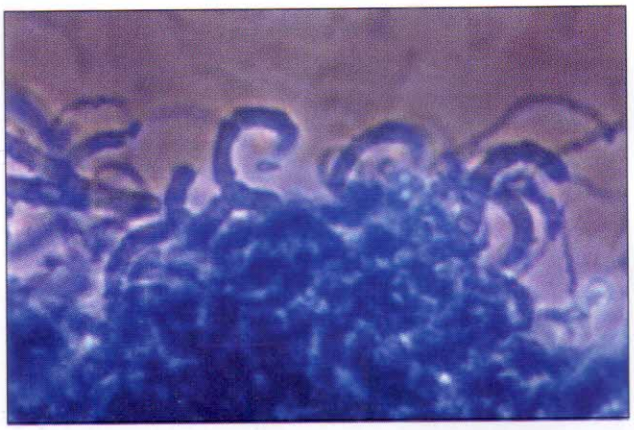

Fig. 12 : *A. incurvatum* – Thick walled dumbbell shaped peridial hyphae and appendages, the peridial hyphae are coiling towards the main axis. (X400)

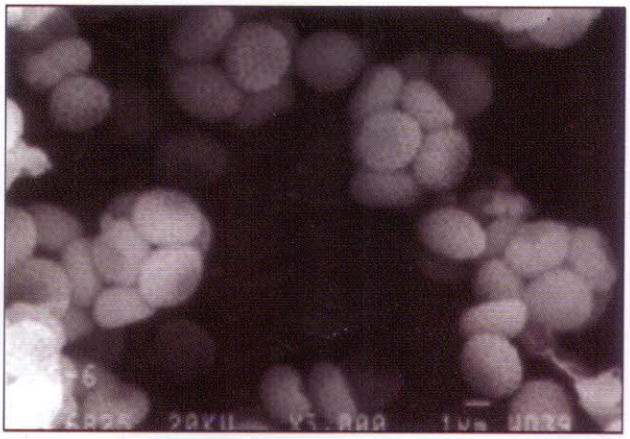

Fig. 13 : *Auxarthron conjugatum* – Globose asci. (X3,000)

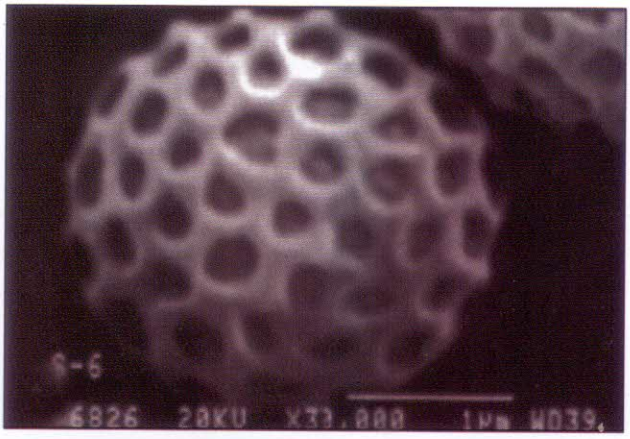

Fig. 14 : *A. conjugatum* – Enlarged view of an ascospore showing punctuations on its surface. (X30,000)

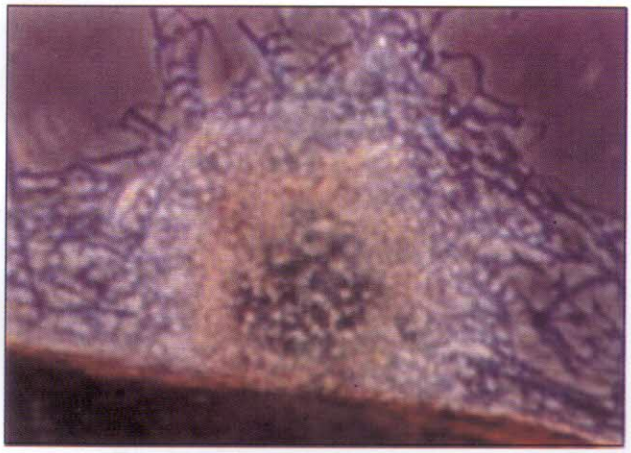

Fig. 15 : *Ctenomyces serratus* – Developing ascoma on horse hair having hyaline peridial hyphae. (X100)

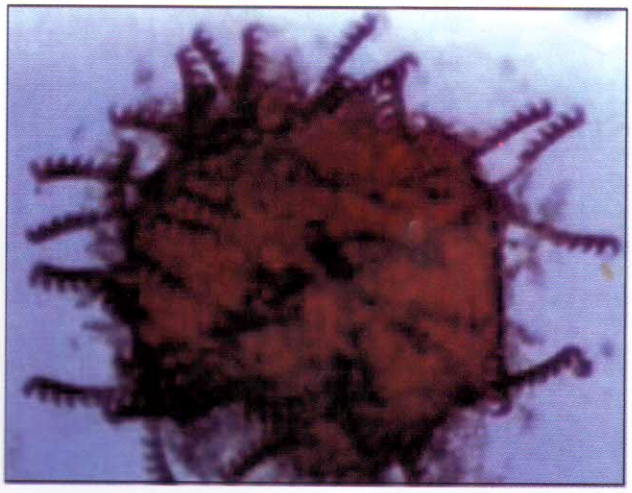

Fig. 16 : *C. serratus* – Complete mature ascoma with radiating characteristic ctenoid appendages. (X100)

Fig. 17 : *C. serratus* – Joined peridial hypahe at base (arrow). (X100)

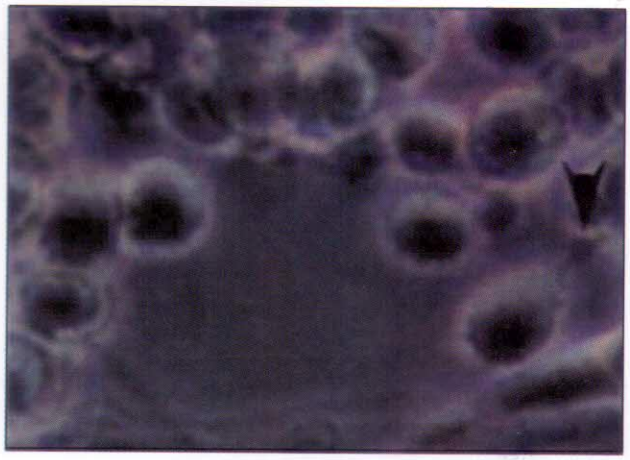

Fig. 18 : *C. serratus* – Chrysosporium anamorph showing condia characteristically swollen at base (arrow). (X400)

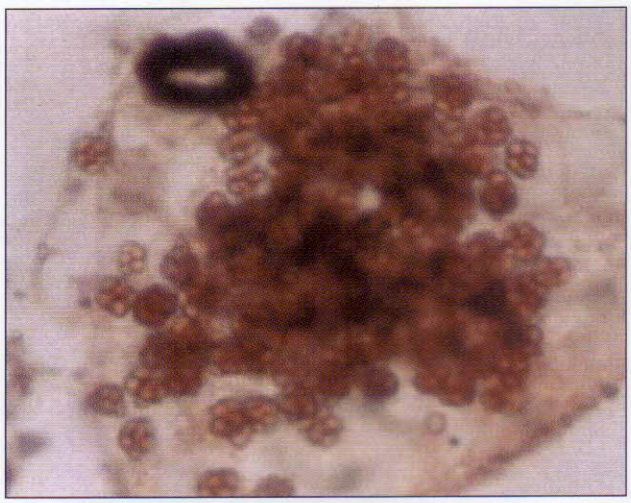

Fig. 19 : *Gymnascella citrina* – Incomposito-peridium covered with undifferentiated peridial hyphae containing almost naked asci. (X200)

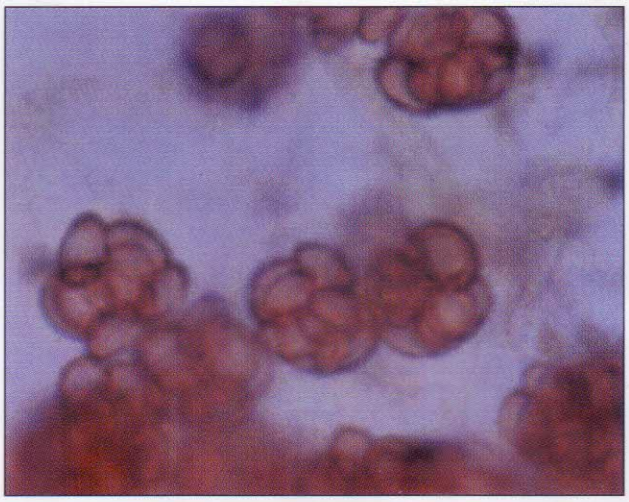

Fig. 20 : *G. citrina* – Globose asci with compactly arranged ascospores. (X400)

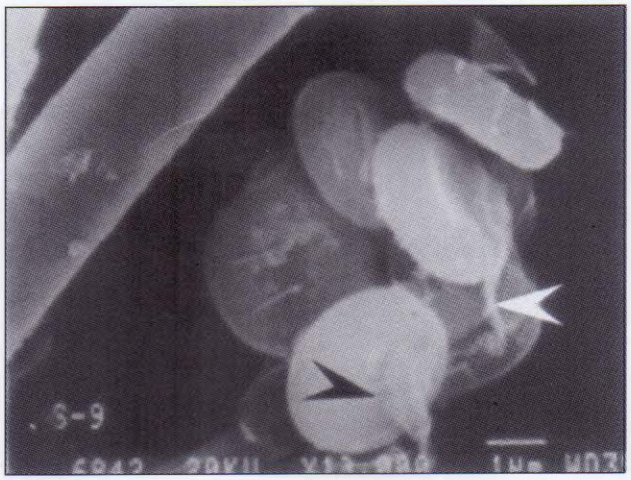

Fig. 21 : *Gymnoascoides petallosporus* – Ascus with ruminants of ascal wall as indicated by arrows. (X12,000)

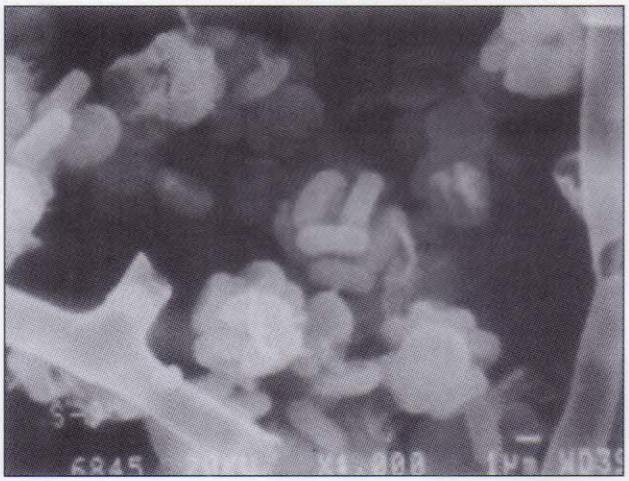

Fig. 22 : *G. petallosporus* – globose to petaloid asci. (X4,000)

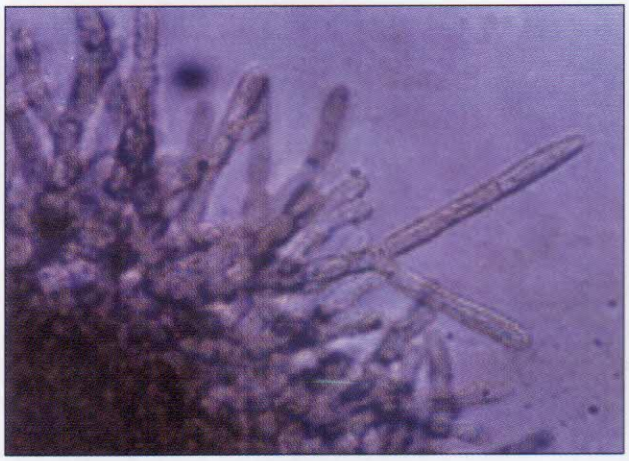

Fig. 23 : *Nanniziopsis vreesii* – Asperulate peridial hyphae constricted at septa. (X200)

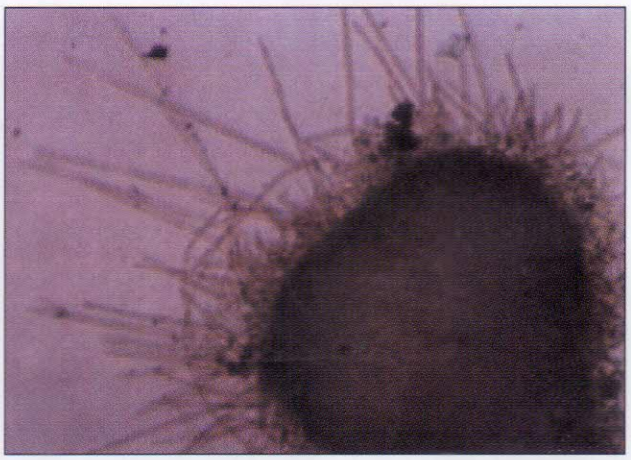

Fig. 24 : *N. vreesii* – Ascoma with radiating peridial hyphae. (X100)

lar, 200-500 µm diam., entangled multi-ascocarp structures up to 1 mm in diam. **Peridial hyphae** smooth, 2-2.5 µm wide, branching at right angle, loosely arranged. **Asci** pale brownish to brown, globose 5-5.75 µm diam., loosely arranged, dispersed as soon as kept on a water droplet. **Ascospores** yellow to pale brown, oblate, 1.3-3.2 µm.

The species was generally found associated with *Microsporum gypseum*. In fact, the ascomata of *G. petalosporus* were just mingled with macroconidial clusters of *M. gypseum* in most of the instances and it was difficult to separate the two species.

Material examined : Culture K305 isolated from Soil No. S305, Madar Tekri, Jabalpur, MP, 13.2.2002, Leg-RS; Other materials are the permanent slides prepared of the ascomata formed on soil : S32, Rotary Club Campus, Jabalpur, 20.11.1999, Leg-RS; S50 Babaiha, Kanha, Mandla, MP, 1999, Leg-RS; S69 Civil Lines, Jabalpur, MP 2000, Leg-RS; S84 Bhagvanpura, Khargone, MP, Leg-RS; S180 Tongapal village, Bastar, CG, 9.1.2001, Leg-RS; S214 Bandhavgarh, MP, 16.6.2001, Leg-RS; S305 Madar Tekri, Jabalpur, MP, 13.2.2002, Leg-RS, SL312 Katni, MP, 27.8.2002, Leg-RS; S316 Amarpatan, Satna, MP, 27.8.2002, Leg-RS; S317 Lalpur, Satna, 27.8.2002, Leg-RS; S327 Morela, Shahdol, MP, 28.8.2002, Leg-RS; S334 Andhiyar Khoh, Sidhi, MP, 29.8. 2002, Leg-RS.

The species is very common and has been isolated on several occasions from Indian soils mainly hy Dr. G.R. Ghosh and her coworkrs (Orr *et al.*, 1977b; Ghosh and Biswas, 1995; Ghosh and Bhatt, 2000)

Nannizziopsis vreesii (Apinis) Currah 1985, *Mycotaxon* **24** : 164, Figs 59a, 60a, b, c. Guarro, Cano & de Vroey, 1991, *Mycotaxon* **42** : 193-200.
= *Rollandina vreesii* Apinis *Trans. Brit. Mycol. Soc.* **55** : 499-502, 1970, Fig 1a-z.
= *Arachnotheca vreesii* (Apinis) Samson *apud* von Arx, 1981.
(Figs. 23 & 24)

Ascomata white to cream, globose to subglobose, 420-570 µm (without peridial appendages), 750-780 µm (with appendages). **Peridial hyphae** hyaline, slightly asperulate, branched, slightly constricted at septa (not all). **Peridial appendages** long up to 300 µm, hyaline, septate, slightly asperulate, radiating from ascomata. **Asci** globose, up to 6 µm diam, hyaline to pale cream. **Ascospores** round up to 2 µm diam. slightly roughened or reticulate, pale yellow in mass.

Material examined : Slide of ascomata from hair baited soil S194 from under a bird carcass, Bodh Ghati, Bastar, CG; 11. 1.2002; Leg-RS.

Currah first described the species when he made a new combination (Curah, 1985). The fungus is first time being reported from Indian soil and can be differentiated from other two species of *Nannizziopsis* by having asperulate peridial hyphae, while the other two species (*N. hispanica* Cano & Guarro and *N. tropicalis* Cano, Vidal & Guarro) have smooth hyphae and appendages.

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