

NEW SPECIES OF *CONIOTHYRIUM* ON *SALVADORA* FROM PAKISTAN

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Abstract

Ten new species of *Coniothyrium* on *Salvadora* spp., viz., *Coniothyrium pakistanicum*, *C. oblongatum*, *C. undulatum*, *C. maqsoodii*, *C. ismailii*, *C. suttonii*, *C. sultanii*, *C. sivanesanii*, *C. punithalingamii*, *C. truncatum* and an already reported *Coniothyrium salvadorae* are described, illustrated and compared with related taxa.

Introduction

During the course of examination of Coelomycetes on *Salvadora* spp., a large number of taxa were found with hogenous aseptate, brown conidia formed in pycnidial conidiomata apparently in the absence of conidiophores, with enterogenous and progressive conidiogenous cells (*sensu* Hennebert & Sutton, 1994), enteroblastic percurrently proliferating conidiogenous cells and succession of sequential conidia formed at higher levels (*sensu* Minter *et al.*, 1983a,b), annellidic (*sensu* Sutton, 1980). There are only a few *Coelomycete* genera which resemble these fungi on *Salvadora*. *Coniella* Höhn., *Microsphaeropsis* Höhn., and *Readeriella* H. & P. Sydow differ in having enterogenous stationary (*sensu* Hennebert & Sutton, 1994) enteroblastic conidiogenous cells with a succession of sequential conidia formed at the same level (Minter *et al.*, 1983a, 1983b), phialidic (*sensu* Sutton, 1980). In *Coniella* conidia and conidiogenous cells are confined to a basal cushion shaped mass of tissue in conidiomata (Sutton, 1980). Conidia in *Readeriella* have 3 obtuse protuberances at their apices (Sutton, 1980). *Avettaea* Petrak is characterized by aseptate, brown conidia enclosed in a mucilaginous sheath (Sivaneson & Sutton, 1983). *Lasmeniella* Petrak & Sydow is characterized by eustromatic simple to convoluted multilocular conidiomata with conidia flattened but circular in outline having one central pore and a truncate base with one basal appendage (Sutton, 1980). *Aplosporella* Speg., differs in having eustromatic conidiomata, with a common ostiole, paraphyses and aseptate brown conidia, the outer walls of which are pitted or reticulate (Sutton, 1980). *Cymbothyrium* Petrak also differs in having eustromatic clypeate conidiomata and aseptate brown cymbiform conidia (Sutton, 1980). Similarly *Cytoplea* Bizz & Sacc. (Sutton, 1980), has clypeate eustromatic conidiomata with columnar locules and conidiogenous cells proliferating enterogenously and stationary (*sensu* Hennebert & Sutton, 1994) with a succession of sequential conidia formed at the same level (*sensu* Minter *et al.*, 1983a, 1983b), phialidic, (*sensu* Sutton, 1980).

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Harknessia Cooke (Sutton, 1971, 1980) is differentiated by eustromatic conidiomata, aseptate, brown, guttulate conidia with longitudinal striations, generally with one basal and sometime one apical appendage. *Cyclothyrium* Petrak (Sutton, 1980) also differs in its eustromatic convoluted conidiomata and enterogenously and stationary proliferating conidiogenous cells (*sensu* Hennebert & Sutton, 1994), with a succession of sequential conidia formed at the same level (*sensu* Minter *et al.*, 1983a, 1983b), phialidic (*sensu* Sutton, 1980).

Genera such as *Coniothyrium* Corda, *Sphaeropsis* Sacc., and *Lichenoconium* Petrak & Sydow are of closer affinity because of the pycnidial conidiomata, absence of conidiophores and aseptate brown conidia. *Lichenoconium* Petrak & Sydow, however, is parasitic on lichens (Hawksworth, 1977). In *Sphaeropsis*, conidia are aseptate, brown, smooth and with the inner wall ornamented (Wang *et al.*, 1986) and generally develop a septum before germination (Sutton, 1980). *Coniothyrium* is characterized by pycnidial or pycnidoid eustromatic conidiomata, absence of conidiophores, conidiogenous cells proliferating enterogenously and progressively (*sensu* Hennebert & Sutton, 1994) with percurrent proliferations and a succession of sequential conidia formed successively at higher levels (*sensu* Minter *et al.*, 1983a, 1983b), annellidic (*sensu* Sutton, 1980) and hogenous, aseptate, brown conidia, the outer wall with or without ornamentation. It therefore appears that *Coniothyrium* is the most satisfactory genus for the taxa on *Salvadora* under study. These are described below:

CONIOTHYRIUM Corda, nom. cons. *Icones fungorum* 4: 38 (1840); Sutton, *Coelomyces* (CAB., IMI.) Kew: 122-123 (1980).

Clisosporium Fr., nom. rej., *Syst. myc.* 1: 47 (1821).

?*Monoplochia* Westd., *Bull. Acad. R. Sci. Belg.*, 2 ser., 7: 91 (1859).

?*Asteropsis* G. Frag., *Trab. Mus. Nac. Cienc. Nat. Madrid*, ser. bot. 12: 50 (1917).

?*Coniothyrinula* Petrak. *Annls mycol.* 21: 2 (1923).

Original spp. *C. pini* Corda, *C. palmarum* Corda, *C. subtile* Corda, *C. glomeratum* Corda.

Lectotype sp: *C. palmarum* Corda, *Int. Code Bot. Nom. App.* III. Nomina generica conservanda et rejicienda.

Mycelium immersed, septate, brown or hyaline, branched. *Conidiomata* pycnidial, separate, globose, dark or pale brown, immersed, unilocular, thin-walled; wall of brown, thick-walled textura angularis or globulosa. *Ostiole* circular, central sometimes papillate. *Conidiophores* absent. *Conidiogenous* cells indeterminate, discrete, doliiform to cylindrical, hyaline or pale brown, smooth, proliferating enterogenously and progressively with 1-4 percurrent proliferations and formed from the inner cells of the pycnidial wall. *Conidia* formed first hogenously later enterogenously, brown thick-walled, 0-1 euseptate, cylindrical, spherical, elliptical or broadly clavate, verruculose, apex obtuse, base truncate sometimes with a marginal frill.

Sutton (1971, 1980) while dealing with the status of *C. palmarum*; suggested that majority of the species described in *Coniothyrium* were not congeneric with the type species, therefore he proposed *Microsphaeropsis* Höhn., for those species which proliferate enterogenously and stationary (*sensu* Hennebert & Sutton 1994), enteroblastically with a succession of sequential conidia formed at the same level (*sensu* Minter *et al.*, 1983a, 1983b), phialidic (*sensu* Sutton, 1980).

KEY TO *CONIOTHYRIUM* SPP., ON *SALVADORA* SPP.

1. Conidia uniformly pigmented ----- 2
1. Conidia more pigmented on lateral or apical and basal sides -- III. *C. pakistanicum*
2. Conidia dark brown ----- VIII. *C. oblongatum*
2. Conidia light brown ----- 3
3. Conidial wall uneven ----- I. *C. undulatum*
3. Conidial wall not uneven ----- 4
4. Conidia spherical to oblongo-globose ----- 5
4. Conidia oval to cylindrical, to oblong ----- 7
5. Conidia spherical and thin-walled ----- IV. *C. maqsoodii*
5. Conidia globose or oblong-globose and thick-walled ----- 6
6. Conidia with an oblique secessional scar ----- V. *C. ismailii*
6. Conidia without a secessional scar ----- VII. *C. suttonii*
7. Conidial length exceeding 7 μm ----- 8
7. Conidial length less than 7 μm ----- 9
8. Conidia 10-16x5.6-8 μm ----- II. *C. sultanii*
8. Conidia 5.6-11.2x4-8.8 μm ----- VI. *C. sivanesanii*
9. Conidia without guttules ----- XI. *C. punithalingamii*
9. Conidia with guttules ----- 10
10. Conidia thin-walled, 2.8-4.8x1.8-3.2 μm ----- IX. *C. salvadorae*
10. Conidia thick-walled, 5.6-6.8x4-5 μm ----- X. *C. truncatum*

I. *Coniothyrium undulatum* Abbas, Sutton & Ghaffar sp. nov.

Fig. I (i,ii).

Conidiomata pycnidialia ad eustomatica, separata, raro aggregata, nigra, globosa ad oblongo-globosa, unilocularia raro multilocularia, 165-330x180-230 μm . *Ostiolum* singulum, centrale, circulare, 10-15 μm diam. parietes ex textura angulari, 4-10 cellulis crassis et 8-35 μm lati, stratis duobus consistantes, exteriori 1-7 cellulis crassis atri, interiori 3-6 cellulis crassis centrum versus hyalinis. In conidiomata multilocularia, parietes usque 12 cellulis crassis et 20 μm latis consistantia. *Conidiophora* absentia. *Cellulae conidiogena*e discretae, indeterminatae, hyalinae, cylindricae vel lageniformes, vel ampulliformes enteroginibus, progressivis, percurentibus, proliferationibus, 4-8 x 1.6-4.5 μm . *Conidia* Primova formamali hologenitica cero enterogenitica, aseptata, globosa vel oblongo-globosa, brunnea, 5.6-7.2x4.8-6.4 μm . Parietes conidiorum 0.6-0.8 μm crassis.

In ramis emortuis *Salvadorae persica*, *viatici*. inter Karachi et Hyderabad, Pakistan, 8 Apr. 1964, S. Ahmad 16912a (IMI 13891a), holotypus.

Coniothyrium undulatum Abbas, Sutton & Ghaffar sp. nov.

Conidiomata pycnidial to eustomatic, immersed, black, globose to oblong-globose, separate or occasionally aggregated, generally unilocular but sometimes multilocular, 165-330 x 180-230 μm . *Ostiole* single, central, circular, 10-15 μm diam. Wall of textura angularis, 4-10 cells thick and 8-35 μm wide, differentiated into two layers, an outer layer 1-7 cells thick, black, darker and thicker in the upper region than lower region, with an inner layer 3-6 cells thick, gradually becoming hyaline towards the

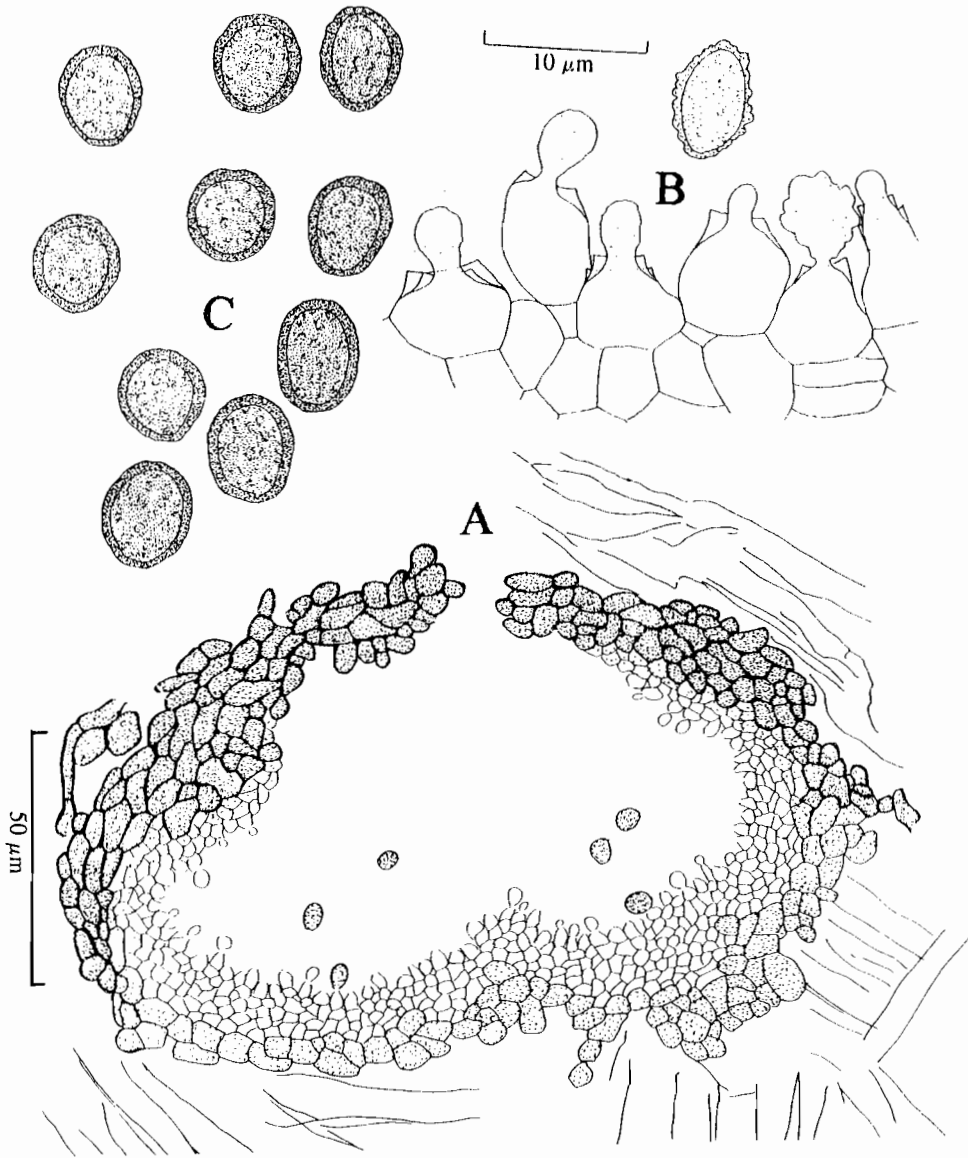


Fig.1(i). *Coniothyrium undulatum* (A) V.S. of conidioma; (B) conidiogenous cells; (C) conidia.

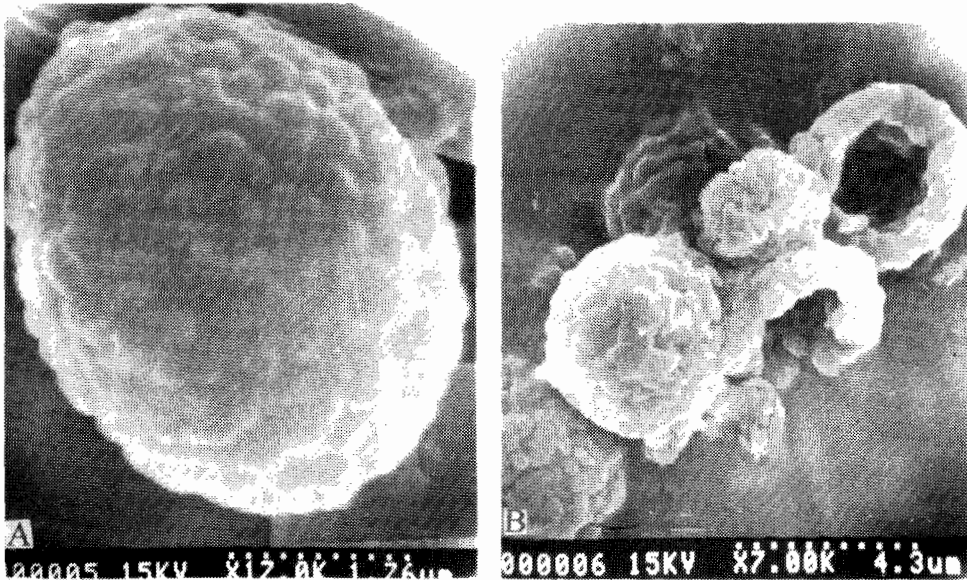


Fig. 1(ii). *Coniothyrium undulatum* (A) Conidia in SEM; (B) conidiogenous cells in SEM.

centre. In multilocular conidiomata the wall is up to 12 cells thick and $20\ \mu\text{m}$ wide, the middle layer separating locules of up to 6 cells thick and darker than the region towards the conidiomatal cavity which is up to 3-6 cells thick, hyaline or light brown in colour. *Conidiophores* absent. *Conidiogenous cells* discrete, indeterminate, hyaline, smooth, cylindrical to lageniform to ampulliform, enterogenous progressive (*sensu* Hennebert & Sutton, 1994) with 1-2 percurrent proliferations, succession of sequential conidia formed successively at higher levels (*sensu* Minter *et al* 1983, 1983b), annellidic (*sensu* Sutton, 1980) collarettes prominent, channels wide and with very marked periclinal thickening, $4.8 \times 1.6-4.5\ \mu\text{m}$. *Conidia* formed first hogenous later enterogenous, aseptate, globose to oblong-globose, brown, $5.6-7.2 \times 4.8-6.4\ \mu\text{m}$, walls $0.6-0.8\ \mu\text{m}$ thick. The outer wall looks uneven by optical microscopy, in scanning electron microscope hemispherical protuberances are evident.

Coelomycete fungi on *Salvadora* with aseptate brown conidia are few and can easily be distinguished from *Coniothyrium undulatum*. *Coniothyrium salvadorae* Petrak & Scharif, described by Petrak (1956) on *S. persica* from Iran, is redescribed in the present study. In *C. salvadorae* conidia are pale brown to blackish brown, ovoid to oblong, thin-walled, minutely verruculose, with or without guttules ($2.8-4.8 \times 1.8-3.2\ \mu\text{m}$), whereas conidia in *C. undulatum* are globose to oblong-globose, thick-walled, with an uneven outer surface by optical microscopy.

Coniothyrium pakistanicum can easily be differentiated from *C. undulatum* by its cylindrical to oblong conidia, truncate bases and apical, basal or sometimes lateral walls more deeply pigmented. Similarly *C. sultanii*, *C. sivanesanii* and *C. truncatum*, also

differ by their rectangular, thick-walled, golden yellowish to brown conidia with a truncate base having small marginal frills and obtuse apices. *Avettaea salvadorae* (Abbas & Sutton, 1988) differs from *C. undulatum* by its eustromatic conidiomata with paraphyses and aseptate brown smooth-walled conidia enclosed in a mucilaginous sheath. Similarly *Avettaea alcornii* Sivanesan & Sutton (1985) resembles *C. undulatum* in having a similar type of hemispherical protuberant conidial ornamentation under SEM. However, it differs in having larger oblong-globose conidia 9-11 μm diam. In the early stages of conidial development, conidia are enclosed in a thick mucilaginous sheath which later becomes thin and hardly visible in mature conidia.

Punithalingam (1970a) studied the surface ornamentation in *Coniothyrium* spp., under scanning electron microscopy by the carbon replica method. The conidial surface of *C. fuckelii* (IMI 135488a) was found to be smooth, whereas *Microsphaeropsis onychiuri* (Punithalingam) Morgan-Jones (IMI 137464) (as *Coniothyrium onychiuri* Punithalingam, 1970b) and *Microsphaeropsis sarcinellae* (Sahni) Morgan-Jones (IMI 112817b) are rough. Punithalingam (1970a) described *C. sarcinellae* and *C. minitans* as having similar hemispherical protuberances which are found here in *C. undulatum* by scanning electron microscopy. However, *M. sarcinellae* can be differentiated from *C. undulatum* by the enterogenous and stationary proliferating conidiogenous cells (*sensu* Hennebert & Sutton, 1994), enteroblastic with a succession of sequential at same level (*sensu* Minter *et al.*, 1983a, 1983b), phialidic (*sensu* Sutton, 1980) and longer and wider conidia measuring 5-9.8x6-7 μm (Sutton, 1980). Similarly *M. onychiuri* also differs from *C. undulatum* by the enterogenous and stationary proliferating conidiogenous cells (*sensu* Hennebert & Sutton, 1994), enteroblastic with a succession of sequential conidia formed at the same level (*sensu* Minter *et al.*, 1983a, 1983b) and smaller conidia, 3-4 x 2-3.5 μm (Punithalingam, 1970b; Morgan-Jones, 1975; Sutton, 1980). *C. minitans* also differs by its parasitic nature on sclerotial fungi and having smaller conidia, 4.5-4.8x3.3-4.2 μm (Punithalingam, 1970a).

Specimens examined:

Coniothyrium undulatum Abbas, Sutton & Ghaffar sp. nov.

On twigs of *Salvadora persica*, Karachi to Hyderabad highway Road, Pakistan, 8 Apr. 1964, S. Ahmad 16912a (IMI 138491a), holotype.

Coniothyrium fuckelii Sacc.

Isolated from *Malus pumila*, India (IMI 135488a).

Coniothyrium pakistanicum Abbas, Sutton & Ghaffar sp. nov.

On stem of *Salvadora oleoides*, Ladhur Sheikhpura, Pakistan, 17 Mar. 1962, S. Ahmad 15458a (IMI 93024a), holotype.

Coniothyrium salvadorae Petrak & Scharif

On twigs of *Salvadora persica*, Minab, Kariam, Iran, 5 Apr. 1955, Gh. Scharif, 859 (IMI 49091), holotype.

Coniothyrium sivanesanii Abbas, Sutton & Ghaffar sp. nov.

On stem of *Salvadora oleoides*, Karachi, Pakistan, S.Q. Abbas (IMI 324384), holotype.

Coniothyrium sultanii Abbas, Sutton & Ghaffar sp. nov.

On stem of *Salvadora oleoides*, Ladhur, Sheikhpura, Pakistan, 17 Mar. 1964, S. Ahmad 15458b (IMI 93024b), holotype.

Avettaea salvadorae (Petra) Abbas & Sutton

On twigs of *Salvadora oleoides*, Changa Manga, Pakistan, 25 Mar. 1950, S. Ahmad 3129 (IMI 228842), holotype, (= holotype of *Haplosporella salvadorae* Petra); Changa Manga, Pakistan, 23 Feb. 1962, S. Ahmad 15428 (IMI 93001), (= holotype of *Coniothyrium salvadorinum* Ahmad).

Microsphaeropsis onychiuri (Punithalingam) Morgan-Jones

On *Onychiurus pseudofimetarius*, Auckland, New Zealand, 1969, Mrs J. Your (IMI 137464), holotype, (= holotype of *Coniothyrium onychiuri* Punithalingam).

II. *Coniothyrium sultanii* Abbas, Sutton & Ghaffar sp. nov.

Fig.2.

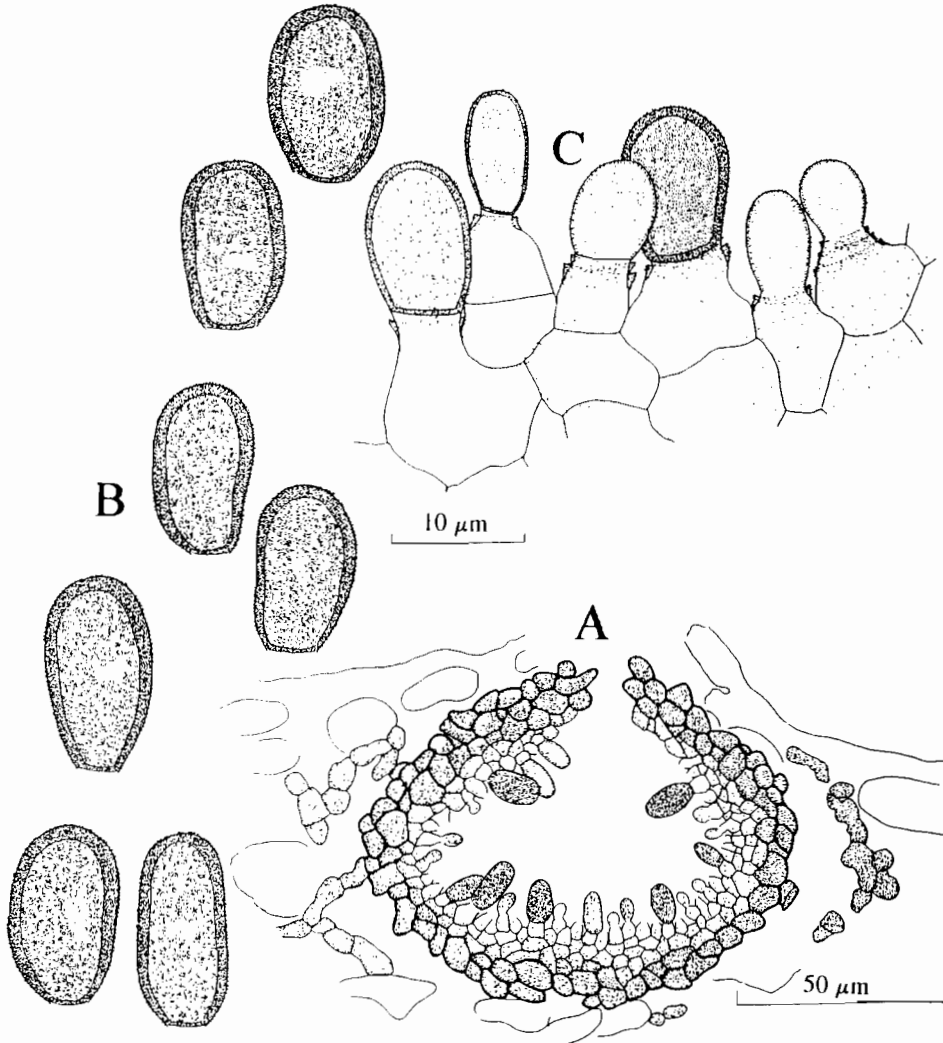


Fig.2. *Coniothyrium sultanii* IMI 93024 (A) V.S. of conidioma; (B) conidia; (C) conidiogenous cells.

Conidiomata pycnidilia, nigra, globosa vel oblongo-globosa, separata vel raro aggregata, immersa, unilocularia, 68-148x66-99 μm . *Ostiolum* singulum, circulare, centrale, 9-12 μm diam., parietes ex textura angulari, 2-4 cellulis crassis ad 4-15 μm lati, ex strato duobus compositi. Stratum exterius 1-2 cellulis crassum consistans ad cellulis nigris et grandis. Stratum interius 1-2 cellulis crassum consistans ad cellulis parvis, hyalinis et tenuioribus. *Conidiophora* absentia. *Cellulae conidiogenae* discretiae, indeterminatae, hyalinae, ochraceae et verrucosae, lageniformes ad ampulliformes, 4.8-9.6x4-8 μm , cum 1-3 proliferationibus enterogenibus progressivis percurrentibus. *Conidia* Primova formali hologenitica cero enterogenitica, aseptata, oblonga vel rectangularia, 10-16x5.6-8 μm , L/B ratio 1.88-2:1, ochracea vel brunnea, verruculosa, apicem obtusa, basim anguste-truncata cum a segmentis marginalis; parietes 1-1.8 μm crassis conidiorum.

In ramis emortuis, *Salvadorae oleoides*, Ladhur, Sheikhpura, Pakistan, 17 Mar. 1962, S. Ahmad 15458b (IMI 93024b), holotypus.

Coniothyrium sultanii Abbas, Sutton & Ghaffar sp. nov.

Conidiomata pycnidial, simple, immersed, solitary to aggregated, unilocular 68-148 X 64-99 μm , ostiole circular, central 9-12 μm diam. Wall composed of textura angularis, 2-4 cells thick, black, 4-15 μm wide, consist of 2 layers, outer layer 1-2 cells thick of dark larger cells and an inner layer 1-3 cells thick of less dark smaller cells. *Conidiophores* absent. *Conidiogenous cells* lageniform to ampulliform, discrete, indeterminate, hyaline, sometime pigmented, slightly verruculose, 4.8-9.6x4-8 μm , formed from the innermost layers of the wall, with 1-3 enterogenous and progressive (*sensu* Hennebert & Sutton, 1994), enteroblastic percurrent proliferations with a succession of sequential conidia formed at higher levels (*sensu* Minter *et al.*, 1983a, 1983b) collarettes prominent and more pigmented, cytoplasmic channels wide. *Conidia* formed first hogenous later enterogenous, aseptate, oblong to rectangular, golden yellow to brown, L/B ratio 1.88-2:1, verruculose, guttulate, apex broadly obtuse, base narrowly truncate, 10 - 16 x 5.6 - 8 μm with a marginal frill; conidial wall 1-1.8 μm thick.

Coelomycetes on *Salvadora* having pycnidial conidiomata, hogenous conidia and enterogenous and progressive conidiogenous cells and 0-1 septate brown conidia, with or without ornamentation are few and significantly different from *Coniothyrium sultanii*. *Coniothyrium salvadorae* Petrak & Scharif, redescribed in the present study, clearly differs by its smaller, thin-walled, oval to globose-ovoid, guttulate, pale brown to blackish brown conidia (2.8-4.8 x 1.8-3.2 μm). *Haplosporella salvadorae* Petrak, *Coniothyrium salvadorinum* (as *C. salvadorina*) Ahmad and *Sphaeropsis salvadorae* Ahmad also reported on *Salvadora* (Petrak & Ahmad, 1954; Ahmad, 1964, 1971) were found to have conidia enclosed in a mucilaginous sheath. Therefore they have been renamed *Avettaea salvadorae* (Abbas & Sutton, 1988a). This species differs from *C. sultanii* by the pycnidial to eustromatic conidiomata (195-910 x 156-325 μm) with paraphyses. Conidia are aseptate, brown, smooth (13-21.5 X 10.5-17.5 μm) and enclosed in mucilaginous sheath. *Coniothyrium undulatum* differs from *C. sultanii* by its globose to oblong-globose conidia with an uneven surface (5.6-7.2 x 4.8- 6.4 μm). It also differs from *Coniothyrium pakistanicum* which has oblong to cylindrical, aseptate, brown conidia (6.4-12 x 2.4-4.8 μm), which are more deeply pigmented in the apical, basal and lateral regions. Similarly *Microdiplodia salvadorina* Ahmad (1962) can

easily be differentiated by the one septate, brown conidia which are constricted at the septa with both ends obtuse (8-11 x 4-5 μm) whereas in *C. sultanii*, the conidia are aseptate, brown, thick-walled, truncate at the base, apex obtuse (10-16 x 5.6-8 μm).

Specimens examined:

Coniothyrium sultanii Abbas, Sutton & Ghaffar sp. nov.

On stem of *Salvadora oleoides*, Ladhur, Sheikhpura, Pakistan, 17 Mar. 1962, S. Ahmad 15458b (IMI 93024b), holotype; Lahore, Sheikhpura, Pakistan, 31 Mar. 1962, S. Ahmad 1960 (IMI 82316); Lahore, Sheikhpura, Pakistan, 17 Mar. 1962, S. Ahmad 15451b (IMI 93017b).

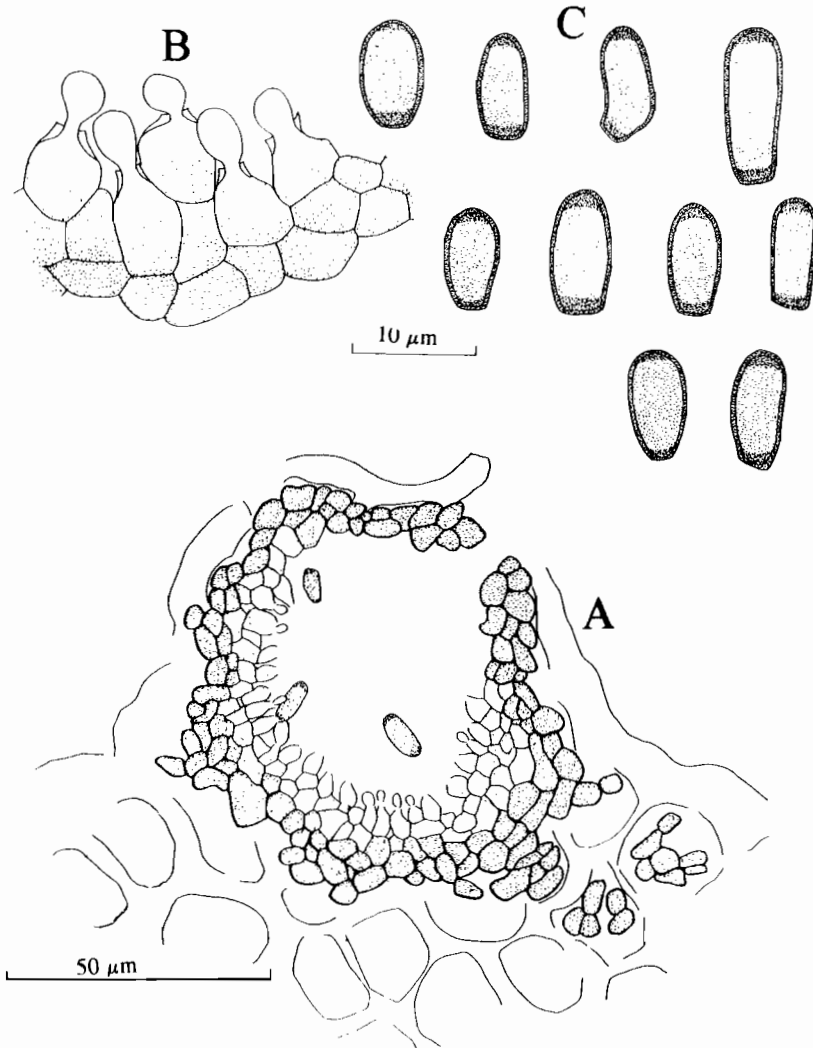


Fig. 3(i). *Coniothyrium pakistanicum* (A) V.S. of conidioma; (B) conidiogenous cells; (C) conidia.

III. *Coniothyrium pakistanicum* Abbas, Sutton & Ghaffar sp. nov.

Fig.3 (i,ii).

Conidiomata pycnidialia vel eustromatica, quam pycnidialia tum pyriformia, nigra, immersa, *ostiolum* singulum, centrale, circulare, leviter papillatum 4-5 μm diam., quam eustromatica tum pyriformia vel convoluta 80-250x72-210 μm . Sed generalis 80-112 x 72-104 μm , parietes 1-4 cellulis crassis ad 2-16 μm lati. In conidiomata eustromatica, parietes secendes consistans 2-16 μm crassi. *Conidiophora* absentia. *Cellulae conidiogena*e discretatae, indeterminatae, lageniformes, hyalinae vel pallide brunneae, 1-2 proliferantibus, enterogenibus progressivis, 4-9.6x3.2-4.8. *Conidia* Primova formanali hologenitica cero enterogenitica, aseptata, laevia, pallido brunnea, oblonga ad cylindrica, apicem obtusa, basim truncata, parietibus crassis, 6.4-12x 2.4-4.8 μm .

In ramis emortuis *Salvadorae oleoides*, Ladhur, Sheikupura, Pakistan, 17 Mar. 1962, S. Ahmad 15458a, (IMI 93024a), holotypus.

Coniothyrium pakistanicum Abbas, Sutton & Ghaffar sp. nov.

Conidiomata pycnidial to eustromatic, when pycnidial then pyriform, unilocular, black, immersed, when eustromatic then unilocular to multilocular, pyriform to convoluted 80-250 X 72-210 μm , but generally 80-112 X 72-104 μm , wall 1-4 cells thick and 2-16 μm wide, composed of textura angularis. In eustromatic conidiomata the middle layer up to 24 μm wide separates the locules. *Ostiole* central, circular, single, papillate, 4-5 μm diam., *Conidiophores* absent. *Conidiogenous cells* formed from innermost layer of wall, lageniform, discrete, indeterminate, pale brown 4-9.6x3.2-4.8 μm , enterogenous, progressive with 1-2 percurrent proliferations (*sensu* Hennebert & Sutton, 1994), collarettes and periclinal thickenings prominent, cytoplasmic channel wide. *Conidia* formed first hogenous, later enterogenous, aseptate, smooth, pale brown, oval to oblong to cylindrical, thick-walled, base truncate, apex obtuse 6.4-12x2.4-4.8 μm . Apical, basal and sometimes lateral regions more pigmented than remainder of the conidial wall.

Coniothyrium pakistanicum differs from all the *Coniothyrium* spp. reported from *Salvadora*. *Coniothyrium sultanii*, *C. sivanesanii* and *C. truncatum* differ in having oblong, thick-walled, verruculose conidia with a truncate base, respectively measuring 10-16 X 5.6-8 μm , 5.6-11.2 X 4-8.8 μm and 5.6-6.8x4-5 μm . Similarly *C. salvadorae* differs in having small ovoid to oblong thin-walled, guttulate conidia (2.8-4.8 X 1.8-3.2 μm). *C. undulatum* can be distinguished by the globose to subglobose conidia (5.6-7.2 X 4.8-6.4 μm) with uneven surfaces. Similarly *C. oblongatum* differs from *C. pakistanicum* by oval to globose, smooth, thick-walled, dark brown conidia with both ends obtuse (3.7-7.8x3.6-5.6 μm). *Avettaea salvadorae* also differs by its eustromatic conidiomata with paraphyses and aseptate, globose to pyriform, brown conidia (13.5-21.5x10.5-17.5 μm) enclosed in a mucilaginous sheath. *Diplodia salvadorina* Ahmad differs from *C. pakistanicum* in having 1-septate, ovoid to oblong, brown conidia (14.6-21.5x8.6-10 μm). Similarly *C. pakistanicum* also differs from *Microdiplodia salvadorina* Ahmad which has 1-septate, brown conidia constricted at the septum (8-11 X 4-5 μm).

Specimens examined:

Coniothyrium pakistanicum Abbas, Sutton & Ghaffar sp. nov.

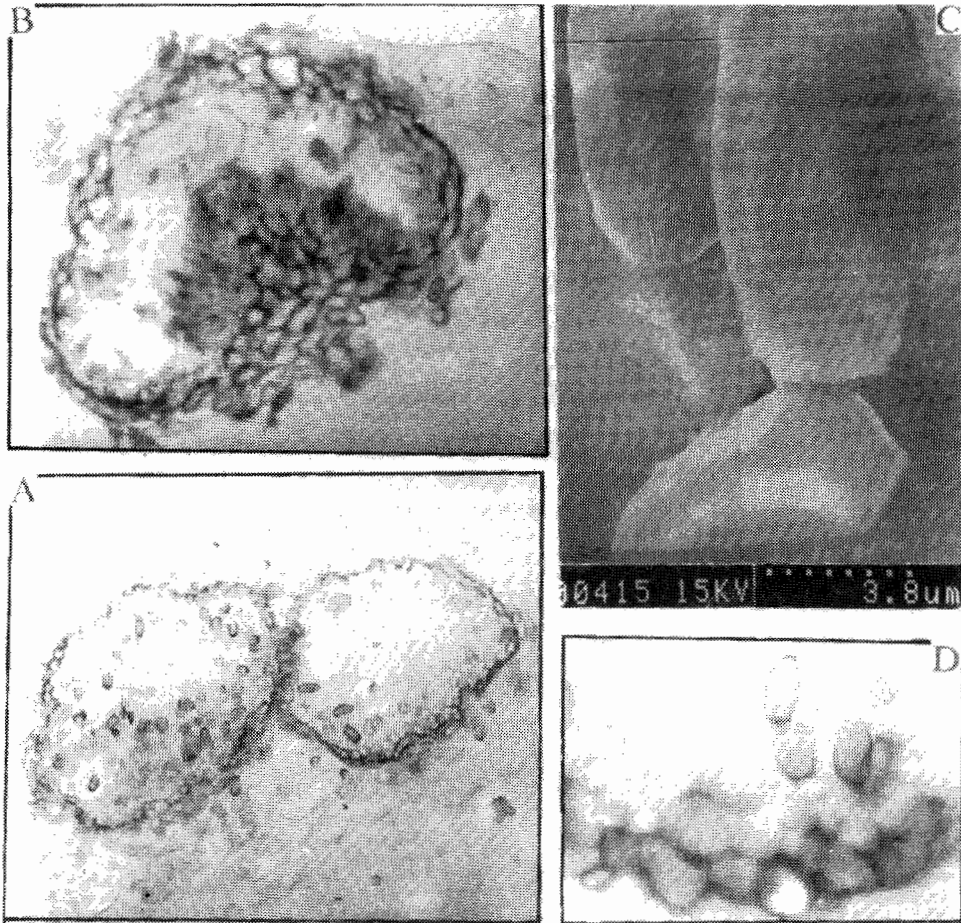


Fig.3(ii). *Coniothyrium pakistanicum* (A) V.S. of aggregated conidiomata, 250X; (B) V.S. of conidioma, 100X; (C) conidia and conidiogenous cells in SEM; (D) conidia and conidiogenous cells, 1000X.

On twigs of *Salvadora oleoides*, Ladhur, Sheikupura, Pakistan, 17 Mar. 1962, S. Ahmad 15458a (IMI 93024a), holotype; Ladhur, Sheikupura, Pakistan, 16 Mar. 1962, S. Ahmad 15451 (IMI 93017).

IV. *Coniothyrium maqsoodii* Abbas, Sutton & Ghaffar sp. nov.

Fig. 4.

Conidiomata pycnidialia, solitaria, pyriformia, nigra, immersa, unilocularia, 60-84 x 68-96 μm . *Ostiolum* singulum, centrale, circulare, 5-10 μm diam. Parietes 1-2 cellulis crassi ad 4-8 μm lati, consistans textura angulari ex strato duobus compositi, stratum exterius ex cellulis crassis, grandis et brunneo-nigris consistans, quam stratum interius cellulis crassis, hyalinis, tenuioribus consistans. *Conidiophora* absentia. *Cellulae*

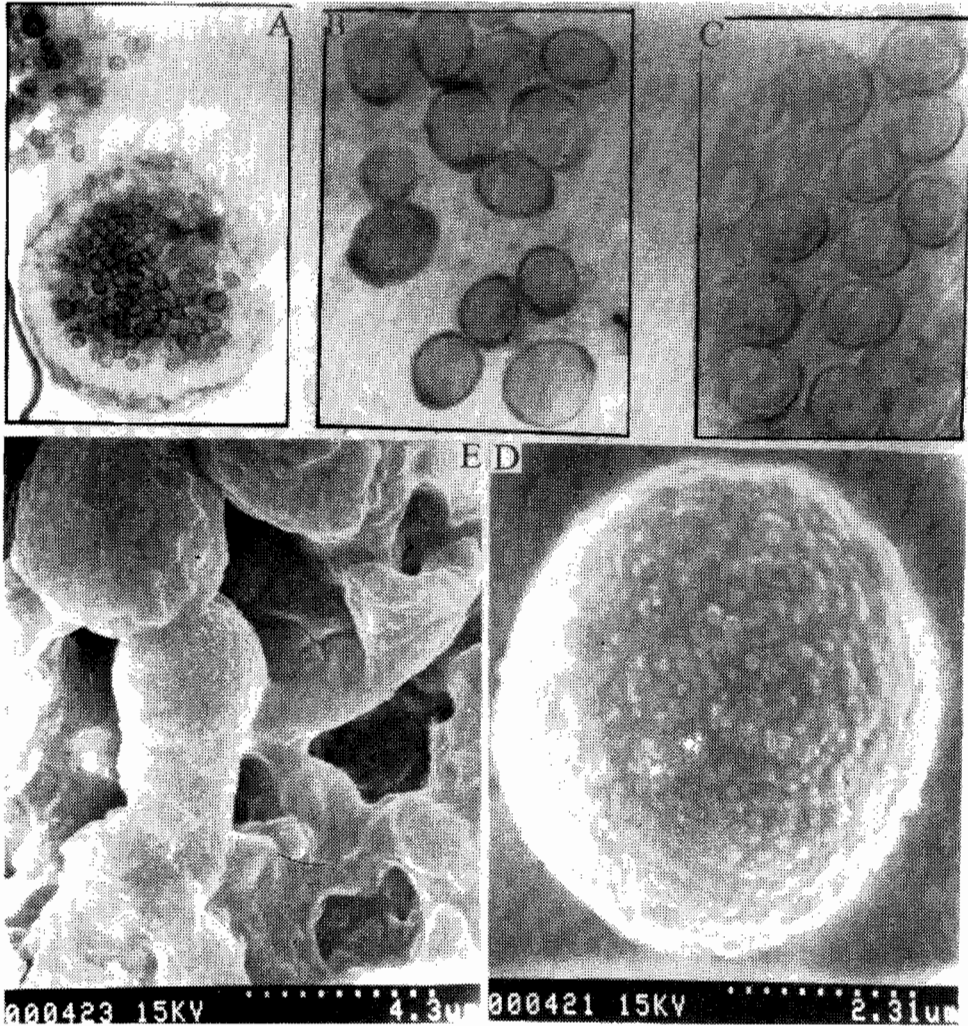


Fig.4. *Coniothyrium maqsoodii* (A) V.S. of conidioma, 40X; (B) conidia in bright field, 1000X; (C) conidia in Nomarski optics, 1000X; (D) conidia in SEM; (E) conidiogenous cells in SEM.

conidiogenae discretae, indeterminatae, cylindricae vel ampulliformes 1-4 proliferantibus, enterogenibus, progressivis 8-13.5 x 4.8 - 6.9 μm . *Conidia* Primova formali hologenitica cero enterogenitica immatura oblonga quam conidia matura aseptata, oblongo-globosa, tenuiora, minute verruculosa, apicem et basim late obtusa 4.8-8 x 4-8 μm .

In ramis emortuis, *Salvadorae oleoides*, Karachi Pakistan. 14 Mar. 1987. S.Q. Abbas UCMH 751 (P), holotypus.

Coniothyrium maqsoodii Abbas, Sutton & Ghaffar sp. nov.

Conidiomata simple pycnidial, globose, solitary, black, immersed, unilocular, pyriform, 60-84 X 68-96 μm , *ostiole* single, circular, central 5-10 μm diam., wall of *textura angularis* 1-2 cells thick, 4-8 μm wide, consisting of two layers, an outer layer 1 cell thick, of brownish black large cells and an inner layer also 1 cell thick of hyaline, thin-walled, smaller cells. *Conidiophores* absent. *Conidiogenous cells* discrete, indeterminate, hyaline, cylindrical to ampulliform, enterogenous, progressive, with 1-4 percurrent proliferations, upper region with blackish brown collarete and wide channel, 8-13.5 x 4.8-6.4 μm . *Conidia* formed first hologenous later enterogenous, aseptate, oblong-globose, thin-walled, minutely verruculose, both ends broadly obtuse, 4.8-8x4-8 μm , immature conidia oblong.

C. maqsoodii resembles *C. suttonii* in conidial morphology but can easily be differentiated by its thin-walled conidia.

The type collection of *C. maqsoodii* also bears *Hadrotrichum globiferum* (Ell. & Everh.) Davis. This species has thick-walled, verruculose, spherical conidia 10-12 μm diam. This created some confusion and initially it was thought that *C. maqsoodii* belonged to *C. suttonii* due to the presence of thick-walled conidia of *H. globiferum*. However critical studies revealed that the pycnidia of *C. maqsoodii* contained only thin-walled conidia, and hence *C. maqsoodii* and *C. suttonii* differ from each other.

Specimen examined:

Coniothyrium maqsoodii Abbas, Sutton & Ghaffar sp. nov.

On twigs of *Salvadora oleoides*, Karachi, Pakistan, 14 Mar. 1987, S.Q. Abbas UCMH 751 (P), holotype.

V. *Coniothyrium ismailii* Abbas, Sutton & Ghaffar sp. nov.

Fig.5.

Conidiomata pycnidialia, solitaria, nigra, immersa, globosa vel pyriformes, unilocularia, 64-96x80-104 μm . *Ostiolum* singulum, centrale, circulare, papillatum 9-12 μm diam., parietes 4-6 cellulis crassi et 15-25 μm lati, ex *textura angulari*, ex stratis duobus compositi. Stratum exterius 1-2 cellulis crassum et grandius, paries superior cellulis atrobrunneis consistans quam paries inferior, cellulis pallidissime-brunneis consistans. Stratum interior 3-4 cellulis crassum ad cellulis parvis, hyalinis et tenuioribus compositum. *Conidiophora* absentia. *Cellulae conidiogenae* discretiae, indeterminatae, hyalinae, laeves, ampulliformes vel lageniformes, regio superior minute verruculosa et pallidissime-brunnea, 1-2 proliferantibus enterogenibus, progressivis, 6.5-8.8 x 5.6-8 μm . *Conidia* primova formanali hologenitica cero enterogenitica, aseptata, oblongo-globosa, immatura rectangularia, parietes crassis, apicem et basim angustotruncata, ad basim excentrica, 7.2-12 x 6.4-8.8 μm , l/b ratio 1.125-1.36.

In ramis emortuis *Salvadorae oleoides*, Ladhur, Sheikhpura, Pakistan, 16 Mar. 1962, S. Ahmed 15451c (IMI 93017c), holotypus.

Coniothyrium ismailii Abbas, Sutton & Ghaffar sp. nov.

Conidiomata pycnidial, solitary, black, immersed, globose, to pyriform, unilocular, 64-96x80-104 μm . *Ostiole* central, circular, single, papillate, 9-12 μm diam., wall of *textura angularis*, 4-6 cells thick, 15-25 μm wide, differentiated into 2 layers, outer layer 1-2 cells thick of larger, thick-walled blackish brown cells and an inner layer 3-4

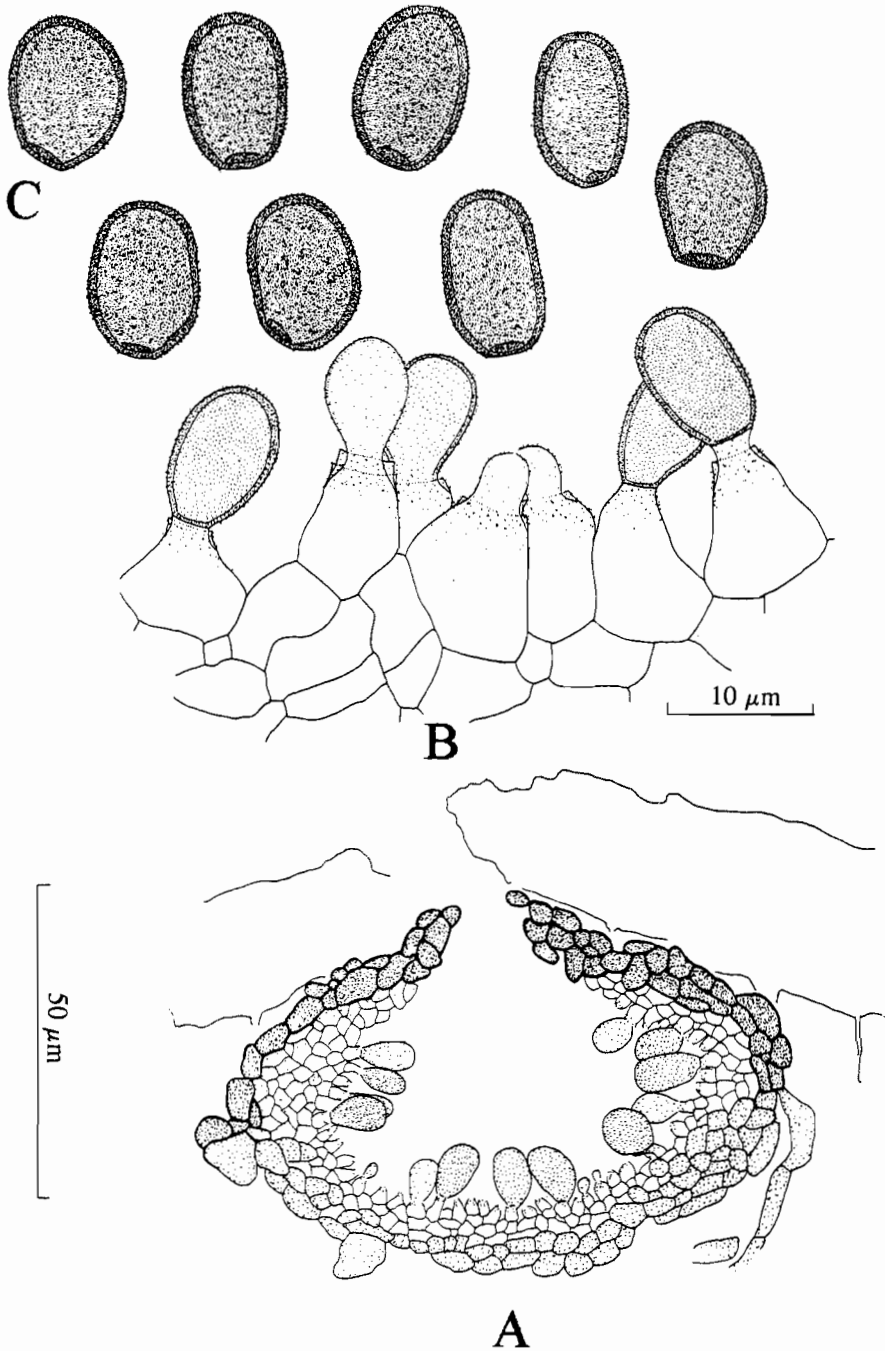


Fig.5. *Coniothyrium ismailii* (A) V.S. of conidioma; (B) conidiogenous cells; (C) conidia.

cells of smaller, thin-walled hyaline cells. *Conidiophores* absent. *Conidiogenous cells* ampulliform to lageniform, indeterminate, discrete, hyaline, but upper region minutely verruculose and brown, enterogenous, progressive with 1-2 percurrent proliferations, channel wide, collarettes and periclinal thickening prominent, 6.5-8.8 X 5.6-8 μm . *Conidia* formed first hogenous later enterogenous aseptate, oblong-globose (immature rectangular), thick-walled, verruculose, apex broadly obtuse, base narrowly truncate with a prominent slightly excentric basal scar, 7.2-12 X 6.4-8.8 μm , l/b ratio 1.125:1.36.

Coniothyrium ismailii closely resembles *C. sultanii*, *C. sivanesanii* and *C. truncatum* in conidial morphology, but can easily be differentiated. Conidia in *C. sultanii* are oblong to cylindrical to pyriform, verruculose, apex obtuse, base truncate, with two minute frills which are remnants of the outer conidial wall, showing schizolytic conidial secession (10-16 x 5.6-8 μm), l/b ratio 1.88-2:1, conidial wall 1.5-2 μm thick. Conidia in *C. ismailii* are oblong-globose (7.2-12 X 6.4-8.8 μm) l/b ratio 1.125:1.36, apex obtuse, base narrowly truncate, with an excentric basal scar, showing schizolytic secession without frills. Similarly in *C. sivanesanii* the conidial range is wider (5.6-11.2 x 4-8.8 μm) than in *C. ismailii* (7.2-12 X 6.4 - 8.8 μm), however the upper limit of the conidial range is slightly lower. Furthermore *C. sivanesanii* can be differentiated from *C. ismailii* by its oblong to cylindrical conidia with the apex and base more or less of equal width and a frilled truncate base. *C. truncatum* can also be differentiated from *C. ismailii* by its smaller oblong to cylindrical conidia (5.6-6.8x4-5 μm) with the apex and base more or less of equal width and a frilled truncate base.

Specimen examined:

Coniothyrium ismailii Abbas, Sutton & Ghaffar sp. nov.

On stem of *Salvadora oleoides*, Ladhur, Sheikhpura, Pakistan, 16 Mar. 1962, S. Ahmad 54581c (IMI 93017c), holotype.

VI. *Coniothyrium sivanesanii* Abbas, Sutton & Ghaffar sp. nov.

Fig.6 (i,ii,iii).

Conidiomata pycnidialia, nigra, separata, immersa, globosa ad depressa-globosa ad lageniformia, unilocularia, 80-152 x 73-160 μm . *Ostiolum* singulum, circulare, centrale, papillatum, 5-20 μm diam. Parietes 2-4 cellulis crassi et 4-16 μm lati, ex textura angulari ad strato duobus compositi. Stratum exterior 1-2 cellulis crassum, atro brunneum, grandius, parietibus crassis quam stratum interior, 1-2 cellulis crassum ex cellulis pallidioribus tenuioribus, parvioribus et crassis. Saepe *conidiophora* absentia, sed raro uno cellula singula subtentia. *Cellulae conidiogenae* discretatae, laeves, indeterminatae, in conidiophoris incorporatae, cylindricae vel fusiformes vel ampulliformes, hyalinae ad pallide-brunneae. 1-4 proliferantibus, enterogenibus, progressivis 4-9.6x3.2-9.6 μm . *Conidia* Primova formanali hogenitica cero enterogenitic aseptata, oblonga vel rectangularia vel oblongo-globosa, aurata vel atrobrunnea, 5.6-11.2x4-8.8 μm , basim truncata, apicem obtusa, parietibus crassis, minute verruculosa cum segmentis marginalis.

In ramis emortuis, *Salvadorae oleoides*, Karachi, Pakistan, S.Q. Abbas (IMI 324384), holotypus.

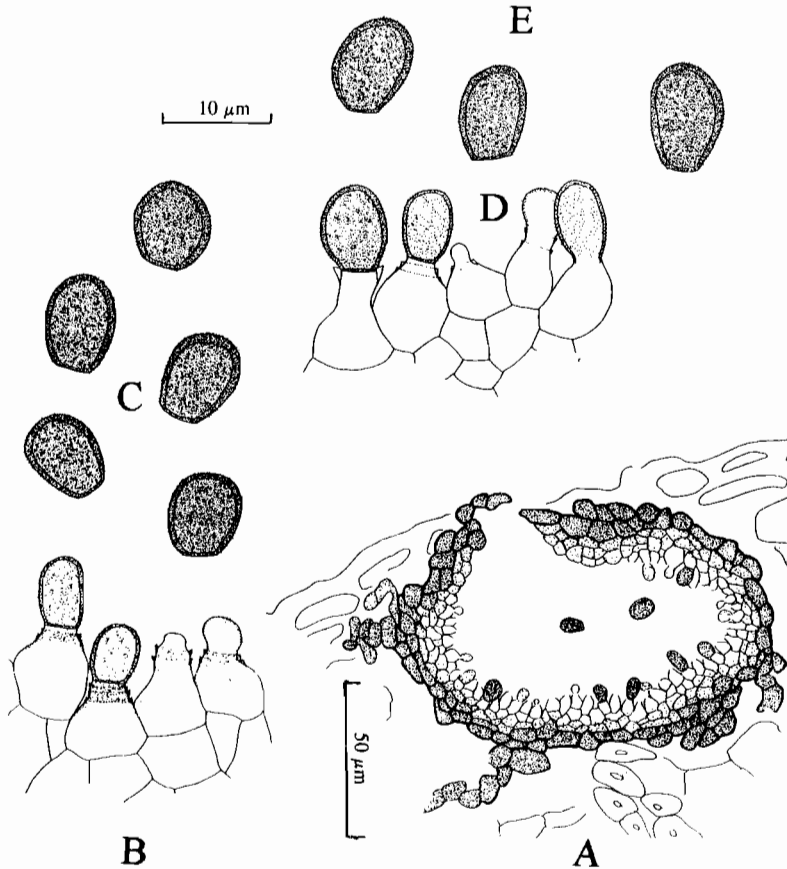


Fig. 6(i). *Coniothyrium sivanesanii*, IMI 93017 (A) V.S. of conidioma; (B) conidiogenous cells; IMI 93208 (C) conidia; (D) conidiogenous cells; (E) Conidia.

Coniothyrium sivanesanii Abbas, Sutton & Ghaffar sp. nov.

Conidiomata pycnidial, immersed, globose to depressed globose to lageniform, black, separate, unilocular, 80-152 x 73-106 μm , *ostiole* central, circular, papillate 5-20 μm diam., wall of *textura angularis*, 2-4 cells thick, 4-16 μm wide, outer layer 1-2 cells thick, dark brown and thick-walled; inner layer 1-2 cells thick, thin-walled, hyaline. *Conidiophores* generally absent but when present then unicellular and smooth. *Conidiogenous* cells discrete, occasionally integrated, indeterminate, cylindrical to fusiform to ampulliform, hyaline, sometimes pale brown and smooth, enterogenous, progressive 1-4 prominent proliferations collarettes flared, wide channels and prominent periclinal thickenings, 4-9.6 x 3.2-9.6 μm . Conidia formed first hologenous later enterogenous, aseptate, yellowish brown to blackish brown, oblong to globose-oblong, thick-walled, verruculose, base truncate with marginal frills, and apex obtuse, 5.6-11.2 X 4-8.8 μm .

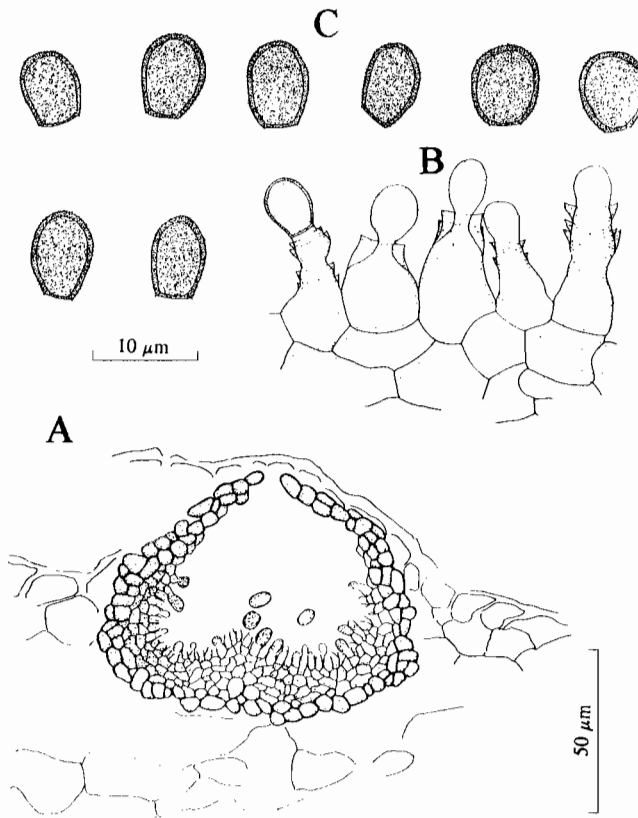


Fig. 6(t). *Coniothyrium sivanesanii*, IMI 324384 (A) V.S. of conidiomata; (B) conidiogenous cells, (C) conidia.

This species closely resembles *Coniothyrium sultanii* and *C. truncatum* in conidial morphology, but conidia are smaller ($5.6-6.8 \times 4-5 \mu\text{m}$) in *C. truncatum* and larger ($10-16 \times 5.6-8 \mu\text{m}$) in *C. sultanii*. Petrak (1956), when describing *C. salvadorae* also mentioned another taxon with conidia $6-11 \times 4.5-6.5 \mu\text{m}$. He was not confident if it was *Coniothyrium* or *Pseudodiplodia*. Critical studies of the type specimen of *C. salvadorae* (IMI 94190) showed that at least 5 other *Coniothyrium* spp., are present on the type specimen. The taxon Petrak referred to is named *Coniothyrium sivanesanii* sp. nov.

Specimens examined:

Coniothyrium sivanesanii Abbas, Sutton & Ghaffar sp. nov.

On twigs of *Salvadora oleoides*, Karachi, Pakistan, S.Q. Abbas, (IMI 324384), holotype; Ladhur, Sheikhpura, Pakistan 16 Mar. 1962, S. Ahmed 15451d (IMI 93017d); on *S. persica*, Karachi, Pakistan 29 Feb. 1986 S.Q. Abbas UCMH 186, (IMI 314984); on twigs of *S. oleoides*, Chokundi, Sindh, Pakistan, 9 Mar. 1987, S.Q. Abbas UCMH 645b (IMI 315428); on twigs of *S. oleoides*, Khadeji Fall, Sindh, Pakistan. 14 Mar. 1987, S.Q. Abbas UCMH 593 (IMI 315380); on twigs of *S. oleoides*, Khadeji Fall, Sindh, Pakistan, 14 Mar. 1987, S.Q. Abbas UCMH 710 (IMI 315488).

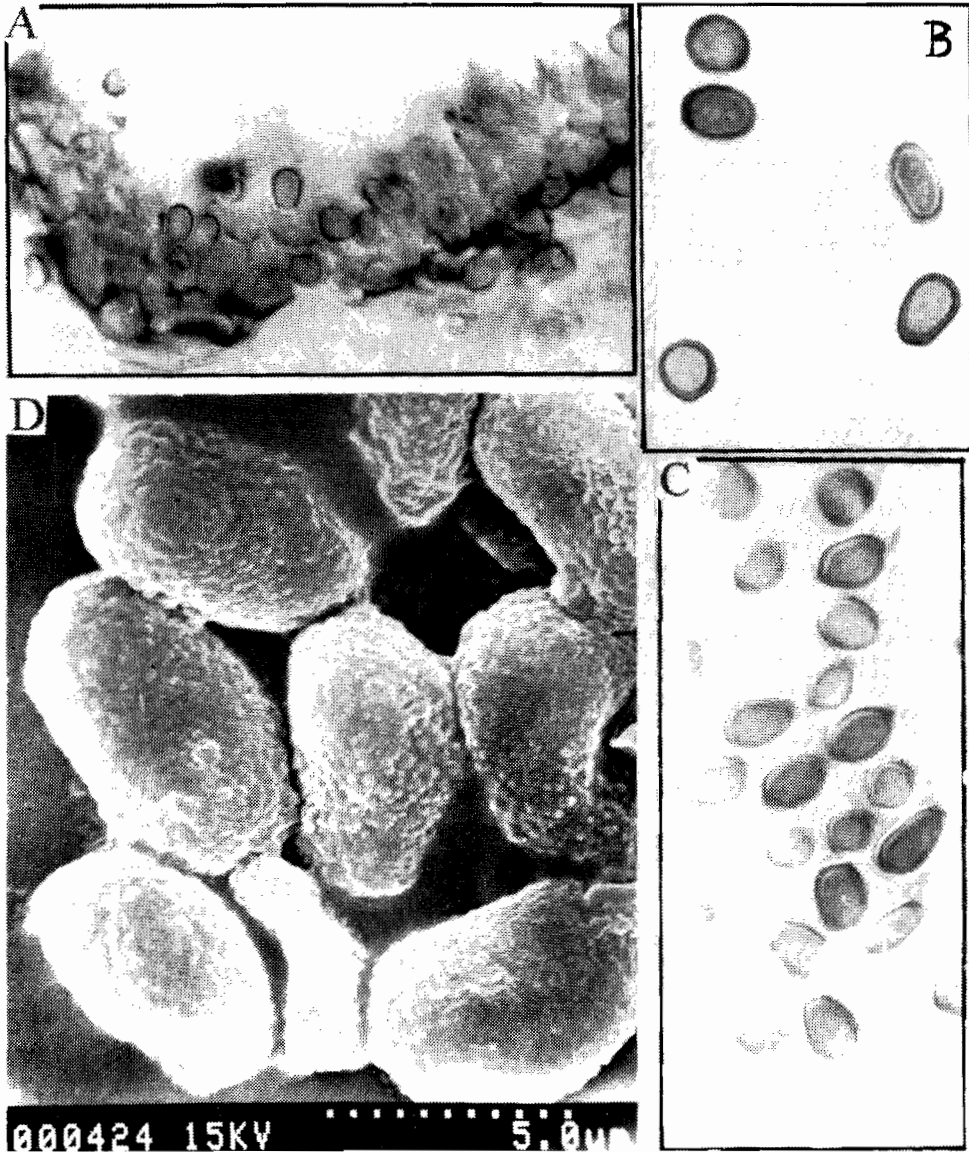


Fig. 6(iii). *Coniothyrium sivananii*, IMI 93017 (A) V.S. of conidioma with conidiogenous cells, 1000X; (B) conidia, 1000X; IMI 324384 (C) conidia in Nomarski optics, 1000X; (D) conidia in SEM.

VII. *Coniothyrium suttonii* Abbas, Sutton & Ghaffar sp. nov.

Fig. 7.

Conidiomata pycnidialia, nigra, immersa, solitaria, raro aggregata, pyriformes, unilocularia 64-160x60-150 μm , *ostiolum* singulum, centrale, circulare 10-15 μm diam., parietes 1-2 cellulis crassi ad 4-12 μm lati, ex textura angulari ad strato duobus compositi. Stratum exterior 1 cellula crassum, grandum, brunneonigrum, quam stratum interior 0-1 cellula crassum, parvum, hyalinum et tenuius. Generalis *conidiophora* absentia, raro cellula singula substenta 3.2-5.6 x 3-6 μm . *Cellulae conidiogenae* discretae, determinatae, raro conidiophoris incorporatae, cylindricae ad lageniformes vel ampulliformes, 1-2 proliferantibus, enterogenibus, progressivis 4-13.6 x 3.2-6.4 μm . *Conidia* Primova formanali hologenitica cero enterogenitica, aseptata, brunnea, sphaerica (conidia immatura oblonga), pariete crassa, minute verruculosa 4.8-8 (9.6) x 4-8 μm .

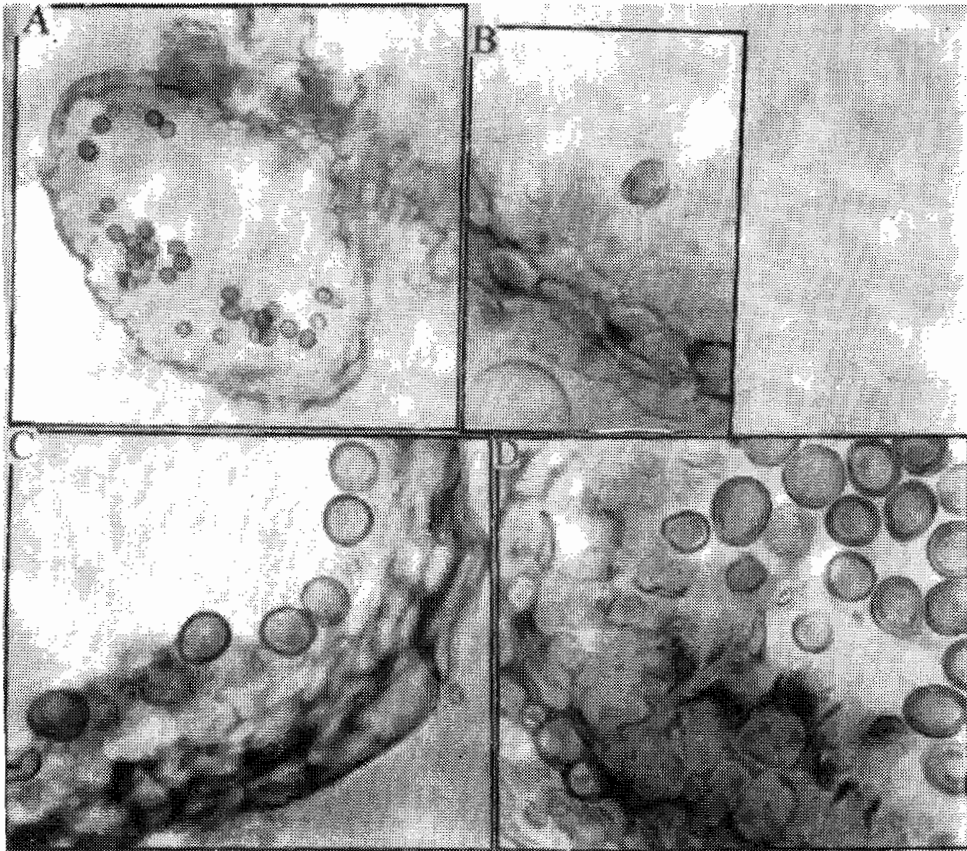


Fig. 7. *Coniothyrium suttonii* (A) V.S. of conidioma, 40X; (B) conidiogenous cells, 1000X; (C) conidioma and conidiomatal wall and conidia, 1000X; (D) conidia and conidiogenous cells, 1000X.

In ramis emortuis *Salvadorae oleoides*, Karachi, Pakistan. 14 Mar. 1987, S.Q. Abbas UCMH 752 (N), holotypus.

Coniothyrium suttonii Abbas, Sutton & Ghaffar sp. nov.

Conidiomata pycnidial, immersed, black, solitary, sometimes aggregated, pyriiform, unilocular, 64-160x60-150 μm , *ostiole*, single, circular, central 10-15 μm diam. Wall 1-2 cells thick and 4-12 μm wide of textura angularis, consisting of two layers, the outer dark and thick-walled, the inner thin and hyaline. *Conidiophores* generally absent, but when present then single celled, 3.2-5.6 X 3-6 μm . *Conidiogenous cells* cylindrical to ampulliform, discrete, indeterminate, sometimes integrated, enterogenous, progressive with 1-2 percurrent proliferations, hyaline but becoming brown or blackish brown in the upper collarette region, collarette and periclinal thickening prominent, channel wide, 4-13.6 x 3.2-6.4 μm . *Conidia* formed first hogenous later enterogenous, aseptate, brown, spherical (immature oblong), thick-walled, minutely verruculose 4.8-8, (9.6)x 4-8 μm .

Various collections of Coelomycetes on *Salvadora* and the holotype of *Coniothyrium salvadorae* (IMI 94190) also have brown, spherical, thick-walled conidia. In some collections, they are mainly small, whereas in others they are comparatively larger (IMI 82316), perhaps indicating two different species. Examination of additional specimens of *Salvadora* showed that small and larger conidia were both present in the same specimen UCMH 752 (N). This suggests that this is one variable species. Cultural studies would further help to resolve this anomaly.

Coniothyrium suttonii can be distinguished from all other *Coniothyrium* spp., found on *Salvadora*. *C. sultanii* (10-16 X 5.6-8 μm), *C. sivanesanii* (5.6-11.2 X 4-8.8 μm), and *C. truncatum* (5.6-6.8x4-5 μm) differ in having aseptate, oblong, thick-walled conidia with truncate bases, whereas *C. salvadorae* has aseptate, brown, oblong to ovoid, thin-walled, guttulate (2.8-4.8 X 1.8-3.2 μm) conidia with narrow truncate bases. Similarly *C. pakistanicum* differs in having aseptate, cylindrical to oblong, smooth-walled (6.4-12x2.4-4.8 μm) conidia, more deeply pigmented on the apical, basal and sometimes lateral sides. *C. undulatum* also differs in its oblong to oblong-globose, thick-walled, aseptate, brown (5.6-7.2 X 4.8-6.4 μm) conidia with uneven surfaces. *Coniothyrium oblongatum* differs in its oblong, thick-walled, dark brown conidia (3.7-7.8x3.6-5.6 μm). Similarly *Coniothyrium maqsoodii* differs from *Coniothyrium suttonii* in having oblong-globose, thin-walled and minutely verruculose 4.8-8x4-8 μm conidia.

Specimens examined:

Coniothyrium suttonii Abbas, Sutton & Ghaffar sp. nov.

On stem of *Salvadora oleoides*, Karachi, Pakistan, 14 Mar. 1987. S.Q. Abbas UCMH 752 (N), holotype, on stem of *S. oleoides*, Karachi, Pakistan, 14 Mar. 1987, S.Q. Abbas UCMH 753 (M); on stem of *S. oleoides*, Ladhur, Sheikhpura, 27 July 1947, S. Ahmad 1960 (IMI 82316C).

VIII. *Coniothyrium oblongatum* Abbas, Sutton & Ghaffar sp. nov.

Fig.8 (i,ii)

Conidiomata eustomatica, nigra, solitaria vel aggregata, globosa vel depressa globosa vel applanata-globosa, unilocularia vel bilocularia, 116-250x116-145 μm ; *ostio-*

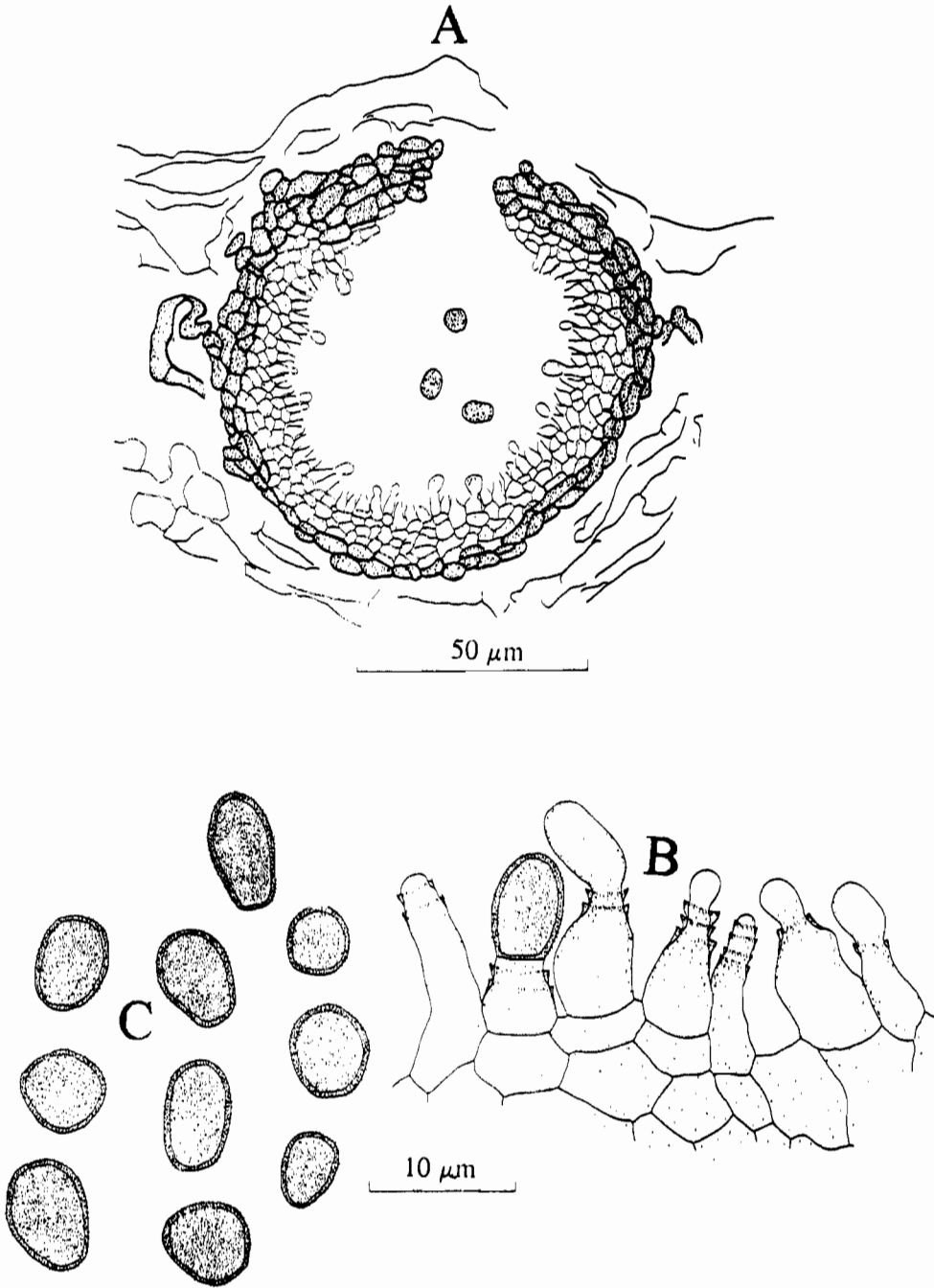


Fig. 8(i). *Coniothyrium oblongatum* (A) V.S. of conidioma; (B) conidiogenous cells; (C) conidia.

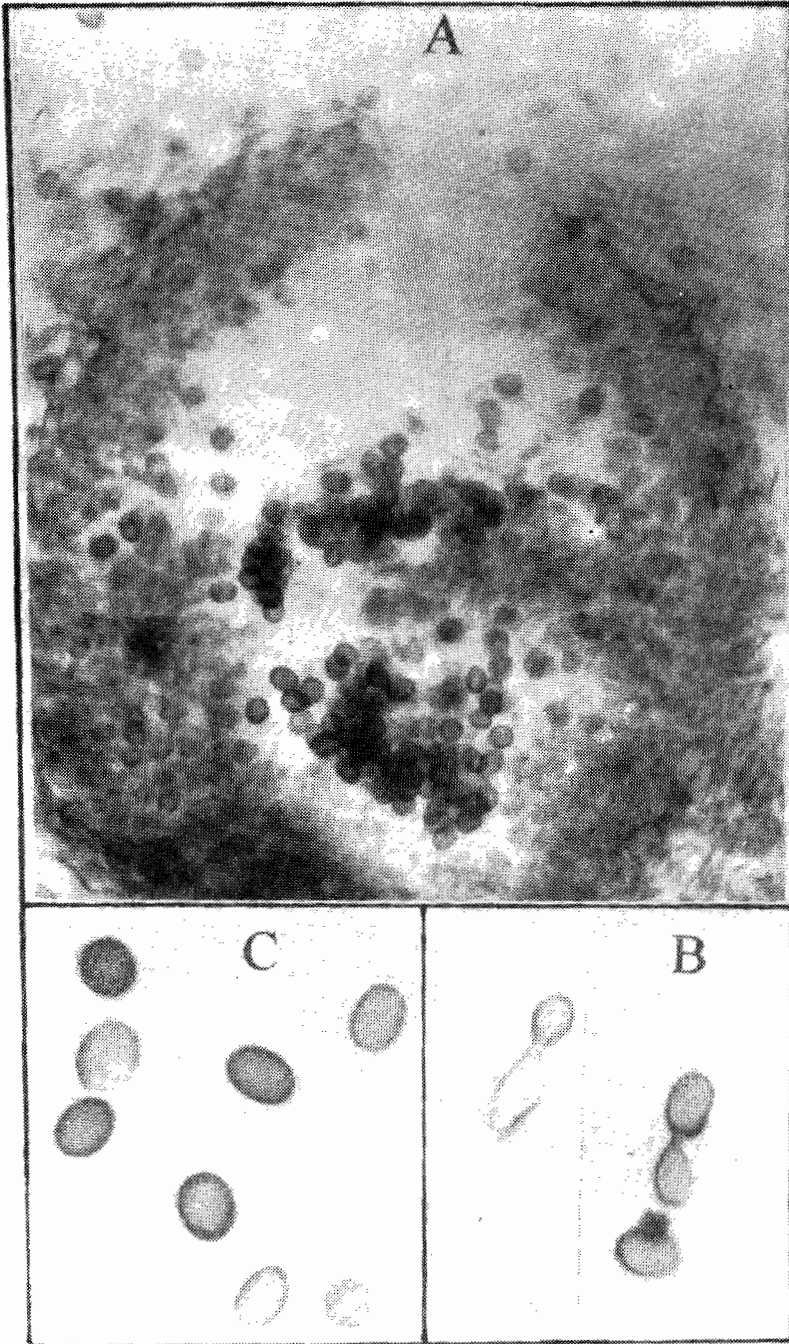


Fig.8(ii). *Coniothyrium oblongatum* (A) V.S. of conidioma, 250X; (B) conidiogenous cells, 1000X; (C) conidia, 1000X.

lum singulum, circulare, centrale 10-15 μm in diam. Parietes 3-6 cellulis crassi ad 8-20 μm lati, ex textura angulari compositi, parietibus gradatim hyalinis versus centrum. *Conidiophora* absentia. *Cellulae conidiogenae* discretatae, indeterminatae, cylindricae vel ampulliformes vel lageniformes, laeves, 1-4 proliferantibus, enterogenibus, progressivis minute verruculosae 4-8x4.6-6.4 μm ., *Conidia* primova formanili hologenitica cero enterogenitica, aseptata, atrobrunnea, elliptica vel elliptico oblongata, apicem ad basim obtusa, 3.7-7.8x3.6-5.6 μm .

In ramis emortuis *Salvadorae oleoides*, Karachi Pakistan, 13 Dec. 1986, S.Q. Abbas UCMH 753 (VVV) (IMI 261986), holotypus.

Coniothyrium oblongatum Abbas, Sutton & Ghaffar sp. nov.

Conidiomata eustromatic, solitary or aggregated, globose to depressed globose to appanate globose, black, unilocular or bilocular, 116-250 x 116-140 μm . *Ostiole* single, central, circular, 10-15 μm diam. Wall of textura angularis, 3-6 cells thick, 8-20 μm wide, gradually becoming hyaline towards the centre. *Conidiophores* absent. *Conidiogenous cells* cylindrical, ampulliform to lageniform, discrete, indeterminate, smooth, slightly verruculose, with 1-4 enterogenous, progressive proliferations, collarettes prominent, minute periclinal thickenings and wide channels, 4-8 X 4.6-6.4 μm . *Conidia* formed first hogenous later enterogenous, aseptate, ovoid to oblong-ovoid, smooth, dark brown, both ends obtuse, 3.7-7.8x3.6-5.6 μm .

This taxon differs significantly from all the *Coniothyrium* spp., found on *Salvadora* in having dark brown, slightly verruculose, thick-walled, ovoid to oblongo-ovoid conidia. *Coniothyrium salvadorae* Petrak differs in having oval to ovoid to oblong-ovoid, thin-walled, minutely verruculose conidia with a central guttule (2.8-4.8x1.8-3.2 μm). *C. undulatum* also differs in having globose to globose-spherical conidia with uneven surfaces (5.6-7.2 X 4.8-6.4 μm). *C. pakistanicum* also differs by the smooth-walled, cylindrical to oblong (6.4-12 X 2.4-4.8 μm) conidia with more pigmentation at the apices, bases and lateral walls. In the same way *C. sultanii* (10-16 X 5.6-8 μm), *C. sivanesianii* (5.6- 11.2 X 4-8.8 μm) and *C. truncatum* (5.6-6.8x4-5 μm) differ in having dark, thick-walled, verruculose conidia with truncate bases.

Specimens examined:

Coniothyrium oblongatum Abbas, Sutton & Ghaffar sp. nov.

On stems of *Salvadora oleoides*, Karachi, Pakistan, 13 Dec. 1986, S.Q. Abbas, UCMH 753 (VVV) (IMI 261986), holotype.

IX. *Coniothyrium salvadorae* Petrak & Scharif, *Sydowia* 10: 8 (1956) 1957. (Description amended).

Fig.9.

Conidiomata pycnidial, solitary or aggregated, immersed, black, unilocular, globose to depressed globose, 50-105x50-116 μm . *Ostiole*, circular, central, 5-8 μm in diam. Wall of textura angularis, 1-4 (10) cells thick, but generally 1 cell thick, 5.5-10.5 μm wide, when 2-4 cells thick then differentiated into two layers, an outer layer 1-2 cells thick, dark black, the inner layer 1-2 cell thick, hyaline and thin-walled. *Conidiophores* absent. *Conidiogenous cells* cylindrical, ampulliform, 4-10.3x5.5-10.9 μm , with 1-4 enterogenous progressive proliferations, collarettes prominent, channels wide and periclinal thickenings minute. *Conidia* formed first hogenous later enterogenous,

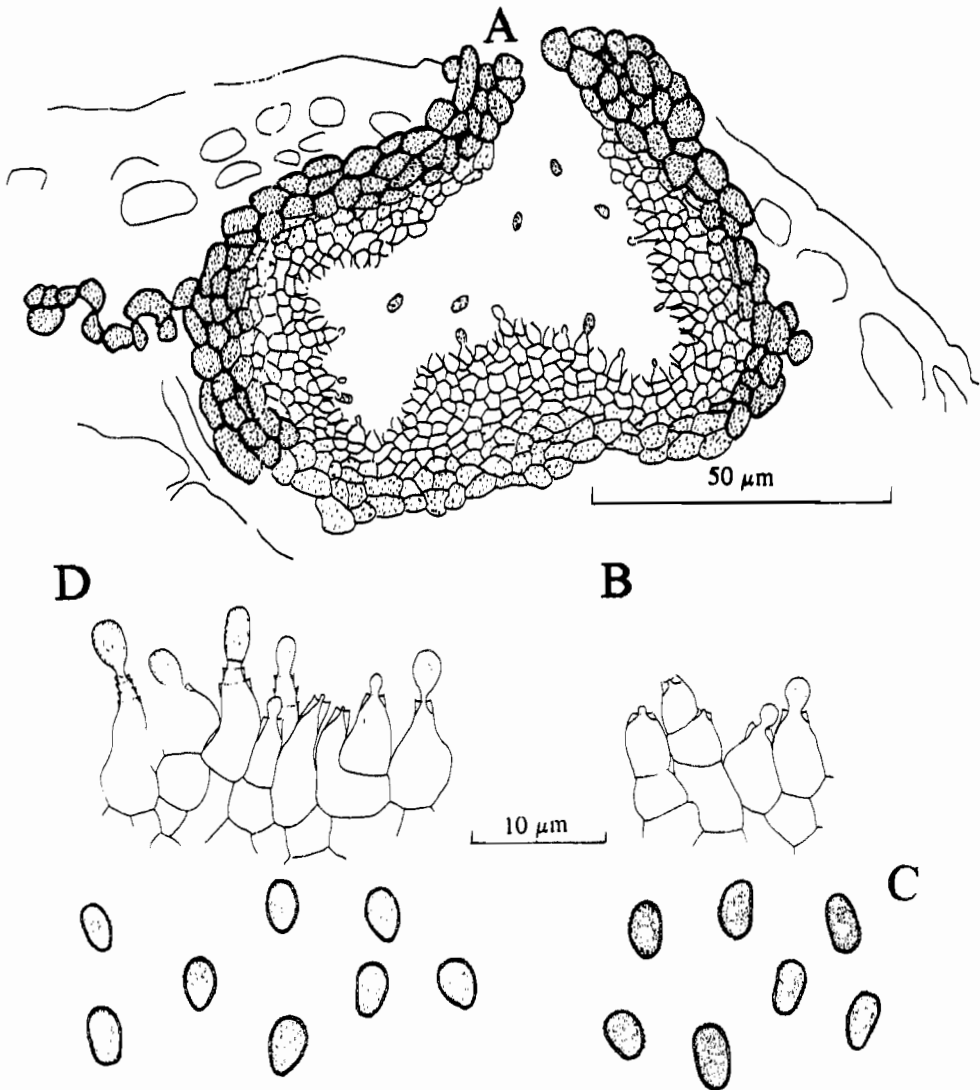


Fig.9. *Coniothyrium salvadorae*, IMI 324046 (A) V.S. of conidioma; (B) conidiogenous cells; (C) conidia; IMI 94190, type (D) conidiogenous cells; (E) conidia.

aseptate, pale brown, oblong to ovoid, oblong-ovoid, thin-walled, base narrowly truncate, apex obtuse, guttulate, outer wall minutely verruculose, $2.8-4.8 \times 1.8-3.2 \mu\text{m}$.

On stem of *Salvadora persica*, Minab, Kariam, Iran, 5 Apr. 1955, Gh. Scharif 850 (IMI 94190), holotype.

From the type specimen of *C. salvadorae* Petrak & Scharif on *Salvadora persica*, at least 5 undescribed *Coniothyrium* spp., are now known. Petrak (1956) when describing *C. salvadorae* also mentioned the presence of brown conidia of a taxon measuring

6-11 x 4.5-6.5 μm . He was not confident whether it belonged to *Coniothyrium* or *Pseudodiplodia*. However, from the description, *C. salvadorae* can easily be differentiated. The present study generally confirms the original description of *C. salvadorae* but with slight variations. Petrak (1956) described conidiomata from the type as pycnidia 80-120 μm diam., and a wall 6-10 μm wide, whereas in the present study conidiomata were found to be 73-125 μm , and the wall 5.5-8 μm wide. However, from other collections of *Salvadora oleoides* from Pakistan (IMI 324046; UCMH 710,726,754) conidiomata have been found to be 50-125x50-116 μm and the wall 5.6-10.5 μm wide. Descriptions of conidiophores and conidiogenous cells were not given by Petrak (1956). From the type specimen of *S. salvadorae* conidiophores are concluded as absent and conidiogenous cells to be discrete, indeterminate, hyaline, with 1-4 enterogenous progressive proliferations, prominent but narrow to wide channel and minute periclinal thickenings. Conidiogenous cells from other specimens also fall in the same range. Conidia from the type were described by Petrak (1956) as aseptate, pale brown, oval to ovoid, guttulate, found in mucilaginous material, 3-4.5x2.5-3.5 μm . However in the present study, conidia from the type were found to be formed first hologenous later enterogenous aseptate, pale brown, ovoid to oblong, guttulate, 3.2-4.8x1.8-3.2 μm , which is slightly larger and narrower. Specimens of *Salvadora oleoides* from Karachi (UCMH 710,726,754) and other parts of Pakistan showed that the conidial range is slightly wider 2.8-4.8x1.8-3.2 μm than in the type specimen. *Coniothyrium salvadorae* differs from all the *Coniothyrium* spp., found on *Salvadora* by its smaller, thin-walled, verruculose, guttulate conidia. It more closely resembles *Coniothyrium truncatum*, *Coniothyrium fuckelii* Sacc. and *Coniothyrium punithalingamii*. *Coniothyrium truncatum* has larger, wider conidia (5.6-6.8x4-5 μm) than *C. salvadorae*. Similarly *C. fuckelii* has more or less the same conidial dimensions (2.4-5 X 2-3.5 μm) as *C. salvadorae* but differs in having smooth-walled conidia, as reported by Punithalingam (1970a) on *Malus pumila* (IMI 135488a). On the type specimen of *C. salvadorae* (IMI 94190), *C. fuckelii* was also present. The conidia were smooth, eguttulate, with both ends obtuse, 3.8-5.7x1.6-2.8 μm , whereas *C. salvadorae* has a single prominent guttule and the outer wall is verruculose and the base truncate. Sutton (1980) was of the opinion that *C. fuckelii* is congeneric with *Microsphaeropsis*. *C. punithalingamii* resembles *C. salvadorae* in having thin-walled, minutely verruculose, oblong conidia with obtuse apices and truncate bases, however it differs in having bigger conidia 4.7-5.9x3.1 - 3.75 μm , with wider truncate bases.

Coniothyrium salvadorae also differs from *Avetiaea salvadorae*, which has eustromatic conidiomata with paraphyses, conidiophores, and aseptate brown, oblong to globose conidia enclosed in a mucilaginous sheath, 13.5-21.5 x 10.5-17.5 μm .

Specimens examined:

Coniothyrium salvadorae Petrak & Scharif

On stem of *Salvadora persica*, Minab, Kariam, Iran, 5 Apr. 1955, Gh. Scharif 850 (IMI 94190, holotype; on stems of *Salvadora oleoides*, Khadeji Fall, Sindh, Pakistan, 14 Mar. 1987, S.Q. Abbas UCMH 710,754; on stem of *Salvadora oleoides*, Karachi, Pakistan, 24 Apr. 1978, S.Q. Abbas UCMH 726.

X. *Coniothyrium truncatum* Abbas, Sutton & Ghaffar sp. nov.

Fig.10.

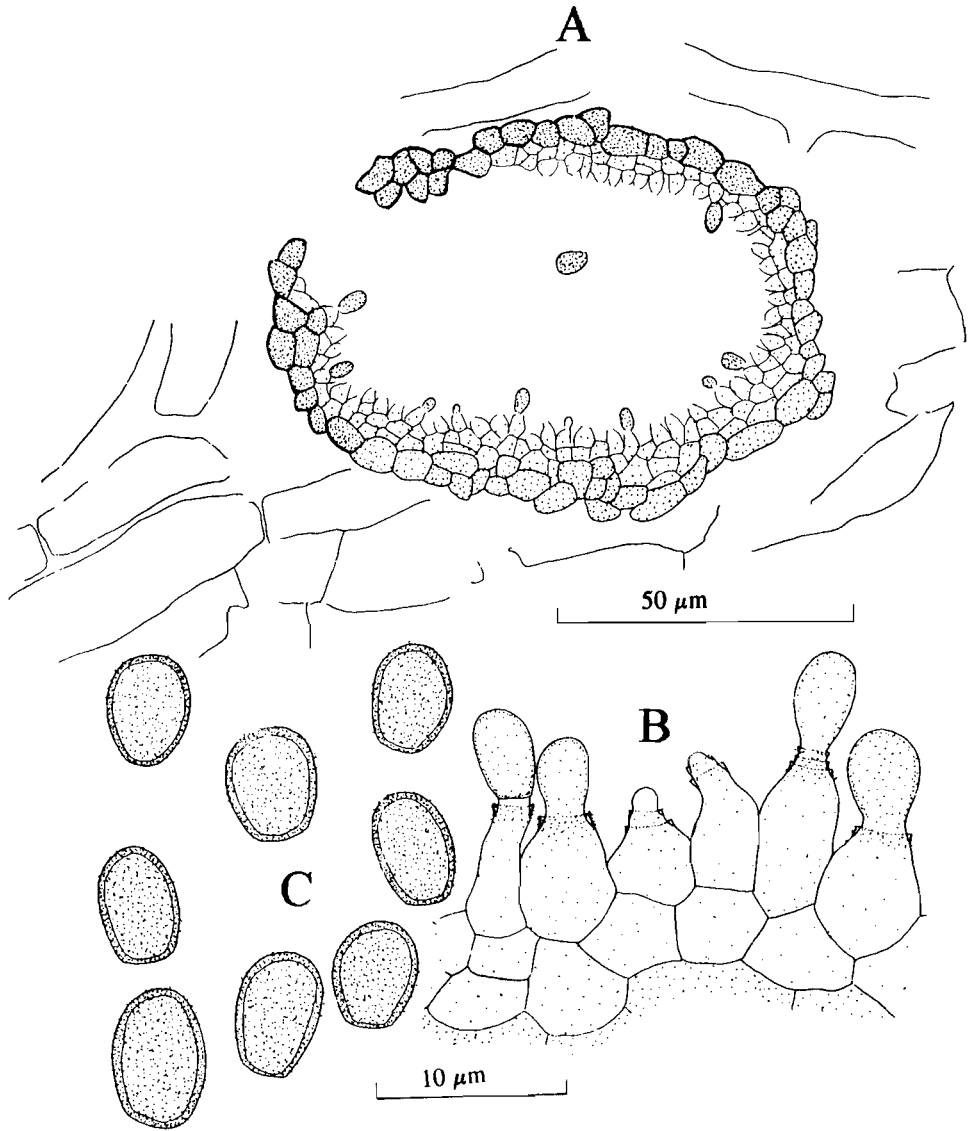


Fig.10. *Coniothyrium truncatum* (A) V.S. of conidioma; (B) conidiogenous cells; (C) conidia.

Conidiomata simplicia, pycnidialia, immersa, nigra, solitaria, raro aggregata, globosa vel applanata-globosa, unilocularia, nigra, 66-150x165 μm . *Ostiolum* singulum, circulare, lateralis 10-15 μm diam. Parietes 1-4 cellulis crassi ad 4-8 μm lati, ex textura angulari ad strato duobus compositi, stratum exterior 1-2 cellulis crassum, parte superiore circa ostiolum atrobrunnea quam parte inferiore pallidisse-brunnea, stratum interior 1-2 cellulis crassum, parvum, gradatim hyalinum ad tenuior. *Conidiophora*

absentia. *Cellulae conidiogenae* discretiae, indeterminatae, flavidae ad minute verruculosae, 1-4 proliferantibus, enterogenibus, progressivis, $5.3-8.8 \times 2-4.7 \mu\text{m}$. *Conidia* primovo formantia hologenitica cetero enterogenitica aseptata, pallidissime-brunnea, oblonga, pariete crassa, verruculosa, basim parvus truncata, apicem obtusa, $5.6-6.8 \times 4-5 \mu\text{m}$.

In ramis emortuis *Salvadorae oleoides*, Karachi, Pakistan, 14 Mar. 1987, S.Q. Abbas UCMH 754 (XIV), holotypus.

Coniothyrium truncatum Abbas, Sutton & Ghaffar sp. nov.

Conidiomata simple, pycnidial, immersed, black, solitary, sometimes aggregated, globose to applanate-globose, unilocular, ($66-150 \times 66-165 \mu\text{m}$). *Ostiole* single, circular, lateral, $10-15 \mu\text{m}$ diam., wall of textura angularis, 2-4 cells thick, $4-8 \mu\text{m}$ wide. *Conidiophores* absent. *Conidiogenous cells* cylindrical to ampulliform to lageniform, pale yellowish $5.3-8.8 \times 2-4.7 \mu\text{m}$, 1-3 enterogenous, with 1-4 proliferations, prominent collarettes. *Conidia* formed first hogenous later enterogenous, aseptate, pale brown, thick-walled, verruculose, oblong, apex obtuse, base narrowly truncate or obtuse, $5.6-6.8 \times 4-5 \mu\text{m}$.

Coniothyrium truncatum differs from all the *Coniothyrium* spp., found on *Salvadora* but resembles *C. oblongatum*, *C. sultanii*, *C. sivanesanii* and *C. salvadorae* in conidial morphology. *C. truncatum* closely resembles *C. oblongatum* in having pycnidial conidiomata and conidia of similar size. Conidia in *C. truncatum* are $5.6-6.8 \times 4-5 \mu\text{m}$ while they are $3.7-7.8 \times 3.6-5.6 \mu\text{m}$ in *C. oblongatum*, however both taxa can easily be differentiated. In *C. oblongatum* pycnidia are $116-250 \times 116-140 \mu\text{m}$, ostiole central, wall 3-6 cells thick, collarettes up to 4, more spaced and flared and conidia are dark brown, spherical to oval to oblong, with both ends obtuse. In contrast to this in *C. truncatum*, pycnidia are $66-150 \times 66-165 \mu\text{m}$, ostiole lateral, wall 2-4 cells thick, collarettes up to 3, not flared, less spaced and conidia are oblong to ovoid, pale brown, base truncate or obtuse and apex obtuse. Whereas in *C. sultanii* conidia are $10-16 \times 5.6-8 \mu\text{m}$ and in *C. sivanesanii* $5.6-11.2 \times 4-8.8 \mu\text{m}$, the latter differs in having larger, wider, thick-walled, broader, truncate-based conidia. *C. salvadorae* also resembles *C. truncatum* in having pycnidial conidiomata, enterogenous, progressive conidiogenous cells and aseptate verruculose brown conidia with truncate bases but differs in the smaller, ovoid to oblong conidia $2.8-4.8 \times 1.8-3.2 \mu\text{m}$ with a central guttule and narrow truncate bases.

Specimen examined:

Coniothyrium truncatum Abbas, Sutton & Ghaffar sp. nov.

On stem of *Salvadora oleoides*, Karachi, Pakistan, 14 Mar. 1987, S.Q. Abbas UCMH 754 (XIV), holotype.

XI. *Coniothyrium punithalingamii* Abbas, Sutton & Ghaffar sp. nov.

Fig. 11.

Conidiomata pycnidialia, solitaria, nigra, globosa vel sphaerica, $80-100 \mu\text{m}$. *Ostiole* singulum, centrale, circulare, $10-15 \mu\text{m}$ diam., parietes 1-4 cellulis crassis ad $10 \mu\text{m}$ lati ex textura angulari, ad strato duobus compositi. Stratum exterior 1-cellula crassum, atro-nigrum ad crassior quam stratum interior 2-3 cellulis crassum hyalinum ad tenuior. Generatim *conidiophora* absentia, raro cellula singula subtenta, hyalina,

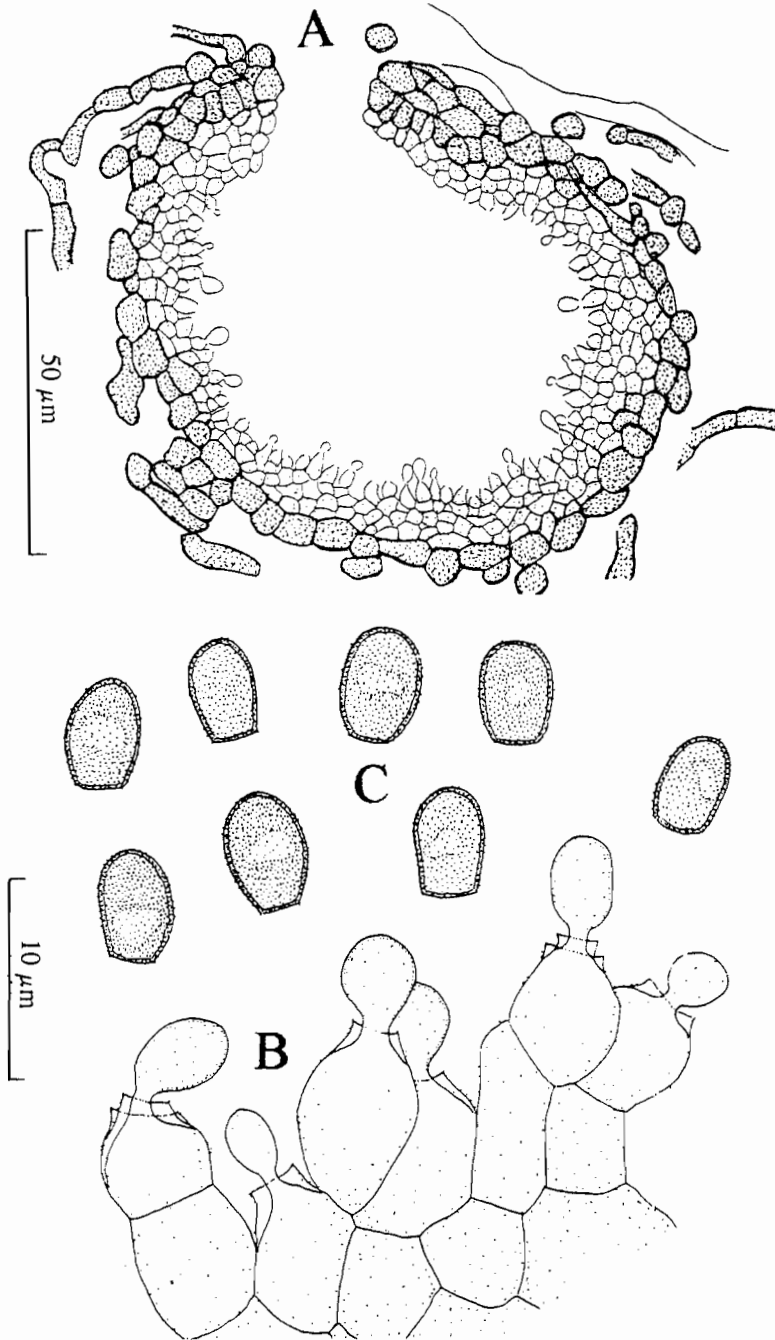


Fig.11. *Coniothyrium punithalingamii* (A) V.S. of conidioma; (B) conidiogenous cells; (C) conidia.

2.5-4.5x5-6.4 μm *Cellulae conidiogenae* ampulliformes vel lageniformes, hyalinae 1-2 proliferantibus enterogenibus progressivis 5.1-9.6x5.5-6.7 μm percurrentibus proliferationibus. *Conidia* primova formam holo-genitica cero, enterogenitica, aseptata, oblonga, brunnea, tenuiores cum guttula singula, minute verruculosa, apicem obtusa, basim truncata, 4.7-5.9x3.1-3.75 μm .

In ramis emortuis *Salvadorae oleoides*, Karachi, Pakistan, 13 Oct. 1986, S.Q. Abbas UCMH 755 (VII), holotypus.

Coniothyrium punithalingamii Abbas, Sutton & Ghaffar sp. nov.

Conidiomata pycnidial, solitary, black, globose to spherical, 80-100 μm . *Ostiole* single, circular, central, 10-15 μm diam. Wall 1-4 cells thick and of textura angularis, composed of two layers, outer layer 1-cell thick, darker and thicker, inner layer 2-3 cells thick, hyaline and thin-walled. *Conidiophores* generally absent, when present then single cell and hyaline 2.5-4.5x5-6.4 μm . *Conidiogenous cells* ampulliform to lageniform, hyaline 5.1-9.6x5.5-6 μm , enterogenous, progressive, with 1-2 percurrent proliferations, wide channel and prominent periclinal thickening. *Conidia* formed first holo-genous later enterogenous, oblong, brown, aseptate, thin-walled, slightly verruculose with a single guttule, apex obtuse, base truncate, 4.7-5.9x3.1-3.75 μm .

This species resembles *Coniothyrium truncatum*, *C. sivanesanii* and *C. salvadorae* in having oblong, minutely verruculose conidia with an obtuse apex, and truncate base. *C. salvadorae* further resembles it in having thin-walled conidia and a central guttule, however it clearly differs in having a narrow truncate base and smaller conidia 2.8-4.8x1.8-3.2 μm . *C. sivanesanii* differs in having thick-walled larger conidia 5.6-11.2x4-8.8 μm without guttules. Similarly *C. truncatum* differs from *C. punithalingamii* in having slightly longer and wider conidia 5.6-6.8x4-5 μm than the latter, with smaller and thin-walled conidia 4.7-5.9x3.1-3.75 μm .

Specimen examined:

Coniothyrium punithalingamii Abbas, Sutton & Ghaffar sp. nov.

On stem of *Salvadora oleoides* Karachi, Pakistan, 13 Oct. 1986, S.Q. Abbas UCMH 755 (VII), holotype.

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