Mating types of *Phytophthora colocasiae* from the Pacific region, India and South-east Asia

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Abstract. Mating type interactions were examined between 54 *Phytophthora colocasiae* isolates from the Pacific region, India and South-east Asia. Forty isolates were found to be A² mating type and 14 did not form oospores with either mating type. No A¹ or self-fertile isolates were found.

Phytophthora colocasiae is the causal agent of leaf blight and corm rot of taro (*Colocasia esculenta*), a destructive disease that destroyed Samoa's taro industry following its introduction in 1993 (Chan *et al.* 1998). It is present throughout most of Asia and is scattered through the Pacific region (CMI 1997). Research on mating types suggests that Hainan Island, China, is within the centre of origin (Zhang *et al.* 1994).

Phytophthora colocasiae is heterothallic, requiring the presence of opposite mating types (A¹ and A²) for the formation of oospores. Heterothallic species of *Phytophthora* readily produce oospores in intra- or interspecific pairings of two compatible types (Ko 1979). The aim of this study was to examine the occurrence of the A¹ and A² mating types of *P. colocasiae* in the Pacific region, India and South-east Asia. The results of earlier determinations of mating type in *P. colocasiae* are summarised in Table 1.

Fifty-four isolates of *P. colocasiae* were obtained from Guam, Hawaii, Northern India, Indonesia, Philippines, Papua New Guinea, Pohnpei, Samoa, Thailand, and Vietnam. Representative isolates have been deposited in the International Collection of Microorganisms from Plants (ICMP), Manaaki Whenua Landcare Research, Auckland, New Zealand. Two tester isolates of *P. nicotianae* were obtained from L.W. Timmer, University of Florida (P91-28 = mating type A¹, Riv-1 = mating type A²). Among the isolates of *P. colocasiae* obtained from Hawaii were two previously determined to be mating type A² by J. Uchida, University of Hawaii.

Isolates were placed 10–15 mm apart on unclarified V8 agar (100 mL V8 juice, 2 g CaCO₃, 15 g agar, 900 mL distilled water) and on rape-malt agar (500 mL rapeseed extract, 1 g malt extract, 17 g agar and 500 mL distilled water), and incubated at 24 ± 1°C in the dark.

Each isolate was paired with itself and with *P. nicotianae* A¹ and A² mating types and a Hawaiian A² isolate (Pc37) of *P. colocasiae* on separate plates. In addition, the two *P. nicotianae* mating type isolates were paired with each other. Pairs of cultures were examined for the formation of oospores after 7, 10 and 14 days. The process was repeated at least once for those isolates that did not form oospores with either of the tester isolates.

Oospores formed between fertile cultures in 1–2 weeks and between the tester isolates in 5–6 days. The results are summarised in Table 2.

This study has found only one mating type (A²) throughout the Pacific region, including Guam, Hawaii, Indonesia, Philippines, Papua New Guinea and Samoa. An earlier study (Ko 1979) records only the A¹ mating type in Hawaii. More recently all isolates tested in Hawaii have been found to be mating type A² (J. Uchida, pers. comm.). Only the A² mating type was found among the Hawaiian isolates in the present study, and the mating type of the two A² isolates provided by J. Uchida is confirmed.

Apart from the Hawaiian report by Ko (1979), *P. colocasiae* mating type A¹ has been recorded only from Hainan Island and Northern India. Mating type A² was previously known from Hainan Island and Yunnan in China, Taiwan, and Hawaii. That range can now be extended to include Guam, Indonesia, Northern India, Papua New Guinea, Philippines, Pohnpei, Samoa, Thailand and Vietnam.

Fourteen of the 54 isolates tested did not form oospores when paired with either of the tester isolates. Non-mating strains (A⁰ mating type) were found in Indonesia, Thailand and Papua New Guinea. Strains of A⁰ mating type have been previously reported from mainland China and Hainan Island (Ann *et al.* 1986; Zhang *et al.* 1994). In this study, the majority of isolates from Papua New Guinea were A⁰. The failure of the strains to mate is unlikely to be due to insufficient incubation time. Zhang *et al.* (1994) and Narula and Mehrotra (1980), using similar incubation conditions, found that *P. colocasiae* formed oospores with the opposite mating type in 3 days and 7–10 days, respectively. It is also unlikely to be due to the interspecific pairing as both *P. parasitica* (*P. nicotianae*) and *P. palmivora* have been used successfully in the past for mating type determination of various species of *Phytophthora* (Ko 1979; Narula and Mehrotra 1980; Ann *et al.* 1986; Zhang *et al.* 1994). Savage *et al.* (1968) found that an A² isolate of *P. colocasiae* formed oospores when paired with A¹ isolates of 11 different *Phytophthora* species. In this study, all of the A² isolates from Papua New Guinea formed oospores sparingly when paired with the opposite mating type. It is possible that the A⁰ isolates from Papua New Guinea are of

Table 1. Summary of mating types of *Phytophthora colocasiae* previously recorded from different countries

Country	Region	A ¹	A ²	A ⁰	Total	Reference
Uncertain ^A	—	0	5	0	5	Savage <i>et al.</i> (1968)
	—	0	5	0	5	Brenneman and Gallegly (1967)
Hawaii	Mainland	101	0	0	101	Ko (1979)
	Maui Is.	8	0	0	8	Ko (1979)
	Kauai Is.	5	0	0	5	Ko (1979)
China	Hainan Is.	136	102	42	280	Zhang <i>et al.</i> (1994)
	Hainan Is.	0	0	2	2	Ho <i>et al.</i> (1983)
	Yunnan	0	1	0	1	Ho <i>et al.</i> (1983)
Taiwan	—	0	799	0	799	Ann <i>et al.</i> (1986)
North India	—	75	0	0	75	Narula and Mehrotra (1980)

^A Isolates are likely to have originated from Hong Kong, India and Sri Lanka.

Table 2. Mating types of *Phytophthora colocasiae* isolates from the Pacific region, India and South-east Asia

Country of origin	No. tested	Collection date	A ¹ mating type	A ² mating type	A ⁰ mating type
Guam	3	1999	0	3	0
Hawaii	16	1998–99	0	16 ^A	0
Northern India	5	1997–99	0	5	0
Indonesia	2	2001	0	1	1
Philippines	2	2001	0	2	0
Papua New Guinea	16	1998–2001	0	5	11
Pohnpei	1	1999	0	1	0
Samoa	5	1998	0	5	0
Thailand	2	2001	0	0	2
Vietnam	2	2001	0	2	0
Total	54	—	0	40	14

^A Includes two isolates identified as A² mating type by J. Uchida.

the A² mating type but have lost the ability to reproduce sexually. The affinities of A⁰ strains may be able to be resolved by the use of strain-specific molecular markers.

Because of the apparently restricted distribution of the A¹ mating type and the geographical separation from the areas in which it is found (Hainan Is., Northern India), the likelihood of its introduction to the Pacific region is considered to be relatively low. Nevertheless, its introduction would constitute a risk to the region. Not only would the resultant oospores create a new, longer-lived form of inoculum, but the potential for new, more virulent genotypes is increased both by the new incursions and by their genetic recombination with existing locally adapted strains.

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