Mycoscience 35: 309–313, 1994

A new species of *Neosartorya* from Taiwan soil

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Accepted for publication 10 August 1994

A new species of *Neosartorya, N. multiplicata* (anam. *Aspergillus multiplicatus*), isolated from soil collected at Houli, Taichung, in Taiwan, is described and illustrated. The species is characterized by its restricted growth on Czapek agar, white ascomata, nearly globose ascospores with ribbed surface ornamentation of several linear ridges, and a limited development of conidia on common media. A key to all accepted species of the genus is provided.

Key Words——*Aspergillus multiplicatus*; Eurotiales; *Neosartorya multiplicata*; soil-borne fungus; Taiwan.

Members of *Neosartorya* Malloch et Cain in the Eurotiales (Malloch and Cain, 1972) are typically thermoresistant propagules found in soils, marine sediments and house dusts, and even in final products of the fruit canning industry (Domsch et al., 1980; Ueda, 1986; Horie et al., 1992b; Peterson, 1992; Samson et al., 1992; Splittstoesser et al., 1993). They are characterized by white or yellowish colonies, globose, non-ostiolate ascomata with a membranaceous peridium, globose to ovoid, unitunicate asci, and hyaline, lenticular ascospores with two or more equatorial crests. Their anamorphs, members of subgenus *Fumigati* section *Fumigati* in the genus *Aspergillus* (Raper and Fennell, 1965; Gams et al., 1985), are usually characterized by columnar, light blue-green to dark green conidial heads, smooth-walled or sometimes roughened conidiophores with a flask-shaped vesicle, uniseriate aspergilla, and globose or ellipsoidal, small conidia. Most species are thermotolerant, being able to grow well at 37°C or higher temperatures. Since Raper and Fennell (1965) defined 5 species and 2 varieties in the *Aspergillus fischeri* series in the "*Aspergillus fumigatus* group" (=sect. *Fumigati*), the following 6 species have been added: *N. fennelliae* Kwon-Chung et Kim (Kwong-Chung and Kim, 1974), *N. spathulata* Takada et Udagawa (Takada and Udagawa, 1985), *N. hiratsukae* Udagawa, Tsubouchi et Horie (Udagawa et al., 1991), *N. pseudofischeri* Peterson (Peterson, 1992), *N. tatenoi* Horie, Miyaji, Yokoyama, Udagawa et Takagi (Horie et al., 1992a) and *N. primulina* Udagawa, Toyazaki et Tsubouchi (Udagawa et al., 1993). Meanwhile, based on her scanning electron microscope (SEM) studies of spore ornamentation for numerous Aspergilli on stored products, Kozakiewicz (1989) proposed two combinations, *N. glabra* (Fennell et Raper) Kozakiewicz and *N. spinosa* (Raper et Fennell) Kozakiewicz, both raised up to the species rank. Samson et al. (1990), as a result on their SEM study of ascospore ornamentation in *Neosartorya*, suggested that there are more additional species, but they have not yet provided descriptions.

An unusual *Neosartorya* was recently isolated from soil in Taiwan. One of its most distinctive characteristics is the nearly globose ascospores with ribbed surface ornamentation consisting of several linear ridges. It is considered to be sufficiently different from all previously described species to warrant its description as a new species. Color nomenclatures are from the Kornerup and Wanscher (1978) color handbook and the Rayner (1970) color chart, and are referred to with the letters M and R, respectively.

Neosartorya multiplicata Yaguchi, Someya et Udagawa, sp. nov. Figs. 1, 2

Coloniae in agaro Czapekii paulo restrictae, planae, tenues, laxe floccosae, albae; ascomata tarde formantes; conidiogenesis moderata, ad marginem dispersa; reversum incoloratum. Coloniae in agaro "Czapek-yeast extract (CYA)" effusae, velutinae, radiatim sulcatae, ex coacto mycelio basali paulo compacto constantes, abundantibus ascomatibus formantes, albae; conidiogenesis sparsa, inconspicua; reversum griseo-flavum vel olivaceo-bubalinum. Coloniae in agaro maltoso effusae, floccosae, planae, ex coacto mycelio basali tenuiter constantes, abundantibus ascomatibus formantes, albae; conidiogenesis nulla; reversum obscure viride vel glaucovenetum.

Ascomata superficialia, dispersa vel confluentia, non ostiolata, alba vel parum cremea, globosa vel subglobosa, 100–300 μm diam, hyphis hyalinis laxe intricatis circumdata, tarde maturescentia; peridium tenue, semitranslucens, membranaceum, "textura epidermoidea" et "textura angularis"; stratum externum ex cellulis hyalinis, irregularibus, incrassatis, 2.5–8 μm latis compositum; stratum interius ex cellulis hyalinis, tenuibus, complanatis, angularibus compositum. Asci octospori, singulares, subglobosi vel ovoidei, 10–14×10–12 μm, evanescentes. Ascosporae hyalinae, globosae vel subglobosae, 4–5 μm

diam, sine cristis aequatorialibus distinctis, cum cristis linearibus numerosis praeditae, nervatae vel aliquantum reticulatae. Status anamorphus: *Aspergillus multiplicatus*.

Holotypus PF 1154, colonia exsiccata in cultura ex solo, Houli, Taichung, Taiwan, 14. ix. 1993, T. Yaguchi et al. isolata et ea in collectione fungorum, Musei et Instituti Historiae Naturalis Chiba (CBM) conservata.

Etymology: from Latin, *multi-*=many- and *plicatus*=folded into pleats, referring to the ascospore ornamention.

Anamorphosis: *Aspergillus multiplicatus* Yaguchi, Someya et Udagawa, anam. nov.

Capitula conidica parva, dilute viridi-grisea, divergentia vel laxe columnaria. Conidiophora ex mycelio basali vel hyphis aeriis oriunda; stipites stricti vel interdum sinuosi, hyalini vel dilute brunnei, 20-160×2.5-4 μm, leves, incrassati, saepe septati; vesiculae hyalinae vel dilute brunneae, clavatae vel ampulliformes vel irregulares, 4-8 μm diam. Aspergilla uniserialia; phialides hyalinae, ampulliformes vel cylindricae, 5-8(-12)×2.5-4 μm, in summa 1/2 vesicula insidentes. Conidia hyalina, globosa vel subglobosa, 2.5-4 μm diam, levia. Status teleomorphus:

Neosartorya multiplicata.

Holotypus PF 1154, loc. cit.

Colonies on Czapek agar growing rather restrictedly, attaining a diameter of 18 mm in 7 days at 25°C and 40 mm in 14 days at 25°C, plane, consisting of a thin basal felt overgrown by a loose flocculent mycelium, white in color; ascomata slowly developed throughout the colony; margins thin and irregular; conidiogenesis moderate, mostly localized at the marginal areas; exudate none; odor indistinct; reverse uncolored. Colonies on CYA growing rapidly, attaining a diameter of 36 mm in 7 days at 25°C and 75 mm in 14 days at 25°C, velvety, radially sulcate, consisting of a rather compact basal felt enmeshing a continuous layer of abundant ascomata, white in color; margins broad and submerged; conidiogenesis sparse, not sufficiently produced to influence the colony appearance; exudate fairly abundant, in small clear droplets; odor none; reverse Greyish Yellow (M. 4B3) or Olivaceous Buff (R). Colonies on malt extract agar (MEA) growing rapidly, attaining a diameter of 35 mm in 7 days at 25°C and 72 mm in 14 days at 25°C, floccose, plane, consisting of a thin basal felt and abundant ascomata, white in color; conidiogenesis lacking; exudate limited, clear; reverse Dull Green (M. 25D3) or Glaucous Blue-green (R). Colonies on oatmeal agar (OA) growing rather rapidly, attaining a diameter of 28 mm in 7 days at 25°C and 56 mm in 14 days at 25°C, plane, thin, characterized by a continuous layer of abundant ascomata, granular in appearance, white in color; margins

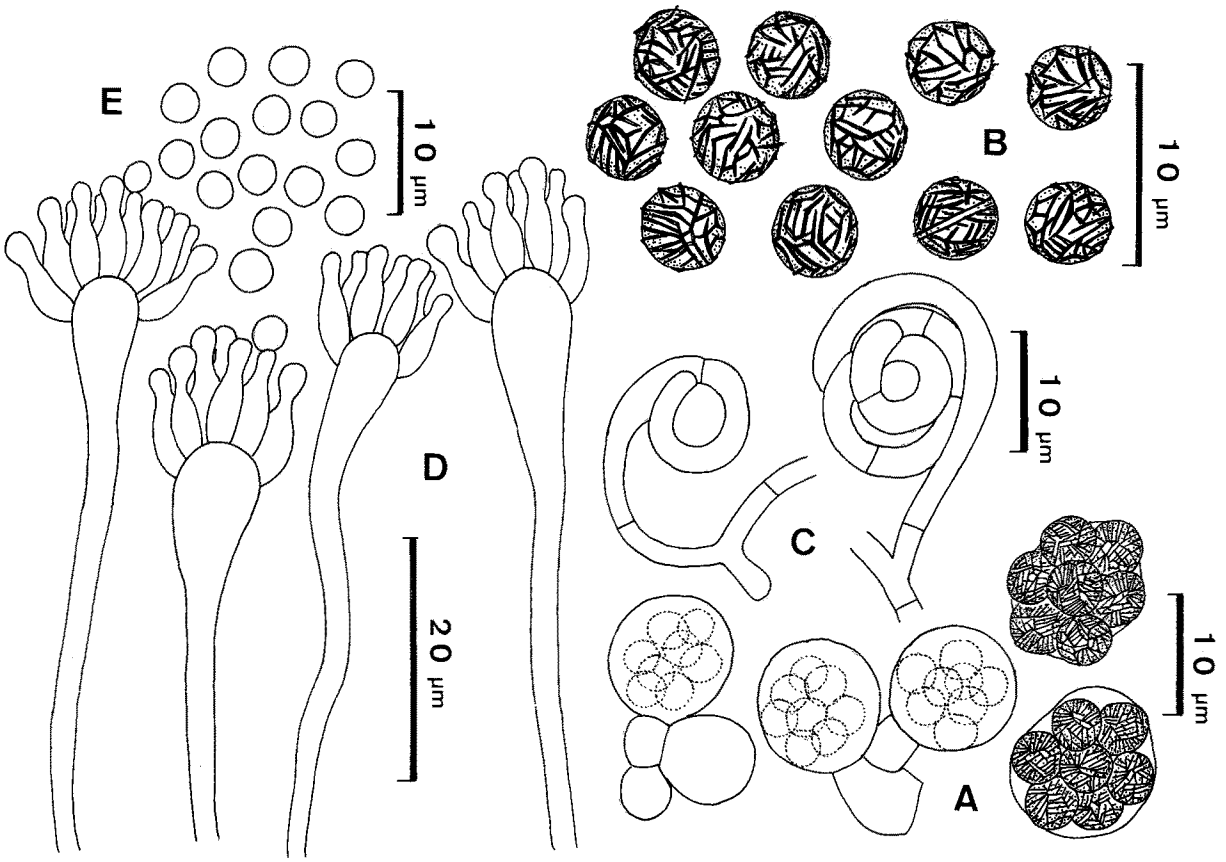

Fig. 1. *Neosartorya multiplicata*, PF 1154.

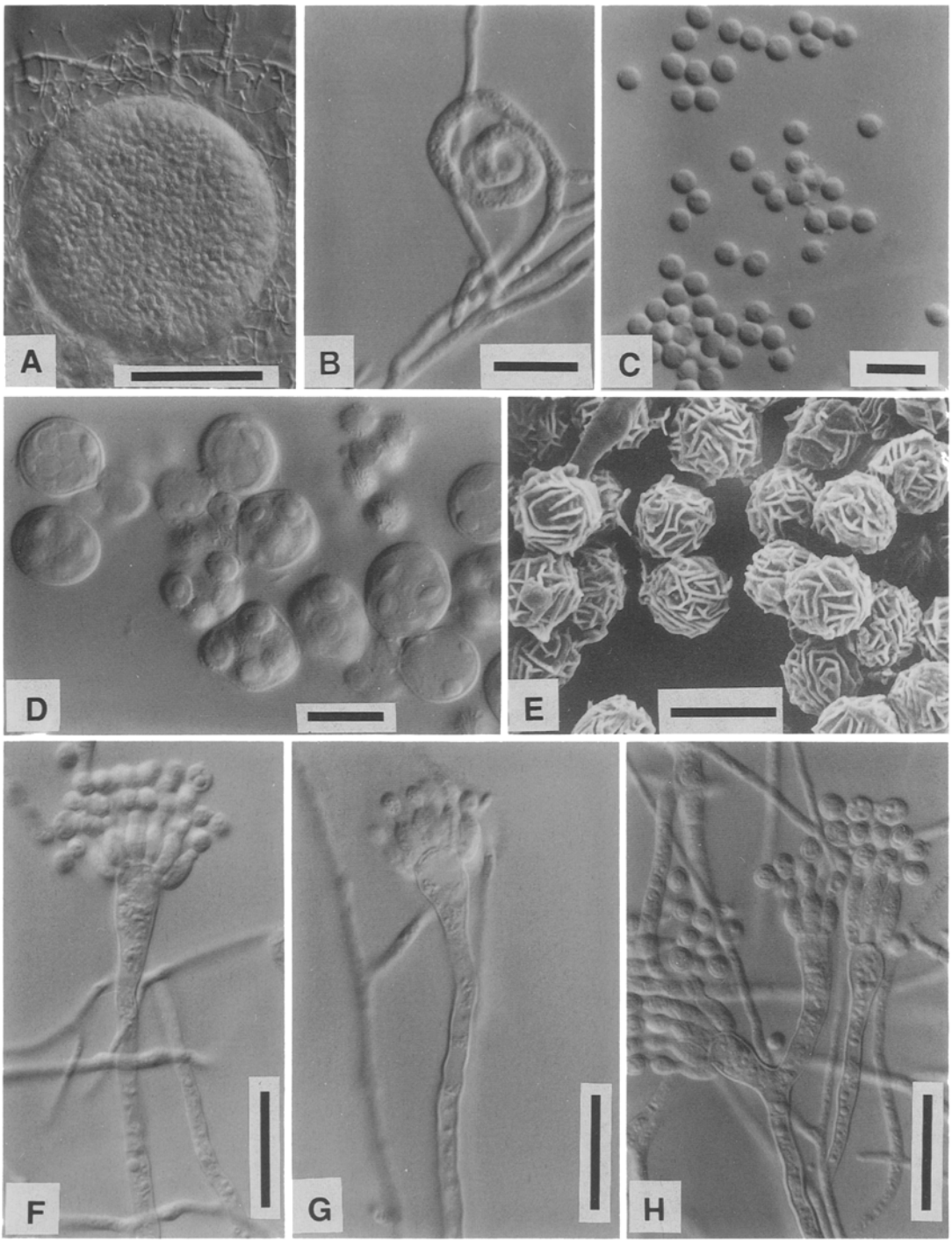

Fig. 2. *Neosartorya multiplicata*, PF 1154.
A. Ascoma. B. Ascomatal initial. C. Conidia. D. Asci. E. Ascospores (SEM micrograph). F–H. Aspergilla. Scale bars: A = 100 μm; B–D = 10 μm; E = 5 μm; F–H = 20 μm.

thin, more or less irregular; conidiogenesis lacking; exudate abundant, clear, collecting in large droplets; reverse Greyish Green (M. 27C3) or Greenish Glaucous to Malachite Green (R). At 37°C, colony diameters on CYA, MEA and OA in 7 days are between 75 and 80 mm.

Ascomata superficial, scattered or confluent in small clusters, non-ostiolate, white to slightly cream colored, globose to subglobose, 100–300 μm in diam, covered loosely with hyaline, branched, smooth, septate, 1.5–4 μm thick hyphae, maturing within 21 days at 25°C; peridium about 4–10 μm thick, thin, semitransparent, membranaceous, textura epidermoidea and textura angularis, two-layered; outer layer consisting of hyaline, irregular shaped, thick-walled cells measuring 2.5–8 μm

wide; inner layer of hyaline, thin, flattened, angular cells measuring 5-10 μm wide. Ascomatal initials developing as branches of hyphae with large curled tips measuring about 14.5 μm in diam. Asci 8-spored, borne singly, at first pyriform and short-stipitate, then becoming subglobose to ovoid, 10-14×10-12 μm, evanescent at maturity. Ascospores hyaline, globose to subglobose, 4-5 μm in diam, with a shallow furrow in the lateral view but without distinct equatorial crests, ornamented on surfaces by several linear ridges about 0.5 μm high, presenting ribbed or somewhat reticulate pattern.

Conidial heads small, faintly greenish gray, divergent or loosely columnar, up to 50-60 μm long. Conidiophores arising from the basal mycelium or aerial hyphae; stipes straight or somewhat sinuous, hyaline to pale brown, 20-160×2.5-4 μm, smooth and fairly thick-walled, often septate near the base; vesicles hyaline to pale brown, clavate to flask-shaped or irregular, 4-8 μm in diam. Aspergilla uniseriate; phialides hyaline, ampulliform or cylindrical, 5-8(-12)×2.5-4 μm, covering the upper half of the vesicle. Conidia hyaline, globose to subglobose, 2.5-4 μm in diam, smooth-walled.

Specimen examined: PF 1154 (holotype), a dried culture of an isolate from soil, Houli, Taichung County, Taiwan, 14 September 1993, coll. T. Yaguchi. The holotype has been deposited with the Natural History Museum and Institute, Chiba (CBM), Japan.

The new species can be distinguished from other species of *Neosartorya* by its almost globose ascospores, which have ribbed ornamentation with several linear ridges, and by the reduced production of its conidial heads on common media. In its ascospore characteristics, the species somewhat resembles *N. primulina*, which also produces nearly globose ascospores without distinct equatorial crests (Udagawa et al., 1993). The two species differ in the surface ornamentation of the ascospores, that of *N. primulina* being more irregular with ridges and triangular or verrucose projections. Moreover, the two species can easily be separated from one another by their anamorphic morphology. The conidiophores and the vesicles of *N. primulina* are larger (200-600×2.5-6 μm and 7.5-16 μm in diam, respectively). In addition, colonies on CYA of *N. primulina* have a pale yellow or primrose color due to the ascoma production.

Key to species of *Neosartorya*

1. Heterothallic 2
1. Homothallic 3
2. Ascomata persistently white in color; ascospores with two equatorial crests and convex surfaces distinctly cerebriform; conidiophores smooth ..... *N. fennelliae*
2. Ascomata pale yellow to light yellow; ascospores with two equatorial crests and convex surfaces almost smooth; conidiophores conspicuously roughened ..... *N. spathulata*
3. Ascospores showing distinct equatorial crests ... 4
3. Ascospores without distinct equatorial crests ... 13
4. Ascomata white to cream in color 5
4. Ascomata in yellow, golden, or orange shades ... 11
5. Ascospores with four equatorial crests and convex surfaces slightly reticulate or irregularly ridged ..... *N. quadricincta*
5. Ascospores showing two distinct equatorial crests 6
6. Convex surfaces of ascospores reticulate 7
6. Convex surfaces of ascospores variously spinulose or verrucose 9
7. Convex surfaces bearing anastomosing ridges to give a lobate-reticulate appearance ..... *N. fisheri*
7. Convex surfaces microreticulate 8
8. Convex surfaces of ascospores ornamented by distinctly and narrowly reticulate ridges; ascospores somewhat large ..... *N. tatenoi*
8. Convex surfaces of ascospores obtusely and more finely reticulate; ascospores somewhat small ..... *N. hiratsukae*
9. Ascospores with widely separated equatorial crests and convex surfaces verrucose ..... *N. glabra*
9. Ascospores with less widely separeted equatorial crests; convex surfaces of ascospores distinctly ornamented 10
10. Convex surface or ascospores rough to distinctly spinulose ..... *N. spinosa*
10. Convex surface or ascospores ornamented by roughly triangular flaps of tissue ..... *N. pseudofischeri*
11. Colonies on Czapek agar at 25°C growing rapidly; ascomata large (mostly more than 200 μm in diam); convex surfaces of ascospores echinulate ..... *N. aureola*
11. Colonies on Czapek agar at 25°C growing restrictedly; ascomata small, less than 200 μm in diam; convex surfaces of ascospores verrucose 12
12. Ascospores with prominent equatorial crests; ascomata pure yellow; conidia with microverrucose wall ..... *N. stramenia*
12. Ascospores with low equatorial crests; ascomata orange; conidia with lobate-reticulate wall ..... *N. aurata*
13. Ascospores with a very irregular ornamentation composed of several narrow ridges and triangular or verrucose projections ..... *N. primulina*
13. Ascospores ornamented by several ridges, presenting ribbed or somewhat reticulate pattern ..... *N. multiplicata*

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