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Phytophthora Diseases of Some Ornamental Foliage Plants as New Records in Taiwan

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ABSTRACT

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Eight new Phytophthora diseases of ornamental foliage plants were described. *Phytophthora parasitica* was detected from five species of plants. It caused blight and wilt of painted nettle and peperomia, leaf and stem blight of compact dracaena and fatsia, and root rot of croton. *P. citrophthora* was isolated from pothos and Malabar chestnut. The fungus infected the whole plants of the former and the young seedlings of the latter. *P. palmivora* attacked leaves, petioles, and rhizomes of maidenhair fern and induced wilt of the affected plants. Similar diseases were reproduced when seedlings, cuttings or plantings of each host were inoculated with zoospore suspension of their respective isolates of *Phytophthora* species in pathogenicity tests. Same species of *Phytophthora* was reisolated from all artificially infected tissues. All eight *Phytophthora* diseases were reported for the first time in Taiwan. Besides, *P. parasitica* on croton, *P. citrophthora* on pothos and Malabar chestnut, and *P. palmivora* on maidenhair fern have not been described in any other places.

Key words : New Phytophthora diseases, *Phytophthora citrophthora*, *P. parasitica*, *P. palmivora*, ornamental foliage plants, Taiwan

INTRODUCTION

Ornamental plants have become important economic commodities in Taiwan in recent years and many famous varieties of ornamental plants were introduced from foreign countries and grown wildly. New diseases of these plants occurred subsequently and caused substantial losses to farmers. In Taiwan, Phytophthora diseases of many ornamental plants are very serious due to frequent heavy rainfall and high humid environmental conditions, which are favorable to the spread of sporangia and zoospores of *Phytophthora* species in the fields [11,14,19]. Survey of new diseases of ornamental plants incited by *Phytophthora* species, therefore, was conducted annually. New Phytophthora diseases of orchids [5], carnation [9], baby's breath [10], lily [12], English ivy [4], white arum lily [26], ornamental plants in Araceae [3] and Compositae [6], and some potted flowers [2,7] have been published recently. I reported herein new Phytophthora diseases of some other important foliage ornamental plants.

MATERIALS AND METHODS

Isolation, maintenance and identification of pathogens

Diseased tissues of ornamental plants, suspected to be attacked by *Phytophthora* species, were collected from fields. Pieces of tissue taken from stems, roots (ca. 5-10 mm long), leaves and flowers (ca. 7X7 mm^2) with disease symptoms were disinfested with 0.5% NaClO for 3 min. The treated tissues were plated onto selective medium consisting of 5% clarified V-8 juice agar and 2% Bacto agar supplemented with 200 ppm ampicillin, 50 ppm mycostatin, and 10 ppm pentachloro-nitrobenzene [25]. V-8 juice plus 0.2% $CaCO_3$ was clarified by centrifugation at 1500 rpm for 5 min. After incubation at 24℃ for 1-7 days, mycelial mats of *Phytophthora* spp. growing out of diseased tissues on selective medium were transferred to 5% V-8 juice agar. Single-zoospore cultures were obtained using the method described by Ko [23]. Cultures were maintained on 5% V-8 juice agar blocks in sterile water in test tubes at 24℃ [13]. Classification Keys described by Stamps et al. [27] and Waterhouse [29,30] were used for identification of the *Phytophthora* isolates obtained.

Production of sporangia and zoospores

The method described by Hwang *et al.* [20] was used to produce large amount of sporangia for morphological studies and pathogenicity tests. Zoospore suspension was prepared by chilling the mycelial mats with sporangia at 15℃ for 30 min and moving back to 24℃ for another 30 min.

Determination of mating types and production of oospores

Each isolate of *Phytophthora* was grown on 10% V-8 juice agar (10% V-8 juice, 0.02% $CaCO_3$, 2% Bacto agar) at

24℃ in darkness for 10 days. Isolates, which did not form oospores individually, were paired with the standard A^1 (p991) and A^2 (p731) mating type of *Phytophthora parasitica* for determination of their mating types [8]. Those isolates forming oospores in single cultures were designated as homothallic. Those forming oospores when paired with the A^2 tester were A^1; while those forming oospores with A^1 tester were A^2. The polycarbonate membrane method described by Ko [21] was used for study of sexual reproduction of heterothallic species of *Phytophthora*, and for determination of their sexuality types [22].

Growth of *Phytophthora*

Phytophthora isolates were grown on 5% V-8 juice agar for 3-5 days. Agar discs (5 mm diam.) cut from the periphery of the colonies with a sterile cork borer were each placed on the edge of a V-8 agar plate and incubated at 8, 10, 12, 15, 18, 21, 24, 27, 30, 33, 36 or 38℃ in darkness. Colonies were measured daily until the mycelia reached the opposite edge of the plates or 10 days after inoculation. Four plates were used for each temperature and the experiment was repeated twice.

Pathogenicity tests

One or two isolates of *Phytophthora* obtained from each host species were selected for pathogenicity tests. Zoospore suspension used as inoculum was counted and adjusted to 10^5-10^6 zoospores/ml with aid by a microliter pipette [24]. Seedlings (Malabar chestnut and maidenhair fern), or cuttings (other plants) used for pathogenicity tests were grown in disinfested soils in 9-cm-diameter pots. For inoculation, roots of tested plants moved from soil were dipped in zoospore suspension at 24℃ for 24 hr, and replanted in potted soil. A small piece of sterile cotton containing 1 ml of zoospore suspension also was placed on/around flower, leaf, steam or basal stem. Five plants were inoculated for each treatment and tests were repeated twice. Controls for each test were similarly treated with distilled water. After incubation at 24℃ for 3 days, disease incidence was rated every 3 days. Diseased tissues were taken from artificially infected plants for pathogen reisolation following the procedures as described above.

RESULTS

Survey of Phytophthora diseases of ornamental plants

Eight new diseases of ornamental foliage plants incited by *Phytophthora* species were found in the study. Some of these diseases have been mentioned briefly in a previous report [19], but all of them have not been described in detail. Moreover, the causal relationship between the *Phytophthora* species and the disease has not been established for any of these diseases. Most Phytophthora diseases of ornamental crops occurred in the wet seasons in Taiwan when they were grown in pots in greenhouse or directly planted in the fields. Some of them became very serious under continuous rain and caused considerable economic losses to farmers.

The names of the affected foliage ornamental plants, disease symptoms, numbers of isolates obtained and locations associated with each *Phytophthora* disease were listed in Tables 1 and 2 and disease symptoms on some ornamental plants were showed in Figs. 1 to 6. Each Phytophthora disease and the characteristics of the respective causal agent were described as follows:

Diseases caused by *Phytophthora parasitica* (on peperomia 椒草, painted nettle 彩葉草, compact dracaena 密葉竹蕉, fatsia 八角金盤, and croton 變葉木)

Currently *P. parasitica* Dastur (= *P. nicotianae* Breda de Haan) probably is the most important and common pathogen in the genus *Phytophthora* to cause diseases of ornamental plants in Taiwan. In this survey, a total of 5 plants, which having not been formally recorded as host plants of *Phytophthora* species, were found to be infected by the fungus in the fields. During rainy seasons, the fungus caused serious diseases on several species of ornamental plants, such as peperomia and painted nettle, and resulted in considerable economic losses to farmers. The whole plants of painted nettle and peperomia can be attacked by *P. parasitica* in nurseries (Figs. 1&2). The affected tissues, including leaf, stem, and root systems, turned brown or black initially and appeared as leaf droop, stem shrunk and root rot later. Eventually, the affected plants wilted and died. Eleven A^2 isolates were obtained from painted nettle in 3 nurseries, and 4 A^1 and 1 A^2 isolates were from peperomia in 2 nurseries. Colonies of these isolates from painted nettle and peperomia showed the pattern of mosaic spots on 5% V-8 agar plates. These isolates produced abundant sporangia in water and a few chlamydospores on agar plates. Sporangia were unsymmetrical, spherical to oval, papillate and non-deciduous. The main characteristics of these isolates were listed in Table 2. Both plants showed high susceptibility to the fungus in the pathogenicity tests. Almost all inoculated 1 to 3-mo-old cuttings were killed within 2 weeks after spray with zoospore suspension (ca. 10^6 zoospores/ml) of their respective host isolates and *P. parasitica* was reisolated from the affected tissues.

On compact dracaena and fatsia (Fig.3), *P. parasitica* was found to cause leaf and stem blight of the affected plants in the fields in Tainan and Nantow, respectively. Two A^1 isolates were obtained from compact dracaena and three A^2 isolates were from fatsia. The same fungus also caused slight root necrosis of croton in a nursery in Changhua and 2 A^2 isolates were obtained. Characteristics of all these isolated cultures were listed in Table 2 and their pathogenicity was proved via inoculation and reisolation studies.

Diseases caused by *Phytophthora citrophthora* (on pothos vine 黃金葛 and Malabar chestnut 馬拉巴栗)

Phytophthora citrophthora (Smith & Smith) Leonian was isolated from the diseased tissues of pothos vine and Malabar chestnut collected from the fields. A total of 10 A^1 isolates of *P. citrophthora* were obtained from 3 pothos vine nurseries locating in Nantow and Taipei. The fungus caused

Table 1. Isolation of *Phytophthora* species from diseased tissues of ornamental foliage crops as new host records in Taiwan

Name of host Scientific, English & Chinese	Infected sites	*Phytophthora* species	First isolation year	Location and No. of isolates obtained	Disease severity in the fields[1]
Coleus blumei (painted nettle) 彩葉草	Whole plant	*P. parasitica*	1995	Chiayi (8A^2), Taichung (3A^2)	+++
Peperomia spp. (peperomia) 椒草	Whole plant	*P. parasitica*	1992	Chiayi (4A^1), Changhua (1A^2)	++
Dracaena deremensis (compact dracaena) 密葉竹蕉	Stem & leaf	*P. parasitica*	1989	Tainan (2A^1)	+
Fatsia japonica. (fatsia) 八角金盤	Stem & leaf	*P. parasitica*	1990	Nantow (3A^2)	+
Codiaeum variegatum (croton) 變葉木	Root	*P. parasitica*	1996	Changhua (5A^2)	+
Epipremnum aureum (pothos) 黃金葛	Leaf & stem	*P. citrophthora*	1992	Nantow (8A^1), Taipei (2A^1)	++
Pachira macrocarpa (Malabar chestnut) 馬拉巴栗	Leaf	*P. citrophthora*	1990	Changhua (2A^1)	+
Adiantum raddianum (maidenhair fern) 鐵線蕨	Whole plant	*P. palmivora*	1990	Changhua (2A^2)	++

1. Degree of disease severity in the field: +++, serious; ++: moderate; +: slight.

Table 2. Size of sporangia, growth reactions to temperatures and pathogenicity of isolates of *Phytophthora* spp. obtained from the foliage ornamental plants in this study

Host & variety	*Phytophthora* sp., isolate no., and mating type	Sporangia		Pedicel length (μm)	Growth reaction to temperatures (°C)[3]	Susceptibility of inoculated plants[4]
		Length X Width (μm)	Length/width			
Coleus blumei 彩葉草	*P. parasitica*, PPPn1-3 (A^2)	32-(55.0)-70 X 24-(41.8)-52[1]	1.13-(1.31)-1.48[1]	_[2]	10-(24-32)-36	+++
Peperomia serpens cv. *Variegata*, 蔓性椒草	*P. parasitica*, PPPr1-2 (A^1)	27.5-(52.0)-65 X 20-(42.7)-57.5	1.02-(1.23)-1.86	_	10-(24-32)-36	+++
Dracaena deremensis cv. *Virens Compacta*, 密葉竹蕉	*P. parasitica*, PPDr1 (A^1)	40-(51.7)-70 X 25-(40.5)-44.5	1.0-(1.30)-1.71	_	10-(28-32)-36	+
Fatsia japonica, 八角金盤	*P. parasitica*, PPFA (A^2)	31-(49.5)-65 X 25.5-(37.7)-45	1.03-(1.32)-1.64	_	10-(24-28)-36	++
Codiaeum variegatum 變葉木	*P. parasitica*, PPCr1 (A^2)	36-(48.3)-62 X 28-(38.0)-44[1]	1.12-(1.27)-1.63	_	10-(28-32)-36	+
Epipremnum aureum, *Golden pothos*, 黃金葛	*P. citrophthora*, PCPv1-3 (A^1)	44-(51.3)-60 X 28-(32.3)-36[1]	1.32-(1.59)-1.84	7.0-(12.5)-25	<10-(24-28)-33	+++
Pachira macrocarpa 馬拉巴栗	*P. citrophthora*, PCMA (A^1)	45.5-(58.9)-83.5 X 35.0-(39.1)-45.5	1.12-(1.51)-1.93	6.5-(15.2)-32	<10-(24-28)-33	++
Adiantum raddianum 鐵線蕨	*P. palmivora*, PPaD$_1$ (A^2)	25-(38.8)-50.5X 20.0-(28.1)-34.5	1.04-(1.38)-1.6	0.1-(1.8)-4.9	10-(24-28)-35	+++

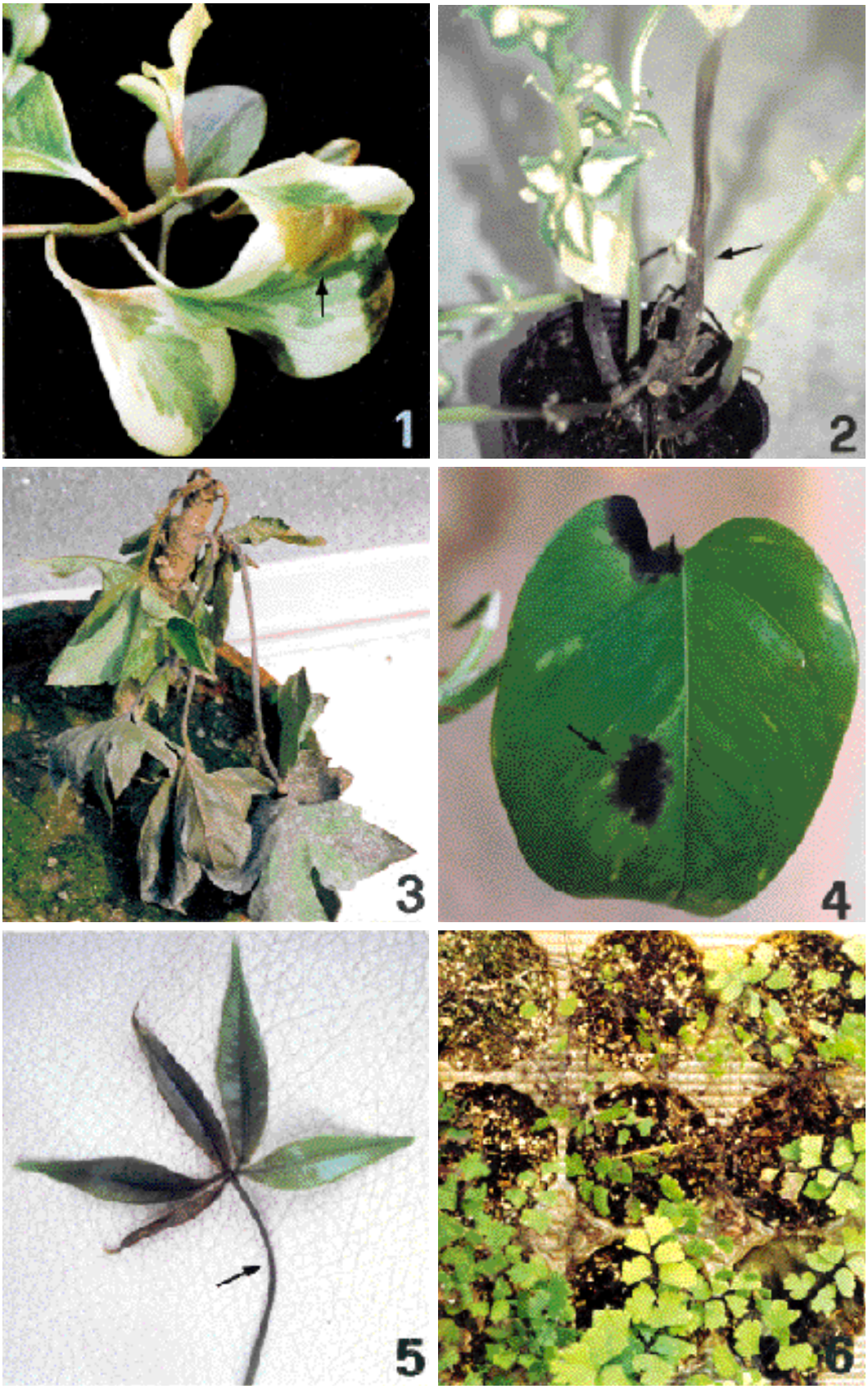
1. Data in parenthesis are in average.
2. -: sporangia are non-deciduous.
3. Mycelial growth reactions to temperatures on V-8 agar are indicated as minimum -(optimum)-maximum.
4. Susceptibility of inoculated plants, +++: highly susceptible, 50-100% of inoculated plants died; ++: moderately susceptible, 50-100% inoculated portions rotted completely; +: inoculated portions necrotic or blight slightly.

leaf and stem blight of the affected plants during wet seasons (Figs. 4 & 5). The isolates produced finely radiate mycelial patterns on 5% V-8 agar plates. Sporangia of these isolates were spherical to ovoid, papillate and partially deciduous with pedicels about 5-20 μm long. The characteristics of a tested isolate were listed in Table 2. Results showed that leaves of pothos vine were very susceptible to the pathogen. All the inoculated leaves appeared dark water soaking spots within 3-5 days and the whole plants died within one month when zoospore suspension of *P. citrophthora* containing 10^6 zoospores/ml was sprayed to 1-month-old cuttings without wounded treatment. *P. citrophthora* identical to the cultures used for inoculation was reisolated from the affected tissues.

Phytophthora leaf blight on seedlings of Malabar chestnut was found in a field in Tienwei, Changhua. Two A^1 isolates were obtained. Upon inoculation with zoospores of the isolated fungus, seedlings of Malabar chestnut showed symptoms similar to those appearing in the fields. The same fungus was reisolated from the affected plants. The characteristics of a tested isolate were listed in Table 2.

Disease caused by *Phytophthora palmivora* (on maidenhair fern 鐵線蕨)

Phytophthora palmivora (Butler) Butler attacked leaves, petioles and rhizomes, and caused wilt of the whole-affected plants of maidenhair fern in a nursery in Changhua under moist conditions. The affected leaves drooped with water



Figures 1 to 6. Disease symptoms of ornamental foliage plants incited by *Phytophthora* species. Leaf blight of *Peperomia serpens* cv. *Variegata*, (蔓性椒草) (Fig.1) , basal stem rot of *Coleus blumei* (彩葉草) (Fig.2), and leaf blight of *Fatsia* sp.(八角金盤) (Fig.3) caused by *Phytophthora parasitica*; leaf blight of *Epipremnum aureum* (黃金葛) (Fig.4) and *Pachira macrocarpa* (馬拉巴栗) (Fig.5) caused by *P. citrophthora*; death of *Adiantum raddianum* (鐵線蕨) (Fig.6) caused by *P. palmivora.*

soaking black spots, the infected portions of petioles shrunk with dark brown discoloration and the infected rhizomes were necrotic with black spots. Whole plants died within a short period of time (Fig. 6). Two A^2 isolates were obtained in a nursery in Changhua. These isolates formed abundant sporangia as well as a few chlamydospores on 5% V-8 agar.

Sporangiophores branch simple sympodially. Sporangia have semi-spherical papilla and are deciduous with very short pedicels (< 5 μm). The main characteristics of these isolates were listed in Table 2. Maidenhair fern showed high susceptibility to *P. palmivora* when young potted seedlings were sprayed with zoospore suspension (*ca.* 10^6 spores/ml) and kept in the plastic bags. Disease symptoms similar to those appeared in nature were reproduced, and the same fungus was reisolated from all diseased tissues.

DISCUSSION

The genus *Phytophthora* deBary has been reported as the causal agents of numerous important plant diseases in the world [17] including Taiwan [18,19]. Although many ornamental plants have been recorded as the hosts of *Phytophthora* species in Taiwan, new Phytophthora diseases still appear in nurseries each year. A total of eight Phytophthora diseases of ornamental foliage crops, which have not been formally reported, are presented here. Peperomia, painted nettle, compact dracaena, croton, Malabar chestnut, fatsia, and maidenhair fern are reported to be infected by *Phytophthora* species for the first time in Taiwan. *P. parasitica* has been isolated from the diseased Pothos vine by the author in 1992 [2]. While *P. citrophthora* was detected on the diseased tissues of the same species of plants in this study. Among the eight new diseases, *P. parasitica* on croton, *P. citrophthora* on pothos and Malabar chestnut, and *P. palmivora* on maidenhair fern have not been described in any other places previously. Disease symptoms of the other four Phytophthora diseases shown in the fields in Taiwan are similar to those reported in other countries [15,16].

Although most of these host plants, except new varieties of peperomia, have been cultivated in Taiwan for a long time, Phytophthora diseases of these plants were noticed and became serious in recent year. Plant susceptibility, favorable climate conditions and diverse sources of inocula may be the principal factors contributing to the seriousness of Phytophthora diseases of ornamental plants in Taiwan. Most of the tested introduced plants showed high susceptibility to the fungi in pathogenicity tests (Table 2). The climate factors such as high relative humidity and temperature in Taiwan are favorable to the development of Phytophthora diseases [11,14]. New *Phytophthora* isolates may arrive with the imported plants. An atypical type of *Phytophthora capsici* Leonian was directly detected on the import alazea [7] and carnation recently (unpublished data). Moreover, *P. parasitica* isolates obtained from different host plants could cause severe diseases on other hosts in cross-inoculation studies (3,9 & unpublished data).

A total of three species of *Phytophthora* including *P. parasitica*, *P. citrophthora*, and *P. palmivora* inciting new diseases of ornamental foliage crops were found in this study. The characteristics of all tested cultures of *P. parasitica* from painted nettle, peperomia, compact dracaena, fatsia, and croton are similar (Table 2). All isolates produced spherical chlamydospores and hyphal swellings on agar medium, and formed unsymmetrically spherical to ovoid, papillate and non-deciduous sporangia with a short length/width ratio of about 1.2-1.4. All isolates belong to cross-inducing (Heterothallic) type which do not form oospores when cultured individually. They were either A^1 mating type of the sexuality type S4, which can be stimulated by A^2 and induce A^2 of *P. parasitica* to form oospores, or A^2 of S1 type, which can be stimulated by A^1 and induce A^1 to form oospores [21,22]. All tested isolates growing on 5% CV-8 agar formed white colonies with patterns of scatter mosaic spots and a few aerial mycelia. The maximum growth temperatures on 5% CV-8 agar were about 36-37°C. Therefore, all Taiwanese cultures of *P. parasitica* causing diseases of the six crops have essentially all the characteristics of typical *P. parasitica* (Table 2) [27] based on Tucker's descriptions in 1931 [28].

Phytophthora citrophthora obtained from pothos and Malabar chestnut (Table 2) were similar to those isolated from citrus [1] and other crops [7,8] in Taiwan. All tested isolates from the two crops formed white colonies with radiate patterns on 5% CV-8 agar plates and produced sporangia on agar as well as in water. Sporangia are papillate, spherical to oval and partially deciduous with a pedicel about 5-20 μm long. Chlamydospores are absent. The maximum temperatures for mycelial growth are about 32-33°C. Therefore, all cultures belong to typical type of *P. citrophthora* described by Leonian [29,30]. All isolates are A^1 mating type just like those obtained previously in Taiwan [1,7]. They did not form selfing- oospores when paired with A^2 types on polycarbonate membrane, but did stimulate A^2 of *P. parasitica* to produce oospores. Therefore, the cultures belong to A^1 mating type of the sexuality type S3 [21,22].

All isolates of *P. palmivora* from maidenhair fern in Taiwan have all characteristics conforming to the fungus described by Bulter (Table 2) and belong to typical type [27,30]. All of them formed white smooth colonies on 5% CV-8 agar plates. The maximum temperature for mycelial growth is 35 °C. These isolates produce spherical chlamydospores and hyphal swellings under liquid and solid conditions. The fungus form symmetrically spherical to ovoid, papillate and deciduous sporangia on agar medium with a short pedicel about 2-5 μm long. All isolates belong to A^2 of S1 type, which can be stimulated by A^1 and induce A^1 to form oospores [21,22].

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LITERATURE CITED

1. Ann, P. J. 1984. Species, mating types and *pathogenicity* of Phytophthora distributed in citrus orchards in Taiwan. Trans. Br. Mycol. Soc. 82:631-634.

2. Ann, P. J. 1992. Phytophthora diseases of ornamental plants in Araceae in Taiwan. Plant Pathol. Bull. 1:79-89.
3. Ann, P. J. 1992. New diseases and records of potted flowers caused by *Phytophthora parasitica* in Taiwan. Plant Pathol. Bull. 1:166-173.
4. Ann, P. J. 1993. Phytophthora diseases of English ivy in Taiwan. Plant Prot. Bull. 35(2):149-155. (in Chinese)
5. Ann, P. J. 1995. Phytophthora diseases of orchids in Taiwan. Plant Pathol. Bull. 4:152-162. (in Chinese)
6. Ann, P. J. 1996. Phytophthora diseases of Compositae in Taiwan. Plant Pathol. Bull. 5:146-153.
7. Ann, P. J. 2000. New diseases records of flowering potted plants caused by *Phytophthora* species in Taiwan. Plant Pathol. Bull. 9:1-10.
8. Ann, P. J., and Ko, W. H. 1988. Hormonal heterothallism in *Phytophthora parasitica*: a novel mode of sexual reproduction? J. Gen. Microbiol. 134:2985-299.
9. Ann, P. J., Kunimoto, R., and Ko, W. H. 1990. Phytophthora wilt of carnation in Taiwan and Hawaii. Plant Prot. Bull. 32:145-157.
10. Ann, P. J., and Liu, S. S. 1993. Phytophthora wilt of baby's breath. Plant Pathol. Bull. 2:106-110.
11. Ann, P. J., Ko, W. H., and C. W. Kao. 1991. Disease controls of soil-borne *Phytophthora* and their suppressive soils in Taiwan. Plant Prot. Bull. 33:142-147. (In Chinese)
12. Ann, P. J., Lo, C. T., and Hsieh, T. F. 1992. Phytophthora blight of *Lilium* spp. in Taiwan. Plant Prot. Bull. 34:64-69. (In Chinese)
13. Boesewinkel, H. J. 1976. Storage of fungal cultures in water. Trans. Br. Mycol. Soc. 66:183-185.
14. Chang, H. S. 1983. Crop diseases incited by *Phytophthora* fungi in Taiwan. Plant Prot. Bull. 25:231-237.
15. Chase, A. R. 1987. Compendium of Ornamental Foliage Plant Diseases. APS press, St. Paul, Minnesota, 92 pp.
16. Daughtrey, M. L., Wick, R. L., and Peterson, J. L. (eds.) 1995. Compendium of Flowering Potted Plant Diseases. APS press, St. Paul, Minnesota, 90 pp.
17. Erwin, D. C., and Ribeiro, O. K. 1996. Phytophthora Diseases Worldwide. APS press, St. Paul. Minnesota, 562 pp.
18. Ho, H. H. 1990. Taiwan *Phytophthora*. Bot. Bull. Acad. Sin. 31:89-106.
19. Ho, H. H., Ann, P. J., and Chang, H. S. 1995. The Genus *Phytophthora* in Taiwan. Acad. Sin. Mon. Ser. 15. Taipei, Taiwan, ROC. 86 pp.
20. Hwang, S. C., Ko, W. H., and Aragaki, M. 1976. A simplified method for sporangial production by *Phytophthora cinnamomi*. Mycologia 68:1233-1234.
21. Ko, W. H. 1978. Heterothallic *Phytophthora*: evidence for hormonal regulation of sexual reproduction. J. Gen. Microbiol. 107:15-18.
22. Ko, W. H. 1980. Hormonal regulation of sexual reproduction in *Phytophthora*. J. Gen. Microbiol. 116:459-461.
23. Ko, W. H. 1981. Reversible change of mating type in *Phytophthora parasitica*. J. Gen. Microbiol. 125:451-454.
24. Ko, W. H., Chase, L. and Kunimoto, R. 1973. A microsyringe method for determining concentration of fungal propagules. Phytopathology 63:1206-1207.
25. Ko, W. H., Chang, H. S., and Su, H. J. 1976. Isolates of *Phytophthora cinnamomi* from Taiwan as evidence for an Asian origin of the species. Trans. Br. Mycol. Soc. 72:353-358.
26. Liou, R. F., Lee, J. T., and Ann, P. J. 1999. First report of Phytophthora blight of white arum lily caused by *Phytophthora meadii*. Plant Pathol. Bull. 8:37-39.
27. Stamp, D. J., Waterhouse, G. M., Newhook, F. J., and Hall, G. S. 1990. Revised Tabular Key to the Species of *Phytophthora*. Mycol. Pap. 162, Comm. Mycol. Ins. Kew, Surrey, England.
28. Tucker, C. M. 1931. Taxonomy of the genus *Phytophthora* de Bary. Mo. Agric. Exp. Sta. Res. Bull. 153. 208 p.
29. Waterhouse, G. M. 1963. Key to the species of *Phytophthora* deBary. Mycol. Pap. 92, CMI, Kew Surrey, England.
30. Waterhouse, G. M. 1970. The genus *Phytophthora* deBary-diagnoses (or descriptions) and figures from the original papers. Mycol. Pap. 122. CMI, Kew Surrey, England.

摘　要

安寶貞. 2000. 一些觀葉植物疫病在台灣之新紀錄. 植病會刊 9:47-52. (台中縣霧峰鄉 農業試驗分所植物病理系，電子郵件信箱: pjann@wufeng.tari.gov.tw; 傳真機: 04-3338162)

自 1989-1999 年調查本省作物疫病時，發現有八種未曾正式報告之觀葉植物疫病，分述如下。在田間，疫病菌 *Phytophthora parasitica* 自五種觀葉植物之罹病組織檢出，它引起彩葉草與椒草全株枯萎、密葉竹蕉與八角金盤葉枯、及變葉木根腐。*P. citrophthora* 危害黃金葛全株與馬拉巴栗幼苗，造成葉片與莖部枯萎。而 *P. palmivora* 則感染鐵線蕨全株，導致葉片腐敗、葉柄褐變凹陷、及地下走根壞疽。從這八種作物分離出之三種疫病菌之菌株均為標準型。這些寄主植物在接種個別分離得到的疫病菌遊走子懸浮液後，都出現與田間自然發病時相同的病徵，而且相同的疫病菌亦均自發病組織回分得到。這些新病害中，*P. parasitica* 危害變葉木、*P. citrophthora* 危害黃金葛與馬拉巴栗、以及 *P. palmivora* 危害鐵線蕨在世界其他各地均尚未發表過。

關鍵詞： 疫病、疫病菌、新紀錄、*Phytophthora parasitica, P. citrophthora, P. palmivora*、觀葉植物、台灣