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Marine fungi from two sandy Mediterranean beaches on the Egyptian north coast

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Abstract

I surveyed marine fungi collected from the Mediterranean coast of Egypt. A total of 31 taxa, including 19 ascomycetes and 12 anamorphic fungi, were identified from 100 submerged driftwood samples collected randomly along two sandy beaches. The most frequent fungus was *Corollospora maritima*. Other common fungi include *C. portsaidica*, *Leptosphaeria oraemaris*, *Cumulospora marina* and *Periconia prolifica*. Among the 31 taxa identified during this study, 21 are new records for the Mediterranean Sea, bringing the total number of Mediterranean marine fungi to 79. Seven new fungi were recorded during the course of this study, of which two new species of *Corollospora* and one anamorph have been described, and work is in progress to describe the remaining four. An unknown species of *Didymosphaeria* is illustrated in this paper, but not formally described because there was insufficient material available for further study of the species.

Keywords: *Corollospora*; *Didymosphaeria*; marine fungi; Mediterranean Sea; subtropical.

Introduction

Our knowledge of marine fungi from the African shore of the Mediterranean Sea is not adequate, and this study was initiated to fill this knowledge gap. Marine fungi play an important role in nutrient regeneration cycles as decomposers of dead and decaying organic matter (Fell and Master 1980). Early researchers collected marine fungi on driftwood, shoreline plants and soil. Since the observations of Barghoorn and Linder (1944) on the occurrence of lignicolous marine fungi, the number of taxa described has increased dramatically. Kohlmeyer and Volkmann-Kohlmeyer (1991) listed 321 species; Hyde et al. (2000) put the figure at 444 species. Currently, 530 species in 321 genera have been described from marine habitats including 424 ascomycetes, 94 anamorphic species and 12 basidiomycetes (Jones et al. 2009).

Data on the geographical distribution of marine fungi are relatively scarce because most collections have been made in rather localized areas, predominantly in Southeast Asia, Europe and North America (Kohlmeyer 1983, Shearer et al. 2007).

A few studies have been carried out to document marine fungi from the Red Sea; Aleem (1978) recorded *Corollospora pulchella* Kohlm., I. Schmidt *et* N.B. Nair and *Periconia prolifica* Anast. from the Red Sea coast of Saudi Arabia; Schatz (1985) described *Adomia avicenniae* S. Schatz on pneumatophores of *Avicennia marina* (Forsk.) Vierh. from the Red Sea; El-Sharouny et al. (1998) recorded 36 marine fungi from Safaga mangrove on the Egyptian Red Sea, including 18 species on decayed attached mangrove wood of *A. marina*; El-Sharouny et al. (1999) recorded 18 fungi on submerged decayed leaves of *A. marina* and algal thalli collected from Safaga mangroves; Abdel-Wahab (2000) recorded 25 fungi on intertidal wood of *A. marina* collected from three mangrove stands, namely, Sharm El-Sheikh, Abu-Mingar and Safaga located on the Red Sea coast of Egypt. Three new species, *Halosarpheia unicellularis* Abdel-Wahab *et* E.B.G. Jones, *Swampomyces aegyptiacus* Abdel-Wahab, El-Sharouny *et* E.B.G. Jones and *S. clavatispora* Abdel-Wahab, El-Sharouny *et* E.B.G. Jones, were published from Red Sea mangroves in Egypt (Abdel-Wahab et al. 2001a,b). Abdel-Wahab (2005) recorded 39 fungal species on decayed wood of *Avicennia marina* collected from six mangrove sites located in the southern part of the Egyptian Red Sea coast. The total number of marine fungi recorded from the Red Sea is 84 (Abdel-Wahab 2005).

It is generally accepted that the Mediterranean Sea has among the world's most oligotrophic waters. Conspicuously, it harbors somewhere between 4% and 18% of the known marine species of fungi, while representing only 0.82% in surface area and 0.32% in volume of the world's oceans (Bianchi and Morri 2000). The European coast of the Mediterranean Sea has been extensively examined for marine fungi (Kohlmeyer 1963, Jones et al. 1972, Montemartini 1979, Furtado and Jones 1980, Genovese et al. 1980, Grasso et al. 1985, 1990, Cuomo et al. 1988). These studies documented 58 species, which were listed by Cuomo et al. (1988).

Materials and methods

A total of 100 submerged decaying drift wood samples were collected randomly from two sandy beaches on the Mediterranean Sea [sand beach 75 km west of Alexandria (31°14′ N, 29°17′ E)] and one at Port Said city (31°30′ N, 32°22′ E) between June 25 and June 28, 2006. The salinity of the two sites was 16. The two collection sites border the Nile delta and are affected by the water draining from the two main branches of the Nile River, the Rosetta branch at the Alexandria site and the Damietta branch at Port Said. Most of the collected wood samples were presumably carried by water

drained from the Nile river branches. The Port Said site is close to Lake Manzala, a brackish lake that is connected with the Mediterranean Sea through three channels. Most of the collected driftwoods from the Port Said site were decayed stems of *Phragmites australis* (Cav.) Trin. *ex* Steud. The low salinity of the two sites could be a result of water draining from the Nile River.

Samples were washed with sea water, incubated at room temperature in plastic boxes lined with filter paper moistened with sterilized seawater. Samples were examined after 2 weeks for the presence of fungi, and then periodically over 3 months. Methods used for the preparation of materials for light microscopy have been reported by Jones and Hyde (1988). Permanent slides and herbarium material of the fungi recorded were deposited in the author's herbarium and can be examined on request. The following data were calculated for each of the study sites:

$$\text{Percentage occurrence of each fungus} = \frac{\text{Number of collections of the fungus}}{\text{Number of samples collected}} \times 100$$

$$\text{Number of fungi per sample} = \frac{\text{Total number of fungal collections}}{\text{Number of samples collected}}$$

Jaccard and Sorenson similarity indices for the mycota of the two sites were calculated according to the formulae:

Jaccard similarity index (Cj)=j/(a+b-j)

Sorenson similarity index (Cs)=2j/(a+b)

where j=is the number of species common to both sites, and a=the number of species in site A, with b=the number of species in site B. For both indices, values of unity indicate cases of complete similarity, and a value of zero indicates 100% dissimilarity. Photographs were taken using an Olympus BX51 differential interference contrast light microscope and Olympus DP12 (Olympus, Tokyo, Japan) digital imaging system. Samples with the fungi were dried at 60°C for 24 h and deposited along with the isolated fungal cultures in the author's culture collection.

Results

In total, 31 species (19 ascomycetes and 12 anamorphic fungi) were identified from 194 fungal collections taken from 100 driftwood samples collected from the two sites. Fungi recorded were classified as very frequent among samples (above 20%), frequent (10–20%), common (5–10%) and infrequent (below 5%). The most common fungus was *Corollospora maritima* Werderm., with 34% overall frequency of occurrence; there were four frequent species, seven common and 19 infrequent (Table 1).

Fungal communities in the two sites were markedly different. Jaccard and Sorenson similarity indices were 0.13 and 0.22, respectively, which means that the similarity between the mycota at the two sites was very low. The highest fungal diversity (25 species) was recorded from the sandy beach at Port Said, whereas only 10 species were recorded from the sandy beach at Alexandria. Genera with the most species were *Corollospora* (five species), *Leptosphaeria* (three species) and two species belonged to each of the genera *Cirrenalia*, *Cumulospora*, *Phoma*, *Thielavia* and *Zalerion*.

Sand beach at Port Said

In total, 25 fungi (15 ascomycetes and 10 anamorphic fungi) were identified from 141 fungal collections, with an average of 2.8 species identified from each sample. Very frequent species included *Corollospora maritima* (44%), *Corollospora portsaidica* (22%), *Leptosphaeria oraemaris* (26%) and *Cumulospora marina* (36%). Four species were frequent, namely, *Periconia prolifica* (20%), *Cirrenalia* sp. (10%), *Thielavia* sp. 2 (12%) and *Leptosphaeria peruviana* (12%). A total of 14 fungi were common and only three fungi were infrequent (Table 1).

Sand beach 75 km west of Alexandria

In total, 10 fungi (six ascomycetes and four anamorphic fungi) were identified from 50 driftwood fungal collections, with an average of one species identified on each sample. *Corollospora maritima* was the only very frequent species (24%), three fungi were frequent, namely, *Corollospora gracilis* (16%), *Corollospora anglusa* (10%) and *Lulworthia* sp. (10%), and six fungi were common.

Discussion

Corollospora maritima was the most common fungus found during this study. The fungus is widely distributed in Mediterranean coastal waters (Grasso et al. 1985, 1990, Cuomo et al. 1988) and is a very common cosmopolitan species (e.g., Indian Ocean, Hyde and Jones 1989; New Zealand, Lintott and Lintott 1982; Chile, Shearer and Burgos 1987; Denmark, Rees et al. 1979; Canada, Miller and Whitney 1981).

Of the 31 fungi recorded during this study, 21 are new records for the Mediterranean (Table 1), bringing the total number of marine fungi recorded from the Mediterranean to 79. Two new *Corollospora* species and one anamorph were recorded during the course of this study and were recently described (Abdel-Wahab et al. 2009). In addition, work is in progress to describe two new *Cirrenalia* spp., a new species of *Zalerion* and an unknown species of *Didymosphaeria* (Table 1).

Seven fungi, namely, *Corollospora maritima*, *Lignincola laevis*, *Lulworthia* sp., *Torpedospora radiata*, *Periconia prolifica*, *Trichocladium achrasporium* and *Zalerion maritimum* were recorded consistently from the European coast of the Mediterranean Sea and this study. All these species are cosmopolitan in their distribution. *Torpedospora radiata*

Table 1 Frequency of fungi recorded from two beaches on the Egyptian Mediterranean coast.

	Alexandria	Port Said	Total
Ascomycetes			
Antennospora quadricornuata (Cribb *et* J.W. Cribb) T.W. Johnson	–	6	3
Bathyascus sp.	–	4	2
Corollospora anglusa Abdel-Wahab *et* Nagahama	10	–	5
Corollospora sp.	–	6	3
Corollospora gracilis Nakagiri *et* Tokura	16	–	8
Corollospora maritima Werderm.	24	44	34
Corollospora portsaidica Abdel-Wahab *et* Nagahama	–	22	11
Didymosphaeria sp. (MF 823)	–	6	3
Leptosphaeria oraemaris Linder	6	26	16
Leptosphaeria peruviana Spegazzini	–	12	6
Leptosphaeria sp.	–	6	3
Lignincola laevis Höhnk	–	6	3
Lulworthia sp.	10	–	5
Nais aquatica K.D. Hyde	8	–	4
Savoryella lignicola Jones *et* Eaton	–	6	3
Swampomyces clavatispora Abdel-Wahab, EI-Sharouny *et* E.B.G. Jones	–	4	2
Thielavia sp.1	–	4	2
Thielavia sp.2	–	12	6
Torpedospora radiata Meyers	–	6	3
Mitosporic fungi			
Cirrenalia sp.1	–	6	3
Cirrenalia sp.2	6	10	8
Cumulospora marina I. Schmidt	–	36	18
Cumulospora varia Chatmala *et* Somrith.	–	4	2
Dialaceniopsis landolphiae Bat.	6	–	3
Halenospora varia (Anastasiou) E.B.G. Jones	6	–	3
Periconia prolifica Anastasiou	–	22	11
Phoma epicoccina Punith., M.C. Tulloch *et* C.M. Leach	8	6	7
Phoma hedericola (Durieu *et* Mont.) Boerema	–	6	3
Trichocladium achrasporium (Meyers *et* R.T. Moore) M. Dixon in Shearer *et* J.L. Crane	–	8	4
Zalerion maritimum (Linder) Anastasiou	–	6	3
Zalerion sp.	–	8	4
Number of samples collected	50	50	100
Total number of fungal taxa	10	25	31
Number of ascomycete taxa	6	15	19
Number of mitosporic fungi	4	10	12
Total number of fungal collections	50	141	191
Number of fungal taxa per driftwood sample	1	2.82	1.91

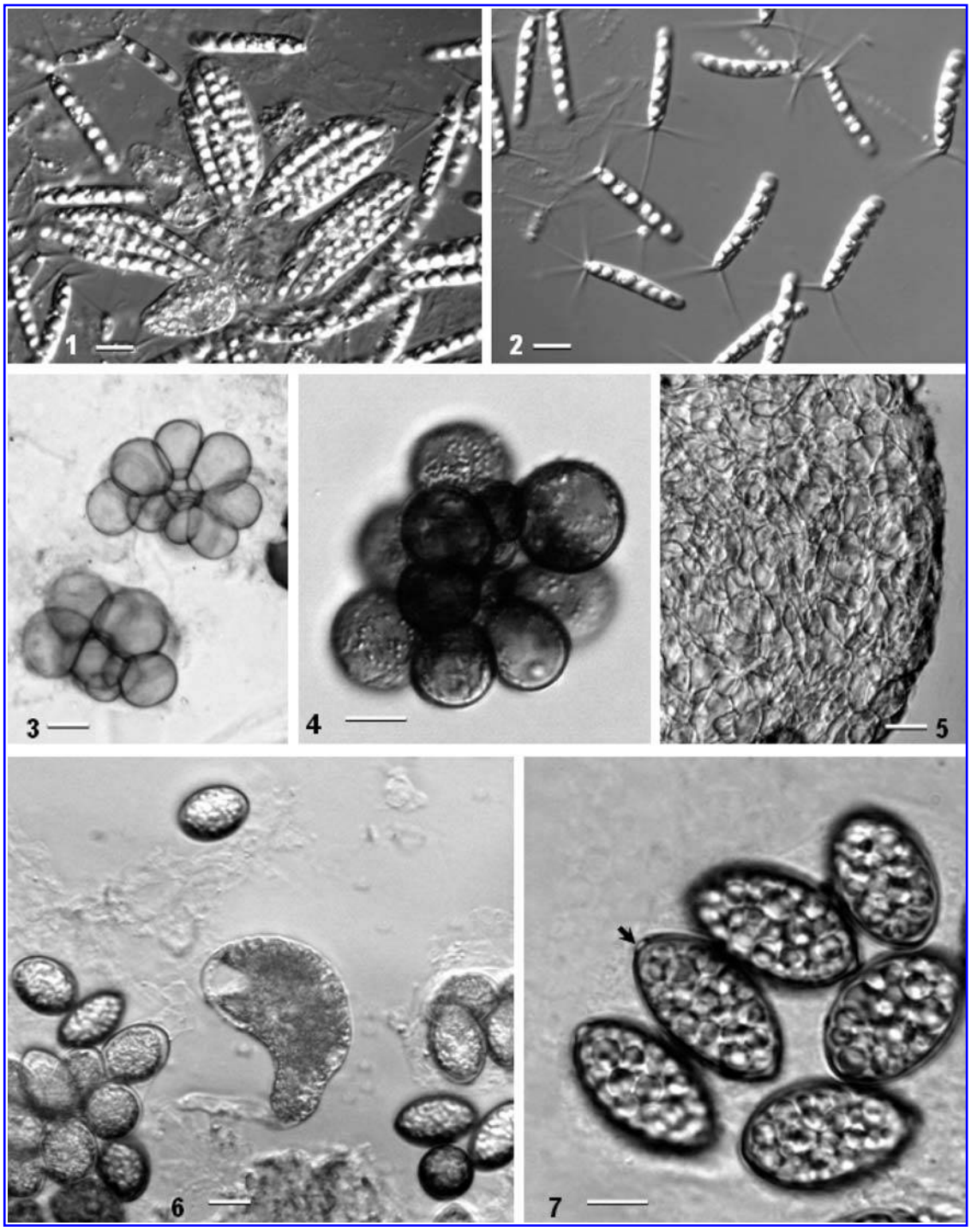
(Figures 1 and 2) was previously recorded from Lake Burullus in the northern part of Egypt (El-Sharouny et al. 2009).

Two freshwater fungi were recorded during this study, namely, *Cirrenalia* sp. and *Nais aquatica*. The salinity of the water from the two sites was 16. It seems that these two species tolerate this level of salinity or they have recently arrived on the driftwood from lower salinity sites.

Marine fungal diversity in the Red Sea (Abdel-Wahab 2005) is higher than in the Mediterranean Sea, and this could be, in part, a result of the paucity of organic substrates available for fungal colonization in the Mediterranean Sea. Most of the recorded marine fungi from the Red Sea are from mangroves (Abdel-Wahab 2005).

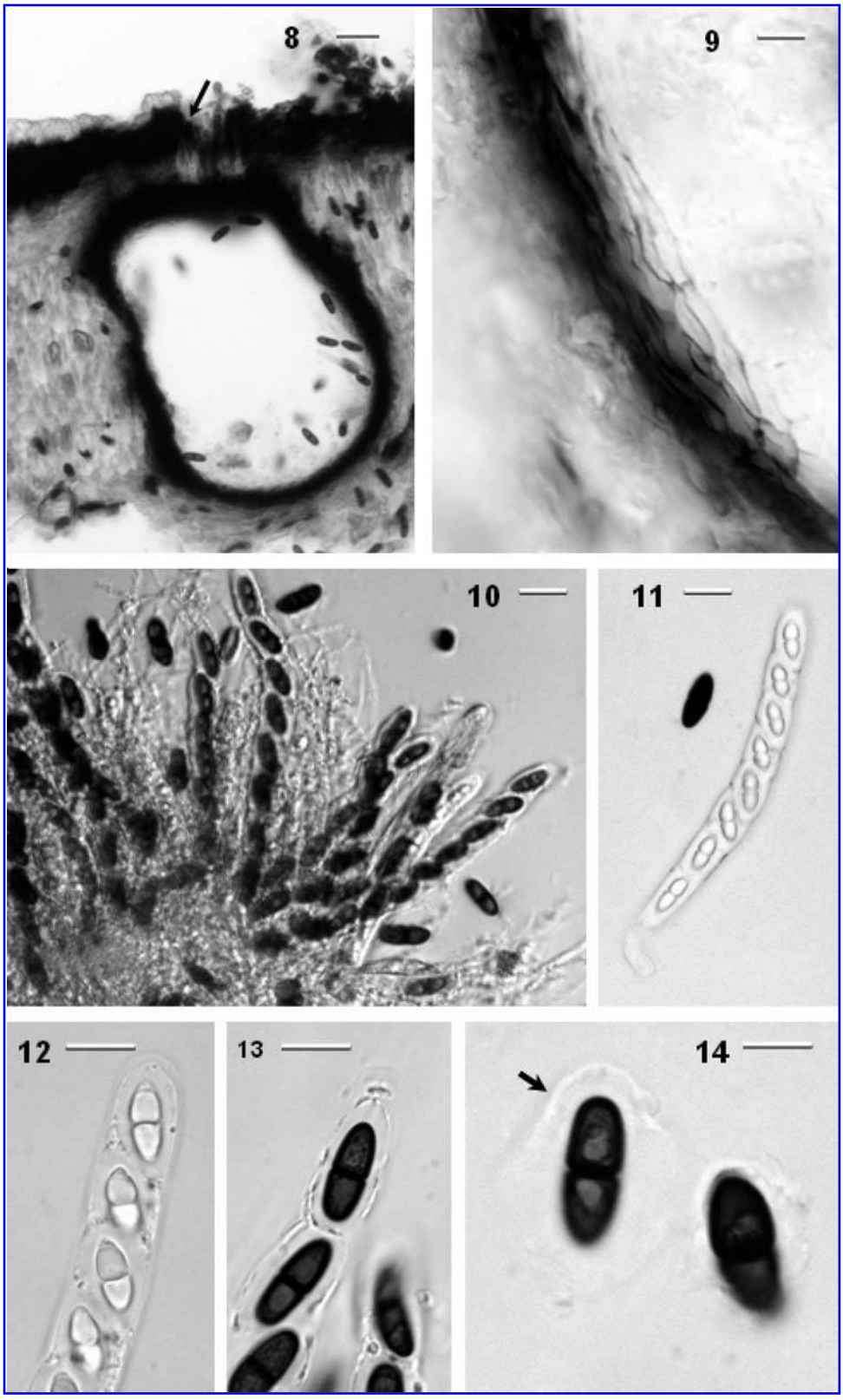
Of the 31 species recorded in this study, five species, namely, *Antennospora quadricornuata*, *Corollospora maritima*, *Halenospora varia*, *Periconia prolifica* and *Swampomyces clavatispora* were common to both the Mediterranean Sea and Red Sea. The first four species are cosmopolitan in their distribution, whereas *S. clavatispora* was originally described from mangroves in the Egyptian Red Sea (Abdel-Wahab et al. 2001a) and was recently recorded from Lake Manzala (Abdel-Aziz 2008).

Eight species, namely, *Bathyascus* sp., *Nais aquatica*, *Torpedospora radiata*, *Cumulospora marina* (Figures 3 and 4), *Halenospora varia*, *Periconia prolifica*, *Trichocladium achrasporium* and *Zalerion maritimum* were consistently recorded from brackish and saline lakes in the northern part of Egypt and this study (El-Sharouny et al. 2009). This similarity could be a result of the similar range of water salinities in the two studies.



Figures 1–7 Interference light micrographs of representatives of fungi recorded during this study.
(1–2) *Torpedospora radiata*: (1) Asci at different stages of development. (2) Three-septate ascospores with polar appendage at one end. (3–4) *Cumulospora marina*, conidia at different stages of development. (5–7) *Thielavia* sp.: (5) Surface view of the membranous peridial wall that forms textura angularis. (6) Immature clavate ascus surrounded by mature ascospores. (7) Ascospores at higher magnification, note the polar germ pores (arrowed). Scale bars: Figures 1–7=10 μm.

Five fungi were recorded for the first time in marine habitats, namely, two species of *Thielavia* (Figures 5–7) and the anamorphic fungi *Dialaceniopsis landolphiae* Bat., *Phoma epicoccina* Punith., M.C. Tulloch *et* C.M. Leach and *Phoma hedericola* (Durieu *et* Mont.) Boerema. The latter three fungi were recorded previously from the brackish Lake Manzala



Figures 8–14 *Didymosphaeria* sp.
(8) Longitudinal section through ascomata (note the black thin stroma at the surface of the wood, arrowed). (9) Peridial wall. (10) Asci and pseudoparaphyses. (11) Immature ascus. (12) Magnified portion of the apical part of immature ascus. (13) Mature ascus. (14) Ascospores surrounded by gelatinous sheath (arrowed). Scale bars: Figure 8=40 μm, Figures 9–14=10 μm.

in Egypt (Abdel-Aziz 2008). *Thielavia* species were previously recorded from soil samples collected from the shore of the Dead Sea (Grishkan et al. 2003).

Taxonomy

Didymosphaeria sp. (MF 823) (Figures 8–14)

Stroma forms a black layer of fungal tissues mixed with host cells that are 20–45 μm thick (Figure 8). Ascomata 180–225 μm high, 150–165 μm wide, immersed under black stroma, ostiolate, coriaceous, solitary or gregarious (Figure 8). Peridium 10–22 μm thick, forming textura angularis of thin-walled cells with large lumina, yellow brown to brown in color (Figure 9). Pseudoparaphyses 2–3 μm thick, hyaline, branched, septate, in gel matrix. Asci 85–112× 9–12 μm cylindrical to clavate, overlapping uniseriate, with ocular chamber, 8-spored. Ascospores 13–16×4.5–6.5 μm, one-septate, brown to dark brown, slightly to deeply constricted at the septa, straight to slightly curved, the two cells of the ascospores are similar in size and shape or slightly different, smooth, surrounded by a hyaline gelatinous sheath.

Note

This *Didymosphaeria*-like fungus might be an undescribed species but there was insufficient material to isolate and further characterize it.

Conclusion

Of the 31 marine fungi recorded during this study, 21 are new records for the Mediterranean Sea. Seven fungi are new to science, of which three were described (Abdel-Wahab et al. 2009) and work is in progress to describe the remaining four fungi. These new records and new species indicate that the African coast of the Mediterranean Sea is understudied and needs more extensive surveys of marine fungi. The present study showed latitudinal distribution of marine fungi across the Mediterranean Sea, with only seven cosmopolitan marine species recorded consistently from the European and African coasts of the Sea. Tropical species were recorded from the African coast, whereas temperate species were recorded from the European coast of the Mediterranean Sea.

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