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<th>Biodiversity of intertidal estuarine fungi on Phragmites at Mai Po Marshes, Hong Kong</th>
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<td>Author(s)</td>
<td>Poon, MOK; Hyde, KD</td>
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<td>Citation</td>
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Biodiversity of Intertidal Estuarine Fungi on *Phragmites* at Mai Po Marshes, Hong Kong

M. O. K. Poon and K. D. Hyde*

Department of Ecology and Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong

* Corresponding author

Intertidal decaying stems and leaf sheaths of *Phragmites australis* were randomly collected and their mycota examined. Sixty one species of fungi were associated with the decaying stems and leaf sheaths, including *Antiptodera* spp., *Lignincola laevis*, *Phomatospora phragmiticola* and *Zopfiella latipes*. The following new species are described, *Halosarpheia phragmiticola*, *Massarina phragmiticola*, *Phomatospora phragmiticola* and *Cytoplacospheria phragmiticola*. The fungal communities associated with decaying *Phragmites australis* permanently submerged in the gei wai (tidal shrimp farms) differ from those in the intertidal region. The diversity of these fungi are discussed in relation to the biodiversity of fungi in mangrove communities in Hong Kong and with those fungi of other salt marsh communities.

Introduction

Temperate coastal wetlands are often dominated by salt marsh grasses, such as species of *Spartina* and *Juncus*. Most research on the associated mycota of these temperate plants in based on *Spartina* (Johnson and Sparrow 1961, Meyers et al. 1970, Meyers 1974, Gessner 1976, 1977, Gessner and Kohlmeyer 1976, Kohlmeyer and Kohlmeyer 1979). There is also some information on the fungi associated with *Juncus roemerianus* Scheele (Kohlmeyer and Volkmann-Kohlmeyer 1993 a, b, 1995, Volkmann-Kohlmeyer and Kohlmeyer 1993, 1994, Kohlmeyer et al. 1995 a, b, c, 1966).


In subtropical regions, salt marsh grasses such as *Phragmites australis* (Cav.) Trin. ex Steud [also known as *Phragmites communis* (L.) Trin.] coexist with the mangrove tree species. The tidal shrimp ponds (gei wai) of Mai Po were originally excavated from native mangrove habitats with communities of *Kandelia candel* (L.) Druce, *Avicennia marina* (Forsk.) Vierh. and *Aegiceras corniculum* (L.) Blanco. Traditional gei wais at Mai Po were characterised by repeated draining and flooding and details of operational methods can be found in Macintosh (1983). Mangroves (mostly *Kandelia candel*) were originally the chief primary producers in Mai Po Marshes. However, due to progressive change in the operation of the gei wai from traditional shrimp catching to fish culture, this has resulted in some gei wai (e.g. gei wai no. 12) being kept undrained for several months. Semi-permanent flooding had resulted in death of mangroves which are subsequently replaced by *Phragmites australis*, which colonises the banks and edges of gei wais and elevated mud platforms. *Phragmites australis* has now acquired co-dominance in the gei wais with *Kandelia candel*, and is one of the main primary producers (Lee 1990). It was estimated that about 40% of open or elevated mud platforms in the gei wai were covered with *P. australis* in early 1988 (Lee 1990).

Fungi have long been recognised as one of the major decomposers of salt marsh plants, beside bacteria (e.g. Meyers et al. 1970, Gessner 1977, Newell 1993, 1996). Recent research on the dynamics of microorganisms and the change in the chemical composition of decomposing *Phragmites australis* in Japan, have shown that fungi are the main decomposers of decaying leaves before and after submergence in seawater, while bacteria were only dominant decomposers within the short period following submergence (Tanaka 1991). Tanaka (1991) suggested that the decrease in the fungal populations during the short time following submergence can be attributed to the inability of terrestrial fungi to survive in the saline aquatic environment.

As crucial decomposers of a major primary producer, in a highly productive subtropical estuarine region, fungi warrant more attention to their biodiversity and ecology than has previously been given. Unfortunately, the mycota of *Phragmites australis*, is even less well investigated than either *Spartina alterniflora* Loisiel. or *Juncus roemerianus*. Only two marine fungi, *Phaeosphaeria albopunctata* (West.) Shoemaker et C. E. Babc. and *Cirrenalia fusca* I. Schmidt, have been reported from *P. australis* by previous re-
searchers (Kohlmeyer and Kohlmeyer 1979). Massaro-
iosphaeria typhicola (Karst.) Leuch. has been found
on P. australis in freshwater locations in Finland
(Karsten 1873). Several terrestrial mitosporic fungi
have also been reported on leaves and stems and leaf
sheaths of P. australis (e.g. Cunnell 1958, Sutton and
Alcorn 1974). In this study an assessment of the biodi-
versity of the mycota found on decaying stems and leaf
sheaths of P. australis at the Mai Po Marshes is made.

Materials and Methods

Study area

All sampling was conducted along the edge of a tidal
shrimp pond ('gei wai', no. 12) and on both sides of
the sluice gate of gei wai no. 12 outside the security
fence, in Mai Po Marshes. Mai Po Marshes are situ-
ated along the northwestern coast of the New Terri-
tories facing the Pearl River estuary (22°29'N,
114°02' E).

Sampling site

Two sampling sites were chosen to initiate a compari-
son between the fungi found in two different habitats.

Outside security fence: Phragmites australis is sub-
jected to natural tidal inundation with the basal por-
tion (ca. 30 cm) of the plant submerged regularly dur-
ing high tides.

Along the edge of gei wai: The amount of time for the
basal to middle portion of plant being inundated is
regulated solely by the operation method of gei wai.
During the period of this study, up to one half (ca.
70 cm) of the plant had been immersed for several
months.

Collection of samples

In order to collect saprophytic fungi responsible for
the decompositions of decaying Phragmites australis,
dead stems and leaf sheaths were randomly collected
from within one to two meters of the shore at the
two sites. These were lying on the mangrove floor
outside the security fence, or standing upright with
the lower part submerged in the gei wai, and were
naturally decomposing samples. One hundred and
twenty five decaying stem and leaf sheath segments
to cm) were collected from outside the security fence
and 144 samples were collected from the gei
wai, with ca. half of the samples collected in August
and the other half in November 1995. Samples were
placed in plastic bags, sealed and returned to the lab-
ory. Samples were then incubated on moist tissue
paper, in clear plastic boxes (25 × 12 × 10 cm) at
room temperature and normal lighting conditions,
for what was found to be an optimum period of 1—3
weeks to induce sporulation of fungi. The fungi were
identified by using a Leica MZ 12 dissecting micro-
scope at 15—20 X magnification. Voucher slides and/
or dried material of the fungi found were prepared
and are held in the mycological herbarium of The
University of Hong Kong [HKU(M)].

Analyses

Frequency of occurrence of fungi collected is ex-
pressed as the number of collections of a species at
each site divided by the total number of samples
examined from this site. Based on these figures, fungi
collected are classified as ‘very frequent’ (>20%),
‘frequent’ (10—20%) and ‘infrequent’ (<10%) species,
as adopted by Tan and Leong (1989). It was not fea-
sible to identify all taxa to species level, as some gen-
era lack modern treatments or up to date keys and
may contain numerous species. However, each unique
taxon is named (e.g. Farrovia sp. represents
one species of Farrovia, Phomopsis sp. 1 and Pho-
mosis sp. 2 represent two species of Phomopsis. They
are reported here in order to give an estimation of
fungal diversity occurring on Phragmites australis
at Mai Po Marshes.

Water temperatures at the time of collection was
between 24—31 °C, while the salinity range outside
security fence and along edge of gei wai no. 12 was
2.5—19%, and 2—15% respectively. In situ am-
monium concentration (NH^) of water outside security
fence and along edge of gei wai no. 12 was 15—26
ppm, and 22—26 ppm respectively.

Results

Sixty one taxa of higher fungi were found associated
with decaying stems and leaf sheaths of Phragmites
australis and the results are presented in Table I. Forty
one taxa were collected from 125 decaying plant
samples from outside security fence, and 47 taxa were
found on 144 plant samples along the edge of the gei
wai. The ratio of ascomycetes to coelomycetes to hy-
phomycetes was roughly equal (17 : 19:25). Lig-
nicola laevis was overall the most common species
(22.7%), while another very frequent taxon was Colle-
totrichum sp. (21.2%). Frequent taxa were Phomopsis
sp. 1 (19.3%), Aniptoderaphragmiticola (15.2%), Fus-
arium sp. (14.9%), Cladosporium sp. (13%), Trichoder-
ma sp. (12.3%), Cytoplea sp. (11.9%) and Rhinocladiella
sp. (11.2%), while other taxa were infrequent.

Outside the security fence, Lignicola laevis (37.6%) was
the most common species. Other very frequent
taxa were Trichoderma sp. (26.4%), Aniptoderaphrag-
miticola (23.2%) and Colletotrichum sp. (22.4%). Along
the edge of the gei wai, Fusarium sp. (28.8%),
Cladosporium sp. (24.3%), Phomopsis sp. 1 (21.5%) and
Colletotrichum sp. (20.1%) were very frequent.

Twenty seven taxa including Colletotrichum sp.,
Phomopsis sp. 1, Rhinocladiella sp., Lignicola laevis
and Aniptoderaphragmiticola were found common to
both sites. The majority of taxa (34), however, occurred at a single site. Thirteen taxa were found only outside the security fence, such as Trichoderma sp., Phomatospora marina and Phragmitensis marina. Twenty taxa were also found only along the edge of the gei wai, such as Fusarium sp., Cladosporium sp. and Macrophomina sp.

Saprophytic fungi occurring on Phragmites australis

The lower parts of the standing decaying stems and leaf sheaths (up to 30 cm) of Phragmites australis found outside the security fence, are subjected to daily tidal inundation. Along the edge of the gei wai, up to one half of the standing decaying stems and leaf sheaths of *P. australis* (ca 70 cm) are immersed for several months. Fungi occurring on these lower plant parts can be considered to be intertidal fungi, while those occurring on the upper parts of the stems and leaf sheaths of *P. australis* are terrestrial. Middle portions of the plants are occasionally submerged or exposed to salt spray and hence colonised by mostly intertidal fungi.

Intertidal fungi. Differences in intertidal fungal composition between the two sites (outside the security fence and along the edge of the gei wai) were observed. Eleven intertidal fungi were confined to the decaying stems and leaf sheaths lying on the mangrove floor, collected outside the security fence. Lignincola laevis (37.6%) and Aniptodera phragmiticola (23.2%) were the most dominant intertidal species here, while Gaeumannomyces sp. was an infrequent ascomycete. Three coelomycetes (Chaetosbolisia sp., Microsphaeropsis sp., Stauronema sp.) and two hyphomycetes (Pithomyces maydiscus and Spegazzinia tesseratha) were infrequent.

Six hyphomycetes (Acremonium sp. 2, Alternaria alternata, Arthrobotrys conoides, Dactylaria sp., Gliomastix sp. 1, Sarocladium sp.) were confined to the plant samples collected at the water/air interface, along the side of the gei wai. The most common taxa being the hyphomycetes Cladosporium sp. (24.3%), Sarocladium sp. (8.3%) and Arthrobotrys conoides (4.9%). One coelomycete, Dimasporasma striogum, and one ascomycete, Massarina thalassiae also occurred on these lower portions of plant samples.

Most intertidal fungi were found at both sites, although some exhibited a clear affinity towards a specific site. The ascomycetes Aniptodera phragmiticola, Lignincola laevis and Massarina phragmiticola were mostly found outside the security fence. The coelomycetes Cytoplascosphaeria phragmiticola, Phoma sp., Phomopsis sp. 1, Sclerotagonospora sp. and Septoria sp.) were common to both sites, although Cytoplascosphaeria phragmiticola and Septoria sp. were more common along the edge of the gei wai. The hyphomycetes Arthrinium state of Apiospora sp., Drechslera hawaiiensis, Phaeosaria sp., Rhinocladiella sp., Stachybotrys sp., and Tetraploa aristata were also common to both sites, but Tetraploa aristata was more frequently recovered outside the security fence.

Terrestrial fungi. Sixteen terrestrial fungi were found associated with the decomposition of the apical to middle portion of decaying stems and leaf sheaths of *Phragmites australis*. Four of these were common to both sites. Chaetomium globosum was the only terrestrial ascomycete found on the upper levels of the plant samples. This species was common at both sites, but was more frequently recovered outside the security fence. Cytoplea sp. and the Arthrinium state of Apiospora montagnei were found on plant samples, both outside the security fence and along the edge of the gei wai.

Outside the security fence, Trichoderma sp. (26.4%) and Chaetomium globosum (6.4%) were the most frequently recorded terrestrial fungi. *Phomopsis* sp. 2, Tetrancrum sp., Dendrostilbella sp. and Thrichoderma sp. were only collected here.

Along the edge of the gei wai, *Fusarium* sp. (28.8%) was the most commonly recorded taxon. Eight less frequent terrestrial deuteromycetes (Cladosporium sp. Macrophomina sp. Neottiosporina sp. Pestalotiopsis sp. Stagonospora sp. Acremonium sp. 1, Gliomastix sp. 2 and Paecilomyces sp.) were limited to plant samples along the edge of the gei wai.

Descriptions of fungi

An account of selected saprophytic fungi found on decaying stems and leaf sheaths of *Phragmites australis* during this study is given in the following section.

Ascomycetes

Halosarpeha phragmiticola O. K. Poon et K. D. Hyde, sp. nov.

Figs 1–10

Etymology: In reference to Phragmites australis the host.

Diagnosis

Ascomata ca 350 μm in diameter, ca 400 μm alta, globose vel subglobosa, immersa vel superficia, ostiolata, papillata, coriacea, nigra, solitaria. Asci 105–167.5 × 32.5–47.5 μm, 8-spori, clavati, pedicellati, appendiculati. Ascosporae 25–35 × 7.7–10.5 μm, ellipsoido-fusiformes, 1-septatae, appendiculatae.

Ascomata 350–400 μm in diameter, globose to subglobose, immersed to superficial, ostiolate, coriaceous, black, solitary, with a long black cylindrical neck (Fig. 1). Neck up to 700 μm long, 70 μm in diameter, cylindrical, superficially covered with short hyaline hairs, periphyssate. Peridium up to 10 μm thick, two layered; outer layer comprising black thick-walled cells; inner layer comprising hyaline...
Table I. Estuarine saprophytic fungi associated with decaying stems and leaf sheaths of *Phragmites australis* collected in Mai Po Marshes in August and November 1995.

<table>
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<th>Fungi</th>
<th>Outside fence</th>
<th>Along edge of gei wai</th>
<th>Total no. of collections</th>
<th>% occurrence</th>
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<td>% occurrence</td>
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<td>ASCOMYCETES (17 taxa)</td>
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<td><em>Aniptodera chesapeakensis</em> Shearer et Miller</td>
<td>6</td>
<td>4.8</td>
<td>2</td>
<td>1.4</td>
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<td><em>Aniptodera phragmiticola</em> O. K. Poon et K. D. Hyde</td>
<td>29</td>
<td>23.2</td>
<td>12</td>
<td>8.3</td>
</tr>
<tr>
<td><em>Chaetomium globosum</em> Kunze ex Steud.</td>
<td>8</td>
<td>6.4</td>
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<td><em>Halosarpeia unicaudata</em> (E. B. G. Jones et LeCampion—Alsumard) R. G. Johnson, E. B. G. Jones et S. T. Moss ex Kohlm. et Volkm.-Kohlm.</td>
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<td>37.6</td>
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<td><em>Pleospora spartinae</em> (Webster et Lucas) Apinis et Chester</td>
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<td><em>Pseudohalonectria falcata</em> Shearer</td>
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<td>2.4</td>
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<td><em>Verruculina enalia</em> (Kohlm.) Kohlm. et Volkm.-Kohlm.</td>
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<td>0</td>
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<td>9</td>
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<td><em>Zopfiella latipes</em> (Lundqvist) Malloch et Cain</td>
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DEUTEROMYCETES (44 species)

| Coelomycetes (19 species) | | | | | |
| | | | | | |
| *Chaetosbolisia* sp. | 1 | 0.8 | 0 | 0 | 1 | 0.4 |
| *Chaetospermum camelliae* Agnihothr. | 1 | 0.8 | 2 | 1.3 | 3 | 1.1 |
| *Colletotrichum* sp. | 28 | 22.4 | 29 | 20.1 | 57 | 21.2 |
| *Cytoplacosphaeria phragmiticola* O. K. Poon et K. D. Hyde | 1 | 0.8 | 15 | 10.4 | 16 | 5.9 |
| *Cytoplea* sp. | 15 | 12 | 17 | 11.8 | 32 | 11.9 |
| *Dimenasporium stigmogenum* Pers. ex Fr. | 0 | 0 | 1 | 0.7 | 1 | 0.4 |
| *Macrodiomna* sp. | 0 | 0 | 16 | 11.1 | 16 | 5.9 |
| *Microsphaeropsis* sp. | 9 | 7.2 | 1 | 0.7 | 10 | 3.7 |
| *Neottiospora* sp. | 0 | 0 | 1 | 0.7 | 1 | 0.4 |
| *Pestalotiopsis* sp. | 0 | 0 | 2 | 1.3 | 2 | 0.7 |
| *Phoma* sp. | 5 | 4 | 4 | 2.8 | 9 | 3.3 |
| *Phomopsis* sp. 1 | 21 | 16.8 | 31 | 21.5 | 52 | 19.3 |
| *Phomopsis* sp. 2 | 2 | 1.6 | 0 | 0 | 2 | 0.7 |
| *Pseudohalonectria falcata* Shearer | 1 | 0.8 | 0 | 0 | 1 | 0.4 |
| *Septoria* sp. | 5 | 4 | 6 | 4.2 | 11 | 4.1 |
| *Sclerotodespora* sp. | 1 | 0.8 | 21 | 14.6 | 22 | 8.2 |
| *Stagonospora* sp. | 0 | 0 | 2 | 1.3 | 2 | 0.7 |
| *Stauronema* sp. | 2 | 1.6 | 0 | 0 | 2 | 0.7 |
| *Tetranacrium* sp. | 1 | 0.8 | 0 | 0 | 1 | 0.4 |

Hyphomycetes (25 species)

| *Acremonium* sp. 1 | 0 | 0 | 7 | 4.9 | 7 | 2.6 |
| *Acremonium* sp. 2 | 0 | 0 | 1 | 0.7 | 1 | 0.4 |

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Table I. Continued.

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No. of samples examined: 125

*Massarina phragmiticola* O. K. Poon et K. D. Hyde, sp. nov. Figs 11–20

Mode of life: Saprobic.

Habitat: Stems and leaf sheaths of *Phragmites australis*.

Known distribution: Hong Kong.

Material examined: Decaying stems and leaf sheaths of intertidal *P. australis*, Mai Po Marshes, Hong Kong (22°29' N, 114°02' E), 17 Aug. 1995, O. K. Poon [HKU(M) 5186, holotype]; decaying stems and leaf sheaths of intertidal *P. australis*, Mai Po Marshes, Hong Kong (22°29' N, 114°02' E), 16 Nov. 1995, O. K. Poon [HKU(M) 5187].

This collection on decaying stems and leaf sheaths of *P. australis* in the intertidal region is superficially very similar to *Halosarpehea culmiperda* Kohlm., Volkm.-Kohlm. et O. E. Erikss. (Kohlm. et al. 1995c). The species, however differs, as *H. culmiperda* has wider ascospores (9–13 µm) with subapical cap-like appendages, narrower clavate asci (23.5–30 µm wide) and tawny ascomata. In *Halosarpehea phragmiticola* ascospores are 7.7–10.5 µm wide, appendages hamate and 32.5–47.5 µm wide, and ascomata are black. *Halosarpehea phragmiticola* should be compared with *Aniptodera juncicola* Volkm.-Kohlm. et Kohlm., from *Juncus roemerianus* (Volkman-Kohlmeyer and Kohlmeyer 1994). *Aniptodera juncicola* lacks appended ascospores, and has greyish brown to fuscous ascomata. The ascospores also differ in shape from those of *Halosarpehea viscosa* (I. Schmidt) Shearer et Crane.

Fig. 1. Section of ascoma (bar = 100 μm). Fig. 2. Section of ascoma, illustrating peridium (bar = 10 μm). Figs 3–8. Mature asci (bars = 20 μm). Figs 9–10. Mature ascospores with filamentous appendages at both ends (bars = 10 μm).

Fig. 11. Section of aggregated ascomata (bar = 100 μm). Fig. 12. Section of individual ascoma (bar = 100 μm). Fig. 13. Section through papilla (bar = 50 μm). Fig. 14. Section of peridium (bar = 10 μm). Fig. 15. Hypha-like septate pseudoparaphyses (arrow) in a gelatinous matrix (bar = 100 μm). Figs 16–18. Mature asci (bars = 50 μm) fissitunicate in 16. Figs 19–20. Mature ascospores (bars = 10 μm). Fig. 19. Mature ascospore with distal appendage (arrow) markedly smaller than proximal appendage.
Diagnosis

Ascomata 180–280 μm in diameter., 150–200 μm alta, solitaria vel aggregata, imersa, subglobosa vel ellipsoidae, nigra, glabra, ostiulata, breve papillata. Ascii 102.5–133 × 12.5–16.3 μm, cylindrici vel clavati, fissitunicati, 8-spori, pedicellati. Ascosporeae 28–37.5 × 4.7–6.5 μm (x = 33.5 × 5.3 μm, n = 25), hyalinae, bicellulares, cylindricae, utrinque obtusae, guttulatae, appendiculatae.

Ascomata 180–280 μm in diameter, 150–200 μm high, solitary or aggregated, immersed, subglobose to ellipsoidal, black, glabrous, ostiulate, short papillate (Figs 11–13). Peridium 11.8–19.7 μm thick comprising several layers of compressed, brown-walled angular cells (Fig. 14). Pseudoparaphyses ca 85 μm long, 2.5–3 μm in diameter at the base and 1.5–2.5 μm in diameter in the apex, filiform, hypha-like, septate, numerous, mostly free-ended, unbranched or branched at the base, markedly shorter than the asc, invested in mucilage (Fig. 15). Ascii 102.5–133 × 12.5–16.3 μm, 8-spored, cylindrical to clavate, fissitunicate, pedicellate, invested in mucilage, developing from base of locale (Figs 15–18). Ascospores 28–37.5 × 4.7–6.5 μm (x = 33.5 × 5.3 μm, n = 25), 2–3 seriate, 2-celled, hyaline, obtuse at both ends, uni-septate, constricted at septa; apical cell irregularly cylindrical, straight, basal cell cylindrical, straight or slightly curved at the end; guttulate, appended at both ends; appendages cupulate, mucilaginous; apical appendage 3.7–6.3 μm in diameter, markedly smaller than basal appendage; basal appendage 7.5–9.5 μm in diameter (Figs 19, 20).

Mode of life: Saprobiert.

Habitat: On decaying stems and leaf sheaths of intertidal Phragmites australis.

Known distribution: Hong Kong.

Material examined: Decaying stems and leaf sheaths of Phragmites australis, Mai Po Marshes, Hong Kong (22°29' N, 114°02' E), 16 Nov. 1995, O. K. Poon [HKU(M) 5188, holotype].

Massarina phragmiticola was found to be an interspecifically related species occurring on dead P. australis stems and leaf sheaths. It can readily be distinguished from the Massarina rieciata Kohlm., Volkm.-Kohlm. et O. Erikss. and M. carolinensis Kohlm., Volkm.-Kohlm. et O. Erikss. from Juncus roemarianus (Kohlmeier et al. 1995 b, 1996) as M. rieciata has smaller ascospores (19–25 × 5.5–7 μm) surrounded by a spreading mucilaginous sheath. In M. carolinensis ascospores are also smaller (16.5–21 × 4.5–6.5 μm) and are totally surrounded by a gelatinous sheath. Massarina phragmiticola and M. rieciata are marine species, while M. carolinensis is a terrestrial species.

Phomatospora phragmiticola O. K. Poon et K. D. Hyde, sp. nov.

Mode of life: Saprobiert.

Habitat: Stems and leaf sheaths of Phragmites australis.

Known distribution: Hong Kong.

Material examined: Decaying stems and leaf sheaths of intertidal P. australis, Mai Po Marshes, Hong Kong (22°29' N, 114°02' E), 17 Aug. 1995, O. K. Poon [HKU(M) 5189, holotype].

Phomatospora phragmiticola can be considered to be an obligate marine fungus as it has the highest affinity in the intertidal region. Phomatospora phragmiticola can be confused with P. bellaminuita Kohlm., Volkm.-Kohlm. et O. E. Erikss. (Kohlmeier et al. 1995 b) which was found at the lower parts of decaying Juncus roemarianus in the U.S.A. The differences between these species and other marine species are given in Table II. Phragmites phragmiticola differs from P. berkeleyi Sacc, which has smaller ascospores (Kirk 1984).

Cytoplascomphaeria phragmiticola O. K. Poon et K. D. Hyde, sp. nov.

Figs 36–45

Diagnosis

Ascomata 155–175 μm in diameter, 125–133 μm alta, immersa, globosa vel subglobosa, membranacea, nigra, ostiulata, breve papillata, solitaria. Asci 85–125 × 5–7.5 μm, 8-spori, cylindrici, unisetunica, pedicellati, apparatu apicali praediti. Ascosporeae 7.5–11.3 × 3–5 μm (x = 9.3 × 4.2 μm; n = 50), unisetunicae, ellipsoidae, hyalinae, striatae, appendiculatae.

Fig. 21. Section of ascoma (bar = 50 μm). Fig. 22. Section through neck (bar = 50 μm). Fig. 23. Section through peridium (bar = 10 μm). Fig. 24. Hypha-like hyaline paraphyses (bar = 20 μm). Figs 25–28. Mature asci (bars = 20 μm). Fig. 29. Apex of mature ascus illustrating apical ring (bar = 10 μm). Figs 30, 34 and 35. Mature ascospores (bars = 10 μm). Fig. 39. Mature ascospore, showing longitudinal striations. Figs 31–33. Mature ascospores with bifurcate appendages (bars = 5 μm).
soidea vel lenticularia. Conidiophora nullae. Cellulae conidigenae 9.8—12.5 × 7.3—8 μm, enteroblasticae, phialidicae, discreteae, determinatae, ampulliformes vel doliformes, laeves. Conidia 17.5—75 × 2.5—5 μm, cylindrica, laevia, curva, hyalina, 0—5 septata.

Conidiomata ca 800 μm in diameter, 290 μm high, eustromatic, loosely aggregated into stromata with 1—5 locules, immersed, brown, ellipsoidal to lenticular, scarcely erumpent (Figs 36, 37). Peridium outer wall consists of several layers of thick-walled dark brown cells, in the form of textura angularis; becoming thinner and paler towards the conidiogenous region. Ostioles indistinct, dehiscence possibly by rupture of the upper wall (Fig. 38). Conidiophores absent. Conidigenous cells 9.8—12.5 × 7.3—8 μm, enteroblastic, phialidic, discrete, determinate, ampulliform to doliform, smooth, with apical or lateral apertures, collarette clearly visible, channels comparatively wide, hyaline, developing from inner cells of locules (Figs 39—42). Conidia 17.5—75 × 2.5—5 μm, cylindrical, straight, curved or irregular, thin-walled, minutely guttulate, smooth, hyaline, 0—5 septate, not constricted at septa (Figs 43—45).

Mode of life: Saprobic.

Habitat: On decaying stems and leaf sheaths of Phragmites australis.

Known distribution: Hong Kong.

Material examined: Decaying stems of leaf sheaths of P. australis, Mai Po Marshes, Hong Kong (22°29' N, 114°02' E), 16 Nov. 1995, O. K. Poon [HKU(M) 5191, holotype].

Cytoplacosphaeria phragmiticola is a facultative brackish water species frequently occurring on Phragmites australis stems and leaf sheaths collected from the sides of the gei wai. It has a high affinity around 10—20 cm above the water-air interface, which is the upper to middle portion of P. australis stems and leaf sheaths. Cytoplacosphaeria phragmiticola was recovered once on the basal portion of P. australis stem and leaf sheath in the intertidal region outside the gei wai.

This species is similar to the type species Cytoplacosphaeria rimosa (oud.) Petr., which occurs on Phragmites sp., in Latvia, Czechoslovakia and England (Sutton 1980). However, C. rimosa has conidiogenous cells with a distinct collarette and shorter eguttulate conidia (13—20 × 3 μm). This makes C. phragmiticola readily distinguishable from C. rimosa. The ostiole in C. rimosa is reported to be single, circular and papillate, whereas it appears that C. phragmiticola dehisces by rupture of the upper wall.

Microsphaeropsis sp.

Figs 46—55

Conidiomata pycnidal, ampulliform, occasionally subglobose, black, immersed, papillate, mostly unicellular, occasionally bilocular, ca 280 μm in diameter, 240 μm high (Figs 46, 47). Peridium 11—23 μm thick, outer wall of 1—3 layers of thick-walled dark brown cells, in the form of textura angularis; middle wall of 3—5 layers of thick-walled pale brown cells,

Table II. Synopsis of marine species of Phomatospora.

<table>
<thead>
<tr>
<th></th>
<th>P. acrostichi</th>
<th>P. bellaminata</th>
<th>P. kandelae</th>
<th>P. phragmiticola</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>K. D. Hyde</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Volkm.-Kohlm.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ascomata (μm)</strong></td>
<td>106—274 high</td>
<td>115—125 high</td>
<td>145—260 high</td>
<td>125—133 high</td>
</tr>
<tr>
<td><strong>Ascospore size (μm)</strong></td>
<td>5.7—7.1 × 2—2.8</td>
<td>10.1—12.5 (13) × 3.7—4.6 (x = 11.3) × 125—325 diam.</td>
<td>11.5 × 16 × 5.5—8 (x = 9.3 × 4.2, n = 50)</td>
<td></td>
</tr>
<tr>
<td><strong>Appendages</strong></td>
<td>Bifurcate, at one end</td>
<td>Gelatinous caps, staining blue in methylene blue</td>
<td>Caps which may become filamentous</td>
<td>Bifurcate, not staining blue in methylene blue</td>
</tr>
<tr>
<td><strong>Ascospore arrangement in ascus</strong></td>
<td>Uniseriate</td>
<td>1—2 seriate</td>
<td>Uni-or-overlapping uniseriate</td>
<td>Uniseriate</td>
</tr>
<tr>
<td><strong>Ascospore shape</strong></td>
<td>Ellipsoidal with rounded ends</td>
<td>Ellipsoidal with rounded ends</td>
<td>Ellipsoidal with rounded ends</td>
<td>Ellipsoidal with somewhat acute ends</td>
</tr>
<tr>
<td><strong>Habitat</strong></td>
<td>Acrostichum, intertidal</td>
<td>Juncus, lower part of stems and leaf sheaths</td>
<td>Kandelia, intertidal</td>
<td>Phragmites, lower parts of stems and leaf sheaths</td>
</tr>
<tr>
<td><strong>Reference</strong></td>
<td>Hyde 1988</td>
<td>Kohlmeyer and Volkmann-Kohlmeyer 1995 a</td>
<td>Hyde 1992</td>
<td>This paper</td>
</tr>
</tbody>
</table>
Figs 36–45. *Cytoplastosphaeria phragmiticola* (from holotype).

Figs 36–38. Sections of conidiomata (bars = 100 μm). Fig. 39. Conidia arising from conidiogenous cells developing from base of locule (bar = 50 μm). Figs 40, 41. Conidiogenous cells with developing conidia (bars = 20 μm). Fig. 42. Conidiogenous cell (bar = 20 μm). Figs 43–55. Mature conidia (bars = 5 μm).
Figs 46–55. *Microsphaeropsis* sp.

Figs 46, 47. Sections of conidiomata (bars = 100 μm). Fig. 48. Section through peridium (bar = 20 μm). Fig. 49. Section through papilla (bar = 20 μm). Figs 50, 51. Conidiophores with developing conidia (bars = 10 μm). Figs 52–55. Mature conidia (bars = 5 μm).
in the form of textura porrecta; inner wall of single layer of hyaline thin-walled cells, in the form of textura angularis (Fig. 48). Papilla ca 80 μm long, 130 μm wide (Fig. 49). Conidiophores absent. Conidiogenous cells enteroblastic, phialidic, determinate, discrete, doliform to cylindrical, collarette minute, smooth, hyaline, developing from inner cells of pycnidial wall (Figs 50, 51). Conidia 3.7-5 X 3.7-4.5 μm, 1-celled, brown, thick-walled, ellipsoid, bigelutate at both ends, aseptate, enclosed in a thin mucilaginous sheath (Figs 52-55).

This is a marine species which occurred only at the basal portion of decaying standing stems and leaf sheaths of Phragmites australis and on decaying stems and leaf sheaths of P. australis submerged in brackish water. No species from this genus is reported on salt marsh plants. There are 800 names in Coniothyrium and many of them probably belong in Microsphaeropsis (Sutton 1980). A major revision of the group is needed and therefore it would be unwise to name this species beyond generic level. Coniothyrium obiones Jaap is a marine species which has been reported on dead stems and leaf sheaths and moribund propagules of a coastal salt marsh plant Halimione portulacoides (L.) Aellen collected in England and Germany (Kohlmeyer and Kohlmeyer 1979). Microsphaeropsis sp. collected from Phragmites australis, has non-tapered conidiogenous cells and conidia enclosed in mucilaginous sheaths, and differs from Coniothyrium obiones Jaap.

Discussion

Biodiversity of fungi found in Hong Kong mangroves

The results of these studies are preliminary observations on the fungi involved in the decay of stems and leaf sheaths of Phragmites australis at Mai Po Marshes in Hong Kong. Because of the relatively small sample sizes based on two site visits in August and November 1995 the data on frequency and composition must be treated with caution as additional collections at different times may result in different compositions. However, the results do represent the first data on the biodiversity of fungi on grasses in the tropics.

Similar studies on biodiversity of fungi on other grasses in Hong Kong are unavailable for comparison. However, there have been several reports on lignicolous fungi from mangroves in Hong Kong (Vrijmoed 1990, Vrijmoed et al. 1994, Sadaba et al. 1995).

In the study of Vrijmoed (1990), Vrijmoed et al. (1994) and Sadaba et al. (1994), and in this study, Lignincola laevis was the most frequently identified fungus on Acanthus ilicifolius L., Avicennia marina, Kandelia candel, Phragmites australis and driftwood. Aniptodera chesapeakensis was also commonly found on Acanthus ilicifolium, Avicennia marina and Phragmites australis. Halosarphaea sp. and Lulworthia sp. were common to both Kandelia candel and driftwood. Species of Leptodictyon were found on Acanthus ilicifolium and Phragmites australis and driftwood. Halonectria milfordensis was found on Aegiceras cornulatum and Kandelia candel.

The number of taxa recorded in this study (61) is higher than reported by Sadaba et al. (1995) on Acanthus ilicifolium. Only 44 higher fungi were found associated with decaying standing parts of Acanthus ilicifolium (Sadaba et al. 1995). There were differences in fungal composition on Phragmites australis and Acanthus ilicifolium. In the intertidal region of Mai Po Marshes, the most common taxa on standing parts of Acanthus ilicifolium were Acerrionon sp. (55%), Colletotrichum sp. (42.5%), Phoma sp. (42.5%), Fusarium sp. (25%) and Tubercularia sp. (24.2%) (Sadaba et al. 1995). On the other hand, the common taxa found on dead stems and leaf sheaths of Phragmites australis were Lignincola laevis (22.7%), Colletotrichum sp. (21.2%), Phomopsis sp. 1 (19.3%), Aniptodera phragmiticola (15.2%), Fusarium sp. (14.9%), Cladosporium sp. (13%) and Trichoderma sp. (12.3%).

The differences in mycota reported may be due to different host species studied. Sadaba et al. (1995) only collected Acanthus ilicifolium samples from the intertidal region of Mai Po Marshes (outside the security fence), while Phragmites australis were collected from both the intertidal region and along the edge of the gei wai. There appears to be a group of fungi which are only found inside or along the edge of the gei wai. Nonetheless, two frequent taxa (Colletotrichum sp. and Fusarium sp.) are common to both hosts.

Few mitosporic fungi are reported by Vrijmoed (1990), since most mitosporic fungi are terrestrial species and are unlikely to occur on the decaying plant samples found in the aquatic environment. The large number of fungi recorded from Phragmites australis and Acanthus ilicifolius reflected the intensive study of these plants. Further study is needed concerning the host specificity of fungi associated with mangrove plants in Hong Kong.

Biodiversity of salt marsh fungi found on grasses

The diversity of fungi recorded from other salt marsh grasses, such as species of Spartina is lower than those found in this study. Phragmites australis has the greatest number of fungal species recorded (63), followed by Spartina alterniflora (49), Spartina townsendii H. Groves et J. Groves (39), an unidentified species of Spartina (30), Spartina patens (Aiton.) Muhl. (16), Spartina cynuosuroides (L.) Roth (14), Spartina foliosa Trin. (3), Spartina maritima (Curtis) Fernald (2), and Spartina anglica C. E. Hubbard (1) (Gessner and Kohlmeyer 1976).

The most common species found on these species of Spartina are Buergenerula spartinae Kohlm. et
Gessner, Claviceps purpurea (Fr.) Tul., Phaeosphaeria albobractata, Leptosphaeria marina Ellis et Everh., Passerinila obiones (Crouan et Crouan) K. D. Hyde et Mouzouras, species of Lulinworthia, Phaeosphaeria spuradiocica Leuchte., Puccinia sparganioides Ellis et Barth., Phoma sp., and Stagonospora sp. (Gessner and Kohlmeyer 1976). The most common taxa on Phragmites australis are Aniptodera phragmiticola, Cladosporium sp., Colletotrichum sp., Fusarium sp., Lignincola laevis, Phomopsis sp. 1 and Trichoderma sp.

Gessner (1977) found a characteristic group of fungi associated with Spartina alterniflora along the east coasts of North and South America. Differences in fungal taxa found on Phragmites australis and species of Spartina can be attributed to temperature, host specificity and location. Perhaps it is unlikely for a group of fungi adapted to decomposing S. alterniflora to be found on decaying stems and leaf sheaths of P. australis. Further investigation is required regarding host specificity of saprophytic fungi on grasses.

Saprophytic fungi occurring on Phragmites australis in Mai Po

The differences in fungal composition at the two sites in Mai Po may be due to the preference of fungi towards certain inundation periods. Salinity difference is not a factor contributing to these differences. Salinities in intertidal region and gei wai are nearly the same due to the connection of two water bodies via the sluice gate. There are also differences in species composition of terrestrial fungi between the two sites. This is not expected since terrestrial fungi are not affected by the differences of inundation period as in aquatic species.

There are also differences between the intertidal and terrestrial fungi. With the exception of Chaetomium globosum all ascomycetes are intertidal fungi (e.g. Phomatospora phragmiticola and Lignincola laevis). On the other hand, most terrestrial taxa were mitosporic fungi, such as Fusarium sp., Glomastix sp. 2. sp., Macrosporema sp. and Trichoderma sp. This may be due to the fact that mitosporic fungi, especially hyphomycetes are better adapted to the terrestrial environment at the upper level of the dead standing plant. Rapid colonisation of substrates by production of large amount of light conidia is characteristic of most hyphomycetes.

Terrestrial fungi (e.g. Chaetomium globosum and Dendrostilbella sp.) were not recovered from lower portions of standing decaying stems and leaf sheaths of Phragmites australis as they are probably not adapted to periodic submergence in seawater. This was also observed in the succession pattern of decomposers on P. australis in Japan (Tanaka 1991).

In conclusion, fungal communities associated with decaying Phragmites australis permanently submerged in the gei wai, are different to those in the intertidal region. The diversity of fungal taxa found in this study is probably an underestimate, since the identification of species depends on the reproductive structures being produced, and a relatively short study was carried out.

We would like to thank Dr T. K. Goh for identifying some of the mitosporic fungi listed in this study. Professor J. Kohlmeyer and Dr T. K. Goh are thanked for presubmission reviews. H. Leung and A. Y. P. Lee are thanked for technical assistance.

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