

seen in crush mounts. Chlamydospores of *T. stromaticum* are characteristic in being large and multicellular.

Synanamorphs.--When two or more anamorphs form in a life cycle, they are known as synanamorphs. Chlamydospores are synanamorphs. In addition to chlamydospores, some *Trichoderma* species – many of those that produce their conidia from discrete pustules – produce a second, morphologically distinct synanamorph. Synanamorphs have been observed in twelve species, viz. *T. crassum*, *T. erinaceum*, *T. fasciculatum*, *T. hamatum*, *T. pubescens*, *T. spirale*, *T. strictipile*, *T. tomentosum*, *Hypocrea cremea*, *H. surrotunda*, *H. estonica*, and *H. semiorbis*. These conidiophores arise in the aeral mycelium or from the surface of the agar and are distinguished from the typical *Trichoderma* form in that their conidia are borne in glistening drops of liquid and the conidiophores have verticillium- or gliocladium-like branching (e.g. *T. erinaceum* FIGS. 81, 82, *T. spirale* FIGS. 66-69, *T. strictipile* FIGS. 107, 108). Sometimes *T. spirale* only forms the synanamorph, not the typical *Trichoderma* morph. The function of the synanamorphs is not known.

KEY TO 18 COMMON SPECIES OF *TRICHODERMA*

Because of the ability to use DNA sequencing and because of international interest in *Trichoderma* in ecology and biological control, taxonomy of *Trichoderma* is in a phase of expansion. New species are being found in new geographic locations and in new ecological niches (e.g. (Bissett et al 2003, Evans et al 2003) or as anamorphs of *Hypocrea* species (Chaverri et al 2003a). More than 50 species of *Trichoderma* have been described. Most of the species described before 2002 are included in keys published by Gams and Bissett (1998). An interactive key for the identification of *Trichoderma* species is available at

<http://nt.ars-grin.gov/taxadescriptions/keys/TrichodermaIndex.cfm> . Following is a key to 18 of the most commonly encountered species of *Trichoderma*. To use this key it is necessary to grow cultures on potato dextrose agar (PDA) at 25°C and 30°C for growth rates, and on a medium such as cornmeal dextrose agar or malt agar for microscopic observations. Measurements of microscopic characters are based on measurement of 30 units for each character for each collection.

1. Conidia forming in white or yellow pustules; cork-screw hairs arising from the pustules; north and south temperate regions; not tropical 10. *T. polysporum*
1. Conidia green, forming in pustules or not; when in pustules, sometimes associated with sterile hairs or protruding conidiophores that are only fertile at the tip 2
 2. Conidia globose to subglobose, L/W 1.0-1.2 3
 2. Conidia typically ovoidal to ellipsoidal, L/W > 1.3 8
3. Conidia smooth 4
3. Conidia ornamented 5
 4. Colony typically with a coconut odor; chlamydospores abundant within 10 days on CMD; growing very poorly on potato dextrose agar at 35° C 8

2. *T. atroviride*

4. Colony lacking distinctive odor; chlamyospores typically not formed within 10 days on CMD; growing well sporulating at 35°C 5. *T. harzianum*
5. Conidia finely ornamented, spinulose but many appearing smooth, subglobose to ovoidal (L/W 1.2); conidiophores with branches typically paired and increasing in length with distance from the tip of the conidiophore; phialides swollen in the middle, arranged in whorls of 3 or more, rarely solitary 1. *T. asperellum*
5. Conidia conspicuously ornamented, warted, subglobose (L/W 1.0-1.1); conidiophores with branches typically unpaired and phialides often solitary, usually not swollen, often hooked or sinuous *T. viride* complex 6
6. Conidia 3.8-4.0 x 3.5-3.8 µm, L/W 1.1; colony radius 13-20 mm on PDA and 11-25 mm on SNA at 30 C after 72 h 18. *T. viride* s. str.
6. Conidia 3.2-5.0 x 3.2-4.5 µm, L/W 1.0-1.2; colony radius 0-40 mm on PDA and 0-31 mm on SNA at 30 C after 72 h 7
7. Conidia 3.5-3.8 x 3.2-3.4 µm, L/W 1.1; colony radius on PDA 25-35 mm and on SNA 18-27 mm at 30°C after 72 h *T. cf. viride* sp. A
7. Conidia 3.2-5 x 2.8-4.5 µm, L/W 1.1-1.2; colony radius on PDA and SNA < 10 mm at 30°C after 72 h *T. cf. viride* sp. B
8. Conidia held in conspicuous drops of clear, green liquid; chlamyospores abundant in crush mounts 17. *T. vires*
8. Conidia held in dry heads; chlamyospores when present not abundant in crush mounts 9
9. Most phialides arising singly from the conidiophore 10
9. Most phialides arising in whorls 11
10. Conidia oblong to ellipsoidal, 4.0-5.5 x 2.0-2.5 µm, L/W 1.5 8. *T. longibrachiatum* (see also *T. citrinoviride*)
10. Conidia ellipsoidal, 2.4-4.0 x 2.0-2.8, L/W 1.3 12. *T. sinensis*
11. Conidia forming in pustules or not but lacking hairs and projecting conidiophores..... 1
11. Conidia typically forming in pustules, with hairs and/or projecting conidiophores ... 13
12. Conidia oblong, (3.1--3.7—4.5(--6.0) x (2.0--2.2—3.0(--3.3) µm, L/W (0.9-)1.3-1.9(-2.5); conidiophores consisting of a long, narrow axis from which paired branches arise; phialides flask-shaped, held in whorls of 2-4 at the tips of fertile branches, (4.3-)-6.2-10.2(-15.5) µm long 7. *T. koningii* s. str.
12. Conidia ellipsoidal, (2.7-)-3.0-3.7(-5.0) x (1.8-)-2.0-2.7(-3.2) µm, L/W (1.0-)-1.2-1.6(-2.0); conidiophores consisting of a short, broad axis from which paired branches arise; phialides subglobose, held in clusters of many at the tips of fertile branches, (3.0-)-4.5-7.0(-11.2) µm long 9. *T. minutisporum*

13. Hairs arising from pustules sinuous or helical, sterile 14
 13. Hairs arising from pustules straight, fertile or not 15
14. Conidia 2.5-3.5 x 1.7-2.5 6. *T. helicum*
 14. Conidia 3.5-4.5 x (2.0-)2.5-3.0(-3.7) μm 13. *T. spirale*
15. Conidial production restricted to 1 mm diam pustules with short sterile hairs; pustules easily removed from agar surface, slow to turn green, often remaining white to yellow for a long time; occurring on cacao and other tissue infected with *Crinipellis pernicioso* or isolated from *Theobroma* species in Tropical America 16. *T. stromaticum*
 15. Not forming small, easily removed pustules; hairs otherwise 16
16. Projecting conidiophores producing one or a few phialides at the tip of a stipe that is sterile for more or less distance; colonies often with a coconut odor 17
 16. Projecting hairs sterile; no coconut odor 18
17. Conidia oblong or narrowly ellipsoidal, 3.6-4.5 x 2.0-3.0 μm , L/W = 1.5-2.0 15. *T. strigosum*
 17. Conidia ellipsoidal, 3.5-4.7 x 2.7-3.5 μm , L/W 1.4 3. *T. erinaceum*
18. Colony radius on PDA at 30°C after 72 h in darkness 5-10 mm 11. *T. rossicum*
 18. Colony radius on PDA at 30°C after 72 h in darkness > 30 mm 19
19. Hairs unbranched, sterile; conidia (3.9-)4.2-5.0(-5.8) x (2.4-)2.7-3.0(-3.4) μm , l/w = (1.2-)1.4-1.8(-2.1); phialides broadly ellipsoidal to ovoidal, (4.5-)5.2-7.2(-9.5) μm long, ratio of length to the widest point = (1.2-)1.3-2.1(3.1) 4. *T. hamatum*
 19. Hairs branched, sterile or fertile; conidia (2.8-)4.5-4.7(-8.0) x (2.2-)3.5-3.6(-5.3) μm , L/W (0.9-)1.9(-2.2); phialides mainly arising in divergent whorls, less frequently singly and then at or near the tip of the main axis, somewhat swollen and flask-shaped, straight, (4.0-)7.4-7.9(-15.0) μm long 14. *T. strictipile*

DESCRIPTIONS OF 18 COMMON SPECIES OF *TRICHODERMA*

1. *Trichoderma asperellum* Samuels, Lieckfeldt & Nirenberg, Sydowia 51: 81. 1999. FIGS. 5-8, 11-19. FIGS. 48, 54, 55, 70-72.

Teleomorph: None known.

Colony radius after 72 h on PDA at 30C: (7-)54(-64)mm, at 35C (0-)27(-42) mm; 40C: 0 mm. Colonies grown for 72 h on PDA at 30C in darkness forming up to 5 concentric rings of dense conidial production, with conidia toward the center dark green and conidia toward the margin just beginning to form, aerial mycelium lacking. Conidia forming at 25C after 40h in darkness. No yellow pigment diffusing through the agar at any temperature. No odor.