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*Original Paper*

# Corticolous fungi in Nile Delta region

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**Abstract**

Fungal communities on the dead bark of twelve living tree (*Acacia Arabica*, *Azadirachta indica*, *Casuarina equisetifolia*, *Eucalyptus rostrata*, *Ficus sycomorus*, *Malus domestica*, *Mangifera indica*, *Morus alba*, *Psidium guajava*, *Ricinus communis*, *Salix safsaf* and *Vitis vinifera*) were studied in Nile Delta region. Eighty-seven fungal taxa were identified. Thirty, thirty-nine, and eighteen species were recorded from ascomycetes, anamorphic fungi and myxomycetes, respectively. The most common genera were *Chaetomium*, *Zopfiella*, *Podospora*, *Saccobolus* and *Physarum* and the most common species were *Zopfiella latipes*, *Zopfiella karachiensis* and *Chaetomium bostrychodes*. *Eucalyptus rostrata*, *Casuarina equisetifolia* and *Salix safsaf* trees records the highest number records and diversity of fungi.

**Key word:** Myxomycetes, anamorphic fungi, ascomycetes, dead bark.

## Introduction

Dead plant substrates are essential components in terrestrial (Delaney *et al.*, 1997) and freshwater ecosystems (Jacobson and Jacobson 1999). The surface of dead bark from living trees contains a wide variety of organisms including bacteria, bryophytes, and lichens. Fungi also comprise a large percentage of the dead bark microflora (Bier 1963a, b). Fungi that complete their life cycle from spore to fruiting body formation on the bark of living trees and vines are termed corticolous fungi. Large numbers of species and genera of microfungi have been reported from bark and litter of forest trees (Fernandez and Boyer 1989).

However, few studies were conducted on corticolous fungi (Baird *et al.*, 2007). corticolous myxomycetes were studied by many workers (Brooks 1967; Keller and Brooks 1973; Stephenson 1989; Snell *et al.*, 2003; Everhart and Keller 2008; Liu *et al.*, 2013; Clayton *et al.*, 2014). The occurrence of corticolous fungi has been investigated for some different tree species (Garner 1967; Sivak and Person 1973).

While Butin and Kowalski (1986) illustrated that ascomycetes and mitosporic fungi were the most common taxa present on five hard wood species, Kliejunas and Kuntz (1974) identified many fungal genera from healthy bark with the most common genera being *Alternaria*, *Epicoccum*, *Fusarium*, *Penicillium*, *Phoma* and *Trichoderma*. (Baird *et al.*, 2007) identified 94 species of fungi from bark of three tree species in Forests of the Great Smoky Mountains National Park.

One third of all myxomycetes species are known to occur on dead bark of living trees (Mitchell 2004). Many of these are also known to occur in other microhabitats, but at least some species seem restricted to bark of living trees. Prominent examples include various species of *Echinostelium*, *Licea*, and *Macbrideola* (Alexopoulos 1964; Mitchell 1980; Mitchell 2004). Critical microhabitat factors of the bark that have been observed to

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influence the distribution and abundance of myxomycetes are water-holding capacity, texture (smooth, rough, spongy, etc.), pH, and amount of epiphyte cover (lichens, liverworts, mosses) (Stephenson 1989; Snell 2002). Corticolous myxomycete species are adapted to arid conditions and rapid production of a large number of stalked sporangia (Novozhilov *et al.*, 2000). Dead bark of some living plants has different nutrient concentration and in some plants tends to be relatively acidic (Stephenson 1989). Saad El-Din (2008) recorded six species namely, *Comatricha laxa, Perichaena chrysosperma, Perichaena depressa, Arcyria cinerea, Stemonitis flavogenita* and *Licea operculata* from dead bark of living trees in Upper Egypt. Abdel-Raheem (2002) reported eight myxomycetes species from bark samples of dead and living trees in Upper Egypt.

## Materials and methods

### Study area:

The studied area lies between latitude 30° 08′ S and 31° 20′ N and between longitudes 30° 54′W and 31° 45′ E. The Delta has a Mediterranean climate, characterized by little rainfall. The delta temperatures were averaging 30-48 °C and 10-19 °C in summer and winter, respectively. Usually it is rains and humid in winter (Elewa 2010).

### Samples collection, preparation and examination:

Five hundred and eleven samples of dead bark of living trees were collected randomly from streets and Nile tributaries edges in Nile Delta governorates. The samples were collected in four times over 2 years in the period from February 2010 to December 2011. All bark samples were collected in the height not exceeding 3 meter of the trees. Samples were collected by cutting or sawing off pieces of the bark and placed in clean plastic bags. Bark was collected from 12 living tree species; *Acacia Arabica, Azadirachta indica, Casuarina equisetifolia, Eucalyptus rostrata, Ficus sycomorus, Malus domestica, Mangifera indica, Morus alba, Psidium guajava, Ricinus communis, Salix safsaf* and *Vitis vinifera.* The trees were from different families and have different bark physical characteristics. Samples were soaked in water overnight and then washed by tap water. Samples incubated at room temperature (22-28 °C) with the diffuse of light in moist chamber culture fitted with moist soft paper**.** Cultures were sprayed by sterile distilled water from time to time to avoid dryness. Samples examined periodically for about 4-6 months. Cultures were checked for sporulating structures using a dissecting microscope (Olympus SZ61 or model Tl2, CE Olympus Co, Ltd). The sporulating samples were dried gradually on air at room temperature and stored in soft bags or in a small box for permanent storage.

### Data analysis

Numbers of species and frequencies of occurrence of each species were recorded and calculated for each plant tree. Shannon-Weiner diversity index (Shannon and Weaver 1963) was used to measure the diversity in the studied plants. Calculations were carried out according to Magurran (1988).

Frequency of occurrence of each fungus (%) was calculated on the following formula = (Number of samples that a particular species occurred on / Total number of examined samples) x 100. Shannon-Weiner index was calculated for each studied plant by using Shannon's formula (Shannon and Weaver 1963). ($H'$) = - ∑Pi log Pi, Where Pi is the relative abundance of a particular species (the proportion of the total number of individuals represented by species i). Equitability components or Evenness (J′) were calculated using the Pielou (1975) Formula. J′= $H'$/ H′max; Where H′max represents the maximum possible diversity for the number of species (S) present in the community and it was calculated as: H′max = log S.

## Results

Eighty-seven fungal taxa (30 ascomycetes, 39 anamorphic fungi and 18 myxomycetes) were identified from dead bark of living trees collected from Nile Delta region. A list of species and frequency of occurrence of each species in the different plants is given in table (1). Ratio of anamorphic fungi to ascomycete taxa in dead bark samples of living trees was 1.3:1. The total number of fungal collections

was 818 recorded from 511 samples. The average number of species identified on each sample was 1.6, with a range of 0.93 (*Azadirachta indica*) to 2.34 (*Casuarina equisetifolia*) taxa per sample. Species richness ranged between 8 species in Dead bark of *Azadirachta indica* to 69 species in *Eucalyptus rostrata* (Table 2). The mean number of species per genus (S/G) in dead bark samples was 1.٥.

The most common genera in Nile Delta region were *Chaetomium*, *Zopfiella*, *Podospora*, *Saccobolus* and *Physarum*, were reported in 16.4%, 19.9%, 9.8%, 8.4% and 12.9% of the total collected samples, respectively (Table 1). *Zopfiella latipes* (12.3% of the total collected samples), *Zopfiella karachiensis* (10.9 %) and *Chaetomium bostrychodes* (10.7%) were the most common species of studied dead bark samples.

Sordariomycetes dominate the ascomycete assemblage in dead bark samples in Nile delta region. Sordariomycetes was represented by 16 species, Dothideomycetes by 6 and Pezizomycetes by 5. The most dominant ascomycete genera regarding to the number of reported species were: *Podospora* (4 species), *Achaetomium*, *Chaetomium* and *Zopfiella* (3 species)**.** *Zopfiella latipes* (12.3%), *Zopfiella karachiensis* (10.9%), *Chaetomium bostrychodes* (10.7%) and *Saccobolus citrinus* (8.8%) were the most common ascomycete species in dead bark samples (Table 1). Thirty-nine species of anamorphic fungi belong to 29 genera were identified. The most common genera of anamorphic fungi were *Botryodiplodia*, *Stachybotrys* and *Phaeoisaria* were represented by 41, 37 and 31 records respectively. Most anamorphic fungi records were reported from dead bark of *Eucalyptus rostrata* (32.8% of anamorphic records), *Salix safsaf*, (12.9%) and *Casuarina equisetifolia* (12.9%). The most common anamorphic species were *Stachybotrys atra* (8.6%), *Phaeoisaria clematidis* (7.2%), *Botryodiplodia theobromae* (5.6%) and *Trichothecium roseum* (5.58%).

Eighteen species of myxomycetes representing 11 different genera were identified from dead bark of living trees. The most common myxomycetes genus was *Physarum* (12.9% of the collected samples). *Physarum* sp., and *Perichaena depressa* were the most common myxomycetes species where representing by 25 and 15 records, respectively (Table 1). Most myxomycetes records were from dead bark of *Eucalyptus rostrata* (42.6%) and *Salix safsaf* (17.6%), while myxomycetes was absent in *Malus domestica*, and *Azadirachta indica* samples.

**Biodiversity of fungi in the studied dead bark of living trees:**

Twenty-six species were identified from 32 samples of *Acacia Arabica* dead bark collected from Delta governorate; including 12 species of ascomycetes, 9 anamorphic fungi and 5 myxomycetes (Table 2). *Zopfiella karachiensis* (25.0%) and *Physarum* sp., (15.6%) were the most common species. Nine species were reported from 14 samples of *Azadirachta indica* including 4 species of ascomycetes, 4 anamorphic fungi (Fig. 1). The most common species in *Azadirachta indica* samples were *Zopfiella karachiensis* (28.5%), *Aspergillus terreus* (14.2%) and *Chaetomium globosum* (14.2%).

Eighty records of 35 samples of *Casuarina equisetifolia* were represented by thirty-three fungi (10 ascomycetes, 21 anamorphic fungi and 2 myxomycetes) (Table 2). *Chaetomium* sp., and *Zopfiella latipes* were the most common species (22.8% and 17.1% of the total samples, respectively). Sixty-nine species were reported from *Eucalyptus rostrata* dead bark samples, including 25 species of ascomycetes, 30 anamorphic fungi and 14 myxomycetes (Fig. 1). *Chaetomium* sp., (11.4%) *Zopfiella karachiensis* (14.5%) and *Zopfiella latipes* (14%) were the more common species.

Twenty-nine samples of *Ficus Sycamrous* dead bark produced twenty-four species, including 9 species of ascomycetes, 11 anamorphic fungi and 4 myxomycetes (Fig. 1). *Saccobolus citrinus* (20.6% of samples),

*Podospora communis* (13.8%) and *Trichothecium roseum* (13.8%) were the most common species in *Ficus Sycamrous* samples. Fourteen species (4 ascomycetes, 10 anamorphic fungi) were identified from 35 bark samples of *Malus domestica* (Table 2). The most common species in *Malus domestica* were *Stachybotrys atra* (18.8%) and *Saccobolus minimus* (12.5%).

Ten species were reported from 17 samples of *Mangifera indica* including one species of ascomycetes, 8 anamorphic fungi and one species of myxomycetes (Fig. 1). *Botryodiplodia* sp., (17.6%), *Curvulaia lunata* (17.6%) and *Physarum gyrosum* (17.6%) were the more dominant in *Mangifera indica* samples. Twenty-three species were reported from 29 samples of *Morus alba* dead bark, including 4 species of ascomycetes, 10 anamorphic fungi and 9 myxomycetes (Fig 1). *Chaetomium* sp., and *Stachybotrys atra* were the most common species in *Morus alba*, were represented in 16.0% and 14.2% of the total samples, respectively.

Twelve species (one ascomycete, 9 anamorphic fungi and 2 myxomycetes) were identified from 18 records reported from 16 samples of *Psidium guajava* bark samples (Table 2). *Arcyria cinerea*, *Phaeoisaria clematidis* and *Fusarium equiseti recored* high presentation on *Psidium guajava* bark samples where it is had 12.5% of total samples. Nine species were reported from 16 samples of *Ricinus communis* dead bark, including 8 anamorphic fungi, and one myxomycete (Fig. 1). No ascomycete species was reported from dead bark of *Ricinus communis*. *Botryodiplodia* sp., and *Stachybotrys atra* (18.8%) were the most common species.

Seventy-two samples *Salix safsaf* were collected and representing by 35 species, including 11 species of ascomycetes, 15 anamorphic fungi and 9 myxomycetes (Fig. 1). The most common species were Muchrooms sp. 1, *Zopfiella latipes* and *Saccobolus citrinus* were represented by 18.0%, 15.3% and 13.9% respectively. Ten species (3 ascomycetes, 6 anamorphic fungi and one myxomycete) were identified through 22 records from 18 samples of *Vitis vinifera* (Table 2). *Torula herbarum* (27.7%), *Trichothecium roseum* (22.2%), and *Graphium* sp., (16.6%) were the most common species.

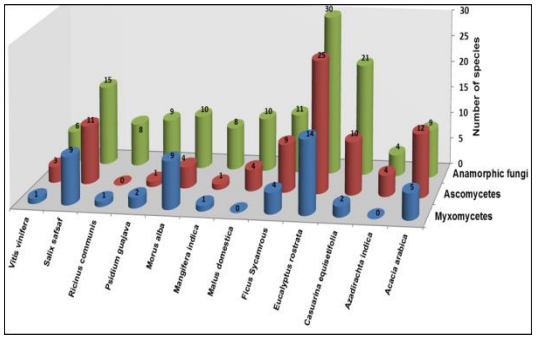


**Fig. (1):** Proportion of the taxonomic groups in the studied bark samples.

| **Species Name** | **Ac** | **Az** | **Ca** | **Eu** | **Fi** | **Ma** | **Mn** | **Mo** | **Ps** | **Ri** | **Sa** | **Vi** | **Total** | **FO** | **F A** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Frequency of occurrence** | | | | | | | | | | | | | | |
| **Ascomycota** | | | | | | | | | | | | | | | |
| ***Achaetomium*** | **12.5** | - | **8.5** | **6.2** | **3.4** | - | - | - | - | - | **4.2** | - | **23** | **4.5** | |
| *Achaetomium globosum* JN Rai & JP Tewari | **3.1** | - | - | 1.6 | - | - | - | - | - | - | - | - | 4 | 0.93 | 2 |
| *Achaetomium umbonatum* K Rodr, Stchigel & Guarro | - | - | - | 0.5 | - | - | - | - | - | - | - | - | 1 | 0.23 | 1 |
| *Achaetomium* sp. | **9.4** | - | 8.5 | 4.2 | 3.4 | - | - | - | - | - | 4.2 | - | 18 | 4.19 | 5 |
| ***Ascobolus*** | **18.7** | | **8.5** | **1.6** | - | - | - | - | - | - | - | **5.6** | **13** | **2.5** | |
| *Ascobolus calesco* AE Bell & Mahoney | **9.4** | - | 5.7 | - | - | - | - | - | - | - | - | - | 5 | 1.16 | 2 |
| *Ascobolus behnitziensis* Kirschst. | **9.4** | - | 2.8 | 1.6 | - | - | - | - | - | - | - | 5.6 | 8 | 1.86 | 4 |
| ***Chaetomium*** | **9.4** | **14.2** | **28.5** | **21.8** | **17.2** | - | - | **17.8** | - | - | **16.7** | - | **84** | **16.4** | |
| *Chaetomium bostrychodes* Zopf | - | - | - | 0.5 | - | - | - | - | - | - | 2.8 | - | 3 | 0.70 | 2 |
| *Chaetomium globosum* Kunze | **3.1** | 14.2 | 5.7 | 9.9 | 6.9 | - | - | 1.9 | - | - | 11.1 | - | 35 | 8.14 | 7 |
| *Chaetomium* sp. 1 | **6.2** | - | 22.8 | 11.4 | 10.3 | - | - | 16.0 | - | - | 2.8 | - | 46 | 10.70 | 6 |
| *Coniochaeta* sp. | **6.2** | - | - | 1.6 | - | - | - | - | - | - | - | - | 5 | 1.16 | 2 |
| *Emericella nidulans* (Eidam) Vuill., | - | 7.1 | - | 1.6 | - | - | - | - | - | - | - | - | 4 | 0.93 | 2 |
| *Iodophanus carneus* (Pers.) Korf | - | - | 5.7 | 1.0 | - | - | - | - | - | - | - | - | 4 | 0.93 | 2 |
| *Lojkania dimidiata* ZQ Yuan & ME Barr | - | - | - | 2.1 | - | - | - | - | - | - | - | - | 4 | 0.93 | 1 |
| *Micropeltopsis quinquecladiopsis* EB Jones, Sivichai & Hywel-Jones Hywel-Jones | - | - | - | - | - | - | - | - | 6.3 | - | - | - | 1 | 0.23 | 1 |
| *Neotestudina* sp. | - | - | - | 1.0 | 3.4 | 6.3 | - | - | - | - | - | - | 4 | 0.93 | 3 |
| *Orbilia* sp. | - | - | - | - | 3.4 | - | - | - | - | - | 1.4 | - | 2 | 0.47 | 2 |
| ***Pleospora*** | **6.2** | - | - | **3.1** | - | - | - | - | - | - | - | - | **8** | **1.6** | |
| *Pleospora phaeocomoides* (Berk. & Broome) G. Winter | 6.2 | - | - | 2.1 | - | - | - | - | - | - | - | - | 6 | 1.40 | 2 |
| *Pleospora* sp. | - | - | - | 1.0 | - | - | - | - | - | - | - | - | 2 | 0.47 | 2 |
| ***Podospora*** | - | **7.1** | - | **4.2** | **24.1** | **6.3** | - | - | - | - | **2.8** | - | **20** | **9.8** | |
| *Podospora communis* (Speg.) Niessl | - | - | - | 4.1 | 13.8 | 6.3 | - | - | - | - | 2.8 | - | 12 | 2.79 | 4 |
| *Podospora dolichopodalis* JH Mirza & Cain | 12.5 | - | - | 0.5 | 10.3 | - | - | - | - | - | - | - | 4 | 0.93 | 2 |
| *Podospora* sp. 1 | - | 7.1 | - | 0.5 | - | - | - | - | - | - | - | - | 2 | 0.47 | 2 |
| *Podospora* sp. 2 | - | - | - | 1.0 | - | - | - | - | - | - | - | - | 2 | 0.47 | 1 |
| *Roumegueriella rufula* (Berk. & Broome) Malloch & Cain | - | - | - | 0.5 | - | - | - | - | - | - | - | 5.6 | 2 | 0.47 | 2 |
| ***Saccobolus*** | **12.4** | - | **5.7** | **8.3** | **20.6** | **12.5** | - | **3.6** | - | - | **15.3** | - | **43** | **8.4** | |
| *Saccobolus citrinus* Boud. & Torrend | 9.4 | - | 5.7 | 7.8 | 20.6 | - | - | 3.6 | - | - | 13.9 | - | 38 | 8.84 | 6 |
| *Saccobolus minimus* Velen. | 3.1 | - | - | 0.5 | - | 12.5 | - | - | - | - | 1.4 | - | 5 | 1.16 | 4 |

**Table (1):** Corticolous fungi of twelve living trees bark in Nile delta region.

| **Species Name** | **Ac** | **Az** | **Ca** | **Eu** | **Fi** | **Ma** | **Mn** | **Mo** | **Ps** | **Ri** | **Sa** | **Vi** | **Total** | **FO** | **FA** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Frequency of occurrence** | | | | | | | | | | | | | | |
| *Westerdykella dispersa* (Clum) Cejp & Milko | - | - | 2.8 | - | - | - | - | - | - | - | 1.4 | - | 2 | 0.47 | 2 |
| ***Zopfiella*** | **37.5** | **28.5** | **31.3** | **29.6** | **3.4** | **12.5** | **-** | **5.3** | **-** | **-** | **15.3** | **5.6** | **102** | **19.96** | |
| *Zopfiella cephalothecoidea* Guarro, Abdullah, Al-Saadoon & Gené Gené | - | - | - | 1.0 | - | - | - | - | - | - | - | - | 2 | 0.47 | 1 |
| *Zopfiella karachiensis* (S.I. Ahmed & Asad) Guarro | 25.0 | 28.5 | 14.2 | 14.5 | - | 12.5 | - | - | - | - | - | - | 47 | 10.93 | 5 |
| *Zopfiella latipes* (N. Lundq.) Malloch & Cain | 12.5 | - | 17.1 | 14.0 | 3.4 | - | - | 5.3 | - | - | 15.3 | 5.6 | 53 | 12.32 | 7 |
| *Zygopleurage multicaudata* Mirza | - | - | - | - | - | - | - | - | - | - | 5.6 | - | 4 | 0.93 | 1 |
| Unidentified Ascomycetes sp. 1 | - | - | - | 0.5 | - | - | 5.9 | - | - | - | - | - | 2 | 0.47 | 2 |
| **Anamorphic fungi** | | | | | | | | | | | | | | | |
| *Acrogenospora sphaerocephala* (Berk. and Broome) MB Ellis | - | - | - | 0.5 | - | - | - | - | - | - | - | - | 1 | 0.23 | 1 |
| *Alternaria alternate* (Fr.) Keissl. | - | - | 8.5 | 0.5 | 10.3 | - | - | - | - | 12.5 | 4.2 | - | 12 | 2.79 | 5 |
| ***Aspergillus*** | **-** | **21.4** | **5.7** | **6.2** | **3.4** | **-** | **11.8** | **3.6** | **-** | **-** | **-** | **-** | **22** | **4.3** | |
| *Aspergillus flavus* Link | - | 7.1 | 2.8 | 1.6 | 3.4 | - | - | 3.6 | - | - | - | - | 8 | 1.86 | 5 |
| *Aspergillus niger* Tiegh | - | - | - | 3.1 | - | - | 11.8 | - | - | - | - | - | 8 | 1.86 | 2 |
| *Aspergillus terreus* Thom | - | 14.2 | 2.8 | 1.6 | - | - | - | - | - | - | - | - | 6 | 1.4 | 3 |
| ***Botryodiplodia*** | **-** | **7.1** | **11.4** | **8.3** | **6.9** | **-** | **17.6** | **3.6** | **-** | **18.8** | **9.7** | **5.6** | **41** | **8.02** | |
| *Botryodiplodia theobromae* Pat., | - | 7.1 | 5.7 | 6.2 | 6.9 | - | - | 3.6 | - | - | 7.0 | - | 24 | 5.58 | 6 |
| *Botryodiplodia* sp. | - | - | 5.7 | 3.1 | - | - | 17.6 | - | - | 18.8 | 2.8 | 5.6 | 17 | 3.95 | 6 |
| *Camposporium antennatum* Harkn. | - | - | - | - | 3.4 | - | - | - | - | - | - | - | 1 | 0.23 | 1 |
| ***Canalisporium*** | **3.1** | **-** | **-** | **2.1** | **-** | **-** | **-** | **-** | **-** | **-** | **2.8** | **-** | **7** | **1.4** | |
| *Canalisporium caribense* (Hol.-Jech. and Mercado) Nawawi and Kuthub. | 3.1 | - | - | 1.0 | - | - | - | - | - | - | - | - | 3 | 0.7 | 2 |
| *Canalisporium exiguum* Goh and KD Hyde | - | - | - | 1.0 | - | - | - | - | - | - | 2.8 | - | 4 | 0.93 | 2 |
| *Chromelosporium macrospermum* Hennebert, | - | - | - | 1.6 | - | - | - | - | - | - | - | - | 3 | 0.7 | 1 |
| *Cirrenalia* sp. | 6.2 | - | - | 1. 6 | - | - | - | 1.8 | - | - | - | - | 6 | 1.4 | 3 |
| *Curvularia lunata* (Wakker) Boedijn | - | - | - | 1.0 | - | 12.5 | 17.6 | - | - | - | 1.4 | 11.1 | 10 | 2.33 | 5 |
| *Desertella* sp. | - | - | - | 1.0 | - | - | - | - | - | - | 2.8 | - | 4 | 0.93 | 2 |
| *Didymostilbe australiensis* Goh & K.D. Hyde | - | - | 5.7 | - | - | - | - | 1.8 | - | - | - | - | 3 | 0.7 | 2 |
| *Epicoccum nigrum* Link | - | - | 2.8 | - | - | 6.3 | 11.8 | - | 6.3 | - | - | - | 5 | 1.16 | 4 |
| ***Fusarium*** | **-** | **-** | **7** | **0.5** | **-** | **12.5** | **11.8** | **-** | **25.0** | **12.5** | **-** | **-** | **18** | **3.5** | |
| *Fusarium equiseti* (Corda) Sacc. | - | - | 11.4 | 0.5 | - | - | 11.8 | - | 12.5 | - | - | - | 9 | 2.09 | 4 |
| *Fusarium solani* (Mart.) Sacc. | - | - | 8.5 | - | - | 12.5 | - | - | 12.5 | 12.5 | - | - | 9 | 2.09 | 4 |

**Table (1):** Continuation.

| **Species Name** | **Ac** | **Az** | **Ca** | **Eu** | **Fi** | **Ma** | **Mn** | **Mo** | **Ps** | **Ri** | **Sa** | **Vi** | **Total** | **FO** | **F A** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Frequency of occurrence** | | | | | | | | | | | | | | |
| *Graphium* sp. | 3.1 | - | 2.8 | 1.6 | 3.4 | - | 11.8 | 3.6 | 6.3 | - | 9.7 | 16.6 | 21 | 4.88 | 9 |
| *Hadrosporium fraserianum* Syd., | - | - | - | - | - | - | - | - | - | - | 2.8 | - | 2 | 0.47 | 1 |
| *Ketubakia indica* Kamat, Varghese and V.G. Rao | 3.1 | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.23 | 1 |
| *Monodyctys* sp. | 3.1 | - | - | 1.0 | - | - | - | - | - | - | 4.2 | - | 6 | 1.40 | 3 |
| *Myrothecium inundatum* Tode | - | - | - | 0.5 | - | 6.3 | 5.9 | - | - | 12.5 | - | - | 5 | 1.16 | 4 |
| *Nigrospora oryzae* (Berk. and Broome) Petch | - | - | - | 0.5 | - | 6.3 | - | - | 6.3 | - | - | - | 3 | 0.7 | 3 |
| ***Penicillium*** | **-** | **7.1** | **11.4** | **1.6** | **-** | **18.8** | **11.8** | **-** | **12.5** | **12.5** | **2.8** | **-** | **19** | **3.7** | |
| *Penicillium charlesii* G. Sm. | - | - | 2.8 | - | - | 6.3 | - | - | - | 12.5 | 2.8 | - | 6 | 1.40 | 4 |
| *Penicillium citrinum* Thom | - | 7.1 | 8.5 | 0.5 | - | 12.5 | 11.8 | - | 12.5 | - | - | - | 11 | 2.56 | 6 |
| *Penicillium oxalicum* Currie and Thom | - | - | - | 1.0 | - | - | - | - | - | - | - | - | 2 | 0.47 | 1 |
| *Phaeoisaria clematidis* (Fuckel) S. Hughes | 3.1 | - | 11.4 | 6.2 | - | 12.5 | - | - | 12.5 | - | 11.1 | 11.1 | 31 | 7.21 | 7 |
| *Phoma* sp. | 6.2 | - | 2.8 | 1.6 | - | - | - | 3.6 | 6.3 | 6.3 | 2.8 | - | 11 | 2.56 | 7 |
| *Stachybotrys **atra*** Corda | 3.1 | - | 2.8 | 9.9 | - | 18.8 | - | 14.2 | - | 18.8 | 2.8 | - | 37 | 8.6 | 7 |
| *Torula herbarum* (Pers.) Link | 6.2 | - | 11.4 | 3.1 | - | - | - | - | - | - | - | 27.7 | 17 | 3.95 | 4 |
| *Trichoderma* sp. | - | - | 5.7 | 0.5 | 3.4 | - | - | - | - | - | - | - | 4 | 0.93 | 3 |
| Trichothecium *roseum* (Pers.) Link | - | - | 8.5 | 3.1 | 13.8 | - | - | 12.5 | - | - | - | 22.2 | 24 | 5.58 | 5 |
| *Ulocladium botrytis* Preuss | - | - | - | 2.6 | 6.9 | - | - | - | - | - | 1.4 | - | 8 | 1.86 | 3 |
| *Volutella minima* Höhn | - | - | - | 1.0 | 6.9 | 6.3 | - | 3.6 | 6.3 | 12.5 | - | - | 10 | 2.33 | 6 |
| *Xylomyces elegans* Goh, WH Ho, KD Hyde KM Tsui | - | - | 2.8 | - | - | - | - | - | - | - | - | - | 1 | 0.23 | 1 |
| Unidentified Coelomycetes sp. | - | - | 2.8 | 0.5 | 10.3 | - | - | - | - | - | 2.8 | - | 7 | 1.63 | 4 |
| Unidentified Deuteromycetes sp. 1 | - | - | - | 1.0 | - | - | - | - | - | - | - | - | 2 | 0.47 | 1 |
| Unidentified Deuteromycetes sp. 2 | - | - | 8.5 | - | 10.3 | - | - | 5.3 | - | - | - | - | 9 | 2.09 | 3 |
| **Myxomycota** | | | | | | | | | | | | | | | |
| *Arcyria cinerea* (Bull.) Pers., | - | - | - | - | - | - | - | - | 12.5 | - | 1.4. | - | 3 | 0.70 | 2 |
| *Badhamia spinispora* (Eliasson & N Lundq.) HW Keller & Schokn. | 6.2 | - | - | 0.5 | - | - | - | - | - | - | - | - | 3 | 0.70 | 2 |
| *Diderma effusum* (Schwein.) Morgan | - | - | - | - | - | - | - | 1.8 | - | - | - | - | 1 | 0.23 | 1 |
| ***Didymium*** | **12.4** | **-** | **2.8** | **2.6** | **-** | **-** | **-** | **-** | **12.5** | **-** | **-** | **-** | **12** | **2.3** | |
| *Didymium nigripes* (Link) Fr., | 12.4 | - | 2.8 | 2.1 | - | - | - | - | 12.5 | - | - | - | 11 | 2.56 | 4 |
| *Didymium trachisporum* G. Lister | - | - | - | 0.5 | - | - | - | - | - | - | - | - | 1 | 0.23 | 1 |

**Table (1):** Continuation.

| **Species Name** | **Ac** | **Az** | **Ca** | **Eu** | **Fi** | **Ma** | **Mn** | **Mo** | **Ps** | **Ri** | **Sa** | **Vi** | **Total** | **FO** | **FA** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Frequency of occurrence** | | | | | | | | | | | | | | |
| *Echinostelium* sp. | - | - | - | 0.5 | - | - | - | 3.6 | - | - | 4.2 | - | 6 | 1.40 | 3 |
| *Licea* sp. | 12.4 | - | - | 1.56 | 6.9 | - | - | - | - | - | - | - | 9 | 2.09 | 3 |
| *Lycogala epidendrum* (J.C. Buxb. ex L.) Fr. | - | - | - | 2.1 | - | - | - | - | - | - | 2.8 | - | 6 | 1.40 | 2 |
| *Perichaena depressa* Lib. | - | - | - | 3.6 | 10.3 | - | - | - | - | 6.3 | 2.8 | 11.1 | 15 | 3.49 | 5 |
| *Physarella oblonga* (Berk. & M.A. Curtis) Morgan, J. | - | - | - | 3.1 | - | - | - | 3.6 | - | - | 5 | - | 13 | 3.02 | 3 |
| ***Physarum*** | **21.8** | **-** | **8.5** | **14.5** | **17.2** | **-** | **17.6** | **14.2** | **-** | **-** | **16.7** | **-** | **66** | **12.9** | |
| *Physarum bitectum* G. Lister | - | - | - | 2.1 | - | - | - | 1.8 | - | - | - | - | 5 | 1.16 | 2 |
| *Physarum cinereum* Link | - | - | - | 1.0 | 10.3 | - | - | 3.6 | - | - | 1.4 | - | 8 | 1.86 | 4 |
| *Physarum compressum* Alb. & Schwein., | - | - | - | - | - | - | - | - | - | - | 5.6 | - | 4 | 0.93 | 1 |
| *Physarum gyrosum* Rostaf. | 6.2 | - | - | 4.2 | - | - | 17.6 | 3.6 | - | - | - | - | 15 | 3.49 | 4 |
| *Physarum leucophaeum* Fr. | - | - | - | - | - | - | - | - | - | - | 2.8 | - | 2 | 0.47 | 1 |
| *Physarum nutans* Pers., | - | - | - | 2.6 | - | - | - | 3.6 | - | - | - | - | 7 | 1.63 | 2 |
| *Physarum* sp. | 15.6 | - | 8.5 | 4.7 | 6.9 | - | - | 1.8 | - | - | 7.0 | - | 25 | 5.81 | 6 |
| *Stemonitis* sp. | - | - | - | 2.6 | - | - | - | 1.8 | - | - | - | - | 6 | 1.40 | 2 |
| | | | | | | | | | | | | | | | |

**Table (1):** Continuation.

Total = total number of records; FO = frequency of occurrence; FA = frequency of appearance; Ac = *Acacia Arabica*; Az = *Azadirachta indica*; Ca = *Casuarina equisetifolia*; Eu = *Eucalyptus rostrata*; Fi = *Ficus Sycamrous*; Ma = *Malus domestica*; Mn = *Mangifera indica*; Mo = *Morus alba*; Ps = *Psidium guajava*; Ri = *Ricinus communis*; Sa = *Salix safsaf*; Vi = *Vitis vinifera*.

Number of records and diversity indices of the twelve living trees are presented in Table (2). *Azadirachta indica* and *Eucalyptus rostrata* samples had the lowest and highest records number of fungi (13, 335, respectively). A highest records number of ascomycete, anamorphic fungi and myxomycetes were recorded on *Eucalyptus rostrata* bark samples. *Azadirachta indica*, *Psidium guajava* and *Ricinus communis* had the lowest records number of corticolous fungi in Delta region.

Species Shannon-Weiner index ranged from 1.93 to 3.74 in the different studied trees. The highest values were observed in *Eucalyptus rostrata* and *Salix safsaf* trees were 3.74 and 3.29, respectively. *Azadirachta indica* and *Vitis vinifera* had the lowest diversity values (Table 2). Evenness component of diversity varied among the studied trees communities and ranged from 0.6 to 0.94. *Eucalyptus rostrata* had the lowest value of evenness.

| Samples | **Ac** | **Az** | **Ca** | **Eu** | **Fi** | **Ma** | **Mn** | **Mo** | **Ps** | **Ri** | **Sa** | **Vi** | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total No of collected samples | 32 | 14 | 35 | 190 | 29 | 16 | 17 | 56 | 16 | 16 | 72 | 18 | 511 |
| Total No of records | 62 | 13 | 80 | 335 | 55 | 22 | 21 | 58 | 18 | 18 | 114 | 22 | 818 |
| Species richness | 26 | 8 | 33 | 69 | 24 | 14 | 10 | 23 | 12 | 9 | 35 | 10 | 87 |
| No. of records per sample | 1.9 | 0.93 | 2.3 | 1.76 | 1.9 | 1.4 | 1.2 | 1.0 | 1.1 | 1.13 | 1.58 | 1.2 | 1.58 |
| Ascomycetes Individuals | 33 | 8 | 32 | 161 | 22 | 6 | 1 | 15 | 1 | 0 | 45 | 3 | 327 |
| Anamorphic fungi Individuals | 12 | 5 | 44 | 114 | 23 | 16 | 17 | 29 | 13 | 17 | 44 | 17 | 351 |
| Myxomycetes Individuals | 17 | 0 | 4 | 60 | 10 | 0 | 3 | 14 | 4 | 1 | 25 | 2 | 140 |
| Shannon-Weiner index | 3.07 | 1.93 | 3.3 | 3.73 | 3.04 | 2.56 | 2.24 | 2.8 | 2.43 | 2.14 | 3.29 | 2.13 | 3.97 |
| Evenness | 0.83 | 0.86 | 0.83 | 0.6 | 0.87 | 0.93 | 0.94 | 0.75 | 0.94 | 0.94 | 0.77 | 0.85 | 0.61 |

**Table (2):** Distribution of corticolous fungi in the studied dead bark of living trees.

Ac = *Acacia Arabica*; Az = *Azadirachta indica*; Ca = *Casuarina equisetifolia*; Eu = *Eucalyptus rostrata*; Fi = *Ficus Sycamrous*; Ma = *Malus domestica*; Mn = *Mangifera indica*; Mo = *Morus alba*; Ps = *Psidium guajava*; Ri = *Ricinus communis*; Sa = *Salix safsaf*; Vi = *Vitis vinifera*.

**Discussion**

The bark of living trees has been known to be a suitable substratum for many species of fungi. Dead bark samples of twelve living plant trees (*Acacia Arabica*, *Azadirachta indica*, *Casuarina equisetifolia*, *Eucalyptus rostrata*, *Ficus sycomorus*, *Malus domestica*, *Mangifera indica*, *Morus alba*, *Psidium guajava*, *Ricinus communis*, *Salix safsaf* and *Vitis vinifera*) were investigated. A surprising number of species were recorded from the bark in this study. Eighty-seven fungal taxa were identified from dead bark of living trees collected from Nile Delta region. The average number of species identified on each sample was 1.64. A few studies have been carried out on corticolous fungi (Garner 1967; Sivak and Person 1973; Fernandez and Boyer 1989; Baird 1991; Aptroot and Hyde 1999; Baird *et al.,* 2007). (Baird *et al.,* 2007). identified 94 species of fungi from bark of three tree species (*Fagus grandifolia*, *Abies fraseri* and *Tsuga canadensis*) in forests of the Great Smoky Mountains National Park.

The dominant fungal community of dead bark samples in Nile Delta region was anamorphic fungi. The ratio of anamorphic fungi to ascomycete taxa in dead bark samples of living trees was 1.3:1. This pattern of anamorphic fungi dominance in corticolous fungi are consistent with some previous studies in dead bark of living trees (Kliejunas and Kuntz 1974; Baird *et al.,* 2007). and in freshwater habitat (Ho *et al.,* 2001; Kane *et al.,* 2002; Cai *et al.,* 2003). But this was greatly different with results obtained in studying freshwater fungi in Nile delta region where, high number of ascomycetes as compared to anamorphic fungi. The ratio of anamorphic taxa to ascomycete taxa in freshwater habitat in Nile delta region was 0.74: 1.

Most freshwater ascomycete genera reported in this study belonged in the Sordariomycetes. The dominance of Sordariomycetes in freshwater and terrestrial ascomycetes was reported in different regions of the world (Goh and Hyde 1996; Vijaykrishna and Hyde, 2006).

The most common anamorphic species in this study were *Stachybotrys atra*, *Phaeoisaria clematidis*, *Botryodiplodia theobromae* and *Trichothecium roseum. (*Baird *et al.,* 2007). reported that *Trichoderma* was the most common genus in bark samples of three tree species in forests of the Great Smoky Mountains National Park. (Kliejunas and Kuntz, 1974) illustrated that the most common genera from healthy bark being *Alternaria*, *Epicoccum*, *Fusarium*, *Penicillium*, *Phoma* and *Trichoderma*.

Eighteen myxomycetes species were reported from dead bark samples in Nile delta region. More than 100 species of myxomycetes have been reported from bark; many of these taxa are also known to occur in other microhabitats, but some species appear to be specific to bark of living trees (e.g. *Echinostelium*, *Licea*, and *Macbrideola*) (Stephenson and Stempen, 1994; Mitchell, 2004). Physarales dominate the myxomycetes community in this study and in many previous corticolous myxomycetes studies (Snell *et al.,* 2003; Jaaskelaiiinena *et al.,* 2004; Everhart and Keller, 2008).

The highest records number of ascomycete, anamorphic fungi and myxomycetes were reported on *Eucalyptus rostrata* and *Salix safsaf* bark samples while, *Azadirachta indica*, *Psidium guajava* and *Ricinus communis* had the lowest records number of corticolous fungi in Delta region. The genus *Eucalyptus* contains approximately 700 species (Potts and Pederick, 2000), most of which are known to host a range of incredibly diverse and interesting microfungi (Sankaran *et al.,* 1995; Niekerk *et al.,* 2004; Adams *et al.,* 2005; Gryzenhout *et al.,* 2006; Kharwar *et al.,* 2010; Sankarane *et al.,* 1995). illustrated that there are about 20 000 database records were created, dealing with over 2920 different fungal names, representing 630 different

genera associated with *c.* 150 species or subspecific taxa of *Eucalyptus* from *c.* 85 countries. (Kosheleva *et al.,* 2008). reported that bark samples had the highest species richness from substrates collected in Stolby, Russia. (Stephenson, 1989). studied the communities of myxomycetes associated with the bark microhabitats from 13 different species of trees and concluded that different tree species supported quite different communities of myxomycetes.

*Azadirachta indica* had the lowest fungal diversity. Even though, some fungi were reported before from different parts of *Azadirachta indica*. Antimicrobial activities of *Azadirachta indica* have widely been recognized (Okemo *et al.,* 2001; Helmy *et al.,* 2007; Joshi *et al.,* 2011).

The Nile Delta has a Mediterranean climate, characterized by little rainfall and temperatures averaging 30-48 °C and 10-19 °C in summer and winter, respectively. Usually it is rains and humid in winter (Elewa 2010). Temperature, humidity and annual rains consider main controlling factors of corticolous fungi occurrence. Critical microhabitat factors of the bark that have been observed to influence the distribution and abundance of myxomycetes are water-holding capacity, texture, pH, nutrient concentration and amount of epiphyte cover of dead bark samples (Stephenson 1989; Novozhilove *et al.,* 2000; Snell 2002).

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**الملخص العربي**

## فطريات قلف الأشجار في منطقة دلتا النيل

تم تعريف سبع وثمانون نوعاً فطرياً من القلف الميت لاثني عشر نوعا من الأشجار الحية (السنط، النيم، الكازورينا، الكافور، الفيكس، التفاح، المانجو، التوت، الجوافة، الخروع، الصفصاف والعنب) والتي تم تجميعها من منطقة الدلتا شمال مصر. تضمنت الفطريات المعزولة من القلف الميت ٣٠ نوعاً من الفطريات الزقية، ٣٩ نوعا من الفطريات الميتوزيه و ١٨ نوعاً من الفطريات الهلامية.عدد أنواع الفطريات المعرفة من كل نبات تراوحت من ٩ أنواع في نبات النيم إلي ٦٩ نوعاً لنبات الكافور. كانت أجناس كيتوميوم، ذوبيفيللا، بودوسبورا، ساكوبولاس و فيسارم من أكثر الأجناس شيوعاً في عينات القلف الميت للأشجار الحية. وكانت الانواع الفطرية ذوبيفيللا لاتيبس، ذوبيفيللا كاراشينسيس، كيتوميوم جلوبوسم و ساكوبولاس سيتريناس من أكثر الأنواع ظهوراً في منطقة الدلتا. كانت عينات أشجار الكافور، الكازورينا والصفصاف من أكثر العينات ثراءاً بالمعزولات الفطرية وتنوعها.