

SOME NOTES ON TORULA

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(With three Text-figures)

A new species of *Torula* Pers. per Fr., collected at Hyderabad, India, is described as *T. rhombica* Rao & de Hoog. It forms chains of reddish brown, regularly rhomboid conidia. A key to the accepted species of *Torula* is given. All CBS strains maintained under the name *Torula* are discussed; they can be assigned to six different genera. New combinations are proposed in *Poly-paecilum* Smith and *Moniliella* Stolk & Dakin, and a new species of *Scytalidium* Pesante is described.

In the course of studies on dematiaceous Hyphomycetes, the senior author reported on a new species of *Bahusandhika* Subram. as *B. sundara* Rao & Rao (1972). Another species, resembling *Torula terrestris* Misra (1967), is described in this communication. In order to delimit the new species all strains maintained in the CBS collection under the name *Torula* were studied. As a result a key is proposed for the species of *Torula* sensu stricto (Ellis, 1971). The strains which do not fit this genus are re-classified.

***Torula rhombica* Rao & de Hoog, sp. nov.—Fig. 1**

Coloniae in ligno putrido effusae, 1-3 mm diam., quasi 1 mm altae, atrobrunneae; hyphae steriles superficiales, repentes, leves, fere tenuitunicatae, subhyalinae vel pallide rubrobrunneae, 1.5-2 μ m crassae, cellulis 4-6 μ m longis; hyphae fertiles repentes vel adscendentes, rubrobrunneae, crassitunicatae, verrucosae, plerumque 2-3 μ m crassae, septis tenuibus circa 30 μ m distantibus, apicibus conidiiferis lateralibus vel terminalibus. Cellulae conidiogenae singulae vel modice acervatae, sessiles vel pedicellatae, fere crassitunicatae, verrucosae, rubrobrunneae, pyriformes, 3-6 μ m longae, sursum conspicue inflatae ad 5.5 μ m, unam rarius duas cicatrices conidiiferas, 1-1.5 μ m diam. ferunt. Blastoconidia sicca, catenulata, plerumque 5-6-septata, fusiformia vel rhomboidalia, utrinque symmetrica, fere crassitunicata, cellulis mediis dense verrucosis, obscure rubrobrunneis, septis crassis, opacis, extus modice constrictis, 33-43 μ m longa, 11-18 μ m crassa in medio, 3-3.5 μ m in cellulis terminalibus, dilute brunneis; conidiorum catenae simplices, nonnumquam ramosae, ad 150 μ m longae.

Typus: Herb. IMI 162.901 (Herb. CBS 77), in ligno putrido, in seminario arborum Balaji, Hyderabad, Andhra Pradesh, India, Sept. 1969.

Colonies on the natural substrate effused, 1-3 mm in diameter, less than 1 mm high, blackish brown. *Sterile hyphae* superficial, creeping, smooth- and thin- or somewhat thick-walled, subhyaline to pale reddish brown, 1.5-2 μ m wide, with septa at 4-6 μ m distance. *Fertile hyphae* creeping or ascending, reddish brown,

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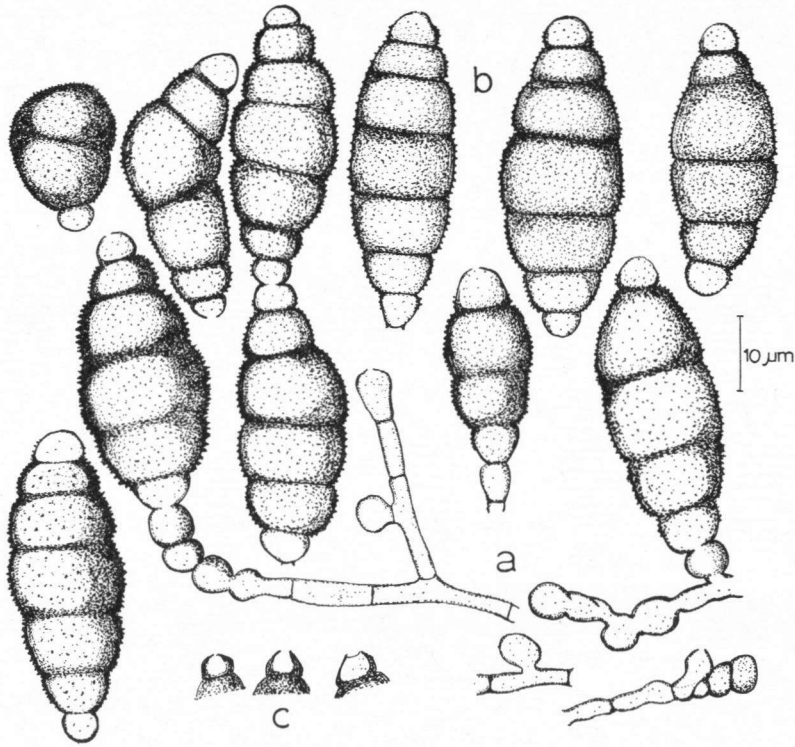


Fig. 1. *Torula rhombica*. — a. Hyphae bearing conidiogenous cells and conidia. — b. Conidia — c. Conidial tips showing apertures or scars.

thick-walled, verrucose, usually $2-3\ \mu\text{m}$ wide, with thin septa about every $30\ \mu\text{m}$, in the apical region with conidiiferous structures in lateral or terminal position. *Conidiogenous cells* solitary or in small groups, sessile or supported by 1-3 short cells, rather thick-walled, verrucose, reddish brown, pear-shaped, $3-6\ \mu\text{m}$ long, apically conspicuously inflated up to $5.5\ \mu\text{m}$, with one, occasionally with two thin-walled circular scars $1-1.5\ \mu\text{m}$ in diameter at the tip. *Conidia* blastic, dry, catenate, usually 5- to 6-septate (number of the septa ranging from 3-7 ultimately), fusiform to rhomboidal, symmetrical, $33-43\ \mu\text{m}$ long, $11-18\ \mu\text{m}$ wide in the median part, $3-3.5\ \mu\text{m}$ at the base and apex, somewhat constricted at the septa, basal and apical cells light brown, the latter cells moderately thick-walled, median cells densely verrucose, dark reddish brown, septa heavily pigmented to form black zones; conidial chains simple, sometimes branched, up to $150\ \mu\text{m}$ long.

MATERIAL EXAMINED.—IMI 162.901 (type; isotype, slides in Herb. CBS no. 77), on decaying wood, Balaji Nursery, Hyderabad, Andhra Pradesh, India, September 1969, *V. Rao*.

In all species of the genus *Torula*, as circumscribed by Ellis (1971), series of conidial cells arise acropetally from inflated conidiogenous cells. Invariably the first cell is initially joined with its supporting cell by a narrow cytoplasmic connection, at most

1.5 μm wide, which soon becomes partitioned by a double septum. Formation of the subsequent cells can take place in two ways. Occasionally the above budding is repeated once or several times, but more often the first cell elongates from a wide, little constricted base and becomes septate after almost having attained its ultimate size (Hashmi & al., 1973). The latter type of cell formation reiterates almost indefinitely, or is interrupted at more or less regular sequences by the firstly mentioned budding. In this way the chains become articulated, the intermediate cell-rows can be regarded as phragmoconidia. Occasionally the phragmoconidia break apart into their separate cells.

The above details of morphogenesis can be used as taxonomic criteria to group the species of *Torula*. In *T. herbarum* (Pers.) Link per S. F. Gray (in L, nrs. 910.267-924, and 998.1000; CBS 379.58, and CBS 442.51, received as *T. graminis*) and *T. caligans* (Batista & Upadhyay) M. B. Ellis (CBS 576.65—type, 269.72 and 308.73), one-celled propagules are rare; if present, they arise by budding and can be regarded as ameroconidia. The phragmoconidia consist of few cells only, which are all of about the same shape and size.

Torula graminis Desm. (CBS 245.57=IMI 1.332, received as *T. herbarum*), is characterized by long, many-celled phragmoconidia, which frequently break up into their separate cells. Only a few narrow connections are found; usually they are confined to the primary cell of the chain and the basal cells of its ramifications.

In developing conidia of *Torula terrestris* Misra (1967; CBS 311.67—type, 330.67 and 902.72) and *T. ndjilensis* Kiffer (1972; CBS 543.73—type), often hardly any constriction can be observed. The phragmoconidia are well defined, with cells mutually differing considerably in shape and size, the median ones being the largest and the darkest. Occasionally the conidia are not catenate. Also *T. rhombica* can be assigned to this group. It is distinct from both species due to the regularly symmetric, fusiform to rhomboid shape of the conidia with the apical and basal cells being of the same shape and size, the dark red-brown colour of the conidia and the mycelium, and the fine, densely verrucose ornamentation of the median conidial cells.

The species hitherto accepted in *Torula sensu stricto* can be identified by the following key:

- 1a. Conidia many-celled, often breaking up into small fragments; conidial cells all alike *T. graminis*
- b. Not combining above characters 2
- 2a. Conidia usually 3- to 5-celled; basal cells of conidia as dark as or darker than the median cells and of about the same width, apical cells pale or bi-coloured 3
- b. Conidia usually 5- to 7-celled; basal cells of conidia conspicuously paler and/or narrower than the median cells, apical cells pale or dark 4
- 3a. Conidia smooth or finely verrucose; apical conidial cell usually brown with a hyaline tip *T. herbarum*
- b. Conidia tuberculate; apical conidial cell entirely subhyaline *T. caligans*
- 4a. Conidia fusiform to rhomboid, densely verrucose, red-brown *T. rhombica*
- b. Conidia fusiform to ellipsoidal, tuberculate, brown to olivaceous 5
- 5a. Conidia usually 10-12 μm wide. *T. terrestris*
- b. Conidia usually 13-15 μm wide. *T. ndjilensis*

It is pertinent to record here that *T. caligans* and *T. terrestris* occasionally produced single terminal conidia, as was already noted by Misra (1967). As such these species are reminiscent of *Polyschema* Upadhyay and differ from both known species in this genus, *P. terricola* Upadhyay (1966) and *P. congolensis* Reisinger & Kiffer (1974), only by some minor morphological characters. Consequently, the synonymy of *Polyschema* and *Pithomyces* Berk. & Br., as suggested by Kendrick & Carmichael (1973) is rejected here, because of the absence of differentiated conidiogenous cells in the latter genus.

The considered strains which could not be classified in *Torula* sensu stricto are discussed below in alphabetical order.

a l l i i. — *Torula allii* (Harz) Sacc., CBS 441.51, sent by E. Baldacci under no. MMP-162.

This strain can be identified as *Humicola nigrescens* Omvik. It does not fit the original diagnosis (Harz, 1871).

b o t r y o i d e s. — *Torula botryoides* Brooks & Hansf., CBS 143.23, T, isolated from a halibut in cold storage, May 1918.

The species was well described and depicted by Brooks & Hansford (1923). In culture it appears to be indistinguishable from the type strain of *Polypaecilum capsici* (Beyma 1944) G. Smith, CBS 176.44. Consequently the species should be referred to as **Polypaecilum botryoides** (Brooks & Hansf.) Rao & de Hoog, *comb. nov.* (basonym: *Torula botryoides* Brooks & Hansf. in Trans. Br. mycol. Soc. 8: 134. 1923).

d e m a t i a. — *Torula dematia* Berkhout, CBS 314.31, sent by P. Lindner; CBS 381.36 and 382.36, isolated by J. W. Jollyman from tobacco; CBS 349.33, isolated by J. J. Harris from condensed milk.

The former three strains are characterized by the presence of long, acropetal chains of pale brown, slightly thick-walled conidia, and hyaline or subhyaline arthroconidia. They are identical with *Moniliella suaveolens* (Lindner) v. Arx. CBS 349.33 has compact, olivaceous colonies, whereas the subhyaline conidia are borne in long acropetal chains, which fragment only in a very late stage. The fungus shows superficial resemblance to *Rhinocladiella compacta* (Carrion) Schol-Schwarz.

j a a p i i. — *Torula jaapii* Lindau, CBS 171.40 (=IFO 6396), isolated by G. A. Heubel from wood of *Camellia sinensis* L.

Since in young cultures of this strain the subhyaline hyphae locally fragment, and in a later stage terminal, brown, thick-walled chlamydo-spores are formed, it should be classified in *Scytalidium* Pesante. It cannot be identified with any of the known species in this genus; as a consequence it is described here as new. The strain does not fit the original diagnosis of *Torula jaapii* given by Lindau (1907); the type specimen (at B) could be identified with *Alysidium resinae* (Fr.) M. B. Ellis.

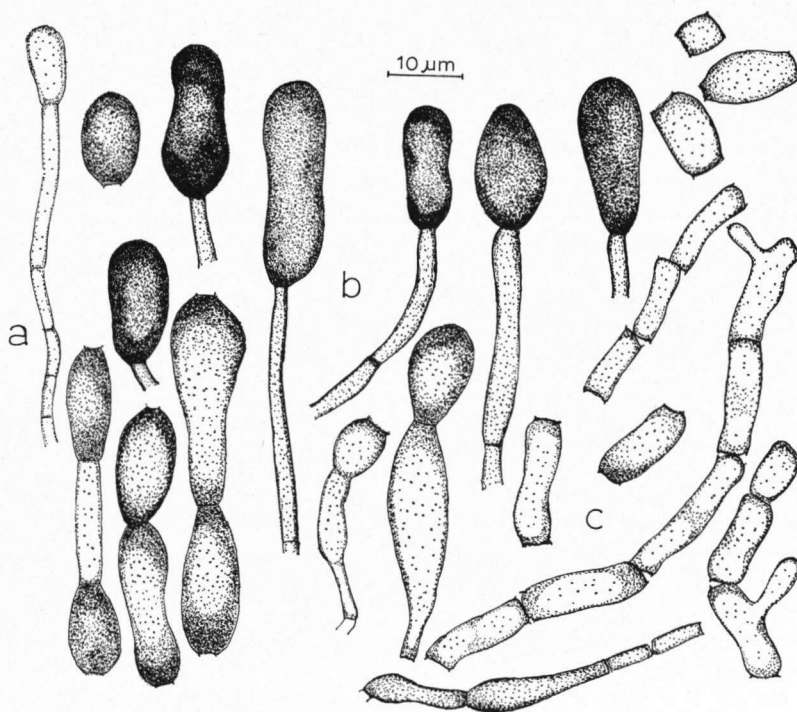


Fig. 2. *Scytalidium terminale*. — a. Fertile hypha with young chlamyospore. — b. Mature chlamyospores. — c. Arthric conidia.

***Scytalidium terminale* Rao & de Hoog, *sp. nov.*—Fig. 2**

Coloniae in agaro farina avenae addita 20°C ad 14 mm diam. post 10 dies, effusae, leves, primum subhyalinae, deinde obscure testaceae. Mycelium pro maxima parte submersum, hyphis levibus tenuitunicatis, hyalinis vel subhyalinis, 1.5–3.0 µm crassis. Conidia duobus modis formantur: altera arthroconidia singula vel catenulata, levia et tenuitunicata, a hyphis colore non differunt, rectangularia, plerumque 10–20 × 3–5 µm, nonnumquam modice inflata; alterae chlamyosporae terminales, nonnumquam intercalares, singulae, nonnumquam breviter catenulatae, leves, crassitunicatae, dilute vel obscure brunneae, obovoidales, ellipsoideae vel pyriformes, plerumque 15–25 × 7–9 µm.

Typus: CBS 171.40, isolatus ex ligno *Camelliae sinensis* a I. Heubel.

Colonies on oatmeal agar at 20°C attaining a diameter of 14 mm in 10 days, effused, smooth, at first subhyaline, later becoming dark brick. Mycelium mainly submerged, hyphae smooth- and thin-walled, hyaline to subhyaline, 1.5–3 µm wide. Conidia of two types: arthric conidia singly or in chains, smooth- and thin-walled, concolorous with the hyphae, rectangular, usually 10–20 × 2–3 µm, sometimes slightly swollen; chlamyospores terminal, sometimes intercalary, single, occasionally in short chains, smooth- and thick-walled, pale to dark brown, obovoidal, ellipsoidal or pyriform, usually 15–25 × 7–9 µm.

Type: CBS 171.40.

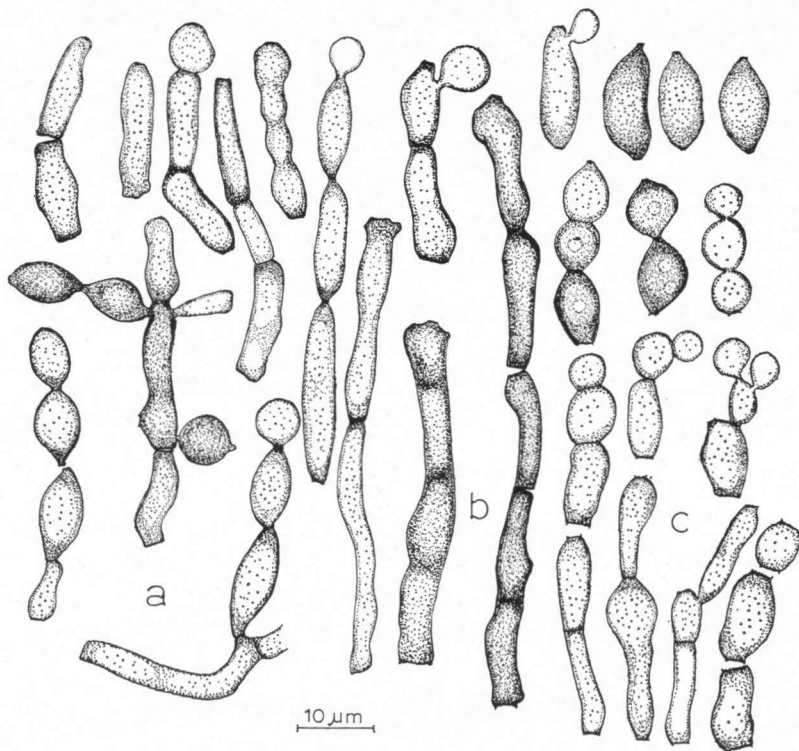


Fig. 3. *Moniliella mellis*. — a. Mature arthric and blastic conidia. — b. Fragmenting hyphae. — c. Young arthric and blastic conidia.

Scytalidium terminale can easily be recognized from other species of the genus by its characteristic terminal chlamydospores, which only rarely occur in short intercalary chains. It is reminiscent of some *Humicola* species, but differs by the presence of arthric conidia.

ligniperdus. — *Torula ligniperda* (Wilkomm) Sacc., CBS 383.36, isolated by L. Grodzinsky from *Abies alba* Mill., Tucumán, Argentina; CBS 317.56 (=IFO 6397), isolated by S. Batko from root of *Quercus* sp.

Both strains are characterized by subhyaline hyphae with chains of intercalary, brown, thick-walled chlamydospores. They are very similar to *Humicola brevis* (Gilman & Abbott) Gilman. According to Siggers (1922), who gave a detailed description of *T. ligniperda*, probably no original material has been preserved; it is not maintained in B. Consequently the identity of this species remains doubtful.

mellis. — *Torula mellis* Fabian & Quinet, CBS 350.33, T, isolated from honey.

This strain shows abundant sporulation with acropetal chains of conidia, as well as arthric conidia. It can be classified in *Moniliella* Stolk & Dakin, and should be referred to as ***Moniliella mellis*** (Fabian & Quinet) Rao & de Hoog, *comb. nov.* (Fig. 3) (basonym: *Torula mellis* Fabian & Quinet in Tech. Bull. Mich. (St. Coll.) agric. Exp. Stn 92: 26. 1928). A detailed description is given below.

Colonies on oatmeal agar at 20°C attaining its maximum diameter of 10–15 mm in 30 days, remaining smooth, pale brown, in age becoming dark to blackish brown. *Mycelium* partly submerged, hyphae smooth- and thin-walled, hyaline to subhyaline, 2–3 µm wide, sometimes swollen up to 5 µm, at a very young stage fragmenting into separate cells. *Conidia* of two types: arthric conidia singly or in chains, smooth, at first thin-walled and subhyaline, later becoming thick-walled and light brown, 0- to 1-septate, usually rectangular, sometimes swollen or irregular, about 6–20 × 3–6 µm, the apical conidia usually give rise to several chains of blastoconidia; blastoconidia arising in terminal or sometimes lateral, simple or branched, acropetal chains, smooth- and thin- or slightly thick-walled, subhyaline to pale brown, continuous, globose, ovoidal or fusiform, intermediate conidia oblong to limoniform, with usually unpigmented scars, 5–15 × 4–6 µm, in each chain the basal conidia conspicuously longer than the apical ones.

The present species can be distinguished from *Moniliella acetoabutans* Stolk & Dakin by the presence of dark, intercalary chlamydo-spores. It is very similar to *M. suaveolens* (Lindner) v. Arx, but differs by its cultural characteristics, the strongly fragmenting mycelium, the pigmentation of the arthric conidia, and the shape and size of the blastic conidia. It is reminiscent of *Hormoconis resinæ* (Lindau) v. Arx & de Vries, but can be recognized by the presence of arthric conidia and the absence of erect, markedly differentiated conidiophores. *Cladosporium* Link per Fr. and some closely related genera are also distinguished on the absence of arthric conidia; moreover they usually differ by having conspicuously pigmented conidial scars (von Arx, 1973).

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REFERENCES

- ARX, J. A. VON (1973). Progress Report CBS 1972. In Verh. K. Ned. Akad. Wet., Afd. Natuurk. (C) 61: 59–81.
- BROOKS, F. T. & HANSFORD, C. G. (1923). Mould growths upon cold-storage meat. In Trans. Br. mycol. Soc. 8: 113–142.
- ELLIS, M. B. (1971). Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew.
- HARZ, C. O. (1871). Einige neue Hyphomyceten Berlins und Wiens, nebst Beiträgen zur Systematik derselben. In Bull. Soc. impér. Moscou 44: 1–88.
- HASHMI, M. H., MORGAN-JONES, G. & KENDRICK, B. (1973). Conidium ontogeny in hyphomycetes. The blastoconidia of *Cladosporium herbarum* and *Torula herbarum*. In Can. J. Bot. 51: 1089–1091.
- KENDRICK, W. B. & CARMICHAEL, J. W. (1973). Hyphomycetes. In Ainsworth, G. C., Sparrow F. K. & Sussman A. S. (Eds.): The Fungi, an advanced treatise IVA: 323–509.

- KIFFER E. (1973). Contribution à l'étude de la microflore fongique du Congo III. *Torula ndjilensis* sp. nov. et *Balanium africanum* sp. nov. In *Naturaliste can.* **100**: 257-263.
- LINDAU, G. (1907). Fungi imperfecti: Hyphomycetes (erste Hälfte), Mucedinaceae, Dematiaceae (Phaeosporae und Phaeodidymae). In Rabenhorst's *Kryptogamen-Flora* 2. Aufl. I 8, Leipzig.
- MISRA, P. C. (1967). *Torula terrestris* n. sp. from soil. In *Can. J. Bot.* **45**: 367-369.
- RAO, V. & RAO, D. (1972). A new species of *Bahusandhika* from India. In *Indian Phytopath.* **25**: 289-291.
- REISINGER, O. & KIFFER, E. (1974). Contributions to the microflora of the Congo IV. *Polyschema congolensis* sp. nov.: taxonomy and ultrastructure. In *Trans. Br. mycol. Soc.* **62**: 289-294.
- SIGGERS, P. V. (1922). *Torula ligniperda* (Willk.) Sacc. A Hyphomycete occurring in wood tissue. In *Phytopathology* **12**: 369-374.
- UPADHYAY, H. P. (1966). Soil fungi from North-East Brazil II. In *Mycopath. Mycol. appl.* **30**: 276-286.