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The Finding of Three Ganodermataceae Species in Taiwan

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Abstract. *Ganoderma densizonatum* and *G. rotundatum* are newly recorded from Taiwan. *Tomophagus colossus* was recently reported in Taiwan, and this paper offers comprehensive description and discussion for the Taiwanian specimen. Specimens of all three were collected from tropical or subtropical belts of Taiwan. Descriptions, basidiocarp photographs, and microscopic line drawings are provided for the three species. Sporal surface ultrastructure is especially given for *T. colossus*, to elucidate the separation between *Tomophagus* and *Ganoderma*.

Key words: *Ganoderma*, new records, polypore, Taxonomy, *Tomophagus*.

INTRODUCTION

Ganodermataceae Donk is distinct from other families of polypores in having peculiar type of double-walled basidiospores. The inner walls of the Ganodermataceae spores are quite often colored, and usually the surface is ornamented. *Ganoderma* P. Karst. represents the largest genus of the Ganodermataceae. This genus is famous in East Asian countries because some species have been considered long as herbal medicine. *Amauroderma rugosum* (Blume & Nees) Torrend, thirteen species and infraspecific taxa of *Ganoderma*, and *Magoderna subresinosum* (Murrill) Steyaert are members of the Ganodermataceae that have been recorded in the list of the fungi in Taiwan (Wang *et al.*, 1999). This paper documents two species of *Ganoderma* new to Taiwan, and one species of *Tomophagus* Murr. only recently known in Taiwan.

TAXONOMY

Ganoderma densizonatum J.D. Zhao & X.Q. Zhang, Acta Mycol. Sinica 4: 86. 1986 (Figs. 1A-B, 2)

Basidiocarp pileate, with a short stipe, woody. Pileus dimidiate, 12 cm wide, growth length 11 cm, up to 3 cm thick at the base. Upper surface glabrous, ochreous brown, brown, or black, occasionally laccate, concentrically sulcate; margin obtuse, somewhat lobed. Context brown, occasionally with dark brown resinous zones, 0.5-2 cm thick. Tube layer brown, paler than context, 0.3-1 cm thick. Pileus crust black, 0.5-2 mm thick, mainly composed of golden brown skeletal hyphae and swollen hyphal ends. Pore surface pale brown; pores suborbicular, ca. 5 per mm. Stipe lateral, about 2.5 cm long and 2 cm thick, concolorous with pileus surface.

Context hyphal system trimitic; generative hyphae rare, colorless, nodose-septate, 2-4 μm diam., thin-walled; skeletal hyphae brown to pale brown, thick-walled to subsolid, with a few distal branches, skeletal stalks 5-7 μm diam., branches 3-5μm diam.; binding hyphae colorless, thick-walled to solid, branched, 1-2.5 μm diam. Basidia not seen. Basidiospores ellipsoid, truncate at apex, usually guttulate, 9.5-11.5×5.5-6.5 μm; exospore colorless, thin; endospore thick, brown, separated from exospore by interwall pillars.

Specimen examined: **TAIWAN.** TAITUNG: Orchid Island, on the way to Tienchih, alt. 50 m, on wood of angiosperm, coll. S.Z. Chen, 24 Oct 1999, *Chen 946* (TNM F10592, HMAS 76614M).

Distribution: Mainland China (Hainan Province, type locality; Jiangsu Province). tropical Taiwan.

Remarks: This species resembles *Ganoderma limushanese* J.D. Zhao & X.Q. Zhang, but has hard and dense structure of pilear crust (Zhao,

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1989; Zhao and Zhang, 2000). It can be further studied by combatibility test, or by analyzing their DNA sequences, to judge their specific separation. *Ganoderma densizonatum* has priority over *G. limushanese*, if both represent the same species.

Ganoderma rotundatum J.D. Zhao, L.W. Hsu & X.Q. Zhang, Acta Microbiol. Sinica 19: 267. 1979 (Figs 1C-D, 3)

Basidiocarp pileate, sessile, woody. Pileus slightly convex, semicircular, 25 cm wide, growth length 14 cm, up to 6 cm thick at the base. Upper surface glabrous, brown, occasionally purplish- or reddish-tinted, slightly laccate, concentrically sulcate and zonate; margin thinning out, obtuse, entire or slightly undulate, yellow. Context up to 5 cm thick, indistinctly duplex, with a dominant wood-colored zone overlying a brown zone near the tube layer. Tube layer up to 1.2 cm thick, with color somewhat intermediate between two zones of the context. Pileus crust brown, ca. 0.5 mm thick, composed of golden brown skeletal hyphae

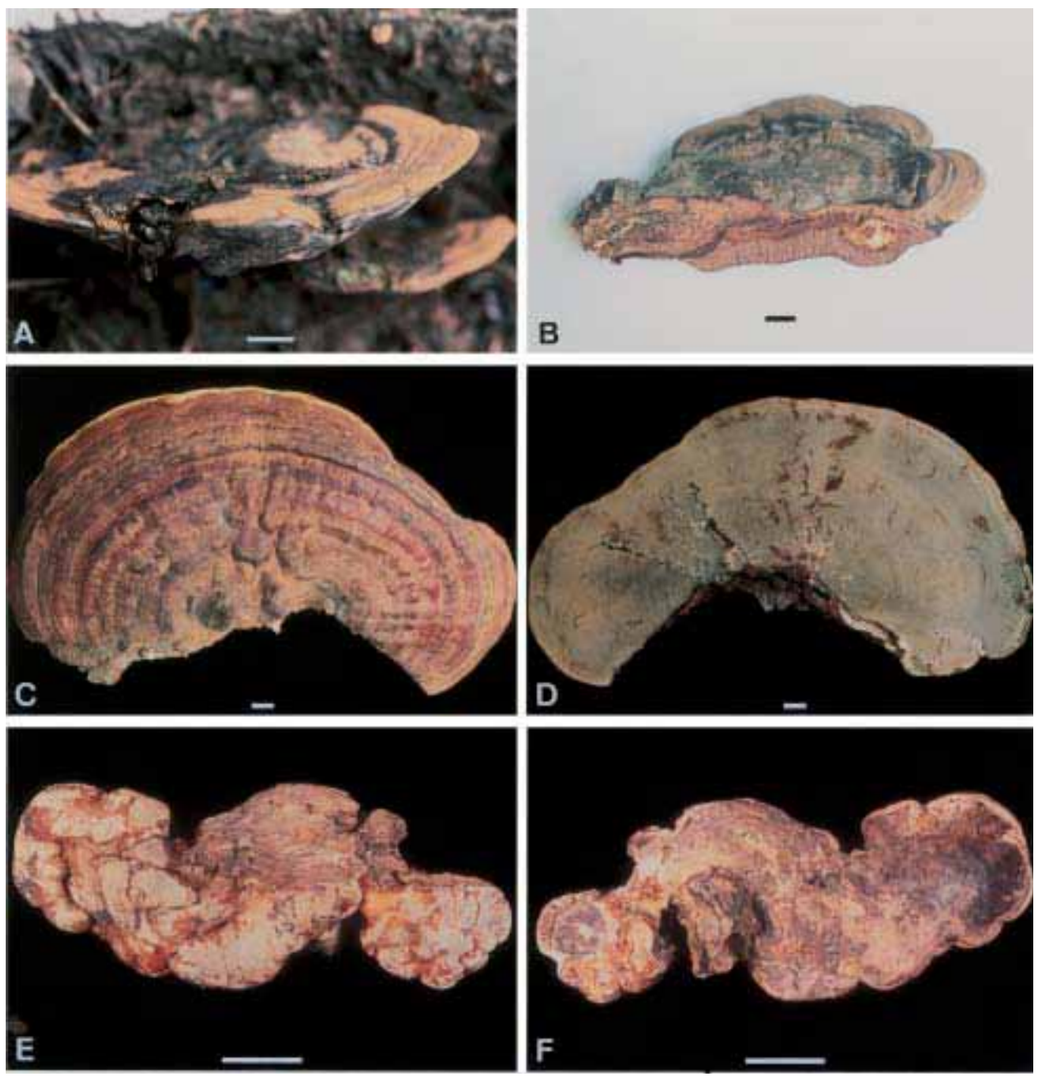

Fig. 1. Basidiocarps. A-B: *Ganoderma densizonatum* (*Chen 946*; A. *in situ*). C-D: *G. rotundatum* (*Wu 9808-1*; C. pileus surface, D. hymenial surafce). E-F: *Tomophagus colossus* (*Wu 83-1*); E. pileus surface, F. hymenial surafce. Scale bars = 1 cm for A-D, or 10 cm for E-F.

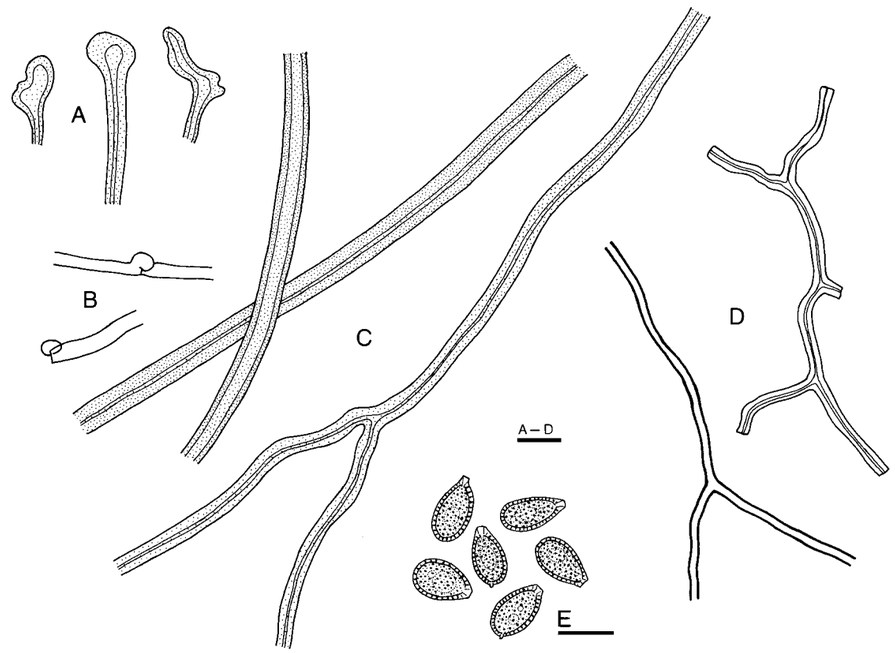

Fig. 2. *Ganoderma densizonatum* (*Chen 946*). A. Apically swollen hyphal ends at pileus crust. B. Contextual generative hyphae. C. Contextual skeletal hyphae. D. Contextual binding hyphae. E. Basidiospores. Scale bars = 10 μm.

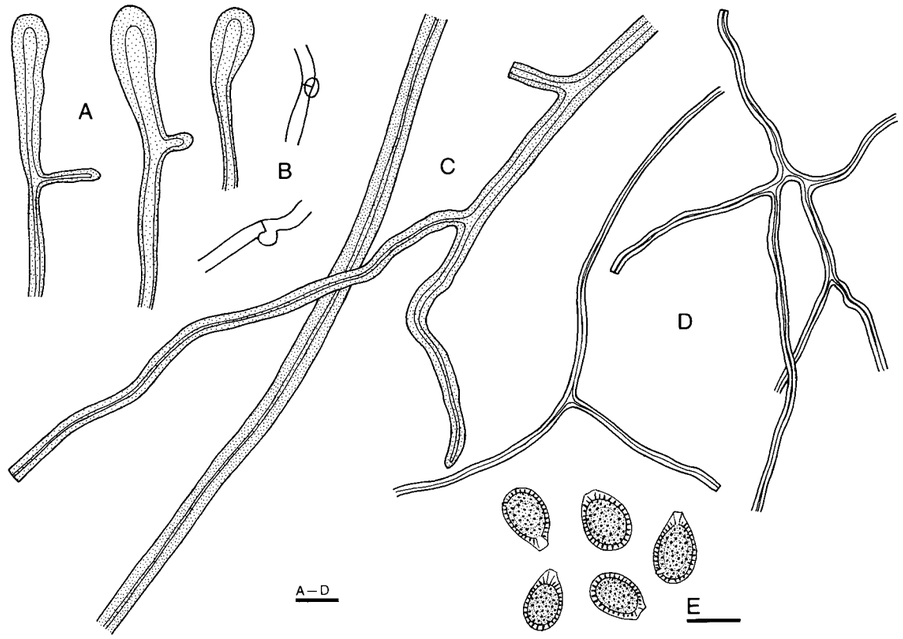

Fig. 3. *Ganoderma rotundatum* (*Wu 9808-1*). A. Apically swollen hyphal ends at pileus crust. B. Contextual generative hyphae. C. Contextual skeletal hyphae. D. Contextual binding hyphae. E. Basidiospores. Scale bars = 10 μm.

and swollen hyphal ends. Pore surface cream; pores suborbicular, ca. 5 per mm. Context hyphal system trimitic; generative hyphae rare, colorless, thin-walled, nodose-septate, 2-3.5 μm diam.; skeletal hyphae yellow to brown, thick-walled to subsolid, with a few distal branches, skeletal stalks 4.5-7 μm diam., branches 2.5-4.5 μm diam.; binding hyphae colorless, thick-walled to solid, branched, 1-2 μm diam. Basidia not seen. Basidiospores ellipsoid or broadly ellipsoid, truncate at apex, bearing one big oily drop, 9.5-12.5 × 6.5-8 μm; exospore colorless, thin; endospore thick, brown, separated from exospore by interwall pillars.

Specimen examined: **TAIWAN.** PINGTUNG: Wutai, on butt of *Acacia confusa*, coll. M.H. Chang, 15 Oct 1998, *Wu 9808-1* (TNM F13739, HMAS 76386).

Distribution: Mainland China (Hainan Province, type locality). tropical Taiwan.

Remarks: This species is characterized by having the large basidiocarps broadly and loosely attached to the tree trunk. This species was previously known only by the holotype. Unfortunately the type specimen was accidently burnt and only part of the basidiocarps remained (Zhao and Zhang, 2000).

Tomophagus colossus (Fr.) Murr., Torreya 5: 197. 1905 (Fig 1E-F, 4, 5)

≡ *Polyporus colossus* Fr., Nova Acta Soc. Sci. Upsal. III 1: 56. 1851.

Basidiocarp pileate, sessile, fairly loose and soft in consistency, light-weighted. Pileus irregularly semicircular, slightly ungulate, 65 cm wide, growth length up to 25 cm, up to 7 cm thick. Upper surface glabrous, ivory-yellow or yellowish brown, slightly laccate, irregularly swollen, irregularly sulcate; margin obtuse, ± undulate. Context soft and punky, easily crumbled, up to 5 cm thick, ivory-colored. Tube layer up to 2 cm thick, dark ivory-colored. Pileus crust ca. 0.3 mm thick, occasionally separable from the context, composed of yellow, swollen skeletal hyphal ends. Pore surface ochraceous after storage; pores suborbicular, ca. 4 per mm. Context hyphal system trimitic; generative hyphae rare, colorless, nodose-septate, 3-4 μm diam., thin-walled; skeletal hyphae dominant, colorless or pale yellow, thick-walled to solid, rarely branched, 2.5-6 μm diam.; binding hyphae rare, colorless, thick-walled, branched, 1-2 μm diam. Basidia not seen. Basidiospores ellipsoid or broadly ellipsoid, truncate at apex, usually containing one big oily drop, 15-19 × 10-12 μm; exospore thin, colorless; endospore thick, yellowish brown, separated from exospore by poroid-reticulate surface.

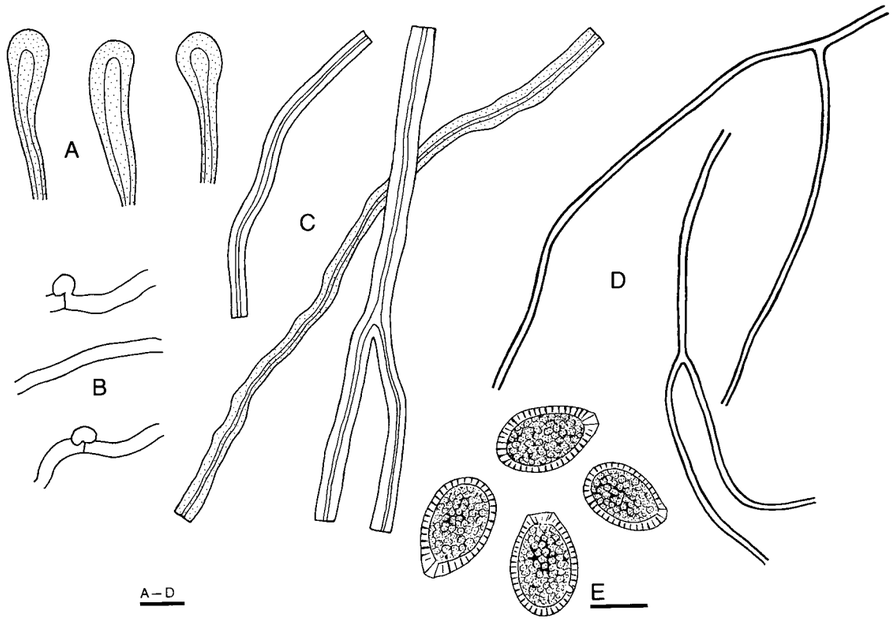

Fig. 4. *Tomophagus colossus* (*Wu 83-1*). A. Apically swollen hyphal ends at pileus crust. B. Contextual generative hyphae. C. Contextual skeletal hyphae. D. Contextual binding hyphae. E. Basidiospores. Scale bars = 10 μm.

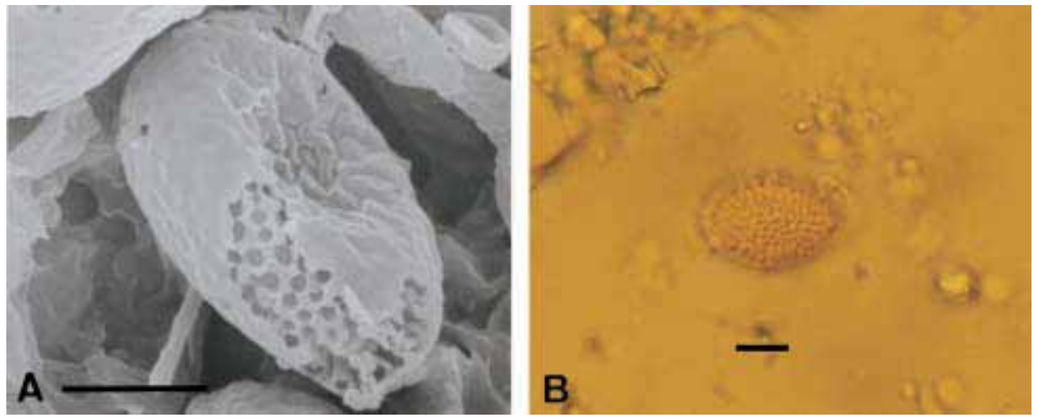

Fig. 5. Basidiospores of *Tomophagus colossus* (*Wu 83-1*), showing poroid-reticulate surface of endspore (A: SEM photograph; B: LM photograph with interference contrast optics). Scale bars = 5 μm.

Specimen examined: **TAIWAN.** MIAOLI: Chunan, in tomb, on rotten coffin made of *Cunninghamia lanceolata*, coll. C.H. Huang, Jul 1983, *Wu 83-1* (TNM F12902).

Distribution: Africa, South Asia, Australia, South and Central America, USA (Florida).

Remarks: *Tomophagus colossus* is a pantropical — subtropical species. This species is easily identifiable by its large, light-weighted and soft basidiocarp, which is paler in color than most other species of the Ganodermataceae. It was the reason that Murrill (1905) created new genus *Tomophagus* for this species, separating it from *Ganoderma*. Recognition of the genus *Tomophagus* based merely on distinctive macroscopic features, was not accepted by most mycologists (Steyaert, 1972; Ryvarden, 1991). Molecular evidence by Moncalvo *et al.* (1995) shows that *Ganoderma* is monophyletic only if *T. colossus* is excluded from this genus. It is noted that the endospore surface of the basidiospores of *T. colossus* is poroid or reticulate (Fig. 5), not aculeate or verrucose as in basidiospores of *Ganoderma* species. Evidence of this distinctive microscopic feature strongly supports the separation of *Tomophagus* from *Ganoderma*.

Dr. Chi-Hsiung Tsai donated the giant specimen of the so-called "coffin mushroom" to the herbarium of National Museum of Natural Science of ROC (TNM) in September of 2001, and this specimen was determined as this species by TNM. Later on, Chang *et al.* (2001) included this specimen in a book of introduction of macrofungi in Taiwan. This specimen was collected from an old wooden coffin entombed one hundred years ago. Coffin Mushroom is a mysterious medicinal fungus in China, also in Taiwan. Modern mycologists have been puzzled about identification of this mysterious fungus. A question is, whether the so-called Coffin Mushroom is a distinct species or not? Many lignicolous fungal species may grow on decaying wooden coffin. Previously *Tomophagus colossus* was reported as growing on decaying trunks of various tree species, but never reported from a wooden coffin. Consequently *colossus* is not the so-called Coffin Mushroom, and the existence of Coffin Mushroom is still a mystery.

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靈芝科（Ganodermataceae）三種在臺灣的發現

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本文報導臺灣產三種靈芝科在臺灣的發現，即密環靈芝（*Ganoderma densizonatum*），大圓靈芝（*G. rotundatum*）以及鬆芝（*Tomophagus colossus*）。前二種爲臺灣新記錄種；最後一種爲臺灣最近報導的種類，然本文對此種有詳細的描述及討論。三種的標本皆發現於臺灣的熱帶或亞熱帶。本文提供此三種之描述、子實體照片以及顯微特徵線條圖。本文特別提供 *T. colossus* 擔孢子表面的超微構造圖，用以支持 *Tomophagus* 與 *Ganoderma* 的區別。

關鍵詞：分類學，多孔菌，新記錄，鬆芝屬，靈芝屬。

Solanum mauritianum Scop. (Solanaceae), a Newly Naturalized Plant in Taiwan

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Abstract. *Solanum mauritianum* Scop., an eastern South America native Solanaceous species, has recently become naturalized in central part of Taiwan. It represents a new record species on this island. The present study gives a taxonomic description for the species. A key to distinguish *S. mauritianum* from *S. erianthum* which has long been known to occur in low elevations of Taiwan, is provided.

Key words : Naturalized plant, Solanaceae, *Solanum mauritianum*, Taiwan, Taxonomy.

INTRODUCTION

Solanum comprises about 1,200 species and is one of the largest genera in the family Solanaceae, most in tropical and subtropical regions, especially in the Americas. Eighteen species were previously recorded in the revised Flora of Taiwan, more than half introduced from elsewhere (D'Arcy and Peng, 1998). Lately, Hsu and Tseng (2003) reported *Solanum elaeagnifolium* Cav. as a new record to the flora of Taiwan. It is a noxious weed and found in southern Taiwan and the Penghu Islands. The present account describes a new record of *Solanum* for the flora of Taiwan. This study provides the additional species distribution, line drawing and photographs to aid in identification.

***Solanum mauritianum* Scop.** Delic. Fl. Faun. Insubr. 3:16. t. 8. 1788.

Shrub or small tree, 2~4 m tall, branched above to form a rounded canopy, unarmed, all parts densely pubescent with sessile to long-stalked stellate hairs, loose and floccose on young growth. Leaves paler on lower surface, simple, alternate, elliptic, up to 30 cm long and 12 cm wide on young vigorous growth, usually ca. 18 cm long and ca. 6 cm wide on mature stems, margins entire, apex acuminate, base cuneate, often oblique, petioles 3~9 cm long, each with 1 or 2 smaller auriculate leaves in axils which are sessile, rounded, sometime absent from weak or distal shoots. Flowers perfect, actinomorphic, numerous in branched corymbs; peduncles up to 15 cm long to first fork, pedicels 2~3 mm long; calyx tube short, 2~3 mm long, lobes narrowly triangular, 1~2 mm long; corolla lilac blue with a pale star-shaped area at base, stellate, 1.5~2.5 cm in diameter; stamens 5, inserted low on corolla tube; filaments ca. 1 mm long; anthers oblong, 2~3.5 mm long, opening by terminal pores; ovary densely pubescent; lower part of style pubescent, 5~7 mm long; stigma green, terminal. Berries dull yellowish, succulent, globose, 1~1.5 cm in diameter, pubescent at least in early stages. Seeds numerous, flattened, 1.5~2 mm long, testa minutely reticulate (Figs. 1, 2).

DISTRIBUTION

The native range of *Solanum mauritianum* is in Uruguay and southeastern Brazil of eastern South America(Smith, 1991; Grierson, 2001), now widely naturalized in warm temperate regions tropics of the world, such as the Pacific islands, Australia, New Zealand, La Reunion, Rarotonga, Cook Islands, Bhutan, Tonga, Africa, Madagascar, Hawaii (Wagner *et al*., 1999), Queensland, and Atlantic islands (D'Arcy, 1986; Kleinschmidt and Johnson, 1979; Kleinschmidt et al., 1991; Takematsu and Ichizen, 1987). It has only been found in Nantou County of central Taiwan and occurs in open situation. Some fruiting individuals are occasionally seen in wild, thus verifying

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