Notes on Fungi Associated with Date-Palm I

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Abstract. Ten species of fungi associated with diseases and decays of Date-palm in Iraq are described and illustrated. Notes on their cultural growth characteristics, ability to decay Date-palm and temperature studies are also added. Previous studies concerning their taxonomy and pathogenicity are reviewed briefly.

Introduction

Date-palm (*Phoenix dactylifera*) cultivation is well established in the Middle East, wherever fresh water for irrigation is available. It is of special significance in Iraq, where an estimated 22.3 million trees grow and about one million people depend upon its cultivation or trade for their living. Inspite of its great economic significance, little is known about the fungi associated with it. Elmer & al. (1968) provided a comprehensive review of the diseases of Date-palm. More recently, Al-Bakr (1972) gave an extensive review of Date-palm cultivation and also mentioned the fungal diseases especially those occurring in Iraq. A search of literature has revealed that the total number of fungi recorded on Date-palm hardly exceeds 35 and some of these are imperfectly identified. Some recent reports are, Freezi (1956), Khazaradze (1957), Pucci (1965), Mathur (1968), Mustafa (1974) and Rattan (1977). This investigation was therefore undertaken to make a comprehensive study of fungi associated with Date-palm. In this first paper of the series, 10 species are described and illustrated from the material collected from Basrah in Iraq. Out of these 8 are new host/substrate records while *Mauginiella scaettae* and *Fusarium oxysporum* are well known pathogens of Datepalm. Six species were isolated in pure culture. Notes on their cultural growth characteristics, effect of temperature on growth and their ability to decay woody leaf-base and inflorescence stalk are also recorded.

Material and Methods

Collections of fungi were made from standing as well as fallen trees from Date-palm plantations around Basrah (Iraq) in 1977—78.

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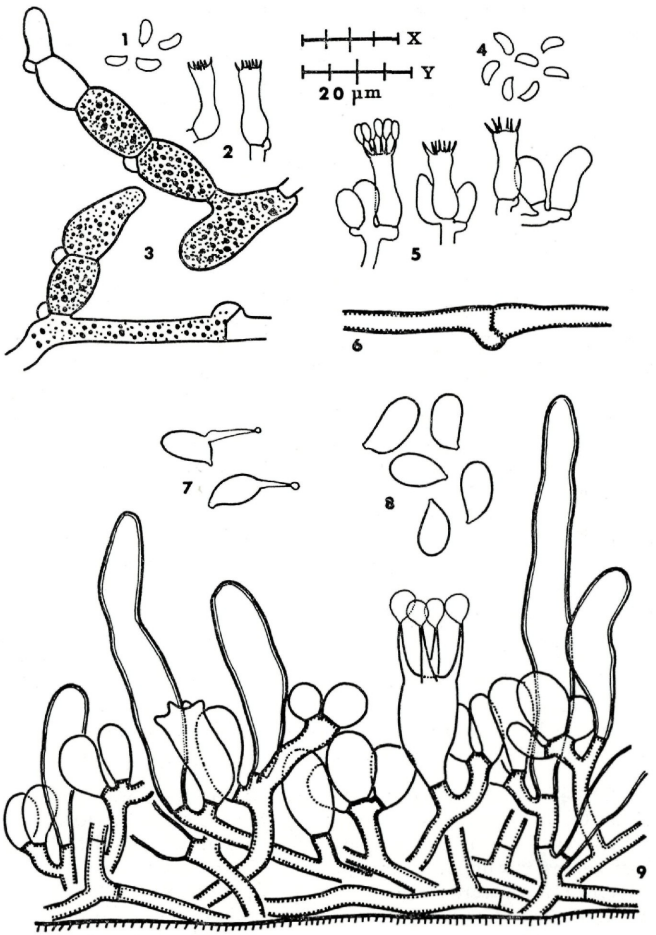


Figs. 1—9. *Sistotrema brinkmanii* (1—6): basidiospores (1) and basidia (2) from fructifications produced in culture; moniliform hyphae produced in culture (3); basidiospores (4), basidia and basidioles (5) and hyphae with ampulliform swelling (6) from fructifications produced in nature. — *Oliveonia pauxilla* (7—9): basidiospores germinating by repetition (7); basidiospores (8); section of fructification showing context hyphae, basidia, basidiolzs and cystidia (9). X, scale for figs. 1—6; Y, scale for figs. 7—9

Wood decay fungi were found to be particularly more common during winter rains (December—April). They occur on freshly trimmed leaf-bases near the crown of the tree or on sheathing leaf-fibres entangled between the leaf-bases and the trunk. Another familiar site for decay fungi is the stalk and spathe of inflorescence. Both are lignified and harbour many wood-decaying fungi. The fungi were preserved and studied by the prevalent methods in practice (RATTAN, 1977).

Cultures were isolated by transferring a part of the fungus or host tissue to test tube slants of Malt Agar or P. D. A. (STEVENS, 1974). Cultures of wood-decaying fungi that did not fruit readily were tempted to do so by being grown in petridishes turned upside down, under refrigeration, or in contact with sterilized pieces of wood. Under such conditions some of the isolates did fruit. The cultural characteristics of fungi were studied by the techniques advocated by NOBLES (1965), without mentioning her Code Numbers. Decay ability of fungi was studied by the methods mentioned by STEVENS (1974). Cultures of decay fungi were incubated, on Malt Agar in 250 ml flasks containing 25 ml of the medium, till the agar surface was completely covered by the fungal mat. Small rectangular blocks ($4 \times 1 \times 1$ cm) from the leaf-base and inflorescence stalk were dried for 24 hours at 105° C and their constant dry weight was noted. These were then soaked in distilled water for few hours and sterilized at 15 lb/sq. in. steam pressure for ½ hour. After cooling they were aseptically transferred to flasks containing fungal mats. These flasks were then incubated at 24° C for 8 weeks during which time wooden blocks were colonized by the fungus. At the end of 8 weeks the blocks were removed and carefully cleansed of all adhering fungal hyphae, dried at 105° C for 24 hours, cooled in a desicator and their constant dry weight was noted. The loss in weight is due to degradation of wood by the fungus. Percentage loss was calculated from the initial dry weight. Measurements are based on the average of 8 blocks.

The effect of temperature on the growth of fungi was studied by Linear Growth Measurement Technique (STEVENS, 1974). The cultures of fungi were grown in 9 cm petridishes containing 30 ml Malt Agar from centre inoculum. Four replicates of each fungus were kept at different temperature ranges (12° C, 16° C, 20° C, 24° C, 28° C, 32° C, 36° C, 40° C). Measurements were taken after every two days. The experiment was terminated as soon as the petridishes were covered at any range of temperature or at the end of 7 days in slow growing species.

The collections and cultures of all species have been lodged in the Herbarium of the Biology Department, Science College, Basrah University, Basrah, Iraq.

1. *Oliveonia pauxilla* (JACKSON) DONK 1958. — Pl. 1, figs. 7—9. Fungus 28: 20.

Fructifications resupinate, adnate, membranous-ceraceous, 25—100 μm thick; hymenial surface smooth, farinose, discontinuous but with tendency to become continuous in fertile areas, cream grey to light grey; margin illdefined, loosely adnate. Context composed of few partly collapsed hyphae. Hyphal system monomitic, hyphae (2.5) 3—5 μm wide, simple-septate, branched, thin-walled; basal hyphae broader than basidia-bearing hyphae. Cystidia 30—60 (85)× 7—11 (15) μm, subcylindrical, thin- to firmwalled, without incrustations, emergent to 60 μm. Basidia 14—20×7—11 μm, broadly clavate, usually twice the diameter of the supporting hypha but narrowing abruptly to its diameter at the base. Basidiospores 6—10.5 (12)×4.5—5 (6.5) μm, ellipsoid to broadly ellipsoid, subhyaline, smooth, thin-walled, prominently apiculate, nonamyloid, germinating by repetition, secondary spores being produced on sterigmata (up to 8.5 μm long); repeating spores common.

Voucher specimens: AHAA Nos. 928, 929, 930, 932, 960, 961, 964, 977, 978, 979, 996.

Remarks: This fungus is associated with white-rot and occurs on decaying leaf-bases, sheathing leaf-fibres, inflorescence stalks and spathes. It seems more common during the winter rains especially in January and February. This species is easily recognised from the related species by the presence of thin-walled cystidia and simple-septate hyphae. The Iraqi collections resemble the species in most respects except for the size of basidia and basidiospores, which appear to be slightly larger. This fungus was first recorded on the rachis of a fern from Canada (JACKSON, 1950). Later, WARCUP & TALBOT (1962) isolated it from the soil in Australia and HAUERSLEV (1976) recorded several finds from Denmark. The occurrence of this species on varied substrata and its wide geographical distribution is noteworthy.

2. *Sistotrema brinkmanii* (BRESADOLA) ERIKSSON 1948. — Pl. 1, figs. 1—6 Kung. Fysiogr. Sallsk. Lund Forh. 18: 1—21.

Fructifications resupinate, byssoid when young but become pelliculose-membranous at maturity, loosely adnate, widely effused, 60—150 μm thick; hymenial surface white, smooth to tuberculate, not creviced, porose-reticulate to powdery under the lens; margin thinning to determinate. Tubercles scattered, 25—300 μm long and 100—150 μm broad at the base, hemispherical to subulate; apices obtuse, fertile. Rhizomorphs common, 15—75 μm broad, branched, white, often ramifying in the substratum. Context subhyaline, composed of a basal zone of few repent hyphae terminating in basidial clusters, parallel and compact in the trama of tubercles, abundantly

crystal incrusted. Hyphal system monomitic, hyphae 3—4.5 (6) µm wide, branched at wide angles, clamped, thin- to firm-walled, occasionally ampulliform swellings (up to 7.5 µm wide) near the septa; basal hyphae broader than basidia-bearing hyphae. Basidia (10) 12—20 (26)×4—5 (6) µm, urniform, sterigmata (4) 6—8, slender, up to 4.5 µm long. Basidiospores 4—6×(1.6) 2—2.8 µm, curved-cylindrical, minutely apiculate, subhyaline, thin-walled, smooth, nonamyloid.

Voucher specimens: AHAA Nos. 876, 877, 1016, 1017, 1018, 1065, 1066, 1067, 1068, 1069, 1081.

Cultural growth characteristics: Growth fast, covering 6 cm in 7 days from centre inoculum; mat translucent white, downy, granular or powdery around the inoculum; advancing zone indistinct; reverse unchanged; no particular odour; oxidase test negative. Aerial hyphae 2—4.5 µm wide, clamped, thin-walled, with greenish oily contents. Advancing zone hyphae 3—6 µm wide, relatively unbranched, clamped. Moniliform hyphae common among aerial and submerged hyphae, cells subglobose to barrel-shaped, 15—25×7—13 µm, with dense cytoplasmic contents. Fructifications produced in culture thin, white, arachnoid to crumbly granular, discontinuous. Hyphae 3—4 µm wide, clamped, sometimes moniliform with inflated cells. Basidia and basidiospores similar to those produced in the fructifications occurring in nature.

Culture examined: AHAA No. 1018C.

Decay tests: Associated with brown-rot. Average weight loss in inflorescence stalk (12.2%) and in leafbase (5.6%).

Temperature studies: Optimum 24° C. Diameter of fungal mat at 12° C (1.6 cm); 16° C (2.0 cm); 20° C (4.8 cm); 24° C (6.0 cm); 28° C (1.7 cm); 32° C (no observable growth).

Remarks: This fungus is fairly common on trunks of standing or fallen Date-palms, leaf-bases, sheathing leaf-fibres, inflorescence stalk and decaying date fruits. It is associated with brown-rot and is frequently encountered from January to March. Production of moniliform chains in culture among aerial and submerged hyphae is a characteristic feature of this species. Such moniliform chains were also reported earlier in cultures of this species (Biggs, 1937; Weresub & Leclair, 1971).

3. *Trechispora farinacea* (Persoon ex Fries) Liberta 1966. — Pl. 2, figs. 10—12

Taxon 15: 318.

Fructifications resupinate, submembranous, loosely adnate, 50—200 µm thick; hymenial surface smooth to toothed, continuous, not creviced, white to cream; margin thinning to determinate. Rhizomorphs usually absent, when present 25—120 µm broad,

branched, white. Teeth ranging from small aculei to 400 μm long, 90—150 μm broad at the base, cylindrical to subcylindrical, scattered to close but not gregarious, separated by smooth sterile areas, simple to rarely branched, apices fertile or sterile with few projecting hyphae. Context subhyaline, a loose weave of hyphae which become compacted and parallel in the trama of the teeth. Hyphal system monomitic, hyphae (1.5) 2—3 μm wide, frequently branched, with ampulliform swellings (up to 6 μm broad) near the consistently clamped septa, thin-walled and subhyaline; crystal common throughout, some clinging closely to the walls of hyphae. Rhizomorphic hyphae 1.5—3 (4.5) μm wide, distinct, crystal incrusted, rarely branched, with ampulliform swellings (up to 9 μm broad), clamped septa distant, walls thin and subhyaline. Basidia 14—20×4.5—6 μm, cylindrical to vaguely utriform, 4-spored, sterigmata up to 6 μm long. Basidiospores 3—4.5×2.5—3 μm, broadly ellipsoid to ovoid, walls thin, subhyaline, with distinct minute echinulations, nonamyloid, acyanophilous; often uniguttulate.

Voucher specimens: AHAA Nos. 1015, 1094, 1100.

Cultural growth characteristics: Growth fast, covering 7.2 cm in 7 days from centre inoculum at 24° C; mat colourless to white with little aerial growth to powdery, translucent; advancing zone indistinct; reverse unchanged; no particular odour; oxidase test negative. Aerial hyphae 1.5—3.2 μm wide, sparsely branched, clamped, thin-walled. Submerged hyphae 2—6 (7) μm wide, branched, clamped, some septa evidently without clamps, thin- to firm-walled. Advancing zone hyphae 2—4 μm wide, sparsely branched, thin-walled.

Culture examined: AHAA No. 1094C.

Decay tests: Associate with brown-rot. Average weight loss in inflorescence stalk (9.2%) and in woody leaf-base (5.2%).

Temperature studies: Optimum 32° C. Diameter of fungal mat at 12° C (1.0 cm); 16° C (2.3 cm); 20° C (7.0 cm); 24° C (7.2 cm); 28° C (7.8 cm); 32° C (9.0 cm); 36° C (4.5 cm); 40° C (no observable growth).

Remarks: This fungus is rather uncommon and occurs on trunks of fallen Date-palms and decaying leaf-bases. It is associated with brown-rot and was observed during February and March. This species shows a wide geographical distribution and occurs over a wide range of woody substrata. The chief diagnostic features are toothed hymenial surface and distinctly echinulate, small basidiospores.

4. *Phanerochaete cremea* (Bresadola) Parmasto 1968. — Pl. 2, figs. 13—16

Consp. Syst. Cort. p.84.

Fructifications resupinate, membranous-ceraceous, loosely adnate, widely effused, 100—300 μm thick; hymenial surface white,

turning cream-ochre to ochraceous or whitish grey on drying, smooth to sparsely tuberculate, not creviced; margin thinning to farinose or ill-defined. Context subhyaline, composed of a basal zone (60—150 µm thick) of loosely woven hyphae which are distinct and comparatively thick-walled but these become compact and agglutinated in the upper part, abundantly crystal incrusted, crystals being larger in the basal zone. Hyphal system monomitic, hyphae 2—5 (6) µm wide, branched at wide angles, simple-septate, walls thin to thick (up to 2 µm), subhyaline. Cystidia 70—125×5—9 µm, cylindrical, firm-walled, wall 0.7 µm thick, unincrusted, aseptate or rarely with a retraction septum, arising from the upper part of the context and may project to 60 µm. Basidia 15—22×4.5—6 µm, clavate-cylindrical, sterigmata 4, up to 4.5 µm long. Basidiospores 4—6×2.5—3.5 µm, ellipsoid, subhyaline, thin-walled, minutely apiculate, smooth, nonamyloid, with few oil globules in the cytoplasm.

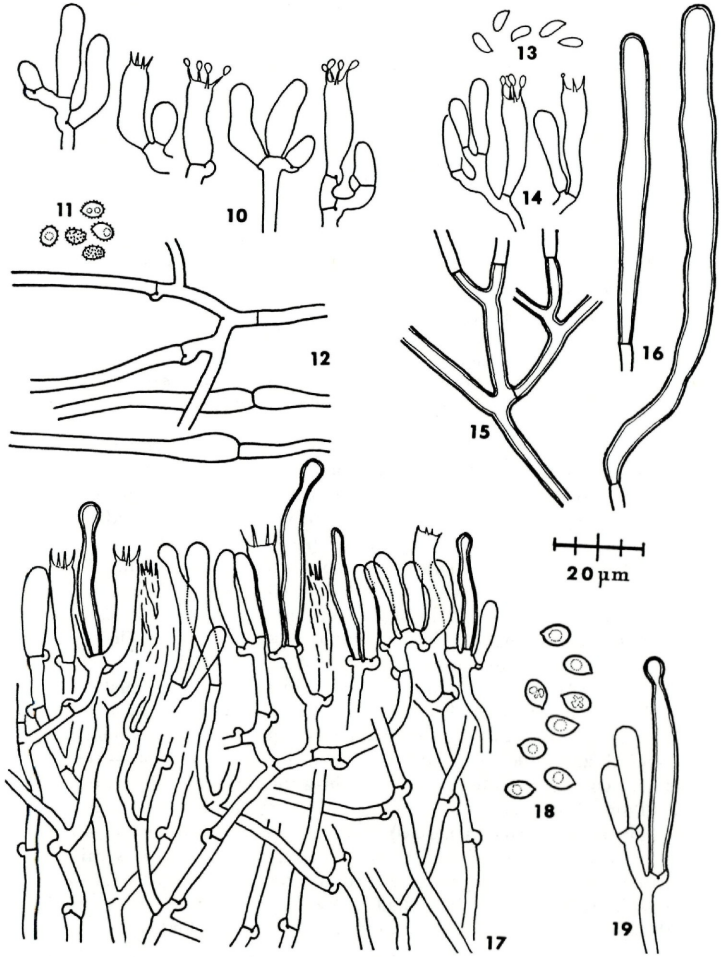
Voucher specimens: AHAA Nos. 816, 970.

Remarks: This fungus is rather uncommon and was collected from the trunk of a fallen Date-palm in October and again in February. It is associated with white-rot. The Iraqi collections resemble the species in most respects.

5. *Hyphoderma sambuci* (Persoon) Jülich 1974. — Pl. 2, figs. 17—19
Persoonia 8: 80.

Fructifications resupinate, submembranous to membranous-crustose, adnate, spreading to 7×4 cm, up to 150 µm thick; hymenial surface white to cream, smooth to tuberculate, porose-reticulate when young but tends to be continuous and farinose at maturity; margin byssoid to abrupt, white. Tubercles few and sparse in some specimens but abundant and gregarious in others, up to 60 µm high and 120 µm broad at the base, hemispherical to subconical, fertile all over. Context subhyaline, composed of loosely woven hyphae in the basal part but these become compact in the subhyemenial zone. Hyphal system monomitic; hyphae 2.5—4 µm wide, clamped, thin- to firm-walled, finely crystal incrusted. Cystidia 25—45 (60)×3—4.5 (6.5) µm, cylindrical to flexuous with swollen (3—6 µm) tips, firm-walled, unincrusted to partly incrusted, arising from the subhymenial hyphae, just emergent or projecting to 30 µm. Basidia 18—28×4.5—6 µm, clavate-cylindrical to subutriform; sterigmata (2) 4, slender, up to 6 µm long. Basidiospores 4.5—6×3—4 µm, broadly ellipsoid minutely apiculate, firm-walled, subhyaline, smooth, 1—2 guttulate, nonamyloid.

Voucher specimens: AHAA Nos. 702—707, 709—711, 744—747, 777—781, 784, 789—790, 805, 830—832, 862, 875, 920—927, 973—976, 1019—1025, 1035, 1038, 1060, 1062—1064, 1082—1084, 1121—1122, 1145—1146, 1152—1153.



Figs. 10—19. *Trechispora farinacea* (10—12): basidia and basidioles (10); basidiospores (11); hyphae with ampulliform swellings (12). — *Phanerochaete cremea* (13—16): basidiospores (13); basidia and basidioles (14); hyphae (15); cystidia (16). — *Hyphoderma sambuci* (17—19): section of fructification showing upper part of context and hymenium (17); basidiospores (18); cystidium and basidioles (19)

Remarks: This fungus is very common on inflorescence stalks, spathes, leaf-bases and sheathing leaf-fibres. It is associated with white-rot and occurs throughout the year. The chief diagnostic features are white and tuberculate hymenial surface, capitate cystidia or cystidioles and broadly ellipsoid, small basidiospores. The Iraqi collections resemble the species in most respects except for the configuration of the hymenial surface which is more pronouncedly tuberculate in the Iraqi collections. ERIKSSON & RYVARDEN (1976) have pointed out that it is a 'species group' rather than a homogeneous taxon.

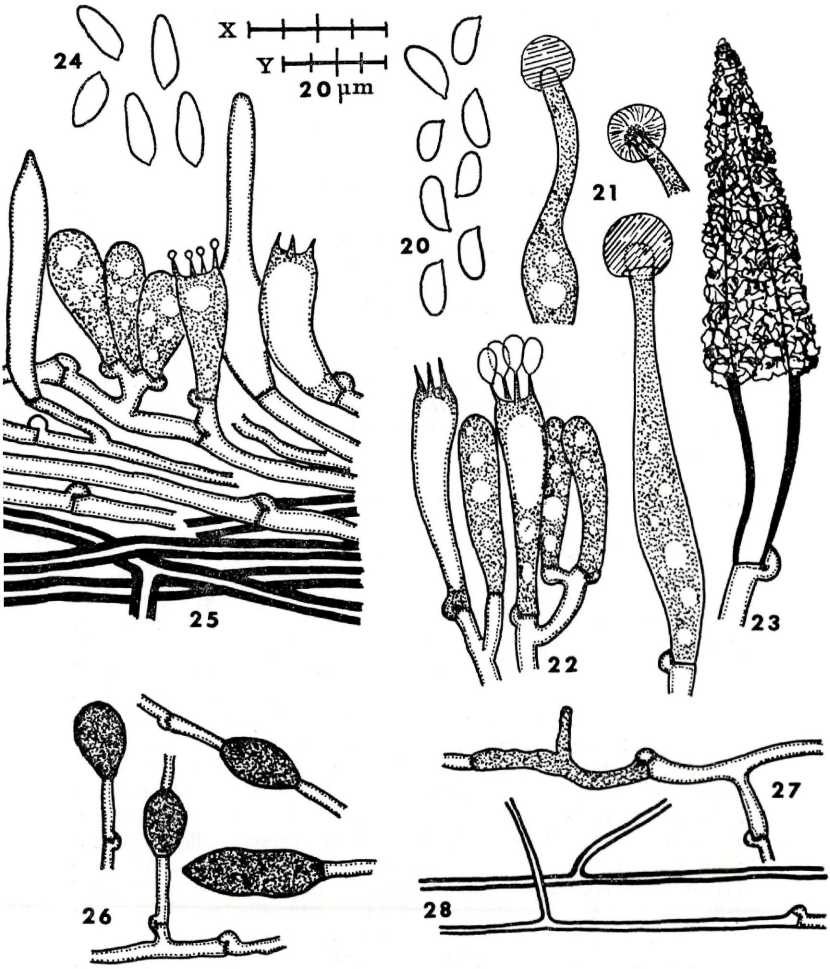
6. *Hyphoderma pubera* (FRIES) WALLROTH 1833. — Pl. 3, figs. 20—23
Fl. Krypt. Germ. 2: 576.

var. *dactylifera* var. nov.

Receptacula resupinata, in sectione 90—1000 µm crassa. Hymenium laeve vel humiliter odontioideum. Gloeocystidia conica vel subcylindracea, 45—100 × 7—12 µm, apicibus globolam resinosam excernentibus. Basidiosporae 7—12 (13) × 4.5—5 µm. Iraq, leg. A.-H. A. AL-DBOON, 715 (holotypus, K; isotypus. Herbarium, Basrah University, Iraq).

Fructifications resupinate, membranous-ceraceous becoming horny on drying, widely effused, adnate, sometimes rolling away from the substratum on drying, 90—1000 µm thick; hymenial surface cream yellow to ochre or ochregrey, smooth to more commonly tuberculate, tubercles hemispherical to subulate, up to 400 µm high, occasionally with delicate ridges or sulcations, continuous; margin thinning and byssoid to abrupt. Context subhyaline, composed of a basal zone of loosely arranged repent hyphae and an upper zone of compactly arranged ascending hyphae. Hyphal system monomitic, hyphae 3—4.5 (6) µm wide, clamped, thin- to firm-walled. Cystidia (40) 60—105 × 13—25 µm, subfusiform, thick-walled, incrusted with subhyaline crystals in the upper $^2/_3$ part, immersed or projecting to 45 µm, numerous and occurring in overlapping rows forming a distinct cystidial zone (90—650 µm thick). Gloeocystidia 45—100 × 7—12 µm, conical to subcylindrical, thin-walled, immersed or projecting to 40 µm, tips covered with orange-yellow to reddish brown, subglobose to globose (10—13 µm across) resinous mass. Basidia 35—45 × 7—9 µm, clavate-cylindrical to subutriform, sterigmata 4, straight to curved, up to 8 (12) µm long. Basidiospores 7—12 (13) × 4.5—5 µm, ellipsoid-cylindrical, thin-walled, smooth, subhyaline, minutely apiculate, with few oil droplets in cytoplasm, nonamyloid.

Voucher specimens: AHAA Nos. 712—717, 723—725, 727, 729—733, 735, 737—741, 743, 750—751, 753—754, 758—759, 767—771, 773—776, 785, 791—804, 811—814, 817—928, 837—840, 885, 905—911, 949—950, 966—1002, 1004, 1006—1008, 1034, 1036—1037, 1051—1057, 1077—1080, 1090—1092, 1105—1107, 1116—1118, 1132—1133, 1147—1151.



Figs. 20—28. *Hyphoderma pubera* var. *dactylifera* (20—23): basidiospores (20); gloeocystidia with apical resinou s mass (21); cystidium (22); basidia and basidioles (23). — *Antrodia albida* (24—28): basidiospores (24); section showing subhymenium and hymenium (25); chlamydospores (26), generative hyphae (27) and skeletal hyphae (28) from culture. X, scale for figs. 24—25; Y, scale for figs. 20—23, 26—28

Remarks: This is one of the commonest fungi occurring on Date-palm and is associated with white-rot. It occurs throughout the year and colonizes decaying leaf-bases, sheathing leaf-fibres, inflorescence stalks and spathes. The chief diagnostic features are presence of abundant incrusted cystidia (lamprocystidia), gloeocystidia with capitate resinous mass and large basidiospores. This taxon is closely related to *H. pubera* but evidently they differ in several respects. In *H. pubera*, the hymenial surface is almost smooth, gloeocystidia rather scanty and without resinous mass and fructifications are thinner (less than 500 μm thick). The size of basidio spores appears rather large in the Iraqi material but there is so much variation within the collections that it cannot be considered as a distinguishing character from *H. pubera*. In view of the above differences a new variety is proposed.

The presence of resinous material at the tip of gloeocystidia is a constant feature in all Iraqi collections and is reminiscent of *H. guttuliferum* (KARSTEN) DONK and *H. macedonicum* (LITSCHAUER) DONK but the former has very different incrusted cystidia while the latter lacks them.

7. *Antrodia albida* (FRIES) DONK 1966. — Pl. 3, figs. 24—28.
Persoonia 4: 339.

Fructifications resupinate, widely effused, spreading to 30× 12 cm, adnate, fleshy-soft when fresh becoming rigid and brittle on drying, 3—5 (10) mm thick; pore surface smooth to uneven, cream to cream-yellow when fresh, turning yellow-ochre on drying; margin fibrillose to abrupt, sterile, white to cream-yellow. Odour disagreable and fish-like. Pores not in strata, up to 5 mm deep; pore mouths oval to angular but may become irregular because of the collapse of dissepiments, 2—3 (4) per mm; dissepiments 30—90 μm thick, lacerate to fimbriate. Context cream coloured, homogeneous, thin (200 μm) to thick (6 mm). Hyphal system dimitic; skeletal hyphae 2—4 μm wide, sparsely branched, aseptate, subhyaline, thick-walled to almost solid; generative hyphae 2—5 μm wide, branched, septate, clamped, thin- to slightly thick-walled. Cystidioles present, slightly larger than basidia, thin-walled. Basidia 10—25×5—7.5 μm, clavate-cylindrical, sterigmata 4, up to 3.5 μm long. Basidiospores 7—10.5 (13)×3—4 (4.5) μm, oblong-ellipsoid to subcylindrical, minutely apiculate, the walls thin subhyaline, smooth, nonamyloid.

Voucher specimens: AHAA Nos. 762—763, 783, 808—809, 829.

Cultural growth characteristics: Growth fast, covering 3.8 cm in 4 days from a centre inoculum; mat white, opaque, forming a chamois-like layer which peels off readily from the agar surface; advancing zone fibrillose; reverse unchanged; odour mushroom-like; oxidase test positive. Aerial hyphae (fibre hyphae or skeletal hyphae)

1.5—3 μm wide, branched, aseptate, wall firm to thick (1.0 μm), subhyaline. Submerged hyphae 2—6 μm wide, branched, clamped, walls thin, subhyaline. Advancing zone hyphae 2.5—4.5 μm wide, sparsely branched, clamped, thin-walled. Chlamydospores 12—16 (28)×7—13 μm, ovoid to subglobose or dumbleshaped, firm-walled, with denser contents, intercalary or terminal, supporting hyphae 1.5—3 μm wide. Fructifications (produced on the sides of petridish after 3 weeks) up to 5 mm thick; pore surface cream yellow; pores angular, averaging 1—2 per mm; skeletal hyphae 1.5—3 μm wide; generative hyphae 1.5—3 μm wide, clamped, Basidia 18—24× 6—8 μm, clavate-cylindrical. Cystidioles 25—30×5—7.5 μm, thin-walled. Basidiospores 8—10.5×3—4 (4.5) μm, oblong to ellipsoid.

Culture examined: AHAA 783C.

Decay tests: Associated with white-rot. Average weight loss in inflorescence stalk (20.4%) and in leaf -base (11.7%).

Temperature studies: Optimum 36° C. Diameter of fungal mat after 4 days incubation at 12° C (no observable growth), 16° C (1.4 cm), 20° C (3.0 cm), 24° C (3.8 cm), 28° C (4.2 cm), 32° C (7.2 cm), 36° C (9.0 cm), 40° C (3.2 cm), 44° C (no observable growth).

Remarks: This fungus is occasionally encountered on fallen trunks of Date-palm especially during summer months (July—September) and is associated with white-rot. It is evident from *in vitro* studies that this fungus is capable of growth over a wide range of temperature (16—40° C) with a relatively high optimum value (36° C).

The chief diagnostic features are fleshy-soft fructifications which become hard and brittle on drying, a dimitic hyphal system and large oblong to ellipsoid basidiospores. The Iraqi collections resemble the species in most respects. *A. albida* is normally resupinate but may produce pilei in some patches. All Iraqi collections are resupinate but some patches growing on vertical surfaces are at least with a suggestion of developing pileus.

8. *Fusarium oxysporum* Schlecht. emend. Snyder & Hansen 1940. Pl. 4, figs. 29—32.

Amer. J. Bot. 27: 64—67.

On host: Occurring as white to cream mouldy growth on young inflorescences and spathes. Hyphae 1.5—3.5 μm wide, branched, thin-walled, subhyaline. Conidiophores hyphoid, simple or branched, bearing phialides, sometimes forming 'sporodochia-like' cushions. Phialides 12—30 (37)×2.5—3 μm, arising singly or in clusters, terminal or laterally producing micro- or macro-conidia. Microconidia 6—14×2.5—3 μm, ellipsoid to subfusiform, or ellipsoid-cylindrical to curved, subhyaline, thin-walled, apex obtuse, base subtruncate to subacute, abundant. Macroconidia less sommon,

subhyaline, falcate, thin-walled, (2) 3—5 (7) septate; 3-septate conidia (18—41 × 2.5—3.5 μm), rather common; 4-septate conidia (36—42 × 3—4 μm), less common; 5—7 septate conidia (39—52 × 3—4.5 μm), rather rare. One septate conidia (13—30 × 2.5—3.2 μm) similar to microconidia in shape but larger in size.

In culture: Growth fast, covering 7.3 cm (on Malt Agar) and 6.1 cm (on P. D. A.) at 24° C in 7 days from a centre inoculum. Mat floccose to felty, white near the periphery becoming peach to purple-violet towards the inoculum; advancing zone finely cottony; reverse unchanged; odour characteristic but not specific; oxidase test negative. Aerial hyphae (1.5—3.5 μm wide) and submerged hyphae (2—4.5 μm wide) branched, thin-walled, subhyaline with greenish oily contents. Advancing zone hyphae 1.5—3 μm wide, sparsely branched. Conidiophores, phialides, microconidia and macroconidia similar to those produced on the host. Chlamydospores rather uncommon, occurring singly or in chains, terminal or intercalary.

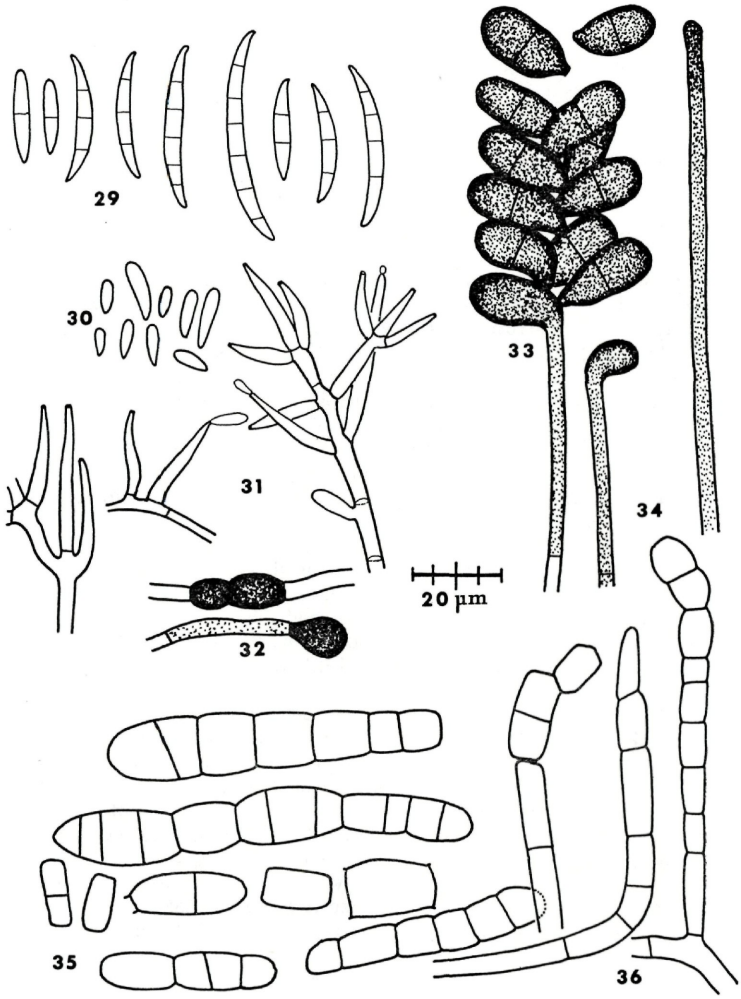
Voucher specimens: AHAA Nos. 1069, 1096, 1097 (both exsiccata and cultures).

Decay tests: Associated with brown-rot. Average weight less in inflorescence stalk (8.3%) and in leafbase (6.2%).

Temperature studies: Optimum 28° C. Diameter of fungal mat at 12° C (2.1 cm), 16° C (3.1 cm), 20° C (7.0 cm), 24° C (7.3 cm), 28° C (7.9 cm), 32° C (6.7 cm), 36° C (2.8 cm), 40° C (no observable growth).

Remarks: This species is widely distributed and its various formae speciales cause serious wilt diseases of economic plants. It usually grows in soil as a saprophyte on dead organic matter. *F. oxysporum* var. *albedinis* (Killian & Maire) Malençon is the causative agent of 'Bayoud' or wilt of Date-palm. This disease has been recorded as very serious in North Africa especially in Algeria and Morrocco (Elmer & al., 1968) but seems to be non-existant in Basrah area. Al-Jabiri (1970) has reported the occurrence of this disease in Basrah area but during these investigations we have not observed it. Date-palms usually die if neglected and can be mistaken for wilt. This needs confirmation.

The occurrence of Fusarium spp. with 'inflorescence-rot' of Date-palm was first reported by Brown & Butler (1938) although the disease was called of minor importance. In Iraq, Hussain & Al-Beldawi (1977) made an incidental reference to *Fusarium*, "rotting of inflorescence may also be caused by weather conditions such as frost injury or by some species of *Fusarium* but '*Sporendonema sebi*' is of major importance as a causal agent of this disease". El-Behadili & al. (1977a) recorded that *Fusarium spp.* is responsible for inflorescence-rot of Date-palm in Najaf, Babylon and Kerbala Governates



Figs. 29—36. *Fusarium oxysporum* (29—32): macroconidia (29); microconidia (30); conidiophores with phialides (31); chlamydospores (32). — *Trichothecium roseum* (33, 34): conidiophore with conidial chain (33); young conidiophores (34). — *Mauginiella scaettae* (35, 36): conidia (35); conidiophores (36)

(Iraq). The screening tests performed by them revealed that this pathogen is responsible for 13% of disease while *M. scaettae* 74.6% and 11.83% of the disease is caused by both these fungi. The occurrence of *F. oxysporum* as a causative agent of 'inflorescence-rot' seems common in Basrah area but no screening tests were performed.

9. *Trichothecium roseum* (Persoon) Link ex Fries 1832. — Pl. 4, figs. 33, 34

Syst. Mycol. 3: 427.

On host: Occurring as white cottony growth on young flowers and spathes but later turns into pinkish powdery mass due to spore production. Hyphae (1.5) 2—3.5 µm wide, branched, thin-walled, subhyaline. Conidiophores erect, 3—4.5 µm wide, up to 140 µm (rarely more) long, hyphoid, aseptate to occasionally septate, unbranched, subhyaline. Conidia 15—24 × 8—12 (14) µm, ellipsoid to ovoid, 2-celled, with a prominent papillate projection at one end, firmwalled (wall up to 1 µm thick), subhyaline through transmitted light but reddish-brown in mass, arising apically and occurring in basipetalous chains (up to 80 µm long).

In culture: Growth moderately fast, covering 5.0 cm (on Malt Agar) and 6.0 cm (on P. D. A.) at 24° C in 7 days from a centre inoculum. Mat white, appressed, turning powdery after sporulation; advancing zone cottony; reverse unchanged; odour not particular; oxidase test inconclusive. Aerial hyphae 1.5—3 µm wide, rather scanty. Submerged hyphae 2—4.5 µm wide, branched, thin-walled. Advancing zone hyphae 2—3 µm wide. Conidiophores 105—240 × 3—4 µm, hyphoid, septate, thin-walled, rarely branched. Conidia 9—21 × 7—11 µm, similar to those produced on the host.

Voucher specimens: AHAA Nos. 1003, 1041, 1071, 1073, 1095, 1096, 1123, 1124, 1127, 1130, 1170 (both exsiccata and cultures).

Decay tests: Associated with white-rot (?). Average weight less in inflorescence stalk (8.0%) and in leafbase (6.6%).

Temperature studies: Optimum 20° C. Diameter of fungal mat at 12° C (1.9 cm), 16° C (3.0 cm), 20° C (5.4 cm), 24° C (4.9 cm), 28° C (3.6 cm), 32° C (2.2 cm), 36° C (no observable growth).

Remarks: This fungus commonly occurs as a saprophyte in soil (Gilman, 1957), or rotten wood (Mitter & Tandon, 1938). Sometimes it occurs as a weak parasite on stored apples (Tyagi in Subramanian, 1971), or corn grains (El-Behadili & al., 1977b). 'Inflorescence-rot' is a serious disease of Date-palm in Basrah area. It is principally caused by *Mauginiella scaettae* but *Fusarium oxysporum* is also associated with this rot (see comments under *F. oxysporum*). During the course of these investigations, it was observed that infected inflorescences are often colonized by another fungus, *T. roseum*. In the

field it colonizes small areas but spreads quickly when inflorescences are incubated under laboratory conditions. However, *T. roseum* was never observed alone infecting the inflorescences. A suspension of spores and mycelium was inoculated on young inflorescences but it failed to cause any infection. Perhaps this fungus occurs as a weak parasite but needs further testing.

10. *Mauginiella scaettae* CAVARA 1926. — Pl. 4, figs. 35, 36

Atti della R. Acc. dei Lincei 322, Ser. 6, p. 67.

= *Geotrichum scaettae* (CAVARA) MAIRE in MAIRE and WERNER, Fungi Maroccani 1156, Mem. Soc. Sc. Nat. Maroc 45, p. 133, 1937. — non *Sporendonema epizoum* (CORDA) CIFFERI & REDAELLI, Atti Ist. Bot. Lab. Critt. Univ. Pavia Ser. 5, vol. 15, p. 132, 1958. — non *Wallemia sebi* (FRIES) v. ARX, Genera of Fungi sporulating in pure culture, p. 166, 1970. (Synonymy after NICOT, 1972).

On host: Occurring as downy mycelial growth on young flowers, spathes or leaf-bases, later changing to powdery mass due to spore production. Intercellular mycelium 3—4.5 µm wide, branched, thin-walled, shortcelled. External or aerial mycelium 3—6 µm wide, branched, septate, thin-walled. Conidia produced by segmentation of aerial hyphae, unicellular or multicellular, up to 128 µm long, 5—16 (18) µm broad, usually with 1—6 (rarely up to 13) septa; wall subhyaline, firm, up to 1 µm thick.

In culture: Growth slow, covering 3 cm (on Malt Agar) and 3.6 cm (on P. D. A.) at 24° C in 7 days from a centre inoculum. Mat white, cottony when young turning powdery after sporulation; advancing zone narrow (1 mm) but distinct; reverse unchanged; odour not particular; oxidase test inconclusive (faint brown coloration). Hyphae (aerial and submerged) 3—5.5 µm wide, branched, septate, thin-walled. Conidia abundant and similar to those produced on the host.

Voucher specimens: AHAA Nos. 860—861, 990—993, 1003, 1040, 1069—1074, 1095, 1098, 1123—1126, 1128—1131, 1169 (both exsiccata and cultures).

Decay tests: Associated with brown-rot. Average weight loss in inflorescence stalk (7.8%) and in leaf-base (6.2%).

Temperature studies: Optimum 20° C. Diameter of fungal mat at 12° C (1.8 cm), 16° C (2.8 cm), 20° C (3.2 cm), 24° C (3.0 cm), 28° C (2.0 cm), 32° C (1.6 cm), 36° C (no observable growth).

Remarks: This fungus is parasitic on inflorescences and leads to their decay. This disease is called 'inflorescence-rot' or "Khamedj" and is of considerable economic importance. In the early stages, the fungus infects young flowers but soon spreads to inflorescence stalk, spathe, and even green leaf-base (coll no. AHAY 991). The conidia are thin-walled, short lived and cannot survive high summer temperature (AL-HASSAN & WALEED, 1977). Evidently, the fungus survives as

mycelium in decaying wood (spathes, inflorescence stalks or leaf-bases) which serves as primary source of inoculum during late winter or early spring outbreaks of the disease. During the course of these investigations several rotting pieces of Date debris were found to be colonized by this fungus.

'Inflorescence-rot' is prevalent in most of the areas under Date-palm cultivation. Studies concerning the biology and pathogenicity of the fungus have been reviewed by ELMER & al. (1968) and NICOT (1972). This disease is quite severe in the vally of Euphrates and Tigris especially in Basrah area where humidity is high. Several local investigations dealing with its occurrence, varietal resistance and effect of fungicides have been carried out by HANSFORD (1949); AL-AZZAMI (1951); ADHAMI (1953); HUSSAIN (1958, 1968); DABBAGH & HUSSAIN (1961); AL-ANI et al. (1965, 71a, 71b); AL-HASSAN & al. (1971); ISMAIL (1971); HUSSAIN & AL-BELDAWI (1977): AL-HASSAN & WALEED (1977).

There is some confusion over the correct name of the fungus. The pathogen of 'inflorescence-rot' was named *Mauginiella scaettae* by CAVARA (1926). He proposed this new genus and species on the basis of multiseptate conidia which are produced by the fragmentation of hyphae. The validity of this taxon was later on supported by CHABROLIN (1928). MAIRE & WERNER (1937), however, found no difference in the conidia and their manner of production in *Geotrichum* and *Mauginiella* and thus they reduced *Mauginiella* to synonymy under *Geotrichum*. ANSELME & BELTZAKIS (1957) mistook another fungus, "*Sporendonema sebi*" FRIES, for the pathogen of 'inflorescence-rot'. Depending upon their isolate, CIFFERI (1958) reduced *Mauginiella* to synonymy under *Sporendonema*. v. ARX (1970) pointed out an earlier generic name, *Wallemia* for *Sporendonema* and proposed the combination *Wallemia sebi* (FRIES) v. ARX and called it as the pathogen of 'inflorescence-rot'. NICOT (1972) on the basis of conidium development has pointed out that *Mauginiella* is a valid generic name (distinct from *Geotrichum*) and the correct name of the pathogen of 'inflorescence-rot' is *M. scaettae*.

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