Fungi on *Musa acuminata* in Hong Kong

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Results of an investigation into the fungi associated with dead tissue of *Musa acuminata* at two sites in Hong Kong are reported. Forty-six fungi were identified, comprising 14 ascomycetes and 32 mitosporic taxa (27 hyphomycetes and 5 coelomycetes). The frequency of occurrence of these fungi at the two sites was also investigated. The most common species was *Memnoniella subsimplex* which occurred on 70% of samples, followed by *Verticillium* sp. (48.75%) and *Zygosporium oscheoides* (47.5%). The mycota of the two sites differed significantly in species composition, although *Memnoniella subsimplex*, *Nigrospora oryzae*, *Pyriculariopsis parasitica*, *Verticillium* sp. and *Zygosporium oscheoides* were common at both sites. *Durispora musae*, *Memnoniella subsimplex*, *Nigrospora oryzae*, *Pyriculariopsis parasitica* and *Verticillium* sp. were restricted to the petioles, while *Anthostomella clypeoides*, *Deightoniella torulosa* and *Hansfordia ovalispora* were restricted to the leaves.

Key words: biodiversity estimates, fungal diversity, host specificity.

Introduction

There have been several estimates of global fungal numbers ranging from 100,000 to 9.9 million and this has been discussed extensively by Fröhlich and Hyde (1999). Hawksworth (1991) has provided the most widely accepted estimate at 1.5 million. Amongst other things, estimates of fungal diversity rely heavily on extrapolation from the suggested ratio (6:1) of fungi to each vascular plant species (Hawksworth, 1991; Fröhlich and Hyde, 1999). Such a ratio is dependent on whether fungi are host specific or whether they occur more frequently on certain hosts (Yanna *et al.*, 2001). Several investigations have provided evidence which suggests that certain fungi are host specific, recurrent (Zhou and Hyde, 2001), or at least occur frequently on certain hosts (Yanna *et al.*, 2001), while specificity at the host family level is undeniable (Cannon, 1991; Fröhlich and Hyde, 2000). The problem with proving

specificity at the host species level is that too few studies have been carried out, especially in the tropics, to confirm that one fungus species is confined to a particular host. For example, it presently appears that 40 taxa are specific to *Nypa fruticans*, however, no other palm host in the intertidal region has yet been studied for fungi (Hyde and Alias, 2000).

Whether fungi are host specific, are recurrent on certain hosts, or are restricted to certain tissue types, will have considerable impact on biodiversity estimates. We therefore initiated a study to investigate the fungi on *Musa acuminata* at two sites in Hong Kong in order to establish: 1) whether the fungi occurring on *Musa acuminata* are likely to be host/family specific, 2) whether the fungi on *Musa* differ significantly between two sites and 3) whether the fungi on *Musa* vary according to tissue type.

Methods and materials

Dead banana tissue was collected from Nim Shue Wan Village, Discovery Bay, Lantau Island on 5 October 1999 and Fung Yuen Village, Tai Po, The New Territories on 4 November 1999. At each site 20 randomly collected decaying leaf samples (each 10 × 10 cm) and 20 decaying petiole samples (each 10 cm long) were collected from individual banana plants. Material was returned to the laboratory in zip lock plastic bags. Samples were incubated individually in zip lock plastic bags, with an addition of tissue paper moistened with sterilised water. Samples were examined for the presence of microfungi after one week of incubation and then periodically for up to one month following the methods detailed in previous studies (Hyde and Goh, 1998; Hyde *et al.*, 1998).

Statistical analysis

A data matrix consisting of the numbers of colonised tissue pieces from each sample unit (i.e. leaf or petiole of either one of the two sites) in rows and fungi in columns was subjected to ordination using correspondence analysis. Sample unit and fungal species ordinations were obtained simultaneously, therefore the ecological interrelationships between sample units and fungal species can be examined in a single analysis.

$$\text{Percentage occurrence} = \frac{\text{number of leaf/petiole samples from which fungus was detected}}{\text{total number of leaves or petiole samples examined in each site}} \times 100$$

Similarity index = 2c/ a+b
a: the number of species in habitat A
b: the number of species in habitat B
c: the number of species in common in habitat A and B

Results and discussion

A list of the species identified on the banana samples at each site and their frequency of occurrence is given in Table 1. Forty-six fungi were identified, comprising 14 ascomycetes and 32 mitosporic taxa (27 hyphomycetes and 5 coelomycetes). The most common species were *Memnoniella subsimplex* (occurring on 70% of samples), *Verticillium* sp. (48.75%) and *Zygomycetes oscheoides* (47.5%).

Three-dimensional correspondence analysis was performed to visualize the effect of tissue type and site on the colonization by fungi (Fig. 1). The first three principal axes accounted for 100% of the variability in the data matrix. X-axis clearly separates the two tissue types, while Z-axis separates the two sites, indicating that there are tissue and site preferences of fungi on dead leaves of *Musa acuminata*. Variability between sites is similar in petioles and in leaves, as expressed by the similar distances between the points representing petioles and leaves from the two sites.

Different fungal communities were found on petioles and leaves of banana. The difference is due to the differential tissue preference of species such as *Durispora musae* and *Pyriculariopsis parasitica* on petioles, and *Deightoniella torulosa* and *Zygosporium oscheoides* on the leaves.

Percentage similarity between fungi on petioles and leaves was 49.2%. *Memnoniella subsimplex*, *Torula herbarum*, *Verticillium* sp., and *Zygosporium oscheoides* were common to leaves and petioles. Of the 46 species identified from the samples, 13 were identified only from leaves and 18 were identified only from petioles. *Pyriculariopsis parasitica* was very common on petioles at Nim Shue Wan, but was infrequent on leaves at both sites. *Durispora musae* and *Hyponectria* sp. were found only on the petioles at both sites. On the other hand, *Anthostomella clypeoides*, *Deightoniella torulosa*, *Hansfordia* sp. and *Nigrospora oryzae* were common on, and mostly confined to the leaves at both sites. It is not surprising that *Deightoniella torulosa* was confined to leaves as this fungus is believed to be a leaf pathogen (Holliday, 1980). These results indicate that some common fungi appear to occur more frequently on certain tissue types. This has also been shown with palms (Yanna *et al.*, 2001). The less common species may also show tissue specificity, e.g. *Colletotrichum musae* and *Leptosphaeria* sp., were found only on petioles, but these taxa were collected too infrequently to be confident of this conclusion.

Of the 46 species collected, 21 taxa occurred at both sites, and the percentage similarity between the two sites was 62.7%. Taxa restricted to Nim Shue Wan site were *Bipolaris halodes*, *Curvularia brachyspora*, *C. geniculata*, *C. pallescens*, *Glomerella* sp. 2, *Mycosphaerella* sp., *Periconiella musae*, *Phialocephala* sp. and *Stachylidium bicolor*, while those only found at Fung

Table 1. Percentage occurrence of fungal taxa on *Musa acuminata* at two sites in Hong Kong.

Fungal Taxa	Nim Shue Wan		Fung Yuen		Overall percentage occurrence
	Petioles	Leaves	Petioles	Leaves	
Anthostomella clypeoides Rehm		5		25	7.5
Bipolaris halodes (Drechsler) Gornostaĭ	5				1.25
Chloridium sp.			10		2.5
Cladosporium musae E.W Mason*	5		10	5	5
Colletotrichum cf. *gloeosporioides* (Penz.) Sacc.	15			5	5
Colletotrichum musae (Berk. and M.A. Curtis) Arx*	15		5		5
Corynesporopsis inaequiseptata Matsush.			5		1.25
Curvularia brachyspora Boedijn	5				1.25
Curvularia geniculata (Tracy and Earle) Boedijn	10				2.5
Curvularia pallescens Boedijn		15			3.75
Dactylaria sp.			20		5
Dactylella sp. 1#	5		5		2.5
Dactylella sp. 2#			10		2.5
Deightoniella torulosa (Syd.) M.B. Ellis*		85		15	25
Diaporthe sp.#			15	5	5
Dictyosporium heptasporum (Garov.) Damon			30		7.5
Didymosphaeria futilis (Berk. and Broome) Rehm				5	2.5
Diplodia sp.	10	20			7.5
Durispora musae W. Photita, S. Lumyong, P. Lumyong and K.D. Hyde*	10		50		15
Glomerella sp. 1#	10	5		15	7.5
Glomerella sp. 2#		5			2.5
Hansfordia ovalispora S. Hughes		30		10	10
Hyponectria sp.#	5		5		2.5
Leptosphaeria sp.#		5		10	3.75
Massarina rubi (Fuckel) Sacc.#			5	5	2.5
Memnoniella subsimplex (Cooke) Deighton	5	75	100	100	70
Mycosphaerella sp.#		15			3.75
Nectria sp.			5		1.25
Nigrospora oryzae (Berk. and Broome) Petch	5	90		30	31.25
Ophioceras sp.#			5		1.25

Table 1. continued

Fungal Taxa	Nim Shue Wan		Fung Yuen		Overall percentage occurrence
	Petioles	Leaves	Petioles	Leaves	
Periconia digitata (Cooke) Sacc.		20	5		6.25
Periconiella musae M.B. Ellis*		5			1.25
Phaeosphaeria sp.#		15	20	25	15
Phialocephala sp.		25			6.25
Phoma sp.	10			5	3.75
Phomatospora sp.#				10	5
Phomopsis sp.			10		5
Pyriculariopsis parasitica (Sacc. and Berl.) M.B. Ellis*	80		30		27.5
Stachybotrys sp.#	25	10	20		13.75
Stachylidium bicolor Link		5			1.25
Stemphylium botryosum Wallr.				5	1.25
Tetraploa aristata Berk. and Broome			10		5
Torula herbarum (Pers.) Link	5	15	35		13.75
Veronaea sp.			20		5
Verticillium sp.	25	80	40	50	48.75
Zygosporium masonii S. Hughes			5		1.25
Zygosporium oscheoides Mont.		90	15	85	47.5
Total no taxa 46	18	20	25	18	

*Known only from *Musa* spp.
#Unidentified species possibly known only from *Musa* spp.

Yuen site were *Chloridium* sp., *Corynesporopsis inaequiseptata*, *Dactylella* sp. 2, *Diaporthe* sp., *Dictyosporium heptasporum*, *Didymosphaeria futilis*, *Massarina rubi*, *Ophioceras* sp., *Phomatospora* sp., *Phomopsis* sp., *Stemphylium botryosum*, *Tetraploa aristata*, *Veronaea* sp. and *Zygosporium masonii*. Taylor *et al.* (2000) examined fungi on *Archontophoenix alexandrae* in Hong Kong, North Queensland and Malaysia and found very few overlapping fungi. The differences in fungi communities were, however, probably a result of removal of the host from its natural habitat as the host is not endemic to Hong Kong or Malaysia.

The results indicate that the species common to *Musa acuminata* in Hong Kong may be widespread, although their percentage occurrence differs

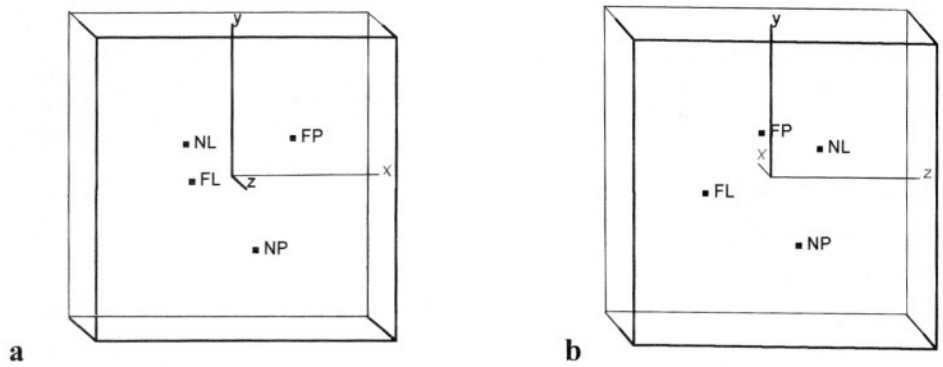

Fig. 1. Three dimensional correspondence ordination of taxa and fungal communities recorded from leaves (L) and petioles (P) of *Musa acuminata* from Fung Yuen (F) and Nim Shue Wan (N). **a.** Diagram oriented at x- and y-axes. **b.** Diagram oriented at y- and z-axes.

between sites. Differences in percentage occurrence of species on the same host at different sites has commonly been noted in studies of fungi in mangroves and is more likely to result from differences in environmental factors than to be host related (Alias *et al.*, 1995; Hyde and Lee, 1995). Many of the fungi recorded in this study are rare species and it is unknown whether they are specific to *Musa acuminata*. It is important to clarify if these rare species are ubiquitous taxa or specific to *Musa acuminata* before we can really understand species numbers.

Of the 46 species recorded in this study, *Cladosporium musae*, *Colletotrichum musae*, *Deightoniella torulosa*, *Durispora musae*, *Periconiella musae* and *Pyriculariopsis parasitica* are known only from *Musa* spp. (Table 1, marked *). Several other species, not identified to species level, may also be specific to *Musa* sp. (Table 1, marked #). Fungi such as *Dactylaria* sp., *Memnoniella subsimplex*, *Stachylidium bicolor*, *Tetraploa aristata*, *Torula herbarum* and *Zygosporium oscheoides* are probably ubiquitous as they have been recorded from numerous other hosts (Ellis, 1971).

This study reveals some of the saprobic fungi found on decaying *Musa* leaves and petioles. The mycota on *Musa* differs from the mycota of some other hosts. For instance, the fungi on monocotyledonous tissues such as palm petioles or leaves (Yanna *et al.*, 2001), on *Pandanaceae* (Whitton, 1999), and on grasses (Wong, 2000) have some similarity, (e.g. *Torula herbarum*), whereas fungal communities on dicotyledonous rainforest litter differ markedly (Parungao *et al.*, 2001)

Although conclusions from this experiment must be treated with caution, it is apparent that several fungi have, to date, only been found associated with *Musa* sp. Unfortunately there have been very few similar studies on other tropical hosts and we cannot be sure that these fungi are host specific. The data also shows that some fungi occur predominantly on petioles, while others occur more commonly on leaves. The recurrence of fungi on certain tissue types has also been shown with palms (Yanna *et al.*, 2001). This indicates further parameters that should be taken into account when considering fungal diversity.

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