Classification of marine Ascomycota, anamorphic taxa and Basidiomycota

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A comprehensive classification of the filamentous marine fungi is outlined, with reference to recent molecular phylogenetic analyses. The classification includes 530 species (in 321 genera) to order level: Ascomycota 424 species (in 251 genera), anamorphic fungi 94 species (in 61 genera) and Basidiomycota 12 species (in 9 genera). The Halosphaeriales is the largest order of marine fungi with 126 species in 53 genera, of which 35 are monotypic. Several taxa are of uncertain position and cannot be assigned to any higher taxonomic ranks. The decadel index shows that most marine fungi were described in the period 1980-1989 (135) and 1990-1999 (156), with 43 new species and 25 new genera from the past eight years. Keys are provided to the major taxa, genera and species. One new species is described in this paper.

Key words: fungal classification, marine fungi, molecular phylogeny, rDNA, new taxa

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Introduction

Although a few synoptic keys are available for the identification of obligate marine fungi (Kohlmeyer and Volkmann-Kohlmeyer, 1991a; Hyde *et al.*, 2000), there has been no attempt to present a classification for them since the book of Kohlmeyer and Kohlmeyer (1979). This monograph addresses this issue.

The number of marine fungi described has increased dramatically since the pioneer study of Barghoorn and Linder (1944) on lignicolous species. Currently some 1,500 names can be found in the literature, but many of these are inadequately described, or may be facultative terrestrial species or synonyms of existing taxa (Jones and Mitchell, 1996). However, Schaumann (pers. comm.) estimates there are some 6,000 marine species, but this figure is not supported by data. The most reliable recent figure is that of Hyde *et al.* (2000) who listed 444 “higher” obligate marine fungi. However, a number of taxa were not listed, while a further 43 new species in ten new genera have been described over the past eight years. A further 15 new genera have been introduced to accommodate species rejected from existing genera. Other species not previously regarded as marine are included in this monograph. The total now stands at **530** and new taxa continue to be described from this habitat.

Kohlmeyer and Kohlmeyer (1979) stated that: “the decrease of new descriptions of marine fungi during the period 1970-1977 indicates that the most common species have been named and that considerable additions of new taxa in the future are unlikely.” However, as new substrata and geographical locations are being examined for fungi, the number of new species continues to rise (Fig. 1): 135 in 1980-

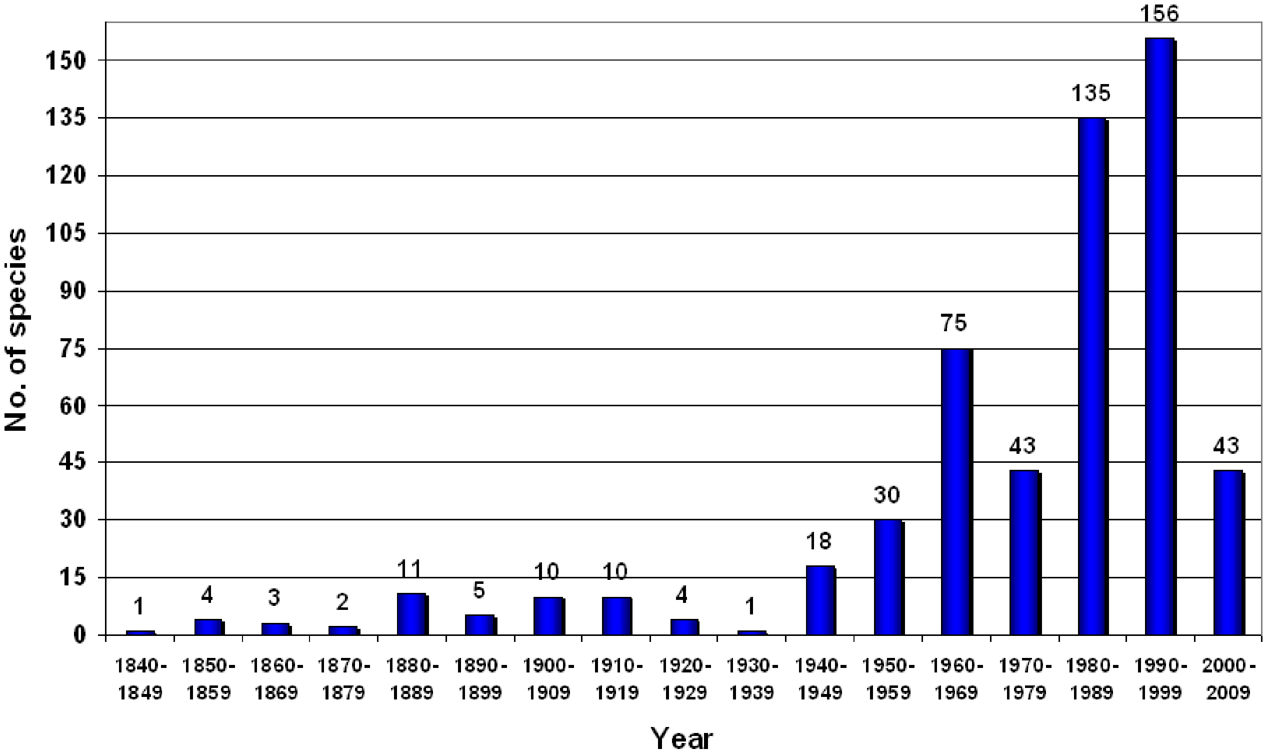


Fig. 1. Decadel increase in the number of marine fungi.

1989; 156 in 1990-1999 and 43 already recorded for the period 2000-2008. This is certainly noticeable for mangrove species (42 species in Kohlmeyer and Kohlmeyer, 1979; over 170 in Hyde *et al*., 2000), and tropical locations continue to yield a wide range of new taxa (Jones *et al*., 2006; Koch *et al*., 2007). Kis-Papo (2005) has reviewed data on the number of marine fungi and settles on 467 species.

Identification and classification of the marine higher fungi have followed traditional avenues of the evaluation and significance of morphological characters at the light microscope level. For the Ascomycota, ultrastructural characters at the transmission and scanning electron microscope levels have also been used (Jones, 1995). These were specifically applied to ascospore appendage ontogeny of the Halosphaeriales, where delineation of genera was questioned, e.g. *Corollospora* (Kohlmeyer, 1972a; Jones *et al*., 1983a), and *Ceriosporopsis* (Johnson *et al*., 1987).

Exploratory studies using TEM and SEM were also used for selected bitunicate marine Ascomycota: *Decorospora gaudefroyi* (as *Pleospora gaudefroyi*) (Yusoff *et al*., 1994b), *Julella avicenniae* (Au *et al*., 1999a) and the genus *Massarina* (Au *et al*., 2001; Read *et al*., 1994, 1997a, b). Although ultrastructural characters helped in the delineation of a number of genera (e.g. *Corollospora*) others were found to be more difficult to resolve (e.g. *Halosarpheia*).

Over the last decade, the use of molecular techniques to examine the phylogeny of organisms has advanced considerably (Spatafora and Blackwell, 1994). Molecular techniques have also been applied to examine the relationships of a number of marine taxa at the ordinal level and at the genus/species level. The earliest study was on the phylogeny of *Halosphaeriopsis mediosetigera* (as a representative of the Halosphaeriales), and the Microascales, with both orders sharing a common ancestor (Spatafora and Blackwell, 1994). This relationship has also been supported by other studies (Chen *et al*., 1999; Kong *et al*., 2000).

Spatafora *et al*. (1998) showed that the genus *Lulworthia* did not group within the

Halosphaeriales clade, also noted by Campbell (1999) and Chen *et al*. (1999). Subsequently, Kohlmeyer *et al*. (2000) erected the new order Lulworthiales to accommodate the genera *Lindra* and *Lulworthia*, while Inderbitzin *et al*. (2004) showed that the genera *Spathulospora* and *Haloguignardia* had affinities with the Lulworthiales. Campbell *et al*. (2005) erected two monotypic genera within the order to accommodate *Lulworthia*-like species that did not form a monophyletic group with *Lulworthia fucicola*, the type species (neotypified by Campbell, 2005). Many taxa in the Halosphaeriales have also been sequenced to infer phylogenetic relationships between morphologically similar taxa. Studies by Kong *et al*. (2000) and Abdel-Wahab *et al*. (2001b) confirmed the polyphyly of the genus *Halosarpheia* and this led to the erection of a number of new genera (Campbell *et al*., 2003; Pang *et al*., 2003a, b).

Many genera in the Ascomycota have not been referred to a family or even an order (Hawksworth *et al*., 1995; Kirk *et al*., 2001). However, the use of molecular techniques has enabled the resolution of a number of genera. Tam *et al*. (2003) have shown that the solely known marine bitunicate genera, *Aigialus*, *Helicascus*, *Julella* and *Paraliomyces*, with unknown ordinal affinity, can now be classified in the Pleosporales. Similar resolution is possible for the basidiomycetes *Calathella*, *Digitatispora*, *Halocyphina*, *Mycaureola* and *Nia* (Binder *et al*., 2001; Hibbett and Binder, 2001, 2002; Binder *et al*., 2006). However, many taxa remain to be examined before their assignment to an order can be made. In this monograph we have reviewed the published literature so as to propose the best taxonomic assignment for "obligate" marine fungi. However, conflict may arise between traditional classifications and the need to incorporate phylogenetic analysis, as in the case of the marine Basidiomycota.

We have supplied a key within each genus with more than one species, and added notes on others that may be useful for further research and understanding of their ecology.

Origin of marine fungi

Many theories have been advanced to account for the origin of marine fungi, and in particular the ascomycetes, the Floridean hypothesis being the favoured one (Denison and Carroll, 1966; Kohlmeyer, 1975a; Demoulin, 1985). *Spathulospora* was considered to be closely related to the Laboulbeniales, a group in turn thought to be related to the Rhodophyta (Kohlmeyer, 1973b). Furthermore, Kohlmeyer (1975a) suggested that *Spathulospora*, with its marine occurrence and as a parasite of the red alga *Ballia*, "was close to the hypothetical ancestor of Ascomycetes". However, in a little cited paper, Walker *et al*. (1979) questioned the view that *Spathulospora* belonged to an ancestral group, or along with the Laboul-beniales and Uredinales, could be considered "living fossils".

That marine fungi are an ecological group has never been in dispute, but did they evolve in the sea or were they secondly adapted to life in the marine milieu? While the latter view has gained in acceptance, there has been little evidence to support it. Spatafora *et al*. (1998) however have advanced the discussion by demonstrating that the Halosphaeriales at least has made the transition from terrestrial to marine habitats with the consequent loss of dehiscing asci. They also concluded that this was not a solitary episode, as the Lulworthiales was also a transitional group, arising independently of the Halosphaeriales (Kohlmeyer *et al*., 2000).

Sakayaroj (2005) and Schoch *et al*. (2006) indicated that within the unitunicate ascomycetes seven and three lineages, respectively, have migrated into the sea. Furthermore five lineages of marine bitunicate ascomycetes are also indicated from analyses of molecular data (Suetrong *et al*., unpublished data) and may be intermediate forms with many retaining active ascospore discharge. The latter group is particularly prevalent in mangrove habitats where ascus discharge can take place during the intertidal period. Likewise, other groups can be shown to have evolved from terrestrial to marine habitats: at least three lineages of the Basidiomycota (Binder *et al*., 2006), as well as ascomycetes with cleistothecial ascomata, but for which no phylogenetic data is available: e.g. *Biflua* and *Marisolaris* (Koch and Jones, 1989).

The most primitive true marine fungi are the Chytridiomycota, or as their sometimes referred "the lower fungi". They are characterized by uniflagellate zoospores that require water for dispersal. They occur in aquatic habitats, both marine and freshwater, and also in terrestrial habitats such as forests, agriculture, desert soils, and acidic bogs (James *et al*., 2006a, b) and highly adapted multiflagellate anaerobic rumen chytrids (Ho and Barr, 1995; Ho, 2007). The Chytridiomycota have long been regarded as the ancestral group of other fungi (Barr, 1992; Margulis and Schwartz, 1998; Slack *et al*., 1999). Molecular studies confirm the early evolution of the fungi with the chytrids as the ancestral group (James *et al*., 2000). As most molecular studies of chytrids have been of taxa from freshwater or terrestrial origin, it is unclear whether ancestral forms were marine (James *et al*., 2006b). However, it seems likely that they evolved in freshwater habitats. Most marine chytrids are parasitic on algae, are few in number and diversity and may well be secondary invaders of marine habitats. Some of these are clearly derived from terrestrial groups, e.g., *Rhizophydium littoreum* (James, pers. comm.). Undoubtedly marine chytrids warrant further study to determine their ancestral phylogeny, as little is known about their phylogenetic position.

Recently, Bass *et al*. (2007) have recovered novel lineages of chytrids from environmental DNA from marine ecosystems. The origin of *Rozella* and the related group microsporidia, and *Thalassochytrium gracilariopsidis*, parasitic on the alga *Gracilariopsis* sp. (Nyvall *et al*., 1999) raises interesting questions as to the origin of marine chytrids.

James *et al*. (2006b) state that the earliest fungi were primarily aquatic and lacked aerial spore dispersal, with at least four independent losses of the flagellum, and giving rise to fungi with aerial dispersal of their spores.

There is no data to indicate when marine fungi evolved from terrestrial species, although Vijaykrishna *et al*. (2006) predicted that fungi became adapted to freshwater some 390 million years ago. Many lineages of marine fungi have been noted, while freshwater fungi occur in only three classes (Vijaykrishna *et al*., 2006).

Substrata supporting marine fungi

Early records of marine fungi were on drift and decaying algae (Cotton, 1909; Sutherland, 1915, 1916a, b), but the study of Barghoorn and Linder (1944) highlighted the existence of a diverse fungal communities occurring on driftwood. Subsequently dead attached or drift mangrove wood was shown to support a wide range of taxa, that differed appreciably from wood in coastal and oceanic waters (Kohlmeyer, 1984; Hyde and Jones, 1989a, b, 1992a; Jones, 2000). Other marine substrata have also been investigated for the occurrence of marine fungi: coral rocks (Kohlmeyer and Volkmann-Kohlmeyer, 1987b), mangrove leaves, hydrozoan tubes, intertidal marsh grasses (Kohlmeyer, 1972b; Gessner and Kohlmeyer, 1976; Cuomo *et al*., 1982, 1985), man-made materials (Jones and Le Campion-Alsumard, 1970) and further observations on algicolous marine fungi (Kohlmeyer and Volkmann-Kohlmeyer, 2003b; Zuccaro and Mitchell, 2006). Morrison-Gardiner (2002) isolated a wide range of fungi from Australian coral reefs, many were typical terrestrial genera but these could not be identified using the available taxonomic keys, and might well represent new taxa. Many other substrata await investigation: tropical marine grasses, mollusk shells and soft rocks (Golubic *et al*., 2005; Raghukumar, 2008).

Materials and Methods

Specimen collection and incubation

Various substrata supporting marine fungi, as mentioned earlier in "*Substrata supporting marine fungi*", were collected randomly at different coastal areas in Thailand and other countries e.g. Bahamas, China, Denmark, Guam (Micronesia, USA), England and Wales (UK). Samples were placed in plastic bags in order to avoid moisture loss. Samples with a thick sediment layer or other debris were washed thoroughly with running tap water. Surface fouling organisms were scrapped off, followed by rinsing with tap water. Samples were then incubated in a plastic box and kept moist by spraying with sterile seawater.

Microscopic examination

Initial examination was carried out using a stereomicroscope with magnifications between 10-40×. The surface of the wood was sliced away in order to locate the buried ascomata or pycnidia. Spore mass contents were scooped out on a slide for examination. The observation of sporulating structures was examined in sterile seawater under a compound microscope. The ascoma structure, ascomal wall, the presence or absence of catenophyses, paraphyses, pseudoparaphyses and periphyses, ascus structure and morphology of ascospores are the most important clues for the identification of ascomycetes (Vrijmoed, 2000). For anamorphic fungi, the morphology of conidiomata and the mode of conidiation are vital for identification, in addition to the conidial characteristics. For basidiomycetes, the morphology of the basidiomata serves as an essential feature for identification. Therefore, keys are provided to the major phyla in this monograph.

Isolation of fungi

The routine isolation procedure was obtained by single spore isolation (Jones and Hyde, 1988; Choi *et al.*, 1999; Vrijmoed, 2000). Fruiting bodies were picked up with fine forceps or needles and transferred to a small volume of sterile seawater on a glass slide. The fruiting bodies were then crushed to release the spores. The spore suspension was then agitated to ensure a homogenous spore distribution and checked under a compound microscope at low magnification for appropriate density and identity. The suspension was then transferred with a Pasteur pipette onto the isolation agar medium. The spores on the agar were left to dry in a closed plate at room temperature and incubated overnight. A low nutrient medium (e.g. corn meal agar) with antibiotics added (a mixture of Penicillin G and Streptomycin in 1g/l) was used in this procedure. Germinating spores were “picked up” and transferred to a fresh agar plate. At least 5-10 isolates of each species were prepared. Their general colony morphology and growth rate were compared to ensure that the isolates obtained were the same species. Axenic cultures were kept at BIOTEC Culture Collection (BCC) (Thailand), City University of Hong Kong (CY) and University of Portsmouth (PP) (UK).

Molecular and phylogenetic analysis

Fungal isolates were obtained from BIOTEC Culture Collection (Thailand), City University of Hong Kong (Hong Kong SAR) and University of Portsmouth (UK) and cultured into GYP sea water broth (4 g/l glucose, 4 g/l yeast extract, 2 g/l peptone). Mycelium (~100 mg) was harvested by filtration, washed twice with sterile distilled water, blotted dry by filter paper and immediately frozen in liquid nitrogen. Mycelial pellets were ground into fine powder using a mortar and pestle, and DNA was extracted using the DNeasy Plant DNA Extraction Kit (QIAGEN) according to the manufacturer’s instructions.

Nuclear ribosomal rRNA genes were amplified using the following primers: small subunit (SSU)- NS1, NS2, NS3, NS5, NS6, NS8 (White *et al.*, 1990) and large subunit (LSU)- JS1, JS5, JS8, LROR, LR7, NL3, NL4, NL4R (Bunyard *et al.*, 1994; Landvik, 1996). PCR reactions were performed in 50 µl using FINNZYMES, DyNAzyme II DNA Polymerase Kit (Macherey-Nagel, Product code F-551S) in a Perkin Elmer thermal cycler. The amplification cycle consisted of an initial denaturation step of 94°C for 2 min followed by 35 cycles of (i) denaturation (94°C for 1 min), (ii) annealing (55°C for 1.5 min) and (iii) elongation (72°C for 2.5 min) and a final 10 min elongation step at 72°C. The PCR products were analyzed by agarose gel electrophoresis and purified using a NucleoSpin Plant DNA Purification Kit (Macherey-Nagel, Catalogue No. 740 570. 50) according to the manufacturer's instructions. PCR products were sent to Macrogen Inc., Korea, for direct sequencing.

Returned sequences were checked for ambiguity and assembled. Sequences were programme-aligned in Clustal W 1.6 (Thompson *et al*., 1994) and manually adjusted in Se-Al v1.0a1 (Rambaut, 1999) and BioEdit version 5.0.6. and 6.0.7 (Hall, 2001, 2004). The tree construction procedure was performed in PAUP* 4.0b10 in Macintosh and Window versions (Swofford, 2002).

SSU and LSU rRNA gene sequences were analyzed individually using equally weighted maximum parsimony method (heuristic searches with a stepwise starting tree, a random stepwise addition of 10 replicates and TBR branch-swapping algorithm). Gaps were treated as missing data. Combined SSU and LSU dataset was analyzed using equally weighted parsimony and weighted parsimony approaches. Weighted parsimony analysis was performed using a step matrix to weight nucleotide transformations based on the transition : transversion (ti:tv) ratio estimated from the dataset using maximum likelihood score in PAUP* (Swofford, 2002). Finally, 1,000 replicates of bootstrapping analysis (Felsenstein, 1985) were performed on each dataset (full heuristic searches, stepwise addition of sequence, 100 replicates of random addition of sequence and TBR branch-swapping algorithm).

Layout of the classification of the marine Ascomycota and Basidiomycota

Three fungal groups are treated: Section A: Basidiomycota, Section B: Ascomycota and Section C: anamorphic species (hyphomycetes and coelomycetes). Most of the latter have no known teleomorphs, but this aspect is advancing with the aid of molecular techniques (Chatmala *et al*., 2002; Shenoy *et al*., 2007). Where anamorph/teleomorph connections have been established, we have included the anamorphic name under its teleomorph name. The anamorphic name is also included in Section C, with the teleomorph in a lower font, thus enabling the reader to cross-reference the taxonomic names in current use. Molecular sequences where available in the GenBank, are denoted by the prefix ◙ to each species.

Each section is divided into higher-level classification and orders according to that outlined by Hibbett *et al*. (2007) and where known, the families (Hibbett, 2006; Spatafora *et al*., 2006; Zhang *et al*., 2006; Cannon and Kirk, 2007). Genera and species of unknown affinities are referred to *incertae sedis*. Anamorphic fungi are listed alphabetically under hyphomycetes and coelomycetes, but as in common practice, no lower taxonomic rank is given. However, teleomorphs are listed under species where they are known.

We appreciate that the rapid progress in molecular phylogeny may change the placement of some of the taxa listed here, but hope it will help researchers focus on taxa needing further evaluation and resolution. Many of the taxa listed are known only from their original description, and attention is drawn to these in the hope that further efforts can be made to collect them. Many may occur in specific niches that would require further exploration.

Classification of many marine fungi remains a confused and an unresolved issue, and is particularly acute for the Ascomycota, the largest group. This is well demonstrated by the fact that some 70 genera are referred to as taxa *incertae sedis* in this monograph. Clearly much effort is required to improve on this state of affairs.

In this treatise we primarily deal with species that have been labelled as obligate marine fungi and those marine derived taxa isolated from submerged substrata or sediments. The latter is not comprehensive but a start must be made to recognize them as true marine fungi. However, we have not included facultative taxa as they are not found under submerged conditions. As much as we dislike these arbitrary designations, it has been necessary to limit the scope of this work. A clear distinction of what is obligate/facultative depends largely on personal opinion, and this applies very much to species saprophytic on decaying culms of maritime grasses, such as *Spartina* species, *Juncus roemerianus*, *Phragmites communis*, mangrove fungi, especially those on the palm *Nypa fruticans* which can occur in almost freshwater; and taxa isolated from marine sediments (often brackish water habitats) (Udea, 1980, 1995a, b; Udea and Udagawa, 1983). Because the latter group has been isolated onto agar media, they are largely ignored by marine mycologists and simply labelled facultative. The fact that some are repeatedly isolated from such habitats argues for a re-evaluation of their status, but this remains outside the scope of this treatise (Jones, 2000). Kohlmeyer and Volkmann-Kohlmeyer (2003c) are critical of recent studies where fungi have been isolated from coral reefs (Kendrick *et al*., 1982; Höller *et al*., 2000; Verbist *et al*., 2000; Morrison-Gardiner, 2002; Nieves-Rivera, 2002; Raghukumar, 2008) because they were isolated onto media, rather than observed sporulating on the substratum.

Care must be taken as some marine fungi may be present in the substratum and do not sporulate under the conditions under observation (Pang and Mitchell, 2005). It is possible that some of these fungi may exist in a similar way to terrestrial endophytes (Zuccaro *et al*., 2003; Zuccaro and Mitchell, 2005). Also there is evidence emerging that these "so-called" terrestrial species may have evolved into marine forms, and further molecular studies are required to elucidate this (Alker *et al*., 2001; Zuccaro *et al*., 2004).

Kohlmeyer and Volkmann-Kohlmeyer in their papers on fungi growing on *Juncus roemerianus*, have attempted to characterize fungi according to their position on the culms and this reflects their degree of inundation by seawater: **obligate**: 6-52 cm above the rhizome e.g. *Phaeosphaeria roemeriani*; **facultative**: 15-56 cm above the rhizome e.g. *Floricola striata*; and **terrestrial or halotolerant**: 45-120 cm above the rhizome, e.g. *Septoriella unigalerita* (Kohlmeyer *et al*., 1997; Kohlmeyer and Volkmann-Kohlmeyer, 2000). However, as noted, there is a considerable overlap in their position with respect to the rhizome. Although we include fungi from inland lakes, e.g. Salton Sea (Anastasiou, 1963a, b), we have excluded those reported from hypersaline salterns (Gunder-Cimerman *et al*., 2000) and the Dead Sea where some 70 filamentous species have been isolated, none typically marine (Buchalo *et al*., 1998; Nevo *et al*., 2003; Wasser *et al*., 2003; Kis-Papo *et al*., 2003; Kis-Papo, 2005).

Some mangrove fungi are regarded as obligately marine but also occur on parts of the trees not inundated by seawater, e.g. *Julella avicenniae*, reported on drift/submerged mangrove wood (Hyde, 1992c) but frequently collected on damaged twigs of *Avicennia marina* above the high tide water mark (Jones, personal observation). Conversely, *Mauritiana rhizophorae* (Poonyth *et al*., 2000b) was described from terrestrial *Rhizophora mucronata*, but has also been collected on intertidal mangrove wood (Alias, pers. comm.). We have therefore adopted a broad interpretation of what we consider to be obligately marine and this may differ significantly from those of others. We have listed a few species that we consider to be borderline species that may also be able to survive exposure to seawater. This has been extended to include taxa isolated from sediments, but cannot be consistently rejected because of their mode of isolation. However, we excluded those considered as halotolerant (Fletcher, 1975; Kohlmeyer *et al*., 2005). Kohlmeyer and Kohlmeyer (1979), Kohlmeyer and Volkmann-Kohlmeyer (1991a), and Hyde and Sarma (2000) have provide synoptic keys for the identification of marine fungi. All new taxa published since these publications (some 43 species) are illustrated by line drawings and photographs.

Marine lichens

Lichens have been largely ignored in the marine mycology literature. Johnson and Sparrow (1961) provide a general account of their occurrence, but without a taxonomic treatment of the taxa. Species included *Arthopyrenia sublitoralis* (on limpet shells), *Lichina pygmaea*, *L. confinis*, *Verrucaria ditmarsica*, *V. maura*, *V. microspora*, and *V. striatula* (all on rock), the discussion focusing on lichen zonation. Kohlmeyer and Kohlmeyer (1979) document submarine lichens and lichen-like associations, listing 18 species in the genera *Arthopyrenia*, *Lichina*, *Stigmidium*, and *Verrucaria*, on *Littorina*, barnacles and algae. *Verrucaria maura* can also be found on marine wood piles and ironwork (Fletcher, pers. comm.). However, there is no taxonomic treatment of these taxa. Jones (1976) did not include marine lichens in his treatise on marine fungi, while Hyde *et al*. (2000) list only two. The best account of marine lichens is that of Fletcher (1973a, b) who details some 80 names of littoral and supralittoral lichens. However, he was unable to examine all of these (Fletcher, pers. comm.). Erichsen (1930) described some twelve marine *Verrucaria* species from the Elbe Estuary in the 1930's, this list is conservative. Therefore the number of lichens listed in this monograph is still conservative.

Nearly all of the species listed here have all been collected in the intertidal zone and thus subject to inundation by seawater. They are cosmopolitan, especially polar to temperate, but rarely recorded from the tropics (Harada, 1995). Hawksworth (2000) com-ments on the marine and freshwater lineages of lichens, in particular the genera *Lichina*, *Pyrenocollema* and *Verrucaria*. This aspect will be considered later in this volume.

Marine yeasts

Marine yeasts also have fared poorly in texts dealing with marine fungi: Johnson and Sparrow (1961) and Kohlmeyer and Kohlmeyer (1979) list eight and twenty three species, respectively of obligate marine yeasts. Kohlmeyer and Kohlmeyer (1979) list a further 140 facultative yeasts. Most of these have been isolated by plating out seawater on to various media or from marine animals and sediments (van Uden and Castello-Branco, 1963; Meyers *et al*., 1967; Fell, 1976). More recent treatment of marine fungi have been confined to filamentous species (Kohlmeyer and Volkmann-Kohlmeyer, 1991a; Hyde *et al*., 2000) and we follow this in this volume.

Techniques for the study of yeasts are polyphasic, phenotypic and molecular, with considerable emphasis on the later, while for filamentous fungi morphology still pays a significant role (Statzell-Tallman *et al*., 2008). Therefore yeasts are best left to specialist's texts, e.g., Kurtzman *et al*., *5th edition of The Yeasts, a Taxonomic Study* (2009). The study of yeasts has also been plagued by the arguments as to whether they are obligate or facultative marine. As for filamentous fungi this is an arbitrary division and emphasis should be placed on habitat and niches within the marine ecosystem. Yeasts isolated from the sea can grow equally well on freshwater media (Fell, pers. comm.).

The number of yeasts documented has steadily increased and with an estimated 1,500 species. Taxa such as *Leucosporidium* spp., *Rhodosporidium* spp., *Candida austromarina*, *C. natalensis*, *Kwoniella mangroviensis* and *Sympodiomyces parvus* are undoubtedly autochonous species as they are recovered in relatively high numbers from ocean samples (Lachance and Starmer, 1998). Their role in nature is to break down a wide range of organic matter, including lignin. Yeast communities in the open ocean are extensive and much greater that filamentous fungi. This may be accounted for by the ratio of surface to volume of the yeasts, enabling greater uptake of nutrients (Fell, pers. comm.). In mangrove swamps there are a large number of yeasts per unit of water, actively involved in recycling mangrove leachates and in turn acting as a food source for filter feeding invertebrates (Statzell-Tallman *et al*., 2008). As with filamentous fungi, many yeasts remain to be described, especially in mangrove swamps (Fell *et al*., 2004). Statzell-Tallman *et al*. (2008) reported 55 species of ascomycetes and 58 species of basidiomycetes yeasts from three mangrove habitats, 50% of which are undescribed.

Many marine yeasts are also secondary invaders of the sea, and a number of phylogenetic lineages have been reported (Jones and Choeyklin, 2008). For example, basidiomycete lineages: **1. Tremellomycetes, Cystofilobasidiales**: *Cystofilobasidium bisporidii*, *C. capitatum* (Fell *et al*., 2001), *Rhodosporidium diobovatum*, *Rh. paludigenum*, and *Rh. sphaerocarpum* (Fell *et al*., 2001); **2. Agaricostilbomycetes**,

Agaricostilbales: *Sterigmatomyces halophilus* (Kurtzman and Fell, 2006); **3. Microbotryomycetes, Sporidiobolales**: *Sakaguchia dacryoidea*, **Leucosporidiales:** *Leucosporidium* spp. (Fell *et al*., 2006; Kurtzman and Fell, 2006) and, ascomycete lineage: **Saccharomycetes, Saccharomycetales**: *Saccharomyces* spp., *Metschnikowia* spp.

Key to the major phyla of marine fungi

1. Meiospores primarily exogenous, born on basidia or similar structures,
Section A: **Basidiomycota** **14**
1. Meiospores produced endogenously, formed in asci,
Section B: **Ascomycota** **21**
1. Mitospores exogenous, or in pycnidia,
Section C: **Anamorphic fungi** (hyphomycetes and coelomycetes) **146**

The following classification is based on the publication “A higher-level phylogenetic classification of the Fungi” by Hibbett *et al*. (2007) for higher order ranks and Cannon and Kirk (2007) for familial placement.

Classification of the marine fungi

Phylum: **BASIDIOMYCOTA**
Subphylum: **Ustilaginomycotina**
Class: **Ustilaginomycetes**
Subclass: **Ustilaginomycetidae**
1.Urocystales 2. Ustilaginales

1. Urocystales

2. Ustilaginales

Subphylum: **Agaricomycotina**
Class: **Agaricomycetes**
Subclass: **Agaricomycetidae**

Agaricales

Agaricomycetes *incertae sedis*
Russulales

Digitatispora clade

Phylum: **ASCOMYCOTA**
Subphylum: **Pezizomycotina**
Class: **Dothideomycetes**
Subclass: **Dothideomycetidae**
Pleosporomycetidae

Subclass: **Dothideomycetidae**
1. Capnodiales 2. Dothideales

1. Capnodiales

2. Dothideales

Dothideales *incertae sedis*

Dothideomycetidae family *incertae sedis*

Subclass: **Pleosporomycetidae**

Pleosporales

Pleosporales *incertae sedis*

Dothideomycetes *incertae sedis*

Hysteriales

Patellariales

Jahnulales

Class: **Eurotiomycetes**
Subclass: **Eurotiomycetidae**
1. Onygeniales 2. Eurotiales

1. Onygeniales

2. Eurotiales

Subclass: **Chaetothyriomycetidae**

1. Chaetothyriales
2. Pyrenulales
3. Verrucariales

1. Chaetothyriales

2. Pyrenulales

3. Verrucariales

Class: **Laboulbeniomycetes**

Laboulbeniales

Class: **Lecanoromycetes**
Subclass: **Lecanoromycetidae**

Lecanorales

Class: **Leotiomycetes**
Subclass: **Lecanoromycetidae**

Helotiales

Class: **Lichinomycetes**

Lichinales

Class: **Arthoniomycetes**

Arthoniales

ARTHONIOMYCETIDAE family *incertae sedis*

Sordariomycetes

Subclass
Xylariomycetidae
Hypocreomycetidae
Sordariomycetidae

Subclass: **Hypocreomycetidae**
1. Hypocreales
2. Coronophorales
3. Halosphaeriales

1. Hypocreales

Hypocreales *incertae sedis*

2. Coronophorales

3. Halosphaeriales

Subclass: **Sordariomycetidae**

1. Diaporthales
2. Chaetosphaeriales
3. Sordariales
4. Ophiostomatales

1. Diaporthales

Diaporthales *incertae sedis*

2. Sordariales

Sordariales *incertae sedis*

3. Chaetosphaeriales

4. Ophiostomatales

Subclass: **Xylariomycetidae**

Xylariales

Xylariales *incertae sedis*

Sordariomycetes *incertae sedis*

1. Lulworthiales
2. Koralionastetales
3. Magnaporthales
4. Phyllachorales

1. Lulworthiales

2. Koralionastetales

3. Magnaporthales

4. Phyllachorales

Phyllachorales *incertae sedis*

Unitunicate Ascomycota family *incertae sedis*

Unitunicate Ascomycota genera *incertae sedis*

Section A:
PHYLUM: BASIDIOMYCOTA

Key to the Basidiomycota

1. Basidiome reduced, parasite, hyphal septum lacking a dolipore and no parthenosomes .... **Ustilaginomycotina**

1. Visible basidiome, saprophytes, symbionts or parasites, basidiospores ballistosporic or statimosporic, clamp-connections present or absent .... **Agaricomycotina**

Subphylum: **USTILAGINOMYCOTINA**

USTILAGINOMYCETES
USTILAGINOMYCETIDAE

Two orders with marine species

1. Parasitic on dicotyledonous hosts .... **Urocystales**
1. Parasitic on members of the Poaceae ... **Ustilaginales**

UROCYSTALES
Urocystaceae

Flamingomyces R. Bauer, M. Lutz., Piatek, Vánky & Oberw., Mycol. Res. **111**: 1202, 2007.. (1)
◙ ***F. ruppiae*** (Feldmann) R. Bauer, M. Lutz., Piatek, Vánky & Oberw., Mycol. Res. **111**: 1203, 2007.

Melanotaenium ruppiae Feldmann, Rev. Gén. Bot. **66**: 36, 1959.

Sori dark on stems and leaves of the host, initially covered by the host epidermis, rupturing at maturity, spores dark, single with no germ pores. Teliospores produced singly, smooth, spore wall comprising and electron-opaque exosporium and an electron-transparent endosporium. Teliospores germinate apically. Initial collection of this species was on *Ruppia maritima* (Ruppiaceae), at the Etang du Canet, Pyrénées Orientales, France (Feldmann, 1959), with a subsequent collection at Bassin d'Arcachon, Gironde, France (Bauer *et al*., 2007). The new genus was placed in the Urocystales (Bauer *et al*., 2007), but earlier placed in the Ustilaginales (Begerow *et al*., 2006; Matheny *et al*., 2006). This was confirmed by the molecular study of Bauer *et al*. (2007). The genus is characterized by the formation of haustoria with an electron-opaque, vesicular matrix coating the fungal cell wall and pigmented teliospores (Bauer *et al*., 2007).

USTILAGINALES
Ustilaginaceae

Parvulago R. Bauer, M. Lutz., Piatek, Vánky & Oberw., Mycol. Res. **111**: 1203, 2007..... (1)
◙ ***P. marina*** (Durieu) R. Bauer, M. Lutz., Piatek, Vánky & Oberw., Mycol. Res. **111**: 1203, 2007.

Ustilago marina Durieu, Annls Sci. Nat. Bot., sér. 5, **5**: 134, 1866.

Sporulation is at the base of the host plant culms, in the intercellular space underneath the 2-layered epidermis, forming bulbous swelling, sori not covered by a presidium (after Bauer *et al*., 2007). This species is known from *Eleocharis parvula* (Cyperaceae) and was recently collected at the Bassin d'Arcachon, Gironde, France (Bauer *et al*., 2007). It is the only member of the Ustilaginaceae occurring on the Cyperaceae and sporulating at the base of the culms of the host plant under the epidermis (Bauer *et al*., 2007).

Subphylum: **AGARICOMYCOTINA**

AGARICOMYCETES
AGARICOMYCETIDAE

Two orders with marine representatives, with reduced basidiomes:

1. A group with large pileate-stipitate basidiomes......... .... **Agaricales**
1. A group of pileate to resupinate basidiomes .... **Russulales** ***incertae sedis***

AGARICALES

After Matheny *et al*. (2006) and equivalent to euagarics clade (Hibbett and Binder, 2001; Binder *et al*., 2006).

1. Basidioma resupinate, basidiospores filiform........... ....***Mycaureola***
1. Basidioma not resupinate, ascospores not filiform 2

2. Basidioma cyphelloid, funnel-shaped...................... 3

2. Basidioma sub-globose, puff ball-like, no stalk, basidiospores with appendages ....***Nia***
2. Basidioma globose on a stalk, basidiospores non-appendaged ....***Physalacria***

3. Basidioma white, surface hairs smooth, basidia 13-22 × 5-9.5 µm.......................................***Halocyphina***
3. Basidioma yellowish to ochre yellow, cup-like, wall with surface hairs, brownish, dextrinoid, minutely encrusted, basidia 60-80 × 5-8.5 µm.........***Calathella***

Lachnellaceae

After Matheny *et al*. (2006) and equivalent to *Nia* clade (Hibbett and Binder, 2001; Binder *et al*., 2006)

Calathella D.A. Reid, Persoonia **3**: 122, 1964. .... (1)

◙ ***C. mangrovei*** E.B.G. Jones & Agerer, Bot. Mar. **35**: 259, 1992.

Basidiomes cyphelloid, pedunculate, superficial on wood, yellowish with a reddish tinge, older specimens ochre-yellow, leathery, tomentose, solitary or gregarious, mycelium with clamp connections, sterile hairs form a ring around the mouth of the basidiocarp that are simple, brownish, non-septate, dextrinoid, round and minutely encrusted, basidia suburniform to cylindrical, hyaline, with 4 sterigmata, basidiospores hyaline, unicellular, smooth-walled, elliptical and accumulate at the tip of the basidiocarps (Figs 3b, c). Initially referred to the Cyphellaceae, but molecular sequences suggest it is better placed in the euagaric clade. A wide spread tropical species, often occurring on freshly cut and exposed branches of the mangrove tree *Bruguiera*.

Halocyphina Kohlm. & E. Kohlm., Nova Hedw. **9**: 100, 1965 .... (1)

◙ ***H. villosa*** Kohlm. & E. Kohlm., Nova Hedw. **9**: 100, 1965 (*Type species*).

Basidiomes cyphelloid, initially turbinate or clavate becoming funnel-shaped, pedunculate, superficial, white or yellowish, soft, thin-walled, tomentose, solitary generally gregarious, basidiome apex covered by sterile hairs, mycelium with clamp-connections, basidia clavate to cylindrical, 4-spored, hyaline, sterigmata present and deliquescing, basidiospores subglobose, unicellular, smooth, hyaline, nonamyloid, accumulating at the tip of the basidiome and washed away by the incoming tide. Detailed account of the basidiome and the release of basidiospores is given by Nakagiri and Ito (1991). Classified in the Polyporales, Cyphellaceae (Kirk *et al*., 2001) while Ginns and Malloch (1977) recorded it as a cyphelloid basidiomycetes. *Calathella mangrovei* shares a common ancestor with *Nia* and *Cyphellopsis* (Hibbett and Binder, 2001). Molecular data confirm its assignment to the euagaric clade and *Nia* clade (Binder *et al*., 2001).

Nia R.T. Moore & Meyers, Mycologia **51**: 874, 1959... (3)

N. epidermoidea M.A. Rosselló & Descals, Mycol. Res. **97**: 68, 1993.

N. globospora Barata & Basilio, Mycol. Res. **101**: 687, 1997.

◙ ***N. vibrissa*** R.T. Moore & Meyers, Mycologia **51**: 874, 1959 (*Type species*).

Basidiomes subglobose, superficial, cylindrical, pedicellate, light coloured becoming yellow, pink or orange, soft tissue, smooth, peridium ruptures at maturity, with clamp connections, basidia subglobose to oval with 4-8 basidiospores, hyaline, lacking sterigmata, basidiospores ovoid to ellipsoidal, unicellular, hyaline, with variable number of appendages, one terminal the others lateral. Initially *N. vibrissa* was classified as a deuteromycete (Moore and Meyers, 1959) but with the demonstration of basidia and clamp connections and a dolipore septum, it clearly belongs in the homobasidiomycetes (Doguet, 1967, 1968; Brooks, 1975). Subsequently it has been referred to the Melanogastrales (Torrendiaceae: Dring, 1973, or Melanogastraceae: Doguet, 1967); Nidulariaceae (Rossello *et al*., 1993) and the Niaceae (Jűlich, 1981). Binder *et al*. (2001) placed *N. vibrissa* in the euagarics clade, forming a sister group with *Henningsomyces candidus*. In a subsequent paper, Hibbett and Binder (2001) confirm the placement of *N. vibrissa* in the euagarics clade, along with two other marine basidio-mycetes: *C. mangrovei* and *H. villosa*. They opined that the shift from a terrestrial to an aquatic habitat can be accounted for by three or four independent transitions, the three shift scenarios giving rise to the terrestrial species *Cyphellopsis anomala* (i.e. derived from a marine ancestor).

Nia and *Halocyphina* are strongly supported in a clade (bootstrap value of 100%) with *C. mangrovei* and two terrestrial species: *Cyphellopsis anomala* and *Favolaschia intermedia*. Hibbett and Binder (2002) speculate that *Physalacria maipoensis* may represent an early stage in the transition from terrestrial to the marine environment for these basidiomycetes. This is based on the terrestrial habitat of most *Physalacria* species, with *Ph. maipoensis* often found in the intertidal zone of tropical mangroves. However, we have collected *Physalacria* species on palm rachis submerged or in amphibious habitats in a peat swamp in Thailand (Pinnoi and Jones, pers. comm.).

There is evidence to suggest that *N. vibrissa* is a species complex and further studies are required to resolve this (Jones and Jones, 1993; Binder and Hibbett, 2001).

Calathella, *Halocyphina* and *Nia* consistently group together and all are adapted for life in aquatic habitats (Hibbett and Binder, 2001). All have reduced basidiomes, possibly as an adaptation to an aquatic environment where large fruit bodies would not survive (Jones, 1988). Hibbett (2007) considers the minute forms of cyphelloid basidiomycetes to be related to selection of spore production from minimal substrates.

1. Basidiomata lack sterile hairs/appendages (4.8-8 μm) .... ***N. globospora***
1. Basidiomata with sterile hairs/appendages 2

2. Basidiospores 11-12 × 7-8 μm, appendages 25-35μm .... ***N. vibrissa***
2. Basidiospores 6-7 × 3-4 μm, appendages 21-28 μm.. .... ***N. epidermoidea***

Physalacriaceae

After Matheny *et al*. (2006) and Binder *et al*. (2006).

Physalacria Peck, Bull. Torrey bot. Club **9**: 2, 1882.. (1)
◙ ***Ph. maipoensis*** Inderb. & Desjardin, Mycologia **91**: 666, 1999.

Basidiomes stipitate-capitate, solitary to gregarious, capitulum globose to subglobose to pyxie-like, white becoming yellow, stipe central, cylindrical, pruinose, arising from a short cushion (Fig. 2), basidia 4-spored, clavate with sterigmata, basidiospores elongate-ellipsoid, smooth, hyaline, non-amyloid, thin-walled, hymenium with gloeocystidia *Physalacria maipoensis* produces a “capitate” fruiting body with a globose head and a short stalk (Fig. 2), and molecular data assign it to the euagarics within a clade comprising *Henningsomyces candidus* and a sister clade to *Schizophyllum commune* but not within the family Marasmiaceae (Binder *et al*., 2001). Inderbitzin and Desjardin (1999) consider the genus as representing “reduced” agarics allied to the genus *Gloiocephala* in the Tricholomataceae.

Mycaureola Maire & Chemin, Comptes. rendu hebd. Séanc. Acad. Sci., Paris, **175**: 321, 1922. .... (1)
◙ ***M. dilseae*** Maire & Chemin, Comptes. rendu hebd. Séanc. Acad. Sci., Paris, **75**: 321, 1922 (*Type species*).

Basidiomes globose, hemispherical to ellipsoidal, sessile, white, smooth, ostiolate, with up to 12 formed in a circle around the edges of decaying algal tissue, basidia are cylindrical to subclavate, no sterigmata, lacking cystidia, each basidium produces 4 sigmoid basidiospores, unicellular, hyaline, smooth-walled, lacking a sheath or appendages (Porter and Farnham, 1986; Stanley, 1992).

Originally referred to the Ascomycota, but ultrastructural studies confirm its assignment to the Basidiomycota (Porter and Farnham, 1986). *Mycaureola*, a monotypic genus, is parasitic on the red alga *Dilsea carnosa* and has a cyphelloid, gasteroid fruiting body that suggests assignment to the Cyphellaceae euagaricoid clade. Molecular sequences indicate that the species nested within *Rhizomarasmius pyrrhocephalus* and *Gloiocephala phormiorum* and is close to *Xerula* and *Oudemansiella* species, in the Physalacriaceae clade (Binder *et al*., 2006).

However, its closest terrestrial relative could not be identified with confidence (Binder *et al*., 2006). *Gloiocephala aquatica*,

Fig. 2. *Physalacria maipoensis* saprophytic on stems of *Acanthus ilicifolius*.

(Desjardin *et al*., 1995), a freshwater species, is in the same clade as *M. dilseae,* indicating that there is a second lineage of marine Agaricales (Binder *et al*., 2001, 2006). *Mycaureola dilseae* is seasonal in its occurrence and restricted to temperate areas occurring during late autumn in the UK when seawater temperatures are low (Stanley, 1992).

AGARICOMYCETES *incertae sedis*

RUSSULALES

After Hibbett *et al*. (2007) and equivalent to russuloid clade (Hibbett and Thorn, 2001; Binder and Hibbett, 2002).

Two genera with marine species:

1. Resupinate thallus small, basidiospores tetraradiate .. ..***Digitatispora***
1. Resupinate thallus extensive, basidiospores not tetraradiate....................................***Haloaleurodiscus***

Digitatispora clade (Hibbett and Thorn, 2001)
Digitatispora Doguet, Comptes. rendu hebd.

Séanc. Acad. Sci., Paris, **254**: 4338,1962.... (2)
D. lignicola E.B.G. Jones, Mycotaxon **27**: 155, 1986.

◙ ***D. marina*** Doguet, Comptes. rendu hebd. Séanc. Acad. Sci., Paris, **254**: 4338, 1962 (*Type species*).

Basidiomes form irregular colonies on the wood surface, mycelium with clamp connections, resupinate, hyaline to gray, soft, basidia cylindrical or subclavate, basidia elongate, no sterigmata, four-spored, hyaline, basidiospores tetraradiate, one basal arm and three radiating apical arms, hyaline, deciduous. A preliminary molecular study of this genus using mitochondrial rDNA sequence suggests this species should be placed in the russuloid clade (Hibbett, pers. comm.). However, further molecular studies are required to confirm this placement.

1. Apical branch of basidiospores up to 25 µm long, 8 µm diam...***D. lignicola***
1. Apical branch of basidiospores up to 41 µm long, 4 µm diam... ***D. marina***

Peniophoraceae

Haloaleurodiscus N. Maek., Suhara & K. Kinjo, Mycol. Res. **109**: 826, 2005.............. (1)
◙ ***H. mangrovei*** N. Maek., Suhara & K. Kinjo, Mycol. Res. **109**: 827, 2005 (*Type species*).

Basidiome resupinate, irregular fruit body on wood, pinkish cream, becoming pale dull-cream to greyish-white when dry, gloeocystidia present, basidia narrowly clavate 65-75 × 9-10.5 µm, with a basal clamp connection and four sterigmata, basidiospores ellipsoid to cylindrical, 13.5-15.5 × 8-9.5 µm, warted, thin to slightly thick-walled, amyloid and lacking appendages. *Haloaleurodiscus mangrovei* was described from decaying and decorticated branch of a living *Sonneratia alba* tree (Maekawa *et al*., 2005). Unlike some marine basidiomycetes, it has ellipsoid to cylindrical basidiospores 13.5-15.5 × 8-9.5 µm, warted, thin to slightly thick-walled, amyloid, and lacking appendages (Fig. 3a). Maekaea *et al*. (2005) suggest that the thickening of the basidiospore walls after discharge from the sterigmata could be the first acquired features to evolve and represent a unique evolutionary transition from terrestrial to marine environments. Although *H. mangrovei* resembles *Aleurodiscus sensu lato*, phylogenetically it nestles in the root of the Peniophorales clade (18S, 28S rDNA sequences) (Maekawa *et al*., 2005).

OTHER BASIDIOMYCOTA

Clipson *et al*. (2001) list five other basidiomycetes in their checklist of European marine fungi, but these are maritime occurring in sand dunes and not obligate marine fungi (*Psalliota litoralis*, *Laccaria trullisata*, *Inocybe decipiens* (= *Inocybe dunensis*), *Tulostoma macrocephalum*). Other maritime basidiomycetes have been reported, but although these are undoubtedly tolerant to sea spray, they are never intertidal or submerged. Similarly, a *Coprinus* species has been collected on cut branches of *Avicennia marina* and floating in the water in Mai Po Mangrove, Hong Kong (Jones, unpublished data). Another basidiomycete found on decaying plant material (particularly *Acanthus ilicifolius*), and wood is an *Aegerita* species (Sadaba *et al*., 1995), whose identity has not been determined (Fig. 5).

At the time of writing we have collected 12 basidiomycetes on the intertidal bases of the palm *Nypa fruticans*, e.g. *Grammothele fuligo* (Fig. 4). Agarics have also been found on mangrove soils, especially *Coprinus*, *Cortinarius* and *Mycena* species; they are short lived, fruit during the intertidal period and shed their spores before the tide returns (Jones, personal observation). These basidiomycetes have received little attention to date and further investigation for their adaptation to semi-aquatic habitats is warranted.

Trees at Khanom mangrove, southern Thailand, were badly affected by butt rot caused by basidiomycetes. The trees were multi branched as the result of fungal attack (Fig. 6). Two species of *Phellinus* were identified by Dr. T. Hattori, Japan: *Phellinus mangrovicus* and *Ph. swieteniae*, and known to be potent wood decay species. *Phellinus mangrovicus* is of special interest as it has not been collected since it was described by Imazeki, over 70 years ago. Therefore a modern description, with illustrations, is therefore required as well as sequence data to determine its phylogenetic relationship with other species in the genus.

Although there is no documentation of butt rot of *Xylocarpus*, there is a report of butt and heart rot in another mangrove tree, *Rhizophora apiculata*. Mwangi (2001) reported that old *Rh. apiculata* trees were attacked by two pathogenic terrestrial polypores: *Phellinus pachyphloeus* and *Ph. rimosus* in Kenya.

Considerable progress has been made to resolve the taxonomic assignment of the marine basidiomycetes. The genera *Calathella*, *Halocyphina*, and *Nia* all appear to be related (euagaric clade) but have very different basidiomatal and spore morphologies. Similarly, *Physalacria* and *Mycaureola* nestle distantly in the Physalacriaceae. Many marine basidiomycetes have a reduced basidiome, regarded as an adaptation to marine conditions (Jones, 1988).

TOTAL BASIDIOMYCOTA .... (12)

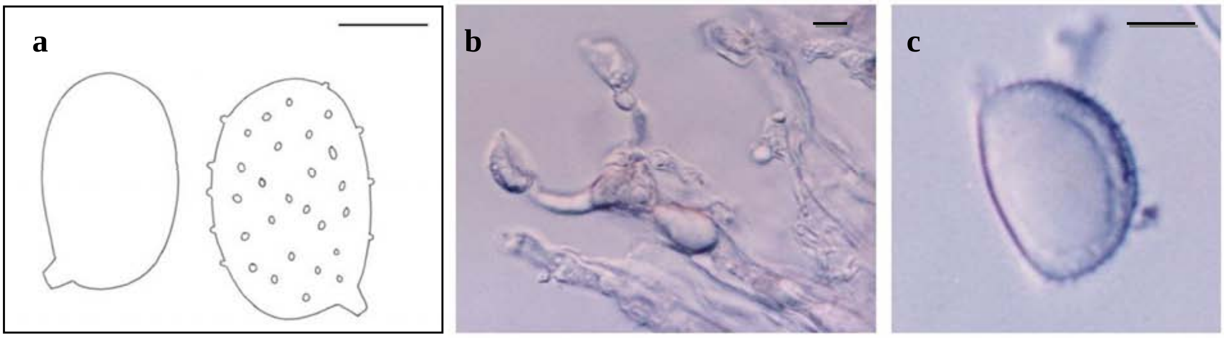


Fig. 3. Basidiospores of **a**. *Haloaleurodiscus mangrovei* (after Maekawa *et al*., 2005), **b.**, **c.** *Calathella mangrovei*, Basidium, sterigmata and basidiospore (b), and basidiospores (c). Bars a, c = 5 µm; b = 10 µm.

Fig. 4. *Grammothele fuligo* saprophytic on the petiole base of the brackish water palm *Nypa fruticans* (**Photo by Rattaket Choeyklin**).

Fig. 5. *Aegerita* propagules on senescent stems of *Acanthus ilicifolius*, Mai Po Mangrove, Hong Kong SAR.

Fig. 6. Butt heart rot of *Xylocarpus granatum* tree in a Khanom mangrove in southern Thailand.

Section B:
PHYLUM: ASCOMYCOTA
PEZIZOMYCOTINA

1. Ascomata with bitunicate asci.................................2
1. Ascomata with unitunicate asci................................5

2. Lichen forming ascomycetes...................................4
2. Non-lichenized ascomycetes...................................3

3. Ascomata perithecial.............**Dothideomycetes (21)**
3. Ascomata predominantly cleistothecial, gymnothecial, globose, asci evanescent.. **Eurotiomycetes (56)**

4. Ascomata apothecial, marine species with no known phycobiot ....**Lecanoromycetes (66)**
4. Ascomata apothecial, various phycobionts .... **Eurotiomycetes (56)**
4. Thallus varied, sometimes poorly developed or absent ....**Arthoniomycetes(69)**

5. Parasitic on insects...........**Laboulbeniomycetes (66)**
5. Ascomycetes not parasitic on insects.......................6

6. Lichen forming ascomycetes with cyanophycean photobionts..............................**Lichinomycetes (69)**
6. Non-lichenized ascomycetes...................................7

7. Ascomata perithecial.............**Sordariomycetes (72)**
7. Ascomata apothecial ....**Leotiomycetes (68)**

DOTHIDEOMYCETES

Two subclasses with marine taxa

1. Ascomycetes lacking paraphyses, pseudoparaphyses or paraphysoids, asci bitunicate globose, ellipsoidal or subcylindrical...... **Dothideomycetidae**
1. Ascomycetes with cellular or trabeculate pseudoparaphyses, bitunicate, asci, cylindrical, clavate, oblong saccate............**Pleosporomycetidae**

DOTHIDEOMYCETIDAE

Two orders with marine taxa

1. Ascomata variable in morphology and structure, formed by lysigenous locules within stromatic tissue, interascal tissue lacking, asci variable morphology, develop in basal fascicle, thick-walled, generally fissitunicate, rarely with apical apparatus, ascospores hyaline to brown, septate constricted at the central septum, occasionally muriform...............***Dothideales***

1. Ascomata small, immersed in host tissue, single or superficial, or imbedded in a pseudoparenchymatal stroma, asci ovoid to saccate to subcylindrical, acospores hyaline to slightly pigmented, 1-septate occasionally 3-septate, sometimes enclosed in a sheath, anamorphs hyphomycetes or Coelomycetes.. .... ***Capnodiales*** (*Mycosphaerellaceae*)

PLEOSPOROMYCETIDAE

One order with marine taxa

Ascomata perithecial, multiloculate, thyrothecium or cleistothecial-like, globose, thick-walled, immersed or erumpent, well-developed ostiole, interascal tissue cellular or trabeculate pseudoparaphyses, asci cylindrical, fissitunicate, apical apparatus, ascospores brown, septate, muriform, often with a gelatinous sheath. Anamorphs hyphomycetes ....***Pleosporales***

Key to marine taxa in the Dothideomycetes

1. Ascomata perithecial.. 2
1. Ascomata cleistothecial ......***Pontoporeia biturbinata***
1. Ascomata apothecial 56

2. Ascospores 1-septate.. 3
2. Ascospores multi-septate 24
2. Ascospores muriform... 47

3. Ascospores hyaline 4
3. Ascospores brown... 17

4. Ascospores with central septum............................... 5
4. Ascospores with eccentric septum......................... 14

5. Ascospores lacking appendages............................... 6
5. Ascospores with appendages 8

6. Growing on mangrove wood ....***Acrocordiopsis***
6. Growing on algae... 7

7. Hosts Fucales or Laminariales........... ***Thalassoascus***
7. Host the red alga *Chondrus crispus*.. ***Lautitia danica***

8. Ascospores with bipolar cilia-like appendages, ascospores 16.5-24 × 5.5-7 µm, on *Juncus* ....***Heleiosa barbatula***
8. Ascospores with a fine halo of fine hairs, 18-27 × 8-14 µm.................................***Capillataspora corticola***
8. Ascospores with mucilaginous appendages............ 9

9. Ascospores with lenticular appendage on side, 17-28 × 8-12 µm .... ***Paraliomyces lentifer***
9. Ascospores lacking a lenticular appendage 10

10. Ascospores with tuberculate wall and surrounded by a sheath, 17-25 × 10-15 µm .... ***Belizeana tuberculata***
10. Ascospores not tuberculate .... .11

11. Ascomata in a stroma................***Scirrhia annulata***

11. Ascomata not stromatic 12

12. Ostiole slit-like .... ***Lophiostoma***
12. Ostiole not slit-like 13

13. Ascomata lenticular, ascospores 18.5-27 × 4-6 µm, on *Nypa* .... ***Astrosphaeriella nypae***
13. Ascomata subglobose, on mangrove wood .... ***Massarina***

14. Ascospores with a sheath .... ***Didymella***
14. Ascospores without a sheath .... ***Mycosphaerella***
14. Ascomata superficial with stalk, ascospores 80-109 × 18-34 µm .... ***Manglicola guatemalensis***
14. Ascomata immersed in substratum 15

15. Ascomata in mangrove wood 16
15. Ascomata on algae .... ***Pharcidia***

16. Ascospores with a delicate sheath, multiloculate .... ***Helicascus***
16. Ascospores with bipolar germ tubes, no sheath, ascospores 59-72 × 24-30 µm .... ***Salsuginea ramicola***

17. Ascomata in a loose stroma, ascospores 37-60 × 16-26 µm, on *Posidonia* .... ***Halotthia posidoniae***
17. Ascomata not stromatic 18

18. Ascomata mammiform, ascospores with bipolar germ tubes, 22-30 × 10-12 µm .... ***Caryosporella rhizophorae***
18. Ascomata not mammiform and lacking bipolar germ tubes 19

19. Ascomata superficial or semi-immersed 20
19. Ascomata immersed in substratum 21

20. Ascomata reddish-brown, subglobose, superficial ascospores 24-32 × 12-15 µm .... ***Bicrouania maritima***
20. Ascomata brown, semi-immersed, ascospores 14-21 × 5-8 µm .... ***Kirschsteiniothelia maritima***

21. Ascospores verrucose 22
21. Ascospores not verrucose 23

22. Ascospores brown 18-23 × 9-11 µm .... ***Didymosphaeria lignomaris***
22. Ascospores dark brown 16-23 × 7-11 µm .... ***Verruculina enalia***

23. Ascospores striate, 23-33 × 9-12 µm .... ***Lineolata rhizophorae***
23. Ascospores not striate, 36-60 × 16-24 µm .... ***Coronopapilla mangrovei***

24. Ascospores 1-3-septate 25
24. Ascospores more than 3-septate 35

25. Ascospores hyaline 26
25. Ascospores pale yellowish to brown 28

26. Ascomata superficial, crater-like, on mangrove wood .... ***Ascocratera manglicola***
26. Ascomata immersed 27

27. On *Juncus*, ascospores with a sheath, ascospores 45-59 × 5.5-10 µm .... ***Loratospora aestuarii***
27. On *Nypa* palm, ascospores with a sheath and apical cellular appendages, 31-42 × 7.5-12.5 µm .... ***Herpotrichia nypicola***
27. On mangrove wood, ascospores with or without a sheath .... ***Massarina***

28. Ascospores versicolored 29
28. Ascospores uniformly coloured 31

29. Ascospores striated, 31-38 × 6-9 µm .... ***Astrosphaeriella striataspora***
29. Ascospores not striated 30

30. Ascospores longer than 45 µm .... ***Passeriniella***
30. Ascospores 28-34 × 10-14 µm, on *Spartina* and driftwood .... ***Byssothecium obiones***

31. Ascomata with pseudoparaphyses 32
31. Ascomata lacking pseudoparaphyses, ascospores yellowish, 50-70 × 10-14 µm .... ***Wettsteinina marina***

32. Pseudoparaphyses trabeculate 33
32. Pseudoparaphyses cellular 34

33. Ascospores fuscous, not eu-septate, 30-41 × 10-16 µm .... ***Trematosphaeria mangrovei***
33. Ascospores black, eu-septate, 30-44 × 12-17 µm .... ***Caryospora australiensis***

34. Ascomata with thick peridial wall .... ***Leptosphaeria***
34. Ascomata with thin peridium .... ***Phaeosphaeria***

35. Ascospores hyaline 36
35. Ascospores brown 38

36. Ascomata superficial on mangrove wood, ascospores with a sheath and apical appendage, 42-50 × 7.5-10 µm .... ***Falciformispora lignatilis***
36. Ascomata immersed 37

37. Pseudoparaphyses trabeculate, ascospores 5-septate, 51-80 × 14-22 µm .... ***Quintaria lignatilis***
37. Paraphyses present, ascospores 3-6-septate .... ***Sphaerulina***

38. Ascospores with septa at the ends, 55-83 × 16-25 µm .... ***Biatriospora marina***
38. Septa uniformly spread along ascospores 39

39. Ascomata superficial 40

39. Ascomata immersed, or under a clypeus, occasionally erumpent..42

40. Ascospores lacking appendages, 30-37.5 × 7.5-11.5 µm ....***Leptosphaeria nypicola***
40. Ascospores with appendages..............................44

41. Ascomata large on *Nypa* palm, single polar appendage, ascospores 31-52.5 × 5-10.5 µm ....***Tirisporella beccariana***
41. Ascospores with a sheath, 7-14-septate.................. ....***Massariosphaeria***

42. Ascospores lacking a sheath or appendages........43
42. Ascospores with a sheath or appendages.............44

43. Ascomata on *Ammophila*, ascospores 5-8-septate 35-55 × 12-16 µm .....***Amarenomyces ammophilae***
43. Ascomata on other substrata ....***Phaeosphaeria***

44. Ascospores versicolor with hyaline end-cells, ascospores 34-48 × 7-10 µm ....***Trematosphaeria lineolatispora***
44. Ascospores uniformly brown. 45

45. Ascospores 4-7-septate..46
45. Ascospores with more than 7-septate..................... .... ***Carinispora***

46. Ascospores 3-7-septate....................***Phaeosphaeria***
46. Ascospores 4-5-septate..........***Paraphaeosphaeria****

47. Ascospores hyaline and thick-walled... ***Lautospora***
47. Ascospores brown 48

48. Ascospores with a sheath with 2-3 subconical gelatinous appendages, 33-48 × 12-21 µm............. .... ***Decorospora gaudefroyi***
48. Ascospores with a sheath but lacking subconical appendages...49

49. Ascospores with lighter end-cells, trabeculate hamathecium .... ***Aigialus***
49. Ascospores uniformly brown 50

50. On driftwood associated with sand 51
50. On other substrata 52

51. Ascospores 5-septate, end-cells slightly paler......... .... ***Platystomum scabridisporum***
51. Ascospores 8-9-septate, uniformly dark brown....... .... ***Decaisnella formosa***

52. Growing on algae, ascospores 28-29.5 × 13-13.5 µm ....***Pleospora gracilariae***
Ascospores 25-35 × 12-17 µm .... ***P. pelvetiae***
52. Growing on salt marsh plant *Triglochin*, ascospores 45-65 × 16-25 µm ....***Pleospora triglochinicola***
52. Growing on *Spartina* ascospores 35-52 × 10-15 µm ....***Pleospora pelagica***
Ascospores 24-38 × 10-13 µm ....***P. spartinae***
52. Growing on other substrata 53

53. On *Juncus* 54
53. On mangrove wood.. 55

54. Asci with a gel-cap, ascospores with pronounced sheath, 26-40 × 11-19.5 µm. ..***Tremateia halophila***
54. Asci lacking a gel cap, ascospores with no gelatinous sheath, 18-22.5 × 5-6.5 µm................... ....***Julella herbatilis***

55. Ascomata with hyphal mycelium, ascospores with a faint sheath, 20-28.5 × 8-11 µm ....***Leptosphaerulina mangrovei***
55. Ascomata lacking ascomatal hyphae, ascospores 28-36 × 12-16 µm .... ***Julella avicenniae***

56. Ascospores with polar setae, hyaline to pale brown, 15-27 × 6-10 µm ....***Banhegyia setispora***
56. Ascospores lacking polar appendages or a prominent sheath.. 57

57. Ascospores hyaline, 5-8-septate, 18-41 × 11-11.5 µm ....***Gloniella clavatispora***
57. Ascospores hyaline, 4-9-septate, 24-48 × 6-24 µm. .... ***Patellaria atrata***

*The two marine *Paraphaeosphaeria* species are not obligately marine.

DOTHIDEOMYCETES
DOTHIDEOMYCETIDAE
CAPNODIALES
Mycosphaerellaceae

Mycosphaerella Johanson, Oefvers., Foerh. K. Sven. Vetensk.-Akad. **41**: 163, 1884 .... (1)

M. pneumatophorae Kohlm., Ber. Dtsch. Bot. Ges. **79**: 32, 1966.

M. salicorniae (Auersw.) Lindau, Hilfsb. Sammeln Ascomyc.: 103, 1903.

Sphaeria salicorniae Auersw., Bot. Trauschveerein, 1863.

Lizonia salicorniae (Auersw.) Auersw., Bot. Trauschveerein, 1869.

Sphaerella salicorniae (Auersw.) Auersw., Gonnermann & Rabenhorst Mycol. Eur. No. **5**: 16, 1869.

Sphaerella peruviana Speg., An. Soc. Cient. Argent. **12**: 115, 1881.

M. staticicola (Pat.) Dias, Mem. Soc. Brot. **21**: 72, 1970.

Sphaerella staticicola Pat., Cat. Raisonné Plantes cellilaires Tunésie, Paris p. 104, 1897.

M. suaedae-australis Hansf., Proc. Linn. Soc. N.S.W. **79**: 122, 1954.

Ascomata globose, subglobose, ellipsoidal, immersed in the host, conical, membranous, ostiolate, epapillate or a short papilla, pale coloured, solitary or gregarious, pseudoparaphyses absent, asci elongate-cylindrical to short clavate, short pedunculate, thick-walled, bitunicate, no apical apparatus, ascospores ellipsoidal to elongate, 1-septate, hyaline, with a mucilaginous sheath. Pycnidia or spermatogonia may be present. A well characterized genus, primarily of *circa* 500 terrestrial species causing leaf spot disease of a wide range of hosts. Marine taxa are generally on the salt marsh plants *Armeria*, *Limonium*, *Salicornia* and *Suaeda*. Ascomata immersed, generally lacking pseudoparaphyses, asci short clavate and ascospores hyaline, one septate often with a gelatinous sheath, e.g. *M. salicorniae*. *Mycosphaerella pneumatophorae* occurs on the "bark" of pneumatophores of *Avicennia* species, with recent records from Asian mangroves (Jones, unpublished data). *Mycosphaerella* species occurring on algae are now referred to *Mycophycias*.

1. Mainly on mangrove pneumatophores (*Avicennia*), ascospores 14-21 × 6-8.5 µm ....***M. pneumatophorae***
1. On other marine or marsh plants, ascospores narrower than 6 µm 2

2. Ascospores longer than 18 µm, saprobic on *Suaeda australis* ....***M. suaedae-australis***
2. Ascospores shorter than 18 µm 3

3. Ascospores 8-18 × 2.6 µm, saprobic on *Salicornia* and *Suaeda* .... ***M. salicorniae***
3. Ascsopores 12-15 × 4-6 µm, saprobic on *Armeria* and *Limonium*...................................... ***M. staticicola***

Sphaerulina Sacc., Michelia **1**: 399, 1878 .. (2)
S. orae-maris Linder, Farlowia **1**: 413, 1944.
S. albispiculata Tubaki, Publs. Seto Mar. Biol. Lab. **15**: 366, 1957.

Ascomata globose, subglobose, immersed, ostiolate, papillate, membranous, hyaline to light brown, periphyses present or absent, paraphyses present or absent, filiform, simple, septate, asci clavate to cylindrical, short pedunculate, unitunicate?, apically thickened, without an apical apparatus, ascospores 3-6-septate, slightly constricted at the septa, hyaline, smooth-walled, no sheath or appendages (Fig. 7). These species are in need of modern taxonomic treatment. Although *S. orae-maris* is accepted as an obligate marine fungus (Kohlmeyer and Volkmann-Kohlmeyer, 1991a), the marine niche of *S. albispiculata* has been queried (Kohlmeyer and Kohlmeyer, 1979). The latter was described by Tubaki (1957) from driftwood on Tane Island, Kyushu, Japan and does not appear to have been reported in the literature since. However, Jones (unpublished data) has collected it on driftwood in Friday Harbour, USA. It can be distinguished from *S. orae-maris* by its well-developed, bushy, white, thick and hairy neck.

Kohlmeyer and Kohlmeyer (1979) query if these species belong in *Sphaerulina* as pseudoparaphyses and bitunicate asci were not conclusively demonstrated in the type material.

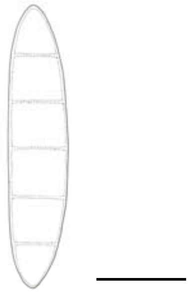


Fig. 7. *Sphaerulina albispiculata*. Ascospore 5-septate, not constricted at the septa. Bar = 10 µm

1. Ascomata with a prominent bushy, white hairy neck, ascospores 25-30 × 5-6 µm, 5-6-septate ....***S. albispiculata***
1. Ascomata with a short papillate neck, ascospores 26-32 × 5-8 µm, 3-septate .... ***S. orae-maris***

Pharcidia Körber., Parerga Lichenologica, Breslau, p. 469-470, 1865. .... (3)
P. balani (G. Winter) Bausch, Pubbl. Stn. Zool. Napoli **15**: 379, 1936.

Epicymatia balani G.Winter ex Har., Jour. De Bot. 1: 233, 1887.

P. laminariicola Kohlm., Bot. Mar. **16**: 209, 1973.
P. rhachiana Kohlm., Bot. Mar. **16**: 210, 1973.

Ascomata globose to ellipsoidal, small, solitary, ostiolate, epapillate, periphysate, dark brown to black, paraphyses septate, ramose, reticulate, in a gelatinous matrix, asci clavate to cylindrical, thick-walled, no apical apparatus, persistent, ascospores ellipsoidal to obovoid, 1-septate, slightly constricted at the septum, hyaline, with or without appendages (gelatinous cap-like and at both ends). *Pharcidia* contains some 90 names, but many are referred to *Stigmidium*, or lichen genera such as *Arthopyrenia*, and *Lichenodiplis*. They occur on brown algae, *Laminaria digitata* (Zuccaro and Mitchell, 2005) or shells of marine animals, e.g. molluscs (Kohlmeyer and Kohlmeyer, 1979).

1. Ascomata on barnacles and other marine shells......... .... ***P. balani***
1. Ascomata on algae 2

2. Ascospores 18-25 × 6-8 µm, with polar cap-like appendages......................................***P. laminariicola***
2. Ascospores 12-20 × 4-5 µm, without appendages ....***P. rhachiana***

1. DOTHIDEALES
Dothideaceae

Scirrhia Nitschke ex Fuckel, Jahrb. Nassauischen Vereins Naturk., Wiesbaden **23-24**: 220, 1870 .... (1)
S. annulata Kohlm., Volkm.-Kohlm., & O.E. Erikss., Can. J. Bot. **74**: 1835, 1996.

Described from senescent culms of *Juncus roemerianus*, it occurs 28-121 cm above the rhizome within the range regarded as obligate to facultative is present throughout the year and grows well on saltwater agar (Kohlmeyer *et al*., 1996). Diagnostic features are the linear stromata, 1-3 mm long, generally superficial, multiloculate with ascomata in longitudinal rows, asci clavate, ascospores 3-septate, brown, with a thin sheath, and 46-60 × 9-11.5 µm. Taxonomic position needs verification at the molecular level to resolve its phylogenetic position.

DOTHIDEALES *incertae sedis*
BOTRYOSPHAERIALES
Botryosphaeriaceae

Amarenomyces O.E. Erikss., Op. Bot. Soc. Bot Lund **60**: 124, 1981 .... (1)
A. ammophilae (Lasch.) O.E. Erikss. Op. Bot. Soc. Bot. Lund **60**: 124, 1981 (*Type species*).

Sphaeria ammophilae Lasch, Flora, Jena **8**: 282, 1850.

Leptosphaeria ammophilae (Lasch) Ves. De Not., Comment. Soc. Critt. Ital. **1**: 236, 1863.

Phaeosphaeria ammophilae (Lasch) Kohlm. & E. Kohlm., Icones Fungorum Maris, Plate 55, 1965.

Leptosphaeria littoralis Sacc., Michelia **1**: 38, 1877.

Phaeosphaeria littoralis (Sacc.) L. Holm, Symb. Bot. Upsal. **14**: 121, 1957.

Sphaeria subuletorum Berk. & Br., Ann. Mag. Nast Hist. Soc. Ser. 2, **9**: 382, 1852.

Leptosphaeria sabuletorum (Berk. & Br.) von Höhn. Hedwigia **60**: 141, 1918.

Metasphaeria sabuletorum (Berk. & Br.) Sacc., Syll. Fung. **2**: 180, 1883.

Sphaeria subulectorum Berk. & Br. 1952.

Montagnula perforans (Roberge ex Desm.) Aptroot, *Mycosphaerella* and its Anamorphs: Conspetus of *Mycosphaerella*, **2**: 150, 2006.

Paradidymella perforans (Roberge ex Desm.) Munk, Dansk bot. Ark. **17**: 179, 1957.

Sphaeria perforans Roberge ex Desm., Ann. Sci. Nat., Bot, ser. 2**, 19**: 23.

Tarospora perforans (Roberge ex Desm.) Höhn

Anamorph: *Amarenographium metableticum* (Trail) O.E. Erikss.

Camarographium metableticum (Trail) Grove, British Stem- and Leaf Fungi (Coelomycetes) **2**: 108, 1937.

Diplodina ammophilae Trail, Scot. Nat. I, P 76

Ascomata subglobose, ellipsoidal to pyriform, immersed, clypeate, ostiolate, papillate, carbonaceous, black, solitary or gregarious, pseudoparaphyses septate, simple, in a gelatinous matrix, asci clavate or subcylindrical, short pedunculate, thick-walled, bitunicate, without an apical apparatus, ascospores, ellipsoidal to fusiform, 5-8-septate, slightly constricted at the septa, yellowish to pale-brown, with a mucilaginous sheath constricted at the central septum (Kohlmeyer and Kohlmeyer, 1979). Assignment of this species at the generic level is subject to debate. The genus was erected based on this species (Eriksson, 1981) but Leuchtmann (1984) and Kohlmeyer and Kohlmeyer (1965) placed it in *Phaeosphaeria*.

Belizeana Kohlm. & Volkm.-Kohlm., Bot. Mar. **30:** 195, 1987....................................... (1)
B. tuberculata Kohlm. & Volkm.-Kohlm., Bot. Mar. **30**: 196, 1987 (*Type species*).

Ascomata subglobose to ampulliform, immersed to erumpent, ostiolate, epapillate or with a short papilla, carbonaceous, black, solitary or gregarious, hyaline cells filling ostiolar canal, pseudoparaphyses simple, rarely branching or anastomosing, asci cylindrical, short pedunculate, thick-walled, fissitunicate, without an apical apparatus, with a small ocular chamber, ascospores ellipsoidal, 1-septate, constricted at the septum, hyaline, thick-walled, two-layered, tuberculate ornamentations between the two layers, the outer gelatinizing and forming a sheath (Kohlmeyer and Volkmann-Kohlmeyer, 1987c). Although tentatively referred to the Pleosporaceae, Pleosporales by Kohlmeyer and Volkmann-Kohlmeyer (1987c), we prefer to leave it in the Dothideales *incertae sedis*, until a more suitable family suggests itself. The ascospores of *B. tuberculata* are unusual in having a verrucose wall sourrounded by a sheath, which becomes sticky in water. A similar species has been collected in Malaysia but further collections are necessary to determine if it is a new species.

Capillataspora K.D. Hyde, Can. J. Bot. **67**: 2522, 1989... (1)
C. corticola K.D. Hyde, Can. J. Bot. **67**: 2522, 1989 (*Type species*).

An inconspicuous species occurring on the bark of the prop roots of *Rhizophora apiculata*, with globose to ovoid ascomata, hyaline to pale brown, coriaceous, periphysate, solitary and hairy around the ostiole (Hyde, 1989a). Asci are thick walled, saccate to clavate without an apical apparatus. Ascospores 18-27 × 8-13.5 µm, 1-septate, constricted at the septum, hyaline surrounded by small fine, hair-like appendages. Its taxonomic position needs verification at the molecular level, but few collections of this ascomycete have been made, and may escape detection because of its inconspicuous perithecia.

Passeriniella Berl., Icon. Fung. (Abellini) **1**: 51, 1891.. (2)
P. mangrovei Maria & K.R. Sridhar, Indian J. Forst. **25**: 319, 2002.
P. savoryellopsis K.D. Hyde & Mouzouras, Trans Br. Mycol. Soc. **91**: 179, 1988.

Ascomata globose to subglobose, immersed, ostiolate, papillate, dark brown to black, coriaceous, solitary or gregarious, periphysate, pseudoparaphyses hyaline, branched, septate, asci cylindrical, pedunculate, bitunicate, with an ocular chamber, ascospores ellipsoidal, versicolour, smooth-walled, 3-septate, constricted at the septa, central cell larger and brown, end cells small and hyaline, lacking a sheath or appendages (Fig. 8). Perplexing species that require to be studied at the molecular level, since *P. obiones* has been transferred to *Byssothecium* (Barr, 2002), however this has not been universally accepted (Index Fungorum).

Currently there is confusion over the placement of *P. obiones* (= *Leptosphaeria discors*). Molecular studies show that *L. discors* does not belong in *Leptosphaeria* or *Phaeosphaeria* (Khashnobish and Shearer, 1996a, b), while the type species of *Passeriniella* has a chequered history (Kohlmeyer and Volkmann-Kohlmeyer, 1991a). Barr (2002) regards *P. obiones* as best placed in *Byssothecium* and we accept that view in this monograph. *Passeriniella savoryellopsis* and *P. mangrovei* conform neither to the generic characteristics of *Byssothecium* or *Passeriniella* (Maria and Sridhar, 2002). In *P. savoryellopsis* the hamathecium tissue, asci, 3-septate ascospores (Barr, 2002 regards them as uniseptate with a short terminal papilla), that are large, deeply constricted at the central septum are not features of either *Byssothecium* or *Passeriniella*. Further collections and a molecular study are warranted before the two species can be referred to a new genus.

1. Asci with 8 ascospores, 44-62 × 17-24 µm .... ***P. mangrovei***
1. Asci with 4 ascospores, 64-88 × 24-28 µm .... ***P. savoryellopsis***

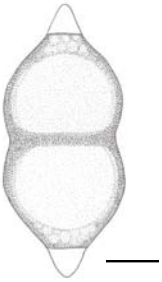


Fig. 8. *Passeriniella mangrovei.* Versicolorous ascospore. Bar = 10 µm.

Thalassoascus Oll., C.R. Hebd. Séances Acad. Sci. **182**: 1348-1349, 1926 .... (3)

T. cystoseirae (Oll.) Kohlm., Mycologia **73**: 837, 1981.

Melanopsamma tregoubovii var. *cystoeirae* Oll., Ann. Inst. Océangor. (Paris) (N.S.) **7**: 172, 1930.

T. lessoniae Kohlm., Mycologia **73**: 837, 1981.

T. tregoubovii Oll., Compt. Rend. Habd. Séancs Acad. Sci **182**: 1348, 1926 (*Type species*).

Melanopsamma tregoubovii (Oll.) Oll., Bull. Inst. Océangor. **522**: 3, 1928.

Melanopsamma tregoubovii var. *cutleriae* Oll., Ann. Inst. Océangor. (Paris) (N.S.) **7**: 172, 1930.

Ascomata subglobose to ellipsoidal, superficial, subiculate, ostiolate, epapillate, periphysate, subcarbonaceous to leathery, black, gregarious, pseudoparaphyses filiform, asci cylindrical to clavate, pedunculate, thick-walled, ascospores ellipsoidal, 1-septate, constricted at the septum, hyaline, thick-walled. A little known genus with 1-septate ascospores, differentiated primarily by ascospore measurements and their algal hosts and warrants further study.

1. On *Cystoseira* spp., ascomata stalked .... ***T. cystoseirae***
1. On other none Fucales, ascomata sessile 2

2. Ascospores less than 28 µm in diam., on *Lessonia* (Laminariales) .... ***T. lessoniae***
2. Ascospores wider than 28 µm, on *Aglaozonia* spp. and *Zanardinia* (Cutleriales) .... ***T. tregoubovii***

DOTHIDEOMYCETIDAE family *incertae sedis*

Lautosporaceae

Lautospora K.D. Hyde & E.B.G. Jones, Bot. Mar. **32**: 479, 1989 .... (2)

L. gigantea K.D. Hyde & E.B.G. Jones, Bot. Mar. **32**: 479, 1989 (*Type species*).

L. simillima Kohlm., Volkm.-Kohlm. & O.E. Erikss., Bot. Mar. **38**: 169, 1995.

Ascomata subglobose to fusiform, immersed, lying horizontal to wood surface, coriaceous, ostiolate, light brown to brown, solitary, pseudoparaphyses cellular, septate, asci cylindrical, four-spored, thick-walled, bitunicate, pedunculate, with an ocular chamber and ring, ascospores fusiform, muriform, 4-7 longi-septa, hyaline, very thick-walled, no sheath or appendages (Hyde and Jones, 1989d) (Figs. 9, 10). *Lautospora simillima* is a second species assigned to the genus, occurring on the culms of *Juncus roemerianus* (Kohlmeyer *et al*., 1995b). It is an obligate marine species occurring 3-12 cm above the rhizome. These two species appear to be very similar and can only be distinguished by ascospore dimensions, which overlap. These species are known from few collections and further studies are required to determine if they are distinct species and also their phylogenetic positions within the Dothideomycetes. No anamorph has been reported.

1. On mangrove wood, ascospores 140-195 × 36-45 µm .... ***L. gigantea***
1. On *Juncus roemerianus*, ascospores 127-210 × 28-57 µm .... ***L. simillima***

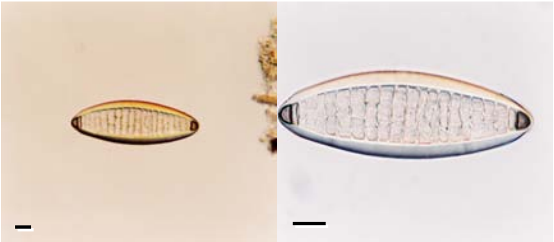


Fig. 9. *Lautospora gigantea.* Ascospores hyaline, muriform and thick-walled. Bars = 20 µm.

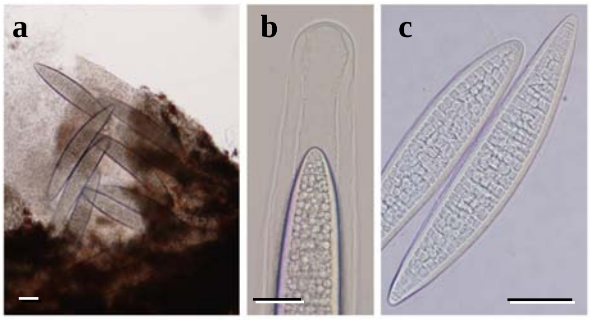


Fig. 10. *Lautospora simillima.* **a.** Mature ascospores in ascoma. **b.** Thick-walled ascus. **c.** Muriform and thick-walled ascospores. Bars = 50 µm.

Planistromellaceae

Loratospora Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **12**: 10, 1993 .... (1)
L. aestuarii Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **12**: 10, 1993 (*Type species*).

This species occurs on *Juncus roemerianus* culms in an intermediate position (10-61 cm above the rhizome) between that regarded as obligately and facultatively marine (Kohlmeyer and Volkman-Kohlmeyer, 1993c). Ascomata black immersed in the culms, carbonaceous, ostiolate, neck with periphyses, asci clavate, thick-walled, fissitunicate without an apical apparatus, with an ocular chamber, J-, while ascospores are hyaline, 3-septate surrounded by a thin mucilaginous sheath. *Loratospora* can be compared with *Leptosphaerulina*, *Monascostroma* and *Wettsteinina* but they differ in the lack of periphyses, their small ascomata, their thin walled ascomatal wall and asci that are ovoid to saccate.

Barr (1996) erected the family Planistromellaceae for six genera in the Dothideales, including *Loratospora*, because their locules open schizogenously by a periphysate ostiole.

Zopfiaceae

Coronopapilla Kohlm. & Volkm.-Kohlm., Mycol. Res. **94**: 686, 1990.......................... (1)
C. mangrovei (K.D. Hyde) Kohlm. & Volkm.-Kohlm., Bot. Mar. **34**: 19, 1991 (*Type species*).

Caryospora mangrovei K.D. Hyde, Trans. Mycol. Soc. Jpn. **30**: 336, 1989.

Coronopapilla avellina Kohlm. & Volkm.-Kohlm., Mycol. Res. **94**: 687, 1990.

Ascomata immersed under a stroma, subglobose, ostiolate, papillate, clypeate, coriaceous, light-coloured, single or gregarious, pale brown, periphysate, pseudoparaphyses trabeculate, anastomosing filaments in a gelatinous matrix, asci cylindrical, long pedunculate, thick-walled, fissitunicate, J-, without an apical apparatus, with an ocular chamber, ascospores ellipsoidal, 1-3-septate, constricted at the central septum, thick-walled and two layered, no sheath or appendages (Kohlmeyer and Volkmann-Kohlmeyer, 1990a). The peridium is hyaline and soft, ascospores are not ornamented and lack a sheath, characters that separate it from *Caryospora*. Originally described by Hyde (1989c) as a *Caryospora* species, but it lacks the characteristic features of that genus: erumpent to superficial ascomata, peridium carbonaceous, and ascospores surrounded by a gelatinous sheath (Kohlmeyer and Volkmann-Kohlmeyer, 1990a). *Coronopapilla* was initially referred to the Didymosphaeriaceae (Kohlmeyer and Volkmann-Kohlmeyer, 1990a).

Caryospora De Not. Micromyc. Ital. Novi **9:** 7, 1855.. (1)
C. australiensis M.A. Abdel-Wahab & E.B.G. Jones, Mycoscience **41**: 379, 2000.

The only marine species assigned to this genus and collected on wood associated with sand in Australia (Abdel-Wahab and Jones, 2000). Ascomata large 870-1000 µm, conical to subglobose, immersed to erumpent, carbonaceous, papillate, periphysate, solitary or gregarious, pseudoparaphyses trabeculate anastomosing above the asci, asci cylindrical to subcylindrical with a wide opercular chamber, ascospores dark brown to black, the end-cells paler, thick-walled, 3-eu-septate and lacking a sheath (Fig. 11a). It differs from *Caryospora* species in possessing cylindrical asci and ascospores lacking a sheath. In *Caryospora* asci are usually saccate and not cylindrical as in *C. australiensis*.

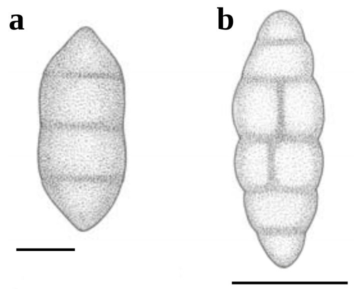


Fig. 11. **a.** *Caryospora australiensis*. Three-septate ascospore. **b**. *Platystomum scabridisporum*. Muriform ascospores. Bars a = 10 µm; b = 20 µm.

Pontoporeia Kohlm.**,** Nova Hedw. **6**: 5-6, 1963.. (1)

◙ ***P. biturbinata*** (Durieu & Mont.) Kohlm., Nova Hedw. **6**: 5, 1963 (*Type species*).

Sphaeria biturbinata Durieu & Mont., Explo. Sci. Algérie, Bot. **1**: 497. 1849.

Amphisphaeria biturbinata (Durieu & Mont.) Sacc., Syll. Fung. **1**: 729, 1882.

Zopfia biturbinata (Durieu & Mont.) Malloch & Cain, Can. J. Bot. **50**: 67, 1972.

Ascomata large 805-1375 µm high, 805-1120 µm diam., globose, dark brown to black, thick-walled, pseudoparaphysate, asci bitunicate, clavate with no apical apparatus, long tapering pedicel and ascospores thick-walled, dark to blackish brown, 1-septate with a prominent hyaline germ pore, 66-90 × 32-44 µm (Fig. 12). Described from the rhizomes of *Posidonia oceanica* (Kohlmeyer, 1963), and appears to be host specific as is *Halotthia posidoniae*. Cuomo *et al.* (1985) found both *P. biturbinata* and *H. posidoniae* common on *Posidonia oceanica* rhizomes with a frequency of occurrence of 52% and 78%, respectively, but not on *Cymodocea nodosa*, another seagrass growing in the same locality. Our examination of *P. oceanica* from Cyprus (collections in December, 2007 and February, 2008) noted that *H. posidoniae* was quite common, but that *P. biturbinata* was rare.

Currently some 16 *Zopfia* names are known, but many of these have been transferred to other genera and families: *Ulospora*, *Neotestudina*, *Lepidosphaeria*, *Testudina* (Testudinaceae), *Zopfiofoveola* (Zopfiaceae). Taxonomic assignment of *Zopfia* is problematic with Von Arx and Műller (1975) assigning it to Zopfiaceae, with Barr (1979a) and Hawksworth (1979) referring it to the Massarinaceae and Testudinaceae, respectively.

We prefer at this stage to retain *P. biturbinata* in the Zopfiaceae because of ascus and ascospore morphology, however we do not consider it well placed in *Zopfia.* Malloch and Cain (1972) offer few details as to why the species should be transfered to *Zopfia.* Recent collections of the species have enabled a better understanding of its phylogenetic relationship (Suetrong *et al*., unpublished data).

DOTHIDIOMYCETES
PLEOSPOROMYCETIDAE
PLEOSPORALES

The number of families in the Pleosporales is unresolved with Schoch *et al.* (2006) referring to only six (Leptosphaeriaceae, Lophiostomataceae, Phaeosphaeriaceae, Pleosporaceae, Sporormiaceae, Testudinaceae), while Myconet (2007) and Kirk *et al.* (2001) list 17 and 19, respectively. Other families have been proposed and are cited in Kirk *et al.* (2001) as Pleosporales *incertae sedis*. We refer marine taxa to nine families within the order. Greater resolution of the familial position of these taxa requires greater taxon sampling and a multigene approach.

1. Didymosphaeriaceae

Didymosphaeria Fuckel, Jahrb. Nassau.Ver. Naturkd. **23-24**: 140, 1870........................... (1)

D. lignomaris Strongman & J.D. Mill., Proc. N. S. Inst. Sci. **35**: 102, 1985.

A doubtful *Didymosphaeria* species infrequently collected and requires further investigation (Strongman *et al*., 1985; Peña and Arambarri, 1998a). Aptroot (1995) monographed the genus *Didymosphaeria* with 550 described names, accepted 7 species and transferred 100 species to other genera. He regarded *D. lignomaris* miss-placed in *Didymosphaeria* and suggested placement in *Lojkania* cf *enalia* (Barr, 1990a). However, this has not been universally accepted.

2. Testudinaceae

Verruculina Kohlm. & Volkm.-Kohlm., Mycol. Res. **94**: 689, 1990 .... (1)

◙ ***V. enalia*** (Kohlm.) Kohlm. & Volkm.-Kohlm., Mycol. Res. **94**: 689, 1990 (*Type species*).

Didymosphaeria enalia Kohlm., Ber. Deutsch. Bot. Ges. **79**: 28, 1966.

Lojkania enalia (Kohlm.) M.E. Barr, N. Amer. Fl., Ser. 2. **13**: 56, 1990.

Ascomata subglobose, ampulliform or ellipsoidal, immersed, ostiolate, papillate, clypeate, carbonaceous, black solitary or gregarious, pseudoparaphyses trabeculate, anastomosing, in a gelatinous matrix, asci cylindrical, short pedunculate, J-, without an apical apparatus, with an ocular chamber, thick-walled, fissitunicate, ascospores ellipsoildal, 1-septate, slightly constricted at the septum, dark-brown, verrucose, lacking a sheath or appendage (Fig. 13).

A species originally described as a *Didymosphaeria* species, but transferred to *Lojkania* (Barr, 1990a) and subsequently to *Verruculina* (Kohlmeyer, and Volkmann-Kohlmeyer, 1990a) with its immersed clypeate ascomata with a dark peridium, a gelatinous matrix around the pseudoparaphyses, asci that are stipitate with an ocular chamber and verruculose dark brown ascospores (Kohlmeyer and Volkmann-Kohlmeyer, 1990a). Initially referred to the Didymosphaeriaceae, Melanommatales by Kohlmeyer and Volkmann-Kohlmeyer (1990a), sequence data place it in the Testudinaceae as the most basal clade of the Pleosporales along with *Lepidosphaeria nicotiae* and *Ulospora bilgramii* (Schoch *et al*., 2006).

3. Leptosphaeriaceae

Leptosphaeria Ces. & De Not., Comment. Soc. Crittogam. Ital. **1**: 234, 1863........................ (5)

L. australiensis (Cribb & J.W. Cribb) G.C. Hughes, Syesis **2**: 132, 1969.

Metasphaeria australiensis Cribb & J.W. Cribb, Univ. Queensl., Pap. Dept. Bot. **3**: 79, 1955.

L. avicenniae Kohlm. & E. Kohlm., Nova Hedw. **9**: 98, 1965.

L. nypicola K.D. Hyde & Alias, Mycol. Res. **103**: 1414, 1999.

L. pelagica E.B.G. Jones, Trans. Br. Mycol. Soc. **45**: 105, 1962.

L. peruviana Speg., An. Soc. Cient. Argent. **12**: 179, 1881.

Ascomata conical, subglobose, obpyriform, ostiolate, papillate, coriaceous or carbonaceous, light brown to brown to black, solitary or gregarious, periphysate, pseudoparaphyses septate, branched with gelatinous walls, asci cylindrical or subclavate-clavate-fusiform, short pedunculate, thick-walled, lacking or with an apical apparatus, ascospores ellipsoidal, fusiform or cylindrical, 3 or more-septa, slightly constricted at the septa, hyaline to pale yellow-brown, with or without a sheath. Morphological characters that best describe *Leptosphaeria* are: “superficial, conoid ascomata that are strongly thickened toward the base, thick-walled scleroplec-tenchyma in the peridium, ascospores that are uniformly pale brown or hyaline and hosts that are primarily dicotyledons” (Khashnobish and Shearer, 1996b). The genus is polyphyletic and in need of a thorough study of wider range of taxa (Cannon and Kirk, 2007).

Currently five species are marine occurring on mangrove substrata, generally wood and maritime plants. Shoemaker and Babcock (1989) and Kohlmeyer and Volkmann-Kohlmeyer (1991a) retain *Leptosphaeria orae-maris* in *Leptosphaeria*, while Khashnobish and Shearer (1996a, b), have transferred it to *Phaeosphaeria.*

Morphologically *Leptosphaeria* and *Phaeosphaeria* are difficult to delineate with confidence as is evidenced by the frequent transfer of species from one genus to the other. Khashnobish and Shearer (1996a) opined that the only useful characters in the delineation of these two genera were: “shape of ascoma, ascomal position relative to the substrate and the type of cells making up the peridium”. However, phylogenetically the two genera cannot be separated, with *Phaeosphaeria* forming a natural group, while *Leptosphaeria* did not form a monophyletic group (Khashnobish and Shearer, 1996b).

Fig. 12. *Pontoporeia biturbinata*. **a.** Front view of mature ascomata (cleistothecial) of *Pontoporeia biturbinata* on rhizomes of the sea grass *Posidonia oceanica*. **b.** Pseudoparaphyses and immature ascus. **c-d.** Thick-walled, ascus with long tapering pedicel. **e-i.** Ascospores bicelled and thick-walled. Bars a = 100 µm; b-i = 10 µm.

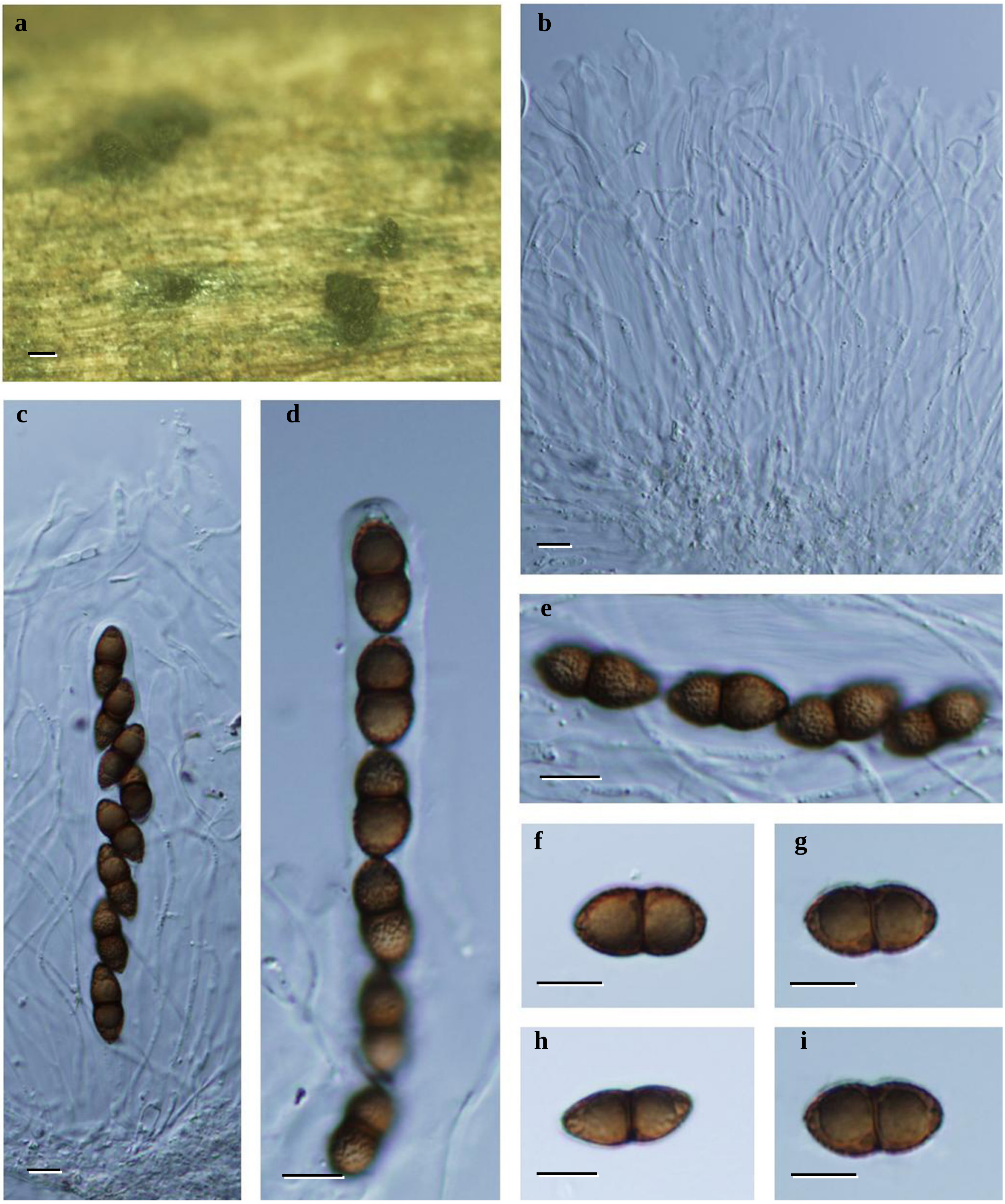


Fig. 13. *Verruculina enalia.* **a.** Ascomata submerged in mangrove wood. **b**. Thin-walled pseudoparaphyses. **c.** Cylindrical asci and pseudoparaphyses. **d.** Ascus cylindrical with an apical pore. **e-i.** Ascospores bicelled and constricted at the septum. Bars a = 100 µm; b-i = 10 µm.

The families Leptosphaeriaceae and Phaeosphaeriaceae are closely related as is evident from recent sequence data (Khashnobish and Shearer, 1996a; Cámara *et al*., 2002; Kodsueb *et al*., 2006; Schoch *et al*., 2006; Suetrong *et al*., unpublished data). Hibbett *et al*. (2007) refrained from classification below ordinal level therefore offer no solution as to the validity of retaining the two families in their present form. Molecular data from Cámara *et al*. (2002) support the separation of *Leptosphaeria* and *Phaeosphaeria*, and consider that the significant morphological characters phylogenetically are: peridial characters, anamorphs and plant hosts. Kodsueb *et al*. (2006) question whether the Phaeosphaeriaceae is a synonym for the Leptosphaeriaceae and advocate a re-evaluation based on wider sampling and multigene sequence analyses. Cannon and Kirk (2007) accept both families.

1. Ascospores with a wide sheath 2
1. Ascospores with an indistinct sheath or lacking a sheath 3

2. Ascospores 18-25 × 6-8 µm, on mangrove wood, tropical .... ***L. avicenniae***
2. Ascospores 28-44 × 8-12 µm, on wood, temperate ... . ***L. pelagica***

3. Ascospores with 3 septa 4
3. Ascospores with 3-5 septa, 30-37.5 × 7.5-11.5 µm, indistinct sheath, on *Nypa* .... ***L. nypicola***

4. Ascospores 12-16 × 4-5.5 µm, olive brown, on *Salicornia* .... ***L. peruviana***
4. Ascospores 19-27 × 6-9 µm, hyaline, on wood .... ***L. australiensis***

4. Lophiostomataceae

Decaisnella Fabre, Annls. Sci. Nat. Bot. Sér. 6, **9**: 112, 1879 .... (1)
◙ ***D. formosa*** Abdel-Wahab & E.B.G. Jones, Can. J. Bot. **81**: 598, 2003.

Ascomata subglobose, immersed, clypeate, ostiolate, coriaceous, black, solitary or gregarious, periphysate, pseudoparaphyses trabeculate, unbranched at the base, anastomosing above the asci, in a gelatinous matrix, asci cylindrical, pedunculate, fissitunicate, with a refractive ring in the endoascus, ascospores fusiform to elongate, muriform, distoseptate, 8-13 transverse septa, 1-6 longitudinal septa, slightly constricted at the septa, golden-brown, smooth-walled, no sheath or appendages (Abdel-Wahab and Jones, 2003) (Fig. 14). Known only from the type locality Mornington Peninsula, Australia, on driftwood associated with sand, where it was common (Abdel-Wahab and Jones, 2003). It conforms to the generic charac-teristics of large ascomata, wide peridium, refractive apical ring surrounding an ocular chamber in the ascus and distoseptation in immature ascospores that are brown and smooth-walled. Molecular data shows that *D. formosa* is well placed in the Lophio-stomataceae with high bootstrap support, forming a sister group comprising *Massarina* and *Lophiostoma* species (Fig. 17) (Suetrong *et al*., 2009 in press).

Herpotrichia Fuckel, Fungi rhenani exsic. No. 2171, 1868... (1)
H. nypicola K.D. Hyde & Alias, Mycol. Res. **103**: 1412, 1999.

Ascomata globose, superficial, ostiolate, short papillate, gregarious, black, pseudoparaphyses filiform, numerous, septate, anastomosing above the asci, in a gelatinous matrix, asci cylindrical-clavate, pedunculate, thick-walled, bitunicate, with an ocular chamber, ascospores fusiform, 1-septate becoming 3-septate, constricted at the central septum, basal part longer and narrower than the apical part, hyaline becoming pale brown, with cellular apical appendages (Hyde *et al*., 1999b).

The only species known from a marine habitat, it has black, globose, superficial papillate ascomata often clustered together, pseudoparaphyses filiform, numerous, septate and anastomosing above the asci, asci bitunicate, cylindric-clavate with an ocular chamber, ascospores 1-3-septate, hyaline to pale brown becoming dark brown at maturity, with apical cellular appendages (Hyde *et al*., 1999b).

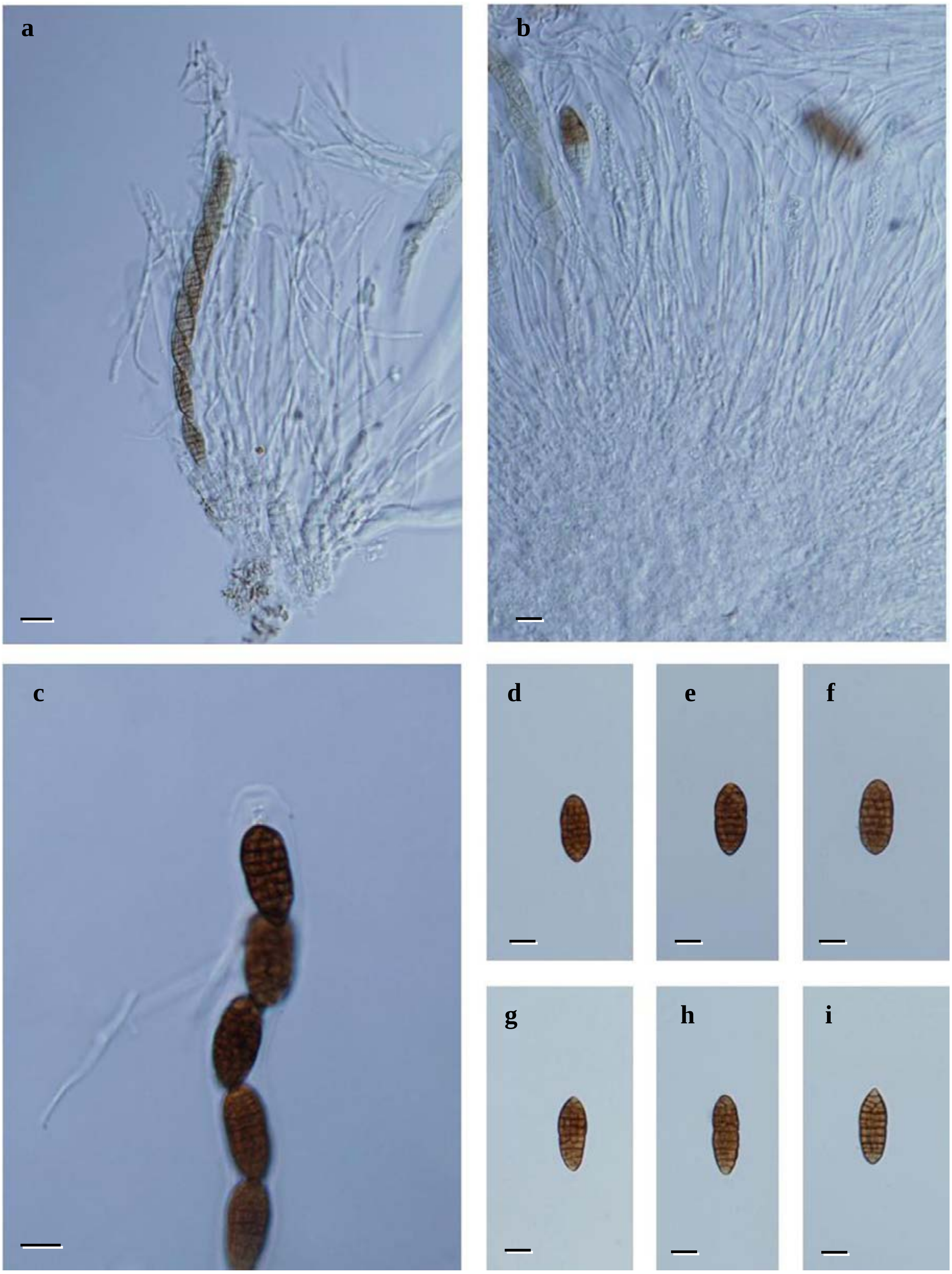


Fig. 14. *Decaisnella formosa.* **a-b**. Asci and thin-walled pseudoparaphyses. **c.** Apical region of ascus with a pore**. d-i.** Muriform brown ascospores. Bars a-i = 10 µm.

Described from the intertidal petiole of *Nypa fruticans*. The genus *Herpotrichia* groups in Lophiostomataceae group 2 of a multigene analyses by Schoch *et al*. (2006) and further resolution at the family level requires greater species sampling.

Lophiostoma Ces. & De Not., Comm. Soc. Crittog. Ital. **1**: 219, 1863............................ (3)

The taxonomic position of marine *Astrosphaeriella*, *Lophiostoma* and *Massarina* species has been re-evaluated at the ultrastructural and molecular level (Read *et al*., 1997a, b; Aptroot, 1998; Hyde and Aptroot, 1998; Hyde *et al*., 2002; Liew *et al*., 2002; Schoch *et al*., 2006). Earlier delineation of the genera based on slit-like versus rounded ostioles was found not to be consistent within a genus at the molecular level (Hyde *et al*., 2002). Marine species have been transferred between these genera and the current assignment is based on the sequence data of Liew *et al*. (2002).

L. acrostichi (K.D. Hyde) Aptroot & K.D. Hyde, Fungi in Marine Environments. Fungal Diversity Press: 106, 2002.

Massarina acrostichi K.D. Hyde, Mycol. Res. **93**: 437, 1989.

L. armatisporum (K.D. Hyde, Vrijmoed, Chinnaraj & E.B.G. Jones) Liew, Aptroot & K.D. Hyde, Fungi in Marine Environments. Fungal Diversity Press: 106, 2002.

Massarina armatispora K.D. Hyde, Vrijmoed, Chinnaraj & E.B.G. Jones, Bot. Mar. **35**: 325, 1992.

L. rhizophorae (Poonyth, K.D. Hyde, Aptroot & Peerally) Aptroot & K.D. Hyde, Fungi in Marine Environments. Fungal Diversity Press: 108, 2002.

Massarina rhizophorae Poonyth, K.D. Hyde, Aptroot & Peerally, Fungal Divers. **3**: 144, 1999.

Ascomata subglobose to elongate, immersed to erumpent, often strongly flattened, carbonaceous, papillate with a round or slit-like ostiole, black, solitary to gregarious, pseudoparaphyses cellular, in a gelatinous matrix, asci cylindrical, thick-walled, bitunicate, short pedunculate, with an ocular chamber and faint ring, ascospores broad fusiform, 1-septate, hyaline, with or without a sheath that may be drawn out terminally.

These species have been transferred from *Massarina* based on morphological and molecular evidence (Liew *et al*., 2002). *Lophiostoma asiana* and *L. mangrovei* have been transferred to *Astrosphaeriella* (Hyde *et al*., 2000).

1. Ascospores 24-33 × 6-10 µm, on the fern *Acrostichum* ....***L. acrostichi***
1. Ascomycetes on mangrove wood 2

2. Ascospores 28-39 × 7-10 µm..........***L. armatisporum***
2. Ascospores 22-28 (-33) × 4.5-6.5 µm........................ ....***L. rhizophorae***

Massarina Sacc., Syll. Fung. (Abellini) **2**: 153, 1883.. (10)

?M. beaurivagea Poonyth, K.D. Hyde, Aptroot & Peerally, Fungal Diver. **3**: 139, 1999.

M. cystophorae (Cribb & J.W. Herb.) Kohlm. & E. Kohlm., Marine Mycology. The Higher Fungi: 427, 1979.

Otthiella cystophorae Cribb & J.W. Herb., Univ. Queensl., Pap. Dept. Bot. **3**: 10, 1954.

Melanopsamma cystophorae (Cribb & J.W. Herb.) Meyers, Mycologia **49**: 485, 1957.

M. lacertensis Kohlm. & Volkm.-Kohlm., Aust. J. Mar. Freshw. Res. **42**: 92, 1991.

?M. mauritiana Poonyth, K.D. Hyde, Aptroot & Peerally, Fungal Diver. **3**: 141, 1999.

◙ ***M. phragmiticola*** O.K. Poon & K.D. Hyde, Bot. Mar. **41**: 145, 1998.

◙ ***M. ramunculicola*** K.D. Hyde, Mycologia **83**: 839, 1992.

M. ricifera Kohlm., Volkm.-Kohlm. & O.E. Erikss., Mycologia **87**: 537, 1995.

?M. rhizophorae Poonyth, K.D. Hyde, Aptroot & Peerally, Fungal Diver. **3**: 144, 1999.

M. thalassiae Kohlm. & Volkm.-Kohlm., Can. J. Bot. **65**: 575, 1987.

◙ ***M. velataspora*** K.D. Hyde & Borse, Mycotaxon **27**: 161, 1986.

Ascomata subglobose to obpyriform, immersed in the substratum under a pseudostroma, or erumpent, ostiolate, epapillate, clypeate, coriaceous, dark brown to black, solitary or gregarious, periphysate, paseudoparaphyses trabeculate, anastomosing filaments, in a gelatinous matrix, asci obclavate, clavate, cylindrical, short pedunculate, thick-walled, J-, ocular chamber without or with an apical apparatus, ascospores ellipsoidal, 1-3-septate, slightly constricted at the septa, with a mucilaginous sheath sometime drawn out to form apical appendages e.g. *M. ramunculicola* (Kohlmeyer and Kohlmeyer, 1979; Read *et al*., 1992b).

Species assigned to *Massarina* have undergone extensive revision as the result of morphological and molecular evaluation (Liew *et al*., 2002). Of 160 *Massarina* names in the literature, Aptroot (1998) only retained 43 taxa, while others have been transferred to *Lophiostoma* as the result of molecular evidence (Hyde and Aptroot, 1998; Hyde *et al*., 2002; Liew *et al*., 2002). Aptroot (1989) considers that *M. ricifera* may be better placed in *Wettsteinina*, and that *M. lacertensis* does not belong in *Massarina* because ascomata are immersed in an extensive thick, black stroma. We retain these species here until further molecular studies are undertaken.

Ascospores in marine *Massarina* species generally have a mucilaginous sheath, often elaborated into appendages (Read *et al*., 1994, 1997a, b; Au and Vrijmoed, 2002; Hyde *et al*., 2002). In *M. acrostichi*, *M. lacertensis*, *M. ramunculicola*, *M. thalassiae* and *M. velatospora* there are well developed sheaths, which is multilayered in *M. ricifera.* Polar caps to the ascospores are found in *M. phragmiticola*, while in *M. cystophorae* polar appendages are present. In *M. ramunculicola*, the exosporial mucilaginous sheath contains a fibrillar component. Prior to the release of ascospores, the fibrillar component penetrates the delimiting membrane at the spore poles to form a polar cap (Read *et al*., 1997b), a unique feature in the genus. Ascospores of *Massarina thalassiae* possess a well-developed exosporial mucilaginous sheath and at the spore poles, a polar chamber is formed within the episporium, which projects into the sheath. However, this does not penetrate through the sheath or the delimiting membrane (Read *et al*., 1994). *Massarina ricifera* also has two types of sheaths, one cap-like around one end of the ascospore, and a more extensive diffuse sheath around the entire spore. It differs from other marine *Massarina* species and requires further investigation at the TEM and molecular level.

Further ecological studies are required to determine if species marked ? are truly marine.

1. Ascospores 1-septate.. 2
1. Ascospores 3-septate.. 5

2. Ascospores with polar appendages or cupulate mucilaginous pad.. 3
2. Ascospores with a sheath.. 4

3. Ascospores 28-37.5 × 4.7-6.5 µm, with cupulate, mucilaginous appendages at both ends, apical smaller than the basal appendage, on *Phragmites* ....***M. phragmiticola***
3. Ascospores 50-65 (-73) × 15-23 (-25) µm, polar drawn out polar appendages, equal in length, on algae...***M. cystophorae***

4. Ascospores 28-44 (-47) × 10-15 µm, sheath entire ... . ***M. lacertensis***
4. Ascospores 35-42.5 × 12.5-18 µm, polar cap extends into the enveloping sheath ....***M. ramunculicola***
4. Ascospores 22-28 (-33) × 4.5-6.5 µm, sheath confined to ascospore tip, extending 2-6 µm, ending bluntly...***M. rhizophorae***

5. Ascospores 45-56 × 14-19 µm...........***M. velataspora***
5. Ascospores length shorter than 45 µm.................... 6

6. Ascospores 28-44 (-47) × 10-15 µm, on wood........ 7
6. Ascospores 19-25 × 5.5-7 µm, on *Juncus*................. ....***M. ricifera***

7. Ascospores 28-44 (-47) × 10-15 µm......................... .... ***M. thalassiae***
7. Ascospores narrower than 10 µm 8

8. Ascospores 26-34 × 8-9.5 µm, on *Bruguiera gymnorhiza* wood.............................. ***M. mauritiana***
8. Ascospores 18-21 × 6-8 µm, on *Hibiscus tiliaceus* ... .***M. beaurivagea***

Paraliomyces Kohlm., Nova Hedw. **1**: 81, 1959.. (1)

◙ ***P. lentifer*** Kohlm., Nova Hedw. **1**: 81, 1959 (*Type species*).

Stromata black immersed in the substratum, ascomata subglobose to pyriform, immersed, ostiolate, papillate or epapillate, carbonaceous, black, solitary, periphysate, pseudoparaphyses filiform, numerous, asci cylindrical, short pedunculate, thick-walled, bitunicate, without an apical apparatus, ascospores ellipsoidal to subfusiform, 1-septate, constricted at the septum, hyaline becoming brown, with a mucilaginous sheath and a lenticular appendage at the central septum.

A monotypic genus, occurring on submerged wood and geographically well distributed in the tropics (Tam *et al*., 2003). The genus can be assigned to the Pleosporales, Lophiostomataceae with confidence as it forms a clade with *Lophiostoma crenatum* and *L. caulium* (Tam *et al*., 2003). Liew *et al*. (2002) have evaluated the monophyly of the genus *Massarina* and transferred a number of taxa to *Lophiostoma.* Included in their analysis was *L. caulium,* also used by Tam *et al*. (2003), and this falls into a well characterized *Lophiostoma* group with narrow, fusiform ascospores. Although *P. lentiferus* has many features in common with other marine *Lophiostoma* and *Massarina* species they are not congeneric.

Ultrastructurally, the ascospores of *P. lentifer* differ significantly from those of other marine *Lophiostoma* and *Massarina* species (Read *et al*., 1992). The mucilaginous sheath in *Paraliomyces* is thick (340-380 nm) with numerous electron-opaque granules. The lateral lentiform appendage is located at the central septum and comprises longitudinally oriented fibrils in an amorphous matrix and attached to the episporium by electron-dense strands that pass through the sheath, features not observed in *Massarina* and *Lophiostoma* species.

Platystomum Trevis., Bull. Soc. R. Bot. Belg. **16**: 16, 1877 .... (1)
◙ ***Platystomum scabridisporum*** Abdel-Wahab & E.B.G. Jones, Mycoscience **41**: 384, 2000.

A newly described marine species from Australian driftwood associated with sand. Ascomata subglobose, immersed, erumpent, papillate, ostiolate, periphysate, black and coriaceous, peridium two-layered, trabeculate pseudoparaphyses, asci cylindrical with an ocular chamber, ascospores fusiform, muriform, 5-8-transverse septate and 1-3-longitudinal septate, constricted at the septa, brown with rough or verrucose spore wall surface (Figs. 11a, 15). Sequence data place it in the Lophiostomataceae as a sister group to *Lophiostoma* species (Fig. 17) (Suetrong *et al*., 2009 in press). However it is not congeneric with *Lophiostoma*, as evidenced by the weak bootstrap support. Barr (1990a) referred *Platystomum* to the Platystomataceae, Melanommatales, however, *Platystomum compressum* has been treated as a *Lophiostoma* species by Holm and Holm (1988) and this was supported by Eriksson and Hawksworth (1991). However, ascospore morphology is significantly different from *Lophiostoma* and we retain it as a separate genus.

Quintaria Kohlm. & Volkm.-Kohlm., Bot. Mar. **34**: 34, 1991 .... (1)
◙ ***Q. lignatilis*** (Kohlm.) Kohlm. & Volkm.-Kohlm., Bot. Mar. **34**: 35, 1991 (*Type species*).

Ascomata obpyriform, immersed, ostiolate, papillate, carbonaceous, black, solitary or gregarious, pseudoparaphyses septate, branching and anastomosing, asci cylindrical, pedunculate, bitunicate, with an apical plate, ascospores fusiform, 5-septate, constricted at the septa, hyaline, no sheath or appendage (Fig. 16). The genus is differentiated from *Trematosphaeria* by having completely immersed ascomata with rounded bases, black incrustations lining the sides of the ostiolar canal, a non-amyloid plate in the ascus and hyaline ascospores.

5. Melanommataceae

Acrocordiopsis Borse & K.D. Hyde, Mycotaxon **34**: 536, 1989 .... (2)
◙ ***A. patilii*** Borse & K.D. Hyde, Mycotaxon **34**: 536, 1989 (*Type species*).
A. sphaerica Alias & E.B.G. Jones, Fungal Diver. **2**: 39, 1999.

Both *Acrocordiopsis* species were reported on mangrove wood with large, black, carbonaceous, conical ascomata seated on a black stromata, epapillate, peridium thick composed of 2-3 layers, pseudoparaphyses abundant, asci cylindrical, bitunicate with an apical thickening and an ocular chamber, with hyaline to yellowish, 1-septate ascospores, lacking a sheath or appendages (Fig. 18) (Borse and Hyde, 1989; Alias *et al*., 1999). Preliminary data confirms its assignment to the Pleosporales.

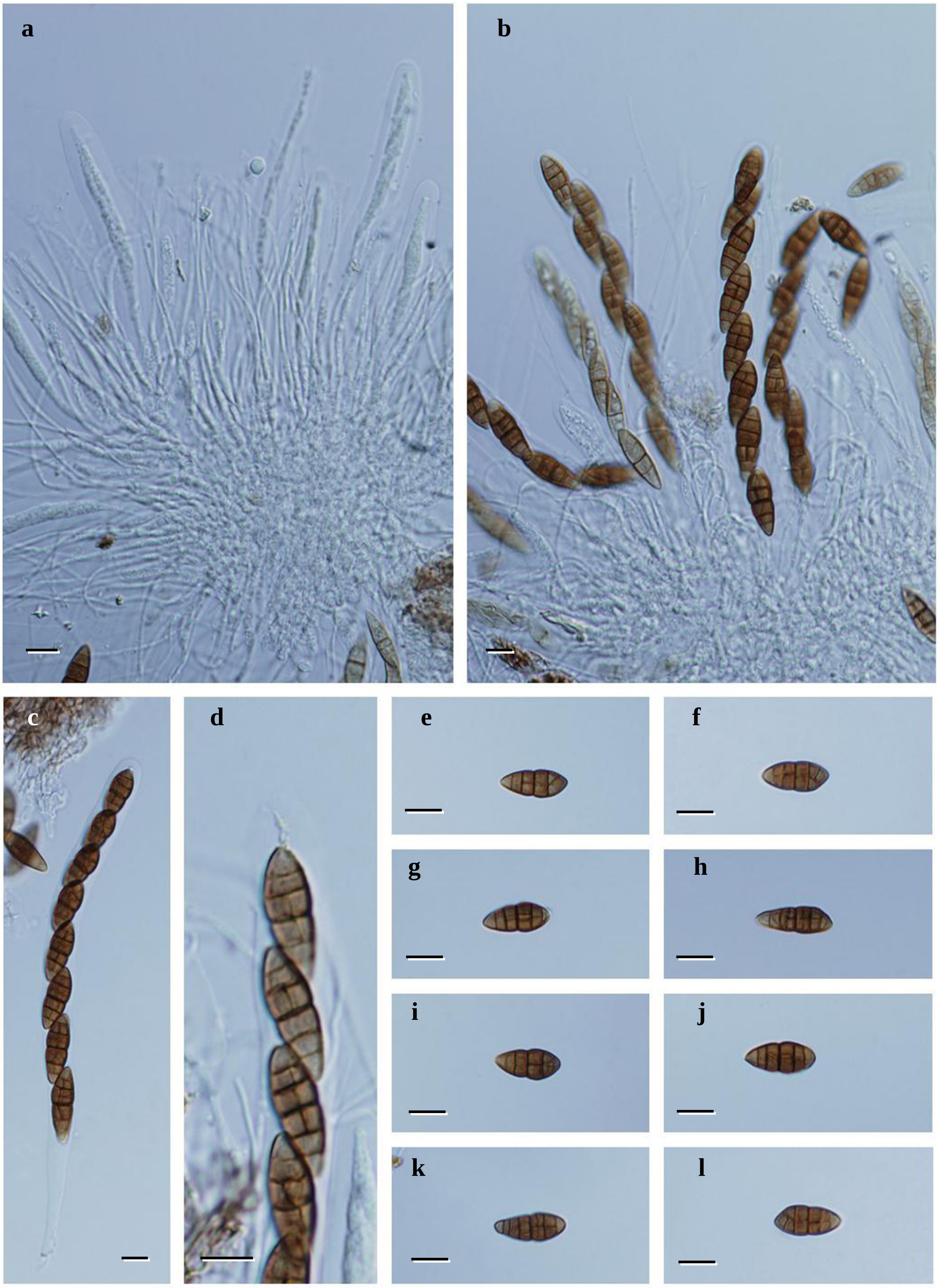


Fig. 15. *Platystomum scabridisporum*. **a-b**. Cylindrical immature asci and pseudoparaphyses**. c.** Cylindrical asci. **d**. Ascus tip with an apical pore. **e-l.** Muriform ascospores. Bars a-l = 10 µm.

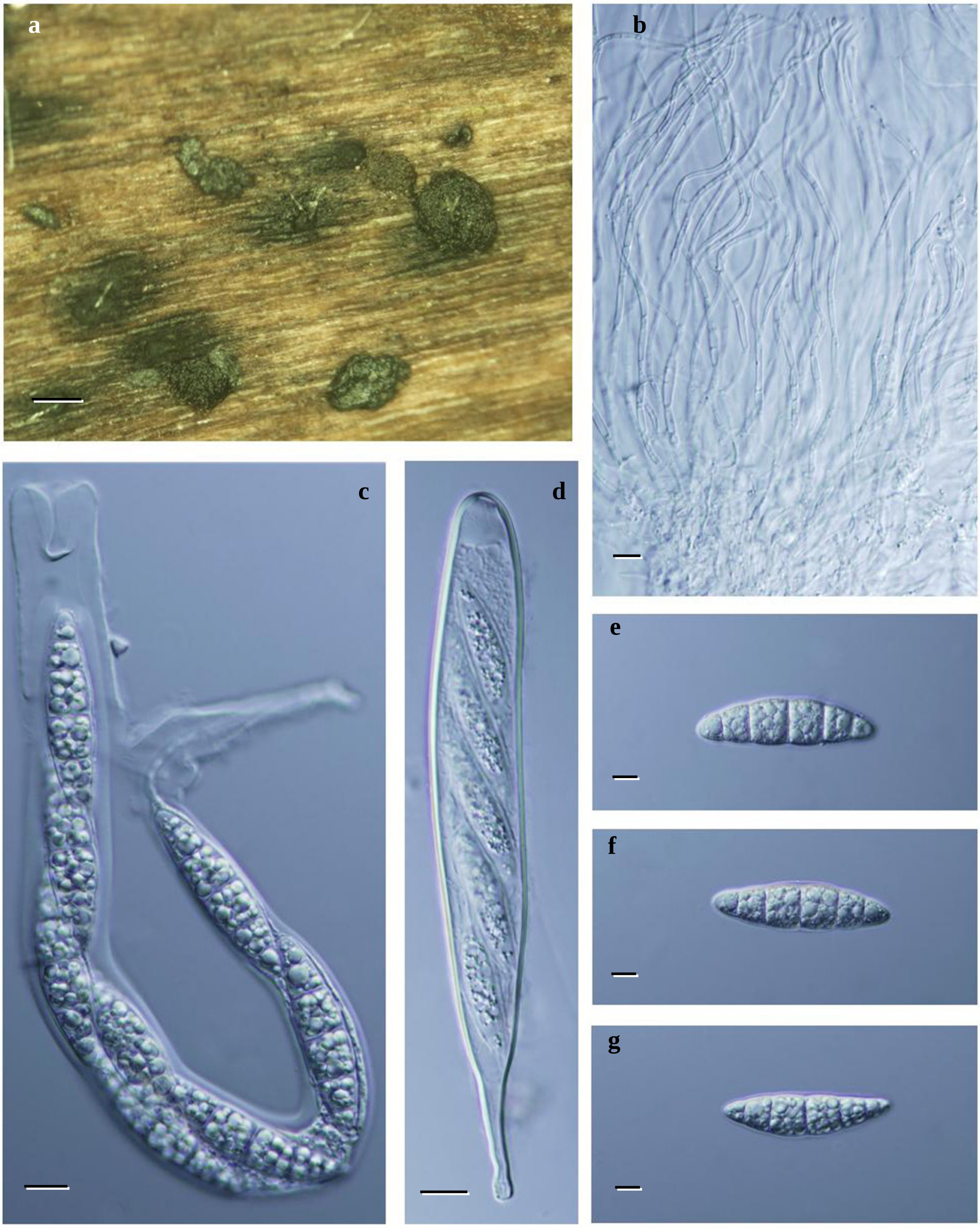


Fig. 16. *Quintaria lignatilis*. **a**. Black ascomata immersed in mangrove wood. **b.** Thin-walled pseudoparaphyses. **c**. Bitunicate ascus with short pedicel. **d**. Ascus cylindrical with uniseriate ascospores. **e-g.** Hyaline 5-septate ascospores. Bars a = 100 µm; b-g = 10 µm.

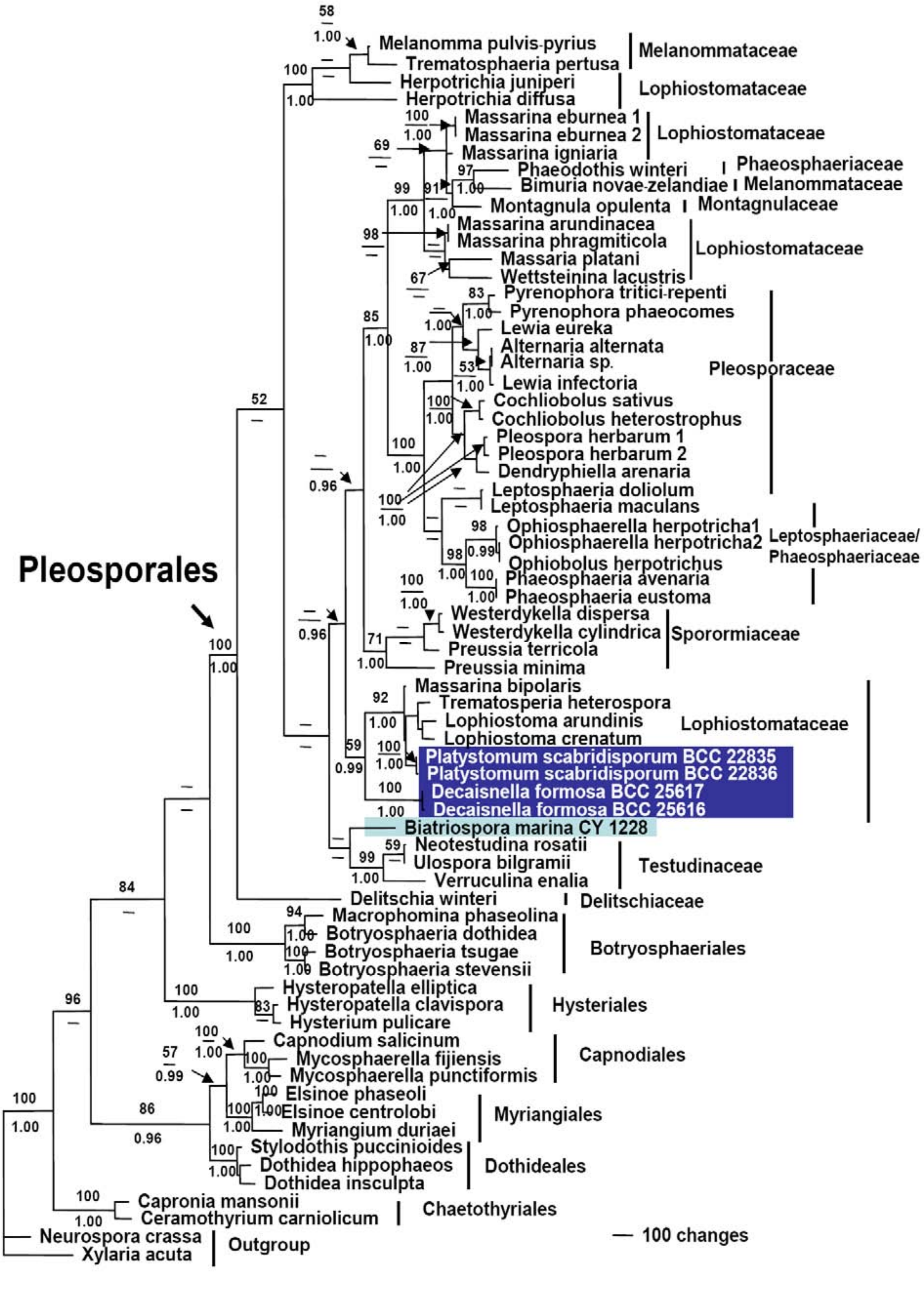


Fig. 17. Phylogram generated from step matrix parsimony analysis from combined SSU, LSU rDNA, RPB2 and EF-1-alpha sequences. Parsimony bootstrap value greater than 50% and Bayesian Posterior Probabilities greater than 0.95 are given above and below each clade, respectively.

1. Ascomatal wall 2-layered, ascospores elongate, less than 16 µm in width....................................***A. patilii***
1. Ascomatal wall 3-layered, ascospores spherical-ellipsoidal, wider than 15 µm................ ***A. sphaerica***

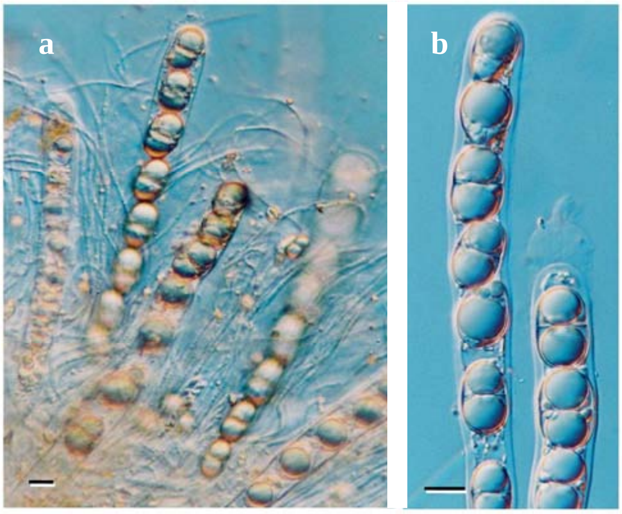


Fig. 18. *Acrocordiopsis patilii.* **a.** Cylindrical asci and thin-walled pseudoparaphyses. **b.** Asci with hyaline, 1-septate ascospores. Bars a-b = 10 µm.

Astrosphaeriella Syd. & P. Syd., Annls. Mycol. **11**: 260, 1913.................................. (4)

◙ ***A. asiana*** (K.D. Hyde) Aptroot & K.D. Hyde, Nova Hedw. **70**: 145, 2000.

Lophiostoma asiana K.D. Hyde, Mycotaxon **55:** 285, 1995.

◙ ***A. mangrovei*** (Kohlm. & Vital) Aptroot & K.D. Hyde, Fungi in Marine Environments. Fungal Diversity Press: 106, 2002.

Lophiostoma mangrovei Kohlm. & Vital, Mycologia **78**: 487, 1986.

A. nypae K.D. Hyde, Bot. J. Linn. Soc. **110**: 96, 1992.

A. striataspora (K.D. Hyde) K.D. Hyde, Bot. J. Linn. Soc. **110**: 97, 1992.

Trematosphaeria striatispora K.D. Hyde, Bot. J. Linn. Soc. **98**: 142, 1988.

Ascomata immersed and subepidermal, becoming superficial, conical or hemispherical, brown to black, solitary or gregarious, ostiole central, papillate, pseudoparaphyses trabeculate in a gelatinous matrix, asci cylindrical, cylindrical-clavate, pedunculate, thick-walled, bitunicate, with an ocular chamber and faint ring, ascospores elongate-fusiform, often tapering at their apices, 1 to multiseptate, slightly constricted at the septa, hyaline, brown to reddish-brown, often with mucilaginous sheaths or appendages.

Astrosphaeriella species are most similar to *Trematosphaeria* and *Caryospora* species in ascomatal features. *Astrosphaeriella* species generally occur on monocotyledons while *Trematosphaeria* occur on wide range of plants, ascospore length-width ratios are higher in *Astrosphaeriella* species than *Trematosphaeria. Astrosphaeriella* differs from *Lophiostoma* species in the narrower trabeculate pseudoparaphyses and with carbonaceous ascomata (Hyde and Fröhlich, 1999). *Astrosphaeriella asiana* and *A. mangrovei* were transferred from *Lophiostoma* on the basis of ascomatal structural morphology, narrower pseudoparaphyses and molecular sequencing data (Hyde *et al*., 2002).

1. Ascospores with a sheath.. 2
1. Ascospores lacking a sheath, hyaline, 31-38 × 6-9 µm, brown with pallid end cells, on *Nypa* .... ***A. striataspora***

2. On *Nypa*, ascospores 18.5-27 × 4-6 µm, hyaline to pale yellow..***A. nypae***
2. On mangrove wood... 3

3. Ascospores (36-) 37.5-55 × 7-11 µm, fusiform, dark brown .... ***A. mangrovei***
3. Ascospores 28-40 × 5-8 µm, broadly fusiform, brown ....***A. asiana***

Bicrouania Kohlm. & Volkm.-Kohlm. Mycol. Res. **94**: 685, 1990 .... (1)

B. maritima (H. Crouan & P. Crouan) Kohlm. & Volkm.-Kohlm., Mycol. Res. **94**: 685, 1990 (*Type species*).

Didymosphaeria maritima (H. Crouan & P. Crouan) Sacc., Syll. Fung. **1**: 703, 1882.

Sphaeria maritima P. Crouan & H. Crouan, Florule du Finistére, Paris: 27, 1867 (non *Sphaeria maritima* Cooke & Plowr., 1877, nom. Illegit.)

Ascomata superficial, lacking a clypeus, subglobose to ellipsoidal, ostiolate, periphysate, short papillate, subcarbonaceous, blackish brown, pseudoparaphyses present, asci cylindrical, short pedunculate, without an ocular chamber or apical apparatus, ascospores ellipsoidal, 1-septate, constricted at the septum, reddish-brown, thick-walled and smooth (Kohlmeyer and Volkmann-Kohlmeyer, 1990a). It was referred to the Melanommataceae, Melanommatales by Kohlmeyer and Volkmann-Kohlmeyer (1990a) but requires further study at the molecular level to confirm its ordinal status. Originally described as a *Sphaeria* species growing on the salt marsh plant *Halimione portulacoides*, which was later transferred to *Didymosphae-ria*, but it clearly does not belong in that genus because of its superficial ascomata.

Caryosporella Kohlm., Proc. Indian Acad. Sci. (Plant Sci.) **94**: 355, 1985 .... (1)
C. rhizophorae Kohlm., Proc. Indian Acad. Sci. (Plant Sci.) **94**: 356, 1985 (*Type species*).

A monotypic genus described from dead wood of intertidal roots and branches of mangrove trees (*Rhizophora mangle*), and probably related to *Caryospora* (Kohlmeyer, 1985). Characterized by large ascomata (750-900 µm high, 830-1050 µm wide), superficial on a thin black stroma, ostiolate, periphysate, carbonaceous, thick peridium (90-160 µm), trabeculate pseudoparaphyses, asci bitunicate, thick-walled, J-, with an apical apparatus, ascospores 1-septate, dark brown, verrucose, and thickened at their apices. Kohlmeyer (1985) referred it to the Massariaceae, Melanommatales, but if it is considered related to *Caryospora*, then an alternative taxonomic group is required. Resolution of its taxonomic position warrants study at the molecular level.

Trematosphaeria Fuckel, Jahrb. Nassau. Ver. Naturkd. **23-24**: 161, 1869-1870.................. (3)
T. lineolatispora K.D. Hyde, Mycol. Res. **96**: 28, 1992.
T. malaysiana Alias, McKeown, S.T. Moss & E.B.G. Jones, Mycol. Res. **105**: 616, 2001.
T. mangrovei Kohlm., Mycopath. Mycol. Appl. **34**: 1, 1968.

Ascomata subglobose, obpyriform, immersed, ostiolate, papillate, coriaceous to carbonaceous, black, solitary or gregarious, necks with hyaline thin hyphae, pseudoparaphyses unbranched, trabeculate, in gelatinous matrix, asci cylindrical, pedunculate, thick-walled, fissitunicate, with an eccentric apical plate, J-, ascospores fusiform multi-septate, slightly constricted to constricted at the septa, hyaline, smooth-walled, lacking a sheath or appendages (Fig. 19) (Kohlmeyer, 1984; McKeown *et al.*, 2001). Three well characterized species from senescent, decaying mangrove wood (McKeown *et al.*, 2001). Although Kohlmeyer (1968a) refered to 25 *Trematosphaeria* species, Bois (1985) accepted only a few.

The genus has been assigned to various families: Pleosporaceae (Kohlmeyer, 1968), and Melanommataceae (Barr, 1990a). We consider the latter the most appropriate at this time. The taxonomic position of *Trematosphaeria* is not fully resolved as the genus is polyphyletic (Schoch *et al.*, 2006), with *T. heterospora* grouping with two other *Lophiostoma* species (Lophiostomataceae clade 1), while *T. pertusa* is in the Lophiostomataceae clade 2, along with *Herpotrichia* and *Pleomassaria* species (Schoch *et al.*, 2006). However, verified strains of *T. pertusa* form a robust cluster with *Bimuria novae-zelandiae*, *Phaeodothis winteri*, *Montagnula opulenta* and *Massarina eburnea*, a sister group with the Pleosporaceae, Phaeosphaeriaceae and Delitschiaceae with moderate bootstrap support (Zhang *et al.*, 2008).

1. Ascospores with wall striation and sheath 2
1. Ascospores lacking wall striation and sheath, 30-(35.5)-41 × 12-13 (-16.5) µm, 3-septate, brown, light brown at extreme poles .... ***T. mangrovei***

2. Ascospores 20-25 × 4-6 µm, fusiform or ellipsoid, 3-septate, light brown, striated, with a sheath .... ***T. malaysiana***
2. Ascospores 34-48 × 7-10 µm, 5-septate, cinnamon brown, striate sheath .... ***T. lineolatispora***

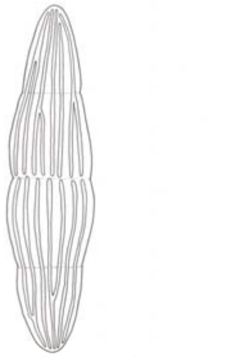


Fig. 19. *Trematosphaeria malaysiana*. Three-septate ascospore with striations along the entire spore. Bar = 5 µm.

6. Monoblastiaceae

Ascocratera Kohlm., Can. J. Bot. **64**: 3036, 1986.. (1)
A. manglicola Kohlm., Can. J. Bot. **64**: 3036, 1986 (*Type species*).

Kohlmeyer (1986a) regards this as a common bitunicate ascomycete in the upper intertidal zone. Ascomata on a thin stroma on the wood surface, crater-like, large (1100-1400 µm diam.), black, carbonaceous, periphysate, trabeculate pseudoparaphyses in a gelatinous matrix, asci bitunicate, thick-walled with an apical apparatus, ascospores hyaline, 3-septate and constricted at the central septum and surrounded by a gelatinous sheath.

Ascospores of *A. manglicola* can be confused with those of *Massarina velatospora*. In our molecular study, *A. manglicola* forms a sister group to *Aigialus* species in a clade that also includes *Quintaria lignatilis* and *Decaisnella formosa.* However it shares few morphological characters (black, ostiolate ascomata, trabeculate pseudoparaphyses, pedunculate, 8-spores, uniseriate, cylindrical asci, septate, ellipsoidal to muriform ascospores) with these taxa (Suetrong *et al*., 2009, in press).

7. Phaeosphaeriaceae

The phylogenetic position of the families Phaeosphaeriaceae and Leptosphaeriaceae has been discussed above, and will not be repeated here.

Carinispora K.D. Hyde, Bot. J. Linn. Soc. **110**: 97, 1992.. (2)
C. nypae K.D. Hyde, Bot. J. Linn. Soc. **110:** 99, 1992 (*Type species*).
C. velatispora K.D. Hyde, Sydowia **46**: 259, 1994.

A genus known only from the palm *Nypa fruticans*, ascomata are large *circa* 0.8 mm, crust-like, with a central ostiole, occur beneath the epidermis with an overlaying clypeus. They lack periphyses and the peridium is light brown composed of thin-walled cells, pseudoparaphyses filiform numerous and in a gel. Asci are clavate to cylindrical, with an ocular chamber and ascospores 7-8-septate, central cells larger, and with a sheath (Fig. 20). The two species have yellow to pale-brown ascospores with measurements that overlap, but differ in the degree of septation and the morphology of the sheath (Hyde, 1992a, 1994b). *Carinispora* resembles *Phaeosphaeria* but differs in that it is a saprobe on the palm *Nypa*, in wall structure, the ocular chamber in the ascus and in the morphology of the ascospore gelatinous sheath. Infrequently collected despite intensive sampling of the host plant (Pilantanapak *et al*., 2005; Jones *et al*., 2005a).

1. Ascospores 42-66 × 7-10.5 µm, 8-9 celled, with a keel-shaped sheath......................................***C. nypae***
1. Ascospores 43-54 × 8-9 µm, 7-8 celled, with a narrow sheath......................................***C. velatispora***

Lautitia S. Schatz, Can. J. Bot. **62**: 31, 1984.... .... (1)
L. danica (Berl.) S. Schatz, Can. J. Bot. **62**:31, 1984 (*Type species*).

Leptosphaeria danica Berl., Icones Fung. **1**: 87, 1892.

Leptosphaeria chondri Rosenv., Bot Tidsskr. **27**: 35, 1906.

Leptosphaeria marina Rostr., Bot. Tidsske. **17**: 234, 1889.

Didymosphaeria danica (Berl.) I.M. Wilson & Knoyle, Trans. Br. Mycol. Soc. **44**: 55, 1961.

Sphaerella chondri H.L. Jones, Oberlin Coll Kab. **9**: 3, 1898.

Guignardia chondri (H.L. Jones) Estee, Publ. Ataz. Zool. Napoli **15**: 378, 1936.

Ascomata ampulliform to subglobose, immersed in cystocarps and tetracarps of *Chondrus crispus*, ostiolate, papillate, coriaceous, pale-coloured, clypeus black, gregarious, pseudoparaphyses thin, septate, simple or branched, asci subclavate to subcylindrical, short pedunculate, thick-walled, bitunicate, ascospores elongate fusiform, 1-septate, slightly constricted at the septum, hyaline, no sheath or appendages. *Lautitia danica* grows on the cystocarps of the red alga *Chondrus crispus* throughout the year, but is more prevalent during November in British coastal waters (Stanley, 1992). Ascomata are globose and produced in the cortex of the alga beneath the epidermis. Ascospores are 33-40 × 5-8 µm. The relationship of the species within the family and order warrants further investigation.

Phaeosphaeria I. Miyake, Bot. Mag. **23**: 93, 1909.. (11)

Ph. capensis T.D. Steinke & K.D. Hyde, Mycoscience **38**: 101, 1997.

Ph. gessneri Shoemaker & C.E. Babc., Can. J. Bot. **67**: 1567, 1989.

◙ ***Ph. halima*** (T.W. Johnson) Shoemaker & C.E. Babc., Can. J. Bot. **67**: 1514, 1989.

Leptosphaeria halima T.W. Johnson, Mycologia **48**: 502, 1956.

Ph. macrosporidium (E.B.G. Jones) Shoemaker & C.E. Babc., Can. J. Bot. **67**: 1532, 1989.

Leptosphaeria macrosporidium E.B.G. Jones, Trans. Br. Mycol. Soc. **45**: 103, 1962.

Ph. neomaritima (R.V. Gessner & Kohlm.) Shoemaker & C.E. Babc., Can. J. Bot. **67**: 1572, 1989.

Leptosphaeria neomaritima R.V. Gessner & Kohlm., Can. J. Bot. **54**: 2032, 1976. (nom. nov. superfl.)

Sphaeria maritima Cooke & Plowr., Grevillea **5**: 120, 1877. (nom. illegit.)

Leptosphaeria maritima Sacc., Syll. Fung. (Abellini) **2**: 72, 1883.

Ph. olivacea Kohlm., Volkm.-Kohlm. & O.E. Erikss., Bot. Mar. **40**: 299, 1997.

Ph. orae-maris (Linder) Khashn. & Shearer, Mycol. Res. **100**: 1351, 1996.

Leptosphaeria oraemaris Linder, Farlowia **1**: 413, 1944.

Ph. roemeriani Kohlm., Volkm.-Kohlm. & O.E. Erikss., Can. J. Bot. **76**: 470, 1998.

◙ ***Ph. spartinae*** (Ellis & Everh.) Shoemaker & C.E. Babc., Can. J. Bot. **67**: 1573, 1989.

Leptosphaeria spartinae Ellis & Everh., J. Mycol. **1**: 43, 1885.

Leptosphaeria sticta Ellis & Everh., J. Mycol. **1**: 43, 1885.

◙ ***Ph. spartinicola*** Leuchtm. Mycotaxon **41**: 2, 1991.

◙ ***Ph. typharum*** (Desm.) L. Holm., Symb. Bot. Ups. **14**: 126, 1957.

Sphaeria scirpicola var. *typharum* Desm., Platentes Crypt. France ed. **2**: 1778, 1849.

Sphaeria typharum (Desm.) Raben., Herb. Myc. ed **2**: 731, 1858.

Pleospora typharum (Desm.) Fuckle, Symb. Mycol. 137, 1870.

Leptosphaeria typharum (Desm.) Karst., Bidr. Känn. Finl. Nat. Folk **23**: 100, 1873.

Sphaeria perpusilla var. *typharum* Auers., Rabenhorst Fungi Europaeae: 831, 1865.

Anamorph: *Scolecosporiella typhae* (Oudem.) Petrak, Ann. Mycol. **19**: 31, 1921.

Ascomata subglobose, pyriform to ellipsoidal, immersed, ostiolate, papillate, coriaceous, dark brown, solitary or gregarious, pseudoparaphyses septate, filamentous, in a gelatinous matrix, branched, anastomosing, asci clavate to cylindrical, short pedunculate, bitunicate, fissitunicate, ocular chamber present, J-, lacking with or without an apical apparatus, ascospores fusiform to ellipsoidal, multi- septate, slightly constricted at the septa, yellowish to pale brown, with or without a gelatinous sheath, lacking appendages.

Phaeosphaeria species are generally parasites of grasses, sedges, rushes and other monocotyledons, although many of the marine species are saprophytes, with anamorphs (where known) in *Stagonospora*. A number of new species have recently been added to this genus, and others transferred from *Leptosphaeria*: *Ph. albopunctata*, *Ph. halima, Ph. macrosporidium, Ph. neomaritima*, *Ph. orae-maris* and *Ph. spartinae* (Shoemaker and Babcock, 1989; Khashnobish and Shearer, 1996a, b). Most of these transfers are made on the basis of the colour of the ascospores. The characters delineating *Leptosphaeria* and *Phaeosphaeria* are discussed under the former genus. *Phaeosphaeria* has ascomata which range from small to large and are generally superficial on the substratum, with generally monocotyledonous hosts. The position of *Ph. typharum* is questionable with Leuchtmann (1984) rejecting its inclusion in *Phaeosphaeria*. Shoemaker and Babcock (1989) retain it in the genus for the present. *Phaeosphaeria roemeriani* is a rare species growing on *Juncus roemerianus,* between 6-52 cm above the rhizome, and is almost permanently inundated by seawater (Kohlmeyer and Kohlmeyer, 1998e) (Fig. 21).

1. Ascospores 3-septate.. 2
1. Ascospores more than 3-septate.............................. 8

2. On *Juncus* 3
2. On other substrata 4

3. Ascospores 16-21 × 4-5 µm, fusiform ....
.... ***Ph. olivacea***
3. Ascospores 23-35 × 9-13 µm, fusiform ....
.... ***Ph. Roemeriani***

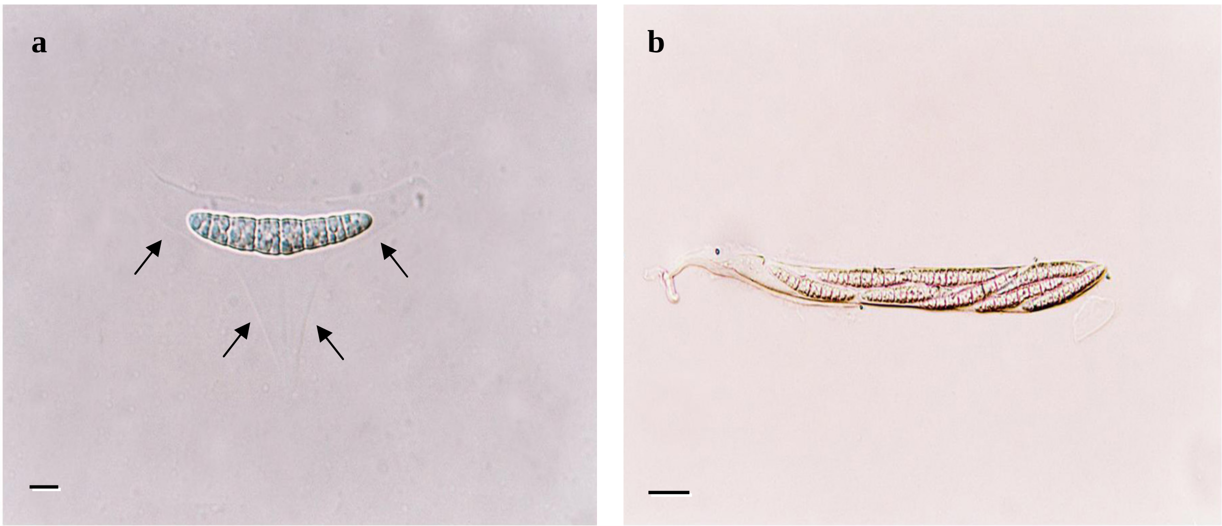


Fig. 20. *Carinispora nypa.* **a.** 7-septate, yellow to pale-brown ascospore with a keel-shaped sheath (arrows). **b.** Clavate ascus with an ocular chamber. Bars a = 10 µm; b = 20 µm.

4. On *Spartina*..5
4. On other substrata 6

5. Ascospores 12-18 × 5-8 µm, yellow-brown, also on driftwood..***Ph. halima***
5. Ascospores 23-35 × 9-13 µm, yellow-brown to brown, only on *Spartina*..................***Ph. spartinicola***

6. Ascospores less than 8 µm wide, golden-brown, echinate 17-24 × 6-8 µm.................. ***Ph. orae-maris***
6. Ascospore wider than 8 µm 7

7. Ascospores (21-) 24-39 (-35) × 8-12 µm, reddish-brown, on *Typha* ....***Ph. typharum***
7. Ascospores 45-68 (-72) × 10-14 µm, hyaline to pale yellow, on wood, *Juncus* and *Spartina* .... ***Ph. macrosporidium***

8. On wood, ascospores 29-36 × 7-8 µm, 6-7-septate, clavate .... ***Ph. capensis***
8. On salt marsh grasses..9

9. Ascospores with no sheath, 35-40 (-52) × 9-11 (-14), 5-septate, yellow-brown, on *Spartina* ....***Ph. spartinae***
9. Ascospores with a sheath 10

10. Ascospores 68-85 × (10-) 15-20 µm, 6-7-septate, yellowish-brown, on *Spartina* ....***Ph. gessneri***
10. Ascospores (30-) 32-45 × (6-) 8-14 µm, 3-5-septate, yellowish-brown, on *Juncus*...................... ....***Ph*. *Neomaritima***

8. Pleosporaceae

Decorospora Inderb., Kohlm. & Volkm.-Kohlm., Mycologia **94**: 657, 2002............... (1)
◙ ***D. gaudefroyi*** (Pat.) Inderb., Kohlm. & Volkm.-Kohlm., Mycologia **94**: 657, 2002 (*Type species*).

Pleospora gaudefroyi Pat., Tabulae Analticae Fungorum, Paris **2**: 40, 1886.

Pleospora salsolae Fuckel var. *schoberiae* Sacc., Michelia **2**: 69, 1880.

Pleospora schoberiae (Sacc.) Berl., Icon. Fung. **2**: 23, 1895.

Pleospora lignicola J. Webser & M.T. Lucas, Trans Br. Mycol. Soc. **44**: 431, 1961.

Pleospora salicorniae Jaap, Verh. Bot. Ver. Prov., Brandenburg **49**: 16, 1907.

Pleospora herbarum (Fr.) Rabenh. var. *salicorniae* (Jaap) Jaap, Ann. Mycol. **14**: 17, 1916.

Ascomata subglobose to ellipsoidal, immersed, ostiolate, epapillate or with a short papilla, carbonaceous, black, solitary to gregarious, pseudoparaphyses septate, ramose, asci clavate, short pedunculate, thick-walled, bitunicate, without an apical apparatus, ascospores ellipsoidal, muriform, brown, with a mucilaginous sheath slightly constricted at the center and drawn out at each apex into 2-3 subconical extensions (Inderbitzin *et al*., 2002). This genus was introduced to accommodate *Pleospora gaudefroyi* as it forms a sister taxon

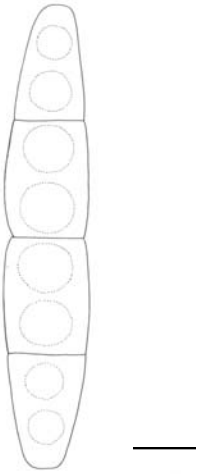


Fig. 21. *Phaeosphaeria roemeriani.* Three-septate ascospore. Bar = 5 µm.

to *Alternaria alternata, Cochliobolus sativus, Pleospora herbarum, Pyrenophora tritici-repentis* and *Setosphaeria rostrata* within the Pleosporaceae (Inderbitzin *et al*., 2002). The genus differs from *Pleospora* at the molecular and morphological level, especially the well developed gelatinous sheath drawn into 2-4 subconical extensions (Yusoff *et al*., 1994b).

Helicascus Kohlm., Can. J. Bot. **47**: 1471, 1969..(2)

◙ ***H. kanaloanus*** Kohlm., Can. J. Bot. **47**: 1471, 1969 (*Type species).*

◙ ***H. nypae*** K.D. Hyde, Bot. Mar. **34**: 314, 1991.

Ascomata ampulliform, lenticular, horizontally arranged under a black pseudoclypeus, immersed, ostiolate, carbonaceous, centrum in 3-5 locules, papillate, periphysate, pseudoparaphyses numerous, persistent, asci subcylindrical to oblong-clavate, pedunculate, thick-walled, bitunicate, with an apical apparatus, ascospores obovoidal, 1-septate, constricted at the septum, dark-brown, spore wall thick, 2-layered, no appendages, lacking or with a sheath. A well characterized genus, the ascomata with many locules, a coiled endoascus, thick-walled brown ascospores with a prominent germ pore growing on mangrove wood. Initially classified in the Dothideomycetes *incertae sedis*, it can now be assigned to the Pleosporales, Pleosporaceae with confidence, as it forms a well supported clade with *Kirschsteiniothelia elaterascus* (Shearer, 1993a; Tam *et al*., 2003). Common characters for taxa in this clade include: persistent, anastomosing hyphal-like pseudoparaphyses, a coiled endoascus, which uncoils when the spores are released. The genus is monophyletic, with *H. nypae* found on the palm *Nypa fruticans* that differs from the type species in having smaller ascospores, a verrucose wall and a persistent sheath (Hyde, 1991b).

1. Ascospores 25-35 × 12-15 µm, ascospore wall verrucose with a persistent sheath, on the palm *Nypa fruticans* .... ***H. nypae***
1. Ascospores 30-55 × 17-25 µm, wall smooth, ascospores lacking a sheath, on mangrove wood....... ....***H. kanaloanus***

Falciformispora K.D. Hyde, Mycol. Res. **96**: 26, 1992... (1)

◙ ***F. lignatilis*** K.D. Hyde, Mycol. Res. **96**: 27, 1992 (*Type species*).

A little known species described from mangrove wood from Mexico (Hyde, 1992b), characterised by ascomata that are black, soft-walled, superficial with a rounded ostiole, bitunicate asci with an ocular chamber, wide and cellular pseudoparaphyses and fusiform, hyaline, 6-8-septate ascospores, slightly constricted at the septa, surrounded by a thin mucilaginous sheath and single scythe-like appendage at its base.

Pleospora Rabenh. ex. Ces. & De Not., Comment. Soc. Crittogam. Ital. **1**: 217, 1863 ... . (6)

◙ ***P. gracilariae*** E.G. Simmons & S. Schatz, Mem. N. Y. Bot. Gard. **49**: 305, 1989.

◙ ***P. pelagica*** T.W. Johnson, Mycologia **48**: 504, 1956.

P*. *pelvetiae G.K. Sutherl., New Phytol. **14**: 41, 1915.

◙ ***P. spartinae*** (J. Webster & M.T. Lucas) Apinis & Chesters, Trans. Br. Mycol. Soc. **47**: 432, 1964.

Pleospora vagans var. *spartinae* J. Webster & M.T. Lucas, Trans. Br. Mycol. Soc. **44**: 427, 1961.

◙ ***P. triglochinicola*** J. Webster, Trans. Br. Mycol. Soc. **53**: 481, 1969.

Anamorph: *Stemphylium triglochinicola* B. Sutton & Piroz., Trans. Br. Mycol. Soc. **46**: 519, 1963.

Marine *Pleospora* species occur on wide range of hosts, *Tamarix aphylla* twigs, seaweeds and salt marsh plants. Ascomata solitary or gregarious, globose, leathery to subcarbonaceous, immersed, ostiolate, papillate, pseudoparaphyses numerous, asci cylindrical to clavate, pedunculate, thick-walled, ascospores ellipsoid, clavariform or fusiform, muriform, with transverse and longitudinal septa, generally constricted at the septa, yellowish or pale brown with gelatinous sheaths.

Although *Pleospora* species frequently have anamorphs, the only marine species with an anamorph is *P. triglochinicola* (*Stemphylium triglochinicola*). The genus *Pleospora* is polyphyletic (Kodsueb *et al*., 2006) and as evidenced by the transfer of the marine *P. gaudefroyi* to *Decorospora*. Further studies are required to determine if marine species are correctly assigned to this genus as species such as *P. bjoerlingii* and *P. iqbalii* show no affinity with other *Pleospora* species (Kodsueb *et al*., 2006).

1\. On algae 2
1\. On other substrate 3

2\. Ascospores with pronounced gelatinous sheaths 28-29.5 × 3-13.5 µm, on *Gracilaria* .... ***Pl. gracilariae***
2\. Ascospores with 6-7 trans-septa, several longisepta, 25-35 × 12-17 µm, on the brown alga, *Pelvetia* .... ***Pl. pelvetiae***

3\. Ascospores with 5 trans-septa, 1 longiseptum, 24-28 × 10-13 µm, on the marsh angiosperm *Spartina* .... ***Pl. spartinae***
3\. Ascospores with 7 trans-septa, 1-3 longisepta, 45-66 × 16-25 µm, on the salt marsh plant *Triglochin* .... ***Pl. triglochinicola***
3\. Ascospores with 7-9 trans-septa, 1 longiseptum, 35-52 × 10-15 µm, on *Spartina* .... ***Pl. pelagica***

Tremateia Kohlm., Volkm.-Kohlm. & O.E. Erikss., Bot. Mar. **38**: 165, 1995 .... (1)
T. halophila Kohlm., Volkm.-Kohlm. & O.E. Erikss., Bot. Mar. **38**: 166, 1995 (*Type species*).

Anamorph: *Phoma* sp.

Ascomata immersed, no ostiole, subcarbonaceous, brown, pseudoparaphyses septate, thickened at their tips, asci clavate, short pedunculate, thick-walled, ascospores ellipsoidal, yellowish-brown, muriform, with 3 transverse septa and 2-4 longitudinal septa, end cells slightly paler, with a thick gelatinous sheath ("perispore"). Forms pycnidia in culture (Kohlmeyer *et al*., 1995b).

This ascomycete occurs on senescent culms of *Juncus roemerianus* and is regularly immersed at high tide in salt marshes, although regarded as a facultative species by Kohlmeyer *et al*. (1995b). Distinguished from similar genera (*Lewia, Diademosa*), by the apical cap to the ascus, J- ocular chamber, ascospores with a wide mucilaginous sheath (up to 25 µm), ascomata not papillate, and with a *Phoma*-like anamorph.

9. Teichosporaceae

Byssothecium Fuckel, Bot. Ztg. **19**: 251, 1861 .... (1)
◙ ***B. obiones*** (P. Crouan & H. Crouan) M.E. Barr, Mycotaxon **82**: 378, 2002.

Passeriniella obiones (P. Crouan & H. Crouan) K.D. Hyde & Mouzouras, Trans. Br. Mycol. Soc. **91**: 183, 1988.

Pleospora obiones P. Crouan & H. Crouan, Florule Finistère (Paris): 22, 1867.

Leptosphaeria discors Sacc. & Ellis, Michelia **2**: 567, 1882.

Leptosphaeria obiones (P. Croun & H. Crouan) Sacc., Syll.fung. (Abellini) 2 : **24**, 1883.

Leptosphaeria obiones f. *evolutior* Grove, J. Bot. (Lond.) **71** : 281, 1933.

Didymosphaeria spartinae Grove, J. Bot (Lond.) **71**: 259, 1933.

Metasphaeria discors (Sacc. & Ellis) Sacc., Syll. Fung. **2**: 173, 1883.

Passeriniella discors (Sacc. & Ellis) Apinis & Chesters, Trans. Br. Mycol. Soc. **47**: 432, 1964.

Passeriniella incarcerata Berl., Icon. Fung **1**: 51, 1892.

Ascomata subglobose or ellipsoidal, immersed to erumpent, ostiolate, subcarbonaceous, dark brown to black, gregarious. Pseudoparaphyses septate, ramose, asci clavate to subcylindrical, short pedunculate, thick-walled, without an apical apparatus, ascospores versicoloured, end cell hyaline, central cells brown, 3-septate, and constricted at the septa. This common ascomycete on decaying *Spartina* culms has been assigned variously to the genera: *Pleospora*, *Leptosphaeria*, and *Passeriniella* (Hyde and Mouzouras, 1988; Barr, 2002). Khashnobish and Shearer (1996a, b) showed that based on molecular analysis *Passeriniella obiones* did not belong in either *Leptosphaeria* or *Phaeosphaeria*. Barr (2002) assigned the species to *Byssothecium* based on its versicolorous ascospores, two dark brown central cells and hyaline terminal cells.

PLEOSPORALES *incertae sedis*

Aigialus Kohlm. & S. Schatz, Trans. Br. Mycol. Soc. **85**: 699 .... (4)
◙ ***A. grandis*** Kohlm. & S. Schatz, Trans. Br. Mycol. Soc. **85**: 699, 1985 (*Type species*).
◙ ***A. mangrovei*** Borse, Trans. Br. Mycol. Soc. **88**: 424, 1987.
◙ ***A. parvus*** S. Schatz & Kohlm., Trans. Br. Mycol. Soc. **85**: 704, 1985.
◙ ***A. striatispora*** K.D. Hyde, Mycol. Res. **96**: 1044, 1992.

Ascomata globose, completely immersed in a black stroma, ostiolate, apapillate, carbonaceous, to coriaceous, black, gregarious, pseudoparaphyses trabeculate, unbranched and anastomosing above the asci, asci cylindrical, pedunculate, thick-walled, apical apparatus, ascospores ellipsoidal to broadly fusiform, muriform, slightly constricted at the septa, dark brown, with hyaline to light brown apical cells, subapical cells covered by a gelatinous sheath.

This genus was initially assigned to the Melanommatales (Kohlmeyer and Schatz, 1985), but referred to the Massariaceae, Pyrenulales by Hawksworth *et al*. (1995). The genus is best accommodated in the Pleosporales, but further studies are required with a greater number of taxa, to assign them to a family with confidence (Tam *et al*., 2003). Sequence data confirms their placement within the Pleosporales and preliminary data suggests an affinity with the Sporormiaceae (Suetrong, pers. comm.), however, the latter have brown, phragmosporous ascospores with germ slits to each cell. In *Aigialus* the ascospores are brown, muriform and lack germ slits. They also differ significantly in ascoma morphology, ascus shape, pseudoparaphyses morphology and in the substrata on which they grow. *Aigialus* species also form a sister group to *Ascocratera manglicola* (Suetrong, pers. comm.). The position of *A. striatispora* in the genus needs to be re-evaluated. *Aigialus rhizophorae* is a *nomen rejectum*.

1. Ascospores with 6 transverse-septate (rarely 8)....... 2
1. Ascospores with more than 8 transverse-septate 3

2. Ascospores 35-55 × 10-16 µm, wall smooth .... ***A. mangrovei***
2. Ascospores 26-38 × 16-19.5 µm, wall with striations .... ***A. striatispora***

3. Ascospores 44-74 × 19-27 µm, (9) 10-11 (-12) tranverse-septa .... ***A. parvus***
3. Ascospores 67-101 × 18-29 µm, with more than 13 transverse-septa... ***A. grandis***

Biatriospora K.D. Hyde & Borse, Mycotaxon **26**: 263, 1986 .... (1)
◙ ***B. marina*** K.D. Hyde & Borse, Mycotaxon **26**: 264, 1986 (*Type species*).

Assigned to the Melanommatales by Hyde and Borse (1986) its taxonomic position remains unresolved, characterized by its large (over 850 µm long) submerged, elongate ascomata in mangrove wood, bitunicate, branched pseudoparaphyses, cylindrical asci with an apical apparatus and a long pedicel and brown to dark-brown, 2-4 septate at each end of the ascospores that are fusiform with a globose end cell. Hyde and Borse (1986) refer to these as end chambers or appendages, but no mucilage is released from them as in *Lulworthia* species. Molecular data confirm its position in the Pleosporales, but it can not be assigned to any family in the order (Fig. 17) (Suetrong *et al*., unpublished data).

Didymella Sacc., Michelia **2**: 57, 1880...............(4)
D. avicenniae S.D. Patil & Borse, Trans. Mycol. Soc. Jpn. **26**: 271, 1985.
◙ ***D. fucicola*** (G.K. Sutherl.) Kohlm., Phytopath. Z. **63**: 342, 1968.

Didymosphaeria fucicola G.K. Sutherl., New Phytol. **14**: 189, 1915.

Didymosphaeria pelvetiana G.K. Sutherl., New Phytol. **14**: 186, 1915.

D. gloiopeltidis (Miyabe & Tokida) Kohlm. & E. Kohlm., Marine Mycology. The Higher Fungi 382, 1979.

Guignardia gloiopeltidis Miyabe & Tokida, Bot. Mag. **61**: 118, 1948.

D. magnei Feldmann, Rev. Gén. Bot. **65**: 414, 1958.

Ascomata solitary, globose, immersed or erumpent, ostiolate, papillate, dark in colour, pseudoparaphyses filiform, asci cylindrical, short pedunculate, thickened apex, ascospores ovoid to ellipsoidal, 1-septate, constricted at the septum, hyaline with no sheaths or appendages. Most species occur on the larger marine algae, with *D. avicenniae* the exception, growing on mangrove wood. Revision of the marine species is required.

1. On mangrove wood (*Avicennia* species), ascospores 25-32 × 10-15 µm, with a sheath ....***D. avicenniae***
1. On algae 2

2. Ascospores narrower than 4 µm, 8-16 × 2-4 µm, parasite of *Rhodymenia*.............................***D. magnei***
2. Ascospores wider than 4 µm....................................3

3. Ascospores 16-23 × 6-8 µm, saprobic on brown seaweeds, with a sheath ....***D. fucicola***
3. Ascospores 14-22 × 4-6 µm, parasitic on the red alga *Gloiopeltis*, no sheath........................ ***D. gloiopeltidis***

Halotthia Kohlm., Nova Hedw. **6**: 9, 1963 . (1)

H. posidoniae (Durieu & Mont.) Kohlm., Nova Hedw. **6**: 9, 1963 (*Type species*).

Sphaeria posidoniae Durieu & Mont., Expl. Sci. Algérie, Bot. 1: 502. 1849.

Amphisphaeria posidoniae (Durieu & Mont.) Ces. & De Not., Comment. Soc. Crittog. Ital **1**: 224, 1863.

Stromata thick, black, subepidermal in host cortex. Ascomata broadly conical to semiglobose, enclosed in a stroma, immersed becoming erumpent, ostiolate, epapillate, carbonaceous, pseudoparaphyses septate, ramose, persistent, asci cylindrical, attenuate at the base, short pedunculate, thick-walled, bitunicate, persistent, ascospores ellipsoidal, subcylindrical to obtuse-fusiform, 1-septate, constricted at the septum, dark brown, wall thickened at both ends, no sheath or appendages (Fig. 22) (Kohlmeyer and Kohlmeyer, 1964-1969). Known only from material on the sea grass *Posidonia oceanica* and sometimes confused with *Pontoporeia biturbinata*, but differs in that it has triangular ascomata with the asci produced in a layer at the base of the ascomata, pseudoparaphyses filiform, branching, asci cylindrical, bitunicate, and ascospores 1-septate dark brown and only slightly constricted at the septum. Along with *Pontoporeia biturbinata* the species was initially assigned to the Pleosporaceae and thought to be related to *Caryospora*, *Herpotrichia* and *Otthia* (Kohlmeyer, 1963). However, its relationship to other taxa in the family, is in need of investigation.

Heleiosa Kohlm., Volkm.-Kohlm. & O.E. Erikss., Can. J. Bot., **74**: 1830, 1996........... (1)

H. barbatula Kohlm., Volkm.-Kohlm. & O.E. Erikss., Can. J. Bot., **74**: 1830-1832, 1996 (*Type species*).

Ascomata globose, immersed, ostiolate, epapillate, clypeate (2-3 under a small clypeus), coriaceous, hyaline at the base, light brown at the sides, pseudoparaphyses branched and anastomosing, septate, in a gelatinous matrix, asci cylindrical, short pedunculate, thick-walled, refractive apical apparatus over the ocular chamber, ascospores ellipsoidal to fusiform, 1-septate, slightly constricted at the septum, pale brown, with 10 or more cilia-like polar appendages. The species can be considered marginally marine as it occurs 42-67 cm above the rhizomes of *Juncus roemerianus*. Kohlmeyer *et al.* (1996) were unable to assign it to any family in the Dothideomycetes although they referred to similarity to *Appendispora frondicola* (Hyde, 1994a). The latter species was placed in the Dothideales *incertae sedis* by Kirk *et al.* (2001).

Julella Fabre, Annls. Sci. Nat. Bot, sér. 6, **9**: 113, 1879.. (2)

◙ ***J. avicenniae*** (Borse) K.D. Hyde, Mycol. Res. **96**: 939, 1992.

Pleospora avicenniae Borse, Curr. Sci. India **56**: 1109, 1987.

J. herbatilis Kohlm., Volkm.-Kohlm. & O.E. Erikss., Bot. Mar. **40**: 296, 1997.

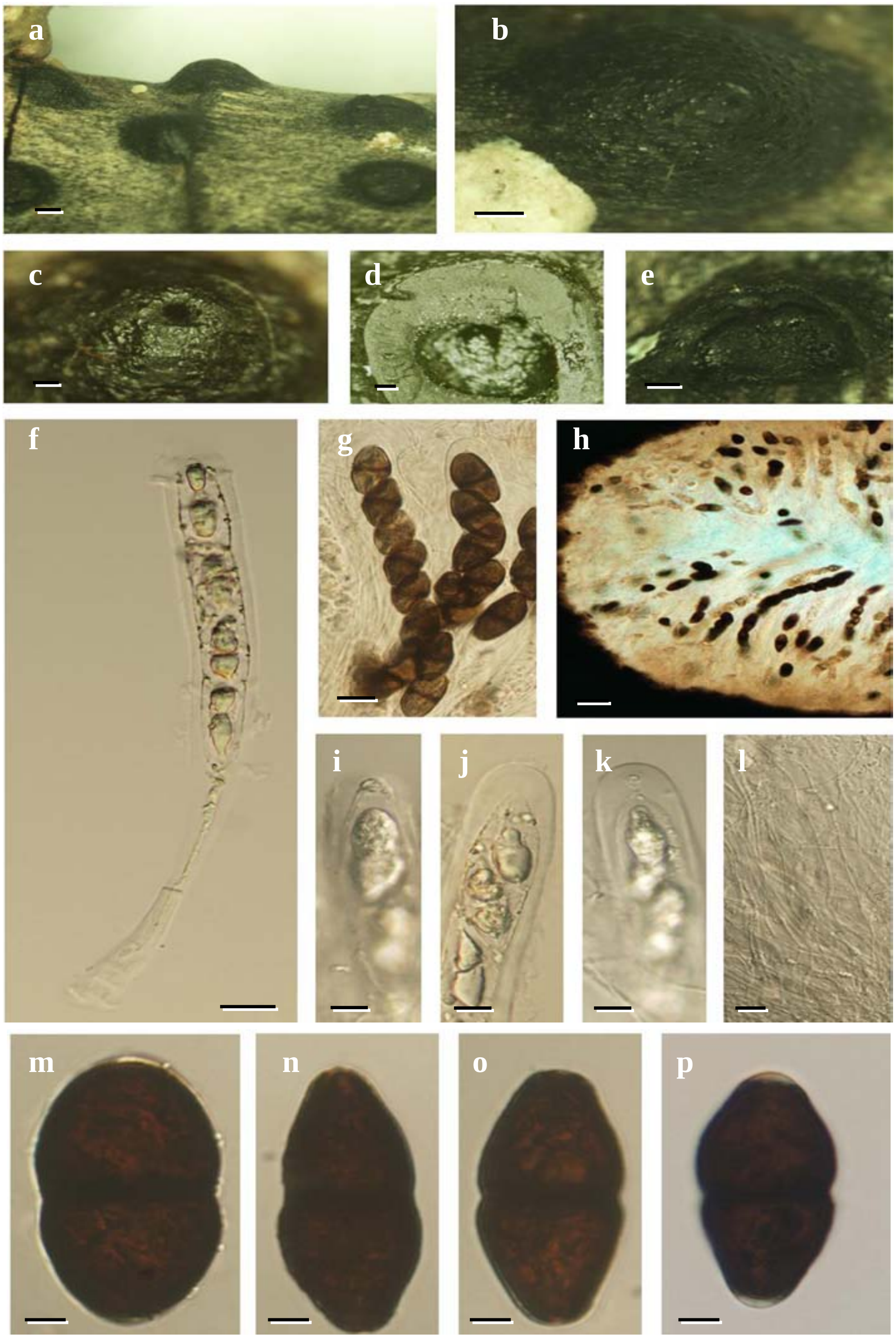


Fig. 22. *Halotthia posidoniae*. **a**. Ascomata conical partly immersed in rhizomes of the sea grass *Posidonia oceanica*. **b**. Surface of ascoma is rough. **c-d**. Ostiolar region of ascomata. **f**. Cylindrical ascus. **g-h**. Asci and pseudoparaphyses arising from basal ascogenous tissue. **i-k**. Apical region of asci with an apical pore. **l**. Thin walled anastomosing pseudoparaphyses. **m-p**. Thick-walled, 1-septate ascospores. Bars a = 500 µm; b, e = 200 µm; c-d, h = 100 µm; f-g, l = 20 µm; i-k, m-p = 10 µm.

Ascomata subglobose, obpyriform to ellipsoidal, immersed becoming erumpent, ostiolate, papillate to epaplliate, coriaceous, clypeate, brown to dark brown, solitary or gregarious, pseudoparaphyses septate, branching and anastomosing, asci clavate to cylindrical, short pedunculate, thick-walled, bitunicate, fissitunicate, ocular chamber apical ring J-, ascospores elipsoidal, muriform, 7-8-transeptate, 1-longiseptate, constricted at the septa, golden-brown, with a gelatinous sheath.

Julella avicenniae was originally described as a *Pleospora* species, but transferred to *Julella* on the basis of it possessing ascomata that develop on woody substrata, immersed beneath a clypeus, the peridium with a single layer of elongated cells, and narrow pseudoparaphyses (Hyde, 1992c). However, it is frequently found on the aerial twigs of *Avicennia marina* in Morib mangrove, Malaysia damaged by a moth larva (Jones, unpublished data).

Although clustering within the Pleosporales, its relationship with other taxa in the order cannot be inferred from data currently available (Tam *et al*., 2003). In a new analysis, *J. avicenniae* forms a sister clade to one comprising *Helicascus*, *Massarina velataspora* and *Kirschsteiniothelia elaterascus* (Suetrong *et al*., unpublished data).

A second maritime species occurs on the senescent leaves of *Juncus roemerianus*, some 23-118 cm above the rhizome. Kohlmeyer *et al*. (1997) regarded *J. herbatilis* as facultatively marine. It is included in the key below for comparison with *J. avicenniae*.

1. On mangrove wood (*Avicennia* species), ascospores 28-36 × 12-16 µm, hyaline but generally brown........ .... ***J. avicenniae***
1. Facultatively marine on culms of *Juncus roemerianus*, ascospores 18-22.5 × 5-6.5 µm, hyaline..***J. herbatilis***

Kirschsteiniothelia D. Hawksw., Bot. J. Linn. Soc. **91**: 183, 1985 .... (1)

◙ ***K. maritima*** (Linder) D. Hawksw., Bot. J. Linn. Soc. **91**: 193, 1985.

Amphisphaeria maritima Linder, Farlowia **1**: 411, 1944.

Microthelia maritima (Linder) Kohlm., Nova Hedw. **2**: 322, 1960.

Microthelia linderi Kohlm., Trans. Br. Mycol. Soc. **57**: 483, 1971.

Ascomata on driftwood, bark, or coniferous wood, ascomata small (57-128 µm high, 104-268 µm in diameter), semiglobose, superficial, ostiolate, short papillate, carbonaceous, black and gregarious. Pseudoparaphyses septate, anastomosing, asci clavate to elongate-ellipsoidal, pedunculate, thick-walled lacking an apical apparatus, and ascospores brown, 1-septate and constricted at the septum.

The genus *Kirschsteiniothelia* has been referred to the Pleosporaceae (Eriksson and Hawksworth, 1981; Kirk *et al*., 2001), Pleomassariaceae (Barr, 1993), and questionably the Massarinaceae (Kodsueb *et al*., 2006). The genus appears to be polyphyletic (Shearer, 1993a) and Schoch *et al*. (2006) are of the opinion that *K. aethiops* does not belong in the Pleosporaceae. Kodsueb *et al*. (2006) show that *K. elaterascus* (a freshwater species) clusters with *Massarina ramunculicola* in a sister clade to the Melanommataceae. However, *K. elaterascus* differs from *K. maritima,* and other *Kirschsteiniothelia* species, in ascus structure, its unusual endoascus with a long coiled base that uncoils during ascus dehiscence, ascospore measurements, the presence of an ascospore sheath and its freshwater occurrence (Shearer, 1993a).

Leptosphaerulina McAlpine, Fung. Diseas. Stone-Fruit Trees: 103, 1902 .... (1)

L. mangrovei Inderb. & E.B.G. Jones, Mycoscience **41**: 233, 2000.

Ascomata erumpent on wood, dark brown, globose, papillate, ostiolate, membranous, with dark brown septate, hyphae anchoring ascoma to substratum, pseudoparaphyses sparse, asci elongate to saccate, clavate, few in number, persistent in nature but deliquescing in culture, ascospores light brown, muriform with 4-5 trans-septa and 1-2 longitudinal septa, thin-walled, ellipsoidal to oval, apical cell may be hyaline, with pronounced sheath constricted at the central septum (Fig. 23).

The first marine species of *Leptosphaerulina* reported from submerged attached decaying branches of the mangrove tree *Kandelia candel* (Inderbitzin *et al*., 2000), also found on the herbaceous mangrove plant *Acanthus ilicifolius* (Jones, pers. observ.) Few *Leptosphaerulina* species occur in warmer climates, while this fungus is the only species found on wood and in the marine environment. Its occurrence in the Pearl River Estuary may be explained by the variable salinity of the water, which ranges from 5-24 ‰

The genus includes some 50 names and is generally referred to the Pleosporaceae (Eriksson and Hawksworth, 1991; Kirk *et al*., 2001), although Kodsueb *et al*. (2006) find that *Leptosphaerulina* and *Macroventuria* are phylogenetically related with no affinities with the Pleosporaceae. These two genera lack pseudoparaphyses, a taxonomic character that differentiates the Pleosporales from the Dothideales. We therefore refer the genus to Dothideomycetes *incertae sedis*.

Lineolata Kohlm. & Volkm.-Kohlm., Mycol. Res. **94**: 687, 1990 .... (1)

◙ ***L. rhizophorae*** (Kohlm. & E. Kohlm.) Kohlm. & Volkm.-Kohlm., Mycol. Res. **94**: 688, 1990 (*Type species*).

Didymosphaeria rhizophorae Kohlm. & E. Kohlm., Icones Fungorum Maris, 4/5: 62a, 1967.

Lojkania rhizophorae (Kohlm. & E. Kohlm. M.E. Barr, N. Amer. Flora, Ser, 2, **13**: 58, 1990.

Ascomata obpyriform, immersed to superficial, ostiolate, papillate, subcarbonaceous to subcoriaceous, periphysate, and dark brown to black, pseudoparaphyses trabeculate, in a gelatinous matrix, asci cylindrical, short pedunculate and ascospores 1-septate, ellipsoidal, brown with surface sculpturing. Originally described as *Didymosphaeria rhizophorae* (Didymosphaeriaceae, Melanommatales), but transferred to this new genus because it differs in the following features: no clypeus, almost superficial ascomata, a coloured peridium, a hamathecium with a gelatinous matrix, asci with an apical ring-like structure around the ocular chamber and ornamented ascospores Kohlmeyer and Volkmann-Kohlmeyer, 1990a). Molecular data confirm its position in the Pleosporales, but cannot be assigned to any family within the order (Suetrong *et al*., unpublished data). It forms a clade comprising *Massarina* species, and *Leptosphaeria bicolor*. Further taxon sampling is required to resolve its position.

Massariosphaeria (E. Müll.) Crivelli, Diss. Eidgenöss. Techn. Hochschule Zürich **7318**: 141, 1983.. (2)

◙ ***M. typhicola*** (P. Karst.) Leuchtm., Sydowia **37**: 168, 1984.

Leptosphaeria typhicola Karst. Mycol. Fenn. **2**: 100, 1873.

Leptosphaeria baldingerae Fautrey & F. Lamb., Revue Mycol., Toulouse, **19**: 53, 1897.

Leptosphaeria cladii Cruchet Bull. Soc. Vaud. Sci. Nat. **55**: 161, 1923.

Phaeosphaeria baldingerae (Fautrey & F. Lambotte) Hedjar., Sydowia **22**: 87, 1969.

Phaeosphaeria typhicola (P. Karst.) Hedjar., Sydowia **22**: 86, 1969.

Chaetomastia typhicola (P. Karst.) M.E. Barr, Mycotaxon **34**: 514, 1989.

◙ ***M. erucacea*** Kohlm., Volkm.-Kohlm., & O.E. Erikss., Can. J. Bot., **74**: 1835, 1996.

Ascomata subglobose, immersed, ostiolate, epapillate to papillate, coriaceous, light to dark brown, pseudoparaphyses septate, densely packed in a gelatinous matrix, asci cylindrical to clavate, short pedunculate, thick-walled, with an ocular chamber, ascospores fusiform, hyaline to light brown, 7-14-septate with a gelatinous sheath. Both species have pycnidia with globose, ovoid to ellipsoidal hyaline conidia.

Massariosphaeria typhicola has been assigned to different genera with Leuchtmann (1984) considering it best placed in *Massariosphaeria*, while Barr’s (1989) more recent review places it in *Chaetomastia*. Leuchtmann (1984) referred *Massariosphaeria* to the Lophiostomatceae while Barr (1989) places it in the Dacampiaceae. Later she assigned *Chaetomastia* to the new family Teichosporaceae (Pleosporales) (Barr, 2002). A molecular study is required to resolve the phylogeny of these genera.

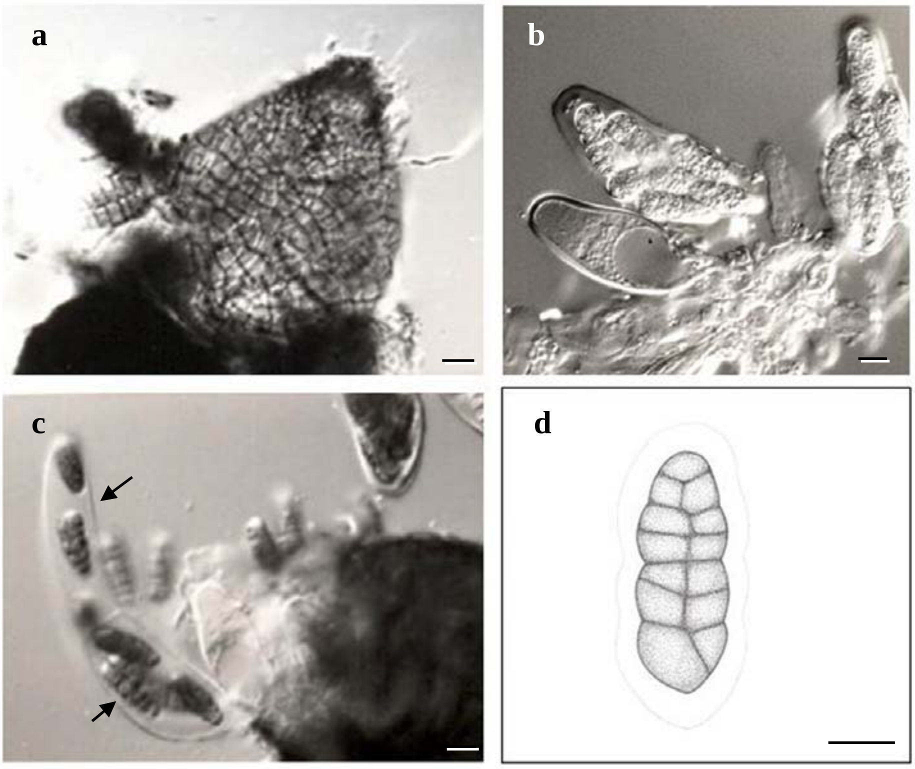


Fig. **23**. *Leptosphaerulina mangrovei*. **a**. Ascoma superficial on substratum. **b**. Immature asci. **c**. Ascus with ectoascus ruptured (lower arrow) and extension of the endoascus (upper arrow). **d**. Line drawing of ascospore. Bars a-d = 10 µm.

1. Ascospores 7-11-septate, 34-62 × 7-13 µm .... ***M. typhicola***
1. Ascospores 10-14-septate, 50-71.5 × 9-12 µm ....***M. erucacea***

Salsuginea K.D. Hyde, Bot. Mar. **34**: 315, 1991.. (1)
◙ ***S***. ***ramicola*** K.D. Hyde, Bot. Mar. **34**: 316, 1991 (*Type species*).

Ascomata fusiform, conical or subglobose, immersed under a dark clypeus, ostiolate, short neck, pseudoparaphyses thin-walled, numerous, anastomosing, asci cylindrical, pedunculate, fissitunicate, with an apical apparatus, large ocular chamber and prominent ring, ascospores 1-septate, constricted at the septum, brown to black, smooth-walled, with hyaline apical germ pores and lacking a sheath or appendages (Hyde, 1991b). *Salsuginea* differs from another mangrove bitunicate ascomycete *Helicascus* in lacking a stroma, as the ascomata are formed under a clypeus with a distinctive ocular chamber to the ascus and ascospores with prominent apical pores and lacking a mucilaginous sheath. Fresh material was not available for a molecular study, so its relationship to *Helicascus* can not be determined at this stage.

Tirisporella E.B.G. Jones, K.D. Hyde & Alias, Can. J. Bot. **74**: 1489, 1996.......................... (1)
T. beccariana (Ces.) E.B.G. Jones, K.D. Hyde & Alias, Can. J. Bot. **74**: 1490, 1996 (*Type species*).

Sphaeria beccariana Ces., Atti Acad. Sci. Fis. Mat. Napoli **8**: 20, 1880.

Melanomma cesatianum (Ces.) Sacc., Syll. Fungorum **2**: 113, 1883.

Gibberidea nipae Henn., Hedw. **47**: 257, 1908.

Tryblidiella beccariana (Ces.) Sacc. Syll. Fung. **2**: 758, 1883.

Anamorph: *Phialophora* cf. *olivacea*.

Probably one of the earliest ascomycetes described from the marine environment on the marine palm *Nypa fruticans* collected by Cesati (1880) in the Philippines and named *Sphaeria beccariana*. Hennings (1908) collected an identical taxon *Gibberidea nipae*.

This is a common species on the lower bases of *Nypa* fronds and the large, carbonaceous, immersed to superficial ascomata easily detected by touch. Pseudoparaphyses are unbranched and constricted at the septa, asci bitunicate, fissitunicate, thick-walled with an apical apparatus comprising a canal and pore, while ascospores are brown, 4-7 septate, verrucose with a polar appendage formed by the inversion of an apical sheath-like material (Fig. 24) (Jones *et al*., 1996). Referred to different orders including the Patellariales, it is best left as Pleosporales *incertae sedis* until molecular studies are undertaken to determine its phylogenetic position.

Fig. 24. *Tirisporella beccariana*. Light microscope micrographs. **a**. Ascus with short pedicel. **b, d**. Ascospores with pale or hyaline polar cell to which the appendage remains attached. **c**. Scanning electron micrograph, ascospore with polar appendage (Ap) formed by fragmentation of a sheath. Arrow highlight verrucose spore wall. Bars a-b = 20 µm; c = 5 µm, d = 10 µm.

Wettsteinina Höhn., Sber. Akad. Wiss. Wien, Math.-naturw. Ki., Abt. 1 **116**: 126, 1907.... (1)
W. marina (Ellis & Everh.) Shoemaker & C.E. Babc., Can. J. Bot. **67**: 1596, 1989.

Leptosphaeria marina Ellis & Everh., J. Mycol. **1**: 43, 1885.

Heptameria marina (Ellis & Everh.) Cooke, Grevillea **18**: 32, 1889.

Metasphaeria marina (Ellis & Everh.) Berl., Icon. Fung. **1**: 140, 1894.

Leptosphaeria treatiana Sacc., Syll. Fung. **10**: 923, 1892.

Ascomata scattered, immersed, ellipsoidal, ostiolate, papillate, periphyses lacking, glaborous, black, pseudoparaphyses, thin, septate, with a slime layer, asci numerous, cylindrical, short pedunculate, ascospores narrowly fusiform, straight or slightly curved 1-3-septate, constricted at the central septum, hyaline, smooth with a sheath. Shoemaker and Babcock (1989) transferred this species from *Leptosphaeria* to *Wettsteinina*, although they state “the type has hyaline ascospores that are variable in shape, long and slender and 1-septate when young, later broader and tardily appearing 3-septate forming a ring-like septa”. Kodsueb *et al*. (2006) examined the phylogenetic relationship of three *Wettsteinina* species and showed they were monophyletic, but distinct from the Pleosporaceae. Schoch *et al*. (2006) showed that *W. lacustris* also did not group within the Pleosporaceae clustering with *Massaria platani*. Placement in the Pleomassariaceae is suggested by Kodsueb *et al*. (2006) but further studies are required with wider taxon sampling.

DOTHIDEOMYCETES *incertae sedis*

1. Lirelliform ascomata, erumpent or superficial, opening by an elongate slit, interascal tissue narrow, cellular pseudoparaphyses, asci cylindrical, fissitunicate, ascospores hyaline or brown, septate, sometime with a mucilaginous sheath, anamorphs varied .... ***Hysteriales***

1. Stromata absent, ascomata erumpent, eventually apothecial, interascal tissue narrow anastomosing pseudoparaphyses, asci cylindrical, fissitunicate, I-, with ocular chambers, ascospores hyaline or brown, septate or muriform, usually no sheath, anamorphs. Anamorphs coelomycetes where known....................
....***Patellariales***

1. Ascomata perithecial, superficial rarely immersed, on a stalk, mycelium wide, asci clavate or cylindrical, pseudoparaphyses present, ascospores brown, generally 1-septate, with a sheath, anamorphs rare....
....***Jahnulales***

HYSTERIALES

Hysteriaceae

Gloniella Sacc., Syll. Fung. (Abellini) **2**: 765, 1883.. (1)

G. clavatispora Steinke & K.D. Hyde, Mycoscience **38**: 7, 1997.

A species collected at a number of sites in South Africa (Steinke and Jones, 1993; Steinke and Hyde, 1997a) and has dark-brown, rounded or discoid to cupulate, flat hysterothecioid ascomata, that are superficial and gregarious. Pseudoparaphyses swollen at the tips, rarely branching, septate, hyaline and longer than the asci. Asci clavate, short pedicel, bitunicate, fissitunicate and with an apical opercular chamber. Ascospores hyaline, smooth 5-8-septate and clavate. This resembles a *Patellaria* species collected in Hong Kong on *Kandelia candel*, but differs in that the paraphyses are not branched. Saprobic on intertidal *Avicennia marina*.

PATELLARIALES

Patellariaceae

Banhegyia L. Zeller & Toth, Sydowia **14**: 326, 1960.. (1)

B. setispora L. Zeller & Toth, Sydowia **14**: 327, 1960 (*Type species*).

Celidium proximellum var. *uralensis* Naoumov, Bull. Soc. Mycol. France **30**: 384, 1914.

Ascomata semiglobose, discoid, apothecial-like, erumpent, leathery, dark brown, pseudoparaphyses septate, simple, hyaline to light brown, extending beyond the asci, apically club-shaped, asci clavate to ellipsoidal, short pedunculate, no apical apparatus, ascospores ellipsoidal, 1-septate, constricted at the septa, hyaline to pale brown with bristle-like appendages at either end of the spore. Collected on coniferous wood with a restricted distribution (Kohlmeyer and Kohlmeyer, 1979). No molecular data is available to support its inclusion in the Patellariaceae and fresh collections are necessary to enable a re-evaluation of its phylogenetic relationship.

Patellaria Fr., Syst. Mycol. (Lundae) **2**: 158, 1822.. (1)

P. atrata (Hedw.) Fr., Syst. Mycol. 2: 160, 1822.

Recently a *Patellaria* species was collected on mangrove wood in Hong Kong (primarily on *Kandelia candel*) and Thailand. Numerous *Patellaria* species have been described, primarily from temperate locations, but none from marine habitats. A brief description follows as it is frequently encountered on mangrove wood.

Ascomata arising singly, initially closed, later opening by a pore to form a flat or convex black disc, apothecioid, superficial, sessile, circular, subgelatinous when moist, 0.3-0.9 (width) × 0.6 mm (high), (x = 0.7 × 0.57 mm, n = 38). Margin entire, raised and incurved. Outer surface of stalk smooth. Hypothecium thin-walled with isodiametric colourless cells 16-40 µm (x = 29.3 µm, n = 9). Hamathecium paraphysoidal, hyaline, branched above, 96-172 × 1-2 µm (x = 132.4 × 1.4 µm, n = 50). Asci cylindric-clavate, with a stipe, bitunicate, thick-walled, with ocular chamber in apical dome, fissitunicate, 8-spored, J- in Meltzer's reagent, 92-150 × 14-40 µm (x = 116 × 23 µm, n = 45). Ascospores irregularly biseriate, clavate, slightly curved, not constricted at the septa, 4-9-septate, hyaline, no mucilaginous sheath, 24-48 × 6-24 µm (x = 37.6 × 10.2 µm, n = 70) (Fig. 27).

No anamorph in culture.

Habitat: on badly decayed wood of *Kandelia candel*, Three Fathom Cove, Hong Kong SAR, China.

Distribution: Hong Kong SAR, China and Thailand.

JAHNULALES

Hypsostromataceae

Manglicola Kohlm. & E. Kohlm., Mycologia **63**: 840, 1971 .... (1)

◙ ***M. guatemalensis*** Kohlm. & E. Kohlm., Mycologia **63**: 841, 1971 (*Type species*).

Fresh collections of this unique ascomycete on *Nypa fruticans* in Thailand has enabled a re-evaluation of its phylogenetic relationship in the Dothideomycetes (Suetrong *et al*., 2009, in press). Ascomata 1100-1750 µm high, 290-640 µm around the center, obtusely clavate to fusiform, stipitate, peridium differentiated into several layers, superficial on the substratum, epapillate, coriaceous, solitary and olive brown. Pseudoparaphyses narrow, numerous, septate anastomosing, or simple, asci cylindrical, thick-walled, few in number and developing at the base of the ascomata, ascospores fusiform, apiculate, unequally 1-septate, constricted at the septum, apical cell larger, orange-brown to chestnut brown, basal cell turbinate, light brown, with a gelatinous appendage (Fig. 25).

Phylogenetically *Manglicola guatemalensis* is the first marine member of the Jahnulales, although the anamorphic fungus *Xylomyces rhizophorae* has also been reported from marine locations (Kohlmeyer and Volkmann-Kohlmeyer, 1998d). Recently a *Xylomyces* species has been shown to be an anamorphic species in the Jahnulales (Campbell *et al*., 2007). Initially *M. guatemalensis* was thought to be closely related to the Pleosporaceae or Venturiaceae (Kohlmeyer and Kohlmeyer, 1971) while Huhndorf (1992) and Huhndorf *et al*., (1994) classified it in the Hypostromataceae *incertae sedis*.

Morphological and molecular evidence places it in the Jahnulales with strong bootstrap support with *Aliquandostipite* species as a sister group (Fig. 26) (Suetrong *et al*., 2009, in press). This is yet another marine lineage and is of particular interest as all other Jahnulales members are freshwater or peat swamp species (Pang e*t al*., 2002; Pinruan *et al*., 2002). It has been hypothesised that marine fungi are derived from terrestrial or freshwater habitats that have migrated into the sea (Shearer, 1993c; Jones, 2000). The mangrove habitat of *M. guatemalensis* may well form a link between lignicolous freshwater taxa and estuarine to marine environments. Vijaykrishna *et al*. (2006) have examined the ancestry of freshwater taxa from terrestrial species and conclude this migration occurred 390 million years ago.

EUROTIOMYCETES

1. Saprobic, parasitic or mycorrhizal, ascomata generally cleistothecial, globose, brightly coloured, hamathecial elements lacking, asci evanescent, scattered throughout ascoma, ascospores unicellular, lenticular, sphaerical or elliptical .... **Eurotiomycetidae**

1. Lichenized, parastic and saprobic, ascomata perithecial, superficial or immersed in a thallus, asci clavate to cylindrical, hamathecium of pseudoparaphyses, ascospores variable, hyaline to brown, simple or muriform .... **Chaetothyriomycetidae**

EUROTIOMYCETIDAE

Two orders with marine taxa.

1. Peridium composed of thick-walled cells, ascomatal appendages present ....**Onygenales**
1. Peridium thin, membranous, no ascomatal appendages...**Eurotiales**

ONYGENALES
Gymnoascaceae

Gymnascella Peck, Ann. Rep. Reg. St. N.Y. **35**: 143, 1884. .... (1)
G. littoralis (G.F. Orr) Currah, Mycotaxon **24**: 87, 1985

Plunkettomyces littoralis G.F. Orr, Mycotaxon **6**: 34, 1977.

Gymnascus littoralis (G.F. Orr) Arx, Persoonia, **13**: 179, 1986.

Arachniotus littoralis (Orr) Arx, Persoonia **9**: 397, 1977.

Ascomata yellow to orange brown, globose, peridial hyphae, hyaline to yellow, simple or branched, smooth, slightly thick-walled, asci globose, ascospores yellow-brown to orange-brown, smooth, thick-walled, oblate with equatorial rim, 2.9-3.8 × 4.2-5.7 µm, anamorph with arthro and aleurioconidia 2.0-2.8 × 3.5-7 µm. *Gymnascella* has priority over *Arachniotus* for those with oblate ascospores. A well-characterized member of the Onygenales (Currah, 1985).

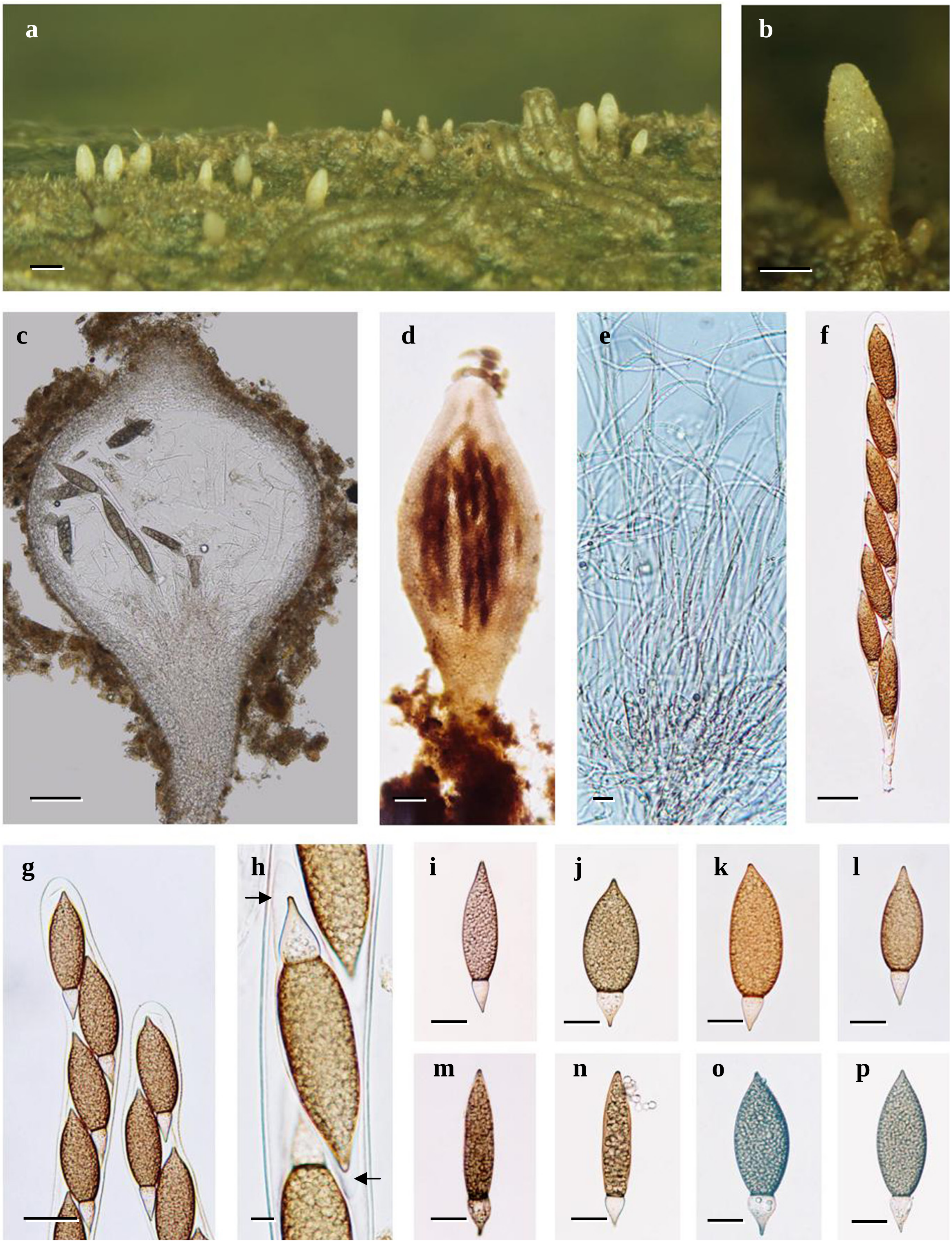


Fig. 25. *Manglicola guatemalensis*. **a**. Mature ascomata of *Manglicola guatemalensis* on the surface of *Nypa fruticans*, partially immersed in mud. **b, d**. Ascoma superficial seated on the substratum. **c**. Longitudinal section of ascoma with stalk, asci and pseudoparaphyses. **e**. Narrow pseudoparaphyses. **f**. Cylindrical ascus. **g**. Ascus tip with ocular chamber. **h**. Ascospore in ascus with apical and basal appendages (arrow). **i-p**. Bicelled ascospores. Bars a = 500 µm; b = 250 µm; c-d = 100 µm; e, h = 10 µm; f-g = 50 µm; i-p = 20 µm

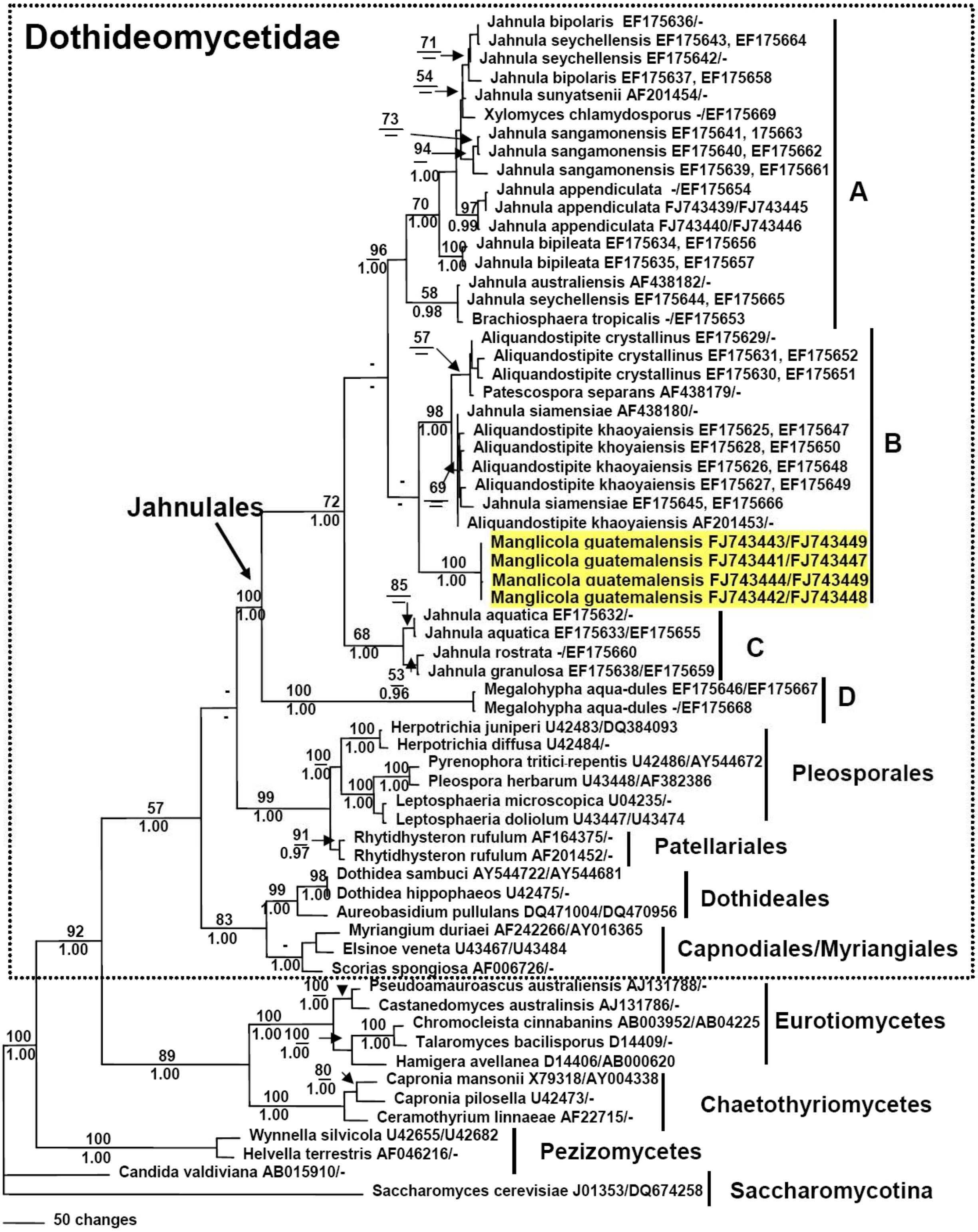


Fig. 26. Phylogram generated from weighted parsimony analysis (step matrix) from combined SSU and LSU rDNA sequences. Parsimony bootstrap value greater than 50% and Bayesian Posterior Probabilities greater than 0.95 are given above and below each clade, respectively.

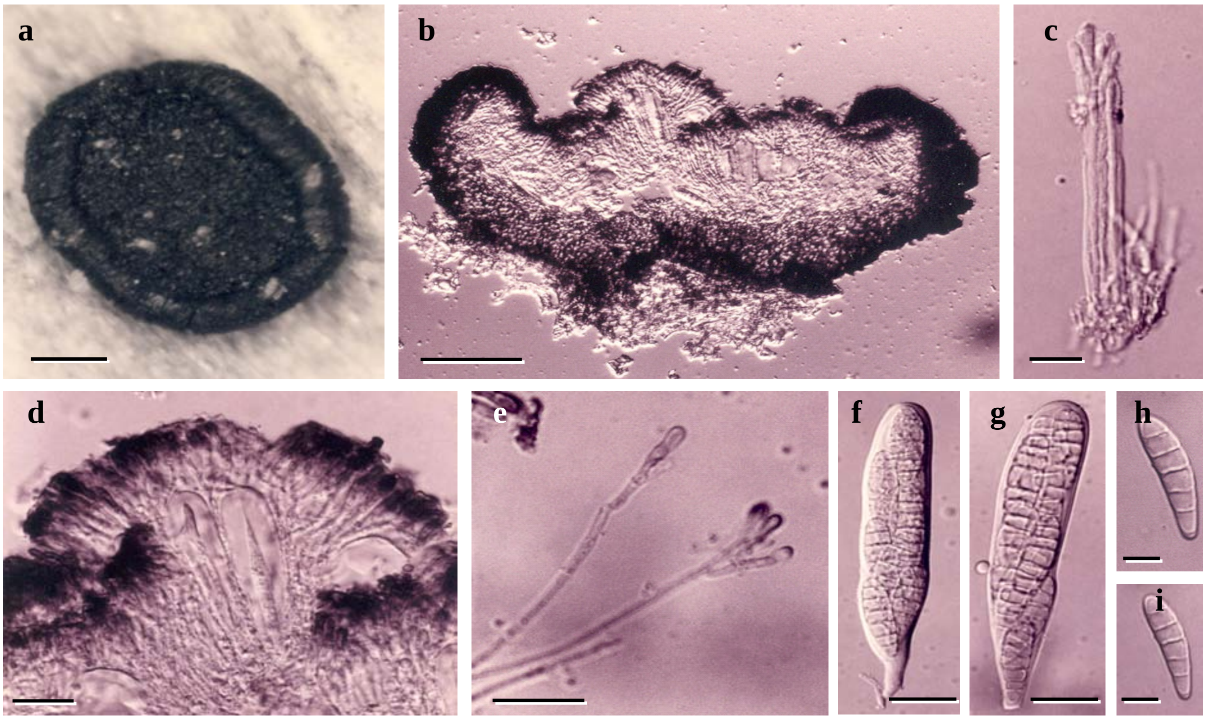


Fig. 27. *Patellaria* cf *atrata*. **a**. Superficial apothecium. **b**. Section through ascoma with hymenium. **c, e**. Pseudoparaphyses with branched club-shaped tips. **d**. Immature thick-walled asci and pseudoparaphyses. **f-g**. Clavate asci. **h-i**. Ascospores hyaline, clavate, curved 4-9 septate. Bars a-b = 200 µm; c-g = 25 µm; h-i = 10 µm.

EUROTIALES
Trichocomaceae

Eupenicillium F. Ludw., Lehrb. Nied. Krypt.: p. 256, 257, 263, 1892.................................. (1)
◙ ***E. limosum*** S. Ueda, Mycoscience **36**: 451, 1995.

Anamorph: *Penicillium limosum* Ueda

Ascomata cleistothecial, globose to subglobose, superficial, scattered, pale yellow, asci subglobose to ellipsoidal, evanescent at maturity, ascospores subglobose 3-3.5 × 2.5-3 µm, hyaline spore wall roughened (Udea, 1995b). Isolated several times from marine sediments in Nahasaki, Japan (Udea, 1995b).

CHAETOTHYRIOMYCETIDAE

Three orders with marine taxa (Geiser *et al*., 2001).

1. Primarily nonlichenized taxa, dark mycelium on substrata or inconspicuous immersed mycelium, ascomata erumpent to superficial, sometimes setose, short apical periphysoids, asci clavate, thickening of the apical region, ascospores hyaline to pale grey and transversely septate to muriform.. **Chaetothyriales**

1. Majority are lichenized associated with green algae, nonlichenized species referred to the Requienellaceae, thin thallus, ascomata immersed or superficial, ostiolate, papillate, pseudoparaphyses trabeculate, asci clavate, ascospores hyaline to brown, transversely septate to muriform .... **Pyrenulales**

1. Mostly lichenized, saxicolous, ascomata superficial to immersed in the thallus, hamathecium often absent or evanescent tissue of gelatinized pseudoparaphyses, ostiole covered with periphyses, asci fissitunicate or evanescent, ascospores hyaline to brown, septate to muriform .... **Verrucariales**

CHAETOTHYRIALES
Herpotrichellaceae

Capronia Sacc., Syll. Fung. (Abellini) **2**: 288, 1883 ....(1)
C. ciliomaris (Kohlm.) E. Müll., Petrini, P.J. Fisher, Samuels & Rossman, Trans Br. Mycol. Soc. **88**: 73, 1987.

Herpotrichiella ciliomaris Kohlm., Nova Hedw. **2**: 313, 1960

Ascomata globose to ovoid, superficial rarely immersed, ostiolate, epapillate, membranous, variable in colour from hyaline to light to dark blue to black, solitary or gregarious, apical paraphysoids merging with periphyses, asci cylindrical to subclavate, short pedunculate, bitunicate, thick-walled apically, ascospores ellipsoidal to subovoid, 1-septate, constricted at the septum, hyaline, with a crown of cilia-like appendages at each pole. Initially described as a *Herpotrichiella* it was transferred by Muller *et al*. (1987) to *Capronia* based on morphological characteristics. An ultrastructural study (Au *et al*., 1999b) showed that the periphysoids arise from the upper third of the ascomal wall, extending through the ostiolar canal and merging with the apical setae. The ascus has no ocular chamber, but the endoascus is thickened at the apex. Ascospores are verrucose, while the cilia-like appendages arise sub-terminally from the mesosporium through discontinuities in the episporium. A frequently collected species on bark in Friday Harbour, USA (Jones, 1985; Au *et al*., 1999b).

The taxonomic position of *C. ciliomaris* remains in question, as it is the only marine species in the genus, with hyaline ascospores, 1-septate with a crown of sub-terminal appendages and no anamorph has been reported for it. These are not characteristic features of *Capronia*.

PYRENULALES

Pyrenulaceae

Pyrenographa Aptroot, Bibliotheca Lichenologica **44**: 103, 1991........................ (1)
◙ ***P. xylographoides*** Aptroot, Bibliotheca Lichenologica **44**: 103, 1991.

Ascomata developing under a dark stroma, subglobose to fusiform, ostiolate, short papilla, periphysate, pseudoparaphyses branched, septate, asci clavate to cylindrical, short pedunculate, thick-walled, bitunicate, with an apical ring, J-, ascospores ellipsoidal to fusiform, 3-septate, not constricted at the septa, yellow brown, thick-walled, smooth and lacking a sheath or appendages (Fig. 28). Originally described from mangrove wood collected in Queensland, Australia (Aptroot, 1991), it is common on various mangrove tree species, especially *Rhizophora apiculata* and *Sonneratia* species (Alias *et al*., 1996; Jones and Abdel-Wahab, 2005; Jones and Pugsili, 2006). Aptroot (1991) states that the fungus stains the wood purple, we have not observed this. However, we have noted that the wood around the ascomata is bleached white and may be due to enzyme action. It is easily recognizable on mangrove wood by the prominent white zones surrounding the raised ascomata. Its position high in the intertidal zone exposes it to sunlight and long periods of drying out at low tides. Found in locations not subject to routine submergence. Here placed in the Pyrenulaceae, it has also been referred to the Requienellaceae (Kirk *et al*., 2001).

Xenus Kohlm. & Volkm.-Kohlm., Crytogamie Bot. **2**: 367, 1992.......................(1)
X. lithophylli Kohlm. & Volkm.-Kohlm., Crytogamie Bot. **2**: 368, 1992 (*Type species*).

Ascomata subglobose, superficial, ostiolate, periphysate, epapillate, clypeate, black and gregarious, pseudoparaphyses trabeculate, branched and anastomosing, asci clavate, thick-walled, without an apical apparatus, ascospores 1-3-septate, slightly constricted at the central septum, hyaline, no appendages or sheath (Kohlmeyer and Volkmann-Kohlmeyer, 1992).

A monotypic genus parasitic on the red alga *Lithophyllum* sp., attached to coral rock collected in the Caribbean (Belize). Kohlmeyer and Volkmann-Kohlmeyer (1992) referred it to the Dothideales *incertae sedis*, but noted similarities with the bitunicate ascomycetes *Arthopyrenia halodytes*, *Pharcidia laminariicola* and *P. rhachiana*. Its taxonomic position is far from clear but a concensus places it in the Pyrenulales.

Requienellaceae

Mauritiana Poonyth, K.D. Hyde, Aptroot & Peerally, Fungal Diver. **4**: 102, 2000............(1)
◙ ***M. rhizophorae*** Poonyth, K.D. Hyde, Aptroot & Peerally, Fungal Diver. **4**: 102, 2000 (*Type species*).

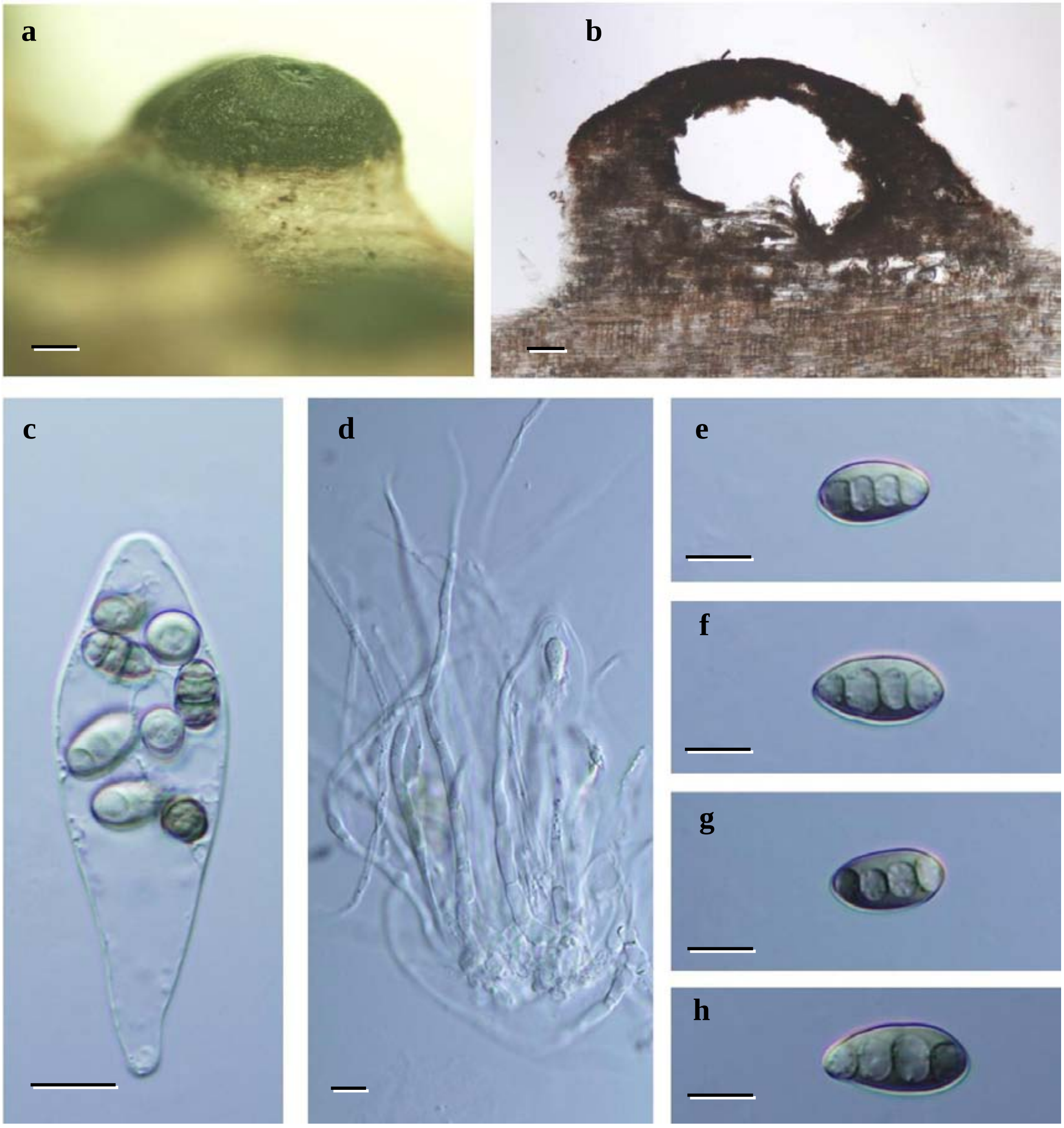


Fig. 28. *Pyrenographa xylographoides*. **a**. Ascoma within a black stroma. **b**. Longitudinal section through an ascoma on a raised cushion of wood. **c**. Ascus clavate with immature ascospores. **d**. Pseudoparaphyses branched. **e-h**. Ascospores brown 3-septate. Bars a-b = 200 µm; c-h = 10 µm.

Ascomata globose to ovoid, immersed, ostiolate, short neck, pale brown, gregarious, pseudoparaphyses filamentous, septate, branching, asci cylindrical to clavate, with an ocular chamber, bitunicate, thick-walled, short pedunculate, ascospores fusiform, dark brown the end cells paler, 9-13-distoseptate, septa thick, slightly constricted at the central septum, smooth walled and lacking a sheath or appendages (Fig. 29). This species has been recovered from marine habitats (Jones, unpublished data on branches of *Hibiscus tiliaceus* immersed in the intertidal, Thailand and Guam) although generally growing on the more terrestrial parts of mangrove trees, especially *Rhizophora mucronata*. Poonyth *et al*. (2000b) referred the genus to the Pyrenulales *sensu stricto*, as it has immersed ascomata, interascal tissue composed of branched pseudoparaphyses, thick-walled, fissitunicate asci and brown, septate ascospores.

Xanthopyreniaceae

Collemopsidium Nyl., Flora **64**: 6, 1881. .... (6)

C. halodytes (Nyl.) Grube & B.D. Ryan Lich. Fl. Greater Sonoran Desert Region **1**: 163, 2002 (*Type species*).

Verrucaria halodytes Nyl., Mém. Soc. Sci. Nat. Cherbourg **5**: 142, 1857.

Arthopyrenia halodytes (Nyl.) Arnold, Ber. Bayer. Bot. Ges. **1** (suppl.): 121, 1891.

Pyrenocollema halodytes (Nyl.) R.C. Harris, Bryologist **90**: 164, 1987.

Verrucaria consequens Nyl., Flora **47**: 357, 1864.

Arthopyrenia consequens (Nyl.) Arnold, Flora **53**: 485, 1870.

Arthopyrenia kelpii Körb., Parerga Lich. 387, 1865.

Verrucaria fluctigena Nyl., Flora **58**: 14, 1875.

Arthopyrenia orustensis Erichsen, Nyt Mag. Naturv. **68**: 159, 1930.

Pyrenocollema orustensis (Erichsen) A. Fletcher, **24**: 368, 1992.

C. elegans (R. Sant.) Grube & B.D. Ryan, Lich. Fl. Greater Sonoran Desert Region **1**: 163, 2002.

Pyrenocollema elegans R. Sant., Lichenologist **24**: 7, 1992.

C. sublitorale (Leight.) Grube & B.D. Ryan Lich. Fl. Greater Sonoran Desert **1**: 163, 2002.

Verrucaria sublitoralis Leight, Lich. Fl. Gr. Britain: 435. 1871.

Arthopyrenia sublitoralis (Leight.) Arnold, Ber. Bayer. Bot. Ges. **1** (suppl.): 121, 1891.

Pyrenocollema sublitorale (Leight.) R.C. Harris, ex Fletcher Lichenologist **24**: 368, 1992.

C. foveolatum (A.L. Sm.) F. Mohr, Mycol. Res. **108**: 529, 2004.

Arthopyrenia foveolata A.L. Sm., J. Bot. **49**: 43, 1911.

C. ostrearum (Vain.) F. Mohr, Mycol. Res. **108**: 530, 2004.

Lecanactis ostrearum Vain., Cat. Welwitsch. Afr. Pl **2**: 430, 1901.

Arthoniactis ostrearum (Vain.) Clem. & Shear, Gen. Fungi :319, 1931.

C. pelvetiae (G.K. Sutherl.) Kohlm., D. Hawksw. & Volkm.-Kohlm., Mycol. Prog. **3**: 54, 2004.

Arthopyrenia pelvetiae (G.K. Sutherl.) D. Hawksw., Lichenologist **12**: 106, 1980.

Dothidella pelvetiae G.K. Sutherl., Trans. Br. Mycol. Soc **5**: 154,1915.

Leiophloea pelvetiae (G.K. Sutherl.) Kohlm. & Kohlm., Marine Mycology, the Higher Fungi, 376, 1979.

Placostroma pelvetiae (G.K. Sutherl.) Meyers, Mycologia **49**: 480, 1957.

Pyrenocollema pelvetiae (G.K. Sutherl.) D. Hawksw. J. Linn. Soc., Bot. **96**: 10, 1988.

Kohlmeyer *et al*. (2004) transferred *Pyrenocollema pelvetiae* to *Collemopsidium*. Species assigned to *Collemopsidium* have variously been placed in *Verrucaria, Arthopyrenia* and *Pyrenocollema* (Mohr *et al*., 2004). *Pyrenocollema orustensis* may not be a synonym of *Collemopsidium halodytes* as this taxon may include several morphological entities (Fig. 30). The genus is assigned to the Xanthopyreniaceae (Eriksson *et al*., 2003), a family of uncertain position, although Grube and Ryan (2002) included it in the Dothideales *incertae sedis*. The position of *C. pelvetiae* is in doubt as it is considered to be an epiphyte rather than a lichenized ascomycete, and it has much larger ascomata than other *Collemopsidium* species (Mohr *et al*., 2004). Lichenized photobionts are cyanobacteria (*Hyella*) (Harada, 2000) or non-lichenized Phaeophyceae (*Pelvetia*).

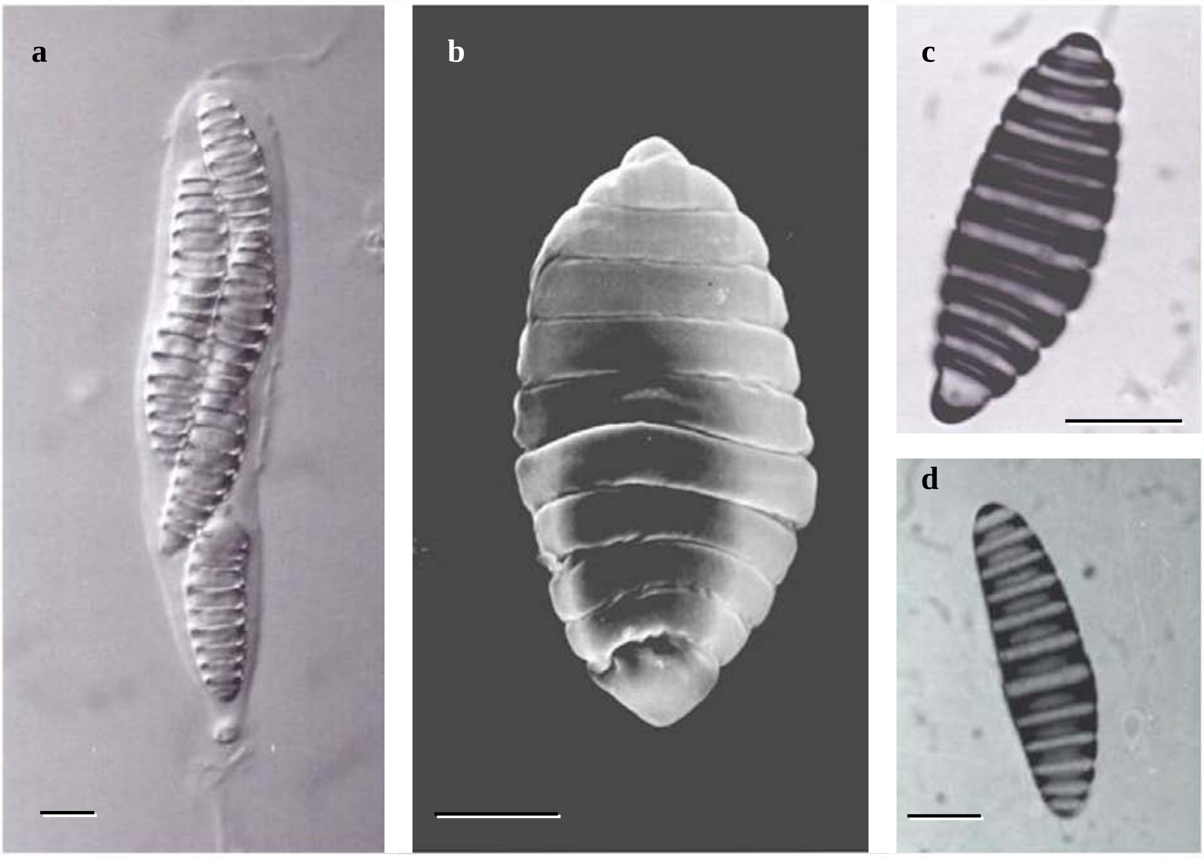


Fig. 29. *Mauritiana rhizophorae*. **a**. Cylindrical ascus with biseriate ascospores. **b**. Scanning electron micrographs of ascospore. **c-d**. Fusiform ascospores with 12-13 distoseptate. Bars a, c-d = 10 µm; b = 5 µm. **(Photos by Aisyah Alias)**.

1. Perithecia large (310-590 µm) on the seaweed *Pelvetia canaliculata*............................... ***C. pelvetiae***
1. Perithecia smaller (less than 0.6 mm in diam.) not on seaweeds 2

2. Thallus superficial on the substratum....................... 3
2. Thallus immersed in the substratum 4

3. Thallus with black, carbonaceous ridges... ***C. elegans***
3. Thallus lacking black ridges, often immersed in calcareous rock and shells...................... ***C. halodytes***

4. Involucrellum intermixed with the substratum, wide spreading... 5
4. Involucrellum not containing substratal material........ .... ***C. ostrearum***

5. Perithecia superficial or semi-immersed, 0.15-0.55 mm diam., involucrellum well developed and spreading laterally............................... ***C. sublitorale***
5. Perithecia immersed in pits in the substratum, 0.1-0.24 mm diam., involucrellum lid-like, not spreading .... ***C. foveolatum***

Key after Mohr *et al*. (2004).

VERRUCARIALES
Verrucariaceae

Mycophycias Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **16**: 2, 1998 .... (2)

M. ***apophlaeae*** (Kohlm.) Kohlm. &Volkm.-Kohlm., Syst. Ascomycetum **16**: 3, 1998.

Mycosphaerella apophlaeae Kohlm., Bot. Mar. **24**: 13, 1981

M. ascophylli (Cotton) Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **16**: 3, 1998 (*Type species*).

Mycosphaerella ascophylli Cotton, Trans. Br. Mycol. Soc. **3**: 95, 1908.

Anamorph: *Septoria ascophylli* Melnik & Ju. Petrov, Nov. Sist. Niz. Rast. 1966: 211, 1966.

Sphaerella ascophylli (Cotton) Sacc. & Trotter, Sacc.: Syll. Fung. **22**: 147, 1913.

Mycosphaerella pelvetiae G.K. Sutherl., New Phytol. **14**: 34-35, 1915.

Sphaerella pelvetiae (G.K. Sutherl.) Sacc., Syll. Fung. **24**: 849, 1928.

Fig. 30. Habitat photomicrograph of *Collemopsidium halodytes*. (**Photo by Anthony Fletcher**).

Ascomata ovoid, ellipsoid to obpyriform, immersed in the host, ostiolate, epapillate, periphysate, coriaceous, brown solitary or gregarious, periphysoid in the upper part of the ascoma, asci fusiform to clavate, pedunculate, ascospores ellipsoidal, 1-septate, hyaline, no appendages or sheaths. These two species have been transferred from *Mycosphaerella* because they have periphysate ostioles with the periphysoids arising from the upper peridium. They form mycophycobioses with marine macroalgae (Kohlmeyer and Volkmann-Kohlmeyer, 1998b).

1. Ascospores 15-20 × 4-5 µm, mycobiont of *Apophlaea lyallii*................................***M. apophlaeae***
1. Ascospores 15-22 × 4-6 µm, mycobiont of *Ascophyllum nodosum* and *Pelvetia canaliculata* ....***M. ascophylli***

Verrucaria Schrad., Spicil. Fl. Germ. 108, 1794... (24)

V. adguttata Zahlbr. (1941) Denkschr. Akad. Wiss. Wein, math. –naturw. K1., CIV p. 250.

V. allantoidea H. Harada, Nova Hedw. **60**: 75, 1995.

V. amphibia Clemente(1807) Apud Acharius, Syn. Lich. 1814, p. 94. syn. *V. symbalana*, Nyl. 1873.

V. aucklandica Zahlbr., Denkschr. Akad. Wiss., Wein, Mathematische-naturwissenschaftliche Klasse **104**: 250, 1941.

V. bubalina M. Mayrhofer & P.M. McCarthy, Muelleria **7**: 344, 1991.

V. ceuthocarpa Wahlenb., in Acharius, Methodus: 22, 1803.

V. corallensis P.M. McCarthy, Aust. Lichenol. **63**: 17, 2008.

V. ditmarsica Erichs., Schr. Naturw. Ver. Schles.-Holst. **22**: 90, 1937.

V. durietzii I.M. Lamb, Lilloa **14**: 205, 1948.

V. fusconigrescens Nyl. (1872) In Bull. Soc. Linn. Normand ser III, vol VI, 1872, p. 266 & 314.

V. halizoa Leight., Lichen Flora of Great Britain & Ireland, 461, 1871.

V. halochlora H. Harada, Nova Hedw. **60**: 74, 1995.

◙ ***V. maura*** Wahlenb., in Acharius Methodus: 19, 1803.

V. meridionalis P.M. McCarthy, Muelleria 8: **103**, 1994.

V. microsporoides Nyl., Bull. Soc. Bot. France **8**: 759, 1861.

◙ ***V. mucosa*** Wahlenb., In Acharius Methodus: 23, 1803.

V. psychrophila I.M. Lamb., Discovery Repts. **25**: 18, 1948.

V. serpuloides I.M. Lamb., Discovery Repts. **25**: 20, 1948.

V. sessilis P.M. McCarthy, N.Z.J. Bot. **29**: 285, 1991.

◙ ***V. striatula*** Wahlenb., in Acharius, Methodus:Methodus: 21, 1803.

V. subdiscreta P.M. McCarthy, Muelleria **7**: 327, 1991

V. tavaresiae R.L. Moe, Bull. California Lichen Soc. **4**: 8, 1997.

V. tessellatula Nyl., in Crombie, J.Bot., London **13**: 335, 1875.

Crustose pyrenocarpous lichens generally with a green unicellular photobiont (genus *Dilabifilum* = *syn*: *Pseudopleurococcus*), thallus discrete, scattered, immersed or superficial, black ascomata, periphysate, asci and paraphyses deliquesce early, clavate to cylindroclavate, fissitunicate asci containing 8 hyaline, ovoid to subglobose to ellipsoidal ascospores (McCarthy, 2001) (Figs. 31-33). Many *Verrucaria* lichens are to be found in the littoral and supralittoral zone and are thus thought to be salt-tolerant (Fletcher, 1975, 1980) but *Verrucaria serpuloides* has been found on dredged-up stones from 30 m in Antarctica (Lamb, 1973).

Perithecial ascomata with an apical ostiole, with short pseudoparaphyses bordering the upper part of the perithecial cavity and hanging into this without touching the hymenium (Gueidan *et al*., 2007). Bitunicate asci dehiscence often by gelification of the outer wall.

Molecular studies of the family concluded they were a sister group to the non-lichenised order Chaetothyriales (Lindemuth and Lumbsch, 2001; Lumbsch *et al*., 2005). Current studies indicate that the generic delineations of the Verrucariaceae were not monophyletic. In fact, *Verrucaria* is highly polyphyletic and is spread out in eleven clades. Four lineages were identified by Gueidan *et al*. (2007), one constituting a marine group (*V. mucosa*, *V. striatula*). A second aquatic group was identified with *V. maura* (marine), *V. adriatica* and *V. scabra* (freshwater), suggesting that this genus migrated to the marine environment on at least two separate occasions.

Recently described species include *V. allantoidea*, *V. halochlora* from Japan and *V. corallensis, V. meridionalis*, *V. subiscreta* from Australia (McCarthy, 1991, 1994; Harada, 1995; McCarthy 2008) (Fig. 32). *Verrucaria tavaresiae* is unique in having a brown alga *Petroderma maculiforme* as a photobiont, while others have green algae (*Coccobotrys, Desmococcus, Dilabifilum, Myrmecia*) or a xanthophyte (*Heterococcus*) photobiont (Moe, 1997). Aquatic *Verrucaria* species are generally cold-water species with various numbers recorded from different localities: Fidalgo Island Washington (7-9 species), New England, (7 species), Great Britain (8 species), the Antarctic Peninsula (6-8 species) and 10 from Scandinavia (Ryan, 1988; Taylor, 1982; Purvis *et al*., 1992; Lamb, 1948; Santesson, 1993). There are many terrestrial *Verrucaria* species known from bark.

1. Photobiont a brown alga, *Petroderma maculiforme* .. .. ***V. tavaresiae***
1. Photobionts from other algal groups **2**

2. Ascospores allantoid, 12-14 × 2-3 µm ***V. allantoidea***
2. Ascospores not allantoid **3**

3. Thallus epilithic and conspicuous grey-brown to green-brown, medium-green, green-black or black **4**
3. Thallus white to pale-grey, often poorly developed, perithecia semi-immersed, to superficial, solitary to 2 - 3 together, 0.4 - 0.8 mm diam., involucrellum thick and well developed .... ***V. halochlora***

4. Thallus not submerged **5**
4. Thallus submerged, jet-black, involucrellum well-developed, ascospores broadly ellipsoid 15- 17.5 × 8-9.5 µm .... ***V. serpuloides***

5. Thallus with prominent, glossy, branched and swollen ridges (jugae) **6**
5. Thallus without prominent black ridges (jugae) **7**

6. Thallus brown .... ***V. striatula*** ssp**.** ***australis***
6. Thallus grass-green .... ***V. striatula***
6. Thallus medium gray green to green black or grey-black .... ***V. corallensis***
6. Thallus pitch black, with black ridges ... ***V. amphibia***

7. Thallus continuous to sparingly rimose, lower to mid-littoral species **8**
7. Thallus strongly rimose to areolate, upper littoral to supralittoral species **10**

8. Ascospores 7-13 µm long **9**
8. Ascospores 12-15 µm long .... ***V. psychrophila***
8. Ascospores 10-16 (-18) µm long .. ***V. microsporoides***

9. Perithecia immersed, to 0.15 mm diam., exciple colourless, hallus thick, hypothallus white, olive - green to dark green-black in sun, on open rocks........ .... ***V. mucosa***
9. Perithecia superficial, 0.2-0.34 mm diam., exciple medium-grey to brown-black, thallus thin, filmy, pale olive-green, usually in shaded crevices .... ***V. halizoa***
9. Perithecia superficial, 0.24-0.45 mm diam., black..... .... ***V. meridionalis***

10. Margin of thallus placodioid-dissected .... ***V. durietzii***
10. Margin not dissected placodioid **11**

11. Ascospores 8-15 × 4-7 µm **12**
11. Ascospores 12-26 × 6-15 µm **15**

12. Thallus black, effuse or in blotches............ **13**
12. Thallus grey-brown to olive-green or green black, not effuse or in blotches **14**

13. Perithecia sessile, to 0.25 mm diam .... ***V. adguttata***
13. Perithecia immersed, 0.1-0.16 mm diam............ .... ***V. ceuthocarpa***
13. Perithecia sessile, 0.02 mm diam ...... ***V. ditmarsica***

14. Thallus grey-brown to mid-green-black, perithecia 0.22-0.45 mm diam .... ***V. aucklandica***

14. Thallus dark olive-green to green-black, perithecia 0.12-0.22 mm diam .... ***V. subdiscreta***

15. Thallus pale-buff to grey-brown.......................... **16**
15. Thallus olive-brown, greenish-grey, dark grey brown to dark greenish-black.............................. **17**

16. Thallus pale-buff with conspicuous black cracks, perithecia 0.1-0.2 mm diam., not radially ridged, exciple colourless, ascospores 10-15 × 6-9 µm...... .... ***V. tessellatula***
16. Thallus buff-brown, grey-brown or green-grey, without prominent black cracks, perithecia 0.2-0.3 mm diam., often radially ridged, exciple brown to brown-black, ascospores 14.5-23.5 × 7-11 µm .... ***V. bubalina***

17. Ascospores 9-16 (17) µm long............................ **18**
17. Ascospores 16-26 µm long, thallus olive brownish, green grey to dark-brown, prothallus distinct, exciple brown black .... ***V. fusconigrescens***

18. Thallus effuse, dull medium-green to green, black, areolate only around the perithecia, exciple brown-black, 25-32 µm thick, ascospores 9-12 (- 16) × 6-7 (8.2) µm.. ***V. sessilis***
18. Thallus strongly rimose to areolate, dark green to greenish black, exciple 10-20 µm thick, hyaline to brown-black, ascospores 12-20 (-22) × 6-8 (- 9) µm .... ***V. maura***

Key modified from Galloway, D.J. 2007: Flora of New Zealand. Volume II. Indigenous Tracheophyta - Monocotyledons except Graminae. First electronic edition, Landcare Research, June 2004. Transcr. A.D. Wilton and I.M.L. Andres.

LABOULBENIOMYCETES
LABOULBENIOMYCETIDAE
LABOULBENIALES:
Laboulbeniaceae

Laboulbenia Mont. & C.P. Robin, Histoire Naturelle des Végétaux Paraites qui croissent sur l'Homme et sur les Naimaraux Vivants, Braillière et Fils, Paris: 622, 1853 .... (1)
L. marina F. Picard, C. R. Séances Soc. Biol. Fil. **65**: 484, 1908.

This species has been described and illustrated by Kohlmeyer and Volkmann-Kohlmeyer (2003b) on which the following summary is drawn from: Thallus 150-230 µm, receptacles 105-112 × 48-53 µm, ascomata 76-118 × 38-44 µm, elongate- ellipsoidal, sessile, ostiolate, hyaline to light-brown, solitary, appendages born on a side branch, asci 4-spored, elongate to clavate, thin-walled, unitunicate, early deliquescing, ascospores 26-35 × 4 µm, elongate-fusiform, pointed at the apex, rounded at the base, 1-septate, lower cell smaller, and surrounded by a mucilaginous sheath. The marine status of this species needs questioning as it was found at the base of the elytra of the beetle *Aepus robini*, living in the *Laminaria* zone (Kohmeyer and Kohlmeyer, 1979).

LECANOROMYCETES
LECANOROMYCETIDAE
LECANORALES
Dactylosporaceae

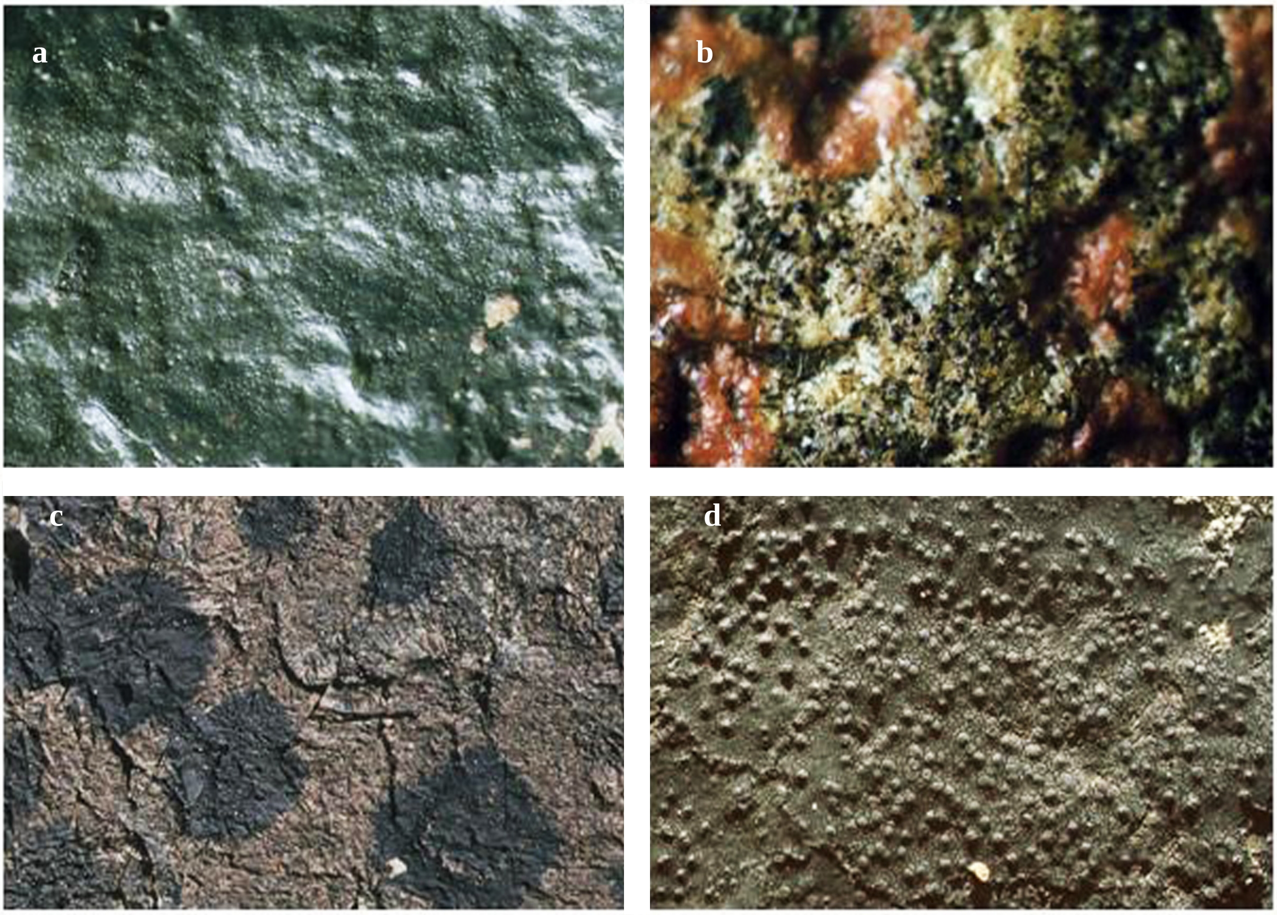
Dactylospora Körb., Syst. Lich. Germ. 271, 1855.. (3)
D. canariensis Kohlm. & Volkm.-Kohlm., Mycotaxon **67**: 248, 1998.
◙ ***D. haliotrepha*** (Kohlm. & E. Kohlm.) Hafellner, Nova. Hedw. **62**: 111, 1979.

Kymadiscus haliotrephus (Kohlm. & E. Kohlm.) Kohlm. & E. Kohlm., Mycologia **63**: 837, 1971.

Buellia haliotrepha Kohlm. & E. Kohlm., Nova Hedw. **9**: 90, 1965.

D. mangrovei E.B.G. Jones, Alias, Abdel-Wahab & S.Y. Hsieh, Mycoscience **40**: 317, 1999.

Apothecia initially sub-globose, becoming subglobose or discoid, flat or convex, superficial, sessile, leathery, dark reddish-brown, becoming black, solitary, sometimes gregarious, asci clavate, short pedunculate, apically thick-walled, without an apical apparatus, ascospores ellipsoidal or obovoid, 1-septate, constricted at the septum, with longitudinal or verrcuose ornamentations (Fig. 34). No appendages except in *D. canariensis*. Au *et al.* (1996) have illustrated the complexity of the ascospore wall in *D. haliotrepha*, the wall consisting of a series of ridges derived from outgrowths of the mesosporium, and surrounded by the exosporium. The areas between the ridges are filled with mucilage and when the exosporium ruptures, the mucilage is lost. Another observation is that the pseudoparaphyses are



Figs. 31. Habitat micrographs of: **a.** *Verrucaria mucosa*. **b.** *V. striatula*. **c.** *V. amphibia* and *Collemopsidium halodytes* in background. **d.** *V. maura* (**Photos by Anthony Fletcher**).

Fig. 32. *Verrucaria maura*. Habitat on shore in South Wales.

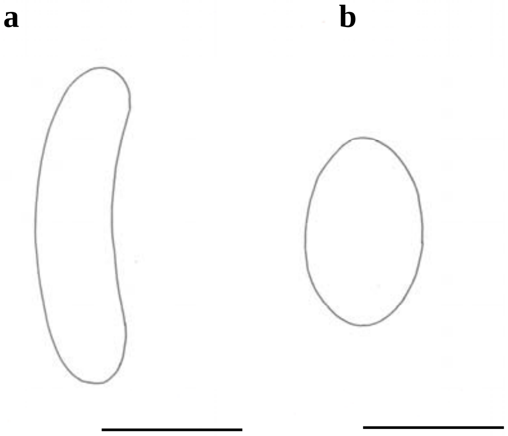


Fig. 33. Ascospores of: **a**. *Verrucaria allantoidea*. **b**. *V. halochlora*. Bars a-b = 5 µm.

surrounded by a hyphal sheath which stains with ruthenium red. Hafellner (1979) suggested that the ascus in *D. haliotrepha* was one layered, but the study of Au *et al*. (1996) confirms that it is bitunicate.

Dactylospora canariensis was originally referred by Kohlmeyer (1967) and Kohlmeyer and Kohlmeyer (1968) to *Banhegyia uralensis* and *B. setispora,* respectively, but on re-examination was found to be a different species from the original collection (Kohlmeyer and Volkmann-Kohlmeyer, 1998c; Kutorga and Hawksworth, 1997). It is the only *Dactylospora* species with appendaged ascospores and produces antheridia in culture.

1. Ascospores with appendages............. ***D. canariensis***
1. Ascospores lacking appendages.............................. 2

2. Ascospores narrow (less than 7 µm), 10.9-17.2 × 3.5-6.4 µm, verrucose spore wall ....***D. mangrovei***
2. Ascospores wider than 7 µm, 18-28 × 8-12 (-14.5) µm, spore wall with longitudinal striations................ .... ***D. haliotrepha***

LEOTIOMYCETES
LEOTIOMYCETIDAE
HELOTIALES
Helotiaceae

Amylocarpus Curr., Proc. R. Soc. Lond., **9**:119-123, 1857-1859................................. (1)
◙ ***A. encephaloides*** Curr., Proc. R. Soc. Lond. **9**: 119, 1859 (*Type species*).

Plectolitus acanthosporum Kohlm., Nova Hedw. **2**: 329, 1960.

Ascomata solitary or gregarious, cleistothecial, globose or subglobose, erumpent to superficial, coriaceous, variously coloured: cream-yellow, yellow or reddish yellow, paraphyses absent, asci broadly clavate or ellipsoidal, apiculate, pedunculate, unitunicate, thin-walled, without an apical apparatus, and deliquescing early, ascospores hyaline, subglobose to ovoidal, unicellular, with 10-25 awl-shaped appendages distributed over the ascospore surface.

A genus of uncertain taxonomic status despite a molecular study by Landvik *et al*. (1996) who report it clustering with the Cyttariales, Leotiales, Rhytismatales, *Thelebolus* and the erysiphalean genus *Blumeria*. However, it shows no morphological affinities with any of these, with the exception of *Blumeria*, both having cleistothecial ascomata and a short stalk to the ascus. The latter is not characteristic of the Plectomycete family Eurotiaceae, where it has previously been assigned. *Amylocarpus encephaloides,* groups with *Neobulgaria premnopia* (Leotiaceae) with low support, in a sister clade comprising *Blumeria graminis* and various members of the Erysiphales (Hambleton and Sigler, 2005). However, it is distantly placed from *Leotia* species (Leotiales) and further studies are needed to resolve the final taxonomic position of *Amylocarpus* (Landvik *et al*., 1996).

Vibrisseaceae

Vibrissea Fr., Syst. Mycol., Index alphab. **2**: 4, 31, 1822.. (1)
V. nypicola K.D. Hyde & Alias, Mycol. Res. **103**: 1419, 1999.

Apothecia superficial, reddish-brown, sessile, discoid, paraphyses filiform, septate, apically branching, swollen at the apex, asci cylindrical, short pedunculate, in a gelatinous matrix, ascospores fasiculate, filiform, unicellular, hyaline with inconspicuous mucilage (Hyde *et al*., 1999b). Occurs on the petiole base of *Nypa fruticans* intertidally in brackish, estuarine habitats. Hyde *et al*. (1999b) drew attention to its similarity to *Vibrissea*, sections *Apostemium* and *Microstemium,* which are difficult to distinguish at the morphological level (Iturriaga, 1997).

Dermateaceae

Laetinaevia Nannf., Nova Acta R. Soc. Scient. Upsal., ser. 4, **8**: 190, 1932 .... (1)
L. marina (Boyd) Spooner, Kew Bull. **38**: 568, 1984.

Orbilia marina Boyd, Trans. Br. Mycol. Soc. **3**: 116, 1908 (1909).

(*Calloria marina* Phillips, in Smith (1908), unpublished manuscript).

Apothecia concave, becoming convex and discoid, erumpent, superficial, sessile, light orange, becoming darker, solitary or gregarious, paraphyses filamentous, branched, septate with swollen tips, asci cylindrical-clavate, tapering at the base, unitunicate, thin-walled, with an apical ring, ascospores ellipsoidal, 1-septate, smooth-walled, hyaline, lacking a sheath or appendages. Hosts usually cast brown seaweeds in the drift zone and strictly not an obligate marine species. Which raises the question of when are fungi truly marine? In this instance when are the seaweeds colonised by the fungus? Some 25 *Laetinaevia* species are listed in Index Fungorum of which *L. marina* is the only marine fungus.

LICHINOMYCETES
LICHINALES
Lichinaceae

Lichina C. Agardh, Syn. Alg. Scand. Xii, 9, 1817... (2)

L. confinis (O.F. Müll.) C. Agardh, Spec. alg. **1**: 105, 1821.

Clathroporina confinis Műll. Ahg., Englers Bot.Jarb. **6**: 403, 1885.

Fucus pygmaeus f. *minor* Turner

Lichen confinis O.F. Műll., Icon. Plant. Daniae. **5**: 5, 1782.

Lichina pumila sensu Gray A natural arrangement of British plants 1: 1-824, 1821.

Lichina pygmaea var *minor* (Turner) Hook.

Neolichina confinis (Műll. Ahg.) Gyein., In Ann. Mus. Nat. Huhgar. 32: 166, 1939.

Pygmaea confinis (O.F. Műll.) Kuntze, Revis.gen.pl. (Leipzig, 2, 1891.

Stereocaulon confine (O.F. Műll.) Hoffm. Dutschl. Flora, p130, 1796.

L. pygmaea (Lightf.) C. Agardh, Flora Scotia **2**: 964, 1777.

Fucus pygmaea Lightf., Flora Scotica **2**: 964,1777.

Thallus fruticose, erect, tufted, in clumps, becoming terete near the apices, 10 mm tall, and 0.1-0.2 mm thick, shiny dark brown to black or dark olive-green, gelatinous when wet, apothecia terminal, globose or flask-shaped, photobiont *Calothrix* (Cyanophyceae) (From http://floraseries.landcareresearch.co.nz). A genus of some 13 species of which two are marine. An important distinction between these two species is the presence of a cortex in *L. pygmaea* which makes it cartilaginous, while *L. confinis* has a loose hyphal weft containing many species of photobiont including Chlorophyceae and principally *Calothrix* (Fletcher, pers. comm.) (Fig. 35).

However, at least nine names are marine, mostly Antarctic, S. America. Only the above two species are known from the Northern Hemisphere (Fletcher, pers. comm.).

1. Lobes flatted, 1cm long, often prostrate, richly branched in one plane, shiny dark brown to black, apothecia terminal, globose, ascospores uniseriate.... .... ***L. pygmaea***
1. Thallus terete, erect, tufted, 5 mm high, lobes dull, olive-brown to black ....***L. confinis***

ARTHONIOMYCETES
ARTHONIALES
Roccellaceae

Halographis Kohlm. & Volkm.-Kohlm., Can. J. Bot. **66**: 1138, 1988 .... (1)

H. runica Kohlm. & Volkm.-Kohlm., Can. J. Bot. **66**: 1138, 1988 (*Type species*).

Ascomata lirelliform, simple or branched, immersed in calcareous substrata, opening with a longitudinal slit, light brown, no periphyses, single or gregarious, paraphysoid, anastomosing, septate, in a gelatinous matrix, asci clavate, short pedunculate, thick-walled, with an ocular chamber, ascospores ellipsoidal to fusiform, 1-septate, not constricted at the septum, smooth, hyaline, and lacking a sheath or appendages (Kohlmeyer and Volkmann-Kohlmeyer, 1988b). A lichenoid species known from Belize, Caribbean and the Great Barrier Reef, Australia found on the lower side of subtidal coral slabs, on worm tubes and on molluscan shells. Originally placed in the Opegraphales by Kohlmeyer and Volkmann-Kohlmeyer (1988b) it is referred here to the Arthoniales (Kirk *et al.*, 2001). However, Lumbsch and Huhndorf (2007) question this assignment.

ARTHONIOMYCETIDAE family *incertae sedis*
Melaspileaceae

Melaspilea Nyl., Act. Soc. Linn. Bordeaux, sér. A 21, 416, 1857... (1)

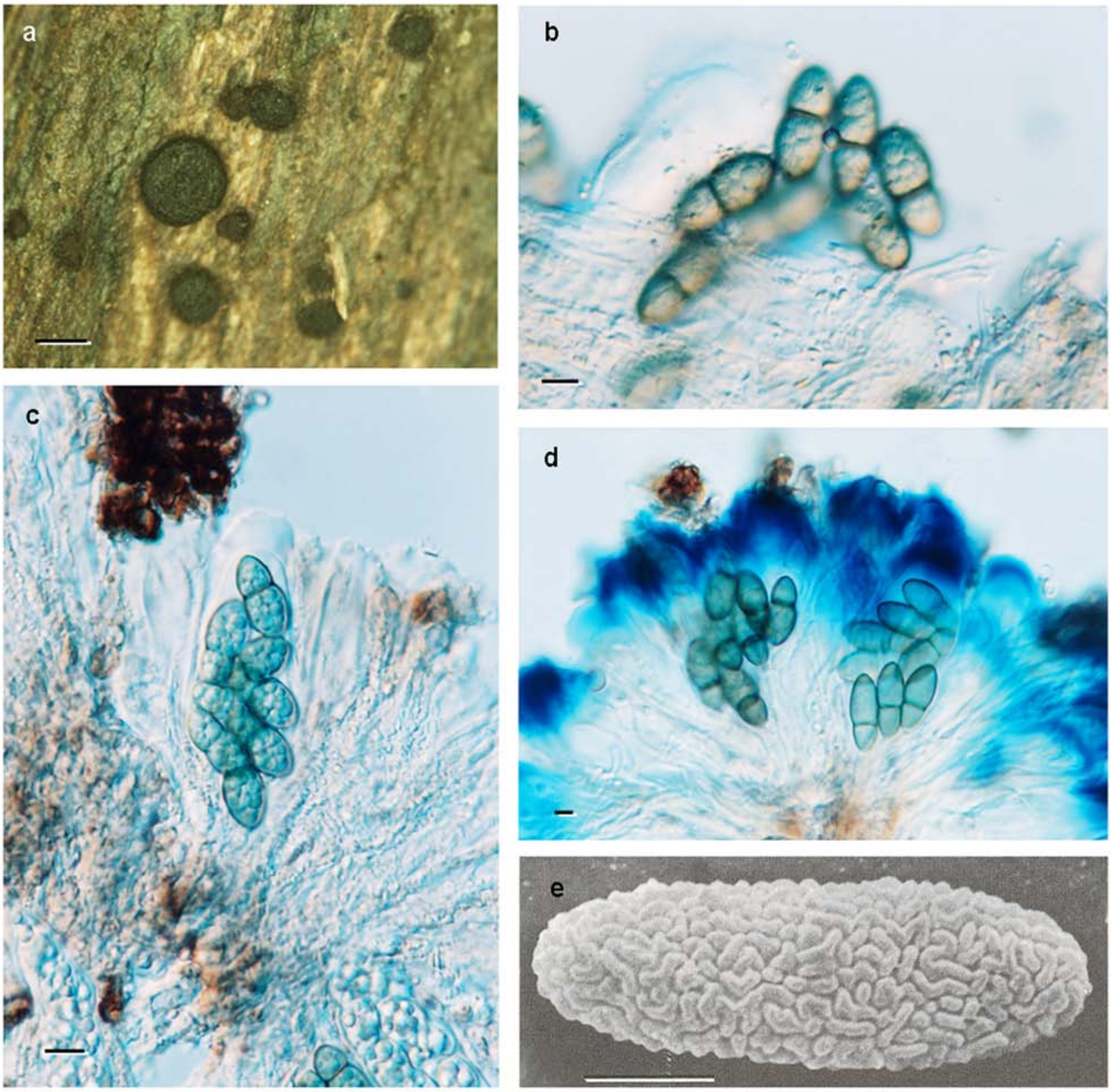


Fig. 34. *Dactylospora haliotrepha*. **a**. Apothecia on mangrove wood. **b-d**. Asci, pseudoparaphyses and ascospores. **d**. Tips of the pseudoparaphyses staining with melzer. **e**. *Dactylospora mangrovei* SEM micrograph of ascospore with corrugated surface. Bars a = 500 µm; b-d = 10 µm; e = 5µm

M. mangrovei Vrijmoed, K.D. Hyde & E.B.G. Jones, Mycol. Res. **100**: 293, 1996.

Ascomata lirelliform, coriaceous, erumpent, dark coloured with an opening that runs the length of the ascoma, solitary or gregarious, pseudoparaphyses branched, anastomosing and in a gelatinous matrix, asci clavate, thick-walled, with an ocular chamber, wall staining blue in Melzer's reagent, ascospores 1-septate, ellipsoidal, hyaline, becoming light brown, constricted at the septum, with a mucilaginous sheath (Fig. 36). The sheath ruptures at the apex to form a band or "skirt" at the septum to which it is attached (Vrijmoed *et al*., 1996). It is found commonly on mangrove wood and can be confused with *Massarina* species with its 1-septate, hyaline ascospores, surrounded by a mucilaginous sheath. However, in *M. mangrovei*, the sheath ruptures apically to form a skirt-like appendage around the spore. Currently some 132 species are assigned to the genus, and includes lichenized, lichenicolous and saprobic taxa (Coppins, 1989). The genus is in need of revision and placement of this species remains unresolved.

Fig. 35. Habitat of **a-b**. *Lichina confinis*. **c-d**. *L. pygmaea* (**Photos by Anthony Fletcher**).

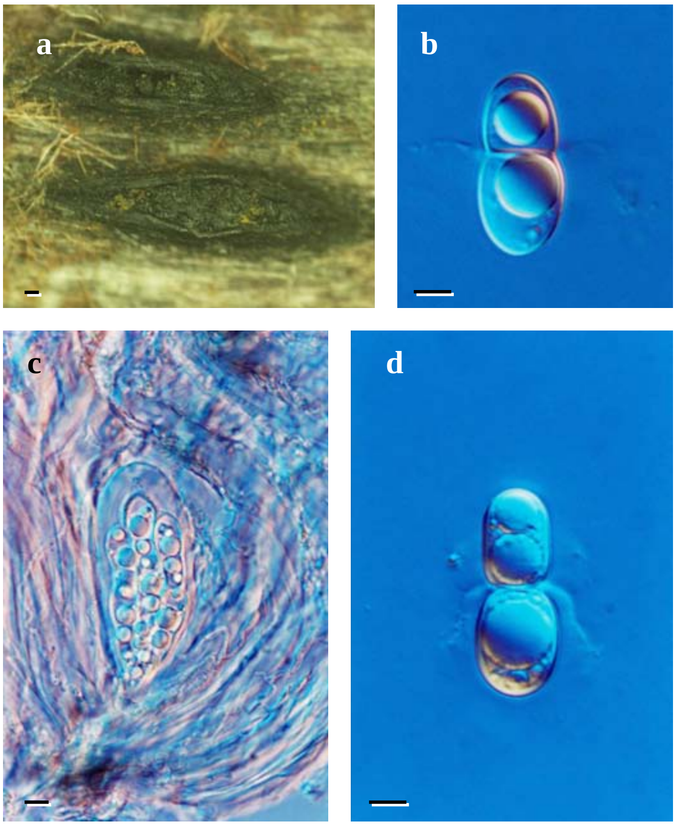


Fig. **36**. *Melaspilea mangrovei*. **a**. Lirelliform ascomata on mangrove wood. **b, d**. Ascospores 1-septate markedly constricted at the septum with a skirt-like equatorial appendage. **c**. Thick-walled ascus and pseudoparaphyses. Bars a = 100 µm; b, d = 5 µm; c = 10 µm.

SORDARIOMYCETES

Three subclasses with marine taxa

After Zhang *et al.* (2006).

Perithecial or derived cleistothecial ascomata, unitunicate asci, basal or peripheral in ascoma with a wide range of anamorphs.

1. Stromata well developed, mostly consisting only fungal tissue, black with thick wall, ostioles papillate, periphysate, ascomata perithecial, interascal tissue well developed, asci cylindrical with J+ apical apparatus, ascospores brown to black, with germ pores .... **Xylariomycetidae**
1. Ascomata in a pseudostroma or coloured stroma or absent, lacking germ pores 2

2. Ascoma perithecial, rarely cleistothecial, sometimes stromatic and coloured, ostiole weakly to well developed, interascal tissue apical paraphyses or catenophyses or absent, asci thin-walled often deliquescing, ascus apical apparatus poorly developed, generally J-, ascospores septate, variable morphology, hyaline to brown, anamorphs may be present .... **Hypocreomycetidae**
2. Ascomata perithecial rarely cleistothecial, rarely stromatic or in a pseudostroma, necks well developed, interascal tissue poorly developed or absent, asci cylindrical or clavate often thick-walled but not fissitunicate, ascospores 0-1-septate, varied anamorphs .... **Sordariomycetidae**

HYPOCREOMYCETIDAE

Three orders with marine taxa

1. Ascomata in a stroma, perithecial, papillate or short necks, generally coloured, asci clavate to cylindrical, ascospores 1-septate, hyaline to pale brown, prominent anamorphs .... **Hypocreales**
1. Ascomata rarely in a stroma.................................... 2

2. Ascomata rarely stromatic, with well developed necks, asci generally clavate, ascospores hyaline rarely coloured, 1-many-septate, rarely with anamorphs .... **Halosphaeriales**
2. Ascomata dark, thick-walled, opening by an irregular lysigenous pore, asci clavate, long peduncle, ascospores hyaline to brown, allantoid .... **Coronophorales**

HYPOCREALES

Key to the marine Hypocreales and Hypocreales *incertae sedis*

1. Ascospores with wing-like appendages .... ***Emericellopsis***
1. Ascospores with polar appendages 2
1. Ascospores without appendages............................... 3

2. Ascospores 1-septate .... ***Etheirophora***
2. Ascospores 3-septate . ... ***Torpedospora***

3. Ascospores unicellular 4
3. Ascospores septate 6

4. Ascospores needle-shaped...................... ***Halonectria***
4. Ascospores oval or globose 5

5. Ascospores 6-11 × 4-7 µm .... ***Payosphaeria***
5. Ascospores 13.5-17 × 10-11.5 µm ... ***Neocosmospora***

6. Ascospores 1-septate 7
6. Ascospores 1-3-septate 9

7. On seaweed (*Laminaria*), ascospores, pale brown verruculose, 13-20 × 7-9 µm .... ***Pronectria***
7. On wood, ascospores hyaline. 8

8. Ascospores 18-21 × 10-13 µm, *Trichothecium*-like anamorph, ascomata yellow to pale brown .... ***Heleococcum***
8. Ascospores 17-26 × 8-13 µm, no known anamorph, ascomata orange .... ***Kallichroma***

9. Ascomata immersed in senescent leaves of *Juncus roemerianus*, asci with an apical ring, ascospores 3-septate, fusiform to elongate ellipsoidal 26.5-34.5 × 6-7 µm.. ***Juncigena***
9. Ascomata in wood, asci apically thickened, ascospores 1-3-septate .... ***Swampomyces***

Bionectriaceae

The assignment of marine *Nectria*-like taxa to this family is debatable and sequences of other genera are required before their true placement can be made. With the exception of *Emericellopsis*, they lack anamorphs, while the often submerged ascomata with long necks are not typical of the Hypocreales, e.g. *Halonectria*.

Emericellopsis J.F.H. Beyma, Antonie van Leeuwenhoek Ned. Tijdschr. Hyg. **6**: 264, 1940. .... (2)
▣ ***E. maritima*** Beliakova, Mikol. Fitopatol. **4**: 530, 1970.
▣ ***E. stolkiae*** D.E. Davidson & M. Chr., Trans. Br. Mycol. Soc. **57**: 385, 1971.

1. Ascospores 5-9 × 3-4.2 µm, 3 triangular wing-like appendages with an attenuated tips, projecting 5.6-10 µm .... ***E. stolkiae***
1. Ascospores 4-5 × 7-8 µm, 2-3 wings, up to 10 µm long .... ***E. maritima***

Anamorph: *Acremonium* species.

Ascomata cleistothecial, globose, glaborous, superficial, asci scattered, globose to subglobose, thin-walled, hyaline, moderately persistent, ascospores ellipsoidal to oval unicellular, dark green to pale brown, surrounded by subhyaline wings, triangular with an attenuated tip, finely spinulose (Davidson and Christensen, 1971). *Emericellopsis* species have been reported from marine habitats (Udea, 1980, 1995a) but are generally regarded as facultatively marine. This aspect requires to be challenged, as they are isolated from marine sediments, and often ruled out as truly marine.

This genus is assigned to the Bionectriaceae, forming a third marine lineage within the family (Rossman *et al*., 2001). Udea (1995a) isolated *E. microspora* from marine sediments and found that optimum growth was in 80% seawater. Artemczuk (1980) lists *Emericellopsis maritima* (Fig. 37) from sediments in the Black Sea, with ascospore measurements of 4-5 × 7-8 µm. *Acremonium* species are also frequently encountered on incubated wood from marine habitats (Jones, unpublished data).

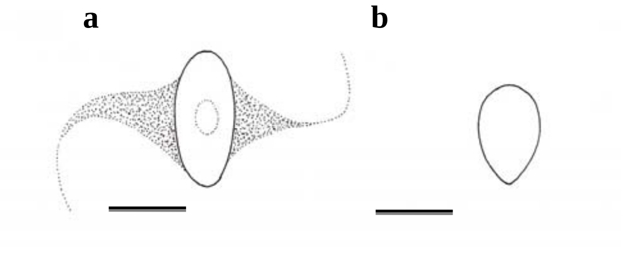


Fig. 37. **a.** *Emericellopsis maritima* Ascospore. **b**. Conidium. Bars a-b = 5 µm.

Halonectria E.B.G. Jones, Trans. Br. Mycol. Soc. **48**: 287, 1965 .... (1)
H. milfordensis E.B.G. Jones, Trans. Br. Mycol. Soc. **48**: 287, 1965 (*Type species*).

Ascomata solitary or gregarious, globose or subglobose, usually immersed, ostiolate, paplliate, coriaceous, orange-coloured to pale brown, lacking paraphyses, asci clavate, short pedunculate, unitunicate, thin-walled, deliquescing early, ascospores elongate, fusiform or cylindrical, unicellular, and hyaline. No appendages or sheath. A genus accepted by Rossman *et al*. (1999) for the present as a member of the Bionectriaceae, but they point out that the immersed ascomata with long necks and the elongate aseptate ascospores are not typical of the Hypocreales. Sequence data are required to resolve its taxonomic position.

Heleococcum C.A. Jørg., Bot. Tidsskr. **37**: 417, 1922... (1)
◙ ***H. japonense*** Tubaki, Trans. Mycol. Soc. Jpn. **8**: 5, 1967.

Anamorph: *Trichothecium*-like

Ascomata gregarious, globose, superficial, no ostiole, cleistothecial, membranous, white becoming orange or pale brown, lacking paraphyses, asci globose or subglobose, sessile, unitunicate, thin-walled, deliquescing, ascospores broad ellipsoidal or ovoidal, 1-septate, not constricted at the septum, hyaline, lacking appendages or a sheath. Molecular studies confirm the assignment of the genus to the Bionectriaceae, with affinities to *Roumegueriella rufula*, another cleistothecial member of the Bionectriaceae (Rehner and Samuels, 1995).

Kallichroma Kohlm. & Volkm.-Kohlm., Mycol. Res. **97**: 759, 1993.......................... (2)
◙ ***K. glabrum*** (Kohlm.) Kohlm. & Volkm.-Kohlm., Mycol. Res. **97**: 759, 1993.

Hydronectria tethys var. *glabra* Kohlm., Mar. Ecol. (P.S.Z.N.I.) **5**: 351, 1984.

◙ ***K. tethys*** (Kohlm. & E. Kohlm.) Kohlm. & Volkm-Kohlm., Mycol. Res. **97**: 759, 1993 (*Type species*).

Hydronectria tethys Kohlm. & E. Kohlm., Nova Hedw. **9**: 95, 1965.

Ascomata solitary or gregarious, subglobose, immersed sometimes erumpent, ostiolate, periphysate, lacking a papilla, orange-brownish to orange-yellowish, peridium thick, lacking paraphyses, asci clavate, unitunicate, thin-walled, deliquescing, ascospores ellipsoidal, fusiform or ovoid, 1-septate, constricted at the septum, hyaline lacking appendages or a sheath. Originally described as *Hydronectria* but transferred by Kohlmeyer and Volkmann-Kohlmeyer (1993a) to *Kallichroma* because the type species of *Hydronectria* is a lichen, with the alga *Trentepohlia*, occurs on rocks in freshwater and is temperate in its distribution. *Kallichroma* species are saprobic, marine (primarily on mangrove wood) and sub-tropical to tropical. They also differ in ascoma, paraphyses, ascus and ascospore morphology from *Hydronectria*. Kohlmeyer and Volkmann-Kohlmeyer (1993a) state the asci are persistent, but we frequently observe asci deliquescing. Molecular data supports placement in the Bionectriaceae, but is the most distant genus in the family (Rossman *et al*., 2001; Schroers, 2001). SEM studies show longitudinal ridges running the length of the ascospores of *K. tethys* (Hyde, 1986).

1. Ascospore wall smooth .... ***K. glabrum***
1. Ascospore wall with longitudinal ridges...... ***K. tethys***

Hypocreaceae

Neocosmospora E.F. Sm., U.S.D.A. Div. Veg. Pathol. Bull. **17**: 45, 1899 .... (1)
N. tenuicristata S. Udea & Udagawa, Mycotaxon **16**: 387, 1983.

Anamorph: *Acremonium tenuicristatum* S. Udea & Udagawa.

Ascomata ovoid to pyriform, superficial, scattered or aggregated, pale coloured becoming pink or orange-red, glaborous with hyaline to pale-yellow, unbranched, septate, smooth-walled short, hyphal-like hairs, short neck, periphysate, asci cylindrical, short pedunculate, hyaline, no apical apparatus, ascospores broadly ellipsoid to ellipsoid, unicellular, yellowish brown, thick-walled, no germ pore, surface ornamented (Fig. 38). The only species known from marine habitats, isolated from marine sludge at Oomura Bay, Japan (Udea and Udagawa, 1983). Characterized by its striated ascospores and a polyphialidic anamorph.

Payosphaeria W.F. Leong, Bot. Mar. **33**: 511, 1990...(1)
P. minuta W.F. Leong, Bot. Mar. **33**: 511, 1990 (*Type species*).

Ascomata globose to pyriform, superficial, ostiolate, papillate, lacking periphyses, membranous, hyaline, solitary or gregarious, paraphyses few, branched, septate, hyaline, asci long cylindrical, short pedunculate, persistent, unitunicate, thin-walled, no apical apparatus, ascospores round to oval, unicellular, hyaline, thin-walled, smooth and lacking a sheath or appendages. A poorly known species described from mangrove wood samples from Malaysia and Singapore, but common on submerged test blocks at these locations with 61 collections (Leong *et al*., 1990). Tentatively assigned by Leong *et al*. (1990) to the Hypocreales (as Nectriales) its taxonomic position needs further study at the molecular level.

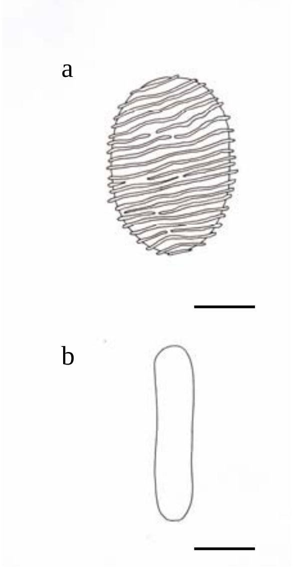


Fig. 38. *Neocosmospora tenuicristata.* **a.** Ascospore**. b.** Conidium. Bars a-b = 5 µm.

Pronectria Clem., Gen. Fungi. 78, 282, 1931 .. .. (1)
P. laminariae (O.E. Erikss.) Lowen, Mycotaxon **39**: 461, 1990.

Nectriella laminariae O.E. Erikss., Svensk. Bot. Tidskr. **58**: 233, 1964.

Ascomata solitary or gregarious, globose, ostiolate, papillate, periphysate, immersed, light brown, paraphyses filamentous deliquescing, asci cylindrical, thin-walled, unitunicate, with an apical pore, ascospores ellipsoidal, ovoid, fusiform, 1-septate, lacking appendages or a sheath and hyaline. Initially described as a *Nectriella* species but transferred to this genus by Lowen (1990) and is an accepted genus in the Bionectriaceae (Rossman *et al*., 1999).

HYPOCREALES *incertae sedis*

Torpedospora Meyers, Mycologia **49**: 496, 1957..(2)
◙ ***T. ambispinosa*** Kohlm., Nova Hedw. **2**: 336, 1960.
◙ ***T. radiata*** Meyers, Mycologia **49**: 496, 1957 (*Type species*).

Ascomata solitary, subglobose to ellipsoidal, immersed or superficial, ostiolate, papillate or epapillate, subcarbonaceous to coriaceous, dark brown, paraphyses ramose, deliquescing or persistent, asci clavate to ellipsoidal, unitunicate, thin-walled, early deliquescing, ascospores cylindrical to elongate-ellipsoidal, 3-septate, constricted at the septum, hyaline but pale orange in a mass, with appendages at one or both poles (Fig. 39) (Sakayaroj *et al*., 2005b).

Although these species have appendaged ascospores and deliquescing asci, and tentatively assigned to the Halosphaeriales, they were later excluded from the order (Kohlmeyer, 1972a). The morphology of the ascomata is very different from those of the Halosphaeriaceae and molecular data show they are a sister group to the Bionectriaceae, Hypocreales from LSU rDNA, or the clades comprising the Phyllachorales, Halosphaeriales, Microascales from SSU rDNA and combined data set (Sakayaroj *et al*., 2005b). At the molecular level the genus clusters with *Swampomyces* (Sakayaroj *et al*., 2005b) and this has been verified by Schoch *et al*. (2006), and confirms that they form a sister group to the Hypocreales in the Hypocreomycetidae. *Torpedospora* and *Swampomyces* also group with the genera *Juncigena* and *Etheirophora*, but share few morphological characters (Schoch *et al*., 2006).

1. Ascospores with appendages at one end, longer than 30 µm..***T. radiata***
1. Ascospores with appendages at both ends, shorter than 25 µm.......................................***T. ambispinosa***

Juncigena Kohlm., Volkm.-Kohlm. & O.E. Eriks., Bot. Mar. **40**: 291, 1997..................(1)
◙ ***J. adarca*** Kohlm., Volkm.-Kohlm. & O.E. Eriks., Bot. Mar. **40**: 291, 1997 (*Type species*).

Anamorph: *Cirrenalia adarca* Kohlm, Volkm-Kohlm & O.E. Erikss.

Ascomata subglobose to pyriform, immersed, ostiolate, papillate, coriaceous, fuscous, solitary, periphysate, pseudoparaphyses thin, branched, septate, asci fusiform to cylindrical, short pedunculate, thin-walled, unitunicate, apical apparatus with an apical ring, J-, ascospores fusiform to elongate-ellipsoidal, 3-septate, constricted at the septa, hyaline, no sheath or appendages. A salt marsh fungus, with a *Cirrenalia adarca* anamorph, which grows on the submerged bases of leaves (between 12-25 cm above the rhizomes) of *Juncus roemerianus*, and thus regarded as obligately marine. Originally Eriksson (1999) considered it to belong in the Magnaporthaceae. Thongkantha *et al.* (2009) found no support for this. Using DNA sequences from protein coding and ribosomal nuclear loci, Schoch *et al*. (2006) noted three subclades (1. *Torpedospora* spp., 2. *Swampomyces* spp. and *Etheirophora* spp. and 3. *Swampomyces* sp. and *Juncigena adarca*) were associated with the Coronophorales with good support. The data suggests that the 3-septate *Swampomyces* species may be congeneric with *Juncigena adarca* but further clarification of the molecular data of *S. triseptatus* is required.

Swampomyces Kohlm. & Volkm.-Kohlm., Bot. Mar. **30**: 198, 1987......................................(4)
◙ ***S. armeniacus*** Kohlm. & Volkm.-Kohlm., Bot. Mar. **30**: 200, 1987 (*Type species*).
◙ ***S. triseptatus*** K.D. Hyde & Nakagiri, Sydowia **44**: 122, 1992.
◙ ***S. aegyptiacus*** Abdel-Wahab, El-Shar. & E.B.G. Jones, Fungal Diver. **8**: 35, 2001.
◙ ***S. clavatispora*** Abdel-Wahab, El-Shar. & E.B.G. Jones, Fungal Diver. **8**: 37, 2001.

Ascomata pyriform, subglobose, globose, coriaceous, centrum apricot coloured, solitary, immersed, ostiolate, necks with periphyses, dark brown to black, paraphyses numerous, simple, hyaline, in a gel, asci cylindrical-oblong, unitunicate, thin-walled, short pedunculate, apically thickened, J-, persistent, ascospores clavate, ellipsoidal, 1-3-septate, hyaline, slightly to constricted at the septa, no appendages or sheaths. All species found predominantly on mangrove wood (Fig. 40)

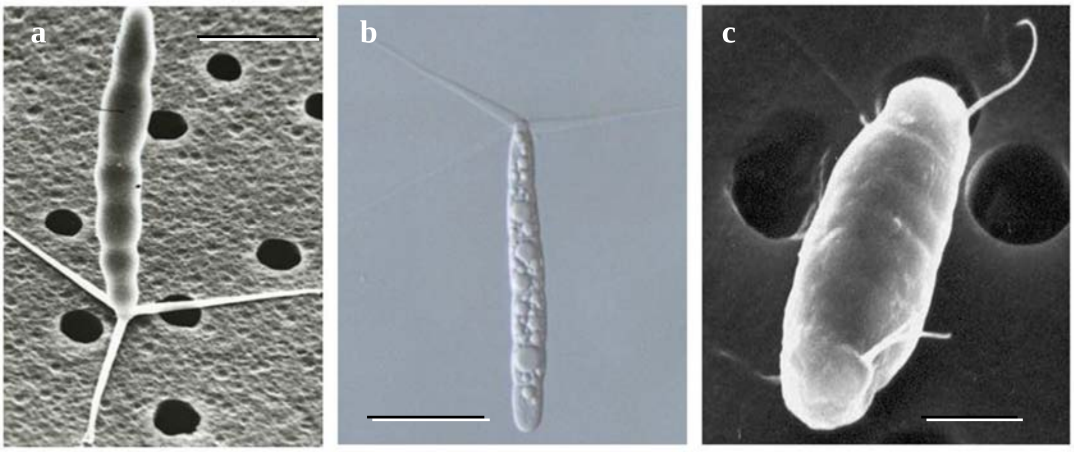


Fig. 39. Ascospores of **a-b.** *Torpedospora radiata.* **c.** *Torpedospora ambispinosa.* Bars a-b = 10 µm, c = 5 µm.

(Abdel-Wahab *et al.*, 2001a). The genus was tentatively assigned to the Polystigmataceae (Kohlmeyer and Volkmann-Kohlmeyer, 1987c), but was left unclassified pending sequence data. At the ultrastructure level, the ascus apex consists of a large amorphous apical thickening, but no central pore was observed, although serial sections were made (Read *et al.*, 1995). Molecular data has not helped in resolving the higher level taxonomic position of this genus, which groups with *Torpedospora* species (Sakayaroj *et al.*, 2005b). *Swampomyces armeniacus* shows closer affinity with *Etheirophora* species, but further strains of *S. triseptatus* need to be sequenced to resolve the status of the genus (Schoch *et al.*, 2006).

1. Ascospores 1-septate, 13-20 × 6.9 µm **S. armeniacus**
1. Ascospores with more than 1 septum........................2

2. Ascospores clavate, 25-28 × 5-6 µm..**S. clavatispora**
2. Ascospores ellipsoidal...3

3. Ascospores 15-19 × 6-8 µm, deeply constricted at the septa ....**S. aegyptiacus**
3. Ascospores 18-25 × 8-11 µm, weakly constricted at the septum, spore wall with granular ornamentation.. .... **S. triseptatus**

Etheirophora Kohlm. & Volkm.-Kohlm., Mycol. Res. **92**: 414, 1989........................... (3)
E. bijubata Kohlm. & Volkm.-Kohlm., Mycol. Res. **92**: 414, 1989 (*Type species*).
◙ ***E. blepharospora*** (Kohlm. & E. Kohlm.) Kohlm. & Volkm.-Kohlm., Mycol. Res. **92**: 415, 1989.

Keissleriella blepharospora Kohlm. & E. Kohlm., Nova Hedw. **9**: 97,1965.

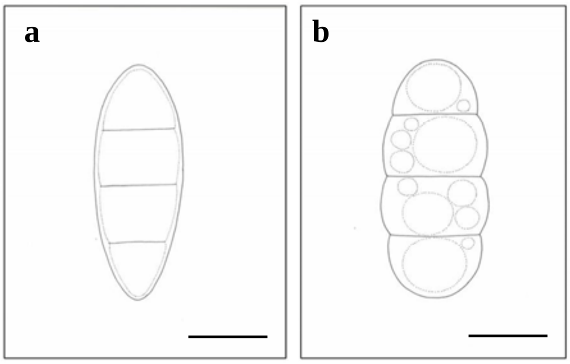


Fig. 40. Ascospores of **a.** *Swampomyces clavatispora.* **b.** *S. aegyptiacus*. Bars a-b = 5 µm.

◙ ***E. unijubata*** Kohlm. & Volkm.-Kohlm., Mycol. Res. **92**: 415, 1989.

Ascomata subglobose, elongate, immersed in wood, ostiolate, papillate, clypeate, coriaceous, light-coloured, peri-physate, paraphyses septate, rarely branched in a gelatinous matrix, asci cylindrical to oblong, pedunculate, J-, thin-walled, persistent, no apical apparatus, ascospores ellipsoidal, 1-septate, hyaline, with variable number of appendages. Kohlmeyer and Volkmann-Kohlmeyer (1989) erected the genus for a group of lignicolous marine fungi of uncertain taxonomic position and incorrectly assigned to the Halosphaeriales by Hawksworth *et al.* (1995) and Kirk *et al.* (2001). Although *Etheirophora* species share a number of features in common with the Halosphaeriales (lignicolous, immersed ascomata, ostioles periphysate, asci unitunicate, with 1-septate hyaline and appendaged ascospores) they differ in having cylindrical, pedunculate, non amyloid persistent asci with polar filamentous appendaged ascospores. Appendages are long

(12-18 µm), bristle-like, rigid, slightly curved and of undetermined origin. Molecular data places them in the TBM clade with affinties to the Coronophorales in the Hypocreomycetidae (Schoch *et al*., 2006).

1. Ascospores with appendages at both ends, 16-21.5 × 6-8 µm ....**E. bijubata**
1. Ascospores with appendages at one end 2

2. Ascospores up to 21 µm, on bark of *Rhizophora mangle*, up to 7 appendages ....**E. blepharospora**
2. Ascospores up to 29 µm, on other hosts, with more than 7 appendages .... **E. unijubata**

CORONOPHORALES

Nitschkiaceae

Groenhiella Jørg. Koch, E.B.G. Jones & S.T Moss, Bot. Mar. **26**: 265, 1983 .... (1)
G. bivestia Jørg. Koch, E.B.G. Jones & S.T. Moss, Bot. Mar. **26**: 265, 1983 (*Type species*).

Ascomata hemispherical-oblong tuberiform, cleistothecial, superficial, leathery to carbonaceous, brown to black, with a weak subiculum, paraphyses numerous, septate, constricted at the septa, simple or branched, asci broadly clavate, long pedunculate, unitunicate thin-walled at maturity, no apical apparatus, generally persistent, ascospores broadly fusiform, 1-septate, slightly constricted at the septum, hyaline later brown, with appendages. Appendages formed by fragmentation of a sheath forming apical and equatorial appendages (Koch *et al*., 1983).

Hibbett *et al*. (2007) refer the Nitschkiaceae to the Coronophorales, the order to which Koch *et al*. (1983) originally assigned *Groenhiella.* However, a molecular study is required to validate its assignment to the Nitschkiaceae and to the Coronophorales. The most recent study is that of Petersen (1997) on the ultrastructure of the ascospores and confirms the exosporic origin of the appendages, comprising fibrillar electron-dense material in an electron-transparent matrix and *circa* 360 nm thick. As the ascus deliquesces the exosporic sheath separates from the episporium and then fragments to form the polar and equatorial appendages.

HALOSPHAERIALES

Halosphaeriaceae

The Halosphaeriales is one of the most intensively studied marine ascomycete order at the morphological, ultrastructural and molecular level with 53 genera (of which 35 are monotypic) and 126 species. Nearly 50% of the genera have been sequenced and found to form a monophyletic group within the Ascomycota (Fig. 41). Hibbett *et al*. (2007) places the Halosphaeriales within the Microascales. However, Zhang *et al*. (2006) and Tang *et al*. (2007a) retain the order, and this is followed in this volume. Tang *et al.* (2007a) undertook a multigene analysis of the systematics of the Sordariomycetes. Three subclasses were defined: Hypocreomycetidae, Sordariomycetidae and Xylariomycetidae as employed in this monograph. They noted that the Microascales is paraphyletic with *Ceratocystis* phylogenetically associated with *Faurelina*, while *Microascus* and *Petriella* formed a separate clade and were basal to other members of the Halosphaeriales (Tang *et al*., 2007a). In the LSU dataset the Halosphaeriales and Microascales form subclades, with the latter in a basal position. In the SSU dataset the Microascales splits the Halosphaeriales into two separate clades, but with weak support. The Microascales are basal to the Halosphaeriales in the RPB2 and combined datasets, but with too few taxa to satisfactorily resolve their taxonomic position (Tang *et al*., 2007a).

Key to the genera

1. Ascospores aseptate 2
1. Ascospores septate 8

2. Ascospores appendaged 3
2. Ascospores lacking appendages..............................4

3. Ascospores with polar and 4 groups of equatorial hair-like appendages ....**Nautosphaeria**
3. Ascospores with a single, uncoiling polar appendage .... **Moana**

4. Ascospores longer than 50 µm, filiform, range 50-300 × 4-15 µm .... **Bathyascus**

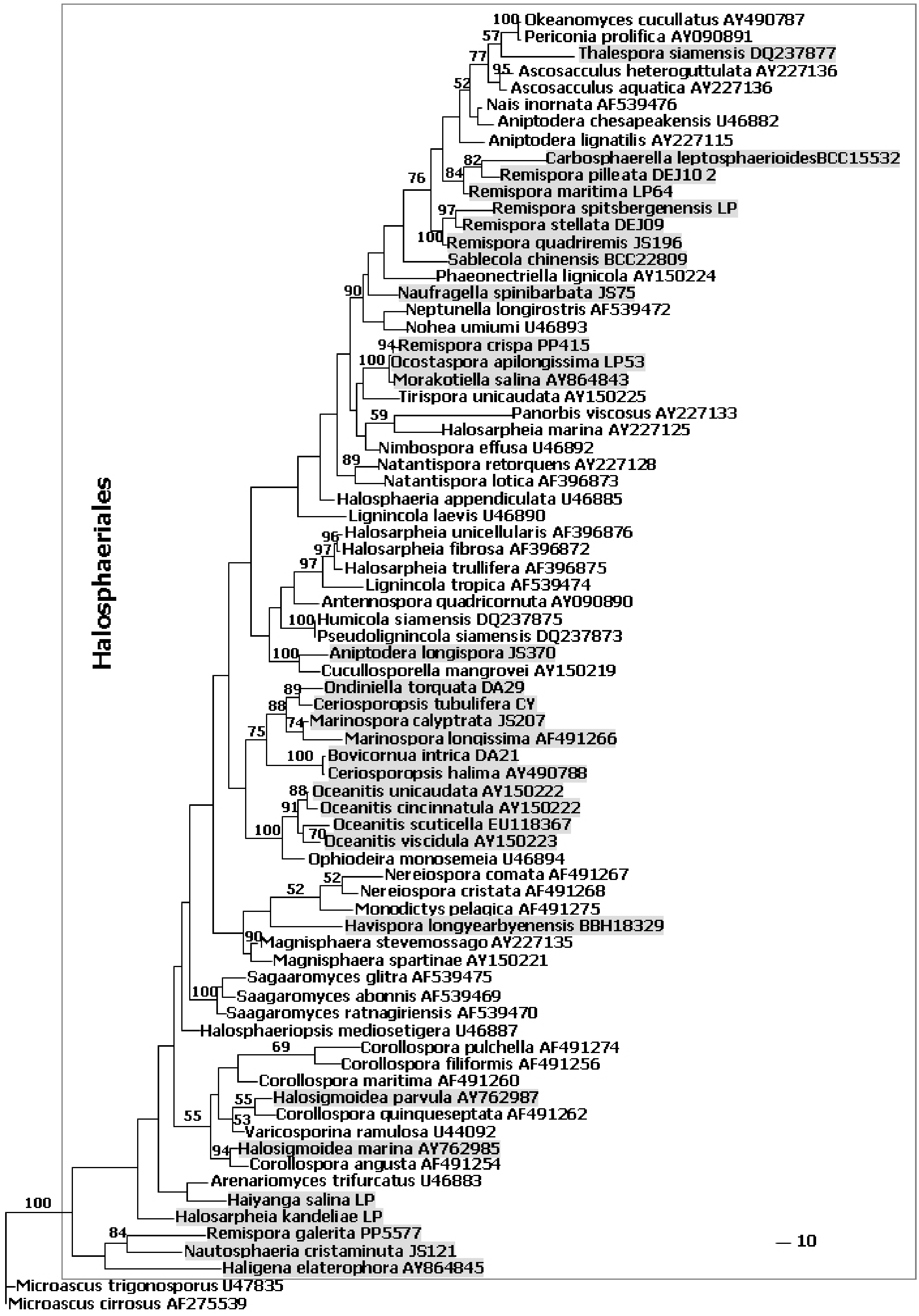


Fig. 41. One of three MPTs inferred from LSU rDNA sequences of all halosphaerialean taxa, generated with maximum parsimony analysis. Bootstrap values higher than 50% are given above branches. Scale bar indicates 10 character state changes.

4. Ascospores shorter than 50 µm, spherical or ellipsoidal 5

5. Ascospores spherical to round 6
5. Ascospores ellipsoidal, range 9-38 × 4-24 µm.. ***Chadefaudia***

6. Asci with an apical pore, ascopores globose to subglobose.. ***Thalassogena***
6. Asci lacking an apical pore 7

7. Ascomata cream-coloured, with long necks, ascospores globose to ellipsoidal .... ***Anisostagma***
7. Ascomata brown, necks short, ascospores spherical.. ***Iwilsoniella***

8. Ascospores 1-septate.. 9
8. Ascospores 1 to many-septate 44

9. Ascospores with no appendages 10
9. Ascospores with polar and/or equatorial appendages or with sheaths 14

10. Asci deliquescing early .... ***Nais***
10. Asci persistent. 11

11. Asci persistent, no retraction of the plasmalemma.. 12
11. Asci with plasmalemma retracted 13

12. Ascus tip thimble-shaped, or slightly thickened.. ***Lignincola***
12. Ascus tip lacking thimble-shaped apical thickening .... ***Alisea***

13. Ascospores without unfurling bipolar appendages.. ***Aniptodera***
13. Ascospores with a faint sheath.............. ***Neptunella***

14. Ascospores with a single polar appendage.......... 15
14. Ascospores with bipolar hamate appendage, or polar and equatorial appendages 18

15. Ascospores with a hamate polar appendage........ 16
15. Ascospores with an ephemeral drop of polar mucilage, becoming 2-4-septate on germination.. ***Okeanomyces***

16. Ascomata formed beneath a stroma, ascospores 6-21× 6-8 µm .... ***Ophiodeira***
16. Ascomata not stromatic. 17

17. Ascospores oval, 24-32 × 8-12 µm .... ***Tirispora***
17. Ascospores filiform, 60-80 × 4-6 µm ascomata thick-walled .... ***Oceanitis***

18. Ascospores with polar unfurling appendages 9
18. Ascospore appendages with a different morphology 24

19. Polar appendages emerging from a hood-like structure.. ***Cucullosporella***
19. Polar appendages not formed through a hood. 20

20. Ascospores longer than 35 µm and wider than 20 µm 22
20. Ascospores shorter and narrower than 35 µm and 20 µm, respectively 21

21. Ascospores wider than 14 µm .... ***Saagaromyces***
21. Ascospores 12-14 µm wide.................. ***Aniptodera***

22. Ascospores wider than 30 µm.. ***Halsarpheia sensu stricto***
22. Ascospores narrower than 30 µm........................ 23

23. Ascospores 21-31 × 8-11 µm .... ***Panorbis***
23. Ascospores 20-34 × 7-11 µm .... ***Natantispora***
23. Ascospores 10- 32 × 4-13µm.. ***Halosarpheia sensu lato***

24. Ascospores with two types of appendages.......... 25
24. Ascospores with only one type of appendage 28

25. Ascospores with a sheath and polar and lateral or subpolar appendages 26
25. Ascospores with no sheath 27

26. Ascospores with polar hair-like and lateral sheath-like appendage .... ***Nimbospora***
26. Ascospores with a fragmenting sheath, and polar unfurling appendages .... ***Tunicatispora***

27. Polar strap-like mucilaginous and subpolar hair-like appendages .... ***Naufragella***
27. Sub-polar hair-like appendages arise from a pad, and on the opposite side long, sticky appendages that uncoil in water .... ***Nohea***

28. Ascospores with polar or subpolar appendages... 29
28. Ascospores with polar and/or lateral appendages 35
28. Ascospores with an exosporic sheath.................. 41

29. Ascospores with polar appendages 30
29. Ascospores with subpolar appendages................ 32

30. Ascospore appendages formed by fragmentation of a sheath.. 31
30. Appendages coiled around the ascospores, uncoiling in water.............................. ***Morakotiella***

31. Ascospore wing-like or radiating appendages.. ***Remispora sensu stricto***
31. Ascospores appendages moustache shaped, each apex surrounded by a large, subglobose cap, with delicate radiating striae, (16-) 20-28 (-35) × 7-12 µm .... ***Remispora galerita***
31. Ascospores appendages spoon-shaped, delicate and fibrillar, 22-34 × 8-12 µm..... ***Remispora crispa***

32. Ascospore appendages with a spade-like tip .... ***Arenariomyces***
32 Ascospores appendages lacking a spade-like tip . 33

33. Ascospores with 2 sub-polar appendages .... ***Antennospora***
33. Ascospores with more than 2 sub-polar appendages 34

34. Ascospores with 3-4 sub-polar spoon-shaped appendages .... ***Haiyanga***
34. Ascospores with 5-7 appendages .... ***Corallicola***

35. Equatorial appendage ring- or annulus-like 36
35. Equatorial appendages distinct 38

36. Chamber-like polar appendage from which mucilage is released ...... ***Ceriosporopsis tubulifera***
36. Polar appendages do not release mucilage 37

37. Equatorial appendage annulus-like ....***Ondiniella***
37. Equatorial appendage ring-like .... ***Lautisporopsis***

38. Equatorial appendages lunate, with a cup-like polar appendage .... ***Halosphaeriopsis***
38. Appendages spoon-like or obclavate 39

39. Appendages spoon-like, do not fragment .... ***Halosphaeria***
39. Appendages become fibrillar at maturity 40

40. Polar appendage longer than equatorial appendages .... ***Ocostaspora***
40. Appendages equal in length .... ***Sablecola***

41. Appendages with a cup-like exosporic fragments at their tips .... ***Marinospora***
41. Appendages lacking cup-like fragments at their tips .... .42

42. Ascomata grayish-white, exosporic sheath envelopes the spore and horn-like polar appendage .... ***Bovicornua***
42. Ascomata brown to dark coloured, appendages not horn-like 43

43. Exosporic sheath highly fibrillar (mucilaginous), *circa* 5 µm wide, appendage slug-like .... ***Limacospora***
43. Exosporic sheath compact, not fibrillar, polar appendage uncoiling in water .... ***Ceriosporopsis***

44. Ascospores with no appendages 45
44. Ascospores with appendages 47

45. Ascospores filamentous, broad at one end, tapering at the other .... ***Trailia***
45. Ascospores not tapering at one end 46

46. Ascospores 5-septate (rarely 9), asci with 4 ascospores .... ***Luttrellia***
46. Ascospores 3-septate, asci with 8 ascospores .... ***Pseudolignincola***
47. Ascospores hyaline or brown with polar and equatorial appendages 48
47. Ascospores hyaline, with only polar appendages 50
47. Ascospores with sheath, lacking polar and equatorial appendages 56

48. Appendages hair-like tufts, one polar and four equatorial 49
48. Polar appendages spine-like, equatorial appendages formed by fragmentation of an exosporic sheath .... ***Corollospora***

49. Catenophyses present, ascospores hyaline, appendages string-like, lacking an equatorial pad... .... ***Havispora***
49. Catenophyses lacking, ascospores with hyaline end cells and brown central cells, equatorial pad present .... ***Nereiospora***

50. Ascospores with a single polar appendage 51
50. Ascospores with bipolar appendages 52

51. Appendage an ephemeral drop of mucilage .... ***Okeanomyces***
51. Tetraradiate appendages formed after release from the ascoma .... ***Thalespora***

52. Ascospores appendages hamate, unfurling in water 53
52. Ascospore appendages not hamate 55

53. Ascospores narrower than 7 µm .... ***Oceanitis***
53. Ascospores wider than 7 µm 54

54. Ascospores verrucose, wider than 40 µm............... .... ***Magnisphaera***
54. Ascospores not verrucose, narrower than 40 µm .... ***Halosarpheia sensu lato***

55. Ascospores appendages sub-polar, spine-like .... ***Arenariomyces***
55. Ascospores appendages broad strap-like .***Haligena***
55. Ascospores appendages round ....***Trichomaris***

56. Ascospores 12-20 µm wide, central cells dark, appendages a fragmenting sheath net-like.............. .... ***Carbosphaerella***
56. Ascospores hyaline, 7-11 µm wide .... ***Appendichordella***

Alisea J. Dupont & E.B.G. Jones, Mycol. Res. in press, 2009 .... (1)
◙ ***A. longicola*** J. Dupont & E.B.G. Jones, Mycol. Res. in press, 2009.

Ascomata globose to obpyriform, ostiolate, papillate, coriaceous, black, superficial, solitary or gregarious, with a long cylindrical to conical neck *circa* 250 µm, periphysate, asci clavate, long pedunculate, thin-walled, unitunicate, persistent, ascospores fusiform, slightly curved, 1-septate, thick-walled, hyaline but distinct appendages not reported. Molecular and morphological data confirm the position of this genus within the Halosphaeriales (Dupont *et al*., 2009). On trawled sunken wood fragments collected at 1,000 m depth in the Pacific Ocean off Vanuatu Islands, the ascomata are large (600-650 µm), with a thick peridial wall, no paraphyses or catenophyses, asci unitunicate, clavate with a long pedicel, persistent, ascospores 32-35 × 3.2-3.6 µm, hyaline, fusiform, 1-septate and with no appendages (Fig. 42). Ultrastructural data suggest there is an exosporium which may form a thin mucilaginous layer around the ascospore.

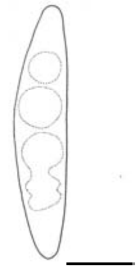


Fig. 42. *Alisea longicola.* Ascospore. Bar = 10 µm.

Aniptodera Shearer & M.A. Mill., Mycologia **69**: 893, 1977 .... (9)

◙ ***A. chesapeakensis*** Shearer & M.A. Mill., Mycologia **69**: 894, 1977 (*Type species*).

A. haispora Vrijmoed, K.D. Hyde & E.B.G. Jones, Mycol. Res. **98**: 701, 1994.

A. intermedia K.D. Hyde & Alias, Mycol. Res. **103**: 1409, 1999.

◙ ***A. juncicola*** Volkm.-Kohlm. & Kohlm., Bot. Mar. **37**: 109, 1994.

A. limnetica Shearer, Mycologia 81: 140, 1989.

◙ ***A. longispora*** K.D. Hyde, Bot. Mar. **33**: 335, 1990.

A. mangrovei K.D. Hyde, Can. J. Bot. **64**: 2989, 1986.

A. nypae K.D. Hyde, Sydowia **46**: 257, 1994.

A. salsuginosa Nakagiri & Tad. Ito, Mycol. Res. **98**: 931, 1994.

Ascomata globose to subglobose, immersed or superficial, ostiolate, papillate, membranous, hyaline to light brown to dark brown, neck variable in length cylindrical, periphysate, catenophyses present but deliquescing, asci clavate, short pedunculate, unitunicate, thin-walled, but with an apical pore and a retracting plasmalemma subapically, persistent or deliquescing, ascospores ellipsoidal, 1-septate, hyaline, thick-walled, with or without apical appendages which unfurl when mounted in water (Hyde and Jones, 1989c; Campbell *et al*., 2003).

Initially this genus was well circumscribed (Shearer and Miller, 1977), but with the addition of further species the situation has become confused. Originally ascospores were characterized as thick-walled, 1-septate, lacking bipolar appendages, with persistent asci, with a retracting plasmalemma, and an apical pore. Since the assignment of species with bipolar, unfurling appendages, the differences between it and *Halosarpheia* have become confused (Kong *et al*., 2000) (Fig. 41). Any taxonomic changes proposed for *Halosarpheia* must take into account the genus *Aniptodera.* Marine *Aniptodera* species occur on a wide range of substrata: mangrove and driftwood, *Nypa fruticans, Juncus roemerianus.* Some freshwater *Aniptodera* species may also occur in saline habitats, for example *A. limnetica* was reported by Nakagiri (1993b) on *Bruguiera gymnorhiza* wood collected in the Shiira River mangrove, Japan. Ascospores in *A. limnetica* are thin-walled and released through a fissure in the apical plate which splits at the pore. We regard *Aniptodera indica* as a synonym of *Tirispora unicaudata* (Ananda and Sridhar, 2002). Assignment of *A. juncicola* and *A. mangrovei* to the genus needs to be tested at the molecular level as they may be better placed in other genera.

The stability of ascospore appendages as a character in the delineation of genera might be questioned in view of the behaviour of those of *Aniptodera salsuginosa* when mounted in water of different salinity. In freshwater the appendages immediately detach but uncoil when mounted in salinities of 3-10 ‰ (Nakagiri and Ito, 1994). The issue of appendaged/non-appendaged ascospores in *A. chesapeakensis* also needs resolution, before the taxonomy of this genus can be resolved.

1. Ascospores with bipolar appendages 2
1. Ascospores lacking appendages 3

2. Ascospores 37-45 × 12-14 µm, on mangrove wood .. .. ***A. mangrovei***
2. Ascospores 14-20 × 4-7 µm, on mangrove bark .... ***A. salsuginosa***

3. Ascospores thick-walled 4
3. Ascospores thin-walled 6

4. Ascospores with very thick-walled, on wide range of substrata, 21-37 × 7-15 µm .... ***A. chesapeakensis***
4. Ascospore walls less thick 5

5. Ascospores 20-25 × 14-18 µm, on mangrove wood .. .. ***A. haispora***
5. Ascospores 24-31 × 8-12 µm, on *Juncus roemerianus* .... ***A. juncicola***

6. Ascospores longer than 35 µm, 32-54 × 9-13.5 µm, on mangrove wood .... ***A. longispora***
6. Ascospores shorter than 35 µm 7

7. Ascospores 10.5-13 × 7-8 µm .... ***A. intermedia***
7. Ascospores 16-22 × 5-7 µm .... ***A. nypae***
7. Ascospores 20-25 × 8-10 µm .... ***A. limnetica***

Anisostagma K.R.L. Petersen & Jørg. Koch, Mycol. Res. **100**: 211, 1996 .... (1)
A. rotundatum K.R.L. Petersen & Jørg. Koch, Mycol. Res. **100**: 211, 1996 (*Type species*).

Ascomata globose to broadly ellipsoidal, immersed to erumpent, coriaceous, ostiolate, papillate, cream-coloured to pale brown, solitary or gregarious, neck long (140-420 µm), periphysate, catenophyses present, asci clavate, pedunculate, unitunicate, thin-walled, lacking an apical apparatus, early deliquescing, ascospores globose to ellipsoidal, unicellular, hyaline, thin-walled without appendages or a sheath (Petersen and Koch, 1996). *Anisostagma rotundatum* resembles *Thalassogena sphaerica*, both possessing sphaerical-ellipsoidal hyaline ascospores and with no appendages or sheaths. Two distinguishing characters are: peridium structure and ascus morphology. In *Thalassogena* the peridial wall is undifferentiated, while in *Anisostagma* it is two layered (inner layer of flattened thin-walled cells and an outer layer forming a *textura angularis*). An apical pore is present in *Thalassogena*, but lacking in *Anisostagma* (Petersen and Koch, 1996). Whether these characters are sufficient to separate these two genera remains to be resolved.

Antennospora Meyers, Mycologia **49**: 501, 1957... (1)
◙ ***A. quadricornuta*** (Cribb & J.W. Cribb) T.W. Johnson, J. Elisha Mitchell Sci. Soc.**74**: 46, 1958 (*Type species*).

Halosphaeria quadricornuta Cribb & J.W. Cribb, Univ. Queensl. Pap. Dept. Bot. **3**: 99, 1956.

Antennospora caribbea Meyers, Mycologia **49**: 503, 1957.

Ascomata subglobose or ellipsoidal, immersed, superficial when growing on the calcareous tubes of mollusks, ostiolate, papillate, coriaceous or subcarbonaceous, dark brown, solitary or gregarious, catenophyses deliquescing, periphysate, asci clavate, pedunculate, untiunicate, thin-walled, no apical apparatus, deliquescing early, ascospores ellipsoidal, 1-septate, slightly constricted at the septum, hyaline with polar appendages. Appendages subterminal, at each end of the spore, at right angles to each other, cylindrical, and attenuate (Figs 41, 43h). Their ultra-structure has been examined by Yusoff *et al.* (1994c). Ascospores of *A. salina* and *A. quadricornuta* are morphologically different with two round, sub-polar appendages in the latter species, while the former has 4-5 sub-terminal wing-like appendages (Yusoff *et al.*, 1994c). Consequently, and supported by molecular data, *A. salina* was transferred to *Haiyanga* (Pang *et al.*, 2008b).

Appendichordella R.G. Johnson, E.B.G. Jones & S.T. Moss, Can. J. Bot. **65**: 941, 1987 (l)
A. amicta (Kohlm.) R.G. Johnson, E.B.G. Jones & S.T. Moss, Can. J. Bot. **65**: 941, 1987 (*Type species*).

Sphaerulina amicta Kohlm., Nova Hedw. **4**: 414, 1962.

Haligena amicta (Kohlm.) Kohlm., Marine Mycology: The Higher Fungi: **288**, 1979.

Ascomata globose to subglobose, immersed, ostiolate, papillate, coriaceous, light brown to reddish-brown, solitary, periphysate, catenophyses deliquescing, asci clavate, pedunculate, unitunicate, thin-walled, without an apical apparatus, deliquescing, ascospores cylindrical or ellipsoidal, 3-septate, constricted at the septa, hyaline and with a pronounced sheath. A monotypic genus (previously assigned to *Sphaerulina* and *Haligena*) characterized by a gelatinous sheath to the ascospore, which is composed of thread-like appendages arising from the episporium (Johnson *et al.,* 1987). Well placed in the Halosphaeriales.

Arenariomyces Höhnk, VerVöff. Inst. Meersforsch. Bremerhaven **3**: 28, 1954....... (4)

A. majusculus Kohlm. & Volkm.-Kohlm., Mycol. Res. **92**: 411, 1989.

A. parvulus Jørg. Koch, Nordic. J. Bot. **6**: 497, 1986.

◙ ***A. trifurcatus*** Höhnk, Veröff. Inst. Meersforsch. Bremerhaven **3**: 30, 1954 (*Type species*).

Halosphaeria trifurcata (Höhnk) Cribb & J.W. Cribb, Univ. Queensl. Pap., Dept. Bot. **3**: 99, 1956

Peritrichospora trifurcata (Höhnk) Kohlm., Nova Hedw. **3**: 89, 1961

Corollospora trifurcata (Höhnk) Kohlm. Ber. Dtsch. Bot. Ges. **75:** 126, 1962

A. triseptatus Kohlm., Mar. Ecol. (P.S.Z.N.I.) **5**: 333, 1984.

Ascomata globose or subglobose, immersed generally superficial, attached to substrata by subicula, with or without ostioles, papillate or epapillate, carbonaceous, black or dark brown, solitary, catenophyses deliquescing, asci fusiform to subclavate, short pedunculate, unitunicate, thin-walled, early deliquescing, ascospores variable fusiform, ellipsoidal or oblong, 1-3-septate, slightly constricted at the septa, hyaline and appendaged. Appendages subterminal at each end of the spores, with a bulbose base and long attenuated arms (Jones *et al.*, 1983a).

The type species has been transferred to numerous genera, but molecular data confirms its position in the Halosphaeriales as a well supported genus (Fig. 41). Jones *et al.* (1983a) in a TEM study showed that the appendages differed from those of *Corollospora,* and re-established the genus. In *Arenariomyces* the subpolar appendages are outgrowths from the mesosporium, while in *Corollospora* they comprise both the mesosporium and episporium (Jones *et al*., 1983a). Furthermore, the base of the appendage is swollen with electron-dense fibres on one side.

1. Ascospores 1-septate... 2
1. Ascospores 3-septate, 27-34 × 6-8 µm. ***A. triseptatus***

2. Ascospores cylindrical, 16-25 × 3-6 µm. ***A. parvulus***
2. Ascospores ellipsoidal 3

3. Ascospores consistently with 3 appendages, mainly on sand, 24-38 × 7-16 µm .... ***A. trifurcatus***
3. Ascospores with 3-4 appendages, mainly on wood, 28-39 × 10-14 µm .... ***A. majusculus***

Bathyascus Kohlm., Rev. Mycol. **41**: 190, 1977.. (4)

B. avicenniae Kohlm., Bot. Mar. **23**: 530, 1980.

B. grandisporus K.D. Hyde, Bot. Mar. **30**: 413, 1987.

B. tropicalis Kohlm., Bot. Mar. **23**: 532, 1980.

B. vermisporus Kohlm., Rev. Mycol. **41**: 191, 1977 (*Type species*).

Ascomata subglobose or ellipsoidal, immersed, ostiolate, papillate, coriaceous, dark brown, solitary, neck lacking periphyses, catenophyses deliquescing, asci fusiform to clavate, unitunicate, thin-walled, early deliquescing, ascospores filiform, 0-1-septate, hyaline and lacking appendages. This genus was initially assigned to the Halosphaeriales because of the deliquescent nature of the asci, but prelimiary molecular studies show that it has little affinity with that order. Furthermore, *B. tropicalis* may be incorrectly placed in the genus because of the thin-walled nature of the ascoma, not a feature of the genus. *Bathyascus* superficially resembles *Pseudohalonectria* in ascospore morphology, but differ in the degree of spore septation, and cylindrical asci with a well developed apical apparatus (Shearer, 1993b). A molecular study is required to confirm whether *B. tropicalis* would be better assigned to *Thalespora* (Jones *et al.*, 2006).

1. Ascospores with no septum, ascomata many layered peridium.. 2
1. Ascospores with 1 septum, 70-100 × 8-10 µm, ascomata thin-walled .... ***B. tropicalis***

2. Ascospores thick-walled, a deep sea species, 50-72 × 4-6 µm... ***B. vermisporus***
2. Ascospores thin-walled, a mangrove species........... 3

3. Ascospores 90-145 × 2.5-4 µm............***B. avicenniae***
3. Ascospores 205-300 × 9-15 µm.......***B. grandisporus***

Bovicornua Jørg. Koch & E.B.G. Jones, Can. J. Bot. **71**: 346, 1993.. (1)

◙ ***B. intricata*** Jørg. Koch & E.B.G. Jones, Can. J. Bot. **71**: 347, 1993 (*Type species*).

Ascomata globose to subglobose, ostiolate with short conical necks, greyish white, erumpent, membranous, gregarious, centrum pseudoparenchyma breaks down, no catenophyses, asci broadly clavate, pedunculate, unitunicate, thin-walled, early deliquescing, no apical pore, ascospores unequally 1-septate, slightly curved, constricted at the septum, hyaline and appendaged. At each pole there is a single appendage enclosed within an outer sheath which swells when mounted in sea water. A genus that shares many features with *Ceriosporopsis* but differs in the degree of elaboration of the ascospore appendages as seen at the TEM level (Yusoff *et al*., 1993). The exosporic wall layer enrobes both the spore and polar appendages, which arise as outgrowths of the spore. The exosporium is bipartite, the inner region has regular, parallel electron-dense lamellations that radiate from the episporium while the outer region consists of electron-dense fibrillar material. Molecular results confirm the placement of *Bovicornua* in the Halosphaeriales. It clusters with *Ceriosporopsis halima* with strong support within the same clade as *Marinospora*, *Ceriosporopsis tubulifera* and *Ondiniella* (Fig. 41).

Carbosphaerella I. Schmidt, Feddes Repert. 80: 108, 1969.. (2)

◙ ***C. leptosphaerioides*** I. Schmidt, Nat. Naturschutz Mecklenburg **7**: 9, 1969.

C. pleosporoides I. Schmidt, Feddes Repert. **80**: 108, 1969 (*Type species*).

Ascomata globose or subglobose, superficial, subiculate, ostiolate, papillate or epapillate, carbonaceous, black, lacking paraphyses, asci obpyriform, subglobose, ovoid, short pedunculate, lacking an apical apparatus, unitunicate, deliquescing early, ascospores ellipsoidal or ovoid, 3-septate or muriform, brown, apical cell paler, with a pronounced gelatinous sheath (Johnson *et al*., 1984). A well delineated genus with its inclusion in the order supported by molecular and morphological evidence. The phylogeny of *C. leptosphaerioides* is confirmed by molecular analysis. It is well delineated in the Halosphaeriales and has affinties with *Remispora pilleata* and *R. maritima* (Fig. 41).

1. Ascospores with transverse septa only... ***C. leptosphaerioides***
1. Ascospores with both transverse and longitudinal septa ....***C. pleosporoides***

Ceriosporopsis Linder Farlowia **1**: 408, 1944 .... (5)

C. caduca E.B.G. Jones & Zainal, Mycotaxon **32**: 238, 1988.

C. cambrensis I.M. Wilson, Trans. Br. Mycol. Soc. **37**: 276, 1954.

C. capillacea Kohlm., Can. J. Bot. **59**: 1314, 1981.

◙ ***C. halima*** Linder, Farlowia **1**: 408, 1944 (*Type species*).

◙ ***C. tubulifera*** (Kohlm.) P.W. Kirk ex Kohlm., Can. J. Bot. **50**: 1953, 1972.

Halosphaeria tubulifera Kohlm. Nova Hedw. **2**: 312, 1960.

Ascomata subglobose to cylindrical, immersed, ostiolate, papillate, coriaceous or subcarbonaceous, light brown to black, solitary or gregarious, catenophyses deliquescing, asci clavate, pedunculate, unitunicate, thin-walled, deliquescing early, ascospores ellipsoidal, 1-septate, hyaline, with appendages. Appendage morphology variable depending on the species (Johnson *et al*., 1987). *Ceriosporopsis cambrensis* may have been described on the basis of more than one species, as the original description is confused in certain details (Jones *et al*., 1995), consequently can be designated a doubtful species.

Ceriosporopsis tubulifera differs in many details from the type species *C. halima,* but primarily in the origin and nature of the ascospore appendage (Figs. 41, 43a, 44a) (Johnson *et al*., 1987). It possesses a polar end-chamber from which mucilage is released, but this does not arise from the mesosporium. However, its phylogenetic position is placed within the *Marinospora* clade with good support (Fig. 41). However, it is not monophyletic with the type species, *Ceriosporopsis halima.* In other *Ceriosporopsis* species the polar appendages arise from the mesosporium (Johnson *et al*., 1987). *Ceriosporopsis circumvestita* and *C. sundica* have been transferred to new genera:

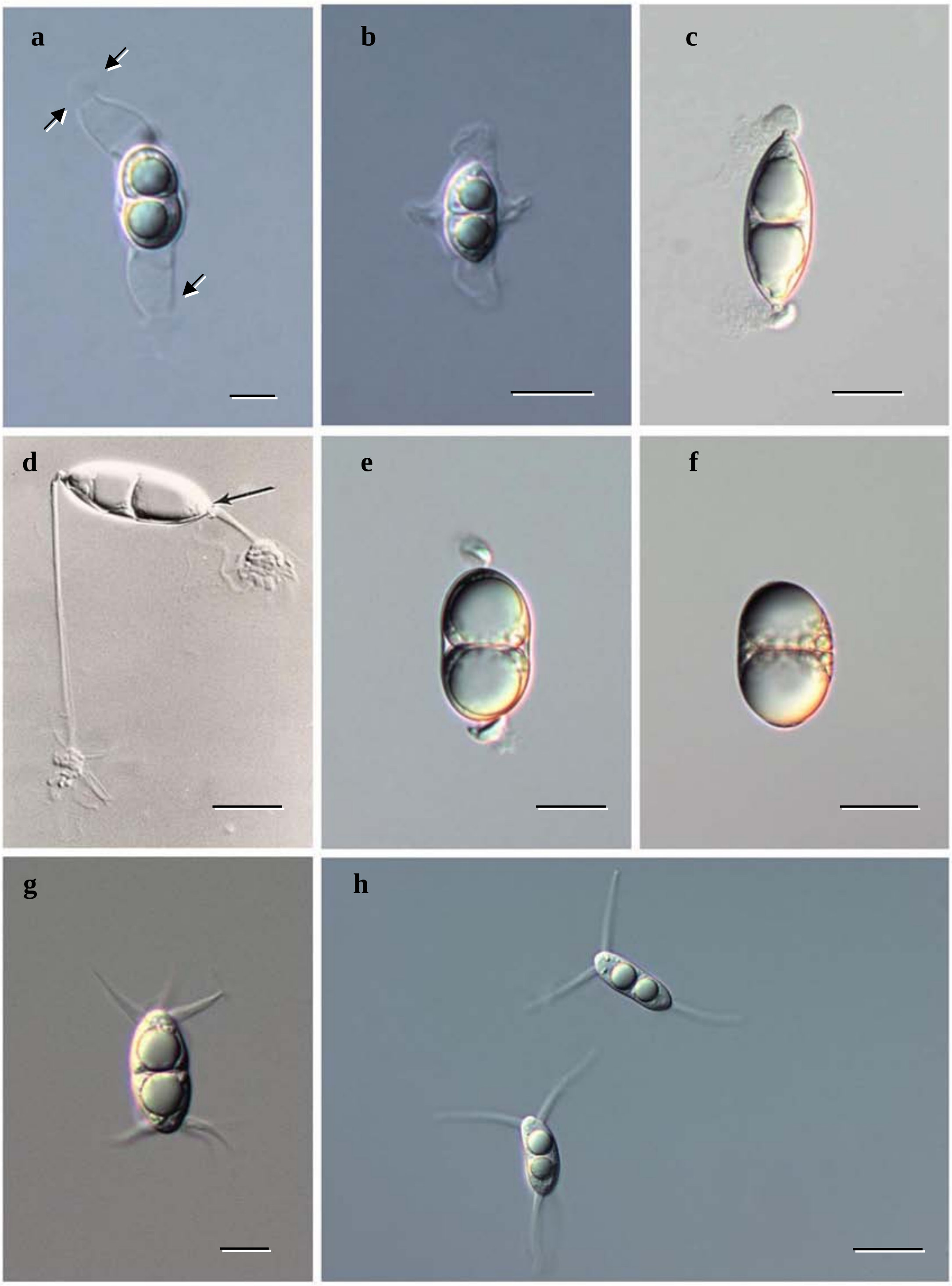


Fig. 43. Ascospores of various halosphaeriaceous ascomycetes. **a**. *Ceriosporopsis tubulifera*. (mucilage arrowed) **b**. *Lautisporopsis circumvestita*. **c, d**. *Cucullosporella mangrovei*, apical collar arrowed. **e.** *Halosarpheia trullifera*. **f**. *Saagaromyces glitra*. **g**. *Haiyanga salina*. **h**. *Antennospora quadricornuta.* Bars a, b, e, g = 10 µm, d, f = 25 µm, h = 20 µm.

Lautisporopsis and *Limacospora*, respectively (Yusoff *et al*., 1994a; Jones *et al*., 1995).

1. Ascospores with equatorial appendages...................2
1. Ascospores lacking equatorial appendages..............3

2. Polar ascospore appendage an end chamber containing mucilage..............................***C. tubulifera***
2. Polar ascospore appendage arising from the mesosporium, without an end chamber......***C. caduca***

3. Ascospore appendages >750 nm...........***C. capillacea***

3. Ascospore appendages <750 nm 4

4. Ascospores 22.5-26 × 8-10 µm .... ***C. halima***
4. Ascospores 29-31.5 × 10.5-14.5 µm ... ***C. cambrensis***

Chadefaudia Feldm., -Maz. Rev. Gén. Bot. **64**: 150, 1957 .... (6)

C. balliae Kohlm., Mycologia **65**: 244, 1973.

C. corallinarum (P. Crouan & H. Crouan) E. Müll. & Arx, The Fungi **4A**: 116, 1973.

Sphaeria corallinarum P. Crouan & H. Crouan, Florule Finistère, Paris: 24, 1867.

Physalospora corallinarum (P. Crouan & H. Crouan) Sacc., Syll. Fung. **1**: 448, 1882.

Mycophycophila corallinarum (P. Crouan & H. Crouan) Kohlm., Nova Hedw. **6**: 128, 1963.

C. gymnogongri (Feldmann) Kohlm., Bot. Mar. **16**: 202, 1973.

Macrophoma gymnogongri Feldmann, Bot. Soc. Hist. Nat. Afr. Nord. **31**: 167, 1940.

Mycophycophila gymnogongri (Feldmann) Cribb & J.W. Cribb, Pap. Univ. Queensl. Dept. Bot. **4**: 43, 1960.

C. marina Feldmann-Maz. Rev. Gén. Bot. **64**: 150, 1957 (*Type species*).

C. polyporolithi (Bonar) Kohlm., Bot. Mar. **16**: 205, 1973.

Mycophycophila polyporolithi Bonar, Mycologia **57**: 379, 1965.

C. schizymeniae Stegenga & Kemperman, Bot. Mar. **27**: 443, 1984.

Ascomata subglobose, superficial or immersed, ostiolate, papillate or epapillate, coriaceous to carbonaceous, dark brown, solitary or gregarious, paraphyses absent, catenophyses deliquescing, asci subglobose to clavate, unitunicate, thin-walled, deliquescing early, ascospores ellipsoidal, 0-septate, hyaline with gelatinous cap-like appendages at both ends of the spore. The taxonomic position of the genus needs re-evaluation, but fresh material for examination is rarely available for study. It is doubtful if it belongs in the Halosphaeriales. All species have unicellular, hyaline ascospores with small polar pad or cap-like appendages. All are parasitic on various algal genera.

1. Ascospores longer than 25 µm: 29-38 × 14-22 µm.... .... ***C. balliae***
1. Ascospores shorter than 25 µm 2

2. Ascomata superficial, base flat 3
2. Ascomata immersed in algal thallus, base rounded . 4

3. Ascomata smaller than 300 µm in diam., ascospores 9-19 × 4-8 µm .... ***C. corallinarum***
3. Ascomata greater then 300 µm im diam., ascospores 16-24 × 4-8 µm .... ***C. polyporolithi***

4. Parasite of *Rhodymenia*, ascospores 12-16 × 4-6 µm .... ***C. marina***
4. On other algal hosts 5

5. On the alga *Schizymenia*, ascospores 12-18 × 1-4 µm .... ***C. schizymeniae***
5. On a wide range of algal hosts, ascospores 14-20 × 4-7 µm .... ***C. gymnogongri***

Corallicola Volkm.-Kohlm. & Kohlm., Mycotaxon **44**: 418, 1992 .... (1)

C. nana Volkm.-Kohlm. & Kohlm., Mycotaxon **44**: 418, 1992 (*Type species*).

Ascomata subglobose, superficial, ostiolate, short papillate or epapilliate, subiculate, coriaceous, dark brown, solitary or gregarious, catenophyses deliquescing, asci deliquescing early, unitunicate, thin-walled, ascospores ellipsoidal, 1-septate, hyaline, slightly constricted at the septum, with 5-7 polar appendages at each pole. This species is very similar to *Arenariomyces* and differs in that the centrum pseudoparenchyma has no pit connections; ascospore appendages do not terminate in a spade-like structure; and it can be found on dead coral rocks (Volkmann-Kohlmeyer and Kohlmeyer, 1992). The genus should be examined at the molecular level to determine if it is distinct from *Arenariomyces* (Jones *et al*., 1983a).

Corollospora Werderm., Notizbl. Bot. Gart. Mus. Berlin-Dahlem **8**: 248, 1922 .... (21)

◙ ***C. anglusa*** Abdel-Wahab & Nagah., Mycoscience, in press, 2009.

Anamorph: *Varicosporina anglusa* Abdel-Wahab & Nagah.

◙ ***C. angusta*** Nakagiri & Tokura, Trans. Mycol. Soc. Jpn. **28**: 417, 1988.

Anamorph: ?*Varicosporina ramulosa* Meyers & Kohlm.

C. armoricana Kohlm. & Volkm.,-Kohlm. Can. J. Bot. **67**: 1281, 1989.

◙ ***C. baravispora*** Steinke & E.B.G. Jones sp. nov. Fungal Diver. **35**: 88, 2009.

C. besarispora Sundari, Mycol. Res. **100**: 1259, 1996.

C. californica Kohlm. & Volkm.-Kohlm., Bot. Mar. **40**: 225, 1997.

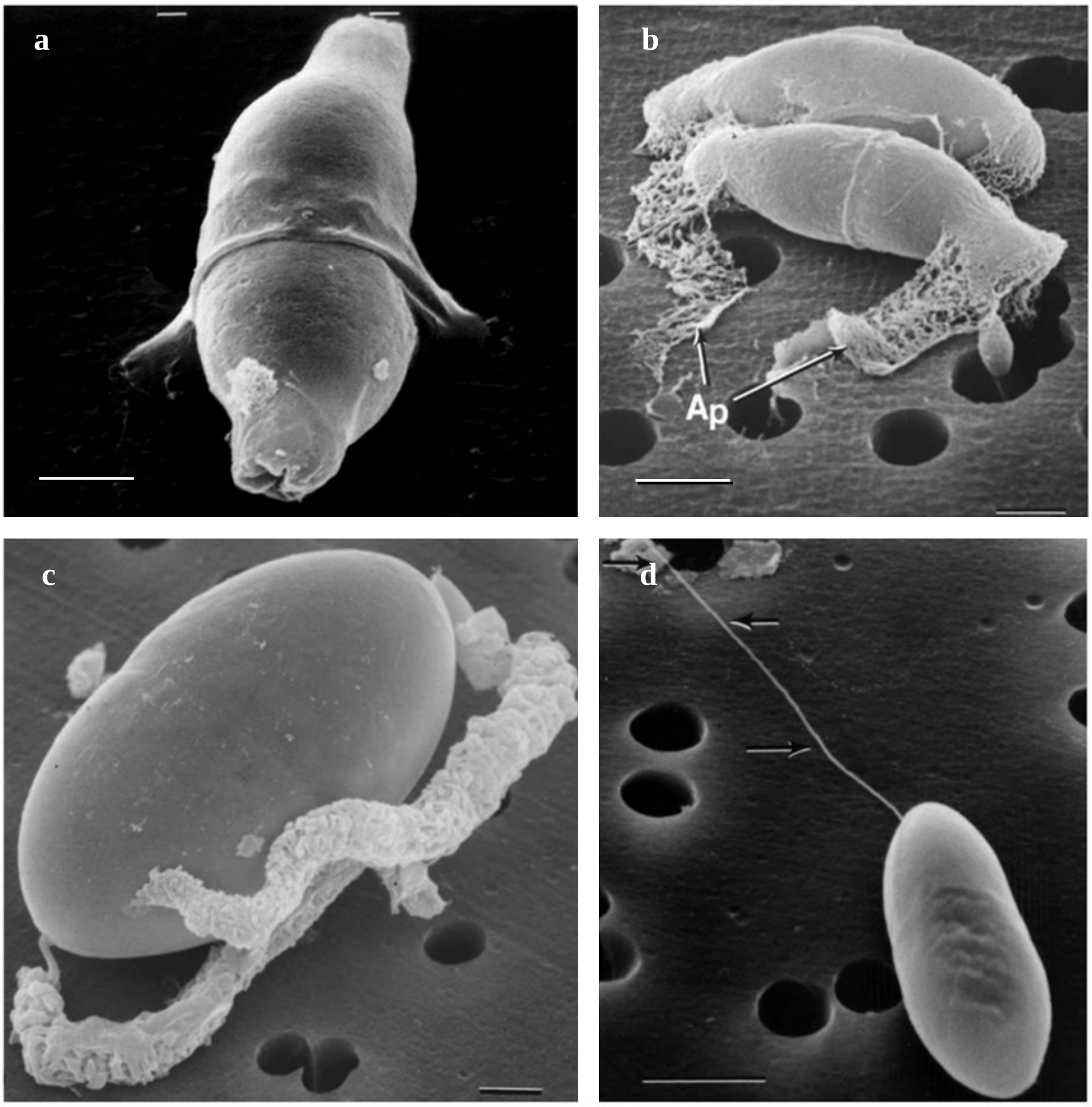


Fig. 44. Scanning electron micrographs of halosphaeriaceous ascomycetes. **a**. *Ceriosporopsis tubulifera*. **b**. *Remispora crispa*. **c**. *Saagaromyces abonnis* **(Photo by Theresa Baker). d.** *Tirispora unicaudata*. Bars a-c = 5 µm, d = 10 µm.

C. cinnamomea Jørg. Koch, Nordic. J. Bot. **6**: 498, 1986.

◙ ***C. colossa*** Nakagiri, Trans. Mycol. Soc. Jpn. **28**: 418, 1988.

◙ ***C. filiformis*** Nakagiri, Trans. Mycol. Soc. Jpn. **28**: 422, 1988.

◙ ***C. fusca*** Nakagiri & Tokura, Trans. Mycol. Soc. Jpn. **28**: 424, 1988.

C. gracilis Nakagiri & Tokura, Trans. Mycol. Soc. Jpn. **28**: 426, 1988.

C. indica Prasannarai, Ananda & K.R. Sridhar, J. Environ. Biol. **21**: 235, 2000.

◙ ***C. intermedia*** I. Schmidt, Natur Naturschutz **7**: 6, 1970.

Anamorph: ?*Varicosporina prolifera* Nakagiri

◙ ***C. lacera*** (Linder) Kohlm., Ber. Dtsch. Bot. Ges. **75**: 126, 1962.

Peritrichospora lacera Linder, Farlowia **1**: 415, 1944.

C. luteola Nakagiri & Tokura, Trans. Mycol. Soc. Jpn. **23**: 102, 1982.

Anamorph: *Halosigmoidea luteola* Nakagiri & Tubaki.

◙ ***C. maritima*** Werderm., Notizbl., Königl. bot. Gart. u. Museum zu Berlin **8**: 248, 1922 (*Type species*).

Arenariomyces cinctus Höhnk, Veröff. Inst. Meeresforsch. Bremerhaven **3:** 28, 1954.

Peritrichospora integra Linder, Farlowia **1**: 414, 1944.

C. novofusca Kohlm. & Volkm.-Kohlm., Bot. Mar. **34**: 34, 1991.

◙ ***C. portsaidica*** Abdel-Wahab & Nagah., Mycoscience, in press, 2008.

C. pseudopulchella Nakagiri & Tokura, Trans. Br. Mycol. Jpn. **28**: 428, 1988.

◙ ***C. pulchella*** Kohlm., I. Schmidt & N.B. Nair, Ber. Dtsch. Bot. Ges. **80**: 98, 1967.

Anamorph: *Clavatospora bulbosa* (Anastasiou) Nakagiri & Tubaki, Bot. Mar. **28**: 489, 1985.

◙ ***C. quinqueseptata*** Nakagiri, Trans. Br. Mycol. Jpn. **28**: 430, 1988.

Ascomata globose or subglobose, superficial, erumpent, subiculate, ostiolate or lacking ostioles, papillate or epapillate, carbonaceous, pale brown to black, catenophyses deliquescing, asci fusiform or subclavate, apiculate, short pedunculate, unitunicate, thin-walled, lacking an apical apparatus, deliquescing, ascospores various fusiform, subellipsoidal, constricted at the septum, 1-14-septate, muriform with longitudinal and trans-septa, hyaline to pale brown to dark brown, with appendages. Two types of appendages: polar spine-like appendages arising as outgrowths of the mesosporium and episporium and secondary fine hair-like appendages formed by fragmentation of the exosporium (Jones *et al*., 1983a) (Figs. 45a-d). Delineation of species has been largely based on ascospore measurements, possession of polar spines and nature of the appendages (Prasannarai *et al*., 2000). However, Nakagiri and Tubaki (1986) also demonstrated significant differences in ascomatal wall structure, number of cell wall layers and especially the columnar-like cells in the outer layer (Sundari *et al*., 1996; Hsieh *et al.*, 2007).

Species are common sand dwelling fungi, forming a cohesive morphological group, and well supported by molecular data (Campbell *et al*., 2002). No distinct taxonomic groups can be discerned within the genus, which is probably paraphyletic, and continuously evolving. However, recent analysis of molecular data suggests the genus may comprise two well-defined groups (Jones *et al*., 2009; unpublished data). *Corollospora* species have anamorphs from three different genera: *Clavatospora*, *Halosigmoidea* and *Varicosporina*.

Campbell *et al*. (2002) provided a sequence of *Corollospora* sp. isolated from material collected in South Africa (Steinke and Jones, 1993). This is sufficiently different from other *Corollospora* species to warrant the erection of a new species, which is proposed here.

Corollospora baravispora Steinke & E.B.G. Jones, sp. nov. .... Fig. 45d.
Mycobank:MB513019

Ascomata globosa vel subglobosa, superficiala, nigra, carbonacia, solitaria vel gregaria, ostiolata, papillata, subiculata. Subiculum texturam angularem formans. Centrum ascomatis immaturi cellulis pseudoparenchymaticis, hyalinis, leptodermis, foveolatis, deliquescentibus. Paraphyses nullae. Asci octospori, ellipsoidei, unitunicati, mox deliquescentes. Ascosporae 36-40 × 18-22 µm, fusiformes, 1-septatae, ad septa leviter constrictae, bruennei. Appendices bigeneres: (i) appendices polares, spiniformes, 10-15 µm longae, 1-2 µm diam. (ii) appendices circa . septum centralem 10-12 µm longae, peritrichiatae, per fragmenta exosporarum effectae et appendices apicales 4-6 µm longae.

Substratum: South Africa, Beachwood, Durban, Coll. E.B.G. Jones, driftwood buried in sand, 15 January 1992,

Holotype: culture PP6266, Sequence AF 491263, Fig. 45d.

Etymology: from the Polynesian “baravi” = beach, and spora, in reference to its habitat.

Ascomata globose, superficial, ostiolate, papillate, subiculate, carbonaceous, black, solitary, attached to sand grains. Neck short, at base of ascomata. Subiculum dark brown to black. Asci thin-walled, unitunicate deliquescing early. Ascospores 36-40 × 18-22 µm, (excluding polar appendages) 1-septate, constricted at the septum, pale brown and appendaged. Polar appendages 15-30 µm long, with equatorial appendages formed by fragmentation of an exosporic sheath.

1. Ascospores light to dark brown 2
1. Ascospores hyaline 7

2. Ascospores 1-or more-septate, no trans-septa.......... 3
2. Ascospores with trans-septa.................................... 6

3. Ascospores with polar spines.................................. 4
3. Ascospores lacking a polar spine 54-72 × 6-7.5 µm, 7-11-septate..***C. californica***

4. Ascospores wider than 10 µm, 1-septate, 36-40 × 18-22 µm, pale brown .... ***C. baravispora***
4. Ascospores narrower than 10 µm 5

5. Ascospores 1-septate, 18-25 × 6-9 µm, dark............. .... ***C. cinnamomea***

5. Ascospores 1-septate, 27-32 × 8-9 µm, brown.......... .... *C*. ***portsaidica***

6. Ascospores 63-220 × 20-38 µm, 12-21 trans-septa, polar appendages 25-75 µm ....***C. fusca***
6. Ascospores 74-99 × 24-34 µm, 13 trans-septa, polar appendages 52-86 µm ....***C. novofusca***

7. Ascospores 1-septate.. 8
7. Ascospores with more than 1-septate..................... 10

8. Ascospores wider than 8 µm, 22-33 × 8-10 µm, polar appendages.. ***C. maritima***
8. Ascospores narrower than 8 µm.............................. 9

9. Ascospores 18-30 × 3-4 (-5), polar appendages 4-7 µm with *Varicosporina* anamorph .... ***C. anglusa***
9. Ascospores 26-45 × 3-7 µm, polar appendages 6.5-12 µm... ***C. gracilis***

10. Ascospores with 3-septate.................................. 11
10. Ascospores with more than 3-septate................. 13

11. Ascospores wider than 7 µm 12
11. Ascospores narrower than 7 µm wide, 35-57 × 3-7.5 µm, polar appendages 3-8 µm .... ***C. angusta***

12. Ascospores 29-44 × 6.5-8.5 µm, polar appendages 9-13 µm .... ***C. armoricana***
12. Ascospores 25-34 × 7-12 µm, polar appendages 10-14 µm ....***C. intermedia***

13. Ascospores with polar appendage 18
13. Ascospores without polar appendages 14

14. Ascospores 5-septate, 50-85 × 5-8 µm .... ***C. luteola***
14. Ascospores with more than 5-septate.................. 15

15. Ascospores predominately 7-septate................... 16
15. Ascospores with more than 7-septate.................. 17

16. Ascospores 60-108 × 13-26 µm .... ***C. colossa***
16. Ascospores 52-112 × 7-16 µm .... ***C. pulchella***

17. Ascospores 7-11-septate, 65-98 × 8-12 µm............ ....***C. pseudopulchella***
17. Ascospores 13-septate, 73-120 × 5-8 µm .... ***C. filiformis***

18. Ascospores 3-5-septate.. 19
18. Ascospores over 5-septate................................... 20

19 Ascospores 39-63 × 10-19 µm, polar appendages 10-14 µm .... ***C. lacera***
19. Ascospores 38-59 × 8-10 µm, polar appendages 5-12 µm .... ***C. quinqueseptata***

20. Ascospores 7-8-septate, 100-163 × 25-38 µm, polar appendages 10-38 µm...................... ***C. besarispora***
20. Ascospores 3-12-septate, 45-102.5 × 7.5-17.5 µm, polar appendages 12-25 µm .... ***C. indica***

Cucullosporella K.D. Hyde & E.B.G. Jones, Mycotaxon **37**: 200, 1990 .... (1)
◙ ***C. mangrovei*** (K.D. Hyde & E.B.G. Jones) K.D. Hyde & E.B.G. Jones, Mycotaxon **37**: 200, 1990 (*Type species*).

Cucullospora mangrovei K.D. Hyde & E.B.G. Jones, Bot**.** Mar. **29**: 491, 1986.

Ascomata subglobose, ovoid or ellipsoidal, immersed, ostiolate, papillate, greyish brown to black, solitary or gregarious, periphysate, catenophyses present, asci clavate, pedunculate, unitunicate, thin-walled, thickened at the apex with a lens-shaped refractive region, persistent, ascospores fusoid to ellipsoidal, 1-septate, not constricted at the septum, hyaline with polar appendages (Hyde and Jones, 1986a). This genus, along with *Halosarpheia*, has bipolar unfurling appendages, but differs from it in that the appendages comprise two components, bundles of fibrillar material in an amorphous matrix (Figs. 43c, d). Molecular sequences and morphological observations confirm that this genus is distinct from other ascomycetes with bipolar unfurling appendages (Alias *et al*., 2001) (Fig. 41).

Haligena Kohlm., Nova Hedw. **3**: 87, 1961 (1)
◙ ***H. elaterophora*** Kohlm., Nova Hedw. **3**: 87, 1961 (*Type species*).

Ascomata globose or ovoid, immersed or superficial, ostiolate, papillate or epapillate, coriaceous or subcarbonaceous, black, solitary or gregarious, periphysate, catenophyses deliquescing, asci clavate, apiculate, pedunculate, unitunicate, thin-walled, lacking an apical apparatus, early deliquescing, ascospores oblong ellipsoidal, 3-5-septate, constricted at the septa, hyaline, with polar appendages (Figs. 49a-e). Appendages initially wrapped around the ascospores but separates to form long strap-like appendages (Johnson *et al*., 1987).

This is a genus that has undergone several revisions with species referred to other genera: *Appendichordella* (Johnson *et al*., 1987), *Magnisphaera* and *Ascosalsum* (*Oceanitis*), largely based on the morphology and ultrastructure of the ascospore appendages (Campbell *et al*., 2003; Dupont *et al*., 2009). Molecular data indicate *H. elaterophora* is

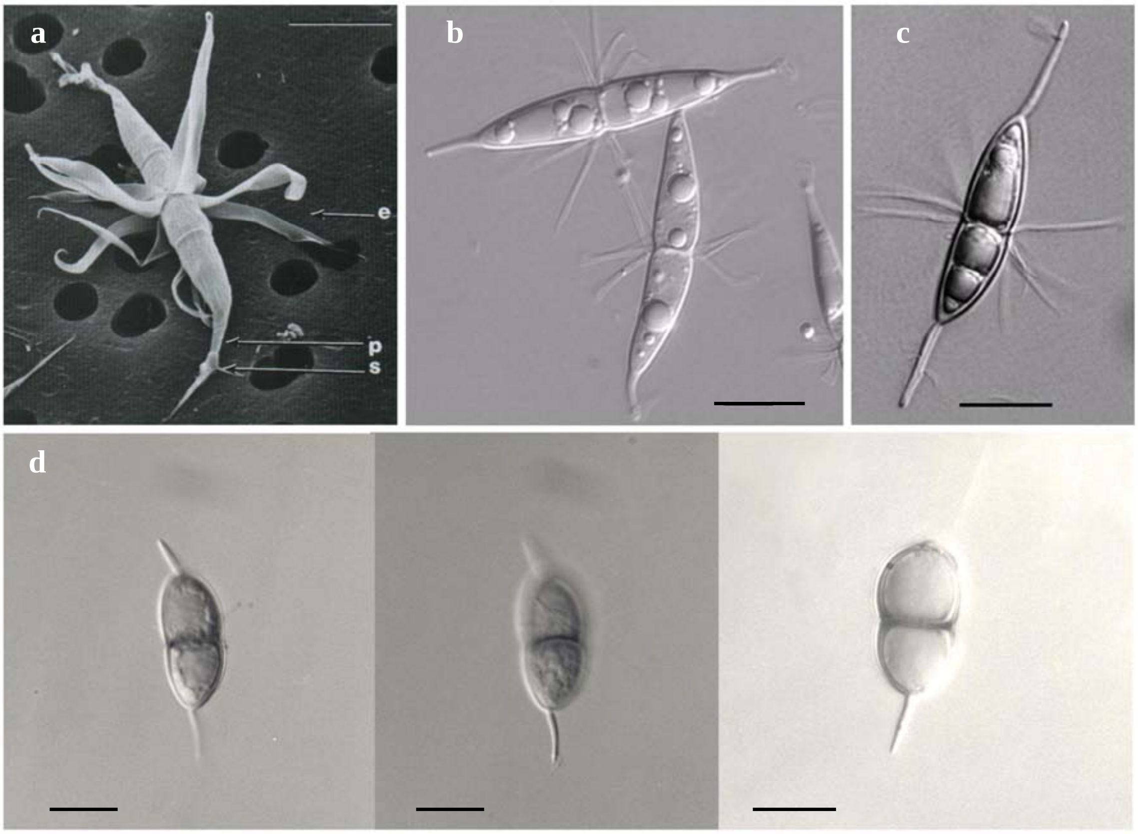


Fig. 45. Ascospores of: **a.** *Corollospora intermedia,* (SEM micrograph). **b.** *C. anglusa*. **c.** *C. portsaidica*. (**Photos b, c by Mohamed Abdel-Wahab**). **d.** *C. baravispora.* Bars a-c = 10 µm, d = 20 µm.

well placed in the Halosphaeriales but it is not monophyletic. *Haligena salina* has therefore been transferred to a new genus *Morakotiella* (Sakayaroj *et al*., 2005a) (Fig. 41).

Halosarpheia Kohlm. & E. Kohlm., Trans. Br. Mycol. Soc. **68**: 208, 1977........................... (3)

Ascomata globose, subglobose, obpyriform, ellipsoidal, immersed to superficial, ostiolate, papillate, coriaceous, pale brown to black, catenophyses deliquescing, necks variable in length, periphysate, asci clavate, pedunculate, unitunicate, thin-walled, retraction of the plasmalemma apically in some species, no apical apparatus, persistent, ascospores broad-ellipsoidal, 1-septate, not constricted at the septum, with apical appendages, initially closely adpressed to the spore wall (hamate) later separating and uncoiling to form long polar thread-like, sticky appendages (Kohlmeyer and Kohlmeyer, 1977) (Figs. 43e, 46). Kong *et al*. (2000) were the first to draw attention to the polyphyletic nature of this genus, and this has been subsequently supported by other studies (Anderson *et al*., 2001).

Although all species have bipolar unfurling appendages they differ greatly in other characters. For example, degree of ascospore septation; wall ornamentation (Jones and Moss, 1978, reported a highly verrucose wall for *H. spartinae*); shape of the ascus; length of the ascus pedicel; deliquescent or persistent asci; asci with or lacking an apical pore; presence of catenophyses, and thickness of the ascoma wall (Jones, 1995). Molecular data suggest that the genus was in need of division but care must be exercised as the genus has many overlapping features with *Aniptodera*, but few species of that genus have been sequenced to date. Paraphyly of the genus must also not be ignored (Mitchell, pers. comm.). As the result of molecular studies (Abdel-Wahab *et al*., 1999, 2001b; Campbell *et al*., 2003; Pang *et al*., 2003a,b; Pang and Jones, 2004) a number of *Halosarpheia* species have already been transferred to new genera. No anamorphs have been reported for the marine *Halosarpheia* species, however Anderson and Shearer (2002) report a *Trichocladium* anamorph for the freshwater species *Halosarpheia heteroguttulata*.

Halosarpheia sensu stricto

◙ ***H. fibrosa*** Kohlm. & E. Kohlm., Trans. Br. Mycol. Soc. **68**: 208, 1977 (*Type species*).

◙ ***H. trullifera*** (Kohlm.) E.B.G. Jones, S.T. Moss & Cuomo, Trans. Br. Mycol. Soc. **80**: 200, 1983.

Remispora trullifera Kohlm., Nova Hedw. **6**: 321, 1963.

Halosphaeria trullifera (Kohlm.) Kohlm., Can. J. Bot. **50**: 1956, 1972.

◙ ***H. unicellularis*** Abdel-Wahab & E.B.G. Jones, Mycoscience **42**: 255, 2001.

1. Ascospores unicellular .... ***H. unicellularis***
1. Ascospores 1-septate 2

2. Ascospores 32-44 × 18-24 µm .... ***H. fibrosa***
2. Ascospores 23-32 (-36) × 14-18 µm. ..... ***H. trullifera***

Halosarpheia sensu lato

H. bentotensis Jørg. Koch, Nordic. J. Bot. **2**: 165, 1982.

H. culmiperda Kohlm., Volkm.-Kohlm. & O.E. Erikss., Mycologia **87**: 532, 1995.

◙ ***H. kandeliae*** Abdel-Wahab & E.B.G. Jones Mycol. Res. **103**: 1500, 1999.

◙ ***H. marina*** (Cribb & J.W. Cribb) Kohlm., Mar. Ecol. (P.S.Z.N.I.) **5**: 345, 1984.

Gnomonia marina Cribb & J.W. Cribb, Pap. Univ. Queensl. Dept. Bot. **3**: 100, 1956.

H. minuta W.F. Leong, Can. J. Bot. **69**: 883, 1991.

H. phragmiticola Poon & K.D. Hyde, Bot. Mar. **41**: 143, 1998.

The position of *H. bentotensis, H. culmiperda, H. kandeliae, H. marina, H. minuta* and *H. phragmiticola* remains unresolved. In a number of cases cultures of these species are not available for a molecular study. Until such data is available it is pointless to speculate as to their future assignment at the generic level.

1. Ascospores 3-septate, 28-36 × 6-8 µm .... ***H. bentotensis***
1. Ascospores 1-septate 2

2. Ascospores less than 15 µm long (10-14 × 4-6 µm)... .... ***H. minuta***
2. Ascospores longer than 15 µm long 3

3. Species on wood 4
3. Species on other substrata 5

4. Ascospores 18-23 (-26) × 9-12 µm, ascus with short pedicel, appendages cap-like, then filamentous .... ***H. marina***
4. Ascospores 12-21 × 4-7.5 µm, ascus with a long pedicel, appendages well developed ..... ***H. kandeliae***

5. Ascospores 25-32 × 9-13 µm, on *Juncus* .... ***H. culmiperda***
5. Ascospores 25-35 × 7.5-10.5 µm, on *Phragmites* .... ***H. phragmiticola***

We accept the species keyed out above as *Halosarpheia sensu stricto* species, however, the remaining must await further studies at the molecular level. *Halosarpheia kandeliae* differs from many of the *Halosarpheia* species in having asci with long drawn out stalks (tail-like). Species with similar ascospore measurements have asci with short pedicels. Another unusual feature of *H. kandeliae* is the polar appendages initially appears amorphous and only later forms the characteristic thread-like bipolar appendages (Abdel-Wahab *et al*., 1999). Although ascospore measurements of *Halosarpheia culmiperda* are similar to those of *H. viscosa,* it differs in ascus morphology. Asci of *H. culmiperda* are similar with those of the *H. fibrosa* group in that they are persistent, clavate to oval, with a pore, and a stalk one third of the ascus length.

Species transferred to other genera:

H. abonnis, H. ratnagiriensis to *Saagaromyces* K.L. Pang & E.B.G. Jones

H. spartinae to *Magnisphaera* J. Campb., J.L. Anderson & Shearer

H. cincinnatula, H. unicaudata and *H. viscidula* to *Oceantitis* J. Kohlm (*Ascosalsum* J. Campb., J.L. Anderson & Shearer)

H. retorquens and *H. lotica* to *Natantispora* J. Campb., J.L. Anderson & Shearer

H. viscosa to *Panorbis* J. Campb., J.L. Anderson & Shearer

H. aquatica and *H. heteroguttulata* to *Ascosacculus* J. Campb., J.L. Anderson & Shearer, both freshwater species.

Halosphaeria Linder, Farlowia **1**: 412, 1944.. .... (1)

◙ ***H. appendiculata*** Linder, Farlowia **1**: 412, 1944 (*Type species*).

Ascomata globose or subglobose, ellipsoidal, immersed erumpent, ostiolate, papillate, coriaceous or membranous, pale to dark brown to black, solitary or gregarious, catenophyses deliquescing, asci clavate or subfusiform, pedunculate, unitunicate, thin-walled, deliquescing early, ascospores ellipsoidal, 1-septate, hyaline, with 3-4 spoon-shaped equatorial appendages and one at each end of the spore. Ultrastructure of the appendages have been elucidated by Jones *et al.* (1984).

Kohmeyer (1972a) referred 12 species to this genus but subsequent studies have assigned them to other genera:

H. cucullata to *Okeanomyces* K.L. Pang & E.B.G. Jones
H. quadricornuta to *Antennospora* Meyers
H. salina to *Haiyanga* K.L. Pang & E.B.G. Jones
H. mediosetigera to *Halosphaeriopsis* T.W. Johnson
H. maritima, *H. pilleata*, *H. quadri-remis, H. stellata* to *Remispora* Linder
H. trullifera to *Halosarpheia* Kohlm. & E. Kohlm.
H. circumvestita to *Lautisporopsis* E.B.G. Jones, Yusoff & S.T. Moss
H. torquata to *Ondiniella* E.B.G. Jones, R.G. Johnson & S.T. Moss

Currently only one species is accepted in the genus (Pang *et al*., 2004b; Sakayaroj *et al*., 2005a).

Halosphaeriopsis T.W. Johnson, J. Elisha Mitchell Sci. Soc. **74**: 44, 1958 .... (1)

◙ ***H. mediosetigera*** (Cribb & J.W. Cribb) T.W. Johnson, J. Elisha Mitchell Sci. Soc. **74**: 44, 1958 (*Type species*).

Halosphaeria mediosetigera Cribb & J.W. Cribb, Univ. Queensl. Pap., Dept. Bot. **3**: 100, 1956.

Anamorph: *Trichocladium achrasporum* (Meyers & R.T. Moore) Dixon

Ascomata subglobose or ellipsoidal, immersed or erumpent, ostiolate, papillate, subcarbonaceous, dark brown to black, solitary or gregarious, asci clavate, pedunculate, unitunicate, thin-walled, lacking an apical apparatus, deliquescing early, ascospores ellipsoidal or subfusiform, 1-septate, slightly constricted at the septum, hyaline with a small apical appendage and 3-4 crescent-shaped equatorial appendages. Appendages formed by the fragmentation of an exosporic sheath (Moss and Jones, 1977; Jones *et al*., 1984). A monotypic genus well placed in the Halosphaeriales and supported by both morphological and molecular evidence (Spatafora and Blackwell, 1994; Sakayaroj *et al*., 2005a) (Fig. 41).

Haiyanga K.L. Pang & E.B.G. Jones, The Raffles Bull. Zool. **19**: 8, 2008 .... (1)

◙ ***H. salina*** (Meyers) K.L. Pang & E.B.G. Jones, The Raffles Bull. Zool. **19**: 8, 2008.

Arenariomyces salina Meyers, Mycologia **49**: 505, 1957.

Remispora salina (Meyers) Kohlm., Mycologia **60**: 262, 1968.

Halosphaeria salina (Meyers) Kohlm., Can. J. Bot. **50**: 1957, 1972.

Antennospora salina (Meyers) Yusoff, E.B.G. Jones & S.T. Moss, Mycol. Res. **98**: 1003, 1994.

Ascomata globose to subcylindrical, immersed, ostiolate, papillate, membranous or coriaceous, dark brown to black, periphysate, catenophyses, asci clavate to ellipsoidal, short pedunculate, thin-walled, unitunicate, no apical apparatus, deliquescing early, ascospores ellipsoidal, 1-septate, slightly constricted at the septum, hyaline with appendages at both ends of the spore. Appendages are obclavate, curved, attenuate and observed to release a drop of mucilage from their tips (Fig. 43g) (Zainal and Jones, 1984). In *H. salina* the appendages are outgrowths of the spore and attached to the mesosporium by an isthmus of electron-dense material. At the TEM level electron-dense striations run the entire length of the appendage, these are confined to the outer layer of the spore while the core appears amorphous (Yusoff *et al*., 1994c).

Haiyanga salina is distantly related to *Antennospora quadricornuta* and *Halosphaeria appendiculata*, but well placed in the Halosphaeriales (Figs 41, 47). *Haiyanga salina*, instead of clustering with *Antennospora quadricornuta* (a genus it was most recently assigned to), forms a moderately-supported group with two isolates of *Arenariomyces trifurcatus* (Fig. 47). However, the two genera differ in their habitat, nature of the ascomata and most strickling in the origin and

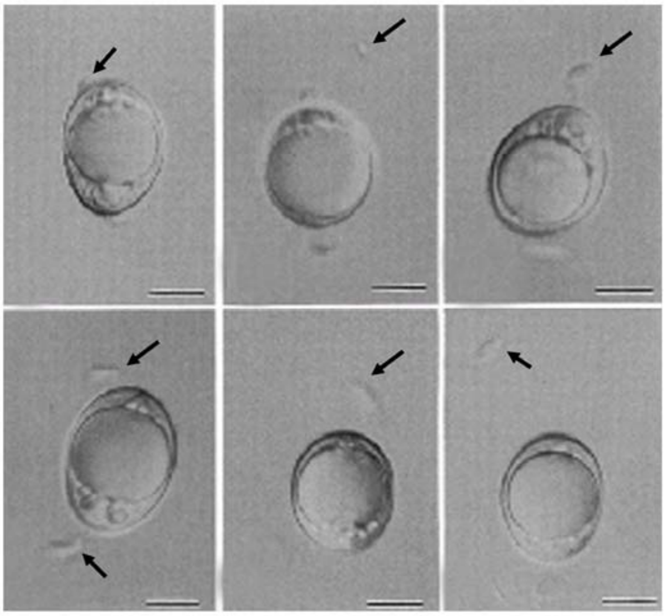


Fig. 46. *Halosarpheia unicellularis*. Ascospores with one polar appendage (arrowed). Bars = 10 µm.

ultrastructural detail of the appendages. Morphological data also support the erection of a new genus for this species, especially the ultrastructure and ontogeny of the ascospore appendages (Pang *et al*., 2008b). Ascospore appendages of *Haiyanga salina* are also similar to those of *Remispora* species, especially *R. stellata* and *R. quadriremis.*

Havispora K.L. Pang & Vrijmoed, Mycologia **100**: 293, 2008 .... (1)
◙ ***H. longyearbyenensis*** K.L. Pang & Vrijmoed, Mycologia **100**: 293, 2008.

Ascomata subglobose to ellipsoidal, immersed, coriaceous, solitary or gregarious, lacking periphyses, catenophyses present deliquescing, long necks, asci clavate, pedunculate, unitunicate, thin-walled, persistent, ascospores ellipsoidal, hyaline, thin-walled, 3-septate, constricted at the septa, with tufts of appendages (Pang *et al*., 2008a).

Appendages polar and four at the central septum, string-like composed of intertwining strands (Fig. 53b). A new genus described from material collected at Longyearbyen, Norway on driftwood and characterized by the ellipsoidal thin-walled ascospores, 24-(30)-36 × 8-(11)-14 µm with tufts of polar and equatorial appendages initially string-like and composed of intertwining strands that separate in seawater (Pang *et al*., 2008a). The tufts of polar and equatorial appendages in *Havispora* resembles those of the genera *Nautosphaeria* and *Nereiospora*. However the ascospores of *N. cristaminuta* are unicellular while *Nereiospora* species have ascospore with brown central cells. *Nereiospora cristata* has *Monodictys pelagica* as its anamorph (Mouzouras and Jones, 1985). The molecular result indicates clearly that this genus is well placed in the Halosphaeriales. It is phylogenetically nestled in the *Nereiospora* and *Monodictys* clade, although with low bootstrap support (Fig. 41).

Iwilsoniella E.B.G. Jones, Syst. Ascomycetum **10**: 8, 1991 .... (1)
I. rotunda E.B.G. Jones, Syst. Ascomycetum **10**: 8, 1991 (*Type species*).

Ascomata subglobose, immersed to superficial, ostiolate, papillate, membranous, dark brown, solitary or gregarious, no catenophyses, asci clavate, short pedunculate, lacking an apical pore, unitunicate, thin-walled, deliquescing early, ascospores round, unicellular, hyaline without a visible sheath.

However, at the scanning electron microscope level a sheath is apparent peeling away from the spore wall. It sporulates in culture on cornmeal seawater agar. It was described from a test block exposed in a water cooling tower with brackish water circulating hyaline, round, one-celled ascospores lacking appendages and deliquescing asci. This genus requires further study to determine if it is correctly assigned to the Halosphaeriales (Jones, 1991).

Lautisporopsis E.B.G. Jones, Yusoff & S.T. Moss, Can. J. Bot. **72**: 1558, 1994 .... (1)

◙ ***L. circumvestita*** (Kohlm.) E.B.G. Jones, Yusoff & S.T. Moss, Can. J. Bot. **72**: 1558, 1994 (*Type species*).

Halosphaeria circumvestita Kohlm., Nova Hedw. **2**: 307, 1960.

Ceriosporopsis circumvestita (Kohlm.) Kohlm., Can. J. Bot. **50**: 1953, 1972.

Ascomata subglobose, ovoid, ostiolate, papillate, immersed to superficial, light to dark brown, coriaceous, solitary or gregarious, catenophyses, asci clavate, pedunculate, unitunicate, thin-walled, no apical apparatus, deliquescing early, ascospores ellipsoidal, 1-septate, slightly constricted at the septum, hyaline with a mucilaginous sheath extended to form equatorial and polar appendages (Fig. 43b). A monotypic genus with the transfer of *Ceriosporopsis circumvestita* to this genus based on a scanning and transmission electron microscope studies of ascospore appendage ontogeny (Yusoff *et al*., 1994a).

Lignincola Höhnk, Veröeff. Inst. Meeresforsch. Bremerhaven **3**: 216, 1955 .... (3)

◙ ***L. laevis*** Höhnk, Veröeff. Inst. Meeresforsch. Bremerhaven **3**: 216, 1955 (*Type species*).

L. nypae K.D. Hyde & Alias, Mycol. Res. **103**: 1417, 1999.

◙ ***L. tropica*** Kohlm., Mar. Ecol. (P.S.Z.N.I.) **5**: 355, 1984.

Ascomata subglobose to ellipsoidal, immersed to superficial, ostiolate, papillate, coriaceous, light brown to black, catenophyses deliquescing, asci clavate or subfusiform, pedunculate, unitunicate, thin-walled, persistent, apiculate, asci released from the ascoma through the neck, ascospores ellipsoidal, 1-septate, hyaline, lacking appendages (Pang *et al*., 2003a). The genus *Lignincola* has only one unifying character, the hyaline, 1-septate ascospores, lacking appendages. *Lignincola longirostris* with an ascus with an apical pore and retraction of the plasmalemma has been transferred to the new genus *Neptunella* (Pang *et al*., 2003a). Clearly *L. tropica* does not belong in the genus either, but lack of a consensus on the morphology of its ascus prevents its transfer to a new genus (Kohlmeyer, 1984; Kohlmeyer and Volkmann-Kohlmeyer, 1988a) (Fig. 41). Originally the ascus was described as possessing an apical pore (Kohlmeyer, 1984), but subsequently Kohlmeyer and Volkmann-Kohlmeyer (1988a) revised the description to exclude taxa with an apical ascus pore from the genus. Molecular data show no affinity between *L. tropica* (ascus with an apical pore) and the type species, consequently it should be transferred to a new genus (Pang *et al*., 2003a). We have been unable to obtain fresh material of *L. tropica* (with no apical pore), therefore reassignment must await further molecular studies. *Lignincola nypae* clearly does not belong in this genus but is left here for the present until fresh material is collected, isolated and sequenced.

1. Ascospores ellipsoidal 2
1. Ascospores cylindrical .... ***L. nypae***

2. Ascospores 22-36 × 12-16 μm, thick-walled. .... ***L. tropica***
2. Ascospores 13-24 × 5-8 μm, thin-walled..... ***L. laevis***

Limacospora Jørg. Koch & E.B.G. Jones, Can. J. Bot. **73**: 1011, 1995 .... (1)

L. sundica (Jørg. Koch & E.B.G. Jones) Jørg. Koch & E.B.G. Jones, Can. J. Bot. **73**: 1013, 1995 (*Type species*).

Ceriosporopsis sundica Jørg Koch & E.B.G. Jones, Nordic J. Bot. **6**: 339, 1986.

Ascomata deeply immersed in wood, pale brown, ostiolate, long necks, no periphyses, asci clavate, tapering, pedunculate, unitunicate, thin-walled, deliquescing early, interthecial filaments present, ascospores 1-0-septate, hyaline, with a mucilaginous sheath.

Originally described as *Ceriosporopsis sundica*, but segregated to a new genus based on ultrastructural characters, primarily the ontogeny of the ascospore appendages (Jones *et al*., 1995).

The polar appendages are extensions of the sheath and not discrete mesosporial outgrowths characteristic of the genus *Ceriosporopsis*. Its relationship with *Ceriosporopsis, Marinospora* and *Bovicornua*, requires evaluation at the molecular level.

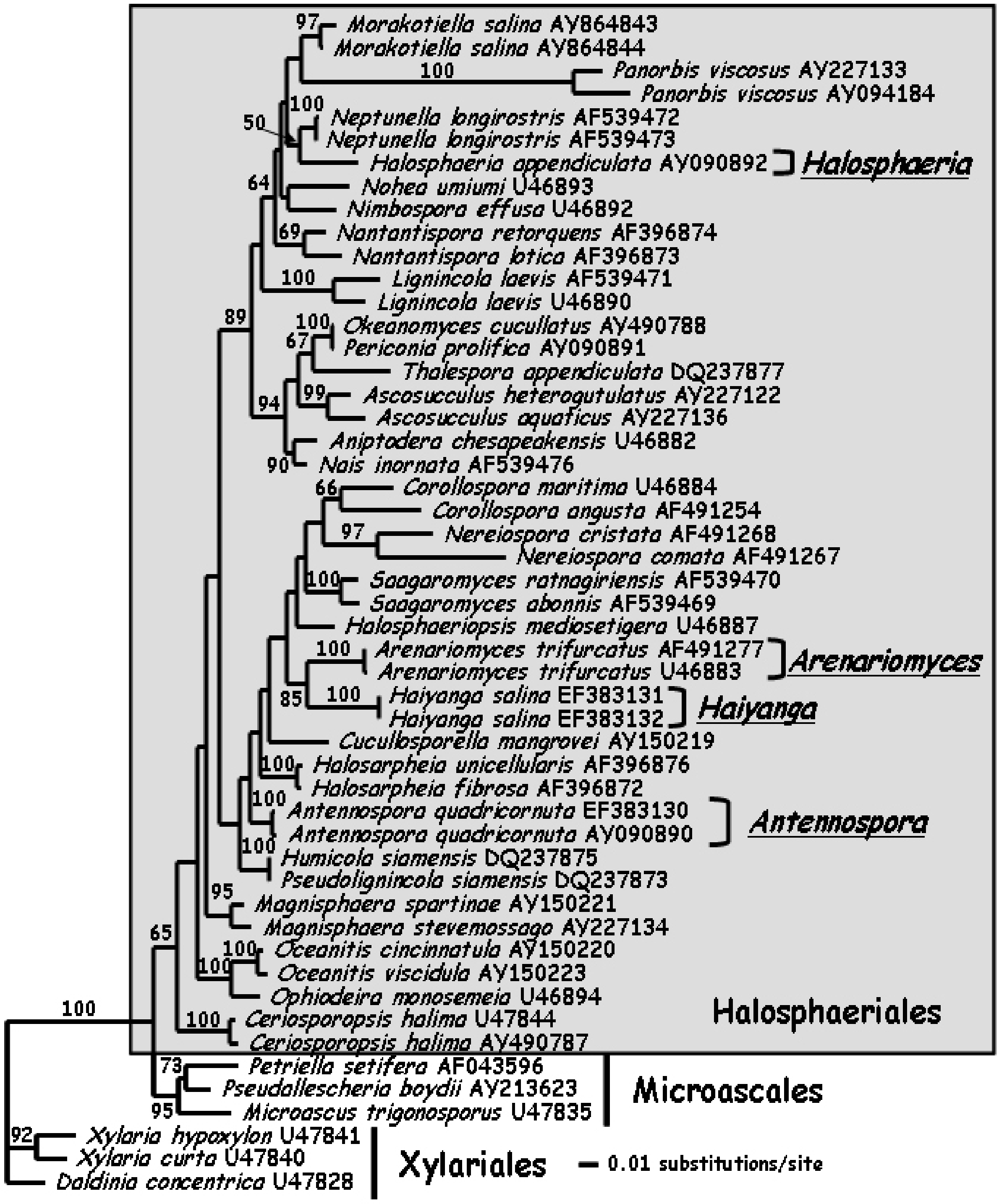


Fig. 47. Phylogram of selected *Halosphaeria* species and related genera in the Halosphaeriales.

Luttrellia Shearer, Mycologia **70**: 692, 1978 .... (1)

L. estuarina Shearer, Mycologia **70**: 693, 1978 (*Type species*).

Ascomata superficial, globose to subglobose, membranous, becoming pale brown, ostiolate, neck long, cylindrical hyaline and periphysate. Asci clavate to cylindrical, thin-walled and deliquescing. Catenophyses present. Ascospores hyaline, multiseptate and lacking appendages. There is no known ana-morph. The only genus in the Halosphaeriales

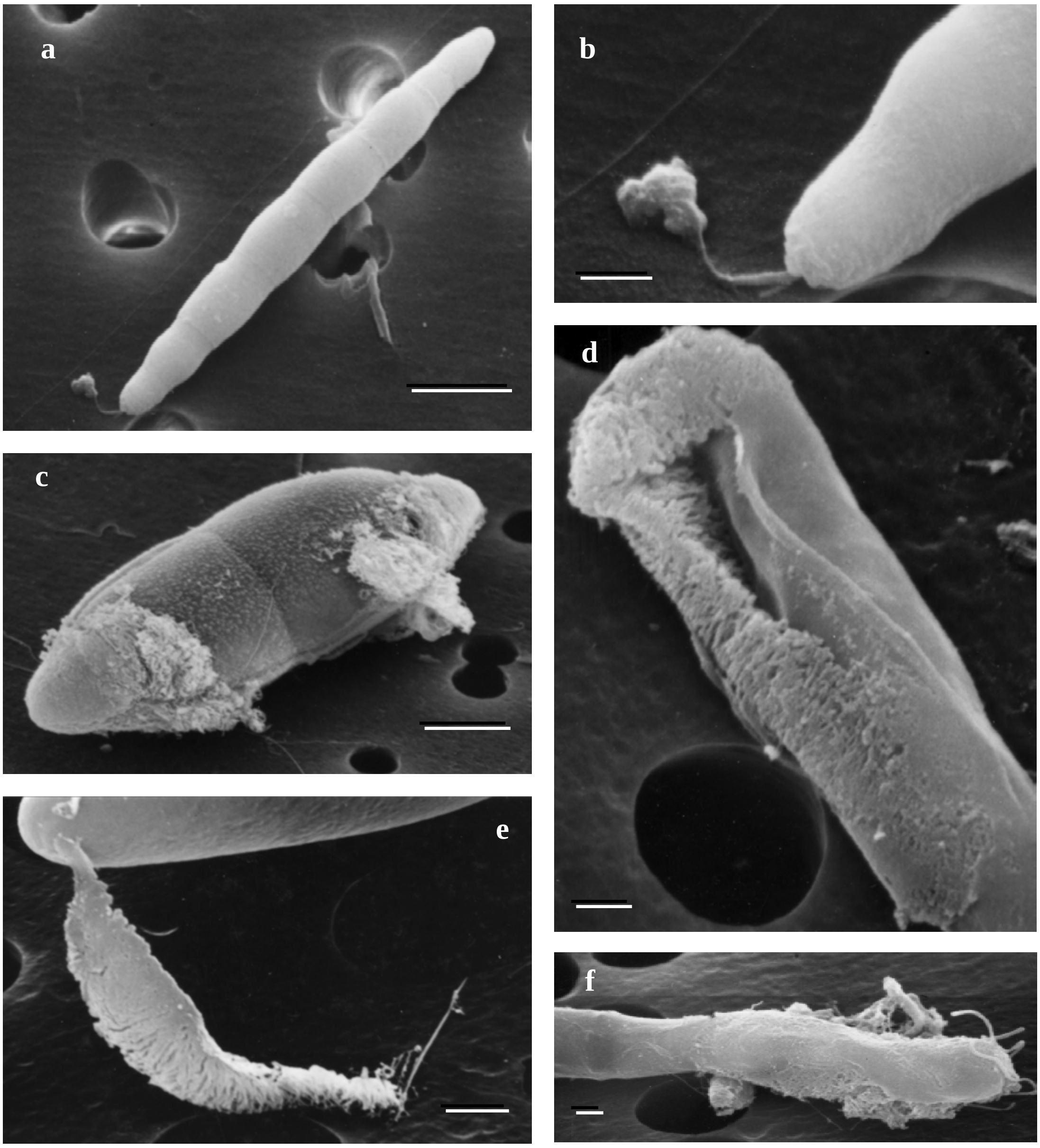


Fig. 48. Scanning electron micrographs of selected ascomycetes with polar unfurling appendages. **a**, **b**. *Oceanitis cincinnatula*. **c**. *Magnisphaera spartinae*. **e.** *Natantispora retorquens*. **d, f.** *Oceanitis unicaudata*. Bars a, c = 10 µm, b, d-f = 2 µm.

with tetrasporic asci. Saprophytic on wood. An infrequently collected species and its position in the Halosphaeriales requires verification.

Magnisphaera J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 546, 2003............... (1)

◙ ***M. spartinae*** (E.B.G. Jones) J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 547, 2003 (*Type species*).

Haligena spartinae E.B.G. Jones, Trans Br. Mycol. Soc. **45**: 245, 1962.

Halosarpheia spartinae (E.B.G. Jones) Shearer & J.L. Crane, Bot. Mar. **23**: 608, 1980.

Matsusphaeria spartinae (E.B.G. Jones) K.L Pang & E.B.G. Jones, Nova Hedw. **77** (1-2):15,2003.

Ascomata globose to subglobose, immersed, ostiolate, papillate, dark brown to black, thick-walled, periphysate, solitary or gregarious, asci clavate, pedunculate, unitunicate, thin-walled, deliquescing early, ascospores ellipsoidal to fusiform, hyaline, 4-9-septate (generally 5), constricted at the septa, with polar appendages, initially closely adpressed to the spore wall, then separating and uncoiling to form long thread-like appendages (Fig. 48c). A new genus erected as the result of a re-evaluation of the genus *Halosarpheia*, distinguished by its broadly acerose, septate ascospores, constricted at the septa, with a verrucose spore wall, polar appendages arising from a pore and supported by 18S rDNA sequence data (Campbell *et al*., 2003) (Fig. 41).

Marinospora A.R. Caval., Nova Hedw. **11**: 548, 1966.. (2)

◙ ***M. calyptrata*** (Kohlm.) A.R. Caval., Nova Hedw. **11**: 548, 1966 (*Type species*).

Ceriosporopsis calyptrata Kohlm., Nova Hedw. **2**: 301, 1960.

Ceriosporella calyptrata (Kohlm.) Caval., Nova Hedw. **10**: 394, 1966.

◙ ***M. longissima*** (Kohlm.) A.R. Caval., Nova Hedw. **11**: 548, 1966.

Ceriosporopsis longissima Kohlm., Nova Hedw. **4**: 398, 1962.

Ceriosporella longissima (Kohlm.) Caval., Nova Hedw. **10**: 394, 1966.

Ascomata ellipsoidal, subglobose, immersed, ostiolate, papillate, subcarbonaceous or subcoriaceous, light brown to black, periphysate, solitary or gregarious, catenophyses deliquescing, asci clavate, unitunicate, thin-walled, no apical apparatus, deliquescing early, ascospores broadly ellipsoidal, 1-septate, constricted at the septum, hyaline, with equatorial and polar appendages: a single appendage at each pole, and 4 radiating appendages at the central septum. Primary appendage an outgrowth of the mesosporium and episporium, with a fragmenting exosporic sheath forming tiny caps to the tips of the primary appendages (Johnson *et al*., 1984).

These species were initially referred to *Ceriosporopsis*, but subsequently transferred to *Ceriosporella* and finally *Marinospora*. Sequence data confirm that the genus is distinct from *Ceriosporopsis*, although closely related (Sakayaroj *et al*., 2004) (Fig. 41). Morphologically its polar and equatorial appendages are distinctive with the cup-like exosporic remnants at their tips (Johnson *et al*., 1984). *Marinospora longissima* has been regarded as a synonym of *M. calyptrata* (Kohlmeyer and Kohlmeyer, 1979), but molecular data indicate they are distinct species (Fig. 41).

1. Ascospores 20-34 × 8-18 µm, with longer polar appendages to equatorial appendages .***M. longissima***
1. Ascospores 20-36 × 7-19 µm, with polar and equatorial appendages equal in size ..... ***M. calyptrata***

Moana Kohlm. & Volkm.-Kohlm., Mycol. Res. **92**: 418, 1989 .... (1)

M. turbinulata Kohlm. & Volkm.-Kohlm., Mycol. Res. **92**: 418, 1989 (*Type species*).

Ascomata subglobose, immersed, ostiolate, papillate, coriaceous, cream-coloured, solitary, periphysate, catenophyses present, asci clavate, pedunculate, rounded at the apex, lacking a pore, persistent, ascospores subglobose, unicellular, hyaline with a single top-shaped appendage that unfurls to form tapering ribbons. The unique feature of this species is the subglobose ascospores with a single polar top-shaped appendage within the ascus, which unfurls in water to produce a long ribbon 250-550 µm long, 1.5-3 µm wide, which stains with methylene and cotton blue (Kohlmeyer and Volkmann-Kohlmeyer, 1989). Its relationship with other members of the Halosphaeriaceae remains to be determined. It is similar to *Thalassogena sphaerica* and *Anisostagma rotundatum* but differs in that these do not have polar appendages.

Morakotiella Sakay. Mycologia **97**: 806, 2005 .... (1)

◙ ***M. salina*** (C.A. Farrant & E.B.G. Jones) Sakay., Mycologia **97**: 806, 2005 (*Type species*).

Haligena salina C.A. Farrant & E.B.G. Jones, J. Linn. Soc. Bot. **93**: 406, 1986.

Ascomata immersed or partly immersed, globose, ostiolate, papillate, coriaceous, black, solitary or gregarious, catenophyses present, early deliquescing, asci fusiform to clavate, pedunculate, thin-walled, unitunicate, deliquescing early, ascospores ellipsoidal, 1-septate, slightly constricted at the septum, (14-) 16-18 (-20) × 8-10 µm, hyaline with polar appendages. Appendages polar, spoon-shaped at their base, attenuate, channelled, attached apically and arising as an outgrowth of the spore wall (Figs. 49 f-j) (Farrant and Jones, 1986). Referred initially to *Haligena* because of its polar appendages coiled around the ascospore, but molecular sequences indicate it is distantly related to *Haligena elaterophora* (Figs. 41, 47). Morphologically they differ in the degree of ascospore septation, the ontogeny of the polar appendages and ascoma structure (Sakayaroj *et al*., 2005a).

Nais Kohlm., Nova Hedw. **4**: 409, 1962...... (1)
◙ ***N. inornata*** Kohlm., Nova Hedw. **4**: 409, 1962 (*Type species*).

Ascomata subglobose, immersed to superficial, ostiolate, papillate, coriaceous, dark brown to black, gregarious, long necks (100-620 µm), periphysate, catenophyses present, asci clavate, short pedunculate, unitunicate, thin-walled, no apical apparatus, deliquescing early, ascospores broadly ellipsoidal, 1-septate, slightly constricted at the septum, hyaline, lacking appendages or a sheath. A genus characterized by hyaline bicelled ascospores with a characteristic arrangement of the internal wall ornamentation along the septum where small oil globules aggregate and lacking appendages. It is inferred from phylogenetic analysis of the partial large subunit ribosomal DNA sequences to be closely related to *Aniptodera*, forming a moderately supported monophyletic group with a bootstrap value of 89% (Pang *et al*., 2003a) (Figs. 41, 47, 55). Two further species have been described: *N. glitra* now transferred to *Saagaromyces* and a freshwater species *N. aquatica*. The latter differs from *N. inornata* in that ascospores develop appendages on release from the ascomata (Hyde, 1992d).

Natantispora J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 543, 2003............... (2)
◙ ***N. lotica*** (Shearer) J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 543, 2003.

Halosarpheia lotica Shearer, Mycotaxon **20**: 505, 1984.

◙ ***N. retorquens*** (Shearer & J.L. Crane) J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 543, 2003 (*Type species*).

Halosarpheia retorquens Shearer & J.L. Crane, Bot. Mar. **23**: 608, 1980.

Ascomata globose, immersed to superficial, ostiolate, papillate, membranous, black, long neck, periphysate, catenophyses present deliquescing, asci clavate, short pedunculate, unitunicate, thin-walled, with an apical pore and retraction of the plasmalemma at the tip of the ascus, deliquescing early, ascospores fusiform to ellipsoidal, 1-septate, hyaline with a hamate appendage initially closely adpressed to the spore wall, separating and unraveling to form long drawn out thread-like polar appendages (Fig. 48e). Campbell *et al*. (2003) segregated these two species from *Halosarpheia* based on sequence data, although distinguishing morphological features at the generic level are not well established. From combined 18S and 28S sequences *Natantispora* species are distantly placed from *Halosarpheia sensu stricto* (Figs. 41, 47) (Abdel-Wahab *et al*., 2001b).

1. Ascospores 26-38 × 10-14 µm, appendages not extending to the middle septum .... ***N. lotica***
1. Ascospores 20-33 × 7-11 µm, appendages extend beyond the middle septum ....***N. retorquens***

Naufragella Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **16**: 10, 1998 .... (2)
N. delmarensis Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **16**: 10, 1998 (*Type species*).
◙ ***N. spinibarbata*** (Jørg. Koch) Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **16**: 11, 1998.

Remispora spinibarbata Jørg. Koch, Nordic J. Bot. **8**: 517, 1989.

Ascomata subglobose, immersed or superficial, ostiolate, papillate, coriaceous, cream-coloured, solitary or gregarious, neck periphysate, catenophyses, asci clavate, pedunculate, unitunicate, thin-walled, early deliquescing, no apical apparatus, ascospores ellipsoidal, 1-septate, not constricted at the septum, hyaline, with two types of appendages.

Polar gelatinous appendages covering the apical region and along one side of the spore, becoming strap-like or forming a wide band; second type subpolar, a fragmenting gelatinous sheath forming a crown of hair-like filaments born on flat cushions. *Naufragella* species are frequently difficult to distinguish from *Remispora*. Mounted in seawater, two types of appendages can be discerned: 1). Gelatinous strap-like polar appendages with faint striations, initially covering the apices and one side of the ascospores but swelling in water and separating from the side of the spore and extending to 90 µm long; and 2). Sub-polar hair-like appendages arising from a small flat cushion and spreading out in water (Koch, 1989).

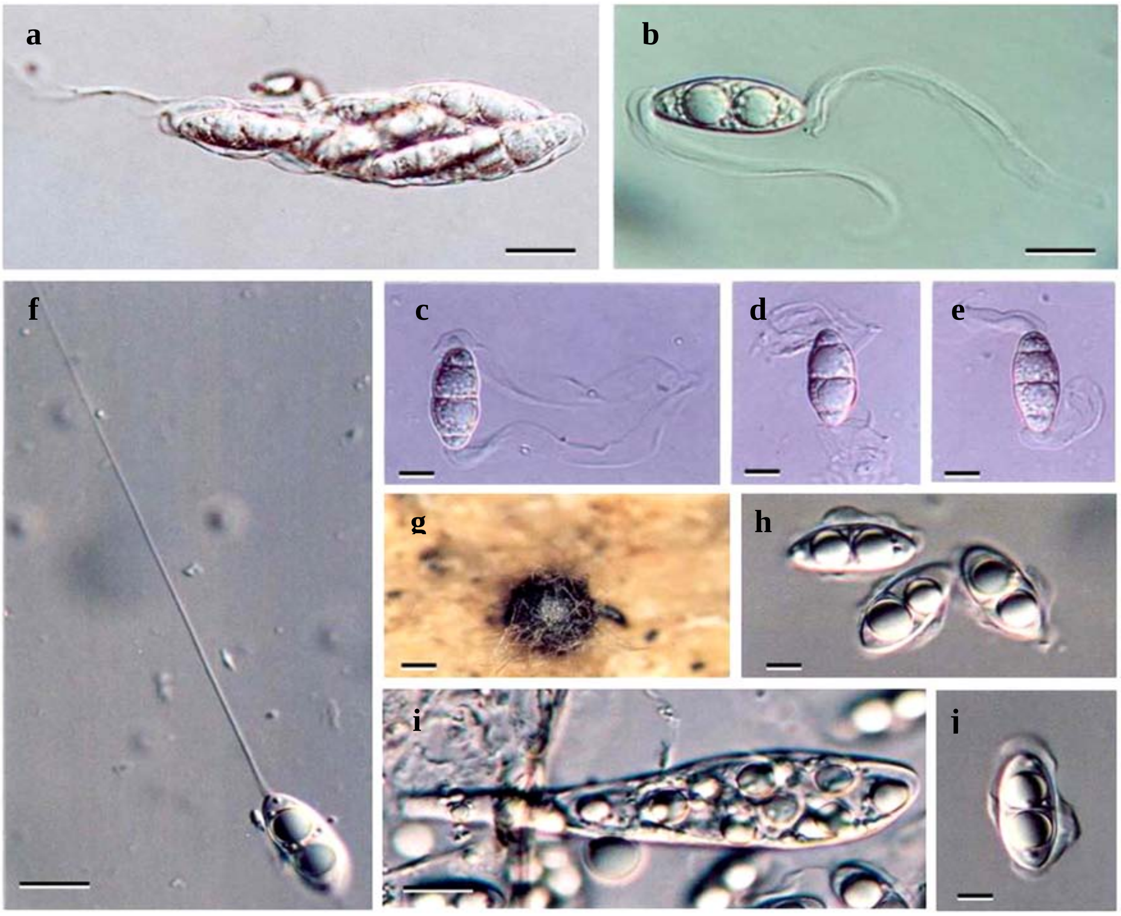


Fig. 49. Morphological features of *Haligena* species **a-e.** *Haligena elaterophora* (JS147) **a.** Ascus containing ascospores; **b-e.** Ascospores multi-septate with bipolar, long, strap-like appendages. **f-j.** *Morakotiella salina* (BCC12781) **f.** Ascospore forms a long thread-like appendage after release into water; **g.** Black, globose ascomata: **h, j.** Ascospores one-septate with tightly coiled appendages around the ascospores; **i.** Cylindrical-clavate ascus. Bars a-e = 20 µm; g = 100 µm; f, h-j = 10 µm. Reproduced by permission of Mycologia.

The origin of these appendages has not been elucidated. The appendaged ascospores of *Nohea umiumi* superficially resemble those of *Naufragella*, but differ in that in the former ascospores have two thick gelatinous appendages attached to one side of the spore and two tufts of subapical fibres on the other side (Kohlmeyer and Volkmann-Kohlmeyer, 1998a). Molecular data show that *Naufragella* is distantly related to *Remispora* (Fig. 41).

Morphologically the two *Naufragella* species are very similar and differ only slightly in ascospore measurements, which overlap, and in the nature of the apical appendages. *Naufragella delmarensis* is probably a synonym of *N. spinibarbata*, but sequence data are required for these two rare species before this is formally proposed (Koch, pers. comm.).

1. Ascospores 18.5-21 × 8-9.5 µm, with striated apical appendages..***N. delmarensis***
1. Ascospores 18-26 × 8-12 µm, with smooth apical appendages..***N. spinibarbata***

Nautosphaeria E.B.G. Jones, Trans Br. Mycol. Soc. **47**: 97, 1964 .... (1)

◙ ***N. cristaminuta*** E.B.G. Jones, Trans Br. Mycol. Soc. **47**: 97, 1964 (*Type species*).

Ascomata globose to subglobose, immersed, ostiolate, papillate, coriaceous, hyaline to pale brown, solitary or gregarious, catenophyses deliquescing, asci clavate to ellipsoidal, short pedunculate, unitunicate, thin-walled, lacking an apical apparatus, deliquescing early, ascospores ellipsoidal, unicellular, hyaline, with tufts of bristle-like appendages apically at the spore equator. Sakayaroj *et al.* (2004) confirmed the assignment of this genus within the Halosphaeriales based on partial 28S rDNA sequences which grouped with *Haligena elaterophora* and *Remispora galerita* (Fig. 41).

However, there is no homology between appendage ontogeny in these genera. The hair-like appendages in *Nautosphaeria* are similar to those of *Nereiospora* species, however the latter are 3-5-septate, central cells brown with hyaline to pale ends cells. Phylogenetically they are not related (Sakayaroj *et al*., 2004).

Neptunella K.L. Pang & E.B.G. Jones, Mycol. Prog. **2**: 35, 2003.. (1)

◙ ***N. longirostris*** (Cribb & J.W. Cribb) K.L. Pang & E.B.G. Jones, Mycol. Progr. **2** : 35, 2003 (*Type species*).

Gnomonia longirostris Cribb & J.W. Cribb, Pap. Dept. Bot. Univ. Qd. **3**: 101, 1956.

Lignincola longirostris (Cribb & J.W. Cribb) Kohlm., Mar. Ecol. (P.S.Z.N.I.) **5**: 353, 1984.

Ascomata subglobose, immersed to erumpent, ostiolate, with long necks (80-1125 µm), membranous, hyaline, pale to brown, solitary or gregarious, no periphyses or paraphyses, asci cylindrical-clavate, ellipsoidal-clavate, short pedunculate, unitunicate, thick-walled apically, with retraction of the plasmalemma at the apex, apical pore, persistent to deliquescing, ascospores elongate ellipsoidal, 1-septate, slightly constricted at the septum, no sheath or appendages (Figs 41, 55).

Assignment of this species with its hyaline, bicelled ascospores lacking appendages has proved difficult, initially referred to *Gnomonia*, then *Lignincola*, but differing from the type species *L. laevis* in ascus morphology. Sequences of the large subunit rRNA gene, indicates that *Lignincola laevis* and *L. longirostris* have a close relationship, but they are not monophyletic. *Neptunella* has therefore been erected for *L. longirostris* as it differs from *L. laveis* as follows: 1). asci with retraction of the plasmalemma, an apical thickening and pore; 2). an extra ascospore wall layer (the exosporium) is present; and 3). asci are persistent and do not get released through the ostiole, as in *L. laevis*. Thus there is morphological and molecular evidence to separate these two taxa (Pang *et al*., 2003a).

Nereiospora E.B.G. Jones, R.G. Johnson & S.T. Moss, J. Linn. Soc. Bot. **87**: 204, 1983...(2)

◙ ***N. comata*** (Kohlm.) E.B.G. Jones, R.G. Johnson & S.T. Moss, J. Linn. Soc. Bot. **87**: 206, 1983. (*Type species*).

Peritrichospora comata Kohlm., Nova Hedw. **2**: 323, 1960.

Corollospora comata (Kohlm.) Kohlm., Ber. Dtsch. Bot. Ges. **75**: 126, 1962.

◙ ***N. cristata*** (Kohlm.) E.B.G. Jones, R.G. Johnson & S.T. Moss, J. Linn. Soc. Bot. **87**: 206, 1983.

Peritrichospora cristata Kohlm., Nova Hedw. **2**: 324, 1960.

Corollospora cristata (Kohlm.) Kohlm., Ber. Dtsch. Bot. Ges. **75**: 126, 1962.

Anamorph: *Monodictys pelagica* (T.W. Johnson) E.B.G. Jones

Ascomata subglobose or ellipsoidal, immersed or superficial, with or without ostioles, papillate or epapillate, carbonaceous, black, solitary or gregarious, centrum cells deliquescing, asci broadly fusiform or clavate, pedunculate, unitunicate, thin-walled, lacking an apical apparatus, deliquescing early, ascospores 3-5-septate. Constricted at the septa, central cells brown, end cells hyaline, with tufts of hair-like appendages apically and at the central septum. Jones *et al*. (1983a) erected the genus to accommodate species with polar and equatorial appendages that are ontogenetically distinct from those of *Corollospora*.

In the study by Campbell *et al*. (2002) *Nereiospora* nestles within the *Corollospora* clade. However, in a more extensive treatment of the Halosphaeriales, *Nereiospora* is distantly placed from *Corollospora* (Fig. 41). In *Nereiospora* appendages arise from the mesosporium, while in *Corollospora* they are spine-like and formed by outgrowths of the epi- and mesosporium, while the secondary appendages are formed by fragmentation of an exosporial layer (Jones *et al*., 1983a).

1. Ascospores 32-54 × 12-17 µm, with 5 septa.............
   .... ***N. comata***
1. Ascospores 24-41 × 8-16 µm, with 3 septa................
   .... ***N. cristata***

Nimbospora Jørg. Koch, Nordic J. Bot. **2**: 166, 1982... (3)

N. bipolaris K.D. Hyde & E.B.G. Jones, Can. J. Bot. **63**: 611, 1985.

◙ ***N. effusa*** Jørg. Koch, Nordic J. Bot. **2**: 166, 1982 (*Type species*).

N. octonae Kohlm., Can. J. Bot. **63**: 1122, 1985.

Ascomata globose to subglobose, ostiolate, papillate, membranous, hyaline, immersed, solitary or gregarious, necks periphysate, no paraphyses, asci clavate, short pedunculate, unitunicate, thin-walled, deliquescing early, ascospores ellipsoidal, 1-septate, not constricted at the septum, hyaline, and appendaged. Ascospores in *Nimbospora* have two types of appendages: a well developed exosporic mucilaginous sheath, and secondary fibrillar appendages at the spore equator that are formed as outgrowths of the mesosporium. These fibrillar appendages initially are contained within the sheath, but on spore release into water, the outer region ruptures and the appendages break through (Read *et al*., 1993a). Sequence data places the genus in the Halosphaeriales in a sister group to *Panorbis viscosus* and *Halosarpheia marina* (Fig. 41) (Sakayaroj, 2005).

1. Ascospores lacking hair-like appendages, sheath with many folds, 22-20 (-31) × 12-16 (-18) µm................ .... ***N. octonae***
1. Ascospores with lateral tufts of hair-like appendages 2

2. Ascospores with one lateral group of appendages, 8-10 µm .... ***N. effusa***
2. Ascospores with 2 or more lateral groups of appendages, 18-27 × 8-12 µm .... ***N. bipolaris***

Nohea Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **10**: 121, 1991 .... (1)

◙ ***N. umiumi*** Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **10**: 122, 1991 (*Type species*).

Ascomata subglobose, immersed or superficial, ostiolate, papillate, coriaceous, cream-coloured, solitary, neck 50-300 µm long, periphysate, catenophyses deliquescing, asci clavate, pedunculate, unitunicate, thin-walled lacking an apical apparatus, deliquescing early, ascospores ellipsoidal, 1-septate, hyaline, with two types of appendages. The first type are on one side of the spore, gelatinous and attached to flat subapical pads, then unfurl to form long sticky filaments, the second type are subapical comprising two bundles of fibres attached to the spore wall. These appendages are superficially similar to *Naufragella,* which also has two types of ascospore appendages, but phylogenetically are distantly placed within the Halosphaeriales (Fig. 41). *Naufragella* and *Remispora* (*sensu stricto*) species have a common ancestor but are not monophyletic. *Nohea* forms a sister group to *Aniptodera chesapeakensis* and *Nimbospora effusa* (Campbell *et al*., 2002), while in a larger data set it nestles in a sister group to *Neptunella longirostris* and is basal to a clade comprising a range of taxa (Fig. 41).

Kohlmeyer and Volkmann-Kohlmeyer (1991c) compare *N. umiumi* with the genera *Halosarpheia* (does not possess tufts of hair-like appendages), *Nautospora* (probably mean *Nautosphaeria*), *Nimbospora* and *Nereiospora* (all having tufts of hair-like appendages, but these lack the long unfurling appendages forming sticky filaments), and any resemblance is therefore superficial. Molecular data show no affinity between these genera (Fig. 41).

Oceanitis Kohlm., Rev. Mycol. **41**: 193, 1977 .... (4)

◙ ***O. scuticella*** Kohlm., Rev. Mycol. **41**: 194, 1977 (*Type species*).

◙ ***O. cincinnatula*** (Shearer & J.L. Crane) J. Dupont & E.B.G. Jones, Mycol. Res. in press, 2009.

Halosarpheia cincinnatula Shearer & J.L. Crane, Bot. Mar. **23**: 613, 1980.

Falcatispora cincinnatula (Shearer & J.L. Crane) K.L. Pang & E.B.G. Jones, Nova Hedw. 77: 14, 2003.

Ascosalsum cincinnatulum (Shearer & J.L. Crane) J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 546, 2003.

◙ ***O. viscidula*** (Kohlm. & E. Kohlm.) J. Dupont & E. B.G. Jones, Mycol. Res. in press, 2009.

Haligena viscidula Kohlm. & E. Kohlm., Nova Hedw. **9**: 92, 1965.

Halosarpheia viscidula (Kohlm. & E. Kohlm.) Shearer & J.L. Crane, Bot. Mar. **23**: 608, 1980.

Falcatispora viscidula (Kohlm. & E.Kohlm.) K.L. Pang & E.B.G. Jones, Nova Hedw. **77**: 14, 2003.

Ascosalsum viscidulum (Kohlm. & E. Kohlm.) J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 546, 2003.

◙ ***O. unicaudata*** (E.B.G. Jones & Le Camp.-Als.) J. Dupont & E.B.G. Jones, Mycol. Res. in press, 2009.

Haligena unicaudata E.B.G. Jones & Camp.-Als., Nova Hedw. **19**: 574, 1971.

Halosarpheia unicaudata (E.B.G. Jones & Camp.-Als.) R.G. Johnson, E.B.G. Jones & S.T. Moss ex Kohlm. & Volkm.-Kohlm., Bot. Mar. **34**: 22, 1991.

Falcatispora unicaudata (E.B.G. Jones & Camp.-Als.) K.L. Pang & E.B.G. Jones, Nova Hedw. **77**: 14, 2003.

Ascosalsum unicaudatum (E.B.G. Jones & Camp.-Als.) J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 550, 2003.

Ascomata subglobose to ellipsoidal, on a thin hypostroma, ostiolate, epapillate, coriaceous, brown to dull orange, gregarious, paraphyses absent, asci clavate, unitunicate, thin-walled, without an apical apparatus, deliquescing, ascospores filiform to elongate fusiform, 1-11-septate, hyaline, with bipolar appendages or at one end of the spore (Figs. 48a, d, f). Appendages initially closely adpressed to the spore wall, separating, and uncoiling to form long thin narrow sticky threads. A genus initially described with needle-shaped, falcate, ascospores, 1-septate, hyaline with an appendage at one end and not collected since its description on trawled submerged wood at 3,975 m, in the Gulf of Angola, Atlantic Ocean (Kohlmeyer, 1977).

A recent collection from submerged wood at 1,000 m in the Pacific Ocean off Vanuatu Islands has enabled further characterization of the genus (Dupont *et al*., 2009). Ascomata aggregated into a stroma, with a thick peridium, 200 µm wide, composed of polygonal cells with large lumina forming a *textura angularis*, merging towards the center into flattened cells. Asci deliquesce early. The cavity of the ascomata are filled with fusiform ascospores, more or less grouped, 1-septate, hyaline, with a single polar appendage initially closely adpressed to the ascospore wall, but separating at maturity. Ascospore wall is two layered, a narrow episporium and a mesosporium with an outer electron-dense zone, and an inner electron-transparent zone, both layers forming the ascospore septum. The polar appendage is composed of tightly coiled filaments arising as outgrowths from the mesosporium with a fibrous multilayered structure (Dupont *et al*., 2009).

Dupont *et al*. (2009), based on the morphological similarity of *O. scuticella* to *Ascosalsum* species, and supported by molecular evidence, transferred all *Ascosalsum* species to *Oceanitis* (Figs 41, 47, 55). The genus *Ascosalsum* was erected to accommodate three species based on LSU rDNA phylogeny supported by morphological evidence (Campbell *et al*., 2003). It differs from *Halosarpheia* in lacking catenophyses and having cylindrical to falcate ascospores.

1. Ascospores with a single appendage........................ 2
1. Ascospores with bipolar appendages, 38-89 × 3-7 µm, 5-16 septa predominantly 11-septate ....***O. viscidula***

2. Ascospores 1-septate..............................***O. scuticella***
2. Ascospores 3 or more-septate.................................. 3

3. Ascospores 36-60 × 2.5-5 µm, 3-5-septate ....***O. unicaudata***
3. Ascospores 34-60 × 4-5 µm, 5-11-septate ....***O. cincinnatula***

Ocostaspora E.B.G. Jones, R.G. Johnson & S.T. Moss, Bot. Mar. **26**: 353, 1983............ (1)
◙ ***O. apilongissima*** E.B.G. Jones, R.G. Johnson & S.T. Moss, Bot. Mar. **26**: 354, 1983 (*Type species*).

Ascomata globose to subglobose, hyaline upper part dark brown or black, ostiolate, papillate, membranous, immersed to partly immersed, short necks lacking periphyses, solitary or gregarious, no paraphyses, asci clavate to subcylindrical, short pedunculate, unitunicate, thin-walled, no apical apparatus or pore, deliquescing early, ascospores 1-septate, slightly constricted at the septum, hyaline, with a single long appendage at each pole, and 6-8 equatorial appendages. A monotypic genus, that is widely distributed in temperate climates and occurs on submerged wood. It most closely resembles *Halosphaeria appendiculata* with its polar and equatorial appendaged ascospores (Jones *et al*., 1983b). It differs in that the polar appendages are much longer and easily become fibrillar, features not found in *H. appendiculata*. Molecular sequences of 18S and 28S confirm its placement in the Halosphaeriales and that is distantly related to *H. appendiculata* (Sakayaroj *et al*., unpublished data, see Fig. 41).

Okeanomyces K.L. Pang & E.B.G. Jones, Bot. J. Linn. Soc. **146**: 228, 2004 .... (1)
◙ ***O. cucullatus*** (Kohlm.). K.L. Pang & E.B.G. Jones, Bot. J. Linn. Soc. **146**: 228, 2004 (*Type species*).

Remispora cucullata Kohlm., Mycologia **56**: 770, 1964.

Halosphaeria cucullata (Kohlm.) Kohlm., Can. J. Bot. **50**: 1956, 1972.

Anamorph: *Periconia prolifica* Anastasiou

Ascomata subglobose, ostiolate, papillate, coriaceous, immersed, brownish-black or brownish-red, solitary or gregarious, catenophyses deliquescing, asci clavate, short pedunculate, unitunicate, thin-walled, without an apical apparatus, deliquescing early, ascospores cylindrical, 1-septate, slightly constricted at the septum, hyaline, with a single cap-like or globose gelatinous appendage at one spore apex, and deciduous. Frequently, appendages not observed. A genus proposed by Pang *et al*. (2004b) to accommodate *Halosphaeria cucullata* based on a recent collection of the fungus in Malaysia. No ascospore appendage was observed in any of the material examined but the characteristic reddish ascomata and the production of the anamorph *Periconia prolifica* from single ascospore isolates confirmed its identity. LSU rDNA phylogeny revealed that this fungus is not related to *Halosphaeria appendiculata*, but groups with *Thalespora appendiculata*, but is not monophyletic with it. They form a sister group to *Ascosacculus* (Fig. 55).

Ondiniella E.B.G. Jones, R.G. Johnson & S.T. Moss, Bot. Mar. **27**: 136, 1984 .... (1)

◙ ***O. torquata*** (Kohlm.) E.B.G. Jones, R.G. Johnson & S.T. Moss, Bot. Mar. **27**: 136, 1984 (*Type species*).

Halosphaeria torquata Kohlm., Nova Hedw. **2**: 311, 1060.

Ascomata elongate-cylindrical or subglobose, immersed or superficial, ostiolate, papillate, membranous, ranges from hyaline to pale brown, necks short and cylindrical, no periphyses, catenophyses deliquescing, asci clavate to subfusiform, apiculate, pedunculate, unitunicate, thin-walled, no apical apparatus, deliquescing, ascospores broadly ellipsoidal, 1-septate, slightly constricted at the septum, hyaline with appendages. Two types of appendages: spine-like polar appendages and an annulus-like equatorial appendage, arising as outgrowths of the episporium, with amorphous material within the appendages and lacking an exosporium (Jones *et al*., 1984). A cold water species. Isolates were examined for thier phylogenetic relationship. The LSU rDNA phylogeny revealed that this genus is not related to *Halosphaeria* (Kohlmeyer, 1972a), but closely related to *Ceriosporopsis tubulifera* and *Marinospora* species (Fig. 41).

Ophiodeira Kohlm. & Volkm.-Kohlm., Can. J. Bot. **66**: 2062, 1988..................................... (1)

◙ ***O. monosemeia*** Kohlm. & Volkm.-Kohlm., Can. J. Bot. **66**: 2062, 1988 (*Type species*).

Ascomata ellipsoidal, immersed under a thin black stroma, ostiolate, papillate, light brown, solitary or gregarious, necks long (60-300 µm long) and periphysate, asci clavate, pedunculate, unitunicate, thin-walled, deliquescing early, lacking an apical apparatus, ascospores ellipsoidal, 1-septate, not constricted at the septum, hyaline, with a single polar appendage, initially hamate, separating from the spore wall and eventually uncoiling to form long, sticky filaments. *Ophiodeira* is a monotypic genus that is reminiscent of *Halosarpheia* species with its single polar appendage uncoiling to form sticky filaments. It differs from the genera with unfurling polar appendages in that the ascomata are formed beneath a thin stroma, has deliquescing asci, absence of catenophyses and with only a single polar appendage (Kohlmeyer and Volkmann-Kohlmeyer, 1988a). At the molecular level it forms a sister clade with *Halosarpheia*-like species with a single polar appendage: *O. scuticella*, *O. cincinnatula*, *O. unicaudata* and *O. viscidula* with bipolar appendaged ascospores (Dupont *et al*., 2009) (Figs 47, 55). The only feature separating it from these taxa is that the ascomata are formed beneath a thin stroma (applies also to *O. scuticella*). Tang *et al*. (2007) have highlighted the congruence between morphological and molecular classification schemes and this is becoming a common observation in phylogenetic studies (Binder *et al*., 2006).

Appendages such as those of *O. scuticella* and *Ophiodeira monosemeia* that do not appear to readily uncoil in water, have been observed for other taxa and may be attributed to their degree of maturation or the media they are mounted in. In *Aniptodera salsuginosa*, the salinity of the water markedly affects the unfurling of the polar appendages (Nakagiri and Ito, 1994), while in a freshwater *Halosarpheia* species, amorphous material was released, and connected to the spore by a fine thread, prior to its organization into filaments (Jones, 2006).

Panorbis J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 544, 2003 .... (1)

▣ ***P. viscosus*** (I. Schmidt) J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 544, 2003 (*Type species*).

Halosphaeria viscosa I. Schmidt, Nat. Naturschutz Mecklenburg **12**: 70, 1974.

Halosarpheia viscosa (I. Schmidt) Shearer & J.L. Crane, Bot. Mar. **23**: 608, 1980.

Ascomata globose, ostiolate, papillate, membranous, immersed or superficial, black, neck with periphyses, catenophyses deliquescing, asci clavate, unituicate, thin-walled, deliquescing, with an apical pore, ascospores cylindrical to fusiform, 1-septate, hyaline, with bipolar appendages. Appendages closely adpressed to the spore wall, separating, and uncoiling to form long sticky thread-like filaments. *Panorbis viscosus* resembles *Natantispora retorquens* morphologically although they are not related phylogenetically (Campbell *et al*., 2003) (Fig. 47). However it is morphologically not well delineated from *Natantispora*, the key provided merely separating them on ascospore shape and measurements: ellipsoid (less than 25 µm) in the former and dufoid-ellipsoid (over 25 µm) in the latter. More genera with polar unfurling appendages need to be sequenced to determine the validity of this genus.

Pseudolignincola Chatmala & E.B.G. Jones, Nova Hedw. **83**: 225, 2006. .... (1)

▣ ***P. siamensis*** Chatmala & E.B.G. Jones, Nova Hedw. **83**: 226, 2006.

Anamorph: *Humicola siamensis* Chatmala & E.B.G. Jones

Ascomata globose, dark brown, deeply immersed in the wood, coriaceous, with a long (710-1100 µm) periphysate neck, solitary, catenophyses present, asci clavate to slightly cylindrical, long pedicellate, unitunicate, thin-walled, truncate at the apex with a refractive thickening and retraction of the plasmalemma at the apex, ascospores cylindrical, 1-4-septate, hyaline, smooth-walled, lacking a sheath or appendages. Described from wood collected in Thailand, it has clavate asci with a truncated thickened apex, a pore, the ascus plasmalemma is retracted and ascospores are 1-4-septate, hyaline, cylindrical and lacking appendages (Fig. 50) (Jones *et al*., 2006). This ascomycete is morphologically similar to *Lignincola nypae*, but differs in the dimensions of ascomata, asci, 1-4-septate ascospores and with a *Humicola* anamorph. Phylogenetically LSU sequences place it in an unsupported clade with *Antennospora, Cucullosporella, Halosarpheia* and *Lignincola tropica* (Figs 41, 47, 55).

Remispora Linder, Farlowia **1**: 409, 1944... (8)

▣ ***R. crispa*** Kohlm., Can. J. Bot. **59**: 1317, 1981.

▣ ***R. galerita*** Tubaki, Publ. Seto Mar. Biol. Lab. **15**: 362, 1967.

▣ ***R. maritima*** Linder, Farlowia **1**: 410, 1944 (*Type species*).

Remispora lobata Höhnk, Veröeff. Inst. Meeresforsch. Bremerhaven **3**: 206, 1955.

Halosphaeria maritima (Linder) Kohlm., Can. J. Bot. **50**: 1956, 1972.

R. minuta E.B.G. Jones, K.L. Pang & Vrijmoed, Can. J. Bot. **82**: 486, 2004.

▣ ***R. pilleata*** Kohlm., Nova Hedw. **6**: 319, 1963.

Halosphaeria pilleata (Kohlm.) Kohlm., Can. J. Bot. **50**: 1957, 1972.

▣ ***R. quadri-remis*** (Höhnk) Kohlm., Nova Hedw. **2**: 332, 1960.

Palomyces quadri-remis Höhnk, Veröeff. Inst. Meeresforsch. Bremerhaven **3**: 213, 1955.

Arenariomyces quadri-remis (Höhnk) Meyers, Mycologia **49**: 505, 1957.

Halosphaeria quadri-remis (Höhnk) Kohlm., Can. J. Bot. **50**: 1957, 1972.

▣ ***R. spitsbergenensis*** K.L. Pang and Vrijmoed, Mycologia, in press, 2009.

▣ ***R. stellata*** Kohlm., Nova Hedw. **2**: 334, 1960.

Halosphaeria stellata (Kohlm.) Kohlm., Can. J. Bot. **50**: 1957, 1972.

Ascomata globose, subglobose, ovoid, immersed or superficial, ostiolate, papillate, coriaceous, hyaline to dark brown, solitary or gregarious, catenophysate, necks periphysate, asci clavate broadly fusoid, pedunculate, apiculate, unitunicate, thin-walled, without an apical apparatus, deliquescing, ascospores 1-septate, ellipsoid to rhomboidal, hyaline, with polar appendages. Appendages morphologically variable depending on the species (Figs. 51, 52a-c, e, 53a).

Molecular sequences indicate that *Remispora* is polyphyletic with *R. spitsbergenensis, R. pilleata*, *R quadri-remis* and *R. stellata* forming a well supported clade, while the type species, *R. maritima* (Fig. 41) forms sister group with *R. pilleata* and *Carbosphaerella leptosphaerioides*. *Remispora crispa* and *R. galerita* are distantly placed (Fig. 41), the former grouping with *Ocostaspora apilongissima* and *Morakotiella salina*, while the latter forms a basal clade to the order with *Nautosphaeria cristaminuta* and *Haligena elaterophora*. *Remispora minuta* is a new species described from unidentified wood collected in Singapore and for which no molecular data is available (Pang *et al*., 2004a). The erection of new genera for *R. crispa* and *R. galerita* are warranted, but further isolates are required to prove their monophyly.

Remispora was described by Barghoorn and Linder (1944) but all species were transferred to *Halosphaeria* by Kohlmeyer (1972a). The genus is characterised by hyaline to brown ascomata, with the peridium composed of one cell type, asci clavate that deliquesce early, and ascospores with polar appendages of variable morphology (Johnson *et al*., 1984; Manimohan *et al*., 1993a). Initial ultrastructural studies of *R. maritima* and *R. pilleata* showed that the appendages were exosporic in origin and consisting of a fibrous component in an amorphous matrix. Fragmentation of the sheath giving rise to the wing-like polar appendages (Jones and Moss, 1978; Johnson *et al*., 1984). However, radiating appendages are found in *R. quadri-remis* and *R. stellata* but the substructure was the same as in *R. maritima* and *R. pilleata* (Manimohan *et al*., 1993a). In *R. cispa*, the appendages are closely adpressed to the spore wall and not wing-like or radiating, but ultrastructurally are similar to *R. stellata* and *R. quadri-remis*. In these two species, appendages arise in a polar position with radiating bundles of electron-dense stands exuded through pores in the episporium and embedded in an amorphous matrix. Similar observations were made for *R. galerita*, but differs from other species in that the polar appendage is more discrete (Manimohan *et al*., 1993b).

1\. Ascospores ellipsoidal 2
1\. Ascospores rhomboid, 24-36 × 12-20 µm........................ ***R. pilleata***

2\. Ascospores with four or more appendages at each pole 6
2\. Ascospores with a single polar appendage........................ 3

3\. Ascospores 18-30 (-32) × 8-13 µm, with wing-like appendages........................ ***R. maritima***
3\. Ascospore appendages variously shaped 4

4\. Cap-like ascospore appendages with radiating strands, 20-28 × 7-12 µm .... ***R. galerita***
4\. Ascospore appendages moustache-like........................ 5

5\. Ascospores constricted at the septum, 17-26 × 6-10 µm........................ ***R. minuta***
5\. Ascospores not constricted at the septum, 22-34 × 8-12 µm........................ ***R. crispa***

6\. Ascospores with 4 appendages at each apex........................ 7
6\. Ascospores with 6 appendages at each apex, 24-30 × 8-12 µm........................ ***R. stellata***

7\. Ascospores 20-28 × 7-13 µm, appendages long, ribbon-like 19-24 × 3-6 µm long ***R. spitsbergenensis***
7\. Ascospores 18-20 (-34) × 8-12 µm, appendages radiating, obclavate 12-21.5 × 2.5-4 µm .... ***R. quadri-remis***

Saagaromyces K.L. Pang & E.B.G. Jones, Mycol. Progr. **2**: 35, 2003 .... (3)

◙ ***S. abonnis*** (Kohlm.) K.L. Pang & E.B.G. Jones, Mycol. Progr. 2: 35, 2003.

Halosarpheia abonnis Kohlm., Mar. Ecol. (P.S.Z.N.I.) **5**: 339, 1984.

Littispora abonnis (Kohlm.) J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 549, 2003.

◙ ***S. glitra*** (J.L. Crane & Shearer) K.L. Pang & E.B.G. Jones, Mycol. Progr. **2**: 35, 2003.

Nais glitra J.L. Crane & Shearer, Trans. Br. Mcol. Soc. **86**: 509, 1986.

◙ ***S. ratnagiriensis*** (S.D. Patil & Borse) K.L. Pang & E.B.G. Jones, Mycol. Progr. **2**: 35, 2003.

Halosarpheia ratnagiriensis S.D. Patil & Borse, Indian Botanical Reporter **1**: 102, 1982.

Littispora ratnagiriensis (S.D. Patil & Borse) J. Campb., J.L. Anderson & Shearer, Mycologia **95**: 549, 2003.

Ascomata ellipsoidal, immersed, ostiolate, papillate, coriaceous, hyaline to brown, necks long (up to 1 mm), periphysate, catenophyses present, asci clavate, long pedunculate, unitunicate, thin-walled, with or without apical pore, persistent, retraction of the plasmalemma at the apex, ascospores ellipsoidal, 1-septate, slightly constricted at the septum, hyaline, with or without polar appendages. Appendages large if present, initially closely adpressed to the spore wall, separating, uncoiling to form long sticky filamentous threads (Fig. 44c). The genus was erected to accommodate two species of *Halosarpheia* and *Nais glitra* (Fig. 43f), as they did not group within the *Halosarpheia sensu stricto* clade, the type species of the genus (Pang *et al*., 2003b) (Fig. 55). Morphologically they differ in the following respects from *Halosarpheia* species: 1). Asci persistent, cylindrical-clavate, with a long stalk up to one third of the length of the ascus; 2). Apical pore present in *S. ratnagiriensis* and *S. glitra*; and 3). Ascospores large, oval and heavily guttulated. Therefore there is molecular and morphological evidence for their segregation from the genus *Halosarpheia.* (Pang and Jones, 2004).

1. Ascospores with no appendages: 42-59 × 21-31 μm . ... ***S. glitra***
1. Ascospore with bipolar appendages......................... 2

2. Ascospores greater than 48 μm: 48-64 (-72) × 22-28 μm.. ***S. ratnagiriensis***
2. Ascospores shorter than 48 μm: 33-47 × 14-22 μm... .... ***S. abonnis***

Sablecola E.B.G. Jones, K.L. Pang & Vrijmoed, Can. J. Bot. **82**: 486, 2004 .... (1)
◙ ***S. chinensis*** E.B.G. Jones, K.L. Pang & Vrijmoed, Can. J. Bot. **82**: 486, 2004 (*Type species*).

Ascomata ellipsoidal to subglobose, immersed to partly immersed, yellow to brown, ostiolate, papillate, necks short and periphysate, lacking catenophyses, asci clavate, pedunculate, unitunicate, thin-walled, no apical apparatus, persistent to deliquescing, ascospores ellipsoidal, hyaline, thin-walled, 1-septate. With one appendage at each pole and four at the equatorial septum (Fig. 53c). Appendages flattened, attenuate and strap-like, with parallel striations, later splitting into fine threads (Pang *et al*., 2004a). A new taxon described from material collected on wood from a sandy beach in southern China. This genus is characterized by its unique bipolar and quadri-equatorial appendages, which disintegrate when mounted in seawater. The appendages are obclavate, tapered to a fine point, appear striated when released from the ascus but later become fibrillar (Pang *et al*., 2004a). The ascospores resemble those of *Halosphaeria appendiculata* and *Ocostaspora apilongissima* with polar and four equatorial appendages. In *O. apilongissima* appendages are striate, fragment into threads, but the polar appendages are much longer than the equatorial ones. In *H. appendiculata* the appendages do not breakdown but maintain their spoon-like morphology (Jones *et al*., 1984). The LSU rDNA data confirms its placement in the Halosphaeriales and is distantly related to *Halosphaeria appendiculata* and *Ocostaspora apilongissima* (Fig. 41).

Thalassogena Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **6**: 223, 1987 .... (1)
T. sphaerica Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **6**: 225, 1987 (*Type species*).

A monotypic genus with cream-coloured ascomata, globose, immersed to superficial, ostiolate, papillate, coriaceous, with long necks (230-570 μm), periphysate, with catenophyses, asci clavate, unitunicate, papillate, pedunculate, J-, flattened at the apex with an apical pore and hyaline subglobose ascospores without sheaths or appendages (Kohlmeyer and Volkmann-Kohlmeyer, 1987a). This species has not been extensively collected and further studies are required to determine if it is correctly referred to the Halosphaeriales. Ascospores superficially resemble *Iwilsoniella rotunda*, but the species differs in ascomatal characteristics, the latter with dark coloured ascomata, with short necks, asci lacking an apical pore and deliquescing early.

Thalespora Chatmala & E.B.G. Jones, Nova Hedw. **83**: 228, 2006................................... (1)
◙ ***Th. appendiculata*** Chatmala & E.B.G. Jones, Nova Hedw. **83**: 229, 2006.

Ascomata ellipsoidal, immersed in wood, ostiolate, papillate, coriaceous, unitunicate,

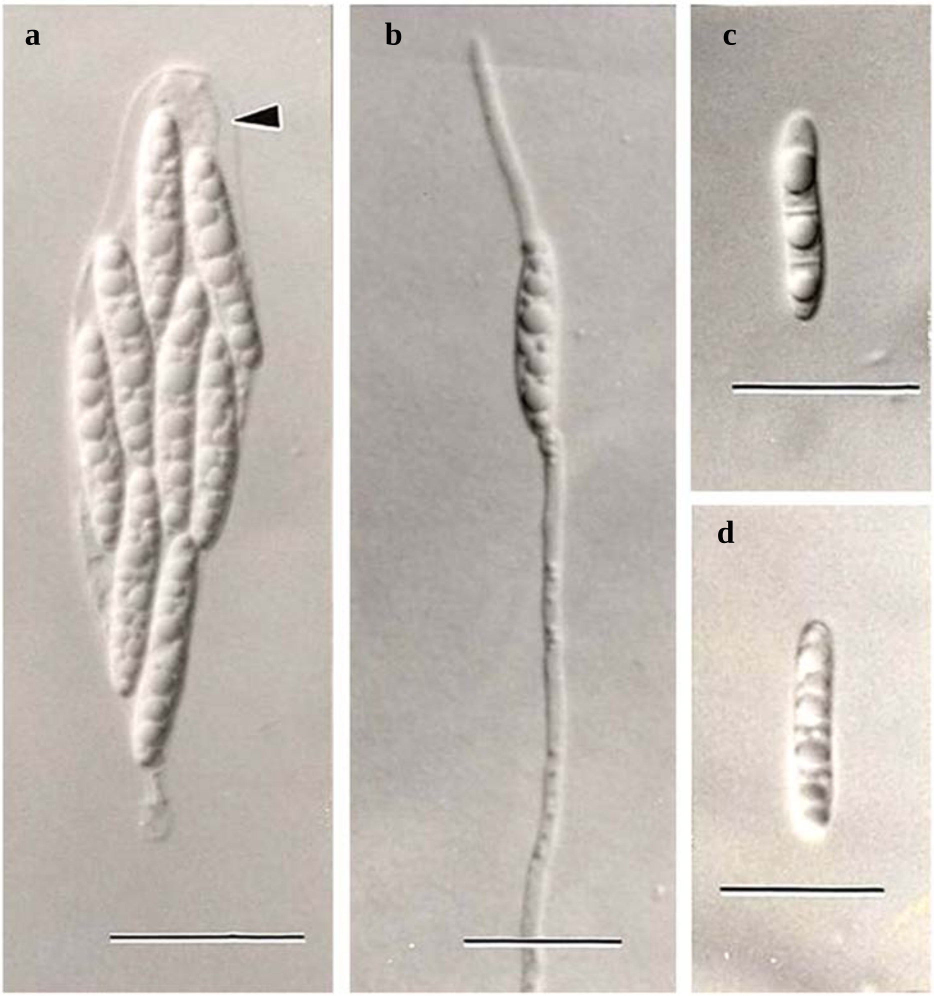


Fig. 50. *Pseudolignincola siamensis.* **a.** Ascus with an apical pore (arrowed). **b.** Three-septate germinating ascospore. **c, d.** Three-septate ascospores. Bars a-d = 20 µm.

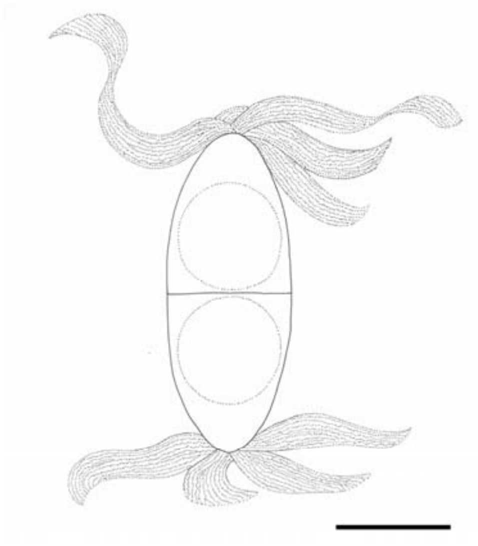


Fig 51. *Remispora spitsbergenensis***.** Bar = 10 µm.

thin-walled, light brown, solitary, paraphyses absent, asci ellipsoidal, short pedunculate, clavate, unitunicate, thin-walled, deliquescing early, ascospores elongate-fusiform, rounded at the pole, tapering toward the base, straight or slightly curved, 1-septate, not constricted at the septum, hyaline, with 2-4 terminal radial appendages formed after release from the ascus (Fig. 54). This species is phylogenetically close to *Okeanomyces cucullatus* (Fig. 55), but they differ in ascospore appendage morphology: a single ephemeral mucilaginous drop/pad in the latter but tetraradiate in *Th. appendiculata* and formed after release from the ascomata (Fig. 54) (Jones *et al.*, 2006). Marine ascomycetes with ascospores over 100 µm include *Bathyascus*, *Lindra* and *Lulworthia*, the latter two genera are members of the Lulworthiales while *Bathyascus* may not be correctly assigned to the Halosphaeriales (Jones, unpublished data).

Tirispora E.B.G. Jones & Vrijmoed, Can. J. Bot. **72**: 1373, 1994...................................... (2)

◙ ***T. unicaudata*** E.B.G. Jones & Vrijmoed, Can. J. Bot. **72**: 1373, 1994 (*Type species*).

Aniptodera indica Ananda & Sridhar, J. Envir. Biol. **22**: 283, 2001.

T. mandoviana V.V. Sarma & K.D. Hyde, Aust. Mycol. **19**: 52, 2000.

Ascomata globose to subglobose, superficial, ostiolate, papillate, periphysate, pale to dark brown, catenophyses present, asci clavate, short pedunculate, with a ring and an apical plate, unitunicate, thick-walled apically with retraction of the plasmalemma at the tip, persistent, ascospores 1-septate, constricted at the septum, ellipsoid, hyaline with a single appendage at one pole (Fig. 44d). Initially adpressed to the spore wall but unfurls to form a long filamentous thread. *Aniptodera indica,* described by Ananda and Sridhar (2001), is reduced to synonymy with *T. unicaudata*. *Tirispora mandoviana* was originally described from freshwater habitats (Sarma and Hyde, 2000) but has recently been collected in Indian mangroves where salinity ranges from 1.1-34.1 ‰ (Maria and Sridhar, pers. comm.).

Phylogenetically *T. unicaudata* forms a sister group to *Halosarpheia marina* and *Panorbis viscosus,* but with weak support (Fig. 55).

1. Asci with retracted plasmalemma, an apical ring and pore, catenophyses present, ascospores 24-32 × 8-12 µm...***T. unicaudata***
1. No retraction of the plasmalemma but with an indistinct apical pore, no catenophyses, ascospores 15-22 × 8-12 µm ....***T. mandoviana***

Trailia G.K. Sutherl., Trans. Br. Mycol. Soc. **5**: 149, 1915.. (1)

T. ascophylli G.K. Sutherl., Trans. Br. Mycol. Soc. **5**: 149, 1915 (*Type species*).

Ascomata subglobose, immersed in blackened area of algal host, ostiolate, papillate with long necks (140-450 µm long), hyaline, thin-walled, solitary or gregarious, no paraphyses, asci cylindrical to clavate, unitunicate, thin-walled, no apical apparatus, deliquescing early, ascospores filamentous, tapering, thick-walled, 1-4-septate, not constricted at the septa, hyaline, bent double and coiled within the ascus, no appendages or sheath. An infrequently collected species known from brown seaweeds, and further studies are required to establish its position in the Halosphaeriales, as Sutherland (1915) referred it to the Hyponectriaceae. However, Rossman *et al*. (1999) excluded it from the Hypocreales because of the long-necked ascomata, lack of apical paraphyses and blackening of the host thallus. We do not consider its placement in the Halosphaeriales as satisfactory, but is left here until collections are available for a molecular study.

Trichomaris Hibbits, G.C. Hughes & Sparks, Can. J. Bot. **59**: 2123, 1981......................... (1)

T. invadens Hibbits, G.C. Hughes & Sparks, Can. J. Bot. **59**: 2123, 1981 (*Type species*).

Ascomata superficial on an extensive subiculum on crab carapace, thick-walled, coriaceous, papilla lacking or short, aparaphysate, periphysate, asci elongate clavate, thin-walled, unitunicate, ascospores oblong to ellipsoidal, 15-22 × 4.6-5 µm, 1-3- septate, bipolar uncoiling appendages. Appendages initially coiled around the ascospore, later uncoil and consist of two parts: a short proximal region is stiffer and a distal region which is flexible, sticky and stretching to a great length (Hibbits *et al*., 1981). It differs from those of the *Halosarpheia* complex in that appendages are not hamate, adhering to the ascospore wall, and later unfurling. A genus requiring further study, at the molecular level, to determine whether it is correctly assigned to the Halosphaeriales.

Tunicatispora K.D. Hyde, Aust. Syst. Bot. **3**: 712, 1990... (1)

T. australiensis K.D. Hyde, Aust. Syst. Bot. **3**: 712, 1990 (*Type species*).

Buxetroldia bisaccata K.R.L. Petersen & Jørg. Koch, Mycol. Res. **101**: 1526, 1997.

Ascomata globose to subglobose, immersed or semi-immersed, hyaline below to light brown above, ostiolate, papillate, membranous, solitary or gregarious, necks periphysate, catenophyses present deliquescing, asci ovoid to clavate, unitunicate, thin-walled, pedunculate, no apical apparatus,

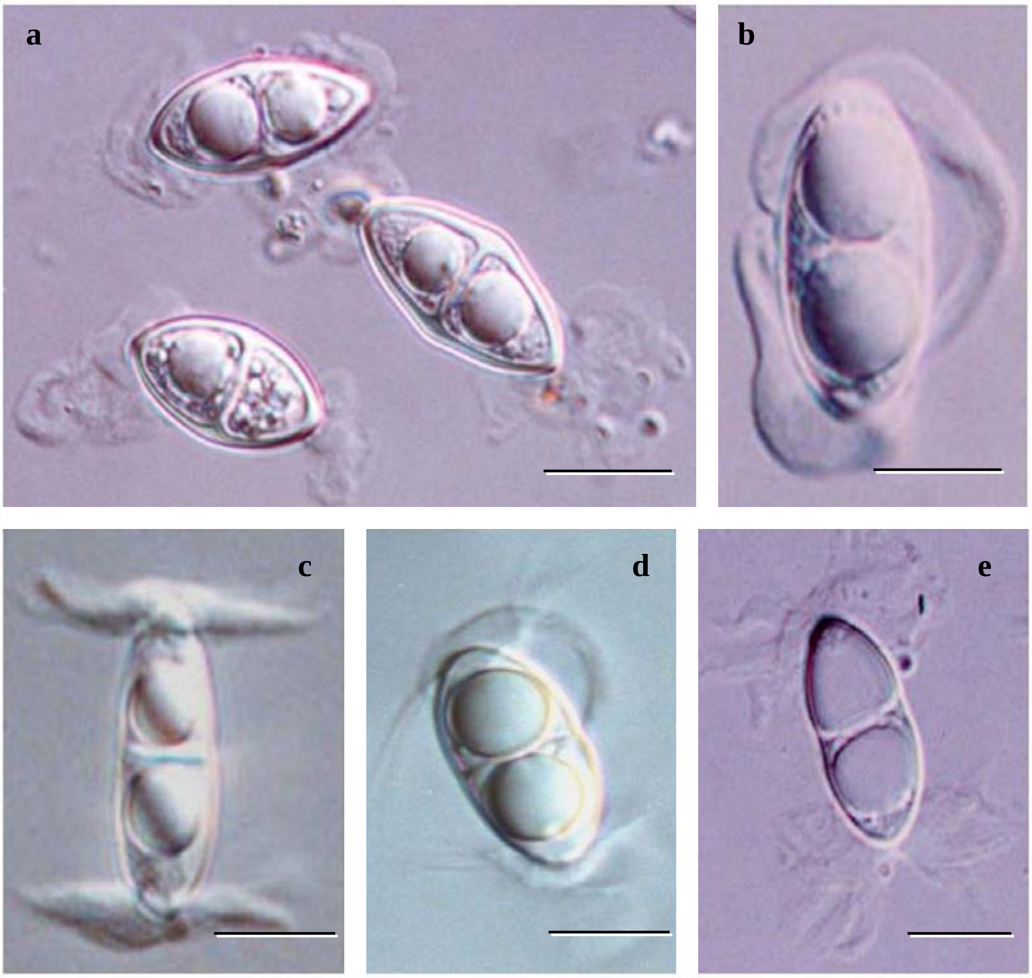


Fig. 52. Ascospores of *Remispora* and *Naufragella* species: **a**. *R. pilleata*. **b**. *R. maritima***. c, e** *R. stellata*. **d.** *Naufragella spinibarbata*. Bars a-e = 10 µm.

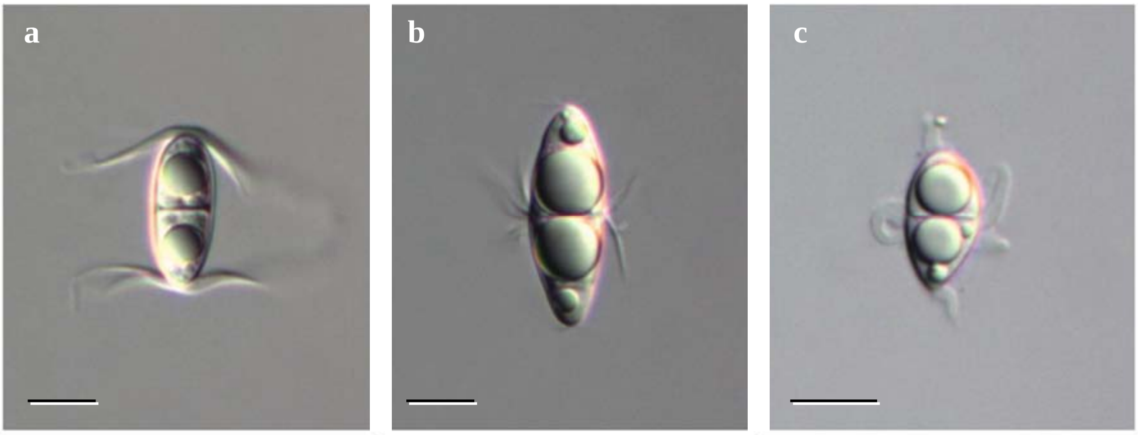


Fig. 53. Ascospores of: **a.** *Remispora spitsbergenensis***. b.** *Havispora longyearbyenensis*. **c.** *Sablecola chinensis*. Bars a-c = 10 µm.

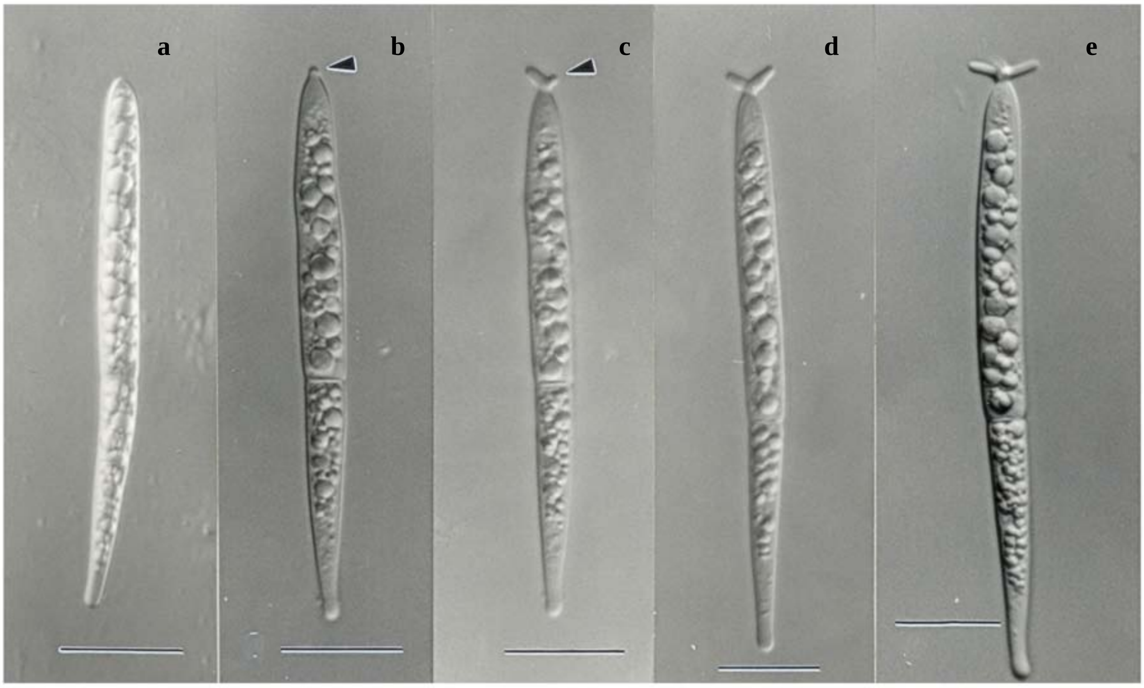


Fig. 54. *Thalespora appendiculata.* **a-e.** Stages in the development of ascospore polar appendages. Bars a-e = 20 µm.

deliquescing early, ascospores ellipsoidal, 1-septate, slightly constricted at the septum, hyaline, with appendages. Two types of appendages: a thin skin-like sheath with a pore at the apex from which a viscous cap emerges. This cap-like appendage slowly unfurls to form thread like appendages.

We regard *Buxetroldia bisaccata* as a synonym of this species as the features separating them are not sufficient for a new genus. This species differs from other genera with unfurling polar appendages in that the ascospore wall comprises three layers: mesosporium, episporium and exosporium. The latter has been shown by McKeown *et al.* (1996) to be loosely attached to the episporium, except at the central septum. The appendages comprise electron-dense fibrillar material, within which there are tripartite strands similar to the episporium. The basal part of the appendage is stoute and arises through a discontinuity in the exosporium. This differs from the porefields reported for *Halosarpheia* species (Alias *et al*., 2001).

Ascospore measurements of *T. australiensis* overlap with those of *Buxetroldia bisaccata*, although the asci are greater in length (125-162 × 32-45 µm) as opposed to 70-102 × 22-26 µm in *T. australiensis* (Hyde, 1990). Thus the differences between the two genera/species, revolve around the degree of separation of the sheath from the ascospore wall. Petersen and Koch (1997) show the sheath bulging away from the ascospore wall. This has also been demonstrated at the TEM level by McKeown *et al*. (1996) who examined collections of the fungus (made by Petersen) from Denmark. Similarities in ascospore appendage morphology, especially the thickness of the basal part and its slowness to unfurl, are found in *B. bisaccata*, *Halosarpheia trullifera* and *T. australiensis*. All possess a sheath varying in its degree of separation from the spore wall and in its degree of persistence. The appendages in these species are cap-like, rather than hamate, initially amorphous and only later unraveling to form extremely fine thread-like. There is evidence that *Halosarpheia fibrosa* may also have an exosporic sheath (Pang *et al.,* 2006). The taxonomic assignment of these taxa needs to be confirmed by a molecular study. Abdel-Wahab *et al*. (2001b) have shown that *H. fibrosa, H. trullifera* and *H. unicellularis* form a well supported clade within the Halosphaeriales.

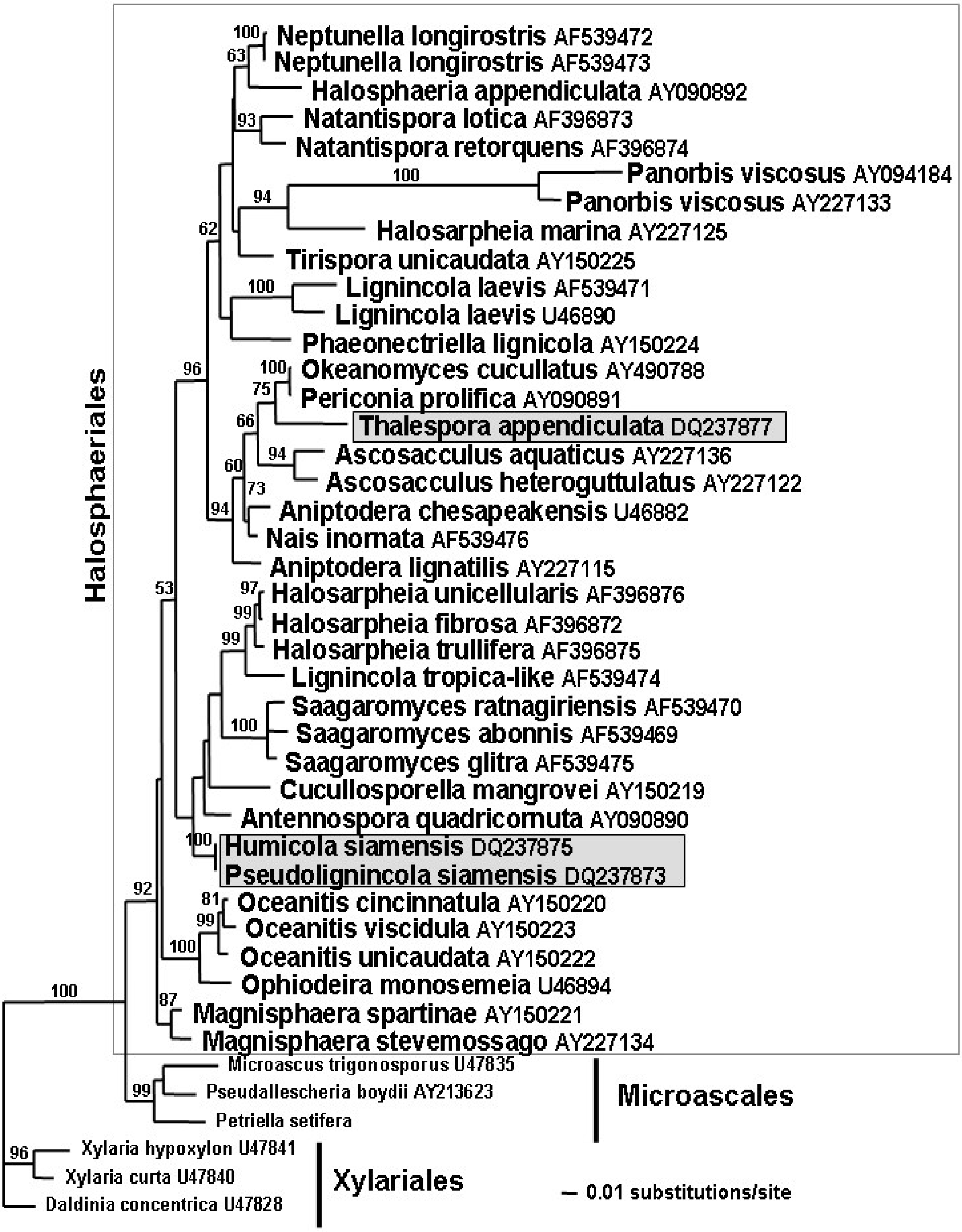


Fig. 55. Taxonomic position of the new genera *Thalespora* and *Pseudolignincola*.

SORDARIOMYCETIDAE

1. Diaporthales
2. Chaetosphaeriales
3. Ophiostomatales

1. Generally stromatic, ascomata perithecial, long-necked, interascal tissue absent, asci thick-walled, J- apical ring, ascospores varied no germ slit, anamorphic coelomycete...................... **Diaporthales**
1. Ascomata not stromatic..2

2. Paraphyses filiform and septate, ascomata superficial or immersed, perithecial, ostiolate or nonostiolate, asci subglobose, clavate or cylindrical, thin-walled, ascospores one-celled, hyaline or pigmented, with germ slit, anamorphs phialidic.... **Chaetosphaeriales**
2. Interascal tissue absent or thin-walled and inconspicuous..3

3. Ascomata perithecial, thick-walled, asci cylindrical or clavate, ascospores with at least one dark cell with germ pore, appendaged, generally lacking anamorphs ....**Sordariales**
3. Ascomata perithecial rarely cleistothecial, thin-walled, long necked, ostiolar setae, asci small, evanescent, formed in chains, ascospores small, unicellular, appendaged or with eccentric wall thickening, anamorphs hyphomycetes ....**Ophiostomatales**

1. DIAPORTHALES

1. Ascospores with appendages..................... ***Diaporthe***
1. Ascospores lacking appendages or sheath 2

2. Ascospores septate............................... ***Hypophloeda***
2. Ascospores unicellular...3

3. Ascospores allantoid, pale yellow to brown, small (range 4-18 × 1.5-3.5 µm).......................***Cryptovalsa***
3. Ascospores naviculoid, hyaline, (25) 30-35 (-40) × (6-) 8-10 (-14) µm...........................***Argentinomyces***

Valsaceae

Cryptovalsa Ces. & De Not. ex Fuckel, Jahrb. nassauischen Vereins Naturk., **23-24**: 212, 1870.. (2)
C. halosarciicola K.D. Hyde, Mycol. Res. **97**: 799, 1993.
C. mangrovei Abdel-Wahab & Inderb., Mycol. Res. **103**: 1628, 1999.

Ascomata in groups in a stroma, immersed becoming erumpent, ectostroma effuse, ascomata subglobose to broadly ellipsoidal, ostiolate, papillate, necks periphysate, coriaceous, paraphyses septate hyaline deliquescent, asci clavate, truncate, long pedunculate, apical refractive non-amyloid ring, ascospores allantoid, unicellular, pale yellow to pale brown, 8-128 per ascus, no appendages or sheaths. A largely terrestrial genus, two are known from mangroves: *C. halosarciicola* on *Halosarcia halocnemoides* in Australia and *C. mangrovei* on *Kandelia candel* in Hong Kong. A third species *C. suaedicola* has been described from the salt marsh plant *Suaeda fruticosa* (Inderbitzin *et al.*, 1999) with ascospores measuring 5-7 × *ca.* 1 µm.

1. Asci 8 spored, ascospores hyaline, smooth walled, 4-7 × 1.5-2 µm ....***Cryptovalsa halosarciicola***
1. Asci 64 spored, ascospores pale yellow-pale brown, verrucose, 5.6-11 (-18) × 1.6-3.6 µm......................... .... ***Cryptovalsa mangrovei***

Diaporthe Nitschke, Pyrenomycetes Germanici: 240, 1870... (1)
D. salsuginosa Vrijmoed, K.D. Hyde & E.B.G. Jones, Mycol. Res. **98**: 699, 1994.

Ascomata in a group within a wide spreading blackened zone on the wood, individual ascomata subglobose, immersed, brown to black, coriaceous, with short necks periphysate, penetrating the host surface, paraphyses hypha-like, filiform, tapering distally, septate and hyaline, asci cylindrical, unitunicate, thin-walled, short pedunculate, flattened apex, J- subapical ring, ascospores 1-septate, not constricted at the septum, hyaline, smooth walled, with a mucilaginous pad at each pole which swells in water and is sticky. The only *Diaporthe* species known from marine habitats, occurring on intertidal mangrove wood, but no anamorph has been linked to this species, although marine *Phomopsis* spp. are known (Vrijmoed *et al.*, 1994). Ascospores are distinctive with a small mucilaginous pad at each end, which swells in water and attaches the spores to substrata.

Gnomonia Ces. & De Not., Soc. crittog Ital. **1**: 231, 1863... (1)
G. salina E.B.G. Jones, Trans. Br. Mycol. Soc. **45**: 107, 1962.

This is a doubtful *Gnomonia* species and known only from the type collection. It is probably best referred to *Halosarpheia* (e.g. *H. trullifera*). Clearly it does not belong in

Gnomonia because of ascus and ascospore morphology and spore dimensions. *Nomen rejectum.*

Melanconidaceae

Hypophloeda K.D. Hyde & E.B.G. Jones, Trans. Mycol. Soc. Jpn. **30**: 61, 1989 .... (1)
H. rhizospora K.D. Hyde & E.B.G. Jones, Trans. Mycol. Soc. Jpn. **30**: 62, 1989 (*Type species*).

Ascomata solitary or gregarious; slightly stromatic; periphysate; asci clavate, thin-walled, with a refractive non-amyloid apical thickening, persistent, with a tapering stalk; paraphyses numerous, septate and broad; ascospores are hyaline, cylindrical, 0-3-septate with no appendages (Hyde and Jones, 1989b).

A monotypic genus that is infrequently reported, occurring on mangrove prop roots with the ascomata just below the surface of the bark. A molecular study is required to establish its true taxonomic position.

DIAPORTHALES *incertae sedis*

Argentinomyces N.I. Peña & Aramb., Mycotaxon **65**: 333, 1997 .... (1)
A. naviculisporus N.I. Peña & Aramb., Mycotaxon **65**: 333, 1997 (*Type species*).

Ascomata subglobose, immersed, ostiolate, papillate, periphysate, membranous, cream-coloured, solitary sometimes gregarious, paraphyses absent, asci clavate short pedunculate, unitunicate, thin-walled, thickened at the apex, without a pore, persistent, ascospores ellipsoidal, 0-3-septate, slightly constricted at the septa, hyaline, without a sheath or appendages (Peña and Arambari, 1997a) (Fig. 56). Although it has similarities with the Halosphaeriales, it clearly does not belong in that order, because of the thick-walled ascus apex, and persistent asci. It also shows similarities to the mangrove species *Rhizophila marina* and *Marinosphaera mangrovei.*

2. SORDARIALES

1. Ascospores unicellular .... ***Chaetomium***
1. Ascospores 2-3-septate 2

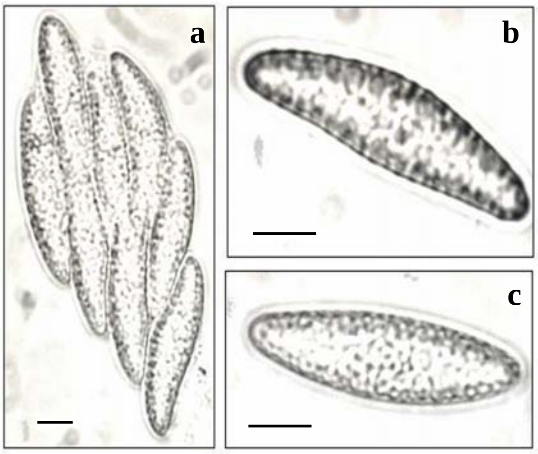


Fig. 56. *Argentinomyces navisculisporus*. a. Clavate ascus. b-c. Ascospores (After Peña and Arambari, 1997b). Bars a-c = 10 µm.

2. Ascospores 1-septate, apical cell dark brown to black .... ***Zopfiella***
2. Ascospores 3-septate... 3

3. Ascospores hyaline, with bipolar, semiglobose cap-like polar appendage ....***Abyssomyces***
3. Ascospores with brown cells............ ***Biconiosporella***
3. Ascospores versicolorus........................... ***Savoryella***

Lasiosphaeriaceae

Biconiosporella Schaumann, Veröff. Inst. Meereforsch. Bremerhaven **14**: 24, 1972..... (1)
B. corniculata Schaumann, Veröff. Inst. Meereforsch. Bremerhaven **14**: 24, 1972 (*Type species*).

Ascomata ovoid, pyriform, flask-shaped, superficial or immersed, ostiolate, papillate, coriaceous, brown to black, solitary or gregarious, periphysate, catenophyses present, asci cylindrical, short pedunculate, thin-walled, unitunicate, persistent, with an apical plate, ascospores biconical, unequally 3-septate, thick-walled, slightly constricted at the septa, dark brown, no sheath or appendages (Schaumann, 1972). Infrequently reported and no recent taxonomic study on this species, often found on heavily decayed wood associated with sand (Jones *et al*., 2005).

Chaetomiaceae

Chaetomium Kunze, Mykologische Hefte (Leipzig) **1**: 15, 1817.................................... (1)
Ch. heteropilum N.J. Artemczuk Mykol. Fitopatol. **14**: 93, 1980.

Ascomata globose, superficial, brown to fuscous, ostiolate, epapillate, with terminal sterile hairs variously ornamented, straight curved or coiled, no paraphyses, asci clavate, thin-walled, unitunicate, hyaline, long pedunculate, no apical apparatus, deliquescing early, ascospores ovoid, pip-like, and olive brown. Isolated from sediments in the Black Sea, ascomata with spine-like appendages that are slightly bulbous at the base, longer hair-like appendages verruculose, ascospores 12.5-16 × 8-9.8 µm.

Chaetomium species are frequently noted from marine habitats but whether they are true marine species is not clear. For example, *Chaetomium ramipilosum* was isolated from *Ammophila arenaria* plant material in a sand dune system and sporulated well on seawater media (Schaumann, 1973b), while Jones (1962) reported *Chaetomium erectum* and *Ch. globosum* on submerged test blocks exposed in the sea at Langstone harbour.

Zopfiella G. Winter, Rabenh. Krypt.-Fl. Ed2 **1(2)**: 56, 1884.. (2)

◙ ***Z. latipes*** (N. Lundq.) Malloch & Cain, Can. J. Bot. **49**: 876, 1971.

Tripterospora latipes Lundq., Bot. Not. **122**: 592, 1969.

Anamorph: *Humicola*-like.

Z. marina Furuya & Udagawa, J. Jap. Bot. **50**: 249, 1975.

Anamorph: *Humicola*-like.

Ascomata globose to subglobose, immersed but usually superficial, lacking an ostiole, coriaceous, dark brown to black, covered with septate branched hairs, solitary, paraphyses present deliquescing early, asci clavate, short pedunculate, unitunicate, with an apical ring, ascospores ellipsoidal, 1-septate, large apical olivaceous to dark brown cell and a smaller hyaline basal cell, lacking appendages or a sheath. Both *Z. latipes* and *Z. marina* have been reported with *Humicola*-like anamorphs and conidia produced on peg-like structures on undifferentiated hyphae, respectively (Guarro *et al*., 1999) and widely distributed. *Zopfiella latipes* has been recorded on *Nypa fruticans* in Thailand at salinities of 5-21 ‰ (Pilantanapak *et al*., 2005) and on other seagrasses (Sakayaroj, unpublished data).

1. Ascospores with subapical germ pore, basal cell broadly cylindrical, 16-22 × 10-13 µm.......***Z. latipes***
1. Ascospores with apical pore, basal cell elongate cylindrical, 14-20 × 10-14 µm ....***Z. marina***

SORDARIALES *incertae sedis*

Abyssomyces Kohlm., Ber. Dtsch. Bot. Ges. **83**: 505, 1970.. (1)

A. hydrozoicus Kohlm., Ber. Dtsch. Bot. Ges. **83**: 505, 1970 (*Type species*).

Ascomata subglobose or pyriform, superficial, ostiolate, papillate, coriaceous, light brown, setose, solitary, short necks periphysate, asci subcylindrical or fusiform, short pedunculate, unitunicate, thin-walled, no apical apparatus, persistent, ascospores subcylindrical, straight or slightly curved, 3-septate, not constricted at the septa, hyaline, appendages gelatinous cap-like, at each end of the spore. *Abyssomyces* was collected at depths of 631 and 641 m on hydrozoan, hydrorhiza and hydrocaulon, attached to stony corals. (Kohlmeyer and Volkmann-Kohlmeyer, 2003b). Few collections are available for study and the genus is in need of further study to determine its phylogenetic relationship.

Savoryella E.B.G. Jones & R.A. Eaton, Trans. Br. Mycol. Soc. **52**: 161, 1969.................... (5)

◙ ***S. appendiculata*** K.D. Hyde & E.B.G. Jones, Bot. Mar. **35**: 89, 1992.

◙ ***S. lignicola*** E.B.G. Jones & R.A. Eaton, Trans. Br. Mycol. Soc. **52**: 161, 1969 (*Type species*).

◙ ***S. longispora*** E.B.G. Jones & K.D. Hyde, Bot. Mar. **35**: 84, 1992.

S. melanospora Abdel-Wahab & E.B.G. Jones, Mycoscience **41**: 387, 2000.

◙ ***S. paucispora*** (Cribb & J.W. Cribb) Jørg. Koch, Nordic. J. Bot. **2**: 169, 1982.

Leptosphaeria paucispora Cribb & J.W. Cribb, Pap. Dept. Bot., Univ. Qd. **4:** 41, 1960.

Ascomata subglobose or ellipsoidal, immersed to superficial, ostiolate, papillate, membranous, pale brown to dark brown, necks with periphyses, paraphyses deliquescing early, solitary or gregarious, asci elongate to cylindrical or clavate, short pedunculate, unitunicate, thin-walled, persistent with an apical pore, ascospores 3-septate, constricted at the septa, versicoloured, apical cells hyaline, central cells brown, mucilaginous sheath around central cells, apical appendages in *S. appendiculata* (Read *et al.,* 1993b) (Fig. 57). This genus has some similarities with members of the Halosphaeriales, in particular the nature of the paraphyses and lack or poorly developed apical pore to the ascus (Jones and Hyde, 1992). Ten species have been assigned to the genus, from freshwater or marine habitats, with *S. appendiculata* and *S. melanospora* found on driftwood associated with sand (Hyde and Jones, 1992b; Abdel-Wahab and Jones, 2000) (Fig. 57).

The genus has been referred to various higher taxa: Ascomycetes *incertae sedis* (Kohlmeyer, 1986b), Tripterosporaceae or Lasiosphaeriaceae in the Sordariales (Jones and Hyde, 1992), Halosphaeriales (Barr, 1990a) and Hypocreales *incertae sedis* (Cai *et al*., 2006). *Savoryella* superficially resembles *Ascotaiwania* both with versicoloured ascospores and their occurrence in aquatic habitats, but differ in the elaborate apical ascus apparatus of *Ascotaiwania,* and its *Monotosporella* and *Helicoon farinosum* anamorphs (Chang *et al.*, 1998; Sivichai *et al.*, 1998; Cai *et al*., 2006). A molecular study has failed to resolve the taxonomic position of *Ascotaiwania* (Ranghoo *et al*., 1999) with Cai *et al*. (2006) referring it to the Hypocreales *incertae sedis*. Their aquatic or intertidal habitat may have resulted in adaptation to these environments with consequent reduction of features of phyletic significance that may have indicated their natural affinities. Therefore, assignment of *Savoryella* species to a higher taxon on morphological criteria is difficult and warrants molecular studies to resolve its taxonomic position (Read *et al*., 1993b).

A recent molecular study of *Savoryella* and *Ascotaiwania* indicates they are closely related, but are not monophyletic. They do not group with any of the major taxa (Boonyuen, pers. comm.), but form an un-named clade distantly placed from the Halosphaeriales, Sordariales, Xylariales and Hypocreales *incertae sedis.* It is best referred to Hypocreomycetidae *incertae sedis*, Sordariomycetes until wider analysis of taxa and genes. While there is no known anamorph for *Savoryella*, *Ascotaiwania* has two: *Helicoon farinosum* (*A. hughesii*), and *Monotosporella* (*A. sawadae, A. mitriformis*) (Ranghoo and Hyde, 1998; Sivichai *et al*., 1998; Boonyuen, pers. comm.).

1. Asci with 2 ascospores, 36-60 × 12-16.5 µm, on mangrove wood.................................. ***S. paucispora***
1. Asci with 8 ascospores.. 2

2. Ascospores appendaged, 26-35 × 11-16 µm, on wood .... ***S. appendiculata***
2. Ascospores not appendaged.................................... 3

3. Ascospores wider than 15 µm, 32-45 × 15-18 µm, on wood associated with sand................ ***S. melanospora***
3. Ascospores narrower than 15 µm, on wood............ 4

4. Ascospores 24-36 × 8-12 µm.................. ***S. lignicola***
4. Ascospores 33.5-46.5 × 7.5-12 µm....... ***S. longispora***

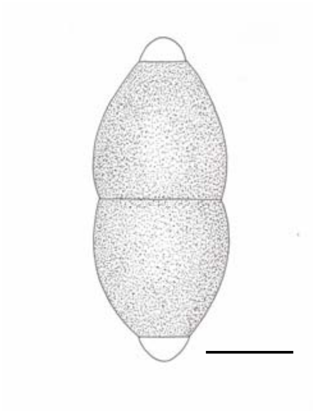


Fig. 57. *Savoryella melanospora.* Ascospore. Bar = 10 µm.

2. CHAETOSPHAERIALES

Chaetosphaeriaceae

Chaetosphaeria Select. fung. carpol. (Paris) 2: 252, 1863... (1)

C. chaetosa Kohlm., Nova Hedw. **6**: 307, 1963.

Ascomata subglobose or pyriform, immersed or partly immersed, ostiolate, paplliate, subcoriaceous, dark brown to black, solitary or gregarious, necks periphysate, paraphyses septate, ramose, asci cylindrical to clavate, long pedunculate, unitunicate, thin-walled, persistent, apical apparatus present, ascospores fusiform or elongate-fusiform, 3-septate, constricted at the septa, hyaline, with polar and equatorial appendages formed by fragmentation of a sheath. The only marine species of a genus with 20 or more terrestrial species growing on wood, bark and leaves, and with a variety of anamorphs (Kirk *et al*., 2001; Réblová and Seifert, 2008).

Chaetosphaeria chaetosa differs in a number of respects from other species in the genus, primarily in ascospores with both polar and equatorial appendages, formed by fragmentation of an exosporic sheath, while no anamorph have been reported for it (Jones *et al*., 1983c). Thus it differs from other *Chaetosphaeria* species which possess a wide range of phialidic anamorphs. Ascospores bear a resemblance to *Corollospora* species, but differ in lacking polar spines (Jones *et al.*, 1983a). Although the genus has been extensively studied at the morphological and molecular level, *Ch. chaetosa* has not been examined (Réblova, 1999; Huhndorf *et al*., 2004; Réblová *et al*., 1999; Réblová and Seifert, 2008). Its phylogenetic position needs to be confirmed by sequence data.

OPHIOSTOMATALES

Lanspora K.D. Hyde & E.B.G. Jones, Can. J. Bot. **64**: 1581, 1986...................................... (1)
◙ ***L. coronata*** K.D. Hyde & E.B.G. Jones, Can. J. Bot. **64**: 1581, 1986 (*Type species*).

Ascomata globose to subglobose, coriaceous, immersed to partly immersed, solitary or gregarious, neck short, cylindrical, periphysate, paraphyses and catenophyses absent, asci cylindrical to oblong-ventricose, unitunicate, thin-walled, short pedunculate, ascospores ellipsoidal, unicellular, hyaline, with longitudinal wall striations, with a crown of appendages at both ends. Appendages crown-like, radiating, delicate, subgelatinous and formed by fragmentation of an exosporium. A genus tentatively assigned by Hyde and Jones (1986b) to the Halosphaeriales, however, preliminary molecular data suggests an affinitiy to the Ophiostomatales (Schoch, pers. comm.).

XYLARIOMYCETIDAE

1. XYLARIALES

Key to xylariaceous and xylariaceous *incertae sedis* species:

1. Ascospores hyaline 2
1. Ascospores brown or black 9

2. Ascospores apiosporous............ ***Apioclypea nypicola***
2. Ascospores not apiosporous.................................... 3

3. Ascospores 0-septate... 4
3. Ascospores septate 6

4. Ascospores with a single or bipolar caps or appendages.. 5
4. Ascospores surrounded by a mucilaginous sheath... 7

5. Ascospores filamentous, ascomata superficial under a stroma .... ***Linocarpon***
5. Ascospores ellipsoidal, ascomata beneath host surface...................................... ***Fasciatispora nypae***

6. Ascospores cymbiform, 34-44 × 7-15 µm, on *Phragmites* .... ***Phragmitensis marina***
6. Ascospores ellipsoid, 17-26 × 5-7 µm on *Nypa* .... ***Frondicola tunitricuspis***

7. Ascospores 0-1-septate, filliform, on *Nypa*............. 8
7. Ascospores 1-septate elongate, 24-36 × 3-4.5 µm, on mangrove leaves .... ***Lanceispora amphibia***

8. Ascospores 70-120 × 2-2.8 µm, ascomata deeply immersed in *Nypa* ....***Neolinocarpon***
8. Ascospores 74-113 × 3-6 µm, ascomata not deeply immersed in *Nypa* ....***Oxydothis***

9. Ascospores 0-septate... 10
9. Ascospores 1-septate... 17
9. Ascospores 13-17-septate ....***Pedumispora***

10. Ascospores with appendages............................... 11
10. Ascospores with a sheath 12
10. Ascospores lacking appendages or a sheath........ 13

11. Ascospores 20-33 × 8-12 µm, single polar appendage appendage, on mangrove substrata....... ....***Adomia avicenniae***
11. Ascospores 6.5-16 × 2-8 µm, single or bipolar appendages .... ***Phomatospora***

12. Ascospores 16-20 × 4-6 µm, prominent sheath drawn out to form polar appendages......... ***Nipicola***
12. Ascospores occasionally with a sheath .... ***Anthostomella***

13. Ascospores lacking germ slits 14
13. Ascospores with germ slits................................. 15

14. Ascospores 6.5-8 × 1.2-16 µm, hyaline to pale yellow, ascomata immersed in a stroma, on mangrove wood............................***Eutypella naqsii***
14. Ascospores 6-12 × 2.28 µm, immersed in mangrove wood.................... ***Eutypa bathurstensis***

15. Ascomata immersed in a stroma, ascospores pale brown to golden yellow to reddish-brown .... ***Astrocystis***
15. Ascomata immersed in wood, ascospores 10-18 × 4-7.5 µm, with or without a sheath, or basal cell .... ***Anthostomella***
15. Ascomata superficial on mangrove wood 16

16. Ascospores 18-28 × 7.5-13 µm, on various mangrove wood .... ***Halorosellinia oceanica***
16. Ascospores 9-12 × 5-6 µm, on *Kandelia candel* wood... ***Nemania maritima***

17. Ascospores with a sheath 18
17. Ascospores lacking a sheath, 10-16 × 5-7 µm .... ***Crytosphaeria mangrovei***

18. Ascospores 17-23 × 7-9 µm, lacerate germ pore at each pole, on *Juncus* ..... ***Ommatomyces coronatus***
18. Ascospores 19-26 × 7-8 µm, on *Nypa*..................... .... ***Arecophila nypae***
18. Ascospores 23-31 × 7.4-10.5 µm on *Juncus* ....***Atrotorquata***

1. Cainiaceae

Arecophila K.D. Hyde, Nova Hedw. **63**: 82, 1996.. (1)
A. nypae K.D. Hyde, Nova Hedw. **63**: 95, 1996.

Ascomata immersed, subglobose, ostiolate, papillate, coriaceous, brown to black, solitary to gregarious, necks periphysate, paraphyses hypha-like, filiform, septate and branched, asci cylindrical to clavate, short pedunculate, unitunicate, thin-walled, J+ amyloid ring, persistent, ascospores ellipsoidal, 1-septate, brown, slightly constricted at the septum, with a mucilaginous sheath. This is a genus introduced by Hyde (1996) to accommodate ascomycetes collected on palms, while others are known from dead culms of bamboo (Umali *et al*., 1999).

Kang *et al*. (1999a) placed the genus in the Cainiaceae based on molecular evidence, formerly refered to the Amphisphaeriaceae. *Arecophila* differs from *Amphisphaeria* in having deeply immersed, subglobose to lenticular ascomata, with a peridium of angular cells with a small or lacking a clypeus. *Arecophila* species develop within the host tissue beneath a clypeus (or lacking), ascomata often lenticular, paraphyses are hyphal-like, asci unitunicate, cylindrical with an apical J+ ring and brown bicellular ascospores that are verrucose or striated. Ascospores are surrounded by a wide mucilaginous sheath. *Arecophila nypae* differs from other species in having ascospores with rounded cells and occurs on the brackish water palm *Nypa fruticans*. *Arecophila* is similar to another marine ascomycete, *Atrotorquata* but differs in lacking an ascospore germ slit (Hyde, 1996).

Atrotorquata Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **12**: 8, 1993 .... (1)
A. lineata Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **12**: 8, 1993 (*Type species*).

Ascomata subglobose, immersed, ostiolate, papillate with a long periphysate neck (140-200 µm), coriaceous, dark brown, solitary, paraphyses, simple or branched, septate, asci cylindrical, short pedunculate, unitunicate, thin-walled, persistent, with an apical apparatus, J+, ascospores ellipsoidal, 1-septate, slightly constricted at the septum, brown, striate and with 5-7 germ slits at each apex, with a gelatinous sheath. A common and host-specific ascomycete on *Juncus roemerianus*, but may not be obligately marine but occurs with other marine organisms (Kohlmeyer and Volkmann-Kohlmeyer, 1993c). It was referred to the Amphis-phaeriaceae, but we prefer its assignment in the Cainiaceae (Kang *et al*., 1999a, b).

2. Clypeosphaeriaceae

Apioclypea K.D. Hyde, J. Linn. Soc., Bot. 116: 316, 1994... (1)
A. nypicola K.D. Hyde, J. Fröhlich & Joanne E. Taylor, Sydowia **50**: 36, 1998.

Ascomata subglobose, immersed underneath a weakly developed clypeus, membranous, ostiolate, brown, solitary or gregarious, periphysate, paraphyses hypha-like, septate, numerous embedded in a gelatinous matrix, asci cylindrical, pedunculate, persistent, with a J+ apical apparatus, ascospores ellipsoidal, hyaline, apiosporus, with a mucilaginous sheath. A genus erected to accommodate unitunicate ascomycetes with ascomata immersed under a clypeus, appearing as minute blackened ostiolar dots (Hyde *et al*., 1998). Ascospores form orange ooze around ostioles. Referred to the Hyponectriaceae (Hyde, 1994b) and Clypeosphaeriaceae (Hyde *et al*., 1999a), sequence data confirms its position in the latter family (Kang *et al.*, 1999c,d).

Ommatomyces Kohlm., Volkm.-Kohlm. & O.E. Erikss., Mycologia **87**: 538, 1995 .... (1)
O. coronatus Kohlm., Volkm.-Kohlm. & O.E. Erikss., Mycologia **87**: 538, 1995 (*Type species*).

Ascomata broadly ovate, immersed, ostiolate, subcarbonaceous, black, short papilla, periphysate, paraphyses, septate, unbranched, thin-walled, asci cylindrical, short pedunculate, unitunicate, with an apical apparatus consisting of several rings, J+, ascospores ellipsoidal, 1-septate, slightly constricted at the septum, brown, thick-walled, with an a lacerate germ pore at each end, with subglobose gelatinous and evanescent caps and a thin sheath around the spore. Kohlmeyer *et al.* (1995c) assigned the genus to the Amphisphaeriaceae, but Kirk *et al.* (2001) place it in Xylariaceae. It differs from the previous family by its broadly ellipsoidal ascospores with elaborate lacerate germ pores, gelatinous spore caps and sheath. The species has a complex ascospore wall comprising a hyaline outer-wall and brown inner wall (which the authors refer to as perispore and endospore respectively, terms that are not defined) and a characteristic apical lacerate pore at each end. Ascospores have apical caps at each pole and a narrow gelatinous sheath.

3. Diatrypaceae

None of the marine Diatrypaceae has been subject to a molecular study, but terrestrial species have been examined by Acero *et al.* (2004) and Carmarán *et al.* (2006) and includes 10 genera. The genera *Eutypa*, *Cryptosphaeria*, *Diatrype*, *Eutypella* were considered polyphyletic suggesting a revision of the family was required (Acero *et al.*, 2004), while polysporous asci in the family appears to have evolved several times (Cannon and Kirk, 2007).

Cryptosphaeria Ces. & De Not., Comm. Soc. crittog. Ital. **1**, 231, 1863............................. (1)
C. mangrovei K.D. Hyde, Trans. Mycol. Soc. Jpn. **34**: 311, 1993.

Ascomata globose to subglobose, immersed, coriaceous, ostiolate, papillate, brown to black, neck periphysate, thin entostroma under the periderm, paraphyses, wide, branched, hypha-like, asci cylindrical, unitunicate, thin-walled, long pedunculate, with an apical apparatus, J- ring, ascospores allantoid, light brown, unicellular, no sheath or appendages. An ascomycete saprobic on intertidal wood of *Rhizophora apiculata*, with large ascomata (325-520 µm high, 650-910 µm wide), immersed singly within the bark and covered by the periderm. Molecular data required to determine if this species would be better assigned to the genus *Eutypa*.

Eutypa Tul. & C. Tul., Select. fung. carpol. **2**: 52, 1863.. (1)
E. bathurstensis K.D. Hyde & Rappaz, Mycol. Res. **97**: 861, 1993.

Anamorph: coelomycetous

Ascomata deeply immersed in the wood, entostroma poorly developed, spherical to flattened, ostiole poorly developed, neck 120-200 µm periphysate, black, paraphyses numerous, persistent, asci clavate, long pedunculate, apical apparatus J-, ascospores allantoid, olive-brown, no sheath or appendages. This species differs from other species in having an ascomatal wall that is three layered, the central one thick and hyaline (Hyde and Rappaz, 1993). Anamorph produced in nature and in culture, the conidia produced holoblastically, filiform, curved, hyaline with a flattened base, 10-33 × 1.5-2 µm.

Eutypella (Nitschke) Sacc., Atti Soc. Venet.-Trento. Sc. Nat., Padova **4**: 80, 1875 .... (1)
E. naqsii K.D. Hyde, Mycol. Res. **99**: 1462, 1995.

Ascomata formed beneath a raised, blackened crust-like stroma on the host surface, ascomata globose to subglobose, membranous, black, ostiolate, neck periphysate, paraphyses hypha-like, sparse, septate, hyaline, and tapering distally, asci cylindrical-clavate, long pedunculate, unituicate, thin-walled, apical apparatus J-, ascospores allantoid, unicellular, straight or curved, hyaline to pale brown, no sheath or appendages. The only known *Eutypella* species on intertidal marine mangrove wood often growing on decorticated

Avicennia species, with ascomata developing under blackened stroma, with necks collectively erumpent through pustulate discs (Hyde, 1995a).

Pedumispora K.D. Hyde & E.B.G. Jones, Mycol. Res. **96**: 78, 1992 .... (1)
◙ ***P. rhizophorae*** K.D. Hyde & E.B.G. Jones, Mycol. Res. **96**: 78, 1992 (*Type species*).

Pseudostromatic tissue, comprising host cells and fungal hyphae, through which occur numerous darkened raised pustules with 1-4 immersed ascomata and 1-4 short necks. Ascomata large, subglobose, coriaceous, brown-black, ostiolate, papillate, necks collectively erumpent, periphysate, paraphyses filiform, simple, asci irregularly fusiform, pedunculate, unitunicate, thin-walled, apically truncate without an apical apparatus, ascospores filiform, tapering towards both ends, curved characteristically, hook-shaped at one end, 13-17-septate, not constricted at the septa, 7-9 longitudinal striations running the length of the spore, tips lacking cytoplasm, yellow to brown (Fig. 58). A characteristic feature of this species is the filliform, 13-17- septate, hyaline to yellow to yellowish-brown, ascospores tapering at both ends, curved and hook-shaped at one end. Asci are unitunicate with no apical apparatus and rupturing to release the ascospores or deliquescing at maturity (Hyde and Jones, 1992a). Assigned tentatively to the Diaporthales (Hyde and Jones, 1992a), but LSU rDNA sequences positions it in the Xylariales with the genera *Libertella* and *Cryptosphaeria* as sister groups (Sakayaroj, 2005). We consider it well placed in the Diatrypaceae as it groups with the genera *Cryptosphaeria, Diatrype, Eutypa* and *Eutypella*.

4. Hyponectriaceae

A family sometimes referred to the Phyllachorales, we follow Barr (1994) and Cannon and Kirk (2007) in placing it in the Xylariales.

Frondicola K.D. Hyde, J. Linn. Soc. Bot. **110**: 100, 1992... (1)
F. tunitricuspis K.D. Hyde, J. Linn. Soc. Bot. **110**: 102, 1992 (*Type species*).

Ascomata immersed under a small clypeus beneath the host epidermis, lenticular, ostiolar canal periphysate, dark brown to black, paraphyses simple, septate, tapering towards their tips, asci cylindrical, short pedunculate, unitunicate, thin-walled, with an apical apparatus, J-, ascospores ellipsoidal, 1-septate, not constricted at the septum, with a pronounced 3-4 lobed mucilaginous sheath. A monotypic genus occurring on the palm *Nypa fruticans*, and infrequently collected. Referred by Hyde (1992a) to the Clypeosphaeriaceae it is a genus that needs evaluation at the molecular level.

Phragmitensis M.K.M. Wong, Poon & K.D. Hyde, Bot. Mar. **41**: 379, 1998 .... (1)
P. marina M.K.M. Wong, Poon & K.D. Hyde, Bot. Mar. **41**: 379, 1998 (*Type species*).

Pseudostroma long (0.7-1.9 mm long) immersed formed from host and fungal tissue, black, with 3-6 ascomata, which are globose to subglobose, necks periphysate, paraphyses hyphal-like, straight, flexuous, septate, constricted at the septa, tapering, asci clavate, unitunicate, thin-walled, short pedunculate, J-, lacking an apical apparatus, ascospores unicellular, cymbiform, basal end more tapered, hyaline, smooth-walled, with a mucilaginous sheath. An infrequent, saprobic, intertidal species on decaying culms of the marsh grass *Phragmites australis* (Wong *et al*., 1998). Although assigned here to the Xylariales, the asci lack an apical apparatus.

5. Xylariaceae

Anthostomella Sacc., Atti Soc. Veneto-Trent. Sci. Nat., Padova **4**: 84, 1875....................... (6)
A. nypae K.D. Hyde, B.S. Lu & Alias, Mycol. Res. **103**: 1409, 1999.
A. nypensis K.D. Hyde, Alias & B.S. Lu, Mycol. Res. **103**: 1410, 1999.
A. nypicola K.D. Hyde, Alias & B.S. Lu, Mycol. Res. **103**: 1411, 1999.
A. poecila Kohlm., Volkm.-Kohlm. & O.E. Erikss., Bot. Mar. **38**: 175, 1995.

A. spissitecta Kohlm. & Volkm.-Kohlm., Mycol. Res. **106**: 369, 2002.

◙ ***A. torosa*** Kohlm. & Volkm.-Kohlm., Mycol. Res. **106**: 365, 2002.

Ascomata globose to subglobose, immersed in the host, pale brown to dark brown to black, ostiolate, epapillate, clypeate, coriaceous, periphysate, solitary or gregarious, paraphyses numerous, simple, septate, asci cylindrical, short pediculate, unitunicate, thick-walled with a J+ apical apparatus, ascospores ellipsoidal, unicellular, with germ-slits extending over the whole length of the spore, hyaline with gelatinous caps or sheaths (Fig. 59). Most of these species have been collected on *Juncus roemerianus, Nypa fruticans, Spartina* spp. and *Pandanus* sp., but many also occur on mangrove wood (Jones and Abdel-Wahab, unpublished data from the Bahamas), and need a more detailed examination (Lu and Hyde, 2000; Kohlmeyer and Volkmann-Kohlmeyer, 2002). *Anthostomella semitecta*, has also been reported as a halotolerant species on *J. roemerianus* with ascospores measuring 15.9-18.8 × 6.6-8.1 µm, 1-septate, a large brown and a small hyaline basal cell, and a prominent gelatinous sheath (Kohlmeyer *et al*., 1995a). Lu and Hyde (2000) rejected the species *A. poecila* and *A. semitecta*, regarding them as synonyms of *A. tenacis* and *A. sepelibilis*, respectively. Molecular data place *A. torosa*, the only marine species sequenced, in the Xylariaceae.

1. On *Nypa fruticans* 2
1. On *Juncus roemerianus* and other plants 4

2. Ascospores lacking a sheath, with a hyaline basal dwarf cell, ascospores 12.5-16.5 × 5-7.5 µm .... ***A. nypicola***
2. Ascospores with a sheath, without a basal dwarf cell. 3

3. Ascospores 11.5-17 × 4.5-5.5 µm, inequilaterally ellipsoidal, thin sheath, full length germ slit. ....***A. nypae***
3. Ascospores 12.18 × 5.5-7.5 µm, inequilaterally broadly ellipsoidal, thin sheath, full length germ slit .... ***A. nypensis***

4. Ascospores longer than 15µm, inequilaterally broadly ellipsoidal, thin sheath, full length germ slit, 16.5-23 × 13.5-15.5 µm, on *Spartina alterniflora* ....***A. spissitecta***
4. Ascospores shorter than 15 µm, and narrower than 8.5 µm 5

5. Ascospores 10-15 × 4-7 µm, on *Juncus roemerianus* ....***A. poecila***
5. Ascospores 13-15 × 5.5-7 µm, with a well developed gelatinous appendage on *J. roemerianus* .... ***A. torosa***

Astrocystis Berk. & Broome, J. Linn. Soc. Bot. **14**: 123, 1873 .... (2)

A. nypae G.J.D. Sm. & K.D. Hyde, Fungal Diver. **7**: 93, 2001.

A. selangorensis G.J.D. Sm. & K.D. Hyde, Fungal Diver. **7**: 104, 2001.

Ascomata erumpent, mammiform, globose to subglobose, ostiolate, minutely papillate, black, carbonaceous, solitary or gregarious, paraphyses hypha-like, septate, in a gelatinous matrix, asci cylindrical, short pedunculate, apical apparatus J+, ascospores ellipsoidal, unicellular, golden brown to dark brown, germ slits run more or less the length of the spore, no sheaths or appendages to the marine species (Smith and Hyde, 2001) (Fig. 60). *Astrocystis* is similar to *Rosellinia*, but differs in ascus and ascospore morphology, asci in *Astrocystis* have short stipes and ascus apparatus is small, while in *Rosellinia* the ascus stipe is long with a massive barrel shaped ascus apparatus. A number of *Astrocystis* species have been described from terrestrial palms (Smith and Hyde, 2001).

The two species listed here have been described from the brackish water palm, *Nypa fruticans* in Kuala Selangor, Malaysia. Although there is no molecular data for the marine *Astrocystis* species, *Astrocystis eleiodoxae* (a peat swamp species) is well placed in the Xylariaceae (Pinnoi *et al*., unpublished data).

1. Stromata splitting stellately, ascospores 8-10 × 3-5 µm, golden brown, germ slit 4/5 of total length......... ....***A. nypae***
1. Stromata not splitting stellately, ascospores 15-19 × 7.5-9 µm, light brown to reddish brown, germ slit whole length of the spore .... ***A. selangorensis***

Fasciatispora K.D. Hyde, Trans. Mycol. Soc. Jpn. **32**: 265, 1991 .... (2)

F. lignicola Alias, E.B.G. Jones & Kuthub., Mycotaxon **52**: 78, 1994.

F. nypae K.D. Hyde, Trans. Mycol. Soc. Jpn. **32**: 267, 1991 (*Type species*).

Stroma dark coloured beneath the host epidermis. Ascomata immersed beneath the stroma, globose, ostiole periphysate, paraphyses persistent, septate, rarely branched, asci cylindrical, unitunicate, thin-walled, with a J+ apical apparatus, ascospores unicellular, ellipsoidal, yellow brown to brown, with a central pallid band and polar gelatinous appendages. *Fasciatispora* was assigned to the Amphisphaeriaceae (Hyde, 1991c, 1995b), but molecular data place *F. petraki* in the Xylariaceae.

1. Ascospores with polar gelatinous appendages, 11.6-17 × 5.6-7.1 ....***F. nypae***
1. Ascospores lacking polar appendages, 8.4-14.9 × 3.9-7.5 µm ....***F. lignicola***

Halorosellinia Whalley, E.B.G. Jones, K.D. Hyde & Laessøe, Mycol. Res. **104**: 368, 2000. .... (1)

◙ ***H. oceanica*** (S. Schatz) Whalley, E.B.G. Jones, K.D. Hyde & Lassøe, Mycol. Res. **104**: 370, 2000 (*Type species*).

Hypoxylon oceanicum Schatz, Mycotaxon **33**: 413, 1988.

Pseudostroma on decorticated wood, single or/in clusters of up to 30 uniperitheciate pseudostroma, ascomata immersed in pseudostroma, subglobose to hemispherical, soft to leathery, ostiolate, papillate, paraphyses numerous, persistent, asci cylindrical unitunicate, J+ ascus tip, ascospores ellipsoidal, dark grey-olive to brown, wall smooth, germ slit straight, half to three quarters total length of spore, without a sheath or appendages.

Halorosellinia oceanica was separated from *Hypoxylon* as it did not meet the criteria for that genus: 1. *Nodulisporium* anamorph; 2. Stromata unipartite, 3. Stromatal tissue below the perithecial layer solid and homogenous and 4. Stromata not upright (Whalley *et al*., 2000). Molecular data indicate a relationships with *Xylaria hypoxylon* (18S, 28S sequences and combined 18S and 28S data set) rather than the genus *Hypoxylon* (Smith *et al*., 2003). However, ITS-5.8S-ITS2 sequences support a relationship with *Astrocystis eleiodoxae* with good support and a sister clade which includes *X. hypoxylon* (Pinnoi *et al*., unpublished data) *Halorosellinia oceanica* produces a wide range of bioactive compounds, including cytochalasins, which is consistent with a taxonomic affinity to *Rosellinia* and *Xylaria* (Whalley and Edwards, 1987; Schlinghgam *et al*., 1998, Li *et al*., 2001). It is world wide in its distribution in tropical mangrove habitats. A *Nemania* species occurs frequently in mangrove habitats and this can be confused with *H. oceanica,* but differs in the smaller size of the ascospores and a pronounced decolourization of the wood around the ascomata.

Nemania Gray, Nat. Arr. Brit. Pl. (London) **1**: 516, 1821, emend. Pouzar, Ceská Mykologie **39**: 16, 1985 .... (1)

◙ ***N. maritima*** Y.M. Ju & J.D. Rogers, Nova Hedw. **74**: 102, 2002.

Stromata scattered, subglobose or globose enclosing 1-many ascomata that are carbonaceous, ostiolate, dark brown, asci cylindrical, short pedunculate, with a J+ apical ring, ascospores ellipsoidal, with broadly rounded end, unicellular, light brown to brown, with a straight germ slit the length of the spore (Fig. 61). A species from *Kandelia candel* mangrove wood collected in Taiwan (Ju and Rogers, 2002) and widely collected in subtropical mangroves (Jones and Abdel-Wahab, 2005). This species can be confused with *Halorosellinia oceanica* as both grow in the same habitat, but the ascospores of *N. maritima* are much smaller 9-12 × 5-6 (-6.5) µm with rounded ends and a germ slit shorter than the spore length. Unlike *H. oceanica* this species is reported to produce the teleomorph in culture but no anamorph has been encountered. Ju and Rogers (2002) believe this species could be segregated to a new genus, but did not elaborate on the grounds for this. Tang *et al*. (2007b) in ITS-RPB2 sequences show that *N. maritima* is placed in the Xylarioideae clade and *Nemania* subclade, being basal to other species. *Xylaria hypoxylon* is nested in the other subclade with *X. grammica* and a *Xylaria* sp. Pinnoi, *et al*. (unpublished data) in an ITS dataset also shows that *N. maritima* is

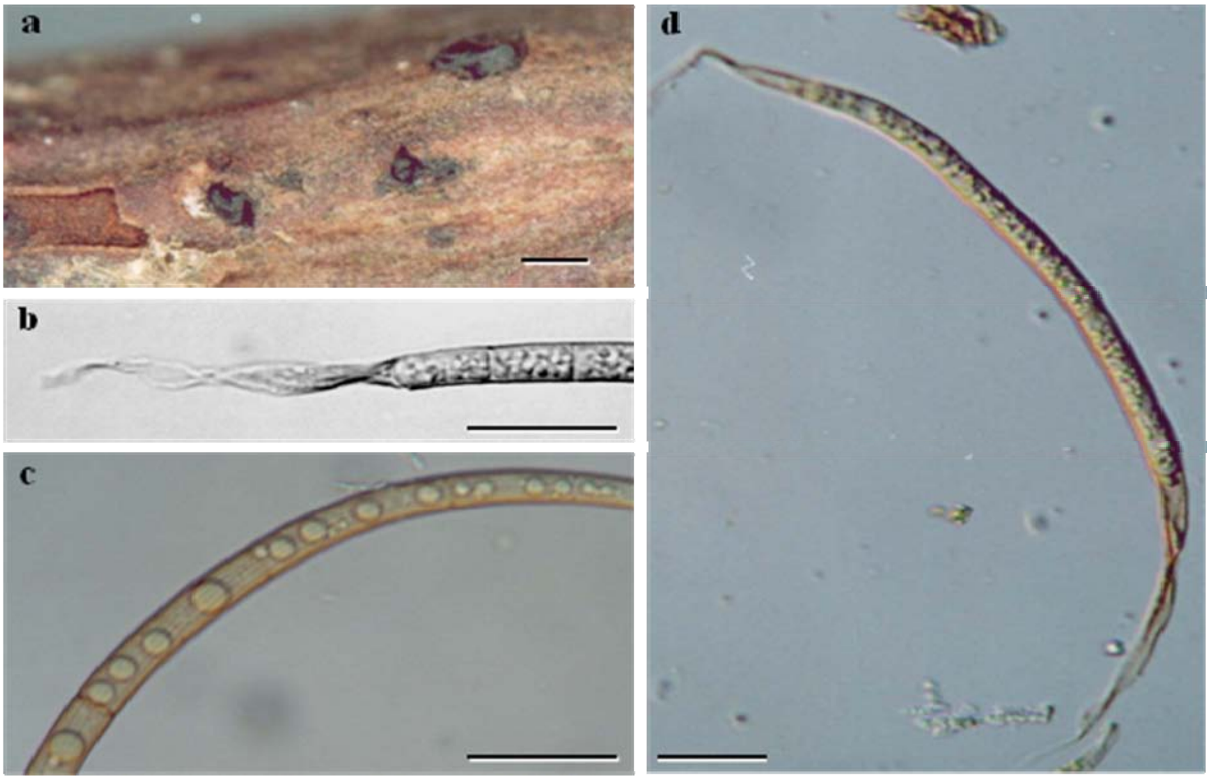


Fig. 58. Morphological features of *Pedumispora rhizophorae*. **a**. Exposed ascomata on wood surface. **b, d**. Filiform ascospores tapering towards both ends. **c**. Longitudinal striations on the ascospore cell wall. Bars a = 1 mm; b-d = 20 µm**.**

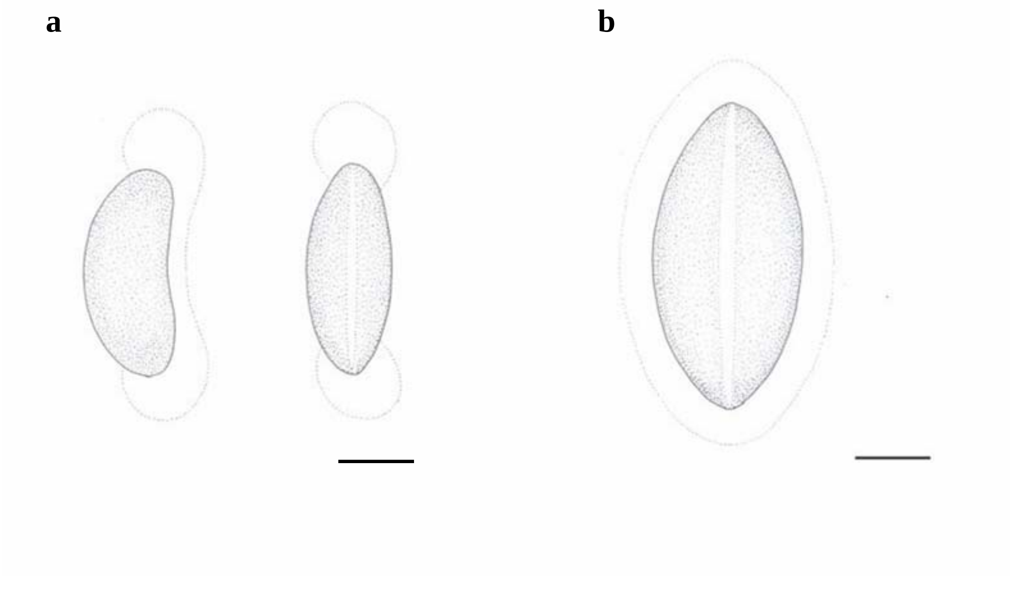


Fig. 59. Ascospores: **a.** *Anthostomella torosa*. **b.** *A. spissitecta*. Bars = 5 µm.

well placed in the *Nemania* clade with high bootstrap support. However, it groups with *N. confluens* with high support, in a sister clade to other *Nemania* species.

This species is also known from Hong Kong and Malaysia and is possibly widespread in its distribution. The fungus was collected at four sites in Hong Kong: Three Fathom Cove, Ting Kok, Ho Chung and Mai Po. It was recorded as the most common species at these four sites colonizing 14% of the total number of samples (Abdel-Wahab and Jones, unpublished data). The Hong Kong material had asci that measure 82-108 × 7.5-10 µm ($\bar{x}$ = 93.5 × 7.7 µm, n = 20), with a subapical ring and inverted cap in shape, ascospores 9-10 × 5 µm ($\bar{x}$ = 9.6 × 5 µm, n = 40). Figure 61, illustrates material collected in Hong Kong.

Nipicola K.D. Hyde, Cryptog. Bot. **2**: 330, 1992... (2)
N. carbospora K.D. Hyde, Cryptog. Bot. **2**: 330, 1992 (*Type species*).
N. selangorensis K.D. Hyde, Sydowia **46**: 262, 1994.

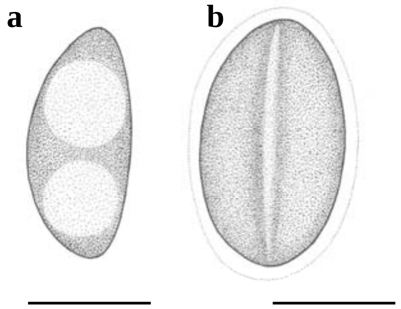


Fig. 60. Ascospores of **a**. *Astrocystis nypae*. **b.** *A. selangorensis*. Bars = 5 µm.

Ascomata formed under the host surface under slightly raised areas, or under a reduced blackened clypei, globose to subglobose, ostiolate, paraphyses amphisphaeriaceous, asci broadly cylindrical, short pedunculate, subapical ring J-, ascospores lunate, unicellular, dark brown to black, with or without a germ slit, with well developed gelatinous sheaths. The two marine species occur on the intertidal palm *Nypa fruticans*, with black lunate ascospores, with a layered mucilaginous sheath and appendages at the ends. It differs from *Anthostomella* in lacking a J+, subapical ring and in its black ascospores (Hyde and Taylor, 1996).

1. Ascospores 17-20 × 4-6 µm, appendages are part of an elaborate sheath drawn out at each end, clypeus poorly developed, ascus ring J-...........***N. carbospora***
1. Ascospores 16-18 × 5-6 µm, germ slit along the entire length of the spore, elaborate mucilaginous sheath, clypeus well-developed, ascal ring J+ ....***N. selangorensis***

XYLARIALES *incertae sedis*

Adomia S. Schatz, Trans. Br. Mycol. Soc. **84**: 555, 1985... (1)
A. avicenniae S. Schatz, Trans. Br. Mycol. Soc. **84**: 555, 1985 (*Type species*).

Ascomata ampulliform to subglobose, immersed, brown, ostiolate, clypeate, periphysate, paraphyses broad, asci cylindrical, unitunicate, thin-walled, deliquescent with a persistent apical cap, ascospore ellipsoidal, brown, unicellular, with an appendage at one end of the spore. This poorly known species was described from material collected in Australia and the Red Sea, Egypt, on *Avicennia marina*, and referred to the Phyllachorales (Schatz, 1985). It has recently been collected in New Zealand and Thailand (Lintott and Lintott, 2002; Jones *et al*., 2005). Collections in Thailand were on *Avicennia marina* pneumatophores.

Lanceispora Nakagiri, Okane, Tad. Ito & Katum., Mycoscience **38**: 208, 1997 .... (1)
L. amphibia Nakagiri, Okane, Tad. Ito & Katum., Mycoscience **38**: 208, 1997 (*Type species*).

Ascomata globose to subglobose, immersed, olivaceous to olivaceous black, ostiolate, papillate, necks lacking periphyses, paraphyses filiform, branched, septate, hyaline, asci cylindrical, unitunicate, long pedunculate, apical ring K+, ascospores oblanceolate, hyaline, rounded apical part, tapering towards the lower end, 1-septate, above the spore middle, lacking a sheath or appendages.

A genus referred by Nakagiri *et al*. (1997) to the Amphisphaeriaceae while Kirk *et al*. (2001) are of the opinion it is close to *Ceriospora*-*Urosporellopsis*. Only one species has been reported from marine habitats while *L. phyllophila* has been described from the petiole of an unidentified dicotyledonous species in leaf litter (Sarma and Hyde, 2001). Assignment to family is unresolved: originally referred to the Amphisphaeriaceae because of its affinities with *Leiosphaerella* (Nakagiri *et al*., 1997), while Barr (1994) thought the latter genus should be assigned to the Hyponectriaceae. Wang and Hyde (1999) rejected this while Kang *et al*. (1999b) suggested the Clypeosphaeriaceae for *Leiosphaerella* and *Oxydothis*. Since *Lanceispora* has much in common with *Leiosphaerella* then this family should be considered, but further molecular studies of this complex is required before final assessment can be made.

Linocarpon Syd. & P. Syd., Ann. Mycol. **15**: 210, 1917..(6)
L. angustatum K.D. Hyde & Alias, Mycoscience **40**: 145, 1999.
◙ ***L. appendiculatum*** K.D. Hyde, Trans. Mycol. Soc. Jpn. **29**: 339, 1989.
L. bipolare K. D. Hyde, Sydowia **44**: 38, 1992.
L. longisporum K. D. Hyde, Sydowia **44**: 44, 1992.
L. nipae (Henn.) K.D. Hyde, Trans. Mycol. Soc. Jpn. **29**: 346, 1989.
Ophiobolus nipae Henn. Hedwigia **49**: 297, 1908.

Pseudostroma black, ascomata circular, lenticular, dome-shaped, beneath the pseudostroma, ostiolate, short papilla may be present, paraphyses filamentous, smooth, septate, hyaline, in a gelatinous matrix, asci cylindrical, pedunculate, truncate at the apex, with J- ring, ascospores filiform, hyaline, slightly curved or straight, apically gelatinous caps or pad-like appendages at both ends (Hyde, 1988; Hyde and Alias, 1999). This genus is common on *Nypa fruticans* and mangrove wood in tropical locations (Hyde and Alias, 1999; Poonyth *et al*., 2000a). Ascospores are filiform to needle-shaped, hyaline, and unicellular, often with polar pad-like appendages or a mucilaginous sheath**.** Ultrastructure studies of *L. appendiculatum* show that the asci are thin-walled (*ca*. 70 nm thick) with a C-shaped apical ring with subapical projections into the epiplasm, ascospores at their tips have a collar-like structure that encloses microfibrils. Appendages are hair-like, wavy, and separate fibrils are surrounded by a thin membrane, which is also present in the ascospores of *L. nypae* (Poonyth *et al*., 2000a). It was referred to the Hyponectriaceae by Hawksworth *et al*. (1995), although Wang and Hyde (1999) excluded it from this family.

1. Ascospores needle-shaped, lacking appendages, 57.5-87.5 × 3.5-6 µm .... ***L. angustatum***
1. Ascospores filamentous with appendages................2

2. Ascospores with appendages at both ends, 90-139 × 2-3 µm.. ***L. bipolare***
2. Ascospores with a single appendage........................3

3. Ascospores C-shaped or sigmoid, one end rounded, one end tapering with mucilage, 124-140 × 2.5-3 µm ....***L. longisporum***
3. Ascospores not markedly curved 4

4. Ascospores 75-120 × 2-3.5 µm, with thistle-shaped appendage, on mangrove wood................................. ....***L. appendiculatum***
4. Ascospores 91-124 × 3.5-4 µm, with a mucilaginous pad at one end, on mangrove wood.............***L. nypae***

Neolinocarpon K.D. Hyde, Bot. J. Linn. Soc. **110**: 104, 1992 .... (2)
◙ ***N. globosicarpum*** K.D. Hyde, J. Linn. Soc., Bot. **110**: 104, 1992.
N. nypicola K.D. Hyde & Alias, Mycoscience **40**: 148, 1999.

Ascomata immersed in the host, oval to subglobose, ostiolate, coriaceous, black, neck short with periphyses, paraphyses tapering, septate, simple, longer than the asci, asci long cylindrical, pedunculate, unitunicate, thin-walled, ring-like refractive apical apparatus, ascospores filiform, straight or curved, hyaline, unicellular, with apical cap-like mucilaginous appendages. This genus marginally differs from *Linocarpon,* and molecular data are required to resolve its taxonomic affinities. A second *Neolinocarpon* species has been described from the dead aerial rachids of *Nypa fruticans* (Hyde and Alias, 1999*)*. They differ as follows: *Neolinocarpon* has deeply immersed ascomata forming below a slightly raised or flattened clypeus and with a refractive globose body below the apical ascus ring, while *Linocarpon* has ascomata that are superficial or slightly immersed and lack a

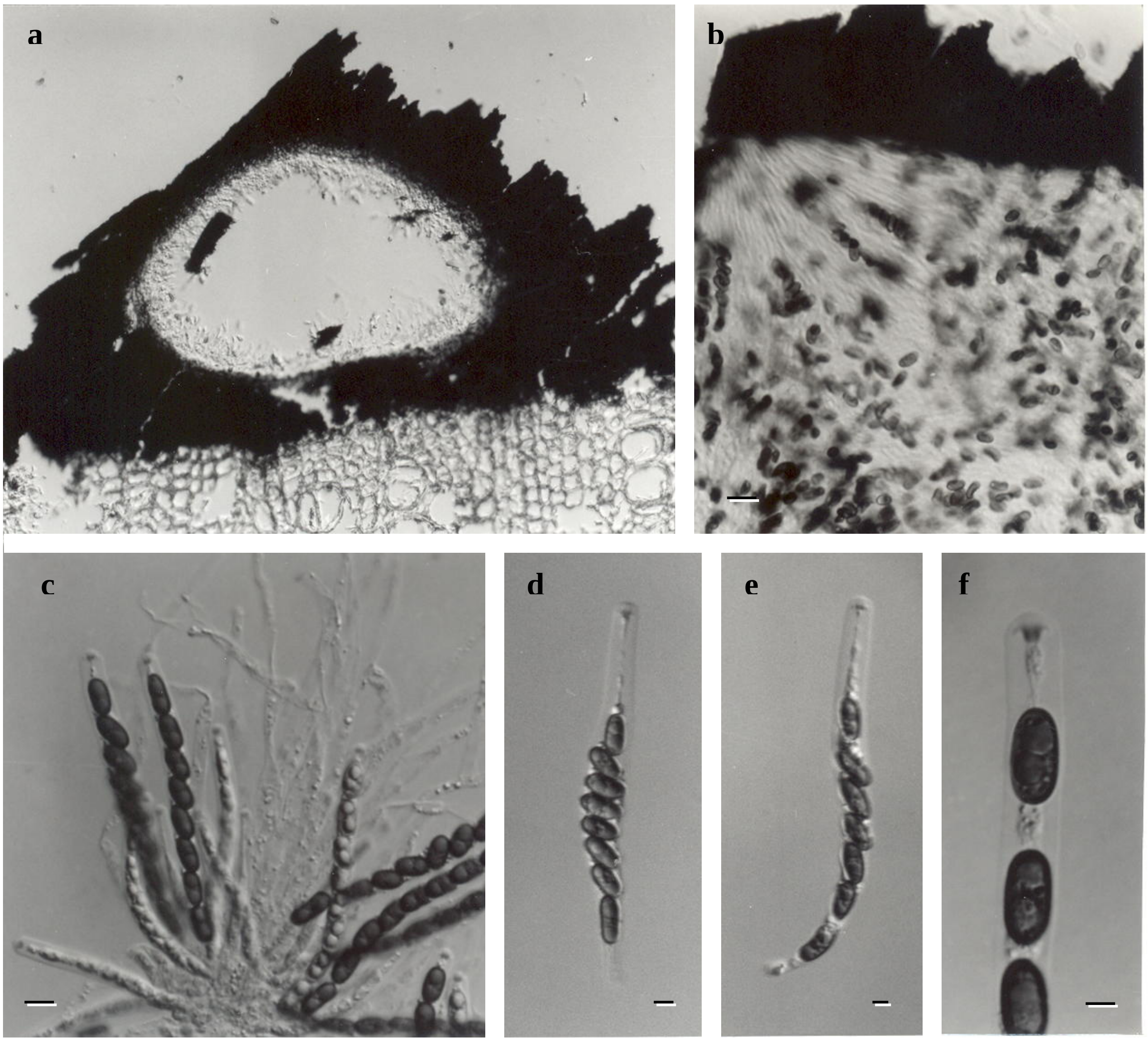


Fig. 61. *Nemania maritima*. **a.** Section through ascoma on superficial wood. **b.** Apical region of the ascoma with asci and paraphyses. **c.** Asci and paraphyses. **d-f**. Asci with eight ascospores and prominent ring. Bars a = 100 µm, b = 10 µm, c = 10 µm, d-f = 4 µm. (**Photos by M.A. Abdel-Wahab**).

refractive globose body (Yanna *et al*., 2003). Ultrastructure studies of selected *Linocarpon* and *Neolinocarpon* species failed to yield characters for the delineation of the genera (Yanna *et al*., 2003). Currently the genus can not be assigned to any family within the Xylariales.

1. Ascomata formed under a clypeus, solitary, ascospores 70-119 × 2-3 µm ....***N. globosicarpum***
1. Ascomata deep within a stroma, ascospores 92-117 × 2-4 µm.. ***N. nypicola***

Oxydothis Penz. & Sacc., Malpighia **11**: 505, 1898.. (2)
O. nypae K.D. Hyde & Nakagiri, Trans. Mycol. Soc. Jpn. **30**: 70, 1989.
O. nypicola K.D. Hyde, Sydowia **46:** 298, 1994.

Ascomata beneath the host epidermis, globose to subglobose, ostiolate, periphysate, brown to black gregarious, paraphyses numerous, filamentous, hyaline, asci cylindrical, pedunculate, unitunicate, thin-walled, with an apical ring J+, ascospores filiform, straight or curved, hyaline, 0-1-septate, not constricted at the septum, with mucilage at the tip of the spore (Hyde and Nakagiri, 1989). Both species occur on ageing or cut fronds of the palm *Nypa fruticans* that have fallen into the water and are well placed in the genus. *Oxydothis nypae* appears to be the most common species, recorded from a variety of collections (Hyde and Alias, 2000; Pilantanapak *et al.*, 2005). Kang *et al.* (1999a) referred the genus to the Clypeosphaeriaceae.

1. Ascospores 1-septate, diameter more than 6 µm, 74-92 µm long, fusiform, with apiculate ends................ .... ***O. nypicola***
1. Ascospores 0-septate, diameter less than 6 µm, 82-113 µm long, ends rounded with mucilage .... ***O*. *nypae***

Phomatospora Sacc., Grevillea **4:** 22, 1875.(6)
P. acrostichi K.D. Hyde, Trans. Br. Mycol. Soc. **90**: 135, 1988.
◙ ***P. bellaminuta*** Kohlm., Volkm.-Kohlm. & O.E. Erikss., Bot. Mar. **38**: 181, 1995.
P. kandeliae K.D. Hyde, Trans. Mycol. Soc. Jpn. **33**: 315, 1992.
P. nypae K.D. Hyde, Sydowia **45**: 200, 1993.
P. nypicola K.D. Hyde & Alias, Mycol. Res. **103**: 1417, 1999.
P. phragmiticola Poon & K.D. Hyde, Bot. Mar. **41**: 148, 1998.

Ascomata globose to subglobose, immersed, pale brown to black, membranous, ostiolate, short papillate, solitary, necks periphysate, paraphyses hypha-like, straight, septate, tapering distally, numerous, asci cylindrical, unitunicate, thin-walled, pedunculate, with a J+ refractive ring, ascospores unicellular, ellipsoidal, hyaline, with longitudinal striae and with or without polar appendages. A genus frequently encountered on mangrove wood, *Nypa fruticans, Phragmites australis* and the fern *Acrostichum speciosum*, while other species await description (Jones, unpublished data). Cai *et al.* (2006) refer the genus to Soradriomycetes *incertae sedis,* but suggest that 18S rDNA sequences indicate a close relationship to the Magnaporthaceae. This hypothesis requires further study to determine assignment to a family and an order.

1. Ascospores lacking an appendage......... ***Ph. nypicola***
1. Ascospores appendaged.. 2

2. Appendages at both ends... 3
2. Appendages at one pole 5

3. Ascospore appendages pad-like ....***Ph. bellaminuta***
3. Ascospore appendages bifurcate 4

4. Ascospores 6.5-9.5 µm, on *Nypa* ....***Ph. nypae***
4. Ascospores 7.5-1.5 µm, on *Phragmites* .... ***Ph. phragmitensis***

5. Ascospore appendages prominent, ascospores 6-7 × 2-3 µm, on a fern................................ ***Ph. acrostichi***
5. Ascospore appendages indistinct, ascospores large, 11.5-16 × 5.5-8 µm, on mangrove wood.................... ....***Ph. kandeliae***

SORDARIOMYCETES *incertae sedis*

1. Ascomata perithecial, non-stromatic, ostiolate, papillate with long necks, coriaceous to carbonaceous, paraphyses, asci variable, thin-walled, deliquescing early, ascospores variable, fusiform, ellipsoidal, filiform, generally with end-chambers containing mucilage, anamorphs generally dermatiaceous hyphomycetes ....**Lulworthiales**
1. Ascomata perithecial, immersed in host tissue, subiculate or without subiculum, periphysate, paraphysate, asci clavate to fusiform, unitunicate, deliquescing, ascospores septate, hyaline, thick-walled, no apical chambers or sheaths ....**Koralionastetales**
1. Ascomata perithecial, immersed in host tissue, often clypeate, ostioles periphysate, paraphyses wide thin-walled, asci cylindrical, persistent with inconspicuous I-apical ring, ascospores aseptate, anamorph coelomycetes.................... **Phyllachorales**
1. Ascomata perithecial, ostiolate, immersed or superficial, often staining the substratum, paraphysate, paraphyses wide at the base tapering apically, asci cylindrical, unitunicate, ascospores septate, often filiform, hyaline, yellow to brown .... **Magnaporthales**

1. LULWORTHIALES

Key to the genera

1. Ascospores with apical chambers or appendages 2
1. Ascospores lacking appendages......................***Lindra***

2. Ascospores 0-septate.. 3
2. Ascospores septate 7

3. Ascospores filiform.. 6
3. Ascospores fusiform, ellipsoidal.............................. 4

4. Ascospore appendages tubular longer than 35µm ....***Kohlmeyeriella***
4. Ascospore appendages apiculate or conical, less than 35 µm long.. 5

5. Ascomata superficial, with sterile hairs, parasitic on red algae... ***Spathulospora***
5. Ascomata immersed in a gall, lacking sterile hairs, on brown algae.....................................***Haloguignardia***

6. Ascomata with bell-like structure within the centrum ....***Rostrupiella***
6. Ascomata lacking the bell-like structure..***Lulworthia***

7. Ascospores 1-septate.................................***Lulwoana***
7. Ascospores many times septate.................***Lulwoidea***

Lulworthiaceae

Kohlmeyeriella E.B.G. Jones, R.G. Johnson & S.T. Moss, Bot. J. Linn. Soc. **87**: 210, 1983...(2)

◙ ***K. crassa*** (Nakagiri) Kohlm., Volkm,.-Kohlm., J. Campb., Spatafora & Gräfenhan., Mycol. Res. **109**: 564, 2005.

Lulworthia crassa Nakagiri, Trans. Mycol. Soc. Jpn. **25**: 378, 1984.

◙ ***K. tubulata*** (Kohlm.) E.B.G. Jones, R.G. Johnson & S.T. Moss, J. Linn. Soc. Bot. **87**: 208, 1983 (*Type species*).

Corollospora tubulata Kohlm., Ber. Dtsch. Bot. Ges. **81**: 53, 1968.

Ascomata subglobse, superficial, subiculate, ostiolate, papillate, subcarbonaceous, black, solitary often associated with sand, asci fusiform to clavate, unitunicate, thin-walled, deliquescing early, ascospores unicellular, fusiform, curved, hyaline, thick-walled, with long polar appendages, with an apical pore from which a drop of mucilage is released. This genus, like *Lulworthia,* has ascospores with end chambers that are long and filled with mucilage, which is released at maturity as a drop, which aids in spore attachment (Jones, 1994). Initially described as a *Corollospora* species, it was subsequently transferred to the new genus *Kohlmeyeriella* based on TEM observations (Jones *et al*., 1983a). Molecular data shows it has no affinities with the Halosphaeriales and has been transferred to the Lulworthiales (Campbell *et al*., 2005). Sequence data shows that *Lulworthia crassa* groups with *K. tubulata* and has thus been transferred to this genus (Campbell *et al*., 2005) (Fig. 62).

1. Ascospores narrow, 140-205 × 5-8 µm.......***K. crassa***
1. Ascospores wider, 137-152 × 17.5-18.5 µm...***K. tubulata***

Lindra I.M. Wilson, Trans. Br. Mycol. Soc. **39**: 411, 1956.. (5)

◙ ***L. crassa*** (Kohlm.) Kohlm. & Volkm.-Kohlm., Bot. Mar. **34**: 23, 1991.

L. hawaiiensis Kohlm. & Volkm.-Kohlm., Can. J. Bot. **65**: 574, 1987.

L. inflata I.M. Wilson, Trans. Br. Mycol. Soc. **39**: 411, 1956 (*Type species*).

◙ ***L. obtusa*** Nakagiri & Tubaki, Mycologia **75**: 488, 1983.

Anamorph: *Anguillospora marina* Nakagiri & Tubaki

◙ ***L. thalassiae*** Orpurt, Meyers, Boral & Simms, Bull. Mar. Sci. Gulf Caribb. **14**: 406, 1964.

L. marinera Meyers, Mycologia **61**: 488, 1969.

Ascomata semiglobose or ellipsoidal, immersed, carbonaceous to subcarbonaceous, black, ostiolate, papillate or epapillate, solitary or gregarious, asci cylindrical to clavate, unitunicate, thin-walled, deliquescing early, lacking an apical apparatus, ascospores filiform, many times septate (up to 50), not constricted at the septa, with a globose to semiglobose gelatinous appendage on wood. Species on seagrasses with coriaceous ascomata immersed in the host, and lacking an apical swelling or appendage. Molecular data indicate that this genus is distantly related to the Halosphaeriales and Kohlmeyer et *al*. (2000) have assigned it to the Lulworthiales.

The genus appears to be polyphyletic with *Lindra obtusa* forming a basal group to the order, while *L. crassa* and *L. marinera* are distantly placed within the Lulworthiales (Campbell *et al*., 2005) (Fig. 62). *Lindra inflata,* the type species, needs to be sequenced before further taxonomic changes are undertaken. Morphologically *L. inflata* differs from *L. marinera* and *L. thalassiae* in the deeply embedded carbonaceous ascomata in wood, thick-walled peridium, ascospores 30-50-septate with a globose swelling gelatinous apical appendage (Wilson, 1956).

1. Ascospores markedly swollen at their tips, 30-51-septate, 210-415 × 4-6 µm, on wood ....***L. inflata***
1. Ascsopores not markedly swollen at their tips.........2

2. Ascospores more than 8 µm wide, 320-520 µm, 15-23-septate, on marine angiosperms and algae.. ***L. crassa***
2. Ascospores less than 8 µm wide, septa fewer than 30 3

3. Ascospores longer than 230 µm, 230-390 × 3-6 µm, on sea grasses....................................... ***L. thalassiae***
3. Ascospores shorter than 230 µm, on other hosts...... 4

4. Ascospores narrower than 3.5 µm, 182-313 × 2.5-3.5 µm, forming subicula on a hard surface (sand)...***L. obtusa***

4. Ascospores 101-188 × 3.5-5.5 µm, 8-18-septate, in wood.. ***L. hawaiiensis***

Lulwoana Kohlm., Volkm.-Kohlm, J. Campb., Spatafora & Gräf., Mycol. Res. **109**: 62, 2005. .... (1)

◙ ***L. uniseptata*** (Nakagiri) Kohlm., Volkm.-Kohlm, J. Campb., Spatafora & Gräfenhan., Mycol. Res. **109**: 562, 2005 (*Type species*).

Lulworthia uniseptata Nakagiri. Trans. Mycol. Soc. Jpn. **25**: 382, 1984

Anamorph: *Zalerion maritima* (Linder) Anastasiou

Ascomata superficial or immersed, globose to subglobose, ostiolate, coriaceous, dark brown or black, neck short, asci fusiform, curved in the ascoma, unitunicate, thin-walled, deliquescing early, ascospores filiform, hyaline, 1-septate, with conical end chambers containing mucilage which is released as a drop when mounted in water and forms an adhesive pad for attachment of the ascospores. A genus erected based on a single morphological character of a 1-septate ascospore, a *Zalerion maritima* anamorph and sequence data (Campbell *et al*., 2005) (Fig. 62).

Lulwoidea Kohlm., Volkm.-Kohlm, J. Campb., Spatafora & Gräfenhan., Mycol. Res. **109**: 564, 2005.. (1)

◙ ***L. lignoarenaria*** (Jørg. Koch & E.B.G. Jones) Kohlm., Volkm.-Kohlm., J. Campb., Spatatfora & Gräfenhan., Mycol. Res. **109**: 564, 2005 (*Type species*).

Lulworthia lignoarenaria Jørg. Koch & E.B.G. Jones, Mycotaxon **20**: 389, 1984.

Ascomata superficial, generally attached to sand grains by subicula, subglobose to ellipsoidal, carbonaceous, asci clavate, pedunculate, unitunicate, thin-walled, deliquescing early, ascospores filiform, hyaline, multiseptate, with polar end chambers filled with mucilage which is released through a pore at maturity when in water. Another genus erected based on sequence data and a single morphological character of ascospores with numerous septa (31-38). A species generally found on sand grains associated with buried wood (Koch and Jones, 1984).

Lulworthia G.K. Sutherl., Trans. Br. Mycol. Soc. **5**: 259, 1916 .... (11)

L. calcicola Kohlm. & Volkm.-Kohlm., Mycologia **81**: 289, 1989.

L. curalii (Kohlm.) Kohlm. & Volkm.-Kohlm., Bot. Mar. **34**: 24, 1991.

Lulworthia kniepii var. *curalii* Kohlm., Mar. Ecol (P.S.Z.N.I.) **5**: 361, 1984.

◙ ***L. fucicola*** G.K. Sutherl., Trans. Br. Mycol. Soc. **5**: 259, 1916 (*Type species*).

Lulworthia medusa var. *fucicola* (G.K. Sutherl.) Booth, Can. J. Bot. **61**: 500, 1983.

L. halima (Diehl & Mounce) Cribb & J.W. Cribb, Univ. Queensl., Pap. Dept. Bot. **3**: 80, 1955.

Ophiobolus halimus Diehl & Mounce, Can. J. Res. **11**: 242, 1934.

Halophiobolus halimus (Diehl & Mounce) Linder, Farlowia **1**: 419, 1944.

Linocarpon halimum (Diehl & Mounce) Petr., **6**: 388, 1952.

L. floridana Meyers, Mycologia **49**: 515, 1957.

◙ ***L. grandispora*** Meyers, Mycologia **49**: 513, 1957.

L. kniepii Kohlm., Nova Hedw. **6**: 140, 1963.

Ophiobolus kniepii Ade & Bauch, Publ. Statzione Napoli **15**: 389, 1936.

L. lindroidea Kohlm., Bot. Mar. **23**: 537, 1980.

L. longirostris (Linder) Cribb & J.W. Cribb, Univ. Queensl., Pap. Dept. Bot. **3**: 80, 1955.

Halophiobolus longirostris Linder, Farlowia **1**: 418, 1944.

L. medusa (Ellis & Everh.) Cribb & J.W. Cribb, Pap. Dept. Bot. Univ. Qd. **3**: 80, 1955.

Halophiobolus medusa (Ellis & Everh.) Linder, *Farlowia* **1**: 419, 1944.

Linocarpon medusa (Ellis & Everh.) Petr., *Sydowia* **6**: 388, 1952.

Ophiobolus medusae Ellis & Everh., Journal of Mycology **1**: 150, 1885.

◙ ***L. purpurea*** (I.M. Wilson) T.W. Johnson, Mycologia **50**: 154, 1958.

Halophiobolus purpurea I.M. Wilson, Trans Br. Mycol. Soc. **39**: 403, 1956.

Ascomata immersed or superficial, globose or cylindrical depending on the host substratum, ostiolate, papillate, solitary or gregarious, pale brown red to purple to dark brown depending on species, paraphyses absent, asci cylindrical, clavate to fusiform, unitunicate, thin-walled, deliquescing early, ascospores filiform curved, hyaline, with conical end chambers formed from the outgrowth of the episporium and mesosporium, and filled with mucilage which is released through a pore at the tip of the appendage (Jones *et al*., 1983a). Many *Lulworthia* species were originally

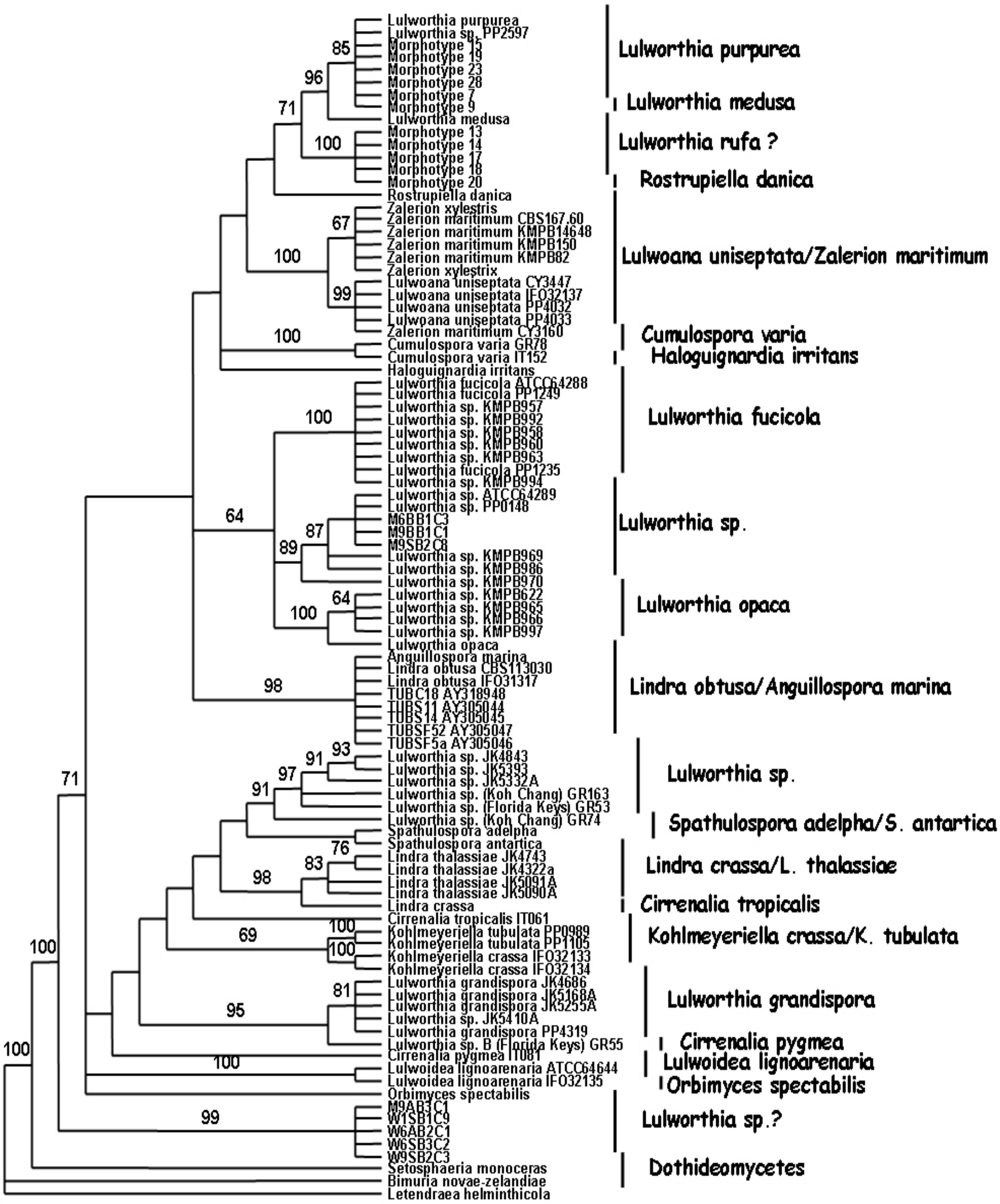


Fig. 62. One of the MPTs inferered from LSU rDNA sequences of all lulworthialean taxa, generated with maximum parsimony anlaysis. Bootstrap values higher than 50% are given above branches.

described by Barghoorn and Linder (1944) as *Halophiobolus*, but subsequently transferred to the earlier taxon *Lulworthia* (Sutherland, 1916b) by Cribb and Cribb (1955). Because of the deliquescing asci and ascospores with an end chamber containing mucilage it was assigned to the Halosphaeriales (Kohlmeyer, 1972a). Kohlmeyer *et al*. (2000) have shown that at the molecular level these species have no affinities with the Halosphaeriales and erected a new order to accommodate them.

Since no type material of *Lulworthia fucicola* could be traced, Campbell (2005) designated a neotype with a *Lulworthia* collection from Chile. However this is a lignicolous strain while *L. fucicola* was described from a brown alga. We do not accept the argument that the significant morphological differences between the algicolous and lignicolous strains are substrate-induced

(Meyers, 1957). Furthermore we reject the synonymy of *Lulworthia cylindrica* with *L. fucicola* (Cribb and Cribb, 1955). Greater efforts must be made to collect *Lulworthia* species from marine algae.

Nakagiri (1984) reviewed the available morphological characters for the separation of the genera *Lindra* and *Lulworthia*: peridial wall structure, ascospore septation, possession of end chambers filled with mucilaginous material and their anamorph conidial development. For their selected examples, only the latter two characters were considered significant at the generic level. Peridial wall structure depends on the habitat of the species: arenicolous species (*L. crassa, L. lignoarenaria*) have a single outer-layer of thick-walled, large cells, but these were not observed in the lignicolous species *(L. uniseptata*). Similar trabeculate carbonaceous outer cells have been observed in *Corollospora besarispora*, another arenicolous fungus (Sundari *et al*., 1996). This demonstrates that the environment can markedly influence the phenology of an ascomycete, as has also been demonstrated for the variability in the length of the necks in *Lulworthia* and *Halosphaeria appendiculata* (Jones, 1962).

The genus has been shown to be polyphyletic based on 18S and 28S sequences analysis and two new genera erected to accommodate species that do not group within the genus *Lulworthia sensu stricto* (Campbell *et al*., 2005). However, further species need to be studied at the molecular level to fully resolve the taxonomic position of the various species. We include three species not recognized by Kohlmeyer and Volkmann-Kohlmeyer (1991a) and Hyde *et al*. (2000): *L. floridana* with ascospores measuring 230-266 × 3.6-5.7 µm and with dark brown ascomata; *L. purpurea* with a thin ascomatal wall comprising only two layers of cells, purplish brown ascomata turning green in lactophenol and median ascospores 185-265 × 3-4 µm and *Rostrupiella danica*, a new species with distinctive inhibition hyphae in the wood and a pad of parenchymatous tissue separating the centrum from the ostiole in the neck (Koch e*t al*., 2007). *Lulworthia purpurea* differs from many *Lulworthia* species in the thin nature of the ascomata, which is only two-layered.

Anamorphs of members of the Lulworthiales include: *Anguillospora marina* (*Lindra obtusa*), *Cirrenalia pygmea*, *Cirrenalia tropicalis*, *Cumulospora varia* and *Orbimyces spectabilis* (all with different *Lulworthia* spp.) and *Zalerion maritima* (*Lulwoana uniseptata*) (Jones *et al*., 2008) (Figs. 62, 63).

As the result of sequence analysis of 18S and 28S a number of transfers have been proposed: *Lulworthia crassa* to *Kohlmeyeriella*, *Lulworthia lignoarenaria* to *Lulwoidea* and *Lulworthia uniseptata* to *Lulwoana* (Campbell *et al*., 2005), but a key to the new genera was not provided. Although there is good molecular support for the separation of *Lulwoidea* and *Lulwoana* from *Lulworthia*, morphological differences are few.

1\. Ascospores 9-12-septate, 170-240 × 4 µm................................ ***L. lindroidea***
1\. Ascospores with no septa.. 2

2\. Lignicolous species.. 3
2\. On other substrata.. 6

3\. Ascospores over 500 µm long (500-756 × 3-5 µm) tropical.. ***L. grandispora***
3\. Ascospores shorter than 500 µm............................. 4

4\. Ascomata deeply embedded in the wood................. 5
4\. Ascomata more superficial, dark brown, 230-266-320 × 3.6-4.2-5.7 µm.................................... ***L. floridana***

5\. Ascospores 155-299 × 3.3-4 µm......... ***L. longirostris***
5\. Ascomata purple in colour, elongate, ascospores 200-350 µm elongate.................................... ***L. purpurea***

6\. Ascomata on coral or coralline algae....................... 7
6\. Ascomata on marine grasses or on *Fucus*................ 9

7\. Ascospores over 200 µm (200-270 × 2.5-6 µm)........ .... ***L. kniepii***
7\. Ascospores shorter than 200 µm............................. 8

8\. Ascospores 80-150 × 5.5-8.5 µm, on coral rock........ .... ***L. calcicola***
8\. Ascospores 120-180 × 4-5 µm, coralline red algae, conch shells, coral reef................................ ***L. curalii***

9\. On the brown alga *Fucus*, ascospores 70-100 (-126) × 4-6 µm .... ***L. fucicola***
9\. On marine grasses... 10

10\. On *Zostera* rhizomes and leaves, ascospores 230-308 × 2-4 µm.. ***L. halima***
10\. On culms of *Spartina* species, ascospores 350-526 µm .... ***L. medusa***

Rostrupiella Jørg. Koch, K.L. Pang & E.B.G. Jones, Bot. Mar. **50**: 294, 2007 .... (1)
R. danica Jørg. Koch, K.L. Pang & E.B.G. Jones, Bot. Mar. **50**: 295, 2007.

Ascomata ellipsoidal-cylindrical, ostiolate, gregarious, deeply embedded, subhyaline, cylindrical neck brown, periphysate, lacking paraphyses or catenophyses, asci cylindrical, short pedunculate, unitunicate, thin-walled, no apical pore, deliquescing early, ascospores hyaline, filiform, tapering towards the poles, 0-septate, curved or twisted, with an apical conoid end-chamber from which mucilage is released in water. Morphological and molecular evidence distinguishes *Rostrupiella* from *Lulworthia fucicola*, the type species of the genus (Koch *et al*., 2007) (Figs. 63, 64).

Morphologically *R. danica* has a bell-like structure that extends from the neck into the centrum and large thin-walled bladder cells, prominent pigmented cells around the neck and in the host wood tissue. A similar structure has been noted in *Haloguignardia irritans*, another member of the Lulworthiales (Kohlmeyer and Kohlmeyer, 1979).

Haloguignardia Cribb & J.W. Cribb, Univ. Queensl., Pap. Dept. Bot. **3**: 97, 1956.......... (5)
H. cystoseirae Kohlm. & Demoulin, Bot. Mar. **24**: 9, 1981.
H. decidua Cribb & J.W. Cribb, Univ. Queensl., Pap. Dept. Bot. **3**: 97, 1956.
◙ ***H. irritans*** (Setch. & Estee) Cribb & J.W. Cribb, Univ. Queensl. Pap. Dept. Bot. **3**: 98, 1956.
Guignardia irritans Setch. & Estee, Univ. Calif., Berkeley, Publ. Bot. **4**: 311, 1913.
H. oceanica (Ferd. & Winge) Kohlm., Mar. Biol. **8**: 344, 1971
Phyllachorella oceanica Ferd. & Winge, Mycologia **12**: 102, 1920.
H. tumefaciens (Cribb & J.W. Herbert) Cribb & J.W. Cribb, Univ. Queensl., Pap. Dept. Bot. **3**: 98, 1956.
Guignardia tumefaciens Cribb & J.W. Herbert, Univ. Queensl., Pap. Dept. Bot. **3(2)**: 9, 1954.
Haloguignardia longispora Cribb & J.W. Cribb, Univ. Queensl., Pap. Dept. Bot. **3(12)**: 98, 1954.

Ascomata subglobose or ellipsoidal, immersed, ostiolate, short papillate, coriaceous, hyaline, periphysate, paraphyses absent, asci ellipsoidal, clavate or cylindrical, thin-walled, unitunicate, deliquescing early, no apical apparatus, ascospores ellipsoidal to fusiform, unicellular, hyaline, with a conical acute chamber at each pole. An unusual genus forming galls on the larger brown algae (*Cystoseira*, *Halidrys*, *Sargassum*) with unicellular, hyaline ascospores with polar cap-like appendages that are divided into a series of chambers containing mucous. Kohlmeyer and Volkmann-Kohlmeyer (2003b) illustrate *H. irritans* with mucous released from the ascospore end chambers through an apical pore. Although they classify the genus in the Phyllachoraceae, Phyllachorales, Inderbitzin *et al*. (2004) have shown that *Haloguignardia irritans* clusters within the *Lulworthia* complex, as a separate branch from the *L. uniseptata* and *L.* cfr *purpurea* clade (Fig. 62.) Clearly further investigations at the ultrastructural and molecular level are required to finally resolve the taxonomic position of the genus.

1. In the brown algae *Cystoseira* or *Halidrys* 2
1. In *Sargassum* species 3

2. Ascospores longer than 60 µm .... ***H. cystoseirae***
2. Ascospores shorter than 60 µm .... ***H. irritans***

3. Ascospores with persistent appendages .... ***H. tumefaciens***
3. Ascospore appendages deciduous 4

4. Ascospores shorter than 35 µm .... ***H. decidua***
4. Ascospores longer thsn 35 µm .... ***H. oceanica***

Spathulosporaceae

Spathulospora A.R. Caval. & T.W. Johnson, Mycologia **57**: 927, 1965 .... (5)
◙ ***S. adelpha*** Kohlm., Mycologia **65**: 615, 1973.
◙ ***S. antarctica*** Kohlm., Mycologia **65**: 619, 1973.
S. calva Kohlm., Mycologia **65**: 622, 1973.
S. lanata Kohlm., Mycologia **65**: 625, 1973.
S. phycophila A.R. Caval. & T.W. Johnson, Mycologia **57**: 927, 1965 (*Type species*).

Thallus crustose on algal host, though not always evident, ascomata subglobose, ovoid, pyriform, subiculate, ostiolate, papillate or epapillate, coriaceous or leathery, dark brown, sterile hairs enclosing ascoma, lacking paraphyses, asci clavate, thin-walled, unitunicate, deliquescing early, ascospores fusiform, cylindrical, ellipsoidal, 0-3-septate, hyaline, with an appendage at each pole. Antheridia, spermatia and trichogynes reported (Kohlmeyer and Kohlmeyer, 1979). All species are parasites of the marine red algal genus *Ballia* (*B. callitrichia*, *B. hirsuta*, *B. scoparia)* often colonizing a single cell of the filamentous thallus. Primarily known from Australia, New Zealand, Antarctic and sub-Antarctic waters, and more recently from Argentina, Chile and Kerguelen and Falkland Islands waters (Kohlmeyer and Kohlmeyer, 1975a). Initially *Spathulospora* was thought to be a primitive ascomycete evolved from a red seaweed ancestor, with its hyaline, unicellular ascospores, conical appendages filled with "mucous", hairs bearing antheridia, simple trichogynes and asci that deliquesce early in development. Sequence data of the genera *Spathulospora* and *Haloguignardia* phylogenetically place them in the Lulworthiales although no formal taxonomic transfer has been undertaken (Inderbitzin *et al*., 2004; Campbell *et al*., 2005) (Figs 62, 63).

1. Ascomata without hairs, ascospores 40-50 × 4-9μm.. .... ***S. antarctica***
1. Ascomata with hairs.. 2

2. Ascospores longer than 65 μm................................ 3
2. Ascospores shorter than 65 μm............................... 4

3. Ascospores less than 14 μm wide, spathulate to spoon-shaped at the apices, 80-100 × 10-13 μm........ ....***S. phycophila***
3. Ascospores wider than 14 μm, conical appendages, 70-104 × 16-23 μm ....***S. adelpha***

4. Ascospore tips spathulate, 39-62 × 8-12 μm, sub-polar appendages... ***S. lanata***
4. Ascospore tips rounded, 45-56 × 14-20 μm, appendages polar.. ***S. calva***

2. KORALIONASTETALES

Koralionastetaceae

This is a new order erected to accommodate the genera *Koralionastes* and *Pontogeneia*, previously not assigned with confidence in any order (Campbell *et al*., 2008). These two genera form a monophyletic clade basal to the Lulworthiales clade. Morphologically they differ in the mature hamathecium, presence of periphyses, (absent in the Lulworthiales) but present in Koralionastetales; and the absence of apical mucous-filled polar appendages in *Koralionastes* and *Pontogeneia*.

Key to the genera

1. On coral rock, associated with crustose sponges .... ***Koralionastes***
1. On algae..***Pontogeneia***

Koralionastes Kohlm. & Volkm.-Kohlm., Mycologia **79**: 765, 1987............................. (5)
K. angustus Kohlm. & Volkm.-Kohlm., Mycologia **79**: 768, 1987.
K. ellipticus Kohlm. & Volkm.-Kohlm., Mycologia **79**: 765, 1987.
K. giganteus Kohlm. & Volkm.-Kohlm., Can. J. Bot. **68**: 1554, 1990.
K. ovalis Kohlm. & Volkm.-Kohlm., Mycologia **79**: 765, 1987 (*Type species*).
K. violaceus Kohlm. & Volkm.-Kohlm., Can. J. Bot. **68**: 1556, 1990.

A unique group of fungi occurring on coralline-coated rocks and sponges, known from the Atlantic Ocean, Belize, Central America (Kohlmeyer and Volkmann-Kohlmeyer, 1987b) and Pacific Ocean, Queensland, Australia (Kohlmeyer and Volkmann-Kohlmeyer, 1990b). Characterised by large ascomata (500-1220 μm diam.), simple septate paraphyses, clavate asci, short pedunculate, deliquescing at maturity, no apical apparatus, ascospores hyaline, thick-walled and septate near the apices, no appendages, with spermatia.

1. Ascospores ovoid, peridium 3-4 strata..................... 2
1. Ascospores ellipsoidal, peridium 2-3 strata 3

2. Ascospores 4-septate (1-6), 94-131 × 50-77 μm, peridium 4 strata, 30-60 μm.........................***K. ovalis***
2. Ascospores 2-septate (2-6), 123-170 × 61-89 μm, peridium 3 strata, 125-190 μm...............***K. giganteus***

3. Ascospores 4 septate (3-6), 85-130 × 25-34 μm, peridium 3 strata, 50-70 μm................... ***K. violaceus***
3. Ascospores ellipsoidal, peridium 2 strata................ 4

4. Ascospores 6-septate (1-8), 81-127 × 27-45 µm, peridium 40-70 µm..................................***K. ellipticus***
4. Ascospores 8-septate (6-10), 81-122 × 18-28 µm, peridium 60-90 µm..................................***K. angustus***

Pontogeneia Kohlm., Bot. Jahrb. **96**: 200, 1975 .... (8)

P. calospora (Pat.) Kohlm., Bot. Jahrb. **96**: 205, 1975.

Zignoella calospora Pat., J. Bot., Paris, **11**: 242, 1897.

P. codiicola (E.Y. Dawson) Kohlm. & E. Kohlm., Marine Mycology. The Higher Fungi: 350, 1979.

Sphaerulina codiicola E.Y. Dawson, Occas. Pap. Allan Hancock Found. **8**: 20, 1949.

P. cubensis (Har. & Pat.) Kohlm., Bot. Jahrb. **96**: 207, 1975.

Zignoella cubensis Har. & Pat., Bull. Soc. Mycol. Fr. **20**: 65, 1904.

P. enormis (Pat. & Har.) Kohlm., Bot. Jahrb. **96**: 208, 1975.

Zignoella enormis Pat. & Har., J. Bot. Paris **17**: 228, 1903.

P. erikae Kohlm., Bot. Mar. **24**: 16, 1981.

P. microdictyi Kohlm. & Volkm.-Kohlm., Mycol. Res., 2009. DOI 10.1016/j.mycres. 2008.110314

P. padinae Kohlm., Bot. Jahrb. **96**: 201, 1975 (*Type species*).

P. valoniopsidis (Cribb & J.W. Cribb) Kohlm., Bot. Jahrb. **96**: 209, 1975.

Zignoella valoniopsidis Cribb & J.W. Cribb, Univ. Queensl., Pap. Dept. Bot. **4**: 41, 1960.

Ascomata subglobose to ovoid, superficial or partly immersed, ostiolate, papillate or epapillate, coriaceous, dark brown, solitary or gregarious, paraphyses septate, thick, asci clavate or fusiform, thin-walled, unitunicate, deliquescing early, no apical apparatus, ascospores filiform, ellipsoidal or fusoid-ellipsoidal, curved, 3-13-septate, hyaline. Parasitic species on a wide range of marine algae. Initially assigned to *Zignoella*, but Kohlmeyer (1975b) established a case for the erection of the new genus *Pontogeneia* because of different morphological features. Ascospores are hyaline, which vary greatly in their morphology, particularly in their length and degree of septation.

1. Ascospores longer than 200 µm, on the brown alga *Halopteris* 2
1. Ascospores shorter than 200 µm, on other algal hosts 3

2. Ascospores 215-325 × 14-21 µm, 10-13-septate ....***P. cubensis***
2. Ascospores 280-350 × 12-14 µm, 4-5-septate ....***P. enormis***
2. Ascospores 200-275 × 19-26 µm, 9-18-septate on the alga *Microdictyon* sp........................... ***P. microdictyi***

3. Ascospores 99-172 × 10-12 µm, 5-9-septate, on *Padina*..***P. padinae***
3. Ascospores shorter than 100 µm, on other hosts...... 4

4. Ascospores 18-28 × 8-10 µm, 2-septate, with a large central cell, on *Egregia* ....***P. erikae***
4. Ascospores longer than 50 µm, no large central cell 5

5. Ascospores 54-85 × 8-14 µm, 3-6-septate, on *Castagnea chordariiformis* ....***P. calospora***
5. Ascospores wider than 20 µm.................................6

6. Ascospores 52-79 × 20-28 µm, 3-septate, on *Codium* species..***P. codiicola***
6. Ascospores 72-100 × 21-30 µm, 2-5-septate, on *Valoniopsis pachynema* .... ***P. valoniopsidis***

3. MAGNAPORTHALES see p. 137, 144

4. PHYLLACHORALES

Key to Phyllachorales and Phyllachorales *incertae sedis*

1. Ascospores unicellular..2
1. Ascospores septate..3

2. Ascospores ellipsoidal, 15-18 × 5-6 µm parasitic on the alga *Apophlaea lyallii* .... ***Polystigma apophlaeae***
2. Ascospores subglobose to ellipsoidal, 13.5-18.5 × 9-12 µm, saprobic on *Spartina*...***Phyllachora paludicola***

3. Ascospores 1-septate, 18-28 × 6-8 µm, parasitic on brown algae.....................***Phycomelaina laminariae***
3. Ascospores 3-septate...4

4. Ascospores 26-31 × 6-8.5 µm, not constricted at the septa, many oil globules per cell, no sheath .... ***Marinosphaera mangrovei***
4. Ascospores 25-39 × 12-14 µm, with a sheath .... ***Mangrovispora pemphis***

Phyllachoraceae

Phyllachora Nitschke ex Fuckel, Jahrb. des Nassauischen Vereins Naturk. **23-24**: 216, 1870.. (1)

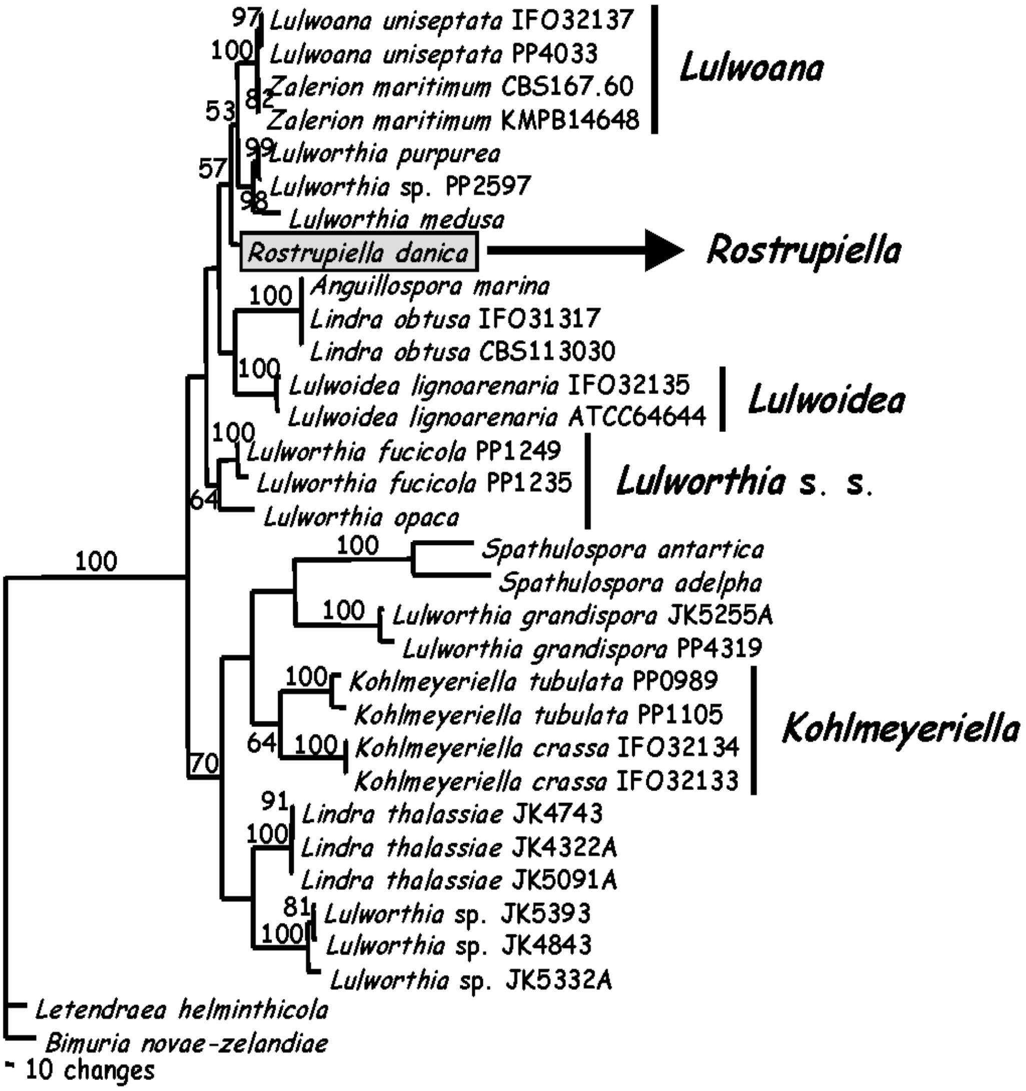


Fig. 63. One of the MPTs inferered from LSU rDNA sequences of selected lulworthialean taxa, to show the phylogenetic relationship of the genus *Rostrupiella*. Bootstrap values higher than 50% are given above branches.

Ph. paludicola Kohlm. & Volkm.- Kohlm., Mycologia **95**: 120, 2003.

Described from dead leaves of *Spartina alterniflora* and collected widely in the USA. Well developed, prominent stromata 1.3-4 cm long, about 0.5 cm wide, with 5-20 ascomata, ostiolate, coriaceous, light brown, arranged in two to four parallel rows, no necks, periphysate; septate paraphyses, apically free; asci cylindrical, short pedunculate, thick-walled, unitunicate, without an apical apparatus, J-; ascospores subglobose to ellipsoidal, unicellular, hyaline, orange- yellowish in mass, and lacking a sheath or appendages (Fig. 65) (Kohlmeyer and Volkmann-Kohlmeyer, 2003a). Well placed in the Phyllachoraceae, Phyllachorales.

Polystigma DC., Fl. Fr. **6**: 164, 1815........... (1)
P. apophlaeae Kohlm., Bot. Mar. **24**: 13, 1981.

Parasitic on the alga *Apophlaea lyallii* causing discolouration of the thallus, and known from a limited number of collections (Kohlmeyer and Demoulin, 1981). Ascospores 15-18 × 5-6 µm, hyaline, unicellular and lacking a sheath or appendage. Further collections are required to determine its phylogenetic relationship within the ascomycetes. Some 70 names are listed for *Polystigma* but many are referred to other genera, therefore the position of *P. apophlaeae* remains to be resolved (Index Fungorum). *Polystigma sonneratiae* has been described as a parasite causing leaf spots of the mangrove tree *Sonneratia caseolaris* and known from

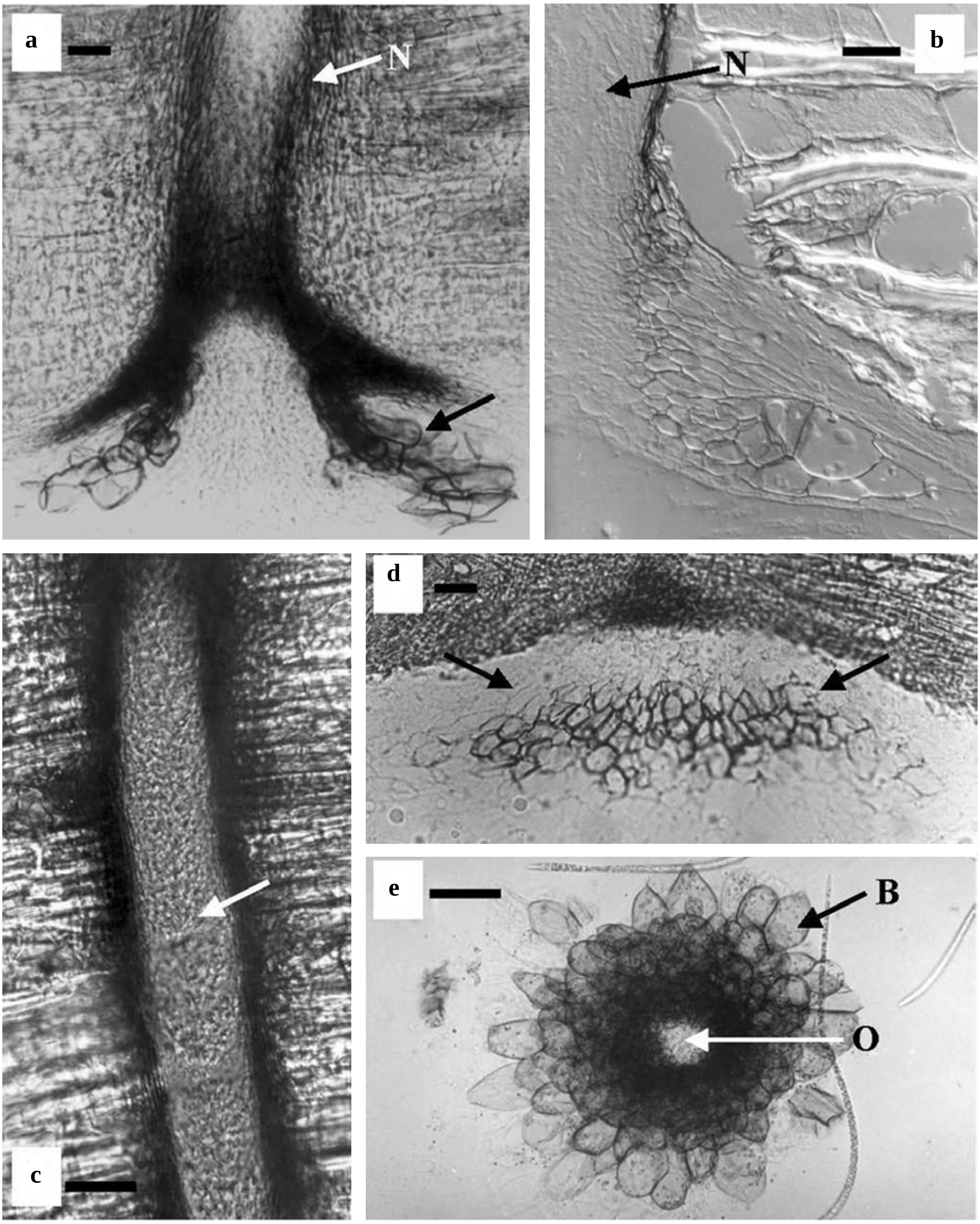


Fig. 64. *Rostrupiella danica.* **a**. Bell-like structure (arrowed) and base of the neck (arrowed N). **b**. Higher magnification of the neck region (arrowed N) with bell layer. **c**. Neck within the woody substratum filled with pseudoparenchymatous hyaline cells (arrowed). **d**. Base of the neck at the tip of the centrum. **e.** Bell-like structure pseudoparenchymatous cells (arrowed o) and bladder-like cells (arrowed B). Bars = 10 µm. Reproduced with permission from Botanica Marina.

collections in Australia and Philippines (Hyde and Cannon, 1992). This species is of terrestrial origin and may not be correctly assigned to this genus (Hyde and Cannon, 1992).

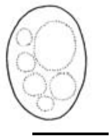


Fig. 65. *Phyllachora paludicola*. Ascospore. Bar = 10 µm.

PHYLLACHORALES *incertae sedis*

Mangrovispora K.D. Hyde & Nakagiri, Syst. Ascomycetum **10**: 19, 1991 .... (1)
M. pemphi K.D. Hyde & Nakagiri, Syst. Ascomycetum **10**: 20, 1991 (*Type species*).

Described from intertidal decayed roots of *Pemphis acidula* with ascomata that are immersed beneath a thin stroma, globose to subglobose, hyaline, membranous, ostiolate, papillate, solitary or gregarious, periphysate, paraphyses numerous, branched, septate in a gel, asci cylindrical, fissitunicate, pedunculate, unitunicate, thin-walled, faint apical tube and apical thickening, ascospores ellipsoidal to fusiform, hyaline, 3-septate, slightly constricted at the septa, thin-walled and with a sheath like structure (Hyde, 1991a). Hawksworth *et al.* (1995) refered the genus to the Hyponectriaceae while Wang and Hyde (1999) excluded it from this family. Further studies are required before this little collected species can be assigned with confidence to any family.

Marinosphaera K.D. Hyde, Can J. Bot. **67**: 3080, 1989... (1)
◙ ***M. mangrovei*** K.D. Hyde, Can J. Bot. **67**: 3080, 1989 (*Type species*).

Ascomata ellipsoidal, globose, subglobose, elongate, immersed, ostiolate, papillate, membranous, light to dark brown, solitary to gregarious, periphysate, paraphyses wide, simple, septate, asci clavate, short pedunculate, persistent, unitunicate, thin-walled, J- subapical plate and pore, ascospores broad ellipsoidal to fusiform, initially 0-septate but becoming distinctly 3-septate, hyaline, smooth-walled and lacking a sheath or appendages (Fig. 66). The species is easily identified by its wide, regularly septate paraphyses.

Hyde (1989b) initially placed the genus, with reservations, in the Phyllachoraceae, but this has received little support (Kirk *et al.*, 2001). The ascus tip is thickened, with a small flattened ocular chamber but no spore discharge has been observed (Read *et al.*, 1995). Molecular results, based on SSU and LSU rDNA analyses, revealed that *Marinosphaera* does not have any affinities with the Phyllachorales. Phylogenetically, *M. mangrovei* is located between the Halosphaeriales and the Microascales, but without any closely related taxa (Fig. 67). Therefore its taxonomic position is not fully resolved at this time, suggesting a further group of fungi remains to be discovered. This is a common species, often found as an early colonizer of mangrove wood (Alias, 1996).

Phycomelaina Kohlm., Phytopathol. Z. **63**: 350, 1968... (1)
P. laminariae (Rostr.) Kohlm., Phytopathol. Z. **63**: 350, 1968 (*Type species*).

Dothidella laminariae Rostr., Bot. Tidsskr. **19**: 213, 1895.

Endodothella laminariae (Rostr.) Theiss. & Sydow, Ann. Mycol. **13**: 582, 1915

Placostroma laminariae (Rostr.) Meyers, Mycologia **49**: 480. 1957.

Hypoderma laminariae G.K. Sutherl., New Phytol. **14**: 190, 1915.

Pseudostroma black ellipsoidal spots on cortex of algae, ascomata subglobose or ampulliform, immersed in the pseudostroma, ostiolate, epapillate, leathery, hyaline to brown, clypeus dark brown, gregarious, papillae with periphysoids. Originally described by Rostrup (1894) it has been transferred variously to other genera until Kohlmeyer (1968b) assigned it to this genus. It occurs on the brown marine algae: *Laminaria* species and possibly *Alaria esculenta*. Still not assigned with authority to an order and requiring further investigation.

Unitunicate ascomycetes family *incertae sedis*

Key to unitunicate ascomycetes *incertae sedis*

1. In seaweeds.. 2
1. In wood and other cellulosic materials.................... 5

2. On green algae 3
2. On red seaweeds 4

3. Ascospores elongate ellipsoidal, 8.5-17.5 × 3-5 µm, on *Prasiola*.................................***Mastodia tessellata***
3. Ascospores broad ellipsoidal, 8.5-14 × 3.5-7 µm, on *Blidingia*.................................***Turgidosculum ulvae***

4. Ascospores with polar appendages, 10-18 × 3-6 µm ....***Retrostium amphiroae***
4. Ascospores lacking appendages, 35-68 × 12-20 µm ....***Hispidicarpomyces galaxauricola***

5. Ascospores unicellular 6
5. Ascospores septate 7

6. Ascospores hyaline 7
6. Ascospores yellow to pale brown.............................8

7. Ascospores smooth walled, filiform 110-180 × 3-4 µm ....***Gaeumannomyces medullaris***
7. Ascospores verrucose, broadly ellipsoidal, 14-18 × 7.5-9.5 µm............................. ***Papulosa amerospora***

8. Ascospores 5-7-septate, 34-44 × 8-10 µm................. ....***Pseudohalonectria halophila***
8. Ascospores 3-septate, 37-66 × 9.5-14 µm................. ....***Buergenerula spartinae***

Hispidicarpomycetaceae

Hispidicarpomyces Nakagiri, Mycologia **85**: 639, 1993... (1)

H. galaxauricola Nakagiri, Mycologia **85**: 639, 1993 (*Type species*).

An unusual ascomycete with large ascomata on the red alga *Galaxaura falcata*, 700-1600 µm high, 800-2100 µm diam. Breaking through from the medullary layer of the host, solitary, ostiolate, epapillate, black arising from collapsed spermodochia. Peridium composed of three-layers, the outer layer with thick-walled short hyphal projections. Paraphyses 1-3-septate, branched. Asci are obclavate to obpyriform, thin-walled, unitunicate, deliquescing early and lacking an apical apparatus. Ascospores are ellipsoid to elliptic-fusiform, unicellular, hyaline and without appendages or sheath. A feature of the species is the production of verticilliate spermatophores, with closely packed ampulliform phialides terminating in a column and producing hyaline, thin-walled spermatia, inflated at the apex and cupulate at the base. Trichogynes are 2-4-septate, simple, cylindrical, brown and thick-walled at the base. Not only is the genus different from *Spathulospora*, but is sufficiently so to warrant erection of a new family, the Hispidicarpomycetaceae (Nakagiri, 1993a). Diagnostic features are the hyphoid thalli, spermadochia multiverticilliate and the hispoid ascoma, which develops by radial growth of hyphae of the ascoma initial (Nakagiri, 1993). The affinity of *Spathulospora* with the Lulworthiales raises the question as to the phylogenetic position of *Hispidicarpomyces.*

Spathulosporaceae

Retrostium Nakagiri & Tad. Ito, Mycologia **89**: 485, 1997... (1)

R. amphiroae Nakagiri & Tad. Ito, Mycologia **89**: 485, 1997 (*Type species*).

Ascomata are conical to hemispherical, superficial, solitary or united, carbonaceous, ostiolate, epapillate, and black. Peridium 45-85 µm thick, but thinner at the base, and two-layered. Ostiolar canal forming a tube-like projection into the centrum but lacking periphyses. Asci subglobose to obpyriform, thin-walled, unitunicate early deliquescing and without an apical apparatus. Ascospores oblong to ellipsoidal, unicellular, hyaline, with polar mucilaginous, subglobose appendages.

Penicilliate spermatophores and trichogynes are also present. Nakagiri and Ito (1997) are of the opinion that *Retrostium* represents a phylogenetic link between spathulosporalean fungi and other algal-inhabiting marine fungi in *Spathulospora*, the genera *Chadefaudia* and *Haloguignardia*. This observation was prophetical in view of the recent referral of *Haloguignardia* to the order Lulworthiales (Inderbitzin *et al*., 2004; Campbell *et al*., 2005).

MAGNAPORTHALES

Magnaporthaceae

Since this monograph was accepted for publication, Thongkantha *et al*. (2008) erected the order Magnaporthales. The genera *Buergenerula*, *Gaeumannomyces* and *Pseudohalonectria* are now included in this order. See page 144 for further discussion.

Buergenerula Syd., Ann. Mycol. **34**: 392, 1936... (1)

◙ ***B. spartinae*** Kohlm. & R.V. Gessner, Can. J. Bot. **54**: 1764, 1976.

Ascomata subglobose to obpyriform, immersed, ostiolate, papillate, coriaceous, light to dark brown, solitary or gregarious, necks periphysate, paraphyses filamentous, simple, or branched, septate, asci cylindrical to subfusiform, short pedunculate, unitunicate, thick-walled, with an apical apparatus, ascospores clavate, thick at the apex, 3-septate, hyaline, lacking a sheath or appendages.

A species widely reported from *Spartina* species, usually growing on senescing or dead culms. It has been confused with *Sphaerulina pedicellata*, initially described from wood panels (Johnson, 1956) because of the thick-walled asci when young and thought to be bitunicate. *Buergenerula spartinae* is paraphysate, with unitunicate thick-walled asci and producing hyphopodia on the host. Although a *Pyricularia* anamorph has been reported for the genus, no anamorph has been

Fig. 66. *Marinosphaera mangrovei*. **a.** Immersed ascomata with long necks on the wood surface. **b**. Cylindrical asci with subapical structures. **c.** Wide-septate, chain-like paraphyses. **d.** Ornamented ascospores full of oil globules. Bars a = 200 µm; b = 20 µm; c, d = 10 µm.

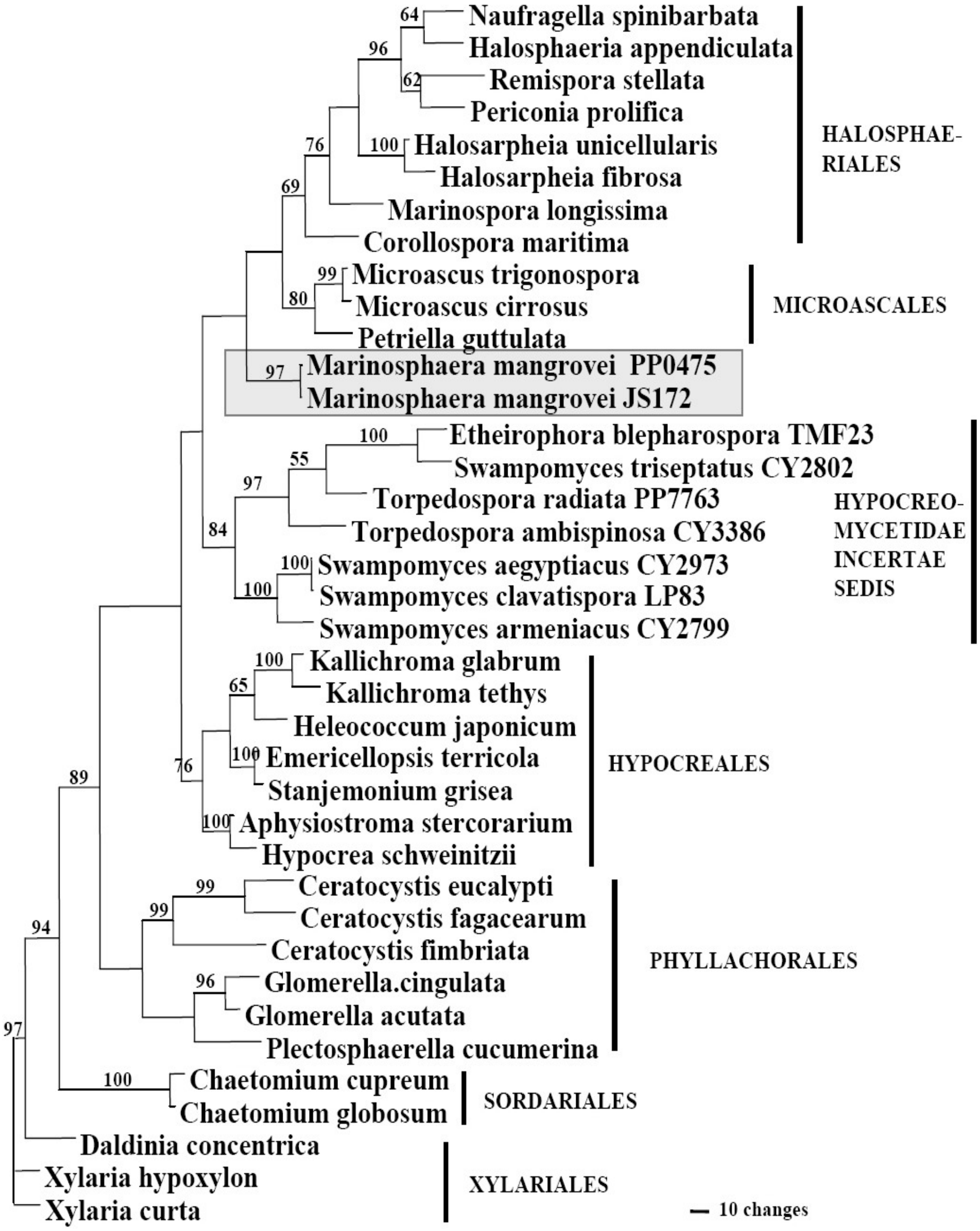


Fig. 67. One of two MPTs inferred from combined SSU and LSU rDNA of *Marinosphaera mangrovei*, generated with maximum parsimony analysis. Bootstrap values higher than 50% given above branches. Scale bar indicates 10 character state changes.

reported for *B. spartinae*, except for spermatial like structures (Kohlmeyer and Gessner, 1976).

Gaeumannomyces Arx & D.L. Olivier, Trans. Br. Mycol. Soc. **35**: 32, 1952 .... (1)
G. medullaris Kohlm., Volkm.-Kohlm. & O.E. Erikss., Mycologia **87**: 540, 1995.

Anamorph: *Trichocladium medullare* Kohlm. & Volkm.-Kohlm.

Ascomata ellipsoidal, immersed, ostiolate, coriaceous, dark brown, solitary, necks cylindrical and periphysate, paraphyses numerous, unbranched, septate, tapering, asci fusoid to cylindrical, short pedunculate, thin-walled, unitunicate, with an apical ring, persistent, ascospores filiform, slightly tapering towards the base, without a sheath or apical appendages. The only marine species in the genus and found on the inundated parts of the culms of *Juncus roemerianus*. This species differs from other *Gaeumannomyces* species in having a *Trichocladium* anamorph (Kohlmeyer *et al*., 1995c). Cannon (1994) and Cannon and Kirk (2007) referred the genus to the Magnaporthaceae while Thongkantha *et al.* (2009) have erected a new order for the family.

Pseudohalonectria Minoura & T. Muroi, Trans. Mycol. Soc. Jpn. **19**: 132, 1978.................... (1)
P. halophila Kohlm. & Volkm.-Kohlm., Bot. Mar. **48**: 310, 2005.

Ascomata obpyriform, immersed, ostiolate, coriaceous, light to dark brown, long neck (130-410 µm) protruding beyond the substratum, paraphyses thin-walled, septate, unbranched, asci fusiform, short pedunculate, unitunicate, persistent, with a refractive tip below the ring, J-, ascospores ellipsoidal to fusiform, 5-6 (-7)-septate, slightly constricted at the septa, echinulate, hyaline and pale brown, lacking a sheath or appendages (Fig. 68). A frequent inhabitant of fragmented old leaves and culms of *Juncus roemerianus*, and the first *Pseudohalonectria* species from marine waters (Kohlmeyer *et al*., 2005). It most closely resembles *P. adversaria* and *P. fuxianii*, but differs in that it is obligately marine and does not grow on wood. It also had distinctly broader ascospores than *P. adversaria*, and more septa than *P. fuxianii* (Kohlmeyer *et al*., 2005).

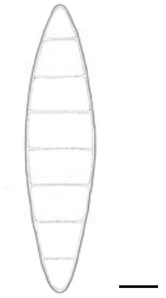


Fig. 68. *Pseudohalonectria halophila*. Ascospore. Bar = 5 µm.

Mastodiaceae

Turgidosculum Kohlm. & E. Kohlm., Bot. Jahrb. Syst. **92**: 429, 1972............................ (1)
T. ulvae (G.M. Reed) Kohlm. & E. Kohlm., Bot. Jahrb. Syst. **92**: 429, 1972 (*Type species*).

Guignardia ulvae G. M. Reed, Univ. Calif., Berkley, Publ. Bot. **1**: 160, 1902.

Ascomata subglobose, immersed in the algal thallus between the upper and lower algal cell layers, dark brown, papillate, ostiolate closed by a gelatinous plug, periphysate, no paraphyses, asci clavate developing all around the inside of the ascomata, pedunculate, unitunicate, thick-walled but deliquescing, ascospores ellipsoidal to ovoid, unicellular, hyaline, lacking a sheath or appendages. A parastic ascomycete on *Blidingia minima* var. *vexata*, and with a restricted known distribution (Schatz, 1980; Kohlmeyer and Volkmann-Kohlmeyer, 2003b).

Mastodia (Hook. f. & Harv.) Hook. f. & Harv., Fl. Antrac., Part II: 499, 1847 .... (1)
M. tessellata (Hook. f. & Harv.) Hook. f. & Harv., Fl. Antarc., Part II: 499, 1847.

Leptogiopsis complicatula Nyl., Flora, Jena **67**: 211, 1884.

Turgidosculum complicatulum (Nyl.) Kohlm. & E. Kohlm., Marine Mycology, The Higher Fungi: 361, 1979.

Guignardia alaskana G.M. Reed, Univ. Calfornia Publ. Bot. **1**: 161, 1902.

Laestadia alaskana (G.M. Reed) Sacc. & D. Sacc., Syll. Fung. **17**: 576, 1905.

Laestadia prasiolae G. Winter, Hedw. **26**: 16, 1887.

Guignardia prasiolae (G. Winter) Lemmerm., Naturwiss. Ver. Bremen, **17**: 199, 1901.

Laestadiata tessellta G. Winter ex Har., Algues, in Mission Sci. Cap Horn, **5**: 29, 1882-1883. (nomen nudum).

Physalospora prasiolae Har., J. Bot., Paris **1**: 133, 1887. (nomen nudum).

Kohlmeyera complicatula (Nyl.) S. Schatz, Mycologia **72**: 114, 1980.

Plagiostoma prasiolae (Winter) Clauzade, Diederich & Cl. Roux, Bull. Soc. Linn. Provence. Num. spec. **1**: 47, 1989.

Ascomata subglobose, immersed in the algal thallus, ostiolate, epapillate, coriaceous, dark brown, solitary or gregarious, necks periphysate, paraphyses not observed in mature specimens, centrum filled with a gelatinous matrix, asci clavate to subcylindrical, short pedunculate, unitunicate, lacking an apical apparatus, deliquescing, ascospores elongate-ellipsoidal to cylindrical, rounded ends, unicellular, hyaline, lacking a sheath or appendages. Kohlmeyer and Kohlmeyer (1979) give a detailed history of the placement of this taxon. A much confused taxon in need of re-evaluation, especially at the molecular level.

Papulosaceae

Papulosa Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **11**: 96, 1993 .... (1)

◙ ***P. amerospora*** Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **11**: 96, 1993 (*Type species*).

Ascomata subglobose to ellipsoidal, immersed, ostiolate, papillate, coriaceous, dark brown, solitary, necks periphysate, lateral paraphyses tapering toward the tip, simple or branched, asci cylindrical, short pedunculate, persistent, with an aical ring, J+, ascospores broadly ellipsoidal, unicellular, hyaline, verruculose, with a thin gelatinous sheath. Saprophyte of senescent culms of *Juncus roemerianus* (Kohlmeyer and Volkmann-Kohlmeyer, 1993b). Winka and Eriksson (2000) refer *P. amerospora* to a new family, Papulosaceae in the sub-class Sordariomycetidae, and most closely related to the orders Ophiostomatales, Diaporthales, Sordariales and Phyllachorales. Insufficient unitunicate marine taxa have been sequenced to enable this family to be assigned to any order.

Untunicate ascomycetes genera *incertae sedis*

1. Ascomata perithecoid... 2
1. Ascomata cleistothecial... 7

2. Ascospores 0-septate... 3
2. Ascospores septate.. 4

3. Ascus thick-walled, with an ocular chamber with a net-like apical apparatus, ascospores hyaline, 59-77 × 33-44 µm.................................... ***Hapsidascus junci***
3. Ascus thin-walled, no apical apparatus, ascospores pale brown, 20-28 × 7-10 µm ..... ***Rhizophila marina***

4. Ascospores with more than 3 septa....... ***Saccardoella***
4. Ascospores 3-septate... 5

5. Ascus clavate to subcylindrical, with an operculum, on brown algae........................... ***Orcadia ascophylli***
5. Asci lacking an operculum...................................... 6

6. Ascomata sea-green to blue, apical ring cylindrical or wedge-shaped, ascospores 18-24 µm........................ ....***Aquamarina speciosa***
6. Ascomata pale coloured, ascus ring subapical, ascospores striate 25.5-40 × 7-10 µm .... ***Aropsiclus junci***

7. Ascospores 0-septate, with bipolar crown of delicate appendages.. ***Eiona***
7. Ascospores 1-septate... 8

8. Ascospores with thread-like spirally unfolding appendages.. 9
8. Ascospore appendages not spirally arranged 10

9. On wood, often associated with sand.... ***Dryosphaera***
9. On seaweed, *Fucus* .... ***Crinigera***

10. Ascospores with polar and lateral appendages.......... .... ***Marisolaris***
10. Ascospores with a mucilaginous sheath........... ***Biflua***

Aquamarina Kohlm., Volkm.-Kohlm. & O.E. Erikss., Mycol. Res. **100**: 393, 1996........... (1)

A. speciosa Kohlm., Volkm.-Kohlm. & O.E. Erikss., Mycol. Res. **100**: 393, 1996.

Ascomata subglobose, immersed, ostiolate, coriaceous, sea-green to blue, neck long (165-345 µm) within the host, periphysate, paraphyses septate, unbranched in a gelatinous matrix, asci cylindrical, short pedunculate, thin-walled, unitunicate with an apical ring J-, ascospores fusiform, 3-septate, not constricted at the septa, hyaline lacking a sheath or appendages (Kohlmeyer *et al*., 1995d). Sporulating on the base of culms of *Juncus roemerianus* and regarded as an obligately marine ascomycete (Kohlmeyer *et al*., 1995d), characterized by sea-green to blue ascomata that are deeply embedded in the substratum. Kohlmeyer *et al*. (1995d) were unable to suggest a suitable family for its assignment and further evaluation is dependent on fresh material for a molecular study.

Aropsiclus Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **13**: 24, 1994 .... (1)
A. junci **(**Kohlm. & Volkm.-Kohlm.) Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **13**: 24, 1994.

Sulcospora junci Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **11**: 100, 1993.

Ascomata embedded in the outer small-celled tissue of *Juncus roemerianus*, cream-coloured, necks breaking through the cuticle, periphysate, periphysoids present, ascospores hyaline, 3-septate with a striated spore wall (Kohlmeyer and Volkmann-Kohlmeyer, 1994). The genus cannot be assigned to any order or family of the Ascomycota.

Biflua Jørg. Koch & E.B.G. Jones, Can. J. Bot. **67**: 1187, 1989 .... (1)
◙ ***B. physasca*** Jørg. Koch & E.B.G. Jones, Can. J. Bot. **67**: 1187, 1989 (*Type species*).

Cleistothecia globose or slightly flattened, coriaceous, white-light buff colour, gregarious, paraphyses absent, attached to wood by thick-walled hyphae with broad ascomatal appendages, asci clavariform to cylindrical, pedunculate, persistent, lacking an apical pore, ascospores ellipsoidal, 1-septate, constricted at the septum, hyaline, with a mucilaginous sheath.

Kirk *et al*. (2001) relegate this genus to genera *incertae sedis*. One of three marine cleistotheical ascomycetes, with sterile appendages on the peridium and growing on wood in association with sand (Koch and Jones, 1989). Their taxonomic relationship is unknown, and all require study at the molecular level, but are infrequently collected, possibly they are overlooked because of the small size of the ascomata. These cleistothecial ascomycetes are generally confined to cold waters and develop on cold incubation of wood samples, and remain in good condition for 2-3 weeks (Koch, pers. comm.).

Crinigera I. Schmidt, Nat. Naturschutz Mecklenburg **7**: 11, 1969 .... (1)
C. maritima I. Schmidt, Nat. Naturschutz Mecklenburg **7**: 11, 1969 (*Type species*).

A genus of doubtful validity collected on the seaweed *Fucus*. Koch and Jones (1989) have shown the species is based on two taxa, and erected the genus *Dryosphaera* for the material on wood.

Dryosphaera Jørg. Koch & E.B.G. Jones, Can. J. Bot. **67**: 1184, 1989 .... (3)
◙ ***D. navigans*** Jørg. Koch & E.B.G. Jones, Can. J. Bot. **67**: 1185, 1989 (*Type species*).
D. tropicalis Kohlm. & Volkm-Kohlm., Can. J. Bot. **71**: 992, 1993.
D. tenuis Andrienko, Ukr. Bot. J. **58**: 244-247, 2001.

Cleistothecia globose, slightly flattened, superficial, white-light buff coloured, coriaceous, gregarious, attached to wood by thick-walled hyphae branched at their tips, ascomata covered with short appendages, each with a stalk and a terminal crown of repeatedly divided branches, asci numerous, developed on lobed hymenium, thick-walled when young, (possibly bitunicate), broadly clavate, short pedunculate, persistent, paraphyses absent, ascospores 1-septate, constricted at the septum, hyaline and appendaged. Appendages appear as a ball of spirally arranged threads frequently terminating in ball-like structures (Koch and Jones, 1989).

Dryosphaera tenuis (Fig. 69) has been described by Andrienko (2001), from the leaf of a *Zostera* sp. in the Odessa region of the Ukraine. It has larger asci 17.3-38.7-61.9 × 5.7-12.2-19 µm, slightly longer ascospores (8.6-11.8-13.3 × 2.2-3.0-3.9 µm) and significantly longer appendages (9.4-14.2-17.6 × 0.3-0.7-1.1 µm) than the previously described species. Papers published by Russian mycologists on marine fungi are rarely cited in the general literature (Kopytina and Andrienko, 1998) and consequently new taxa remain unknown.

1. On *Zostera* leaves, ascospores 8.6-13.3 × 2.2-3.9 µm, appendages 9.4-17.6 × 0.3-1.1 µm.............. ***D. tenuis***
1. On wood associated with sand................................ 2

2. Ascospores 12-15 × 4-5.5 µm................ ***D. tropicalis***
2. Ascospores 8-12 × 3-5 µm..................... ***D. navigans***

Eiona Kohlm., Ber. Dtsch. Bot. Ges. **81**: 58, 1968.. (1)
E. tunicata Kohlm., Ber. Dtsch. Bot. Ges. **81:** 58, 1968 (*Type species*).

Ascomata cleistothecial, subglobose, superficial, no ostiole, coriaceous, brown to

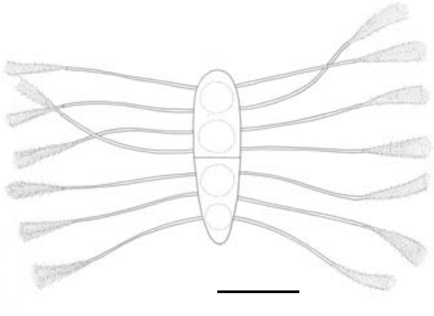


Fig. 69. *Dryosphaera tenuis.* Ascospore. Bar = 5 µm.

green, gregarious, lacking paraphyses, asci broadly clavate or ellipsoidal, unitunicate, thin-walled, scattered throughout the ascoma cavity, early deliquescing and lacking and apical apparatus, ascospores ellipsodial, unicellular., hyaline, with a crown of appendages at both ends of the spore (Kohlmeyer and Kohlmeyer, 1979). Ascospore appendages formed by fragmentation of a sheath (Jones and Moss, 1978). This species is in need of a molecular study to determine its ordinal rank as it may not belong in the Eurotiaceae. Collected in abundance on wood associated with sand (Koch and Jones, 1983; Farrant *et al*., 1985).

Hapsidascus Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **10**: 113, 1991 .... (1)
H. hadrus Kohlm. & Volkm.-Kohlm., Syst. Ascomycetum **10**: 115, 1991 (*Type species*).

An unusual ascomycete with large ellipsoidal ascomata (>750 µm), deeply embedded in mangrove roots of *Rhizophora mangle*, necks almost as thick as the ascoma, and the ostiolar canal filled with a network of thin hyphae, embedded in a matrix. Peridium 3-layered and a paraphysate hamathecium, the upper third of the locule filled with thin anastomosing hyphae in a gelatinous matrix. Asci thick-walled, not fissitunicate with an ocular chamber with a net-like apical apparatus, J-, and ascospores ellipsoid to ovoid, 59-77 × 33-44 µm, unicellular and hyaline (Kohlmeyer and Volkmann-Kohlmeyer, 1991b). No known anamorph and monotypic. It superficially resembles *Lignincola tropica* or *Saagaromyces abonnis*, but differs in ascoma ontogeny, asci with a net-like substructure to the ascus tip and ascospores that are unicellular.

Marisolaris Jørg. Koch & E.B.G. Jones, Can. J. Bot. **67**: 1190, 1989..................................... (1)
M. ansata Jørg. Koch & E.B.G. Jones, Can. J. Bot. **67**: 1193, 1989 (*Type species*).

Ascomata globose, coriaceous, white-light buff coloured, gregarious, superficial on wood, and attached to the surface by thick-walled hyphae, ascomata covered by numerous simple horn-like appendages, tapering, paraphyses absent, asci broadly clavate, pedunculate, persistent, bitunicate with an exotunicate and endotunica visible when mounted in water, ascsopores 1-septate, not constricted at the septum, hyaline with single polar and four equatorial appendages, each appendage comprising an inner part which is looped like a bridge and an outer part a sheath that envelopes the spore. Another genus, which at the present time, cannot be assigned to any taxonomical group and is only known from a few collections on wood associated with sand (Koch and Jones, 1989).

Orcadia G.K. Sutherl., Trans Br. Mycol. Soc. **5**: 151, 1915... (1)
O. ascophylli G.K. Sutherl., Trans Br. Mycol. Soc. **5**: 151, 1915 (*Type species*).

Ascomata subglobose or pyriform, immersed, ostiolate, papillate, coriaceous, subhyaline, gregarious, necks a papilla or long (80-180 µm), periphysate, paraphyses? septate, simple or anasotmosing, deliquescing early, asci clavate, subcylindrical or subfusiform, short pedunculate, thin-walled, unitunicate, with an apical thickening but no apical apparatus, operculum present, ascospores cylindrical, slightly curved, 3-septate, constricted at the septa, hyaline, no sheath or appendages. Initially referred by Sutherland (1915) to the Hyponectriaceae, Xylariales. Rossman *et al*. (1999) excluded the genus from the Hypocreales because of the reported operculate asci, broad opening of the ascomata, and numerous interthecial elements (Kohlmeyer and Kohlmeyer, 1979). A poorly researched species, parasitic/saprophytic on the larger brown algae (*Ascophyllum*, *Fucus*, *Pelvetia*). Rossman *et al*. (1999) suggested an affinity with the Pezizales because of the operculate asci.

Rhizophila K.D. Hyde & E.B.G. Jones, Mycotaxon **34**: 527, 1989 .... (1)
◙ ***R. marina*** K.D. Hyde & E.B.G. Jones, Mycotaxon **34**: 528, 1989 (*Type species*).

Ascomata large (500-965 µm wide, 425-730 µm long), globose to subglobose, immersed, ostiolate, papillate, periphysate, coriaceous, dark brown to black, solitary or gregarious, paraphyses irregular shaped cells, septate, asci clavate, pedunculate, unitunicate, thin-walled, with a slight apical thickening, no apical apparatus, ascospores ellipsoidal to fusiform, unicellular, hyaline but becoming yellowish brown, lacking a sheath or appendages. Often found deeply embedded in mangrove wood and the droppers of *Rhizophora* species (Hyde and Jones, 1989a, Jones, unpublished data).

Similarities with the Phyllachoraceae and *Glomerella* were reported by Hyde and Jones (1989a), but molecular sequences suggest that it may be better placed in the Microascales or Hypocreales (Spatafora and Blackwell, 1994; Winka and Eriksson, 2000).

Saccardoella Speg., Michelia **1**: 461, 1879…(3)
S. mangrovei K.D. Hyde, Mycologia **84**: 803, 1992.
S. marinospora K.D. Hyde, Mycologia **84**: 806, 1992.
S. rhizophorae K.D. Hyde, Mycologia **84**: 806, 1992.

Ascomata globose to subglobose, immersed or erumpent, ostiolate, papillate, coriaceous, carbonaceous, solitary or gregarious, dark brown to black, clypeate, no periphyses, paraphyses numerous, filamentous, hypha-like, branching and anastomosing in gelatinous matrix, asci long-cylindrical, short pediculate, thin-walled, unitunicate, apically flattened or flattened with a subapical ring, ascospores fusiform, 3-9-septate, not constricted at the septa, with acute ends, variable septation, hyaline, with a thin to well developed gelatinous sheath. A genus referred to the Clypeosphaeriaceae and Barr (1994) later revised and extend the limits of the genus. There is confusion about the ascus structure in *Saccardoella* as in slide preparations the ascus may appear thickened and behave like a bitunicate ascus. Mathiassen (1989) was of the opinion that the asci are bitunicate in *Saccardoella transylvanica*, but Barr (1990b) does not concur with that view. Geographically the genus is well distributed with terrestrial, marine and freshwater species (Hyde, 1992; Tsui *et al*., 1998).

1. Ascospores with 7-9 septa, 26-33 × 6-8 µm ....
   ....***S. mangrovei***
1. Ascospores with fewer than 7 septa 2

2. Ascospores with (4-) 5- (-6) septa, 19-26 × 6-8 µm ..
   ....***S. rhizophorae***
2. Ascospores with 3 septa, 25-31 × 7.5-10 µm............
   ....***S. marinospora***

MAGNAPORTHALES
MAGNAPORTHACEAE

Canon and Kirk (2007) accepted the Magnaporthaceae in the Sordariomycetes, a small family of unitunicate perithecial ascomycetes, comprising 13 genera and 93 species (Kirk *et al*., 2008). *Gaeumannomyces* (2 species) and *Magnaporthe* (5 species) are the key members of the family as many species are economically important plant pathogens. *Magnaporthe grisea* (anamorph *Pyricularia oryzae*) is the cause of rice blast and a wide variety of plants (Yaegashi and Herbert, 1976). Because few of the Magnaporthaceae have been sequenced, placement at the ordinal level has remained unresolved (Hibbett *et al*., 2007, while Lumbsch and Hundorf (2007) and Zhang *et al*. (2006) merely refer the family to the Sordariomycetidae along with two other poorly studied families, Annulatascaceae (Wong *et al*., 1998) and Papulosaceae (Winka and Eriksson, 2000).

Thongkantha *et al*. (2008) investigated the molecular phylogeny of selected genera in the Magnapothaceae (*Buergenerula spartinae*, *Gaeumannomyces* spp., *Magnaporthe* spp., *Mycoleptodiscus coloratus*, *Ophioceras* spp. and *Pseudohalonectria* spp.), using 18S and 28S rDNA phylogeny. These genera formed a monophyletic clade, closely related to the Diaporthales and Ophiostomatales. However, the Magnaporthaceae could not be accommodated in any known fungal order and consequently they erected a new order, the Magnaporthales (Thongkantha *et al*., 2008).

Marine representatives of the Magnaporthaceae, Magnaporthales are *Buergenerula* *spartinae*, *Gaeumannomyces medullaris* and *Pseudohalonectria halophila.* Only *G. medullaris* has a known anamorph in *Trichocladium* (*T. medullare*). The anamorphs of *Gaeumannomyces* are generally *Phialophora* species.

Ascomycetes, and their anamorphs comprise the largest marine fungal group (424 + 94 species, respectively) and the most intensively studied. The orders Halosphaeriales and Lulworthiales have been extensively studied at the molecular level, both forming distinct clades in the Sordariomycetidae *incertae sedis* (Hibbett *et al.*, 2007). These results have shown that the Halosphaeriales are a sister group to the Microascales and are secondary invaders of the marine environment (Spatafora *et al.*, 1998). It has been confirmed that the Lulworthiales are morphologically and phylogenetically distinct from the Halosphaeriales (Kohlmeyer *et al.*, 2000). Another significant taxonomic result has been the erection of a new order the Koralionastetales to accommodate the little known genera *Koralionastes* and *Pontogeneia*, previously not assigned with authority to any group (Campbell *et al.*, 2008). Molecular studies have also enabled a better understanding of the generic relationships of many marine ascomycetes: *Corollospora* (Campbell *et al.* (2002), *Halosarpheia*, *Lignincola* and *Nais* (Pang *et al.*, 2003a, b), *Antennospora* (Pang *et al.*, 2008) and anamorphic Lulworthiales (Jones *et al.*, 2008).

In comparison the bitunicate marine ascomycetes have been less well served at the molecular level. Some 40 marine bitunicate ascomycetes have been sequenced, but assignment to families remain unresolved. This reflects the genera lack of resolution within the bitunicate ascomycetes. Sequences of *Manglicola guatemalensis* places it in the Jahnulales.

TOTAL ASCOMYCETES.................... **(424)**

Section C:
ANAMORPHIC FUNGI (COELOMYCETES and HYPHOMYCETES)

1. Spores produced on hyphae .... Hyphomycetes
1. Spores produced in sporocarps............Coelomycetes

HYPHOMYCETES

1. Conidia hyaline 2
1. Conidia coloured 11

2. Conidia 1-celled 3
2. Conidia septate 7

3. Conidia produced in a sporodochium....................... 4
3. Conidia not produced in a sporodochium 5

4. Sporodochia superficial, on wood from deep waters, conidia 16-24 × 6.5-9 µm...***Allescheriella bathygena***
4. Sporodochia cushion-shaped, on salt marsh plants, conidia 3-4 × 1.5-2 µm....***Tubercularia pulverulenta***

5. Conidia tetraradiate, 7-9 × 6-7 µm, on driftwood ....***Heliscella stellatacula***
5. Conidia not tetraradiate or staurosporous................ 6

6. Conidiophores unbranched or sparingly, collarette cylindrical, spore mass pale yellowish-brown, on diseased shrimp, conidia 3-4 × 1.5-2 µm ....***Plectosporium oratosquillae***
6. Conidiophores simple or branched, on algae or soil ....***Acremonium***
6. Conidiophores subglobose, lateral or apical, conidia 2-5 µm, on various substrata ....***Botryophialophora marina***

7. Conidia septate tetraradiate.................***Varicosporina***
7. Conidia filamentous, multiseptate............................ 8
7. Conidia elongate, obovoidal, ellipsoidal, elongate, clavate, 1-5-septate, predacious on nematodes in mangrove habitats (mangrove wood and leaves) 9

8. Conidia filiform, 9-13 (-19)-septate, end cells with cytoplasm, 150-255 (-312) × 2.5-4 µm ....***Anguillospora marina***
8. Conidia sigmoid, curved, variously septate, end cells lacking cytoplasm .... ***Halosigmoidea***

9. Conidia apically and on lateral denticles................ 10
9. Apical conidia only ....***Monacrosporium***

10. Trapping nematodes with adhesive networks.......... ....***Arthrobotrys***
10. Trapping nematodes with adhesive knobs or non-constricting rings .... ***Dactylellina***

11. Conidia coloured, one-celled............................... 12
11. Conidia coloured, septate 16

12. Conidiophores penicilliate or on a terminal ampulla 13
12. Conidiophores not penicilliate or on a terminal ampulla.. 15

13. Conidiogenous cells phialidic 14
13. Conidiogenous cells anellidic, 5-7 × 4-5 µm, on algae ....***Scopulariopsis halophilica***

14. Phialides born on penicilliate conidiophores, conidia variously coloured .... ***Penicillium***
14. Phialides on a terminal ampulla, conidia brown .... ***Aspergillus sydowii***
14. Phialides verrucose, at tip of undifferentiated conidiophore, conidia verrucose, 5-7 × 3-4 µm .... ***Stachybotrys mangiferae***

15. Conidia basauxic, 10.5-15.3 × 5.8-7.9 µm, on algae .... ***Arthrinium algicola***
15. Conidia acroblastosporic......................... ***Periconia***

16. Conidia with transverse septa............................. 17
16. Conidia muriform... 24
16. Conidia helicoid 27
16. Conidia tetraradiate or staurospores.................... 31
16. Chlamydospores only produced 33

17. Conidia over 120 µm long, on submerged test panels .... ***Sporidesmium salinum***
17. Conidia shorter than 120 µm.............................. 18

18. Conidia with a prominent scar 19
18. Conidia without a basal scar 20

19. Conidiophores macronematous, conidia olive-brown, 8-24 × 4.5-8 µm, with protruberant scars at each end, conidia in short chains, on algae, drift plant material.................... ***Cladosporium algarum***
19. Conidiophores macronematous, conidia never in chains, slightly constricted at the septa, with short basal peg-like denticle, on algae, occasionally wood ....***Dendryphiella***

20. Conidia 1-3-septate 22
20. Conidia with more than 3-septate........................ 21

21. Conidia narrower than 8 µm, 24-29 × 5.5-6.5 (-8) µm ....***Amorosia littoralis***
21. Conidia wider than 8 µm.................***Trichocladium***

22. Conidia spathulate, versicolorous, apical cells brown, basal cell hyaline, 35-42 × 9-11 µm, on mangrove wood......... ***Phragmospathula phoenicis***
22. Conidial cells in straight rows, concolorous, constricted at the septa ....***Trichocladium***
22. Conidial pyriform.. 23

23. Conidiophores in sporodochia, conidia obpyriform, 1-2-septate, not constricted at the septa, 20-33.6 × 14.5-20.5 µm......................***Bactrodesmium linderi***

23. Conidiophores not in sporodochia, conidia pyriform, 21-27 × 10-17.5 µm .... ***Brachysporium helgolandicum***

24. Conidia flattened in one plane, up to 90 µm long and 120 µm wide, dictyosporous.. ***Mycoenterolobium platysporum***
24. Conidia not flattened in one plane.......................25

25. Conidiophores with percurrent proliferation, conidia variously shaped .... ***Stemphylium***
25. Conidia aleuriospores..26

26. Conidia entire, clavate, 15-41 × 12-37 µm... ***Monodictys pelagica***
26. Conidia formed by rows of cells or branched...***Dictyosporium***

27. Cells in conidia equal width along the coil, on wood..***Zalerion***
27. Cells variable in width along the coil..................28

28. Apical cell the largest in the coil............***Cirrenalia***
28. Apical cells variable in width..............................29

29. Conidiophores polydenticulate, conidia 15-29 × 12-15 µm, on *Nypa* palm...... ***Helicorhoidion nypicola***
29. Conidiophores not denticulate.............................30

30. Conidia 15-65 × 14-56 µm, cells less than 10 µm wide, spirally contorted into a ball of up to 100 cells ....***Halenospora***
30. Conidia initially a spiral/coil, cells over 10 µm wide, forming a ball of cells by division in several planes ....***Cumulospora***

31. Conidia with tetraradiate arms 32
31. Conidia unicellular but aggregated into groups up to 20, 9-29 × 4-9 µm, on various substrata .... ***Asteromyces cruciatus***

32. Basal cell small, light brown, 6-20 µm, conidia 20-70 × 4-6 µm, on various substrata...***Clavatospora bulbosa***
32. Basal cell large, dark brown to black, conidia 24-42 × 18-37 µm, on wood...........***Orbimyces spectabilis***

33. Spores hyaline, 35-150 × 8-33 µm, on *Cladophora* spp. ....***Blodgettia confervoides***
33. Spores dark brown, on mangrove wood..***Xylomyces***

Acremonium Link, Magazin Ges. naturf. Freunde, Berlin, **3**: 15, 1809 .... (2)
◙ ***A. fuci*** Summerb., Zuccaro & W. Gams, Stud. Mycol. **50**: 288, 2004.
◙ ***A. tubakii*** W. Gams, Cephalosporium-artige Schimmelpilze (Stuttgart): 55, 1971.

Cephalosporium polyaleurum Tubaki, Mycologia **65**: 939, 1973.

Mycelium septate, branched, phialides erect, simple, solitary or in groups, conidia elliptical, obovoid, broadly-ellipsoidal, short, truncate basal hilum, hyaline, forming a ball of conidia in a mucilaginous matrix (Tubaki, 1973b; Zuccaro *et al*., 2004). *Acremonium fuci* was isolated from the brown algae *Fucus serratus* (Germany) and *F. distichus* (Canada) with conidia measuring 5-8 (-15) × 3.2-5 (-6.0) µm (Fig. 70). This species groups within a marine clade of *Emericellopsis* and *Stanjemonium* species primarily isolated from marine habitats, and Zuccaro *et al*. (2004) suggest that further new species remain to be described from this environment. *Acremonium polyaleurum* was recovered from coastal muds and characterized by its small conidia, the formation of aleuriospores and its better growth on seawater media when compared with growth on freshwater media. No teleomorphs have been reported for the two marine species listed above. Zuccaro *et al*. (2004) list a number of *Acremonium* species isolated from the sea: *Acremonium potronii* (skin lesion of a dolphin); *A. tubakii* (*Fucus serratus*); *Emericellopsis minima* (mangrove soil, *Fucus serratus*) and *E. stolkiae* (mud saline lake). *Acremonium* species are frequently encountered on incubated mangrove wood in the topics and warrant further investigation. See section on *Emericellopsis*, page 72.

1. Conidia 5-8 (-15) × 3.2-5 (-6) µm, obovoid-broadly ellipsoidal, on brown algae ....***A. fuci***
1. Conidia 3-6 × 1.5-2.0 µm, elliptical, from marine sediments..***A. tubakii***

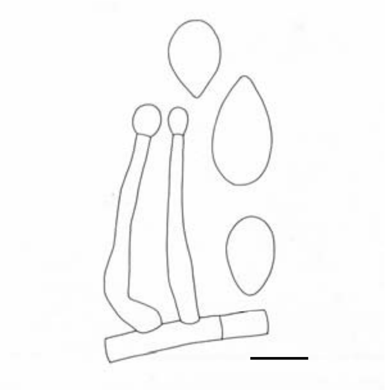


Fig. 70. Conidiophores and conidia of *Acremonium fuci*. Bar = 5 µm.

Allescheriella Henn., Hedw. **36**: 244, 1897. (1)
A. bathygena Kohlm., Revue. Mycol. **41**: 199, 1977.

Sporodochial superficial, conidiophores monoblastic, terminal, determinate, cylindrical, straight, hyaline to pale brown conidia acrogenous, solitary, ellipsoidal to fusiform, unicellular, thick-walled, smooth, and pale brown (after Kohlmeyer, 1977). Only known from a collection made on wood from the Tongue of the Ocean, off the Bahamas Islands (Kohlmeyer, 1977).

Alternaria Nees, Syst. Pilze (Würzburg): 72, 1816.......................................# *Alternaria* spp.

It is uncertain if these are truly marine fungi, but numerous collections have been listed in the literature. These include *Alternaria maritima* on a wide range of substrata (Sutherland, 1916; Johnson and Sparrow, 1961), *A. radicina* (Anastasiou, 1963b) and *A. tenuis* (Siepmann and Johnson, 1960; Anastasiou, 1963b). Kohlmeyer and Volkmann-Kohlmeyer (1991a) do not regard any *Alternaria* species as obligately marine.

Amorosia Mantle & D. Hawksw., Mycol. Res. **110**: 1373, 2006 .... (1)
◙ ***A. littoralis*** Mantle & D. Hawksw., Mycol. Res. **110**: 1373, 2006.

Teleomorph: may be found in the Sporormiaceae, Pleosporales (Mantle *et al*., 2006).

A dematiaceous hyphomycete isolated from the littoral zone in the Bahamas and producing the novel axa-anthraquinone scorpinone and caffeine. Condiophores micronematous or semi-macronematous, arising singly sympodially, monoblastic, determinate, subhyaline to pale brown and smooth walled. Conidia arising singly, 3-4-septate, pale brown to brown, smooth-walled lacking appendages or a sheath, 24-27.5 (-29) × 5.5-6.5 (-8) µm (Fig. 71). It most closely resembles *Trichocladium* species: *T. asperum*, *T. lignicola*, *T. opacum* and *T. pyriforme* but are not phylogenetically related (Mantle *et al*., 2006).

Anguillospora Ingold, Trans. Br. Mycol. Soc. **25**: 401, 1942 .... (1)
A. marina Nakagiri & Tubaki, Mycologia **75**: 488, 1983.

Teleomorph: *Lindra obtusa* Nakagiri & Tubaki.

Mycelium septate, hyaline, conidiophore simple or branched, hyaline, conidiogenous cells hyaline, monoblastic, terminal, precurrent, without a separating cell, conidia solitary, filiform, straight or curved, 9-13 (-19)-septate, swollen at both ends, hyaline, no sheath or appendages.

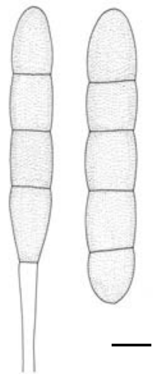


Fig. 71. Conidia of *Amorosia littoralis* (After Mantle *et al*., 2006). Bar = 5 µm.

Arthrobotrys Corda, Pracht-Fl. Eur. Schimmelbild.: 43, 1839............................ (12)
A. arthrobotryoides (Berl.) Lindau, Rabenh. Krypt. –Fl. **(leipzg) 1(8)**: 371, 1905.

Cephalothecium roseum var. *arthrobotryoides* Berl., Malpighia **2**: 245, 1888.

Didymozoophaga arthrobotryoides (Berl.) Soprunov & Galliulina, Microbiol., Reading **20**: 493, 1951.

A. brochopaga (Drechsler) S. Schenck, W.B. Kendr. & Pramer, Can. J. Bot. **55:** 982, 1977.

Arthrobotrys gracilis (Dudd.) S. Schenck, W.B. Kendr. & Pramer, Can. J. Bot. **55:** 983, 1977.

Candelabrella brochopaga (Drechsler) Subram., Kavaka **5**: 95, 1978.

Dactylaria gracilis Dudd., Trans Br. Mycol. Soc. **34**: 194, 1951.

Dactylariopsis brochopaga (Drechsler) Mekht., Mikol. Fitopatol. **1**: 278, 1967.

Dactylariopsis gracilis (Dudd.) Mekht., Khishchnye Nematofagovye Griby-Gifomitsety (Baku) 117, 1979.

Dactylella brochopaga Drechsler, Mycologia **29**: 517, 1937.

Drechslerella brochopaga (Drechsler) M. Scholler, Hagedorn & A. Rubner, Sydowia **51**: 99, 1999.

A. cladodes var. ***macroides*** Dreschler, Mycologia **36**: 144, 1944.

Trichothecium cladodes var *macroides* (Drechsler) Soprunov, Predacious fungi - Hyphomycetes and their use in the control of pathogenic nematodes: 113, 1958.

Arthrobotrys macroides (Drechsler) Mekht., Khishchnye Nematofagovye Griby–Gifomitsety (Baku) 89, 1979.

A. dactyloides Drechsler, Mycologia **29**: 486, 1937.

Arthrobotrys anchonia Drechsler, Mycologia **46**: 762, 1954.

Dactylaria dactyloides (Drechsler) Soprunov, Predacious fungi–Hyphomycetes and their use in the control of pathogenic nematodes: 142**,** 1958.

Dactylariopsis dactyloides (Drechsler) Mekht., Khishchnye Nematofagovye Griby–Gifomitsety (Baku): 120, 1979.

Drechslerella anchonia (Drechsler) M. Scholler, Hagedorn & A.Rubner, Sydowia **51**: 99, 1999.

Drechslerella dactyloides (Drechsler) M. Scholler, Hagedorn & A. Rubner, Sydowia **51**: 99, 1999.

Nematophagus anchonius (Drechsler) Mekht., Khishchnye Nematofagovye Griby–Giforitsety (Baku): 108, 1979.

A. javanica (Rifai & R.C. Cooke) Jarow., Acta Mycologica, Warszawa **6**: 373, 1970.

Candelabrella javanica Rifai & R.C. Cooke, Trans. Br. Mycol. Soc. **49**: 162, 1966.

A. mangrovispora Swe, Jeewon, Pointing & K.D. Hyde, Bot. Mar. **51**: 332, 2008.

A. musiformis Deschler, Mycologia **29**: 481, 1937.

Candelabrella musiformis (Drechsler) Rifai & R.C.Cooke, Trans. Br. Mycol. Soc. **49**: 163, 1966.

Dactylella musiformis (Drechsler) Matsush., Microfungi of the Solomon Islands and Papua-New Guinea (Osaka) 22, 1971.

A. oligospora Fresen., Beitr. Mykol. **1**: 18, 1850.

Arthrobotrys superba var. *oligospora* (Fresen.) Coem.

Didymozoophaga oligospora (Fresen.) Soprunov & Galiulina, Microbiol., Reading **20**: 493, 1951.

A. polycephala (Drechsler) Rifai, Reinwardtia **7**: 371, 1968.

Dactylaria polycephala Drechsler, Mycologia **29**: 530, 1937.

Woroninula polycephala (Drechsler) Mekht., Khishchnye Nematofagovye Griby – Gifomitsety (Baku): 110, 1979.

A. pyriformis (Juniper) Schenk, W.B. Kendr. & Pramer, Can. J. Bot. **55**: 984, 1977.

Dactylaria pyriformis Juniper, Trans. Br. Mycol. Soc. **37**: 437, 1954.

Dactylariopsis pyriformis (Juniper) Mekht., Khishchnye Nematofagovye Griby–Gifomitsety (Baku): 119, 1979.

A. superba Corda, Pracht-Fl. Eur. Schimmelbid: 43, 1839.

Didymozoophaga superba (Corda) Soprunov & Galiulina, Microbiol., Reading **20**: 493, 1951.

A. vermicola (R.C. Cooke & Satchuth.) Rifai, Reinwardtia **7**: 371, 1968.

Dactylaria vermicola R.C. Cooke & Satchuth., Trans. Br,. Mycol. Soc. **49**: 27, 1966.

Nematophagus vermicola (R.C. Cooke & Satchuth.) Mekht., Khishchnye Nematofagovye Griby – Gifomitsety (Baku): 105, 1979.

Teleomorph: in the Orbiliaceae.

Colonies white to cream to yellow, fast growing. Mycelium hyaline, septate and branched. Conidiophores erect 100-900 µm long 1.5-5 µm wide, septate, rarely producing side branches, proliferating and bearing numerous conidia. Conidia are hyaline, 1-5-septate, variously shaped, elongate, ellipsoidal, pyriform, rarely constricted at the septa, up to 60 µm long (Fig. 72). These fungi from adhesive network devices for trapping nematodes. Johnson and Autery (1961) were the first to document a predacious fungus from brackish water habitats when they tentatively identified *Arthrobotrys dactyloides* growing on pine panels (*Pinus taeda*) submerged for 37 days in the saline zone of the Neuse River estuary, North Carolina. Meyers *et al.* (1963) have documented the relationship between marine filamentous fungi and nematodes. Generic delineation of predacious fungi varies between different authors, but generally based on the morphology of the nematode trapping structures.

1. Conidia predominantly 1-septate 2
1. Conidia with 2 or more-septate 6

2. Conidia with central septum 3
2. Conidia with septum below the middle.................... 4

3. Conidiophores up to 850 µm, conidia elongate, obovoidal, ellipsoidal. 13-26 × 7-10 µm. 8-20 conidia per conidiophore .... ***A. cladodes***
3. Condiophores 100-280 µm, conidia broad-ellipsoidal 16-22 × 7-9 µm, 5-14 conidia per conidiophore .... ***A. arthrobotryoides***
3. Conidiophores 220-400 µm, conidia obovoid to clavate, 20-37.5 × 7.5-10 µm ....***A. javanica***

4. Condiophores up to 900 µm.................................... 5
4. Conidiophore up to 700 µm, conidia elongate-clavate 24-36 × 6-8 µm .... ***A. dactyloides***

4. Conidiophores up to 440 µm, conidia obovoid to pyriform, 17.5-28.8 × 10-16 µm, 10-15 conidia per conidiophore .... ***A. oligospora***

5. Conidiophores up to 830 µm, conidia elongate, obovoidal, ellipsoidal, slightly curved, 25-40 × 8.8-12.5 µm…………..……………..……***A. musiformis***
5. Conidiophores up to 900 µm, conidia elongate, oboidal, ellipsoidal, 12-23 × 6-10 µm, 12 conidia per conidiophore .... ***A. superba***

6. Conidia narrow, less than 16 µm 7
6. Conidia wider, 25-50 × 12-24 µm.***A. mangrovispora***

7. Conidiophores 90-270 µm, conidia ellipsoidal 12.5-5 × 3.5-4.5 µm, three dimentional networks ....***A. polycephala***
7. Conidiophores 78-580 µm, conidia cylindrical or elongate-ellipsoidal 20-45 × 5-12.5 µm, trapping with constricting rings........................***A. brochopaga***
7. Conidiophores 150-500 µm, conidia 38-52 × 10-11 µm .... ***A. pyriformis***

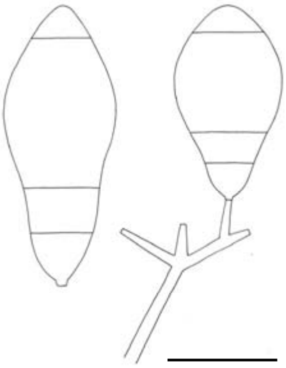


Fig. 72. *Arthrobotrys mangrovispora.* Conidiophores and conidium. Bar = 10 µm. (after Sue *et al.*, 2008).

Arthrinium Kunze, Mykologische Hefte (Leipzig) **1**: 9, 1817..................................... (1)

A. algicola (N.J. Artemczuk) N.J. Artemczuk

Papularia algicola N.J. Artemczuk, Mikol. Fitopatol. **14**: 95, 1980.

Described as a *Papularia* species it is referred here to *Arthrinium*, and isolated from the brown alga *Cystoseira barbata*. Colonies terminal, hyaline, becoming dark, reverse colony pale brown, conidiophores hyaline, conidia lentiform, brown 10.5-15.3 × 5.8-7.9 µm and similar to *Papularia sphaerosperma*.

Aspergillus Link, Observ. Mycol. (Lipstae) **1**: 16, 1809.. (1)

A. sydowii (Bainier & Sartory) Thom & Church, The Aspergilli 147, 1926.

Sterigmatocystis sydowii Bainier & Sartory, Annls. Mycol. **11**: 25, 1913.

This is a species widely reported as causing widespread mortalities of sea fans (*Gorgonia ventalina, G. flabellum*) in the Bahamas, Caribbean, Costa Rica, Cuba, Mexico, USA and Venezuela (Nieves-Rivera, 2002). Its identification as the causal pathogen was determined by a combination of morphology, virulence assays, histopathology and molecular analysis of the 18S of rDNA (Geiser *et al.*, 1998). Other *Aspergillus* species have been frequently reported from sediments, but treatment of these must await further studies.

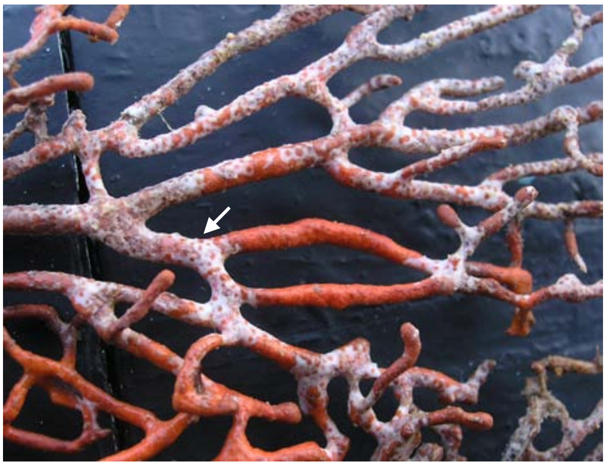


Fig. 73. Sea fan (*Annella* sp.) showing tissue loss due to fungal infections (arrowed) (**Photo by Sakanan Plathong**).

Fig. 74. White encrustation spreading over the axial skeleton of sea fan (*Annella* sp.) (**Photo by Sakanan Plathong**).

As a result of the 2004 tsunami, many gorgonian sea fans of the genus *Annella* at Mu Ko Similan National Park, Andaman Sea, Thailand were destroyed or became infected by unknown microbes. These infections were characterized by white encrustations spreading rapidly over the axial skeleton causing tissue loss and finally death of the colony (Figs. 73, 74). Phongpaichit *et al*. (2006) in a preliminary report noted an *Aspergillus* sp. and other fungal strains had infected the sea fan based on morphological and molecular data.

Asteromyces Moreau & M. Moreau, Revue Mycol., Paris **6**: 79, 1941 .... (1)
A. cruciatus Moreau & M. Moreau ex. Hennebert, Can. J. Bot. **40**: 1213, 1962 (*Type species*).

Colony on agar, greenish-brown, becoming pale brown, mycelium septate, branched, hyaline to brown, conidiogenous cells cylindrical, subglobose to subclavate, hyaline, from which arise up to 12-14 conidia, conidia ovoid to obpyriform, thin-walled, brown, develop singly, first terminal, others laterally, with a short stalk or denticles, conidial mass released in a cluster. A common species isolated from sand with unicellular conidia forming cruciate arrangement of cells. When grown on different media and under different light regimes the conidia can become septate (Jones and Ward, 1973).

Bactrodesmium Cooke, Grevillea **12**: 35, 1883.
B. linderi (J.L. Crane & Shearer) M.E. Palm & E.L. Stewart, Mycotaxon **15**: 319, 1982 ...... (1)

Trichocladium linderi J.L. Crane & Shearer., Mycologia **70**: 866, 1978.

Colonies sporodochial, hyaline becoming black, condiophores micronematous, smooth, thin-walled, hyaline or thick-walled brown, conidiogenous cells holoblastic, integrated, terminal or intercalary, smooth, cylindrical, determinate, conidia solitary, subglobose to obpyriform, 1-2-septate, not constricted at the septa, dark brown to black 20-33.6 × 14.5-20.5 µm. Moved to *Bactrodesmium* because of its compact sporodochia, not a feature of *Trichocladium* which has mononematous and scattered conidiophores. Extremely common on mangrove wood and often confused with *Trichocladium* species, especially *T. nypae* which has smaller conidia 15-20 × 10-15 µm, 2-septate, both occurring in marine habitats (Goh and Hyde, 1999). No teleomorph reported for *B. linderi*, but other species show affinities with *Stuartella* (Dothideales, *incertae sedis*).

Blodgettia Harv., Smithson. Contrib. bot. **10**: 42, 46, 1858.. (1)
B. confervoides Harv., Smithson. Contrib. bot. **10**: 48, 1858.

B. bornetii E.P. Wright, Trans. R. Ir. Acad. **28**: 25, 1881.

A confusing taxon, symbiotic (mycophycobioses) with the green algae *Cladophora caespitosa* and *C. fuliginosa* and collected from various localities (Kohlmeyer and Kohlmeyer, 1979). Mycelium growing within the inner and outer wall layer of the host, septate, branched, occurring as chlamydospores 35-150 × 8-33 µm, 1-7-septate terminal or intercalary chains, constricted at the septa, hyaline, yellow to yellow-brown (after Kohlmeyer and Kohlmeyer, 1979).

Botryophialophora Linder, Farlowia **1**: 403, 1944.. (1)
B. marina Linder, Farlowia **1**: 404, 1944 (*Type species*).

Hyphae septate, branched, hyaline to pale brown, conidiophores subglobose, lateral or apical, conidiogenous cells phialidic, flask-shaped, hyaline, conidia globose, unicellular, hyaline, no sheath or appendage. Reported from a wide range of substrata, wood, test panels, sand, sediments, but Kohlmeyer and Kohlmeyer (1979) question its marine status.

Brachysporium Sacc., Syll. fung. (Abellini) **4**: 423, 1886 (emend Mason & Hughes).......... (1)
B. helgolandicum Schaumann, Helgoländer wiss. Meeresunters. **25**: 26, 1973.

Mycelium superficial on substratum, septate, pale brown, conidiophores simple, erect, septate, pale brown, conidia broadly pyriform, 21-27 × 10-17.5 µm, 2-3-septate, pale brown, and attached to the conidiophores by long spirally coiled pedicels. No sheath or appendages. This is the only species known from marine habitats and is most similar to the genera *Trichocladium* and *Cirrenalia*.

Collected by Schaumann (1973a) on drift bark in the sea at Heligoland, Germany, however Kohlmeyer and Kohlmeyer (1979) do not list it as a marine species.

Cirrenalia Meyers & R.T. Moore, Am. J. Bot. **47**: 346, 1960 .... (7)

C. adarca Kohlm., Volkm.-Kohlm. & O.E. Erikss., Bot. Mar. **40**: 292, 1997.

Teleomorph: *Juncigena adarca* Kohlm., Volkm.-Kohlm. & O.E. Erikss.

C. basiminuta Raghuk. & Zainal, Mycotaxon **31**: 163, 1988.

C. fusca I. Schmidt, Mycotaxon. **24**: 419, 1985.

C. macrocephala (Kohlm.) Meyers & R.T. Moore, Am. J. Bot. **47**: 347. 1960 (*Type species*).

Helicoma macrocephala Kohlm., Ber. dtsch. bot. Ges. **71**: 99, 1958.

Teleomorph: in the Halosphaeriales.

C. ***pseudomacrocephala*** Kohlm., Mycologia **60**: 266, 1968.

◙ ***C. pygmea*** Kohlm., Ber. dtsch. bot. Ges. **79**: 35, 1966.

Teleomorph: in the Lulworthiales.

◙ ***C. tropicalis*** Kohlm., Mycologia **60**: 267, 1968.

Teleomorph: in the Lulworthiales.

Conidiophores present or lacking, cylindrical, septate or lacking septa, hyaline to pale brown, conidiogenous cells monoblastic, integrated, terminal, determinate, conidia solitary, helicoid, 2-12-septate, generally constricted at the septa, brown, the apical cell generally the largest. The morphology and dimensions of the apical cell determine the species. A number of terrestrial species have been described but in our opinion these are not well placed in the genus (Raghukumar *et al.*, 1988). The genus is not monophyletic (See Fig. 62) with teleomorphs in different ascomycete genera while new anamorphic genera need to be described (Jones, personal observation). Reported from a wide range of substrata in the sea.

1\. Conidia 6-septate or more 2
1\. Conidia 5-septate or less 3

2\. Apical cell 6-12 µm, 4-9-celled, hyaline to pale brown, on *Juncus* .... ***C. adarca***
2\. Apical cell 10-20 µm, 6-12-septate, reddish-brown, on wood.. ***C. tropicalis***

3\. Apical cells over 16 µm long 4
3\. Apical cells shorter than 16 µm 6

4\. Apical cell large, 16-23 µm, conidia 3-4-septate, hooked appearance, black to fuscous .... ***C. pygmea***
4\. Apical cell not hooked 5

5\. Apical cell 11-22 µm, 2-4-septate, brown to dark brown .... ***C. fusca***
5\. Apical cell 16-20 µm, 3-6-septate, fuscous to grey-brown .... ***C. pseudomacrocephala***

6\. Apical cell 9-16 µm, 3-5-septate, pale brown .... ***C. basiminuta***
6\. Apical cell 6-14 (17) µm, 2-6-septate, reddish-brown .... ***C. macrocephala***

Cladosporium Link Mag. Ges. naturf. Feunde, Berlin **7**: 37, 1816 .... (1)

C. algarum Cooke & Massee, Grevillea **16**: 80, 1888.

Hyphae septate, branched, pale brown, conidiophores macronematous, cylindrical, septate, simple, straight, smooth, brown, conidiogenous cells polyblastic, integrated, terminal with prominent scars, conidia ellipsoidal, with a basal scar, 0-3-septate, not constricted at the septa, smooth, thick-walled, olive-brown, no sheath or appendages. Reported from drift brown seaweeds and sea grasses. *Cladosporium* species are widely reported from drift material but no investigation has been carried out on the marine taxa.

Clavatospora Sv. Nilsson ex Marvanová & Sv. Nilsson, Trans. Br. Mycol. Soc. **57**: 531, 1971 .... (1)

◙ ***C. bulbosa*** (Anastasiou) Nakagiri & Tubaki, Bot. Mar. **28**: 489, 1985 (*Type species*).

Clavariopsis bulbosa Anastasiou, Mycologia **53**: 11, 1962.

Teleomorph: *Corollospora pulchella* Kohlm., I. Schmidt & N.B. Nair.

Conidia dark brown, composed of a basal bulbous cell and 1-3 radiating arms, 3-6-septate, hyaline to pale brown, cells constricted at the septa, in culture the bulbous basal cell may be absent and conidia develop as a single row of brown cells. Kohlmeyer and Kohlmeyer (1979) refer to these as chlamydospores. A common species on various substrata, particularly wood, when incubated with a layer of water over the surface.

Cumulospora I. Schmidt, Mycotaxon **24**: 420, 1985.. (2)

C. marina I. Schmidt, Mycotaxon **24**: 421, 1985 (*Type species*).

Vesicularia marina I. Schmidt, Natur Naturschutz Mecklenberg **12**: 117, 1974.

Basramyces marinus (I. Schmidt) Abdullah, Abdulk. & Goos, Intern. J. Mycol. and Lichenol. **4:** 183, 1989.

◙ ***C. varia*** Chatmala & Somrith., Fungal Diver. 1**7**: 3, 2004.

Teleomorph: in the Lulworthiales.

Mycelium septate, branched, superficial or immersed, pale brown, conidiophores absent, conidiogenous cells holoblastic, integrated, terminal, determinate, conidia initially spiral, cell division in several planes leads to a tangled knot of cells, numbering up to 40 or more, dark brown to black and constricted at the septa (Fig. 75). *Cumulospora varia* is well placed in the Lulworthiales (100% bootstrap value and 1.00 posterior probability). The two isolates of *Cumulospora varia*, isolated from Mu Ko Chang Island, Thailand, from different collections, are monophyletic, and form a sister group to *Lulwoana uniseptata* and its anamorph *Zalerion maritima* (Jones *et al.*, 2008).

1. Conidia 52-91 × 40-71 µm, up to 20 cells, cells up to 30 µm .... ***C. marina***
1. Conidia 24-87 × 21-51 µm, up to 40 cells, cells up to 20 µm..***C. varia***

Fig. 75. *Cumulospora varia.* Conidium. Bar =10 µm.

Dactylellina M. Morelet, Bull. Soc. Sci. naturelles Archeologie, Toulonet et du Var **178**: 6, 1968... (2)

D. huisuniana (J.L. Chen, T.L. Huang & Tzean) M. Scholler, Hagedorn & A. Rubner, Sydowia **51**: 111, 1999.

Dactylella huisuniana J.L. Chen, T.L. Huang & Tzean, Mycol. Res. **102**: 1269, 1998.

D. lysipaga (Drechsler) Scholler, Hagedorn & A. Rubner, Sydowia **51**: 111, 1999.

Dactylella lysipaga Drechsler, Mycologia 29:503, 1937

Teleomorph: in *Orbilia*.

Colonies light yellow, mycelium branched, septate. Conidiophores up to 250 µm erect. First conidium apical, lateral conidia on branches, condia spindle-shaped, 3-4-septate, 20-49 × 6-10 µm and hyaline. Trapping device, adhesive stalked knobs.

1. Conidiophores up to 250 µm, conidia spindle shaped, 3-4 septate, 20-49 × 6-10 µm...................***D. lysipaga***
1. Conidiophores 86-264 µm, conidia fuisiform, 3-septate, 25-52.5 × 4-6 µm ....***D. huisuniana***

Dendryphiella Bubák & Ranoj., Ann. Mycol. **12**: 417, 1914 .... (2)

◙ ***D. arenaria*** Nicot, Revue Mycol., Paris **23**: 93, 1958.

Scolecobasidium arenarium (Nicot) M.B. Ellis, More Dematiaceous Hyphomycetes (Kew): 194, 1976.

◙ ***D. salina*** (G.K. Sutherl.) G.J.F. Pugh & Nicot, Trans. Br. Mycol. Soc. **47**, 266, 1964.

Cercospora salina G.K. Sutherl., New Phythol**.** **15**: 43, 1916.

Teleomorph: in the Pleosporales, Pleosporaceae.

Hyphae septate, branched, pale brown, conidiophores macronematous, cylindrical, 1-3-septate, simple, apically swollen, pale brown to olive-brown, scars visible when conidia shed, conidia ellipsoidal, cylindrical, 1-11-septate, constricted at the septa, pale brown to olivaceous, solitary, with short stalks but not denticulate. Molecular sequence places these species in the Pleosporales (Jones *et al*., 2008). However the taxonomic position of the species needs needs resolution. Ellis (1976) referred the species to *Scolecobasidium*, however in the marine *Dendryphiella* species conidiogenous cells are enteroblastic and denticles are absent.

Ellis (1976) described pegs on the conidiogenous cells but these may be confused with extensions from the conidia as seen in SEM micrographs (Fig. 76). A new genus may be warranted for the marine species.

1. Conidia 1-3-septate, 9-20 × 4-6 µm........ ***D. arenaria***
1. Conidia 2-9-septate, 14-75 × 6-10 µm........ ***D. salina***

Dictyosporium Corda, Beitr. Gesammten Natur-Heilwiss. **1**: 87, 1836......................... (2)

D. pelagicum (Linder) G.C. Hughes ex T.W. Johnson & Sparrow, In: Fungi in Oceans and Estuaries 391, 1961.

Speira pelagica Linder, Farlowia **1**: 407, 1944.

Speira littoralis Höhnk, Veröeff. Inst. Meeresforsch. Bremerhaven **3**: 221, 1955.

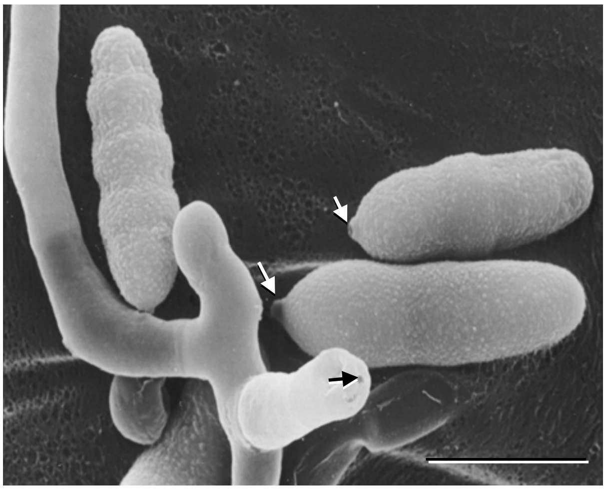


Fig. 76. Scanning electron micrograph of *Dendryphiella salina,* conidiogenous cells and conidia. Peg-like structures on the conidia (white arrows), black arrow indicates pore at the tip of the conidiogenous cell. Bar = 10 µm. No denticles found on the conidiogenous cells.

D. elegans Corda, Weitenweber's Beitrage zur Nat.: 87, 1837.

Conidiophores micronematous, mononematous, hyaline to light brown, conidiogenous cells integrated, determinate, conidia solitary, holoblastic, branched, cheiroid, dark brown to black. Both species occur on submerged wood, *D. pelagicum* a frequently occurring species, while *D. elegans* has been reported on *Rhizophora stylosa* wood in the Shiira River, Japan (Nakagiri, 1993b). Sutton (1985) considered *D. pelagicum* better placed in *Monodictys,* a view shared by Goh *et al.* (1999), however, neither proposed formal designation. *Monodictys* species rarely have branched conidia, thus we keep *D. pelagicum* in *Dictyosporium.*

1. Conidia with 5 rows of cells, (44-) 50-80 × 24-31(-37) µm, golden to reddish-brown .... ***D. elegans***
1. Conidia irregular in shape and number of cells, appears muriform, 12-66 × 9-28 (-36) µm, dark brown to black .... ***D. pelagicum***

***Fusarium* sp.**

A number of *Fusarium* species have also been isolated from sediments and sand dunes including *Fusarium oxysporum* (Nicot, 1958) and *F. solani* growing on recovered submerged twigs of *Tamarix aphylla* (Anastasiou, 1963b), but none of these have been considered to be marine.

Halenospora E.B.G. Jones gen. nov............ (1) Mycobank 513077

Holotytypus: *Helanospora varia* (Anastasiou) E.B.G. Jones [≡ *Zalerion varium* Anastasiou]

Etymology: From halen = welsh for salt in reference to its marine habitat and spora = spore.

Fungus leotiacearum mitosporarum. Mycelio hyalino, septato, ramoso; conidiophoris hyalinis, simplicibus, interdum nullis; conidiis fuscis vel nigris, conidiarum celluis catenatis tandem tortuosis denique dictyosporiformibus terminalibus. Pneumocandin nullis.

Anamorphic Ascomycota (Leotiaceae). Conidiophores simple or absent, conidia dark brown to black, cells formed in a chain, becoming tortous and appearing as terminal dictyospores. Pneumocandin negative. Phylogenetically groups with Glarea lozyensis in the Leotiaceae.

◙ ***H. varia*** (Anastasiou) E.B.G. Jones, comb. nov. Fig. 77, Mycobank 513086.

Zalerion varium Anastasiou, Can. J. Bot. 41: 1136, 1963.

Teleomorph: In the Leotiaceae, Leotatiales.

Zalerion varia (as *Z. varium*) is not congeneric with *Z. maritima* (as *Z. maritimum*) (Bills *et al*., 1999) the type species. Based on ITS sequences, *H. varia* is positioned in the Leotiaceae in a clade comprising *Galrea lozoyensis, Hymenocyphus monotropae* and *Pezicula carpinea* (Bills *et al*., 1999), while *Z. maritima* is a member of the Lulworthiales (Campbell *et al*., 2005; Jones *et al*., 2008).

Worldwide in its distribution occurring on intertidal wood, submerge leaves, seedling of *Rhizophora mangle*. No teleomorph in the Leotiaceae has been identified for the species.

Although the conidia of both *Halenospora* and *Zalerion* initially are simple coil, they differ in that in *H. varia* they "produce a lateral rather than a terminal spiral as in *Z. maritima*" (Anastasiou, 1963a). The individual cells in *H. varia* are narrower than those of *Z. maritima*, and form knot-like structures (Fig. 77) but they are not phylogenetically related. A number of fungi with similar morphology have been observed in tropical locations and await further identification and description (Jones, pers. comm.).

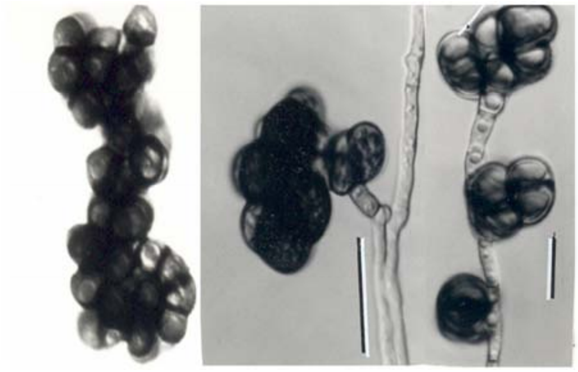


Fig. 77. *Halenospora varia*. Highly convoluted, knot-like conidia. Bars = 10 µm.

Halosigmoidea Nakagiri, K.L. Pang & E.B.G. Jones, Bot. Mar. (in press) .... (3)

H. luteola (Nakagiri & Tubaki) Nakagiri K.L. Pang & E.B.G. Jones Bot. Mar. (in press) (*Type species*).

Sigmoidea luteola Nakagiri & Tubaki., Trans. Mycol. Soc. Japan **23**: 102. 1982.

Teleomorph: *Corollospora luteola* Nakagiri & Tubaki.

H. marina (Haythorn & E.B.G. Jones). Nakagiri, K.L. Pang & E.B.G. Jones, Bot. Mar. (in press).

Sigmoidea marina Haythorn & E.B.G. Jones. Trans. Brit. Mycol. Soc. **74**: 620. 1980.

Teleomorph: In *Corollospora* close to *C. luteola.*

H. parvula Zuccaro, J.I. Mitch. & Nakagiri, Bot. Mar. (in press).

Teleomorph: In *Corollospora.*

Mycelial hyphae branched, septate, hyaline. Conidiophore hyaline pleurogenous on the mycelium initially short and simple then becoming longer and septate. Conidiogenous cells holoblastic, terminal, sympodial or irregularly sympodial and denticulate with schizolytic secession. Conidia aleuriospores, C to U-shaped, rarely sigmoid, solitary, septate, hyaline, terminal and basal cells of mature conidia devoid of contents when mature (Fig. 78).

Halosigmoidea differs from *Sigmoidea* in the following respects: (1) Conidia markedly coiled, rarely sigmoid. (2) Conidial cells slightly swollen. (3) Conidial ends cells lacking contents. (4) Phylogenetically placed in the Halosphaeriales and (5) Marine species found predominantly on decaying seaweeds, especially members of the Fucales (Haythorn *et al*., 1980; Zuccaro and Mitchell, 2005). Mature conidia are generally not constricted at the septa, but before germination each conidial cell becomes rounded and separate into individual cells or several cell clusters, from which hyphae germinate.

1. Conidia less than 100 µm, 4-5 µm wide near the middle, with indentation at some septa .... ***H. parvula***
1. Conidia longer than 100 µm 2

2. Conidia 110-180 × 4.5-10 µm near the middle, colony pale .... ***H. marina***
2. Conidia 108-222 × 4.5-7.5 µm near the middle, colony bright yellow .... ***H. luteola***

Helicorhoidion S. Hughes, Can. J. Bot. **36**: 773, 1958.. (1)

H. nypicola K.D. Hyde & Goh, Mycol. Res. **103**: 1420, 1999.

Colonies on wood black and glistening, conidiophores macronematous, unbranched, pale brown, smooth, 1-4-septate, condiogenous cells indeterminate, terminal, polydenticulate,

Fig. 78. *Halosigmoidea parvula*. End cells (arrowed) devoid of cytoplasm. Conidia 4-5-septate. Bar = 25 µm. (**Photo by Akira Nakagiri**).

conidia ellipsoidal or globose, irregularly helicoid, very tightly coiled, constricted at the septa, 15-20 × 12-15 µm, holoblastic produced on denticles by schizolysis, multiseptate, smooth and brown, occurring on *Nypa fruticans* (Hyde *et al*., 1999b). May be confused with *Zalerion varia*, but differs in the production of denticles on the conidiophores which are 1-4-septate, and long (30-70 × 2.5-4 µm).

Heliscella Marvanová, Trans. Br. Mycol. Soc. **75**: 224, 1980 .... (1)

H. stellatacula (P.W. Kirk ex Marvanová & Sv. Nilsson) Marvanová, Trans. Br. Mycol. Soc **75**: 224, 1980.

Clavatospora stellatacula P.W. Kirk, Mycologia **61**: 178, 1969

Hyphae septate, branched, hyaline, conidiophores phialidic, lageniform, simple, hyaline, conidia hyaline, 7-9 × 6-7 µm, enteroblastic-phialidic, stellate, unicellular, comprising a main axis and 3-4 subconical processes. Occurring on wood (pine test-blocks) and rarely collected since described by Kirk (1969).

Monacrosporium Oudem., Ned. kruidk. Archf, 2 sér. **4**: 250, 1885....................................... (2)

M. eudermatum (Drechsler) Subram., J. Indian bot. Soc. **42**: 293, 1964.

Arthrobotrys eudermata (Drechsler) M. Scholler, Hagedorn & A. Rubner, Sydowia **51**: 102, 1999.

Dactylaria eudermata Drechsler, Mycologia **42**: 40, 1950.

Dactylella eudermata (Drechsler) Seifert & W.B Kendr., Univ. Waterloo Biol. Ser. **27**: 30, 1983.

Genicularia eudermata (Drechsler) Rifai, Reinwardtia **7**: 367, 1968.

Geniculifera eudermata (Drechsler) Rifai, Mycotaxon **2**: 216, 1975.

Golovinia eudermata (Drechsler) Mekht., Khishchnye Nematofagovye Griby – Giforitsety (Baku): 153, 1979.

M. thaumasium (Drechsler) de Hoog & Oorschot, Stud. Mycol. **26**: 120, 1985.

Arthrobotrys thaumasia (Drechsler) S. Schenck, W.B. Kendr. & Pramer, Can. J. Bot. **55:** 984, 1977.

Candelabrella thaumasia (Drechsler) Rifai, Reinwardtia **7**: 369, 1968.

Dactylaria thaumasia Drechsler Mycologia **29**: 522, 1937.

Golovinia thaumasia (Drechsler) Mekht., Mikol. Fitopatol. **1**: 276, 1967.

Teleomorph: in the Orbiliaceae, Orbiliales.

1. Conidia 30-60 × 13-24 µm, broad at the apex, chlamydospores present ....***M. thaumasium***
1. Conidia wider, end cells pointed, no chlamydospores ....***M. eudermatum***

Monodictys S. Hughes, Can. J. Bot. **36**: 785, 1958... (1)

◙ ***M. pelagica*** (T.W. Johnson) E.B.G. Jones, Trans. Br. Mycol. Soc. **46**: 138, 1963.

Piricauda pelagica T.W. Johnson, J. Elisha Mitchell sci. Soc. **74**: 42, 1958.

Piricauda arcticoceanorum R.T. Moore, Rhodora **61**: 95, 1959.

Teleomorph: *Nereiospora cristata* (Kohlm.) E.B.G. Jones, R.G. Johnson & S.T. Moss.

A cosmopolitan species occurring on a wide range of substrata, largely with a temperate distribution. Conidiogenous cells monoblastic, integrated, terminal, determinate, cylindrical, doliiform or subspherical; conidia solitary, dry, acrogenous, simple, oblong rounded ends, pyriform, clavate, ellipsoidal, subspherical or irregular, muriform, brown to black, smooth or verrucose, basal cell sometimes inflated, paler and thinner walled than the other cells. Free sporulating in culture, conidial measurements vary between different collections. Teleomorph connection established by culture techniques (Mouzouras and Jones, 1985).

Mycoenterolobium Goos, Mycologia, **62**: 171, 1970... (1)

M. platysporum Goos, Mycologia **62**: 172, 1970.

Conidiophores micronematous, mononematous, short, hyaline, conidiogenous cells integrated, determinate, conidia solitary, holoblastic, dictyosporus, flattened in one plane, variable shape, fan shaped, and dark brown (Nakagiri, 1993b). Numerous collections from submerged *Rhizophora stylosa* wood collected in the Shiira River, Japan.

Orbimyces Linder, Farlowia **1**: 404, 1944... (1)

◙ ***O. spectabilis*** Linder, Farlowia **1**: 404, 1944 (*Type species*).

Teleomorph: In the Lulworthiales.

Conidiophores short arising from the mycelium, hyaline to pale brown, conidia with a large black basal cell, subglobose to ovoid, thick-walled, glistening, with 1-2 branches giving rise to a crown of radiating appendages, generally one apical and 4 latter arms, each one 2-4 septa, slightly constricted at the septa, and pale brown. Sporulates in culture with a putative teleomorph in the Lulworthiales (Jones *et al*., 2008). *Orbimyces spectabilis,* an infrequently collected anamorphic fungus isolated from intertidal wood in Denmark, was basal to the *Lulwoidea* clade, but with weak support (Fig. 62). Reported from driftwood, test panels, and geographically widely distributed, but uncommon.

Penicillium Link, Magazin Ges. Naturf. Freunde, Berlin **3**: 16, 1809 .... (3)
P. dimorphosporum H.J. Swart, Trans. Br. Mycol. Soc. **55**: 310, 1970.
◙ ***P. dravuni*** Janso, Mycologia **97**: 445, 2005.
P. limosum S. Udea, Mycoscience **36**: 451, 1995.

Teleomorph: *Eupenicillium limosum* S. Udea.

Penicillium limosum and *P. dimorphosporum* were described from marine sediments and *P. dravuni* collected on a submerged alga *Dictyosphaeria versluysii* by scuba diving off the coast of Fiji (Janso *et al*., 2005). *Penicillium dimorphosporum* was isolated from a mangrove swamp in Australia and has yellowish-green colonies, eventually turning deep reddish brown, conidiophores short, smooth, unbranched, phialides variable, conidia oval, smooth, later with prominent tubercles with no known teleomorph (Swart, 1970). *Penicillium dravuni* is monoverticillate, conidia spherical to subglobose, smooth-walled to finely roughened, colonies yellow-grey and belongs in the *P. thomii* series, subseries *P. turbatum* and most closely resembles *P. turbatum* (Fig. 79). Demonstrated to produce the secondary metabolites dictyosphaeric acids A and B and carviolin (Janso *et al*., 2005). No known teleomorphs for *P. dravuni* and *P. dimorphosporum.*

1. Colonies light brown to white, reverse amber to yellow at the margins, monoverticilliate, conidia spherical, 2.5-3 µm long, 2 µm wide ....***P. dravuni***
1. Colonies yellowish-green, becoming deep red, conidia oval, 2.4-2 × 1.8-2 µm.. ***P. dimorphosporum***
1. Colonies pale, with no pigment production, irregular biverticillate, conidia globose to subglobose, 2.8-3.3 × 2.5-3 µm ....***P. limosum***

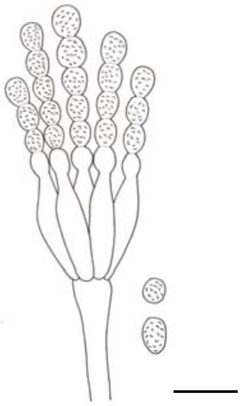


Fig. 79. *Penicillium dravuni.* Conidiophore, phialides and conidia. Bar = 5 µm.

Periconia Tode, Fung. mecklenb. sel. (Lüneburg) **2**: 2-3, 1791................................ (2)
P. abyssa Kohlm., Rev. Mycol. **41**: 202, 1977.
◙ ***P. prolifica*** Anastasiou, Nova Hedw. **6**: 260, 1963.

Teleomorph: *Okeanomyc*es *cucullatus* (Kohlm.) K.L. Pang & E.B.G. Jones.

Hyphae pale brown, septate, branching, conidiophores monoblastic, ellipsoidal, cylindrical to clavate, septate, hyaline to pale brown, conidia unicellular, subglobose or ovoid, smooth, thick-walled, pale brown to dark brown, catenulate, conidia dispersing, no sheath or appendages. *Periconia prolifica* is very common on tropical wood (Vrijmoed *et al*., 1984) occurring on a wide range of substrata, sporulating readily in culture. *Periconia abyssa* is known from recovered wood at 3975-5315 m in the Gulf of Angola and Iberian deep sea (Kohlmeyer, 1977).

1. Conidia 6-13 (-20) µm diameter, light to dark brown, littoral species ....***P. prolifica***
1. Conidia 16-20 µm diameter, brown, deep sea species ....***P. abyssa***

Phragmospathula Subram. & N.G. Nair, Antonie van Leeuwenhoek **32**: 384, 1966 ... (1)
P. phoenicis Subram. & N.G. Nair, Antonie van Leeuwenhoek **32**: 384, 1966.

Conidiophores macronematous, mono-ematous, arising from hyphae on the wood, conidiogenous cells integrated, percurrent, conidia solitary, holoblastic, spathulate, 3-septate, apical cell hyaline, middle cells brown, basal cell hyaline, no sheath or appendage. Collected on intertidal wood of *Rhizophora stylosa* in the Shiira River, Shi-Ya-O, Japan (Nakagiri, 1993b). This species may be more common than reported in the literature (Hyde, 1988).

Plectosporium M.E. Palm, W. Gams & Nirenberg, Mycologia, **87**: 398, 1995.......... (1)
P. oratosquillae Duc, Yaguchi & Udagawa, Mycopth. Mycol. Appl. (In press)

Conidiophores superficial, solitary, unbranched to sparingly branched, smooth walled; conidiogenous cells phialidic, hyaline, cylindrical or subulate; conidia unicellular, hyaline, pale yellowish brown in mass, ellipsoidal, cylindrical to obovoid, sometimes curved, 3-10 × 2-4 µm, smooth-walled, guttulate, in slimy heads at the tips of the phialides (Fig. 80). The fungus is known from diseased mantis shrimp (*Oratosquilla oratoria*) collected in Yamaguchi Pref., Japan (Duc *et al*., in press).

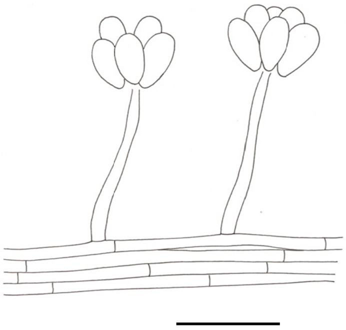


Fig. 80. *Plectosporium oratosquillae*. Conidiophore and conidium. Bar = 5 µm.

Scopulariopsis Bainier, Bull. Soc. mycol. Fr. **23**: 98, 1907 .... (1)
S. halophilica Tubaki, Trans. Mycol. Soc. Jpn. **14**: 367, 1973.

Basipetospora halophila (J.F.H. Beyma) Pitt & A.D. Hocking, Mycotaxon **22**: 198, 1985.

Oospora halophila J.F.H. Beyma, Zentbl. Bakt. ParasitKde, Abt. II **88**: 134, 1933.

Mycelium septate, branched, hyaline, annellophores borne on hyphae, hyaline, 3-18 µm, base cylindrical or slightly constricted, conidia thallic, subglobose to ovate, truncate base, rounded apex, conidial mass white, catenulate in a short chain (Tubaki, 1973a). Isolated from the seaweed *Undaria pinnatifida* (salted) and requires seawater for growth.

Stachybotrys Corda, Icon. fung. (Abellini) **1**: 21, 1837.. (2)
S. atra Corda, Icon. Fung. (Prague) **1**: 21, 1837.
S. mangiferae P.C. Misra & S.K. Srivast., Trans. Br. Mycol. Soc. **78**: 556, 1982.

Conidiophores, macronematous, branched, septate, hyaline to pale brown, verrucose, conidiogenous cells phialidic, in groups of 6-8 at the tip of the conidiophore, clavate, pale brown, conidia, ovoid to ellipsoid, verrucose, brown. *Stachybotrys atra* was reported from submerged twigs of *Tamarix aphylla* in the Salton Sea (Anastasious, 1963b) while *S. mangiferae* was reported on submerged wood of *Rhizophora stylosa* from the Shiira River, Japan by Nakagiri (1993b). *Stachybotrys* has been reported by others from marine habitats (e.g. Meyers and Reynolds, 1959) and is included here so that its occurrence in the sea can be documented and its ecological role determined.

1. Conidia 6.1-10.4 × 3.3-3.6 µm........................ ***S. atra***
1. Conidia 5-7 × 3-4 µm.......................... ***S. mangiferae***

Sporidesmium Link, Mag. Ges. naturf. Freunde, Berlin **3**: 41, 1809 .... (1)
S. salinum E.B.G. Jones, Trans Br. Mycol. Soc. **46**: 135, 1963.

Mycelium septate, branched, brown to dark brown. This species has only been collected on submerged test blocks at Port Erin Marine Station, Isle of Man, when nine collections were made on beech and Scots pine submerged test panels (Jones, 1963). Does not correspond to typical *Sporidesmium* species and further collections are required to resolve its taxonomic position. Typically has a large apical conidial cell *circa* 75 µm long.

Stemphylium Wallr., Flora crypt. Germ, (Nürnberg) **2**: 300, 1833 .... (3)

S. gracilariae E.G. Simmons, Mem. N.Y. bot. Gdn. **49**: 305, 1989.

S. maritimum T.W. Johnson, Mycologia **48**: 844, 1957.

S. triglochinicola B. Sutton & Piroz., Trans Br. Mycol. Soc. **46**: 519, 1963.

Conidiophores macronematous, mononematous, septate, smooth or verrucose, pale brown to brown or olivaceous, solitary or in groups, conidiogenous cells monoblastic, integrated, terminal, percurrent, clavate to subglobose, thin-walled, conidia oblong, ellipsoidal, obclavate or subglobose, muriform, constricted at the septa or not, smooth, verrucose or echinulate, scar at the base, pale brown, brown or olivaceous, solitary acrogenous, no sheath or appendages. Marine species collected on various substrata: algae, salt marsh plants and on submerged wood panels in the sea (Johnson, 1957). It is doubtful if any of these belong in *Stemphylium.*

1. Conidia trigonous, conidia 40-82 × 18-46 µm, up to 12 trans-septate, 1-4-longi-septate, on the salt marsh plant *Triglochin*............................***S. triglochinicola***
1. Conidia ellipsoidal, on other substrata....................2

2. Conidia 22-31 × 13-20 µm, 3-4-trans-septate, 1-2-longi-septa, on red seaweeds................***S. gracilariae***
2. Condia 19-32 × 17-29 µm, 3-4-trans-septa, 2-4-longi-septa, on submerged wood panels ....***S. maritimum***

Trichocladium Harz., Bull. Soc. Imp. nat. Moscou **44**: 125, 1871................................ (7)

T. achrasporum (Meyers & R.T. Moore) Dixon, Trans Br. Mycol. Soc. **51**: 163, 1968.

Culcitalna achraspora Meyers & R.T. Moore, Am. J. Bot. **47**: 349, 1960.

Teleomorph: *Halosphaeriopsis mediosetigera* (Cribb & J.W. Cribb) T.W. Johnson.

T. alopallonellum (Meyers & R.T. Moore) Kohlm. & Volkm.-Kohlm., Mycotaxon **53**: 352, 1995.

Humicola alopallonella Meyers & R.T. Moore, Am. J. Bot. **47**: 346, 1960.

▣ ***T. constrictum*** I. Schmidt, Nat. Naturschutz Mecklenberg **12**: 114, 1974.

T. lignicola I. Schmidt, Mycotaxon **24**: 420, 1985.

T. medullare Kohlm. & Volkm.-Kohlm., Mycotaxon **53**: 349, 1995.

Teleomorph: *Gaeumannomyces medullaris* Kohlm., Volkm-Kohlm. & O.E. Erikss.

T. melhae E.B.G. Jones, Abdel-Wahab & Vrijmoed, Fungal Diver. **7**: 50, 2001.

▣ ***T. nypae*** K.D. Hyde & Goh, Mycol. Res. **103**: 1420, 1999.

Mycelium septate, branching, pale brown to brown, conidiophores poorly differentiated, short pedicels, 0-3-septate, simple, straight, smooth, conidia produced at the apex, hyaline or pale brown, conidiogenous cells monoblastic or polyblastic, integrated, terminal, solitary, clavate, obovoid, pyriform or cylindrical, 1-4-septate, thick-walled, smooth or verrucose, pale to dark brown to black (Jones *et al*., 2001) (Fig. 81). A number of marine species have been assigned to this genus, but they are not monophyletic, as the teleomorph connections referred to above indicates.

Goh and Hyde (1999) referred *Trichocladium linderi* to *Bactrodesmium linderi. Trichocladium nypae* differs only slightly from *T. linderi.* de Bertoldi *et al.* (1972) and Lepidi *et al.* (1977) pointed out that *Humicola alopallonella* was incorrectly referred to *Humicola* because it lacked one-celled conidia, thus Kohlmeyer and Volkmann-Kohlmeyer (1995) transferred it to *Trichocladium.*

1. Conidia 1-2 (3)-septate 2
1. Conidia with more than 3-septate 3

2. Conidia 10-22 (-38) × 8-18 µm, apical cell 8.5-15.5 × 7-12 µm fuscous...........................***T. alopallonellum***
2. Conidia 6.5-14 × 3.5-9 µm, apical cell 6.5-13 × 4-9 µm, dark brown...***T. melhae***

3. Conidia with 2-3-septa, 17-26 × 7-10 µm, distal cell fuscous, elongate ellipsoid, on *Juncus*...................... ....***T. medullare***
3. Conidia with 2-3-septate, 15-20 × 10-13 (-15), curved, dark-brown on *Nypa*.......................***T. nypae***
3. Conidia with more than 3-septate 4

4. Conidia with 2-5 (-6)-septate, 25-32 × 12-17 µm, light brown, slightly constricted.............. ***T. lignicola***
4. Conidia with 2-4-septate...5

5. Conidia 25-47 × 8-20 µm, reddish-brown, subglobose, markedly constricted at the septa, 2-4-septate .... ***T. constrictum***
5. Conidia (15-) 20-34 (45) × (8-) 10-24 µm, often sporodochial, dark brown, compressed, less constricted at the septa, 2-4-septate .***T. achrasporum***

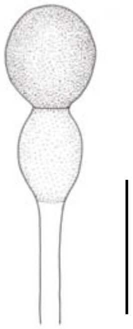


Fig. 81. *Trichocladium melhae.* Conidium. Bar = 10 µm.

Tubercularia Tode, Fung. mecklenb. sel. (Lüneburg): **1**: 18, 1790 .... (1)
T. pulverulenta Speg., An Soc. Cient. Argent. **13**: 32, 1882

Sporodochia cushion-shaped, sessile or short stalk, erumpent, conidiophores, filiform, simple, conidia produced at the apex, hyaline, conidia unicellular, ellipsoidal, hyaline to pink in a mass, smooth-walled (after Kohlmeyer and Kohlmeyer, 1979). Saprophytic on various *Salicornia* species and poorly known.

Varicosporina Meyers & Kohlm., Can. J. Bot. **43**: 916, 1965 .... (3)
V. prolifera Nakagiri, Trans Mycol. Soc. Jpn. **27**: 198, 1986.
Teleomorph: In the genus *Corollospora*
◙ ***V. ramulosa*** Meyers & Kohlm., Can. J. Bot. **43**: 916, 1965.
Teleomorph: In the genus *Corollospora.*
◙ ***V. anglusa*** Abdel-Wahab & Nagah., Mycoscience (in press).
Teleomorph: *Corollospora anglusa* Abdel-Wahab & Nagah.

Mycelium septate, branched, hyaline to pale brown, conidiophores cylindrical, septate, simple, conidiogenous cells monoblastic, integrated, generally terminal, conidia acrogenous, solitary, branched, septate, hyaline, main axis from which arise 2-3 side branches, typically tetra-radiate, and sporulating profusely on wood in a layer of seawater (Fig. 82).

1. Conidia 1-4 (-7)-septate in the main axis ***V. prolifera***
1. Conidia 1-2 (-4)-septate in the main axis***V. ramulosa***
1. Conidia 1-2-septate in the main axis........ ***V. anglusa***

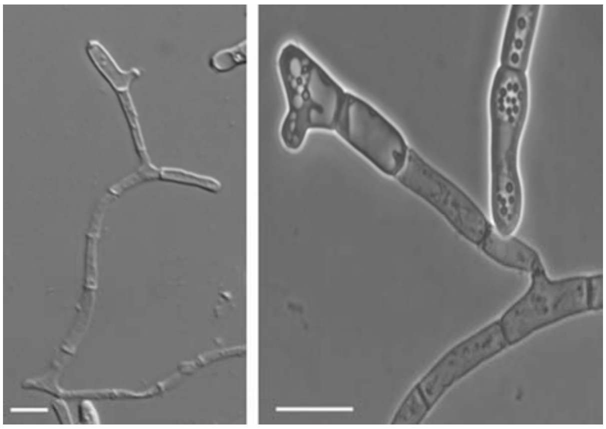


Fig. 82. Conidia of *Varicosporina anglusa*. Bars = 15 µm. (**Photo by Mohamed Abdel-Wahab**).

Xylomyces Goos, R.D. Brooks & Lamore, Mycologia **69**: 282, 1977............................ (1)
X. rhizophorae Kohlm. & Volkm.-Kohlm., Fungal Diversity. **1**: 160, 1998.

Xylomyces produces only chlamydospores of variable form, with 5 species described from freshwater and one on mangrove wood (Goos *et al*., 1977; Goh *et al*., 1997; Kohlmeyer and Volkmann-Kohlmeyer, 1998d). Chlamydospores in *Xylomyces rhizophorae* mostly apical, single or in chains, rarely branching, filamentous, straight or curved, mostly widest at the tips, tapering towards the base, dark brown, 11-34-septate and constricted at the septa (Kohlmeyer and Volkmann-Kohlmeyer, 1998d). They also reported and illustrated *Xylomyces chlamydosporus* from a saline location in Bay Minette, Alabama. We also include this species in the key as it may be encountered in marine habitats.

1. Chlamydospores with 11-34 (-64)-septa, 95-370 (-500) × 8-16 µm.................................***X. rhizophorae***
1 Chlamydospores with 5-19-septate, 95-420 × 26-42 µm..***X. chlamydosporus***

Zalerion R. T. Moore & Meyers, Can. J. Microbiol. **8**: 408, 1962 .... (1)
◙ ***Z. maritima*** (Linder) Anastasiou, Can. J. Bot. **41**: 1136, 1963 (*Type species*).
Helicoma maritimum Linder, Farlowia **1**: 405, 1944.
Helicoma salinum Linder, Farlowia **1**: 406, 1944.
Zalerion nepura R.T. Moore & Meyers, Can. J. Microbiol. **8**: 413, 1962.
Zalerion eistla R.T. Moore & Meyers, Can. J. Microbiol. **8**: 413, 1962.

◙ *Zalerion xylestrix* R.T. Moore & Meyers, Can. J. Microbiol. **8**: 414, 1962.

Zalerion raptor R.T. Moore & Meyers Can. J. Microbiol. **8**: 415, 1962.

Teleomorph: *Lulwoana uniseptata.*

Conidia pluricellular, monacrogenous, single or branched, on simple conidiophores, filaments variable in length and septation, coiled irregularly, producing a balled appearance, and subhyaline to fuscous. Three *Zalerion* species were accepted (Kirk *et al*., 2001), two marine and one of terrestrial origin (Buczacki, 1973), while four species described by Moore and Meyers (1962), based largely on their different enzyme activity, have been reduced to synonymy with *Z. maritima.* Isolates of *Z. arboricola* (a terrestrial species) are not congeneric with *Z. maritima* and isolate ATCC 20868 was transferred to a new genus *Glarea lozoyensis,* based on DNA fingerprinting (Bills *et al*., 1999). *Zalerion varia* likewise is not congeneric with *Z. maritima*, but groups with *G. lozoyensis* in the Leotiaceae, Leotiales, and is therefore assigned to the new genus *Halenospora* (see page 154). *Zalerion varia* isolates differ greatly in their morphology and collections made may not be monophyletic. A strain of *Z. xylestrix* clusters with *Z. maritima* and is considered by Campbell *et al*. (2005) to be conspecific with it, supporting the findings of Anastasiou (1963a)

COELOMYCETES

1. Conidia in an acervulus 2
1. Conidioma eustromatic 3
1. Conidioma pycnidial 4

2. Conidia with polar spines, 11-15 × 2.5-3.5 µm, on drift wood .... ***Dinemasporium marinum***
2. Conidia with no polar spines, hyperparasite of *Haloguignardia* species, conidia 2-5 × 2-2.5 µm .... ***Gloeosporidina cecidii***

3. On *Rhizophora* wood, roots and seedlings, conidia 3-6 × 1-1.5 µm......................... ***Cytospora rhizophorae***
3. On *Phragmites*, conidia 17-5-75 × 2.5-5 µm .... ***Cytoplacosphaeria phragmiticola***
3. On *Nypa fruticans*, conidia 3-4.5 × 1.2-1.6 µm .... ***Plectophomella nypae***

4. Conidia hyaline 5
4. Conidia coloured 13

5. Conidia one-celled 6
5. Conidia 3-7-septate, on various substrata .... ***Stagonospora***
5. Conidia with appendages 11

6. Conidia filiform 7
6. Conidia spherical or ellipsoidal............................... 8

7. Conidia 10-16 × 0.5 µm, on wood .... ***Halonectria milfordensis***
7. Conidia 9-12 × 1.5-2 µm, saprobic on *Avicennia* wood. .... ***Rhabdospora avicenniae***

8. Occurring on *Nypa fruticans* palm........................... 9
8. Occurring on wood and other substrata 10

9. Pycnidium superficial with a large reddish-brown neck, conidia 3.5-5 × 2-2.5 µm .... ***Pleurophomopsis nypae***
9. Pycnidium on a subiculum, conidia 2.4-4 × 1.8-2.4 µm .... ***Nypaella frondicola***

10. On wood, conidia 2.5-4.5 × 2.5-2 µm .... ***Phialophorophoma litoralis***
10. On *Rhizophora*, conidia 11-18 × 3-4 µm. .... ***Phomopsis mangrovei***
10. On various substrata, pycnidia flask-shaped superficial or submerged .... ***Phoma*** and ***Macrophoma*** species

11. Conidia 1-2-septate, with three polar appendages, on various substrata 12
11. Conidia unicellular, cylindrical, 39-49 × 6.5-8.5 µm, with 3-4 apical appendages formed by fragmentation of a sheath, on *Juncus roemerianus* .... ***Tiarosporella halmyra***

12. Conidiogenesis phialidic, conidia 16-23 × 2.5-4 µm, on *Phragmites communis* .... ***Pseudorobillarda phragmitis***
12. Conidiogenesis holoblastic, conidia 10-14 × 3-4.5 µm, on *Rhizophora mangle***,** and other *Rhizophora* species .... ***Robillarda rhizophorae***

13. Conidia one-celled 14
13. Conidia one transverse septum............................ 15
13. Conidia muriform... 17

14 Conidia with funnel-shaped polar appendages, fusiform or naviculate .... ***Koorchaloma***
14. Conidia ellipsoidal, dark brown, thick-walled, with 5-9 tentacle-like appendages .... ***Octopodotus stupendus***
14. Conidia with no appendages, 4-8 × 4-6 µm .... ***Coniothyrium obiones***

15. Saprobic on salt marsh plants............................. 16
15. Saprobic on driftwood, conidia yellowish-brown, 6-8 × 3.5-4.5 µm .... ***Diplodia orae-maris***

16. On *Halimione*, conidia yellow-brown, 9-12 × 4-5 µm ....***Ascochyta obiones***
16. On *Salicornia*, conidia olive to light brown, 4-8 × 4-6 µm ....***Ascochyta salicorniae***

17. Conidia with no sheath, 3-transverse septate, 1-longi-septate, 10-20 × 7-13 µm .... ***Camarosporium roumeguerii***
17. Conidia with a polar cap-like appendage at each end, 22-42 × 10-17 µm, on *Ammophila* ....***Amarenographium metableticum***
17. Conidia with a pronounced mucilaginous sheath, 5-transverse septate, 1-longiseptate, 20-34 × 9-20 µm ....***Camarosporium palliatum***

Amarenographium O.E. Erikss., Mycotaxon **15**: 199, 1982 .... (1)

A. metableticum (Trail) O.E. Erikss., Mycotaxon **15**: 199, 1982 (*Type species*).

Camarosporium metableticum (Trail) Grove, British Stem and Leaf Fungi, Cambridge **2**: 108, 1937.

Camarosporium graminicola Ellis and Everh., Proc. Acad. Nat. Sci. Philadelphia, **1893**: 161, 1893.

Camarosporium metableticum Trail, Scottish Naturalist **8**: 267, 1886.

Diplodina ammophilae Trail, Scott. Natural. **10**: 76, 1889.

Leptosphaeria ammophila (Lasch) Rehm, Asc.: 69, 1882.

Teleomorph: *Amarenomyces ammophilae* (Lasch) O.E. Erikss.

Pycnidia subglobose, immersed, ostiolate, papillate, clypeate?, coriaceous, black, solitary, conidiogenous cells cylindrical, conidia ellipsoidal to trapezoidal, muriform, 3-9 transverse septate, 1-2 longitudinal septate, slightly constricted at the septa, fuscous, apical cells lighter, bearing cap-like, gelatinous, striate appendages at either end of the conidium. Reported from bark, maritime grasses and salt marsh plants.

Ascochyta Lib., Pl. Crypt. Arduenna **1** (Praef.): 8, 1830... (2)

A. obiones (Jaap) P.K. Buchanan, Mycol. Pap. **156**: 28, 1987.

Ascochytula obiones (Jaap) Died., Annls mycol. **10**: 141, 1912.

Diplodia obiones Jaap, Verh. Bot. Ver. Prov. Brandenburg **47**: 96, 1905.

A. salicorniae Magnus, in Jaap, Schr. Naturwiss. Ver. Schleswig-Holstein **12**: 345, 1902.

Stagonosporopsis salicorniae (Magnus) Died., Annls. Mycol. **10**: 141-142, 1912.

Ascochyta salicorniae var. *salicorniae-patulae* Trotter, Annls. Mycol. **3**: 30, 1905.

Ascochyta salicorniae-patulae (Trotter) Melnik, Nov. Sist. Niz. Rast., **12**: 205, 1975.

Ascochyta salicorniae Trotter, Annls. Mycol. **2**: 536, 1904, nom. illegit

Diplodia salicorniae Jaap, Verh. Bot. Ver. Prov. Brandenburg **49**: 16, 1907.

Pycnidia immersed, erumpent, ovate, subglobose, ellipsoidal or pyriform, ostiolate, epapillate to papillate, coriaceous, olive brown, brown to black, solitary or gregarious, conidiogenous cells phialidic, flask-shaped to pyriform, hyaline, conidia blastic, ellipsoidal, obovate or cylindrical, 1-septate, slightly constricted at the septum, smooth-walled, hyaline to yellowish to pale brown. Parasitic or saprophytic on the salt marsh plants *Halimione portulacoides*, *Salicornia europaea*, *S. herbacea* and *S. patula.*

1. Ascospore with a sheath, hyaline to yellowish or light brown, 10-12 × 4-7 µm, ... ***A. salicorniae***
1. Ascospores without a sheath, 9-12 × 4-5 µm, pale yellowish to brown...................................***A. obiones***

Camarosporium Schulzer, Verh. zool.-bot. Ges. Wien **20**: 649, 1870..................................... (2)

C. palliatum Kohlm. & E. Kohlm., Marine Mycology, The Higher Fungi: 519, 1979.

C. roumeguerii Sacc., Michelia **2**: 112, 1880.

Camarosporium obiones Jaap, bot. Ver. Prov. Brandenburg **47**: 97, 1905.

Pycnidia immersed or erumpent, subglobose or ellipsoidal, ostiolate, epapillate or papillate, dark brown, solitary or gregarious, paraphyses present, simple, hyaline, filiform, nonseptate, conidiogenous cells phialidic, flask-shaped, simple, hyaline, conidia subglobose, ellipsoidal or oblong, enteroblastic, monophialidic, muriform, 1-6 transverse septa, 1-4 longitudinal septa, slightly constricted at the septa, smooth, gold, yellowish-brown, olive-brown to brown, with a gelatinous sheath, lacking appendages. Both species occur on the salt marsh plants *Halimione portulacoides*, and various *Salicornia* species.

1. Conidia 5-septate, 20-34 × 9-20 µm, with a pronounced gelatinous sheath, on *Salicornia* species ....***C. palliatum***
1. Conidia 3-septate, 10-20 × 7-13 µm, lacking a sheath, on stems and leaves of salt marsh plants.................... .... ***C. roumeguerii***

Coniothyrium Corda, Icon. Fung. (Abellini) **4**: 38, 1840... (1)
◙ ***C. obiones*** Jaap, Schr. naturw. Ver. Schlesing-Holstein **14**: 29, 1907.

Pycnidia subglobose, immersed to erumpent, ostiolate, short papillate, coriaceous, brown, gregarious, conidiogenous cells phialidic, flask-shaped, unicellular, hyaline, conidia 4-8 × 3.5-6 µm, ellipsoidal, ovoid, subglobose, unicellular, smooth-walled, olivaceous to pale brown, lacking a sheath or appendages. Occurs on the salt marsh plant *Halimione portulacoides*.

Cytoplacosphaeria Petr., Annls mycol. **17**: 79, 1920.. (1)
C. phragmiticola Poon & K.D. Hyde, Bot. Mar. **41**: 148, 1998.

Pycnidia large (circa 800 µm), loosely aggregated into a stroma with 1-5 locules, immersed in the substratum (*Phragmites communis*), ostiole indistinct, brown, ellipsoidal to lenticular, conidiogenous cells enteroblastic, phialidic, pronounced collarette, conidia 17.5- 75 × 2.5-5 µm, straight or slightly curved, thin-walled, 0-5 septate, not constricted at the septa, hyaline (Poon and Hyde, 1998).

Cytospora Ehrenb., Sylv. mycol. berol. (Berlin): 28, 1818... (1)
C. rhizophorae Kohlm. & E. Kohlm., Mycologia **63**: 847, 1971.

Pycnidia immersed, composed of several locules, irregular morphology, ostiolate, epapillate, coriaceous, brown, solitary or gregarious, conidiophores cylindrical, filiform, simple, septate producing conidia apically, hyaline, conidia 3-6 × 1.1-1.5 µm, allantoid or ellipsoidal-cylindrical, unicellular, hyaline, lackng a sheath or appendages, conidia released in a mass. Frequently collected on mangrove trees, particularly roots and seedlings of *Rhizophora* species (Kohlmeyer and Kohlmeyer, 1971).

Dinemasporium Lév., Annls. Sci. Nat. Bot., Sér. **35:** 274, 1846....................................... (1)
D. marinum Sv. Nilsson, Bot. Not. **110**: 321, 1957.

Acervuli cupulate, superficial, greyish-black, sessile, setae needle-shaped, brown scattered over the surface, conidiophores simple, septate, elongate-cylindrical, hyaline, conidiogenous cells cylindrical, smooth, hyaline, producing conidia at their tips, conidia 11-15 × 2.5-3.5 µm, fusoid-allantoid, unicellular, smooth, hyaline, with a single hair-like appendage at each end. Reported from driftwood and rarely collected since its original description.

Diplodia Fr., Annls. Sci Nat. Bot., Sér. 2, **1**: 302, 1834.. (2)
D. orae-maris Linder, Farlowia **1**: 403. 1944.
D. thalassia N.J. Artemczuk, Mikol. Fitopatol. **14:** 95, 1980.

Pycnidia immersed to erumpent, subglobose, ostiolate, papillate, pale to dark brown, glaborous, membranous or coriaceous, solitary or gregarious, conidiophores short cylindrical, hyaline, conidia 1-3-septate, slightly to markedly constricted at the septa, ovoid, ellipsoidal, cylindrical, yellow to brown, yellow in mass. Collections of *D. orae-maris* on driftwood while *D. thalassia* was isolated from marine sediments (Fig. 83, Artemczuk, 1980).

1. Conidia 6-8.5 × 3.5-7.5 µm, on wood. ***D. orae-maris***
1. Conidia larger 8.5-12 × 5.5- 6 µm, in sediments ....***D. thalassia***

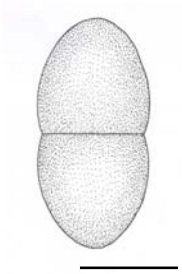


Fig. 83. *Diplodia thalassia.* Bar = 5 µm.

Gloeosporidina Petr., Annls. mycol. **19**: 214, 1921.. (1)
G. cecidii (Kohlm.) B. Sutton, The Coelomycetes (Kew): 517. 1980.

Sphaceloma cecidii Kohlm., J. Elisha Mitchell Scient. Soc. **88**: 255, 1972.

Acervuli discoid, olive coloured, later black, conidiogenous cells phialidic, cylindrical or slightly attenuated, simple with funnel-shaped mouths, conidia unicellular, hyaline, smooth-walled, ellipsoidal, 3-4.5 × 1.8-2.5 µm, truncate at the base, with a cylindrical basal appendage. Growing on the galls of *Haloguignardia* species on *Sargassum natans*.

Koorchaloma Subram., J. Indian bot. Soc. **32**: 124, 1953.. (2)
K. galateae Kohlm. & Volkm.-Kohlm., Bot. Mar. **44**: 147, 2001.
K. spartinicola V.V. Sarma, S.Y. Newell & K.D. Hyde, Bot. Mar. **44**: 321, 2001.

Conidiomata stromatic, sporodochial, punctiform, scattered, superficial, salmon to orange, with dark brown setae that are 3-4-septate, conidiophores erect, branched, thin-walled, smooth, hyaline, conidiogenous cells monoblastic, terminal, subcylindrical with collarettes, smooth, hyaline, conidia blastic-phialidic, solitary, fusiform or naviculate, with gelatinous appendages at both ends, smooth, hyaline, appendages formed by fragmentation of a sheath?, becoming inverted, funnel-shaped, then splitting into thin, radiating filaments, conidial secession schizolytic and released in a slimy mass (Figs. 84a, b) (Sarma *et al*., 2001). *Koorchaloma galateae* was described from *Juncus roemerianus* (Kohlmeyer and Volkmann-Kohlmeyer, 2001b) occurring between 5-25 cm above the rhizome while *K. spartinicola* occurs throughout the intertidal range of its host *Spartina alterniflora*, with a salinity range of 14 to 29 ‰ (Sarma *et al*., 2001).

1. Conidiomata setae 40-65 × 6.5-10 µm, conidia 15.5-21.5 × 4.5-6.5 µm, on *Juncus roemerianus*............... ....***K. galateae***
1. Conidiomata setae 45-80 × 3-5 µm, conidia 14.5-20.5 × 4.5-6.8 µm, on *Spartina alterniflora*.............. ....***K. spartinicola***

Macrophoma (Sacc.) Berl. & Voglino., Atti Soc. Veneto-Trentina Sci. Nat. (Padova) **10**: 172, 1886............................# *Macrophoma* sp.

A wide range of *Macrophoma* strains have been isolated from intertidal wood, mangrove roots, marsh plants, seawater and sediments. However few have been fully identified.

Nypaella K.D. Hyde & B. Sutton, Mycol. Res. **96**: 210, 1992 .... (1)
N. frondicola K.D. Hyde & B. Sutton, Mycol. Res. **96**: 210, 1992.

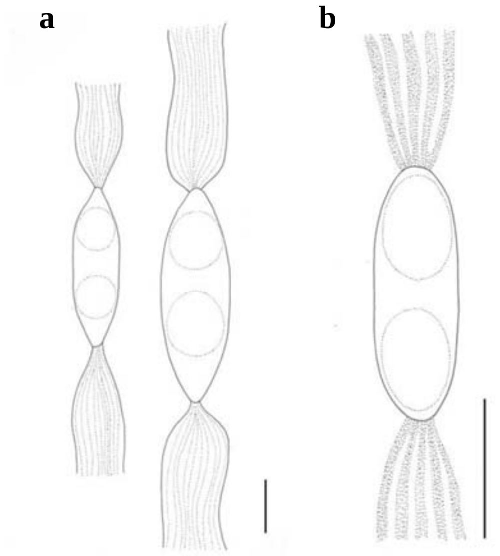


Fig. 84. **a.** *Koorchaloma galateae*.**b.** *K. spartinicola*, conidia with polar appendages. Bars: a = 5 µm, b = 10 µm.

Conidiomata pycnidial, formed on a subiculum, superficial, apricot to pale brown with central ostiole; conidiophores branched at base of the conidiomata; conidiogenous cells phialidic; conidia holoblastic, hyaline, smooth walled, ellipsoidal, unicellular, 2.4-4 × 1.8-2.4 µm, lacking a sheath or appendages (Hyde and Sutton, 1992). Saprotrophic on *Nypa fruticans.*

Octopodotus Kohlm. & Volkm.-Kohlm., Mycol. Res. **95**: 117, 2003.......................... (1)
O. stupendus Kohlm. & Volkm.-Kohlm., Mycol. Res. **95**: 117. 2003 (*Type species*).

Conidiomata pycnidial, immersed in the mesophyll between vascular bundles of leaves of *Spartina alterniflora*, light brown, ostiolate with a short papilla, peridium 6-12 µm thick; conidiophores reduced to conidiogenous cells that are discrete, conoid or irregular polygonal all around the peridial wall; macroconidia aseptate, ellipsoidal, dark brown, thick-walled, verruculose, surrounded by a gelatinous sheath and with 5-9 tentacle-like appendages. Hyaline microconidia also produced on the peridium near the ostiolar canal (Kohlmeyer and Volkmann-Kohlmeyer, 2003a).

Phialophorophoma Linder, Farlowia **1**: 403, 1944.. (1)
P. litoralis Linder, Farlowia **1**: 402, 1944.

Pycnidia immersed, subglobose or ellipsoidal, ostiolate, papillate or epapillate, subcarbonaceous, brown to black, glaborous, solitary, conidiophores cylindrical, branched, septate, with terminal phialides, conidiogenous cells monophialidic, enteroblastic, conidia ellipsoidal, obovoid or clavate, unicellular, smooth-walled, hyaline, no sheath or appendages (Kohlmeyer and Kohlmeyer, 1979). Occurring on a variety of substrata, drift and intertidal wood, bark and dead roots of *Avicennia marina*.

Phoma Sacc., Michelia **2**: 4, 1880............... (8)

****P. capitulum*** V.H. Panwar, P.N. Mathur & Thirum., Trans. Br. Mycol. Soc. **50**: 261, 1967.

P. glomerata (Corda) Wollenw. & Hochapfel, Z. Parasitkde **3**: 592, 1936.

Aposphaeria fibricola (Berk.) Sacc., Syll. fung. (Abellini) **3**: 176, 1884.

Aposphaeria glomerata (Corda) Sacc., Syll. fung. (Abellini) **3**: 175, 1884.

Coniothyrium glomeratum Corda, Icon. fung. (Prague) **4**: 39, 1840.

Peyronellaea alternariaceum (F.T. Brooks & Searle) Goid., Annali Sper. agr., n. s. **6**: 92, 1952.

Peyronellaea fibricola (Berk.) Goid., *Annali Sper. agr.*, n. s. **6**: 92, 1952.

Peyronellaea glomerata (Corda) Goid., Atti Accad. Naz. Lincei, Rendiconti Adunanze Solenni **1**: 455, 1946.

Peyronellaea glomerata (Corda) Goid., ex Togliani, Annali Sper. agr. n.s. **6**: 93, 1952.

Phoma alternariaceum F.T. Brooks & Searle, Trans. Br. Mycol. Soc. **7**: 192, 1921 (1920).

Phoma fibricola Berk., 1853.

***** ***P. hibernica*** Grimes, M. O'Connor & Cummins, Trans. Br. Mycol. Soc. **17**: 100, 1933.

P. laminariae Cooke & Massee, Grevillea **18**: 53, 1889.

***** ***P. multispora*** V.H. Pawar, P.N. Mathur. & Thirum., Trans Br. Mycol. Soc. **50**: 260, 1967.

***** ***P. navium*** Woron. Arbeit. Biol. Wolga-Station, **8**: 61 1925.

***** ***P. ostiolata*** V.H. Pawar, P.N. Mathur. & Thirum., Trans Br. Mycol. Soc. **50**: 262, 1967.

P. suaedae Jaap, Schr. Naturw. Ver. Schleswig-Holstein **14**: 27, 1907.

Phoma spp.

Teleomorph: one *Phoma* sp. has *Tremateia halophila* Kohlm., Volkm.-Kohlm. & O.E. Erikss., as its teleomorph.

Pycnidia ellipsoidal to subglobose, immersed or erumpent, ostiolate, papillate or epapillate, coriaceous, brown to black, conidiogenous cells conical, hyaline, phialidic, flask-shaped, conidia ellipsoidal to subglobose, unicellular, hyaline, smooth walled, with no sheath or appendages. Species marked * have all been isolated from marine soils (Pawar *et al*., 1967), and thus may not be regarded as obligately marine.

Phoma species are ubiquitous, geographically widespread, occurring in variety of environments and habitat niches, as saprophytes, endophytes, as biodeteriogens and parasitic on plants and animals. Because of difficulties in their identification, most are simply referred to as *Phoma* species. Some 3,000 *Phoma* epithets have been recorded in MycoBank (Crous *et al*., 2004), but Borerema *et al*. (2004) only accept *circa* 223 species. Aveskamp *et al*. (2008) questioned the validity of some of these and proposed avenues for future research, including DNA-barcoding (Herbert *et al.*, 2002).

We have not attempted a key to *Phoma* species recovered from marine habitats as the only way to resolve their taxonomy is to examine cultures and undertake molecular sequencing of their DNA.

Phomopsis (Sacc.) Bubák, Öst. bot. Z. **55**: 78, 1905.. (1)

P. mangrovei K.D. Hyde, Mycol. Res. **95**: 1149, 1991.

Teleomorph: In the Diaporthales?

Pycnidia immersed, ellipsoid or subglobose, ostiolate, solitary or gregarious, black, conidiophores branched, stout to filiform, septate, hyaline, conidiogenous cells phialidic, determinate, integrated, hyaline, cylindrical with a termial collarette, conidia holoblastic, fusiform or ellipsoidal, 11-18 × 3-4 µm, straight, unicellular, hyaline, rounded apically, truncate at the base, no sheath or appendages (Hyde, 1991d). Intertidal on prop roots of *Rhizophora* species, no teleomorph reported.

Plectophomella Moesz, Magyar Bot. Lapok. **21**: 13, 1922 .... (1)

P. nypae K.D. Hyde & B. Sutton, Mycol. Res. **96**: 211, 1992.

Conidiomata pycnidial, pale, immersed, ostiolate; conidiophores hyaline, 1-septate; conidiogenous cells phialidic, conidia holoblastic, hyaline, unicellular, smooth, cylindrical 3-4.5 × 1.2-1.6 µm. Collected on *Nypa fruticans*.

Pleurophomopsis Petr., Annls. mycol. **22**: 156, 1924.. (1)
P. nypae K.D. Hyde & B. Sutton, Mycol. Res. **96**: 213, 1992.

Conidiomata pycnidial, superficial, reddish brown, central orange ostiole; conidiophores at the base and sides of conidiomata; conidiogenous cells phialidic; conidia holoblastic, hyaline, aseptate ellipsoid to fusiform, smooth 3.5-5 × 2-2.5 µm and saprotrophic on *Nypa fruticans*. Hyde and Sutton (1992) indicate that the assignment of this species to "*Pleurophomopsis* is debatable, but there appears to be no better choice at present". Cultures of these three coelomycetes (*Nypaella*, *Plectophomella*, *Pleurophomopsis*) are required to enable determination of their phylogenetic relationship.

Pseudorobillarda M. Morelet, Bull. Soc. Sci. nat. Archéol. Toulon Var **175**, 1968 .... (1)
P. phragmitis (Cunnell) M. Morelet, Bull. Soc. Sci. nat. Archéol. Toulon Var **175**: 6, 1968.

Teleomorph: in the Dothideomycetes, (Rungjindamai *et al*., unpublished data). Pycnidia immersed, scattered, globose, dark brown, paraphyses present, conidiogenous cells subcylindrical, lageniform, colourless, smooth, conidia 1-septate, fusiform, both ends rounded, hyaline, smooth, eguttulate, 16-23 × 2.5 µm, with 2-4 appendages, growing on grasses (Plaingam *et al*., 2005). Appendages in *Pseudorobillarda sojae* are non-cellular and arise from the outer wall layer of the conidium as an outgrowth (Plaingam, 2002). *Pseudorobillarda phragmitis* (Fig. 85) was collected on pine and yellow poplar panels from estuarine waters (salinity 3-16‰) by Johnson and Hughes (1960) but originally known from *Phragmites communis* (Cunnell, 1958).

Although *Pseudorobillarda* and *Robillarda* morphologically share some common features (pycnidial, septate hyaline conidia with 3-4 polar appendages), phylogenetically they are distantly related (Rungjindamai *et al*., unpublished data).

Rhabdospora (Durieu & Mont.) Mont., Syll. Gen. Spec.: 277, 1856................................. (1)
R. avicenniae Kohlm. & E. Kohlm., Mycologia **63**: 851, 1971.

Pycnidia immersed, subglobose, unilocular, ostiolate, papillate or epapillate, coriaceous, dark brown to black, solitary or gregarious, conidiophores cylindrical or attenuate, simple, conidia produced at their apex, hyaline, conidia filiform, 9-12.5 × 1.5-2 µm, unicellular, straight mostly curved, hyaline, lacking appendages or a sheath (Kohlmeyer and Kohlmeyer, 1979). Occurring on bark and pneumatophores of *Avicennia* and proproots and trunks of *Rhizophora* trees, releasing conidia in a cirus.

Robillarda Sacc., Michelia **2**: 8, 1880 .... (1)
R. rhizophorae Kohlm., Can. J. Bot. **47**: 1483, 1969.

Teleomorph : in the Amphisphaeriaceae, Xylariales (Rungjindamai *et al*., unpublished data).

Pycnidia immersed or erumpent, ellipsoidal, unilocular, epapillate, subcoriaceous, black, glabrous, solitary or gregarious, conidiogenous cells conical or cylindrical, hyaline, conidia ellipsoidal, 1-septate, slightly constricted at the septum, smooth-walled, hyaline, with 3-4 apical radiating appendages. All collections of *R. rhizophorae* appear to be from *Rhizophora* wood.

Stagonospora (Sacc.) Sacc., Syll. fung. (Abellini) **3**: 445, 1884................................ (1)
S. haliclysta Kohlm., Bot. Mar. **16**: 213, 1973.
Stagonospora spp.

Pycnidia immersed to superficial, subglobose, ostiolate, epapillate, coriaceous, dark brown, solitary or gregarious, conidiogenous cells conoidal, simple, hyaline, conidia formed at the apex, conidia holoblastic, 20-27.5 × 3.5-4.5 µm, fusiform with rounded ends, 3-septate, slightly constricted at the septa, hyaline, smooth-walled, with an mucilaginous cap on the upper cell. Occurring on the brown seaweed *Pelvetia canaliculata* (Kohlmeyer, 1973a) and known only from the type collection. Many *Stagonospora* species have been reported from salt marsh plants,

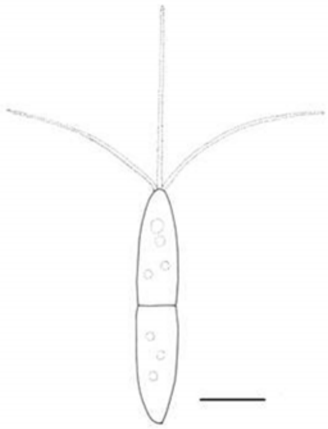


Fig. 85. *Pseudorobillarda phragmitis.* Conidium with three polar appendages. Bar = 20 µm.

especially *Spartina*, *Phragmites*, *Juncus* and *Carex* and warrant further study (Jones, 1963; Jones and Oliver, 1964; Hughes, 1969; Henningson, 1974; Gessner and Kohlmeyer, 1976).

Tiarosporella Höhn., Mitteil. bot. Ins. tech. Hochsch. Wien **1**: 82, 1924.......................... (1)
T. halmyra Kohlm. & Volkm.-Kohlm., Mycotaxon **59**: 79, 1996.

Pycnidia ellipsoidal, obpyriform, immersed, ostiolate, papillate, dark brown, solitary, conidiogenous cells cylindrical to elongate conical, conidia cylindrical, unicellular, hyaline, smooth, with 3-4 apical appendages that are tentaculiform, undulate, gelatinous, tapering to a thin tip, formed by fragmentation and eversion of a sheath (Kohlmeyer and Volkmann-Kohlmeyer, 1996). Found on senescent culms of *Juncus roemerianus*, 7 to 63 cm above the rhizome and considered to be facultative species.

TOTAL
ANAMORPHIC ASCOMYCETES ..... (103)

Concluding remarks

The past 50 years has seen a remarkable advance in our knowledge of marine fungi, a group that some might regard as a minor assemblage of fungi of little general interest. However, marine fungi play a vital role in the recycling of organic matter in coastal and oceanic waters. They are particularly important in the ecology of mangrove ecosystems, recycling leaf and ligno-cellulose, creating particulate material and dissolved organic matter for other organisms in the food web. Yet much needs to done to quantify this activity, especially for filamentous fungi.

Marine ascomycetes account for the greatest diversity of filamentous fungi, also occurring on diverse substrata (Kis-Popa, 2005). However despite intense studies at the molecular level, many genera cannot be assigned to families, and some do not fit into any orders that have been described to date. Often new orders have to be erected to accommodate them: Jahnulales (Pang *et al*., 2002), Lulworthiales (Kohlmeyer *et al*., 2000) and Koralionastetales (Campbell *et al*., 2008).

Despite an earlier view that some marine ascomycetes had originated in the marine environment, we now have documented evidence that they are secondary invaders of the marine milieu. There is no information as to when this event (s) occurred, but the fact that they are worldwide in their distribution suggests an early migration, even before the separation of land masses.

Currently we can distinguish several marine lineages; for example

Basidiomycota:
1. Physalacriaceae clade in the eugarics
2. *Nia* clade, eugarics
3. Peniophoraceae clade
4. Ustilaginomycetes clade
5. Tremellomycetes, Cystofilobasidiales clade
6. Agaricostilbomycetes, Agaricostilbales group
7. Microbotryomycetes, Sporidiobolales
8. Leucosporidiales group

Ascomycota:
9. Saccharomycetales group
10. Halosphaeriales clade
11. Lulworthiales clade
12. Hypocreales clade
13. Koralionastetales clade
14. *Torpedospora/Swampomyces* clade
15. Jahnulales clade
16. Verrucariales clade
17. Cleistothecial bitunicate ascomycetes.

Thus there has been multi-transitions from terrestrial to marine habitats often resulting in a reduced fruiting body, probably and adaptation to the aquatic habitat (Binder *et al*., 2006). Undoubtedly this transition was from terrestrial to freshwater and possibly mangrove ecosystems to completely oceanic conditions. There is an overlap in the genera found in terrestrial/freshwater/mangrove ecosystems, e.g. *Leptosphaeria*, *Phaeosphaeria* and *Massarina* species, occur in all these ecosystems and are also found in fully saline waters. However, few occur under fully submerged coniditions. An interesting group has been members of the Jahnulales, initially described from freshwater and terrestrial habitats, but also in a peat swamp and with *Manglicola* a marine genus (Pinruan *et al*., 2002; Suetrong *et al*., 2009).

So what of the future of marine mycology? While some geographical areas have been widely surveyed (temperate coastal lignicolous fungi, tropical mangrove fungi) vast areas have not been studied (South America, Africa) and cold water areas. Similarly, while some substrata have been intensively studied (cellulosic and ligno-cellulose, sand dwelling species, fungi on sea-grasses), there is much to be done to sample seaweeds, root inhabiting species, parasites of marine animals, endophytes of marine plants and animals (Kis-Papo, 2005; Raghukumar, 2008).

Taxonomic studies of marine fungi have made considerable progress in the last 20 years, especially with advent of molecular techniques. Our understanding of the physiology and biochemistry of marine fungi still remains patchy, with most studies confined to the effect of salinity on growth, movement of ions into mycelium, their ability to degrade cellulose and lignin (Mouzouras *et al*., 1988; Pointing *et al*., 1998). Another area that has attracted research interest is the source of new chemical structures and bioactive compounds from marine fungi. However, this has been confined to meet the needs of the pharmaceutical industry (Höller *et al*., 2000; Pan *et al*., 2008; Jones, 2008; Jones *et al*., 2008), rather to explore their role in the ecology of marine fungi. Few have undertaken broad enzymatic studies or pathological studies of those infecting commercial fish (Duc *et al*., 2009).

Most studies have been directed at the filamentous fungi, in particular the lignicolous ascomycetes, while anamorphic fungi present in mangrove mud's, ocean sediments are neglected and not considered part of the marine fungal community. There needs to be a new direction set for many taxa remain to be discovered in these habitats. Too rigid delineation of what is marine must be overcome, the important fact is they are repeatedly isolated from marine habitats, what is their role in nature? Sam Meyers in the early 1960's proposed the term thalassiomycetes for those fungi recovered from marine habitats. Perhaps we would have made greater advancement in the study of fungi in the sea, had such a term been adopted.

New species included in this volume, and published since Hyde *et al*. (2000).

Basidiomycota

Haloaleurodiscus mangrovei N. Maek., Suhara & K. Kinjo

Ascomycota

Bitunicate

Caryospora australiensis Abdel-Wahab & E.B.G. Jones
Decaisnella formosa Abdel-Wahab & E.B.G. Jones
Leptosphaerulina mangrovei Inderb. & E.B.G. Jones
Mauritiana rhizophorae Poonyth, K.D. Hyde, Aptroot & Peerally
Platystomum scabridisporum Abdel-Wahab & E.B.G. Jones
Trematosphaeria malaysiana Alias, McKeown, S.T. Moss & E.B.G. Jones

Unitunicate

Alisea longicola J. Dupont & E.B.G. Jones
Anthostomella spissitecta Kohlm. & Volkm.-Kohlm.
A. torosa Kohlm. & Volkm.-Kohlm.
Astrocystis nypae G.J.D. Smith & K.D. Hyde
A. selangorensis G.J.D. Smith & K.D. Hyde
Corollospora anglusa Abdel-Wahab & Nagah.
C. baravispora Steinke & E.B.G. Jones sp. nov.

C. indica Pasannarai, K. Ananda & K.R. Sridhar
C. portsaidica Abdel-Wahab & Nagah.
Dryosphaera tennuis Andrienko
Halosarpheia unicellularis Abdel-Wahab & E.B.G. Jones
Havispora longyearbyenensis K.L. Pang & Vrijmoed
Nemania maritima Y.M. Ju & J.D. Rogers
Phyllachora paludicola Kohlm. & Volkm.-Kohlm.
Pontogeneia microdictyi Kohlm. & Volkm.-Kohlm.
Pseudohalonectria halophila Kohlm. & Volkm.-Kohlm.
Pseudolignincola siamensis Chatmala & E.B.G. Jones
Remispora minuta E.B.G. Jones, K.L. Pang & Vrijmoed
Remispora spitsbergenensis K.L. Pang & Vrijmoed
Rostrupiella danica Jørg. Koch, K.L. Pang & E.B.G. Jones
Sablecola chinensis E.B.G. Jones, K.L. Pang & Vrijmoed
Savoryella melanospora Abdel-Wahab & E.B.G. Jones
Swampomyces aegyptiacus Abdel-Wahab, El-Shar. & E.B.G. Jones
Swampomyces clavatispora Abdel-Wahab, El-Shar. & E.B.G. Jones
Thalespora appendiculata Chatmala & E.B.G. Jones
Tirispora mandoviana V.V. Sarma & K.D. Hyde

Hyphomycetes
Acremonium fuci Summerb., Zuccaro & W. Gams
Amorosia littorlais Mantle & D. Hawksw.
Arthrobotrys mangrovispora Swe, Jeewon, Pointing & K.D. Hyde
Cumulospora varia Chatmala & Somrith.
Halenospora varia (Anastasiou) E.B.G. Jones.
Halosigmoidea parvula Zuccaro, J.I. Mitch. & Nakagiri
Penicillium dravuni J.E. Janso
Plectosporium oratosquillae Duc, Yaguchi & Udagawa
Trichocladium melhae E.B.G. Jones, Abdel-Wahab & Vrijmoed

Coelomycetes
Koorchaloma galateae Kohlm. & Volkm. Kohlm.
Koorchaloma spartinicola V.V. Sarma, S.Y. Newell & K.D. Hyde

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REFERENCES

Abdel-Wahab, M.A., Jones, E.B.G. and Vrijmoed, L.L.P. (1999). *Halosarpheia kandeliae* sp. nov. on intertidal bark of the mangrove tree *Kandelia candel* in Hong Kong. Mycological Research 103: 1500-1504.

Abdel-Wahab, M.A. and Jones, E.B.G. (2000). Three new marine ascomycetes from driftwood in Australian sand dunes. Mycoscience 41: 379-388.

Abdel-Wahab, M.A., El-Sharouney, H.M. and Jones, E.B.G. (2001a). Two new intertidal lignicolous *Swampomyces* species from Red Sea mangroves in Egypt. Fungal Diversity 8: 35-40.

Abdel-Wahab, M.A., Pang, K.L. El-Sharouney, H.M. and Jones, E.B.G. (2001b). *Halosarpheia unicellularis* sp. nov., (Halosphaeriales, Ascomycota) based on morphological and molecular evidence. Mycoscience 42: 255-260.

Abdel-Wahab, M.A., and Jones, E.B.G. (2003). *Decaisnella formosa* sp. nov. (Ascomycota, Massariaceae) from an Australian sandy beach. Canadian Journal of Botany 81: 598-600.

Abdel-Wahab, M.A., Nagahama, T. and Abdel-Aziz, F.A. (2008). Two new *Corollospora* species and one anamorph based on morphological and molecular data. Mycoscience (Accepted for publication, in press).

Acero, F.J., González, V., Sánchez-Ballesteros, J., Rubio, V., Checa, J., Bills, G.F., Salazar, O., Plata, G. and Peláez, F. (2004). Molecular phylogenetic studies on the Diatrypaceae based on rDNA-ITS sequences. Mycologia 96: 249-259.

Alias, S.A. (1996). Ecological and taxonomic studies of lignicolous marine fungi in Malaysian mangroves. PhD. Thesis, University of Portsmouth.

Alias, S.A., Hyde, K.D. and Jones, E.B.G. (1996). *Pyrenographa xylographoides* from Malaysia and Australia mangroves. Mycological Research 100: 580-582.

Alias, S.A., E.B.G. Jones and J. Torres. (1999). Intertidal fungi from the Philippines, with a description *Acrocordiopsis sphaerica* sp. nov. (Ascomycota). Fungal Diversity 2: 35-41.

Alias, S.A., Moss, S.T. and Jones, E.B.G. (2001). *Cucullosporella mangrovei*, ultrastructure of ascospores and their appendages. Mycoscience 42: 405-411.

Alker, A.P., Smith, G.W. and Kim, K. (2001). Characterization of *Aspergillus sydowii* (Thom & Church), a fungal pathogen of Caribbean sea fan corals. Hydrobiologia 460: 105-111.

Ananda, K. and Sridhar, K.R. (2001). *Aniptodera indica*, a new species of mangrove inhabiting ascomycete from west coast of India. Journal Environmental Biology 22: 283-286.

Anastasiou, C.J. (1963a). The genus *Zalerion* Moore et Meyers. Canadian Journal of Botany 41: 1135-1139.

Anastasiou, C.J. (1963b). Fungi from salt lakes II. Ascomycetes and Fungi Imperfecti from the Salton Sea. Nova Hedwigia 6: 243-276.

Anderson, J.L., Chen, E. and Shearer, C.A. (2001). Phylogeny of *Halosarpheia* based on 18S rDNA. Mycologia 93: 897-906.

Anderson, J.L. and Shearer, C.A. (2002). *Halosarpheia heteroguttulata*: anamorph and report from the northern hemisphere. Mycotaxon 82: 115-120.

Andrienko, A.A. (2001). Нoии Тa piДkichi bиД морсъких грuib роДу *Dryosphaera* Koch & Jones з чорного моря. Ukranian Botany Journal 58: 242-247.

Aptroot, A. (1991). A monograph of the Pyrenulaceae (excluding *Anthracothecium* and *Pyrenula*) and the Requienellaceae, with notes on the Pleomassariaceae, the Trypetheliaceae and *Mycomicrothelia* (lichenized and non-lichenized Ascomcyetes). Biblotheca Lichenologica 44: 1-178.

Aptroot, A. (1995). A monograph of *Didymosphaeria*. Studies in Mycology 37: 1-160.

Aptroot, A. (1998). A world revision of *Massarina* (Ascomycota). Nova Hedwigia 66: 89-162.

Artemczuk, N. Ya. (1980). Fungi of the Black Sea. III. New species of Ascomycetes and Fungi Imperfecti. Mikology and Fitopathology 14: 93-98.

Aveskamp, M.M., De Gruyter, J. and Crous, P.W. (2008). Biology and recent developments in the systematics of *Phoma*, a complex genus of major quarantine siginificance. Fungal Diversity 31: 1-18.

Au, D.W.T., Jones, E.B.G. and Vrijmoed, L.L.P. (1996). Ultrastructure of asci and ascospores of the mangrove ascomycete *Dactylospora haliotrepha*. Mycoscience 37: 129-135.

Au, D.W.T., Jones, E.B.G. and Vrijmoed, L.L.P. (1999a). Observations on the biology and ultrastructure of the asci and ascospores of *Julella avicenniae* from Malaysia. Mycological Research 103: 865-972.

Au, D.W.T., Jones, E.B.G. and Vrijmoed, L.L.P. (1999b). The ultrastructure of *Capronia ciliomaris*, an intertidal marine fungi from San Juan Island. Mycologia 91: 326-333.

Au, D.W.T., Vrijmoed, L.L.P. and Jones, E.B.G. (2001). Ultrastructure of asci and ascospores of *Massarina velatospora* from intertidal mangrove wood. Botanica Marina 44: 261-266.

Au, D.W.T. and Vrijmoed L.L.P. (2002). A comparative ultrastructural study of ascospore sheaths in selected marine Loculoascomycetes. In: *Fungi in Marine Environments* (ed. K.D. Hyde). Fungal Diversity Research Series 7: 81-91.

Barghoorn, E.S. and Linder, D.H. (1944). Marine fungi: Their taxonomy and biology. Farlowia 1: 395-467.

Barr, D.J.S. (1992). Evolution and kingdoms of organisms from the perspective of a mycologist. Mycologia 84: 1-8.

Barr, M.E. (1979a). On the Massariaceae in North America. Mycotaxon 9: 17-37.

Barr, M.E. (1979b). A classification of Loculascomycetes. Mycologia 71: 935-957.

Barr, M.E. (1983). The ascomycete connection. Mycologia 75: 1-13.

Barr, M.E. (1984). *Herpotrichia* and its segregates. Mycotaxon 20: 1-38.

Barr, M.E. (1990a). North American flora Series 11, part 13, Melanommatales (Loculoascomycets). New York Botanical Garden, New York.

Barr, M.E. (1990b). Porodromus to nonlichenized, pyrenomycetous members of class Hymenoascomycetes. Mycotaxon 39: 43-184.

Barr, M.E. (1993). Notes on the Pleomassariaceae. Mycotaxon 49: 129-142.

Barr, M.E. (1994). Notes on the Amphisphaeriaceae and related families. Mycotaxon 51: 191-224.

Barr, M.E. (1996). Planistromellaceae, a new family in the Dothideales. Mycotaxon 60: 433-442.

Barr, M.E. (2002). Teichosporaceae, another family in the Pleosporales. Mycotaxon 82: 373-389.

Bass, D., Howe, A., Brown, N., Barton, H., Demidova, M., Michelle, H., Li, L., Sanders, H., Watkinson, S.C., Willcock, S. and Richards, T.A. (2007). Yeast forms dominate fungal diversity in the deep oceans. Proceedings of the Royal Society B: Biological Sciences. 274: 3069-3077.

Bauer, R., Luta, M., Piatek, M., Vanky, K. and Oberwinkler, F. (2007). *Flamingomyces* and *Parvulago*, new genera of marine smut fungi (Ustilaginomycotina) Mycological Research 111: 1199-1206.

Begerow, D., Stoll, M. and Bauer, R. (2006). A phylogenetic hypothesis of Ustilaginomycotina based on multiple gene analyses and morphological data. Mycologia 98: 906-916.

Berbee, M.L. (1996). Loculoascomycete origin and evolution of filamentous Ascomycete morphology based on 18S rDNA gene sequence data. Molecular Biology and Evolution 13: 462-470.

Bills, G.F., Platas, G., Peelaez, F. and Masurekar, P. (1999). Reclassification of a pneumocandin-producing anamorph, *Glarea lozoyensis* gen. *et* sp. nov., previously identified as *Zalerion arboricola*. Mycological Research 103: 179-192.

Binder, M., and Hibbett, D.S. (2001). Higher level phylogenetic relationships of homobasidiomycetes (mushroom-forming fungi) inferred from four rDNA regions. Molecular Phylogeny and Evolution 22: 76-90.

Binder, M., Hibbett, D.S, and Molitoris, H.P. (2001). Phylogenetic relationships of the marine gasteromycete *Nia vibrissa*. Mycologia 93: 679-688.

Binder, M., Hibbett, D.S., Wang, Z. and Farnham, W.F. (2006). Evolutionary relationships of *Mycaureola dilseae* (Agaricales), a basidiomycetes pathogen of a subtidal Rhodophyte. American Journal of Botany 93: 547-556.

Bois, J. (1985). An amended description of *Trematosphaeria*. Mycologia 77: 230-237.

Boerema, G.H., De Gruyter, J., Noordeloos, M.E. and Hamers, M.E.C. (2004). *Phoma identification manual. Differentiation of specific and inferspecific taxa in culture*. CABI Publishing, UK.

Borse, B.D. and Hyde, K.D. (1989). Marine fungi from India III. *Acrocordiopsis patillii* gen. et sp. nov. from mangrove wood. Mycotaxon 34: 535.

Brooks, R.D. (1975). The presence of dolipore septa in *Nia vibrissa* and *Digitatispora marina*. Mycologia 67: 172-174.

Buchalo, A.S., Nevo, E., Wasser, S.P., Oren, A. and Molitoris, H.P. (1998). Fungal life in the extremely hypersaline watder of the Dead Sea: first records. Proceedings Royal Society London 265: 1461-1465.

Bunyard, B.A., Nicholson, M.S. and Royse, D.J. (1994). A systematic assessment of *Morchella* using RFLP analysis of the 28S ribosomal RNA gene. Mycologia 86**:** 762-772.

Buczacki, S.T. (1973). A microecological approach to larch canker biology. Transactions of the British Mycological Society 61: 315-329.

Cai, L., Hyde, K.D. and Tsui, C.K.M. (2006). Genera of freshwater fungi. Fungal Diversity Research Series 18: 1-261.

Cámaran, M.P.S., Palm, M.E., van Berkum, P. and O'Neill, N.R. (2002). Molecular phylogeny of *Leptosphaeria* and *Phaeosphaeria.* Mycologia 94: 630-640.

Campbell, J. (1999). Molecular phylogeny of the *Halosphaeriaceae.* Ph.D. Thesis, University of Portsmouth.

Campbell, J. (2005). Neotypification of *Lulworthia fucicola*. Mycologia 97: 549-551.

Campbell, J., Shearer, C.A., Mitchell, J.I. and Eaton, R.A. (2002). *Corollospora* revisited: a molecular approach. In: *Fungi in Marine Environments* (ed. K.D. Hyde). Fungal Diversity Research Series 7: 15-33.

Campbell, J., Anderson, J.L. and Shearer, C.A. (2003). Systematics of *Halosarpheia* based on morphological and molecular data. Mycologia 95: 530-552.

Campbell, J., Volkmann-Kohlmeyer, B., Gräfenhan, T., Spataofora, J.W. and Kohlmeyer, J. (2005). A re-evaluation of Lulworthiales: relationships based on 18S and 28S rDNA. Mycological Research 109: 556-568.

Campbell, J., Ferrer, A., Raja, H.A., Sivichai, S. and Shearer, C.A. (2007). Phylogenetic relationships among taxa in the Jahnulales inferred from 18S and 28S nuclear ribosomal DNA sequences. Canadian Journal of Botany 85: 873-882.

Campbell, J., Inderbitzin, P., Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (2009). Koralionastetales, a new order of marine Ascomycota in the Sordariomyces. Mycological Research. DOI 10.1016/j.mycres.2008.11.013.

Canon, P.F. (1994). The newly recognized family Magnaporthaceae and its interrelationships. Systema Ascomycetum 13: 25-42.

Cannon, P.F. and Kirk, P.M. (2007). *Fungal Families of the World*. CABI, Egham, UK.

Cesati, V. (1880). Mycetum in itinere Borneesi lectorum a cl.od. Beccari. Atti dell 'Accademia Science Fis. Mat. Napoli 8: 1-28.

Chang, H.S., Hsieh, S.Y., Jones, E.B.G., Read, S.J. and Moss, S.T. (1998). Aquatic ascomycota: New freshwater species of *Ascotaiwania* and *Savoryella* from Taiwan. Mycological Research 102: 709-718.

Chatmala, I., Valyasevi, R. and Tanticharoen, M. (2002). Anamorph/teleomorph connections of marine Ascomycota. In*: Fungi in Marine Environments* (ed. K.D. Hyde). Fungal Diversity Research Series 7: 59-68.

Chen, W., Shearer, C.A. and Crane, J.L. (1999). Phylogeny of *Ophioceras* spp. based on morphological and molecular data. Mycologia 91: 84-94.

Choi, Y.W., Hyde, K.D. and Ho, W.H. (1999). Single spore isolation of fungi. Fungal Diversity 3: 29-38.

Clipson, N., Landy, E. and Otte, M. (2001). Fungi. In: *European register of marine species. A check-list of the marine species in Europe and a bibliography of guides to their identification.* (eds. M.J. Costello, C. Emblow and R. White). Patrimonies Naturels 50: 463p.

Coppins, B.J. (1989). Notes on the Arthoniaceae in the British Isles. Lichenologist 21: 195-216.

Cotton, A.D. (1909). Notes on marine Pyrenomycetes. Transactions of the British Mycological Society 31: 92-99.

Cribb, A.B. and Cribb, J.W. (1955). Marine fungi from Queensland-1. University Queensland Papers, Department of Botany 3: 77-81.

Crous, P.W., Gams, W., Stalpers, J.A., Robert, V. and Stegehuis, G. (2004). MycoBank: an online initiative to launch mycology into the 21st centuary. Studies in Mycology 50: 19-22.

Cunnell, G.J. (1958). On *Robillarda phragmitis* sp. nov. Transactions of the British Mycological Society 41: 405-412.

Cuomo, V., Vanzanella, F., Fresi, E., Mazzella, L. and Scipione, M.B. (1982). Micoflora delle fenerogame dell 'Isola d'Ischia: *Posidonia ocenaica* (L.) Delile e *Cymodocea nodosa* (Ucria) Aschers. Bulletin Musea Institute Biologia, Universiti Genova 50: 162-166.

Cuomo, V., Vanzanella, F., S., Fresi, F., Cinelli, F. and Mazzella, L. (1985). Fungal flora of *Posidonia oceanica* and its ecological significance. Transactions of the British Mycological Society 84: 35-40.

Currah, R.S. (1985). Taxonomy of the Onygenales: Arthrodermataceae, Gymnoascaceae, Myxotrichaceae and Onygeniaceae. Mycotaxon 24: 1-26.

Davidson, D.E. and Christensen, M. (1974). *Emericellopsis stolkiae* sp. nov. from saline soils in Wyoming. Transactions of the British Mycological Society 57: 385-391.

de Bertoldi, M., Lepidi, A.A. and Nuti, M.P. (1972). Classification of the genus *Humicola* Traaen. I. Preliminary reports and investigations. Mycopathology Mycology Applicata 46: 289-304.

Demoulin, V. (1985). The red algal-higher fungi Phylogenetic link: the last ten years. BioSystems 18: 347-356.

Denison, W.B. and Carroll, G.C. (1966). The primitive Ascomycete: a new look at an old problem. Mycologia 58: 249-269.

Desjardin, D.S., Martinez-Peck, L. and Rachenberg, M. (1995). An unusual psychrophilic aquatic agaric from Argentina. Mycologia 87: 547-550.

Doguet, G. (1967). *Nia vibrissa* Moore et Meyers, remarquable Basidiomycète marin. Comptes rendus hebdomadaire des séances de l'Académie des sciences, Paris 265: 1780-1783.

Doguet, G. (1968). *Nais vibrissa* Moore et Meyers, Gastéromycète marin. 1., Conditions générales de formation des carpophores en culture. Bulletin de la Société Mycologique de France 84: 434-351.

Dring, D.M. (1973). Gasteromycetes. In: *The Fungi* (eds. G.C. Ainsworth. F.K. Sparrow and A.S.

Sussman), Vol. 4B, Academic Press, New York: 451-478.

Duc, P.M., Hatai, K., Kurata, O., Tensha, K., Yoshitaka, U., Yaguchi, T. and Udagawa, S.I. (2009). Fungal infection of mantis shrimp (*Oratasquilla oratoria*) by two anamorphic fungi found in Japan. Mycologia Applicata (in press).

Dupont, J., Magnin, S., F Rosseau, F., Zbinden, M., Frébourg, G., de Forges B.R., Samadi, S. and Jones, E.B.G. (2009). Systematics of two deep-sea Ascomycetes. Mycological Research (in press).

Ellis, M.B. (1976). *Dematiaceous Hyphomycetes*. CAB International, Wallingford, UK.

Eriksson, O.E. (1981) The families of bitunicate ascomycetes. Opera Botanica 60: 1-220.

Eriksson, O.E. (1999). Outline of Ascomycota 1999. Myconet 3: 1-88. [http://www.umu.se/myconet /M3.html]

Eriksson, O.E. and Hawksworth, D.L. (1991). Notes on ascomycete systemtatics. Systema Ascomycetum 10: 135-150.

Eriksson, O.E., Baral, H.-O., Currah, R.S., Hansen, K., Kurtzman, C.P., Rambold, G. and Læssøe, T. (2003). Outline of Ascomycota. Myconet 9: 1-89.

Farrant, C.A. and Jones, E.B.G. (1986). *Haligena salina*: a new marine pyrenomycete. Botanical Journal of the Linnean Society 93: 405-411.

Farrant, C.A., Hyde, K.D. and Jones, E.B.G. (1985). Further studies in lignicolous marine fungi from Danish sand dunes. Transactions of the British Mycological Society 85: 164-167.

Feldmann, G. (1959). Une ustilaginale marine, paraite du *Ruppia maritima* L. Revue general de botanique 66: 35-39.

Fell, J.W. (1976). Yeasts in oceanic regions, In: *Recent Advances in Aquatic Mycology* (ed. E.B.G. Jones). Elek Science, London 93-124.

Fell, J.W., Boekhout, T., Fonseca, A. and Sampaio, J.P. (2001). Basidiomycetous yeasts. In: *Mycota, Systematics and Evolution* (eds. D.J. McLaughlin, E.G. McLaughlin and P.A. Lemke). Part VII, Springer-Verlag, Berlin Heidelberg 3-35.

Fell, J.W., Statzall-Tallman, A. and Kurtzman, C.P. (2004). *Lachancea meyersii* sp. nov., an ascosporogenous yeast from mangrove regions in the Bahama Islands. Studies in Mycology 50: 359-363.

Felsentstein, J. (1985). Confidence intervals on phylogenies: an approach using the bootstrap. Evolution 39: 783-791.

Fletcher, A. (1973a). The ecology of marine (littoral) lichens on some rocky shores of Anglesey. Lichenologist 5: 368-400.

Fletcher, A. (1973b). The ecology of maritime (supralittoral) lichens on some rocky shores of Anglesey. Lichenologist 5: 401-422.

Fletcher, A. (1975). Key for the identification of British marine and maritime lichens I. Siliceous rocky shore species. Lichenologist 7: 1-52.

Fletcher, A. (1980) Marine and maritime lichens on rocky shores: their ecology, physiology and biological interactions. In: *The Shore Environment: Methods and Ecosystems.* (eds. J.H. Price, D.L. Irvine, W.F. Farnham) Academic Press, London and New York 789-842.

Fröhlich, J. and Hyde, K. D. (1999). Biodiversity of palm fungi in the tropics: Are global fungal diversity estimates realistic. Biodiversity and Conservation 8: 977-1004.

Geiser, D.M., Taylor, J.W., Ritchie, K.B. and Smith, G.W. (1998). Cause of sea fan death in the West Indes. Nature 394: 137-138.

Gessner, R.V. and Kohlmeyer, J. (1976). Geographical distribution and taxonomy of fungi from salt marsh *Spartina.* Canadian Journal of Botany 54: 2023-2037.

Ginns, J. and Malloch, D.W. (1977). *Halocyphina*, a marine basidiomycete (Aphyllophorales). Mycologia 69: 53-58.

Goh, T.K. and Hyde, K.D. (1999). A synopsis of *Trichocladium* species, based on the literature. Fungal Diversity 2: 101-118.

Goh, T.K., Ho, W.H., Hyde, K.D. and Tsui, K.M. (1997). Four new species of *Xylomyces* from submerged wood. Mycological Research 101: 1323-1328.

Goh, T.K., Hyde, K.D., Ho, W.H. and Yanna (1999). A revision of the genus *Dictyosporium*, with descriptions of three new species. Fungal Diversity 2: 65-100.

Golubic, S., Radtke, G. and Le Campion-Alsumard, T. (2005). Endolithic fungi in marine ecosystems. Trends in Microbiology 13: 229-235.

Goos, R.D., Brooks, R.D. and Lamore, B.J. (1977). An undescribed hyphomycete from wood submerged in a Rhode Island stream. Mycologia 69: 280-286.

Grube, M. and Ryan, B.D. (2002). *Colemopsidium*. In: *Lichen flora of the Greater Sonoran Desert Region* (eds. T.H. Nash. B.D. Ryan, C. Gries and F. Bungarts) 1162-164, Lichyenc Unlimited, Temp.

Guarro, J., Cannon, P.F. and van der Aa, H.A. (1999). A synopsis of the genus *Zopfiella* (Ascomycetes, Lasiosphaeriaceae). Systema Ascomycetum 10: 79-112.

Gueidan, C., Roux, C. and Lutzoni, F. (2007). Using a multigene phylogenetic analysis to assess generic delineation and character evolution in Verrucariaceae (Verrucariales, Ascomycota). Mycological Research 111: 1145-1168.

Gunde-Cimerman, N., Zalar, P., de Hoo, G.S. and Plemenitas, C. (2000). Hypersaline waters in salterns: natural ecological niches for halophilic balck yeasts. FEMS Microbiology and Ecology 32: 235-240.

Hafellner, J. (1979). *Karschia.* Revision einer Sammelgattung an der Grenze von lichenisierten und nichtilchenisierten Ascomyceten. Beih. Nova Hedwigia 62: 1-248.

Hall, T. (2001). BioEdit 5.0.6. Department of Microbiology, North Carolina State University. (http://www.mbio.ncsu.edu/BioEdit/bioedit.html)

Hall, T. (2004). BioEdit 6.0.7. Department of Microbiology, North Carolina State University. (http://www.mbio.ncsu.edu/BioEdit/bioedit.html)

Hambleton, S. and Sigler, L. (2005). *Meliniomyces*, a new anamorph for root-associated fungi with phylogenetic affinities to *Rhizoscyphus ericae* (= *Hymenoscyphus ericae*), Leotiomycetes. Studies in Mycology 53: 1-27.

Harada, H. (1995). Two new species of maritime lichens in the genus *Verrucaria* (Lichens, Verrucariaceae) from Japan. Nova Hedwigia 60: 73-78.

Harada, H. (1996). Taxonomic notes on the lichen family Verruariaceae in Japan (VI). *Verrucaria maura* in Japan. Hikobia 12: 55-59.

Harada, H. (2000). Taxonomic notes on pyrenocarpus lichen in Japan (2). *Pyrenocollema halodytes* (Nyl.) R.C. Harris in Egan, a marine cyanolichen. Hokobia 13: 133-139.

Hawksworth, D.L. (1979). Ascospore sculpturing and generic concepts in the Testudinaceae (syn. Zopfiaceae). Canadian Journal of Botany 57: 91-99.

Hawksworth, D.L. (2000). Freshwater and marine lichen-forming fungi. Fungal Diversity 5: 1-7.

Hawksworth, D.L., Kirk, P.M., Sutton, B.C. and Pegler, D.N. (1995). *Ainsworth and Bisby's Dictionary of the Fungi*, 8th Edition, CAB International, UK.

Haythorn, J.M., Jones, E.B.G and Harrison, J.L. (1980). Observations on marine algicolous fungi, including the hyphomycete *Sigmoidea marina* sp. nov. Transactions of the British Mycological Society 74: 615-623.

Henningson, M. (1974). Aquatic lignicolous fungi in the Baltic and along the west coast of Sweden. Svensk Botanisk Tidskrift 68: 401-425.

Hennings, P. (1908). Fungi Philippinensis. I. Hedwigia 47: 250-265.

Herbert, P.D.N., Cywinska, A., Ball, S.L. and De Ward, J.R. (2002). Biological identifications through DNA barcodes. Proceedings of the Royal Society of London B 270: 313-321.

Hibbett, D.S. (2006). A phylogenetic overview of the Agariomycotina. Mycologia 98: 917-925.

Hibbett, D.S. (2007). After the gold rush, or before the flood? Evolutionary morphology of mushroom-forming fungi (Agaricomycetes) in the early 21st century. Mycological Research 111: 1001-1018.

Hibbett, D.S. and Binder, M. (2001). Evolution of marine mushrooms. Biological Bulletin 201: 319-322.

Hibbett, D.S. and Binder, M. (2002). Evolution of complex fruiting-body morphologies in homobasidiomycetes. Proceedings of the Royal Society London B. Biological Science 269: 1963-1969.

Hibbett, D.S. and Donoghue, M.J. (1998). Integrating phylogenetic analysis and classification in fungi. Mycologia 90: 347-356.

Hibbett, D.S. and Thorn, R.G. (2001). Basidiomycota: Homobasidiomycetes. In: *The Mycota* (eds. D.J. McLaughlin, E.G. McLaughlin and P.A. Lemke). Vol. VII. Systematics and evolution. Springer-Verlag, Berlin: 121-168.

Hibbett, D.S., Binder, M., Bischoff, J.F., Blackwell, M., Cannon, P.F., Eriksson, O.E., Huhndorf, S., James, S.T., Kirk, P.M., Lucking, R., Lumbsch, H.T., Lutzoni, F., Matheny, P.B., Mclaughlin, D.J., Powell, M.J., Redhed, S., Scoch, C.L., Spatafora, J.F., Stalpers, J.A., Vilgalys, R., Aime, M.C., Aptroot, A.A., Bauer, R., Begerow, D., Benny, G.L., Castelbury, L.A., Crous, P.W., Dai, Y.C., Gams, W., Geiser, D.M., Griffith, G.W., Gueidan, C., Hawksworth, D.L., Hestmark, G., Hosaka, K., Humber, R.A., Hyde, K.D., Ironisde, J.E., Koljag, U., Kurtzman, C.P., Larsson, K.H., Lichtwardt, R., Longcore, J., Miadlikowska, J., Miller, A., Moncalvo, J.M., Mozley-Standridge, S., Oberwinkler, F., Parmasto, E., Reeb, V., Rogers, J.D., Roux, C., Ryvarden, L., Sampaio, J.P., Schβler, A., Sugiyama, J., Thorn, R.G., Tibell, L., Untereiner, W.A., Walker, C., Wang, Z., Weir, A., Weiss, M., White, M.M., Winka, K., Yao, Y.J. and Zhang, N. (2007). A higher-level phylogenetic classification of the fungi. Mycological Research 111: 509-547.

Hibbits, J., Hughes, G.C. and Sparks, A.K. (1981). *Trichomaris invadens* gen. et sp. nov., an ascomycete parasite of the tanner crab (*Chionoecetes bairdi* Rathburn Crustaceae; Brachyura). Canadian Journal of Botany 59: 2121-2128.

Ho, Y.W. (2007). Anaerobic rumen fungi. In: *Malaysisan Fungal Diversity* (eds. E.B.G. Jones, S. Vikineswary and K.D. Hyde). Mushroom Research Centre, University Malaya and Ministry of Natural Resources and Environment, Malaysia: 117-139.

Ho, Y.W. and Barr, D.J.S. (1995). Classification of anaerobic gut fungi from herbivores with emphasis on rumen fungi from Malaysia Mycologia 87: 655-677.

Höller, U., Wright, A.D., Matthée, G.F., Konig, K.M., Draeger, S., Aust, H.J. and Schulz, B. (2000). Fungi from marine sponges: diversity, biological activity and secondary metabolites. Mycological Research 104: 1354-1365.

Holm, L. and Holm, K. (1998). Studies in the lophiostomataceae with emphasis on the Swedish species. Symbolae Botanica Uppsaliense 28: 1-50.

Hsieh, S.Y., Moss, S.T. and Jones, E.B.G. (2007). Ascoma development in the marine ascomycete *Corollospora gracilis* (Halosphaeriales, Hypocreomycetidae, Sordariomycetes). Botanica Marina 50: 1-12.

Hughes, G.C. (1969). Marine fungi from British Columbia: occurrence and distribution of lignicolous species. Syesis 2: 419-441.

Huhndorf, S.M. (1994). Neotropical ascomycetes. 5. Hypsostromataceae, a new family of Loculoascomycetes and *Manglicola samuelsii*, a new species from Guyana. Mycologia 86: 266-

269.

Huhndorf, S.M., Miller, A.N. and Fernández, F.A. (2004). Molecular systemtatics of the Sordariales: the order and the family Lasiosphaeriaceae redefined. Mycologia 96: 368-387.

Hyde, K.D. (1986). Frequency of occurrence of lignicolous marine fungi in the tropics. In: *The Biology of Marine Fungi* (ed. S.T. Moss). Cambridge Univeristy Press, UK: 311-322.

Hyde, K.D. (1988). Studies on the tropical marine fungi of Brunei. II. Notes on five interesting species. Transactions of the Mycological Society of Japan 29: 161-171.

Hyde, K.D. (1989a). *Capillataspora coticola* gen. et sp. nov., a new bitunicate ascomycete from intertidal prop roots of *Rhizophora apiculata*. Canadian Journal of Botany 67: 2522-2524.

Hyde, K.D. (1989b). Intertidal mangrove fungi from north Sumatra. Canadian Journal of Botany 67: 3078-3082.

Hyde, K.D. (1989c). *Caryospora mangrovei* sp. nov. and notes on marine fungi from Thailand. Transactions of the Mycological Society of Japan 30: 333-341.

Hyde, K.D. (1990). Intertidal fungi from warm temperate mangroves of Australia, including *Tunicatispora australiensis,* gen. et sp. nov. Australian Systematic Botany 3: 711-718.

Hyde, K.D. (1991a). *Mangrovispora pemphi* gen. et sp. nov., a new marine fungus from *Pemphis acidula.* Systema Ascomycetum 10: 19-25.

Hyde, K.D. (1991b). *Helicascus kanaloanus*. *Helicascus nypae* sp. nov. and *Salsuginea ramicola* gen. et sp. nov. from intertidal mangrove wood. Botanica Marina 34: 311-318.

Hyde, K.D. (1991c). A new amphisphaeriaceous fungus from intertidal fronds of *Nypa fruticans*. Transactions of the Myoclogical Society Japan 32: 265-271.

Hyde, K.D. (1991d). *Phomopsis mangrovei*, from intertidal prop roots of *Rhizophora* sp. Mycological Research 95: 1149-1151.

Hyde, K.D. (1992a). Fungi from decaying intertidal fronds of *Nypa fruiticans*, including three new genera and four new species. Botanical Journal Linnean Society 116: 95-110.

Hyde, K.D. (1992b). Intertidal mangrove fungi from the west coast of Mexico, including one new genus and two new species. Mycological Research 96: 25-30.

Hyde, K.D. (1992c). *Julella avivenniae* (Borse) comb. nov. (Thelenellaceae) from intertidal mangrove wood and miscellaneous fungi from the North East Coast of Queensland. Mycological Research 95: 939-942.

Hyde, K.D. (1992d). Tropical Australian Freshwater Fungi. II. *Annulatascus velatispora* gen. et sp. nov., *A. bipolaris* sp. nov., and *Nais aquatica* sp. nov. (Ascomycetes). Australian Systematic Botany 5: 117-124.

Hyde, K.D. (1994a). Fungi on Plams. XI. *Appendispora frondicola* gen. et sp. nov. from *Oncosperma horridium* in Brunei. Sydowia 45: 29-34.

Hyde, K.D. (1994b). Fungi from rachids of *Livistonia* in the Western Province of Papua New Guinea. Botanical Journal of the Linnean Society 116: 315-324.

Hyde, K.D. (1995a). *Eutypella naqsii* sp. nov. from intertidal *Avicennia.* Mycological Research 99: 1462-1464.

Hyde, K.D. (1995b). Fungi from palms. XVII. The genus *Fasciatispora*, with note on *Amphisphaerella*. Nova Hedwigia 61: 249-268.

Hyde, K.D. (1996). Fungi from palms. XXIX. *Arecophila* gen. nov. (Amphisphaeriaceae, Ascomycota), with five new species and two new combinations. Nova Hedwigia 63: 81-100.

Hyde, K.D. and Alias, S.A. (1999). *Linocarpon angustatum* sp. nov., and *Neolinocarpon nypicola* sp. nov. from petioles of *Nypa fruticans*, and a list of fungi from aerial parts of this host. Mycoscience 40: 145-149.

Hyde, K.D. and Alias, S.A. (2000). Biodiversity and distribution of fungi associated with decomposing *Nypa fruticans*. Biology and Conservation 9: 393-402.

Hyde, K.D. and Aptroot, A. (1998). Tropical freshwater species of the genera *Massarina* and *Lophiostoma* (ascomycetes). Nova Hedwigia 66: 489-502.

Hyde, K.D. and Bose, B.D. (1986). Marine fungi from Seychelles V. *Biatriospora marina* gen. et sp. nov. from mangrove wood. Mycotaxon 26: 263-270.

Hyde, K.D. and Cannon, P.F. (1992). *Polystigma sonneratiae* causing leaf spots on the mangrove genus *Sonneratia.* Australian Systematic Botany 5: 415-420.

Hyde, K.D. and Frödlich, J. (1999). Fungi on palms. XXXVI. The genus *Astrosphaeriella,* including 10 new species. Sydowia 50: 81-132.

Hyde. K.D. and Jones, E.B.G. (1986a). Marine fungi from Seychelles. IV. *Cucullospora mangrovei* gen. et sp. nov. from dead mangrove. Botanica Marina 29: 491-495.

Hyde. K.D. and Jones, E.B.G. (1986b). Marine fungi from Seychelles. II. *Lanspora coronata* gen. et sp. nov. from driftwood. Canadian Journal of Botany 64: 1581-1585.

Hyde. K.D. and Jones, E.B.G. (1989a). Marine fungi from Seychelles. VIII. *Rhizophila marina*, a new ascomycetes from mangrove prop roots. Mycotaxon 34: 527-533.

Hyde. K.D. and Jones, E.B.G. (1989b). *Hypophloeda rhizophora* Hyde et Jones gen. et sp. nov., a new ascomycete from intertidal prop roots of *Rhizophora* spp. Transactions of the Mycological Society Japan 30: 61-68.

Hyde, K.D. and Jones, E.B.G. (1989c). Observations on ascospore morphology in marine fungi and their attachment to surfaces. Botanica Marina 32: 205-218.

Hyde, K.D. and Jones, E.B.G (1989d). Intertidal mangrove fungi from Brunei. *Lautospora* *gigantea* gen. et sp. nov., a new Loculoascomycete from prop roots of *Rhizophora* sp. Botanica Marina 32: 479-482.

Hyde, K.D. and Jones, E.B.G. (1992a). Intertidal mangrove fungi: *Pedumispora* (Diaporthales). Mycological Research 96: 78-80.

Hyde, K.D. and Jones, E.B.G. (1992b). Taxonomic studies on *Savoryella* Jones et Eaton (Ascomycotina). Botanica Marina 35: 83-91.

Hyde, K.D. and Mouzouras, R. (1988). *Passeriniella savoryellopsis* sp. nov., a new ascomycete from intertidal mangrove wood. Transactions of the British Mycological Society 91: 179-185.

Hyde, K.D. and Nakagiri, A. (1989). A new species of *Oxydothis* from the mangrove palm *Nypa fruticans*. Transaction of the Mycological Society Japan 30: 69-75.

Hyde, K.D. and Rappaz, F. (1993). *Eutypa bathurstensis* sp. nov. from intertidal *Avicennia.* Mycological Research 97: 861-864.

Hyde, K.D. and Sarma, V.V. (2000). Pictorial key to higher marine fungi. In: *Marine Mycology: A. Practical Approach* (eds. K.D. Hyde and S.P. Pointing). Fungal Diversity Press, Hong Kong: 205-270.

Hyde, K.D. and Sutton, B.C. (1992). *Nypaella frondicola* gen. et sp. nov., *Plectophomella nypae* sp. nov. and *Pleurophomopsis nypae* sp. nov. (Coelomycetes) from intertidal fronds of *Nypa fruticosa.* Mycological Research 96: 210-214.

Hyde, K.D. and Taylor, J. (1996). Fungi from palms XXXI. The genus *Nipicola* (Ascomycetes, Xylariaceae), with one new species. Nova Hedwigia 63: 417-424.

Hyde, K.D. and Wong, S.W. (1999). An ultrastructural study of the asci and banded ascospores of *Fasciatispora petrakii.* Fungal Diversity 2: 129-134.

Hyde, K.D., Goh, T.K., Lu, B.S. and Alias, S.A. (1999b). Eleven new intertidal fungi from *Nypa fruticans.* Mycological Research 103: 1409-1422.

Hyde, K.D., Farrant, C.A. and Jones, E.B.G. (1986). Marine fungi from Seychelles. III. *Aniptodera mangroveii* sp. nov. from mangrove wood. Canadian Journal of Botany 64: 2989-2992.

Hyde, K.D., Fröhlich, J. and Taylor, J.E. (1999a). Fungi on palms. XXXVI. Reflections on unitunicate ascomycetes with apiospores. Sydowia 50: 21-80.

Hyde, K.D., Sarma, V.V. and Jones, E.B.G. (2000). Morphology and taxonomy of higher marine fungi. In: *Marine Mycology-A Practical Approach* (eds. K.D. Hyde and S.B. Pointing). Fungal Diversity Research Series 1, Fungal Diversity Press, Hong Kong: 172-204.

Hyde, K.D., Fröhlich, J. and Taylor, J.E. (1998). Fungi from palms. XXXVI. Reflections on uitunicate ascomycetes with apiospores. Sydowia 50: 21-80.

Hyde, K.D., Wong, W.S. and Aptroot, A. (2002). Marine and estuarine species of *Lophiostoma* and *Massarina*. In: *Fungi in marine environments* (ed. K.D. Hyde). Fungal Diversity Research Series 7: 93-109.

Inderbitzin, P. and Desjardin, D.E. (1999). A new halotolerant species of *Physalacria* from Hong Kong. Mycologia 91: 666-668.

Inderbitzin, P., Jones, E.B.G. and Vrijmoed, L.L.P. (2000). A new species of *Leptosphaerulina* from decaying mangrove wood from Hong Kong. Mycoscience 41: 233-237.

Inderbitzin, P., Jones, E.B.G., Abdel-Wahab, M.A. and Vrijmoed, L.L.P. (1999). A new species of *Cryptovalsa* from Mai Po mangrove in Hong Kong. Mycological Research 103: 1628-1630.

Inderbitzin, P., Kohlmeyer, J., Volkmann-Kohlmeyer, B. and Berbee, M.L. (2002). *Decorospora*, a new genus for the marine ascomycetes *Pleospora gaudefroyi.* Mycologia 91: 651-659.

Inderbitzin, P., Lim, S.R., Volkmann-Kohlmeyer, B. and Kohlmeyer, J. (2004). The phylogenetic position of *Spathulospora* based on DNA sequences from dried herbarium material. Mycological Research 108: 737-748.

Iturriaga, T. (1997). *Vibrissea pfsteri*, a new species with an unusual ecology. Mycotaxon 61**:** 215-221.

James, T.Y., Letcher, P.M., Longcore, J.E., Mozley-Standridge, S.E., Powell, M.J., Griffith, G.W. and Vilgalys, R. (2006a). A molecular phylogeny of the flagellated (Chytridiomycota) and description of a new phylum (Blastocladiomycota). Mycologia 989: 860-871.

James, T.Y., Porter, D., Leander, C.A., Vilgalys, R. and Longcore, J.E. (2000). Molecular phylogenies of the Chytridiomycota supports the utility of ultrastructural data in chytrid systematics. Canadian Journal of Botany 87: 336-350.

James, T.Y., Kauff, F., Schoch, C.L., Matheny, P.B., Hofstetter, V., Cox, C.J., Celio, G., Gueidan, C., Fraker, E., Miadlikowska, J., Lumbsch, H.T., Rauhut, A., Reeb, V., Arnold, A.E., Amtoft, A., Stajich, J.E., Hosaka, K., Sung, G.-H., Johnson, D., O'Rourke, B., Crockett, M., Binder, M., Curtis, J.M., Slot, J.C., Wang, Z., Wilson, A.W., Schüßler, A., Longcore, J.E., O'Donnell. K., Mozley-Standridge, S., Porter, D., Letcher, P.M., Powell, M.J., Taylor, J.W., White, M.M., Griffith, G.W., Davies, D.R., Humber, R.A., Morton, J.B., Sugiyama, J., Rossman, A.Y., Rogers, J.D., Pfiser, D.H., Hewitt, D., Hansen, K., Hambleton, S., Sjoemaker, R.A., Kohlmeyer, J., Volkmann-Kohlmeyer, B., Spotts, R.A., Serdani, M. Crous, P.W., Hughrs, K.W., Matsuura, K., Langer, E., Langer, G., Untereiner, W.A., Lücking, R., Büdel, B., Geiser, D.M., Aptroot, A., Diederich, P. Schmitt, I., Schultz, M., Yahr, R., Hibbett, D.S., Lutzoni, F., McLaughlin, D.J., Spatafora, J.W., and Vilgalys, R. (2006b). Reconstructing the early evolution of Fungi using a six-gene phylogeny. Nature 443: 818-822.

Janso, J.E., Bernan, V.S., Greenstein, M., Bugni, T.S. and Ireland, C.M. (2005). *Penicillium dravuni*, a new marine-derived species from an alga in Fiji. Mycologia 97: 444-453.

Jeewon, R., Liew, E.C.Y. and Hyde, K.D. (2003). Molecular systematics of the Amphisphaeriaceae based on cladistic analyses of partial LSU rDNA gene sequences. Mycological Research 107: 1392-1402.

Jensen, P.R. and Fenical, W. (2002). Secondary metabolites from marine fungi. Fungal Diversity Research Series 7: 293-315.

Johnson, T.W. (1956). Marine fungi. II. Ascomycetes and Deuteromycetes from submerged wood. Mycologia 48: 841-851.

Johnson, T.W. and Autery, G.L. (1961). An *Arthrobotrys* from brackish water. Mycologia 53: 432-433.

Johnson, T.W. and Hughes, G.C. (1960). *Robillarda phramitis* Cunnell in estuarine waters. Transactions of the British Mycological Society 43: 523-524.

Johnson, T.W. and Sparrow, F.K. (1961). *Fungi in oceans and estuaries.* J. Cramer, Germany.

Johnson, R.G., Jones, E.B.G. and Moss, S.T. (1984). Taxonomic studies of the Halosphaeriaceae: *Remispora* Linder, *Marinospora* Cavaliere and *Carbosphaerella* Schmidt. Botanica Marina 27: 557-566.

Johnson, R.G., Jones, E.B.G. and Moss, S.T. (1987). Taxonomic studies of the Halosphaeriaceae: *Ceriosporopsis*, *Haligena* and *Appendichordella* gen. nov. Canadian Journal of Botany 65: 931-942.

Jones, E.B.G. (1962). Marine fungi. Transactions of the British Mycological Society 45: 93-114.

Jones, E.B.G. (1963). Marine fungi 2. Ascomycetes and Deuteromycetes from submerged wood and drift *Spartina.* Transactions of the British Mycological Society 46: 135-144.

Jones, E.B.G. (1976). (ed.) *Recent Advances in Aquatic Mycology.* Elek, London.

Jones, E.B.G. (1985). Wood-inhabiting marine fungi from San Juan Island with special reference to ascospore appendages. Botanical Journal of the Linnean Society 91: 219-231.

Jones, E.B.G. (1988). Do fungi occur in the sea? The Mycologist 2: 150-157.

Jones, E.B.G. (1991). *Iwilsoniella rotunda*, a new Pyrenomycete genus and species from wood in a water cooling tower. Systema Ascomycetum 10: 7-12.

Jones, E.B.G. (1994). Fungal adhesion. Mycological Research 98: 961-981.

Jones, E.B.G. (1995). Ultrastructure and taxonomy of the aquatic ascomycetous order Halosphaeriales. Canadian Journal of Botany 73: S790-S801.

Jones, E.B.G. (2000). Marine fungi: some factors influencing biodiversity. Fungal Diversity 4: 53-73.

Jones, E.B.G. (2006). Form and function of fungal spore appendages. Mycoscience 47: 167-183

Jones, E. B. G. (2008). Marine compounds in marine organisms. Botanica Marina 51: 161-162.

Jones, E.B.G. and Abdel-Wahab, M.A. (2005). Marine fungi from the Bahamas Islands. Botanica Marina 48: 356-364.

Jones, E.B.G. and Le Campion-Alsumard, T. (1970). Marine fungi on polyurethane covered plates submerged in the sea. Nova Hedwigia 19: 567-582.

Jones, E.B.G. and Choeyklin, R. (2007). Ecology of marine and freshwater basidiomycetes. In: *Ecology of Saprotrophic Basidiomycetes* (eds. L. Boddy, J.C. Frankland and P. van West). Elsevier, London: 301-324.

Jones, E.B.G. and Hyde, K.D. (1988). Methods for the study of marine fungi from the mangroves. In: *Mangrove Microbiology. Role of Microorganisms in nutrient cycling of Mangrove Soils and Waters* (eds. A.D. Agate, C.V. Subramanian and M. Vannucci). UNDP/UNESCO, New Dehli, India: 9-27.

Jones, E.B.G. and Hyde, K.D. (1992). Taxonomic studies on *Savoryella* Jones et Eaton (Ascomycotina). Botanica Marina 35: 83-91.

Jones, E.B.G. and Mitchell, J.L. (1996). Biodiversity of marine fungi. In: *Biodiversity: International Biodiversity Seminar* (eds. A. Cimerman and N. Gunde-Cimerman). National Institute of Chemistry and Slovenia National Commission for UNESCO, Ljubljana, Slovenia: 31-42.

Jones, E.B.G. and Moss, S.T. (1978). Ascospore appendages of marine ascomycetes: an evaluation of appendages as taxonomic criteria. Marine Biology 49: 11-26.

Jones, E.B.G. and Oliver, A.C. (1964). Occurrence of aquatic hyphomycetes on wood submerged in fresh and brackish water. Transactions of the British Mycological Society 47: 45-48.

Jones, E.B.G. and Pugsili, M. (2006). Marine fungi from Florida. Florida Scientist 69: 157-164.

Jones, E B G and Ward, A.W. (1973). Septate conidia in *Asteromyces cruciatus.* Transactions of the British Mycological Society 61: 181-186.

Jones, E.B.G., Abdel-Wahab, M.A. and Vrijmoed, L.L.P. (2001). *Trichocladium melhae* sp. nov., a new tropical marine fungus. Fungal Diversity 7: 49-52.

Jones, E.B.G., Chatmala, I. and Pang, K.L. (2006). Two new genera of the Halosphaeriaceae isolated from marine habitats in Thailand: *Pseudolignincola* and *Thalespora.* Nova Hedwigia 83: 219-232.

Jones, E.B.G., Johnson, R.G. and Moss, S.T. (1983a). Taxonomic studies of the Halosphaeriaceae: *Corollospora* Werdmann. Botanical Journal of the Linnean Society 87: 193-212.

Jones, E.B.G., Johnson, R.G. and Moss, S.T. (1983b). *Ocostaspora apilongissima* gen. et sp. nov: A new marine Pyrenomycete from wood. Botanica Marina 24: 353-360.

Jones, E.B.G., Moss, S.T. and Cuomo, V. (1983c). Spore appendage development in the lignicolous marine Pyrenomycetes *Chaetosphaeria chaetosa* and *Halosphaeria trullifera.* Transactions of the British Mycological Society 80: 193-200.

Jones, E.B.G., Johnson, R.G. and Moss, S.T. (1984). Taxonomic studies of the Halosphaeriaceae: *Halosphaeria* Linder. Botanica Marina 27: 129-143.

Jones, E.B.G., Hyde, K.D., Read, S.J., Moss, S.T. and Alias, S.A. (1996). *Tirisporella* gen. nov., an ascomycete from the mangrove palm *Nypa fruticosa*. Canadian Journal of Botany 74: 1487-1495.

Jones, E.B.G., Koch, J., McKeown, T.A. and Moss, S.T. (1995). *Limacospora* gen. nov. and a reevaluation of *Ceriosporopsis cambrensis*. Canadian Journal of Botany 73: 1010-1018.

Jones, E.B.G., Pilantanapak, A., Chatmala, I., Sakayaroj, J., Phongpaichit, S. and Choeyklin, R. (2005). Thai marine fungal diversity. Songklanakarin Journal of Science and Technology 28: 687-708.

Jones, E.B.G., Klaysuban, A. and Pang, K.L. (2008a). Ribosomal DNA phylogeny of marine anamorphic fungi: *Cumulospora varia, Dendryphiella* species and *Orbimyces spectabilis*. The Raffles Bulletin of Zoology suppl. 19: 11-18.

Jones, E.B.G., Stanley, S.J. and Pinruan, U. (2008b). Marine endophytes sources of new chemical natural products: a review. Botanica Marina 51: 163-170.

Jones, E.B.G., Zuccaro, A., Nakagiri, A., Mitchell, J.L. and Pang, K.L. (2009). Phylogenetic relationships of the genus *Sigmoidea* and a new genus *Halosigmoidea* gen. nov. Botanica Marina (in press).

Jones, M.A. and Jones, E.B.G. (1993). Observations on the marine gasteromycete *Nia vibrissa.* Mycological Research 97: 1-6.

Ju, Y.-M. and Roger, J.D. (2002). The genus *Nemania* (Xylariaceae). Nova Hedwigia 74: 75-120.

Julich, W. (1981). *Higher Taxa of Basidiomycetes.* Vaduz, Liechtenstein, J. Cramer.

Kang, J.C., Hyde, K.D. and Kong, R.Y.C. (1999a). Studies on Amphisphaeriales: the Cainiaceae. Mycological Research 103: 1621-1627.

Kang, J.C., Kong, R.Y.C. and Hyde, K.D. (1999b). Phylogeny of Amphisphaeriales 1. Amphisphaericeae (*sensu stricto*) and its phylogenetic relationships inferred from 5.8S rDNA and ITS2 sequences. Fungal Diversity 1: 147-157.

Kang, J.C., Hyde, K.D. and Kong, R.Y.C. (1999c). Studies on the Amphisphaeriales. The Clypeosphaeriaceae. Mycoscience 40: 57-70.

Kang, J.C., Hyde, K.D. and Kong, R.Y.C. (1999d). Studies on the Amphisphaeriales. The genera excluded from the Amphisphaeriaceae, Cainiacae and Clypeosphaeriaceae. Fungal Diversity 2: 135-151.

Kendrick, B., Risk, M.J., Michaelides, J. and Bergman, K. (1982). Amphibious microborers: bioeroding fungi isolated from live corals. Bulletin Marine Science 32: 862-867.

Khashnobish, A. and Shearer C.A. (1996a). Reexamination of some *Leptosphaeria* and *Phaeosphaeria* species, *Passeriniella obiones* and *Melanomma radicans*. Mycological Research 100: 1341-1354.

Khashnobish, A. and Shearer, C.A. (1996b). Phylogenetic relationships in some *Leptosphaeria* and *Phaeosphaeria* species. Mycological Research 100: 1355-1363.

Kirk, P.W. (1969). Isolation and culture of lignicolous marine fungi. Mycologia 61: 174-178.

Kirk, P. M., Cannon, P.F., David, J.C. and Stalpers. J.A. (2001). *Ainsworth and Bisby's Dictionary of the Fungi, 8th ed.* CABI Publishing, London.

Kirk, P.M., Cannon, P.F., Minter, D.W. and Stalpers, J.A. (2008). *Ainsworth and Bisby's Dictionary of the Fungi, 9th ed.* CABI Publishing.

Kis-Papo, T. (2005). Marine fungal communities. In: *The Fungal Community: Its organization and role in the ecosystem* (eds. J. Dighton, J.F. White and P. Oudemans). Third edition. CRC Press.

Kis-Papo, T., Oren, A., Wasser, S.P. and Nevo, E. (2003). Survival of filamentous fungi in Dead Sea water. Microbial Ecology 45: 183-190.

Koch, J. (1989). *Remispora spinibarbata* sp. nov., a marine lignicolous ascomycete from Denmark. Nordic Journal of Botany 8: 517-520.

Koch, J. and Jones, E.B.G. (1983). Vedboende havsvampe fra danske Kyster. Svampe 8: 49-65.

Koch, J. and Jones, E.B.G. (1984). *Lulworthia lignoarenaria*, a new marine pyrenomycete from coastal sands. Mycotaxon 20: 389-395.

Koch, J. and Jones, E.B.G. (1989). The identity of *Crinigera maritima* and three new genera of marine cleistothecial ascomycetes. Canadian Journal of Botany 67: 1183-1197

Koch, J., Jones, E.B.G. and Moss, S.T. (1983). *Groenhiella bivestia*, gen. et sp. nov., a lignicolous marine fungus from Denmark. Botanica Marina 26: 265-270.

Koch, J., Pang, K.L. and Jones, E.B.G. (2007). *Rostrupiella danica* gen. et sp. nov., a Lulworthia-like marine lignicolous species from Denmark and the USA. Botanica Marina 50: 1-8.

Kodsueb, R., Dhanasekaran, V., Aptroot, A., Lumyong, S., McKenzie, E.H.C., Hyde, K.D. and Jeewon, R. (2006). The family Pleosporaceae: intergeneric relationships and phylogenetic perspectives based on sequence analyses of partial 28S rDNS. Mycologia 98: 571-583.

Kohlmeyer, J. (1963). Neue Ascomyceten gattugen auf *Posidonia* rhizomen. Nova Hedwigia 6: 5-13.

Kohlmeyer, J. (1967). Intertidal and phycophilous fungi from Tenerife (Canary Islands). Transaction of the British Mycological Society 50: 137-147.

Kohlmeyer, J. (1968a). A new *Trematosphaeria* from roots of *Rhizophora racemosa*. Mycopathology Mycologia Applicata 34: 1-5.

Kohlmeyer, J. (1968b). Revisions and descriptions of algicolous marine fungi. Phytopathology Zoology 63: 341-363.

Kohlmeyer, J. (1972a). A revision of Halosphaeriaceae. Canadian Journal of Botany 50: 1951-1963.

Kohlmeyer, J. (1972b). Marine fungi deteriorating chitin of hydrozoa and keratin-like annelid tubes. Marine Biology 12:473-492.

Kohlmeyer, J. (1973a). Fungi on marine algae. Botanica Marina 16: 201-215.

Kohlmeyer, J. (1973b). Spathulosporales, a new order and possible missing link between Laboulbeniales and Pyrenomycetes. Mycologia 65: 614-674.

Kohlmeyer, J. (1975a). New clues to the possible origin of the ascomycetes. BioScience 25: 86-93.

Kohlmeyer, J. (1975b). Revision of algicolous *Zigonella* spp. and description of *Pontogenia* gen. nov. (Ascomycetes). Botanische Jahrbücher für Systematik 96: 200-211.

Kohlmeyer, J. (1977). New genera and species of higher fungi from the deep sea (1615-5315m). Revue Mycology 41: 189-206.

Kohlmeyer, J. (1984). Tropical marine fungi. *P.S.Z.N.I.* Marine Ecology 5: 329-378.

Kohlmeyer, J. (1985). *Caryosporella rhizophorae* gen. et sp. nov. (Massariaceae), a marine Ascomycete from *Rhizophora mangle*. Proceedings of the Indian Academy of Science (Plant Science) 94: 355-361.

Kohlmeyer, J. (1986a). *Ascocratera manglicola* gen. et sp. nov. and key to the marine Lucoloascomycetes on mangroves. Canadian Journal of Botany 64: 3036-3042.

Kohlmeyer, J. (1986b). Taxonomic studies of the marine Ascomycotina. In: *The Biology of Marine Fungi* (ed. S.T. Moss), Cambridge University Press: 199-210.

Kohlmeyer, J. and Demoulin, V. (1981). Parastic and symbiotic fungi on marine algae. Botanica Marina 24: 9-18.

Kohlmeyer, J. and Gessner, R.V. (1976). *Buergenerula spartinae* sp. nov., an Ascomycete from salt marsh cordgrass, *Spartina alternoflora*. Canadian Journal of Botany 54: 1759-1766.

Kohlmeyer, J. and Kohlmeyer, E. (1964-1969). *Icones Fungorum Maris.* Cramer, Weinheim & Lehre.

Kohlmeyer, J. and Kohlmeyer, E. (1971). Marine fungi from tropical America and Africa. Mycologia 63: 831-861.

Kohlemeyer, J. and Kohlmeyer, E. (1975). Biology and geographical distribution of *Spathulospora* species. Mycologia 67: 629-637.

Kohlemeyer, J. and Kohlmeyer, E. (1977). Bermuda marine fungi. Transactions of the British Mycological Society 68: 207-219.

Kohlmeyer, J. and Kohlmeyer, E. (1979). *Marine Mycology. The Higher Fungi.* Academic Press, New York.

Kohlmeyer, J. and Schatz, S. (1985). *Aigialus* gen. nov. (Ascomycetes) with two new marine species from mangroves. Transactions of the British Mycological Society 85: 699-707.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1987a). *Thalassogena*, a new ascomycetous genus in the Halosphaeriaceae. Systema Ascomycetum 6: 223-228.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1987b). Koralionastetaceae fam. nov. (Ascomycetes) from coral rocks. Mycologia 79: 764-778.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1987c). Marine fungi from Belize with a description of two new genera of Ascomycetes. Botanica Marina 30: 195-204.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1988a). *Ophiodeira* gen. nov. (Halosphaeriales) and a survey of higher marine fungi from Saint Croix (Virgin Island). Canadian Journal of Botany 66: 2062-2067.

Kohlemyer, J. and Volkmann-Kohlemyer, B. (1988b). *Halographis* (Opegraphales). A new endolithic lichenoid from corals and snails. Canadian Journal of Botany 66: 1138-1141.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1989). Hawaiian marine fungi, including two new genera of Ascomycotina. Mycological Research 92: 410-421.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1990a). Revision of marine species of *Didymosphaeria* (Ascomycotina). Mycological Research 94: 685-690.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1990b). A new species of *Koralionastes* (Ascomycotina) from the Caribbean and Australia. Canadian Journal of Botany 68: 1554-1559.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1991a). Illustrated key to the filamentous marine fungi. Botanica Marina 34: 1-61.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1991b). *Hapsidascus hadrus* gen. et sp. nov. (Ascomycota) from mangroves in the Caribbean. Systema Ascomycetum 10: 113-120.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1991c). *Nohea umiumi*, a new marine ascomycete from Hawaii and French Polynesia. Systema Ascomycetum 10: 121-126.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1992). Two Ascomycotina from coral reefs in the Caribbean and Australia. Cryptogamme Botany 2: 367-374.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1993a). Observations on *Hydronectria* and *Kallichroma* gen. nov. Mycological Research 97: 753-761.

Kohlmeyer, J. and Volkmann-Kohmlmeyer, B. (1993b). Two new genera of Ascomycotina from saltmarsh *Juncus*. Systema Ascomycetum 11: 95-106.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1993c). *Atrotorquata* and *Loratospora*: New ascomycete genera on *Juncus roemeriamus*. Systema Ascomycetum 12: 7-22.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1994). *Aropsiclus* nom. nov. (Ascomycotina) to replace *Sulcospora* Kohlm. & Volkm.-Kohlm. Systema Ascomycetum 13: 24.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1995). Fungi on *Juncus roemerianus*. 1. *Trichocladium medullare* sp. nov. Mycotaxon 62: 349-353.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1996). Fungi on *Juncus roemerianus*. 7. *Tiarosporella halmyra* sp. nov. Mycotaxon 59: 79-83.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1998a). *Naufragella*, a new genus in the Halosphaeriaceae. System Ascomyceteum 16: 9-16.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1998b).

Mycophycias, a new genus for the mycobionts of *Apophlaea, Ascophyllum* and *Pelvetia*. Systema Ascomycetum 16: 1-7.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1998c). *Dactylospora canariensis* sp. nov. and notes on *D. haliotrepha.* Mycotaxon 67: 247-250.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1998d). A new marine *Xylomyces* on *Rhizophora* from the Caribbean and Hawaii. Fungal Diversity 1: 159-164.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (1998e). Fungi on *Juncus roemerianus.* 11. More new ascomycetes. Canadian Journal of Botany 76: 467-477

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (2000). Fungi on *Juncus roemerianus* 14. Three new coelomycetes, including *Floricola*, anam.-gen. nov. Botanica Marina 43: 385-392.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (2001a). Fungi on *Juncus roemerianus:* new coelomycetes with notes on *Dwayaangam.* Mycological Research 105: 500-505.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (2001b). Fungi on *Juncus roemerianus*. 16. More new coelomycetes, including *Tetranacriella,* gen. nov. Botanica Marina 44: 147-156.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (2002). Fungi on *Juncus* and *Spartina*: New marine species of *Anthostomella*, with a list of marine fungi known from *Spartina*. Mycological Research 106: 365-374.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (2003a). *Octopodotus stupendus* gen. & sp. nov. and *Phyllachora paludicola* sp. nov., two marine fungi from *Spartina alterniflora.* Mycologia 95: 117-123.

Kohlmeyer, J. and Volkmannn-Kohlmeyer, B. (2003b). Marine Ascomycetes from algae and animal hosts. Botanica Marina 46: 285-306.

Kohlmeyer, J. and Volkmann-Kohlmeyer, B. (2003c). Fungi from coral reefs: a commentary. Mycological Research 107: 386-387.

Kohlmeyer, J., Hawksworth, D.L. and Volkmann-Kohlmeyer, B. (2004). Observations on two “borderline” lichens: *Mastodia tessellata* and *Collemopsidium pelvetiae*. Mycological Progress 3: 51-56.

Kohlmeyer, J., Spatafora, J.A. and Volkmann-Kohlmeyer, B. (2000). Lulworthiales, a new order of marine Ascomycota. Mycologia 92: 453-458.

Kohlmeyer, J., Volkmann-Kohlmeyer, B. and Eriksson, O.E. (1995a). Fungi on *Juncus roemarianus* 3. New ascomycetes. Botanica Marina 38: 175-186.

Kohlmeyer, J., Volkmann-Kohlmeyer, B. and Eriksson, O.E. (1995b). Fungi on *Juncus roemerianus.* 2. New dictyosporous ascomycetes. Botanica Marina 38: 165-174

Kohlmeyer, J., Volkmann-Kohlmeyer, B. and Eriksson, O.E. (1995c). Fungi on *Juncus roemerianus.* 4. New marine ascomycetes. Mycologia 87: 532-542.

Kohlmeyer, J., Volkmann-Kohlmeyer, B. and Eriksson, O.E. (1995d). Fungi on *Juncus roemerianus.* New marine and terrestrial ascomycetes. Mycological Research 100: 393-401.

Kohlmeyer, J., Volkmann-Kohlmeyer, B. and Eriksson, O.E. (1996). Fungi on *Juncus roemerianus.* 8. New bitunicate ascomycetes. Canadian Journal of Botany 74: 1830-1840.

Kohlmeyer, J., Volkmann-Kohlmeyer, B. and Eriksson, O.E. (1997). Fungi on *Juncus roemerianus.* 9. New obligate and facultative marine ascomycotina. Botanica Marina 40: 291-300.

Kohlmeyer, J., Volkmann-Kohlmeyer, B. and Eriksson, O.E. (1998). Fungi on *Juncus roemerianus.*11. More new ascomycetes. Canadian Journal of Botany 76: 467-477.

Kohlmeyer, J., Volkmann-Kohlmeyer, B. and Eriksson, O.E. (1999). Two new species of *Mycosphaerella* and *Paraphaeosphaeria*. Botanica Marina 42: 505-511.

Kohlmeyer, J., Volkmann-Kohlmeyer, B. and Tsui, C.K.M. (2005). Fungi on *Juncus roemerianus.* 17. New ascomycetes and the hyphomycetes genus *Kolletes* gen. nov. Botanica Marina 48: 306-317.

Kong, R.Y.C., Chan, P.C., Mitchell, J.I., Vrijmoed, L.L.P. and Jones, E.B.G. (2000). Relationships of *Halosarpheia, Lignincola* and *Nais* inferred from partial 18S rDNA. Mycological Research 104: 35-43.

Kopytina, N. L. and Andrienko, A.A. (1998). Marine ascomycetes new for the Caspian sea (Ascomycetes, Halosphaeriales). Xxxxxx 32: 14-17.

Kurtzman, C.P. and Fell, F.W. (2006). Yeast systematics and phylogeny – implications of molecular identification methods for studies in ecology, In: *Yeast Handbook. Vol.1, Biodiversity and Ecophysiology of Yeasts*.

Kutorga, E. and Hawksworth, D.L. (1997). A reassessment of the genera referred to the family Patellariaceae (Ascomycota). Systema Ascomycetum 15: 1-110.

Lachance, M.A. and Starmer, W.T. (1998). Aquatic habitats, ecology and yeasts. In: *The Yeasts, A Taxonomic Study.* (eds. C.P. Kurtzman,. and F.W. Fell). 4th edition, Elsevier, Amsterdam: 21-30.

Lamb, I.M. (1948). Antarctic pyrenocarp lichens. Discovery Reports 25: 1-30.

Lamb, I.M. (1973). Further observations on *Verrucaria serpuloides* M. Lamb. the only known permanantly submerged marine lichen. Occasional Papers of the Farlow Herbarium Crypttogamic Botany 6: 1-5.

Landvik, S. (1996). *Neolecta*, a fruit-body-producing genus of the basal ascomycetes, as shown by SSU and LSU rDNA sequences. Mycological Research 100**:** 199-202.

Landvik, S., Shaile, N.F.J. and Eriksson, O.E. (1996). SSU rDNA sequence support for a close relationship between the Elaphomycetales and the Eurotiales and Onygenales. Mycoscience 37: 237-241.

Leong, W.F., Tan, T.K., Hyde, K.D. and Jones, E.B.G.

(1990). *Payosphaeria minuta* gen. et sp. nov., an Ascomycete on mangrove wood. Botanica Marina 33: 511-514.

Leuuchtmann, A. (1984). Über *Phaeosphaeria* Miyake und andere bitunicate Ascomyceten nit mehrfach querseptierten ascospores. Sydowia 37: 75-194.

Lepidi, A.A., Nuti, M.P., de Bertoldi, M. and Santulli, M. (1977). Classification of the genus *Humicola* Traaen: II. The DNA base composition of some strains within the genus. Mycopathology Mycology Applicata 47: 153-159.

Liew, E.C.Y., Aptroot, A. and Hyde, K.D. (2002). An evaluation of the monophyly of *Massarina* based on ribosomal DNA sequences. Mycologia 94: 803-813.

Li, H.J., Lin, Y.C., Wang, L., Zhou, S.N., Vrijmeod, L.L.P. and Jones, E.B.G. (2001). Metabolites of marine fungus *Hypoxylon oceanicum* (#326) from the South China. Sea. Acta Scientiarum Naturalium University Sunyatseni 40: 70.

Lindemuth, R., Wirtz, N. and Lumbsch, H.T. (2001). Phylogenetic analysis of nuclear and mitochondrial rDNA sequences supports the view that loculoascomycetes (Ascomycota) are not monophyletic. Mycological Research 105: 1176-1181.

Lintott, W.H. and Lintott, E.A. (2002). Marine fungi from New Zealand. In: *Fungi in Marine Environments* (ed. K.D. Hyde) Fungal Diversity Research Series 7: 285-292.

Lowen, R. (1990). New combinations in *Pronectria.* Mycotaxon 39: 461-463.

Lu, B. and Hyde, K.D. (2000). *A World Monograph of Anthostomella.* Fungal Diversity Press, Hong Kong.

Lumbsch, H.T and Huhndorf, S.M. (2007). Outline of Ascomycota – 2007, 13: 1-58.

Lumbsch, H.T. and Lindemuth, R. (2001). Major lineages of Dothideomycetes (Ascomycota) inferred from SSU and LSU rDNA sequences. Mycological Research 105: 901-908.

Lumbsch, H.T., Schmitt, I., Lindemuth, R., Miller, A., Mangold, A., Fernandez, F. and Huhndorf, S. (2005). Performance of four ribosomal DNA regions to infer higher-level phylogenetic relationships of inoperculate euoascomcyetes (Leotiomyceta). Molecular Phylogenetic Evolution 34: 512-524.

Maekawa, N., Suhara, H., Kinjo, K., Kondo, R. and Hashi. Y. (2005). *Haloaleurodiscus mangrovei* gen. sp. nov. (Basidiomycota) from mangrove forests in Japan. Mycological Research 109: 825-832.

Malloch, D. and Cain, R.F. (1972). New species and combinations of cleistothecial Ascomycetes. Canadian Journal of Botany 50: 62-72.

Mantel, P.G., Hawksworth, D.L., Pazoutova, S., Collinson, L.M. and Rassing, B.R. (2006). *Amorosia littorlais* gen. et sp. nov., a new genus and species name for the scorpinone and caffeine-producing hyphomycetes from the littoral zone in The Bahamas. Mycological Research 110: 1371-1378.

Manimohan, P., Moss, S.T. and Jones, E.B.G. (1993a). Ultrastructure of the ascospore wall and appendages of *Remispora galerita.* Mycological Research 97: 1190-1192.

Manimohan, P., Jones, E.B.G. and Moss, S.T. (1993b). Ultrastructure studies of ascospores of some *Remispora* species. Canadian Journal of Botany 71: 385-392.

Margulis, L. and Schwartz, K.V. (1998). *Five Kingdoms: An illustrated guide to the phyla of life on earth.* W.H. Freeman Co., New York.

Matheny, P.B., Gossman, J.A., Zalar, P., Arun Kumar, T.K. and Hibbett, D.S. (2006). Resolving the phylogenetic position of Wallemiomycetes: an enigmatic major lineage of Basidiomycota. Canadian Journal of Botany 84: 1794-1805.

Mathiassen, G. (1989). Some corticolous and lignicolous Pyrenomycetes s. lat. (Ascomycetes) on *Salix* in Troms, N. Norway. Sommerfeltia 9: 1-100.

Maria, G.L. and Sridhar, K.R. (2002). A new ascomycete, *Passeriniella mangrovei* sp. nov. from the mangrove forest of India. Indian Journal of Forestry 25: 319-2002.

McCarthy, P.M. (1991). Notes on Australian Verrucariaceae (Lichens). Muelleria 7: 317-332.

McCarthy, P.M. (1994). Notes on Australian Verrucariaceae (lichenised Ascomycotina) Muelleria 8: 269-273.

McCarthy, P.M. (2001). *Verrucaria.* Flora of Australia, vol. 58A, 176-196.

McCarthy, P.M. (2008). A new species and new combination of Australian Verrucariaceae. Australian Lichenology 63: 17-18.

McKeown, T.A., Alias, S.A., Mos, S.T. and Jones, E.B.G. (2001). Ultrastructural studies of *Trematosphaeria malaysiana* sp. nov. and *Leptosphaeria pelagica.* Mycological Research 105: 615-624.

McKeown, T.A., Moss, S.T. and Jones, E.B.G. (1996). Ultrastructure of ascospores of *Tunicatispora australiensis.* Mycological Research 100: 1247-1255.

Meyers, S.P. (1957). Taxonomy of marine Pyrenomycetes. Mycologia 49: 475-528.

Meyers, S.P. and Reynolds, E.S. (1959). Growth and cellulolytic activity of lignicolous Deuteromycetes from marine localities. Canadian Journal of Microbiology 5: 493-503.

Meyers, S.P., Feder, W.A. and Tsue, K.M. (1963). Nutritional relationships among certain filamentous fungi and a marine nematode. Science 141: 520-522.

Meyers, S.P., Ahearn, D.G., Gunkel, W. and Roth, F.J. (1967). Yeasts from the North Sea. Marine Biology 1: 118-123.

Moe, R. (1997). *Verrucaria tavaresiae* sp. nov., a marine lichen with a brown algal photobiont. Bulletin California Lichen Society 4: 7-11.

Mohr, F., Ekman, S. and Heegaard, E. (2004). Evolution and taxonomy of the marine *Collemopsidium* species (lichenized Ascomycota) in north-west Europe. Mycological Research 108: 515-532.

Moncalvo, J.M., Vilgalys, R., Redhead, S.A., Johnson, J.E., James, T.Y., Aime, M.C., Hofstetter, V., Verduin, S.J.W., Larsson, E., Baroni, T.J., Thorn, R.G., Jacobsson, S., Clemencon, H. and Miller, O.K. (2002). One hundred and seventeen clades of euagarics. Molecular Phylogenetics and Evolution 23: 357-400.

Moore, R.T. and Meyers, S.P. (1959). Thalassiomycetes I. Principles of delimitation of the marine mycota with a description of a new aquatically adapted Deuteromycete. Mycologia 51: 871-876.

Moore, R.T. and Meyers, S.P. (1962). Thalassiomycetes III. The genus *Zalerion*. Canadian Journal of Microbiology 8: 407-416.

Morelet, M. (1968). De aliquibus in mycologia novitatibus. Bulletin Societie Science Natural Archeol. Toulon Var 175: 5-6.

Morrison-Gardiner, S. (2002). Dominant fungi from Australian reefs. Fungal Diversity 9: 105-121.

Moss, S.T. and Jones, E.B.G. (1977). Ascospore appendages of marine Ascomycetes: *Halosphaeria mediosetigera*. Transactions of the British Mycological Society 69: 313-315.

Mouzouras, R. and Jones, E.B.G. (1985). *Monodictys pelagica*, the anamorph of *Nereiospora cristata* (Halosphaeriaceae). Canadian Journal of Botany 63: 2444-2447.

Mouzouras, R., Jones, E.B.G., Venkatasamy, R. and Holt, D.M. (1988). Microbial decay of lignocellulose in the marine environment. In: *Marine Biodeterioration* (eds. M. F. Thompson, R. Sarojini and R. Nagabhushanaim), Oxford and J B H Publishing, New Delhi: 329-354.

Mwangi, J.G. (2001). A new pest causing decline of mangrove forests in Kenya. Africa www.easternarc.org.

Müller, E., Petrini, O., Fischer, P.J., Samuels, G.J. and Rossman, A.Y. (1987). Taxonomy and anamorphs of the Herpotrichiellaceae with notes on genera synonymy. Transactions of the British Mycological Society 88: 63-74.

Nakagiri, A. (1984). Two new species of *Lulworthia* and evaluation of genera-delimiting characters between *Lulworthia* and *Lindra* (Halosphaeriaceae). Transactions of the Mycological Society of Japan 25: 377-388.

Nakagiri, A. (1993a). A new ascomycete in Sapthulosporales *Hispidicarpomyces galauauricola* gen. et sp. nov. (Hispidicarpomyetceae fam. nov.), inhabiting a red alga, *Galaxaura falcata*. Mycologia 85: 638-652.

Nakagiri, A. (1993b). Intertidal mangrove fungi from Irimote Island. IFO Research Communication 16: 24-62.

Nakagiri, A. and Ito, T. (1991). Basidiocarp development of the cyphelloid gasteroid aquatic basidiomycetes *Halocyphina villosa* and *Limnoperdon incarnatum*. Canadian Journal of Botany 69: 2320-2327.

Nakagiri, A. and Ito, T. (1994). *Aniptodera salsuginosa*, a new mangrove-inhabiting ascomycete, with observations on the effect of salinity on ascospore appendage morphology. Mycological Research 98: 931-936.

Nakagiri, A. and Ito, T. (1997). *Retrostium amphiroae* gen. et sp. nov. inhabiting a marine red alga, *Amphiroa zonata*. Mycologia 89: 484-493.

Nakagiri, A., and Tubaki, K. (1982). *Corollospora luteola*. A new marine ascomycete and its anamorph from Japan. Transactions of the Mycological Society of Japan 23: 101-110.

Nakagiri, A., and Tubaki, K. (1986). Ascocarp peridial wall structure in *Corollospora* and allied genera of Halosphaeriaceae. In: *The Biology of Marine Fungi* (ed. S.T. Moss) Cambridge University Press, UK: 245-252.

Nakagiri, A., Okane, I., Ito, T. and Katumoto, K. (1997). *Lanceispora amphibia* gen. *et* sp. nov., a new amphisphaericeous ascomycete inhabiting senescent and fallen leaves of mangrove. Mycoscience 38: 207-213.

Nevo, E., Oren, A, and Wasser, S.P. 2003. *Fungal life in the Dead Sea.* Ruggell.

Nicot, J. (1958). Remargues sur la mycoflore des sols sableux immerges á mare haute. Comptes Rendus Academie Science, Paris 246: 451-454.

Nieves-Rivera, A.M. (2002). Sea fan aspergillosis, What is it? Inoculum December 2003: 10-13.

Nyvall, P., Pedersén, M. and Longcore, J.E. (1999) *Thalassochytrium gracilariopsidis* (Chytridiomycota), gen. et sp. nov., endosymbiotic in *Gracilariopsis* sp. (Rhodophyceae). Journal of Phycology 35: 176-185.

Pan. J.Y., Jones, E.B.G., She, Z.Y. and Ling, Y.C. (2008). Review of bioactive compounds from fungi in the South China Sea. Botanica Marina 51: 179-190.

Pang, K.L. and Jones, E.B.G. (2004). Reclassifications in *Halosarpheia* and related genera with unfurling ascospore appendages. Nova Hedwigia 78: 269-271.

Pang, K.L. and Mitchell, J.I. (2005). Molecular approaches for assessing fungal diversity in marine substrata. Botanica Marina 48: 332-347.

Pang, K.L., Abdel-Wahab, M.A., El-Sharouney, H.M., Sivichai, S. and Jones, E.B.G. (2002). Jahnulales (Dothideomycetes, Ascomycota) a new order of lignicolous freshwater ascomycetes. Mycological Research 106: 1031-1042.

Pang, K.L., Vrijmoed, L.L.P., Kong, R.Y.C., Jones, E.B.G. (2003a). *Lignincola* and *Nais*, polyphyletic genera of the Halosphaeriales (Ascomycota). Mycological Progress 2: 29-36.

Pang, K.L., Vrijmoed, L.L.P., Kong, R.Y.C. and Jones, E.B.G. (2003b). Polyphyly of *Halosarpheia* (Halosphaeriales, Ascomycota): implications on the use of unfurling ascospore appendage as a systematic character. Nova Hedwigia 77: 1-18.

Pang, K.L., Jones, E.B.G. and Vrijmoed, L.L.P. (2004a).

Two new marine fungi from China and Singapore, with the description of a new genus, *Sabelcola*. Canadian Journal of Botany 82: 485-490.

Pang, K.L., Jones, E.B.G., Vrijmoed, L.L.P. and Vikineswary, S. (2004b). *Okeanomyces*, a new genus to accommodate *Halosphaeria cucullata* (Halosphaeriales, Ascomycota). Botanical Journal of the Linnean Society 146: 223-229.

Pang, K.L., Jones, E.B.G., Chiang, W.L. and Vrijmoed, L.L.P. (2006). Ascospore ultrastructure of *Halosapheia fibrosa* (Halosphaeriales, Ascomycota). Nova Hedwigia 83: 207-217.

Pang, K.L., Chiang, M.W.L. and Vrijmoed, L.L.P. (2008). *Havispora longyearbyenensis* gen. et sp. nov., an arctic marine fungus from Svalbard, Norway. Mycologia 100: 291-295.

Pang, K.L., Jones, E.B.G. and Vrijmoed, L.L.P. (2008b). Autecology of *Antennospora* (Ascomycota, Fungi) and its phylogeny. Raffles Bulletin of Zoology 19: 1-10.

Pawar, V.H., Mathur, P.N. and Thirumalachar, M.J. (1967). Species of *Phoma* isolated from marine soils in India. Transactions of the British Mycological Society 50: 259-265.

Peña, N.I. and Arambarri, A.M. (1997a). *Argentinomyces naviculisporis* gen. et sp. nov., a new lignicolous ascomycete from Mar del Plata, Argentina. Mycotaxon 65: 331-338.

Peña, N.I. and Arambarri, A.M. (1997b). Hongos marinos lignicolas de la laguna costera de mar Chiquita (Provincia de Buenos Aires, Argentina). I Ascomycotina Deuteromycotina sobre *Spartina densiflora*. Darwiniana 35: 61-667.

Petersen, K.R.L. (1997). Ultrastructural studies of the marine ascomycete *Groenhiella bivestia*. Botanica Marina 40: 71-75.

Petersen, K.R.L. and Koch, J. (1996). *Anisostagma rotundatum* gen. et sp. nov., a lignicolous marine ascomycetes from Svanmǿllen Harbour in Denmark. Mycological Research 100: 209-212.

Petersen, K.R.L. and Koch, J. (1997). *Buxetroldia bisaccata* gen. *et* sp. nov., a marine lignicolous halosphaeriacean fungus from coastal waters, Denmark. Mycological Research 101: 1524-1528.

Phongpaichit, S., Preedanan, S., Rungjindamai, N., Sakayaroj, J., Benzies, C., Chuaypat, J., and Plathong, S. (2006). Aspergillosis of the gorgonian sea fan *Annella* sp., after the 2004 tsunami at Mu Ko Similan National Park, Andaman Sea, Thailand. Coral Reefs (Short communication). DOI 10.1007/s00338-006-0104-y.

Pilantanapak, A., Jones, E.B.G. and Eaton., E.A. (2005). Marine fungi on *Nypa fruticans* in Thailand. Botanica Marina 48: 1-9.

Pinruan, U., Jones, E.B.G. and Hyde, K.D. (2002). Aquatic fungi from peat swamp palms: *Jahnula appendiculata* sp. nov. Sydowia 54: 242-247.

Plaingam, N. (2002). Ultrastructure and biodiveristy of tropical coelomycetes. Ph.D. Thesis, Kong Mongkut's University of Technology Thonburi, Bangkok.

Plaingam, N., Somrithipol, S. and Jones, E.B.G. (2005). *Pseudorobillarda siamensis* sp. nov. and notes on *P. sojae* and *P. texana* from Thailand. Nova Hedwigia 80: 335-348.

Pointing, S.B., Vrijmoed, L.L.P. and Jones, E.B.G. (1998). A qualitative assessment of lignocellulose degrading enzyme activity in marine fungi. Botanica Marina 41: 293-298

Poon, M.O.K. and Hyde, K.D. (1998). Biodiversity of intertidal estuarine fungi on *Phragmites* at Mai Po marshes, Hong Kong. Botanica Marina 41: 141-155.

Poonyth, A.D., Hyde, K.D., Wong, S.W. and Peerally, A. (2000a). Ultrastructure of asci and ascospore appendages in *Linocarpon appendiculatum* and *L. nipae*. Botanica Marina 43: 213-221.

Poonyth, A.D., Hyde, K.D., Aptroot, A. and Peerally, A. (2000b). *Mauritiana rhizophorae* gen. et sp. nov. (Ascomycetes, Requienellaceae), with a list of terrestrial saprobic mangrove fungi. Fungal Diversity 4: 101-116.

Porter, D. and Farnham, W.F. (1986). *Mycaureola edulis*, a marine basidiomycete parasite of the red alga, *Dilsea carnosa*. Tranactions of the British Mycological Society 87: 575-582.

Prasannarai, K., Ananda, K. and Sridhar, K.R. (2000). *Corollospora indica*, a new fungal species from west coast of India. Journal of Environmental Biology 21: 235-239.

Purvis, O.W., Coppins, B.J., Hawksworth, D.L., James, P.W. and Moore, D.M. eds. (1992). *The lichen flora of Great Britain and Ireland*. British Lichen Society, London.

Raghukumar, C. (2008). Marine fungal biotechnology: an ecological perspective. Fungal Diversity 31: 19-35.

Raghukumar, S., Zainal, A. and Jones, E.B.G. (1988). *Cirrenalia basiminuta*, a new lignicolous marine Deuteromycete from the tropics. Mycotaxon 31: 163-170.

Rambaut, A. (1999). Se-Al. Department of Zoology, University of Oxford, Oxford OX1 4JD, UK. (http://evolve.zoo.ox.ac.uk/Se-Al/Se-Al.html).

Ranghoo, V.M., Hyde, K.D., Liew, E.C.Y. and Spatafora, J.W. (1999). Family placement of *Ascotaiwania* and *Ascolacicola* based on DNA sequences from the large subunit rRNA gene. Fungal Diversity 2: 159-168.

Read, S.J., Jones, E.B.G. and Moss, S.T. (1993a). Ultrastructural observations on *Nimbospora bipolaris* (Halosphaeriaceae, Ascomycetes). Philosophical Transactions of the Royal Society, London B. 339: 483-489.

Read, S.J., Jones, E.B.G. and Moss, S.T. (1993b). Taxonomic studies of marine Ascomycotina: ultrastructure of the asci, ascospores, and appendages of *Savoryella* species. Canadian Journal of Botany 71: 273-283.

Read, S.J., Moss, S.T. and Jones, E.B.G. (1994).

Ultrastructure of asci and ascospores sheath of *Massarina thalassiae* (Loculoascomycetes, Ascomycotina). Botanica Marina 37: 547-533.

Read, S.J., Jones, E.B.G. and Moss, S.T. (1997a). Ultrastructural observations of asci, ascospores and appendages of *Massarina armatispora* (Ascomycota). Mycoscience 38: 141-146.

Read, S.J., Moss, S.T. and Jones, E.B.G. (1997b). Ultrastructure of asci, ascospores and appendages of *Massarina ramunculicola* (Loculoascomycetes, Ascomycota). Botanica Marina 40: 465-471.

Read, S.J., Hsieh, S.Y., Jones, E.B.G., Moss, S.T. and Chang. H.S. (1992). *Paraliomyces lentiferus*: an ultrastructure study of a little known marine ascomycete. Canadian Journal of Botany 70: 2223-2232.

Read, S.J., Jones, E.B.G., Moss, S.T. and Hyde, K.D. (1995). Ultrastructure of asci and ascospores of two mangrove fungi: *Swampomyces armeniacus* and *Marinosphaera mangrovei*. Mycological Research 99: 1465-1471.

Réblová, M. (1999). Studies in *Chaetosphaeria* sensu lato. 1. The genera *Chaetosphaerella* and *Tengiomyces* gen. nov. of the Helminthosphaeriaceae. Mycotaxon 70: 387-420.

Réblová, M. and Seifert, K.A. (2008). A new species of *Chaetosphaeria* with *Menispora ciliata* and phialophora-like anamorphs. Fungal Diversity 29: 99-105.

Réblová, M., Barr, M.E. and Samuels, G.J. (1999). Chaetosphaeriaceae, a new family for *Chaetosphaeria* and its relatives. Sydowia 51: 49-70.

Rehner, S.A. and Samuels, G.J. (1995). Molecular systematics of the Hypocreales: a teleomorph gene phylogeny and the status of their anamorph. Canadian Journal of Botany 73 (Suppl.1): S561-578.

Rostrup, E. (1894/1895). Underjordiske Svampe i Danmark. Medd Bot Foren Kjoebehavn 1: 102-106.

Rossello, M.A., Descals, E. and Cabrer, R. (1993). *Nia epidermoidea,* a new marine gasteromycete. Mycological Research 97: 68-70.

Rossman, A.Y., McKemy, J.M., Pardo-Schultheiss, R.A. and Schroers, H.J. (2001). Molecular studies of the Bionectriaceae using large subunit rDNA sequences. Mycologia 93: 100-110.

Rossman, A.Y., Samuels, G.J., Rogerson, C.T. and Lowen, R. (1999). Genera of Bionectriaceae, Hypocreaceae and Nectriaceae (Hypocreales, Ascomycetes). Studies in Mycology 42: 3-238.

Ryan, B.D. (1988). Zonation of lichens on a rocky seashore on Fidalgo Island, Washington. The Bryologist 91: 167-180.

Sadaba, R.B., Vrijmoed, L.L.P., Jones, E.B.G. and Hodgkiss, I.J. (1995). Observations on vertical distribution of fungi associated with standing senescent *Acanthus ilicifolius* stems at Mai Po mangrove, Hong Kong. Hydrobiologia 295: 119-126.

Sakayaroj, J. (2005). Phylogenetic relationships of marine Ascomycota. Ph.D. Thesis, Prince of Songkla University, Thailand.

Sakayaroj, J., Jones, E.B.G., Chatmala, I. and Phongpaichit, S. (2004). In: *Thai Fungal Diversity* (eds. E.B.G. Jones, M. Tanticharoen and K.D. Hyde) BIOTEC, Thailand: 107-117.

Sakayaroj, J., Pang, K.L., Phongpaichi, S. and Jones, E.B.G. (2005a). A phylogenetic study of the genus *Haligena* (Halosphaeriales, Ascomycota). Mycologia 97: 804-811.

Sakayaroj, J., Pang, K.L., Jones, E.B.G., Vrijmoed, L.L.P. and Abedl-Wahab., M.A. (2005b). A systematic reassessment of marine ascomycetes *Swampomyces* and *Torpedospora*. Botanica Marina 48: 395-406.

Santesson, R. (1993). *The Lichens and Lichicolous Fungi of Sweden and Norway*. SBT-förlaget, Lund.

Sarma, V.V. and Hyde, K.D. (2000). *Tirispora mandoviana* sp. nov. from Chorao mangroves, Goa, the west coast of India. Australian Mycology 19: 52-56.

Sarma, V.V. and Hyde, K.D. (2001). *Lanceispora phyllophila* sp. nov. on petioles of unknown dicotyledonous leaves in Singapore. Mycoscience 42: 97-99.

Sarma, V.V., Newell, S.Y. and Hyde, K.D. (2001). *Koorchaloma spartinicola* sp. nov., a new marine sporodochial fungus from *Spartina alterniflora*. Botanica Marina 44: 321-326.

Schatz, S. (1980). Taxonomic revision of two Pyrenomycetes associated with littoral-marine green algae. Mycologia 72: 110-117.

Schatz, S. (1985). *Adomia avicenniae* from Red Sea and Australian mangroves. Transaction of the British Mycological Society 84: 555-559.

Schaumann, K. (1972). *Biconiosporella corniculata* nov. gen. et nov. spec., ein holzbesiedelnder Asomycet des marinen Liorals. Veröffentlichungen des Instituts für Meersforschung in Bremerhaven 14: 25-44.

Schaumann, K. (1973a). *Brachysporium helgolandicum* nov. sp. ein neuer Deuteromycet auf Treibborke im Meer. Helgoländer Wiss. Meerseunters 25: 26-34.

Schaumann, K. (1973b). *Chaetomium ramipilosum* nov. sp. Morphologie und vergleichende Kulturuntersichungen. Archiv für Mikrobiologie 91: 97-112.

Schilingham, G., Milne, L., Williams, D.R. and Carter, G.T. (1998). Cell wall active antifungal compounds produced by the marine fungus *Hypoxylon oceanicum* LL-15G256. II. Isolation and structure determination. Journal of Antibiotics 51: 303-316.

Schoch, C.L, Sung, G.-H., Volkmann-Kohlmeyer, B., Kohlmeyer, J. and Spatafora, J.W. (2006). Marine fungal lineages in the Hypocreomycetidae. Mycological Research 110: 257-263.

Schroers, H,-J. (2001). A monograph of *Bionectria* (Ascomycota, Hypocreales, Bionectriaceae) and its *Chonostachys* anamorphs. Studies in

Mycology 46 1-214.

Seutrong, S., Sakayaroj, J. Phongpaichit, S. and Jones, E.B.G. (2008). Morphological and molecular characteristics of a poorly known marine ascomycete, *Manglicola guatemalensis*. Mycologia. (Accepted for publication).

Shearer, C.A. (1993a). A new species of *Kirschsteiniothelia* (Pleosporales) with an unusual fissitunicate ascus. Mycologia 85: 963-969.

Shearer, C.A. (1993b). *Pseudohalonectira* (Lasiosphaeriaceae), an antagonistic genus from wood in freshwater. Canadian Journal of Botany 67: 1944-1955.

Shearer, C.A. (1993c). The freshwater ascomycetes. Nova Hedwigia 56: 1-33.

Shearer, C.A. and Miller, M. (1977). Fungi of the Chesapeake Bay and its tributaries V. *Aniptodera chesapeakensis* gen. *et* sp. nov. Mycologia 69: 887-898.

Shenoy, B.D., Jeewon, R. and Hyde, K.D. (2007). Impact of DNA sequence-data on the taxonomy of anamorphic fungi. Fungal Diversity 26: 1-54.

Shoemaker, R.A. and Babcock, C.E. (1989). *Phaeosphaeria*. Canadian Journal of Botany 67: 1500-1599.

Siepmann, R. and Johson, T.W. (1960). Isolation and culture of fungi from wood submerged in saline and freshwater. Journal of the Elisha Mitchell Science Society 76: 150-154.

Sivichai, S., Hywel-Jones, N.J. and Jones, E.B.G. (1998). Lignicolous freshwater ascomycetes from Thailand. *Ascotaiwania sawadae* and its anamorphic state *Monotosporella*. Mycoscience 39: 307-311.

Slack, D., Boyle, W., Zerr, M. and Antoszewwski, E. (1999). A cladisitic analysis of the phylum Chytridiomycota with respect to the kingdom fungi. Journal of Systematic Biology 6: 1-11.

Smith, G.J.D. and Hyde, K.D. (2001). Fungi from palms. XLIX. *Astrocystis, Biscogniauxia, Cyanopulvis, Hypoxylon, Nemania, Guestia, Rosellinia* and *Stillbohypoxylon*. Fungal Diversity 7: 89-127.

Smith, G.J.D., Liew, E.C.Y. and Hyde, K.D. (2003). The Xylariales: a monophyletic order containing 7 families. Fungal Diversity 13: 175-208.

Spatafora, J.W. and Blackwell, M. (1994). The polyphyletic origins of ophiostomatoid fungi. Mycological Research 98: 1-9.

Spatafora, J.W., Volkmann-Kohlmeyer, B. and Kohlmeyer, J. (1998). Independent terrestrial origins of the Halosphaeriales (marine Ascomycota). American Journal of Botany 85: 1569-1580.

Spatafora, J.W., Sung, G.-H., Johnson, D., Hesse, C., O'Rourke, B., Serdani, M., Spotts, R., Lutzoni, F., Horsietter, V., Miadlkowska, J., Gueidan, C., Fraker, E., Lumbsch, T., Lücking, R., Schmityt, I., Hosaka, K., Aptroot, A., Roux, C., Miller, A.N., Geiser, D.M., Haffellner, J., Hestmark, G., Arnold, A.E., Büdel, B., Rauhut, A., Hewitt, D., Untereiner, W.A., Cole, M.S., Scheideger, C., Schultz, M., Sipman, H. and Schoch, C. (2006). A five-gene phylogeny of Pezizomycotina. Mycologia 98: 1018-1028.

Stanley, S.J. (1992). Observations on the seasonal occurrence of marine endophytic and parasitic fungi. Canadian Journal of Botany 70: 2089-2096.

Statzell-Tallman, A., Belloch, C. and Fell, J.W. (2008). *Kwoniella mangroviensis* gen. nov., sp. nov. (Tremellales, Basidiomycota), a teleomorphic yeast from mangrove habitats in the Florida Everglades and Bahamas. FEMS Yeast Research 8: 103-113.

Steinke, T.D. and Hyde, K.D. (1997a). *Gloniella calvatispora*, sp. nov. from *Avicennia marina* in South Africa. Mycoscience 38: 7-9.

Steinke, T.D. and Hyde, K.D. (1997b). *Phaeosphaeria capensis* sp. nov. from *Avicennia marina* in South Africa. Mycoscience 38: 101-103.

Steinke, T.D. and Jones, E.B.G. (1993). Marine and mangrove fungi from the Indian Ocean coast of South Africa. South African Journal of Botany 59: 385-390.

Strongman, D., Miller, J.D. and Whitney, N.J. (1985). Lignincolous marine fungi from Prince Edward Island with a description of *Didymosphaeria lignomaris* sp. nov. Proceeding of the Nova Scotian Institute of Science 35: 99-105.

Sutton, B.C. (1985). Notes on some deuteromycete genera with cheroid or figitate brown conidia. Proceedings of the Indian Academy of Science (Plant Science) 94: 229-244.

Swart, H.I. (1970). *Penicillium dimorphosporum* sp. nov. Transactions of the British Mycological Society 55: 310-313.

Swofford, D.L. (2002). PAUP: Phylogenetic Analysis Using Parsimony, version 4.0b10. Sinauer Associates, Sunderland, Massachusetts.

Swe, A., Jeewon, R., Pointing, S.B. and Hyde, K.D. (2007). Taxonomy and molecular phylogeny of *Arthrobotrys mangrovispora*, a new marine nematode-trapping fungal species. Botanica Marina 51: 331-338.

Swe, A., Jeewon, R., Pointing, S.B. and Hyde, K.D. (2008). Diversity and abundance of nematode-trapping fungi from decaying litter in terrestrial, freshwater and mangrove habitats. Biodiversity and Conservation: DOI 10.1007/s10531-008-9553-7.

Sundari, R., Vikyneswary, S., Yusoff, M. and Jones, E.B.G. (1996). *Corollospora besarispora*, a new arenicolous marine fungus from Malaysia. Mycological Research 100: 1259-1262.

Sutherland, G.K. (1915). New marine fungi on *Pelvetia*. New Phytologist 14: 33-42.

Sutherland, G.K. (1916a). Marine Fungi Imperfecti. New Phytolologist 15: 35-48.

Sutherland, G.K. (1916b). Additional notes on marine pyrenomycetes. Transactions of the British Mycological Society 5: 257-263.

Tang, A.M.C., Jeewon, R. and Hyde, K.D. (2007a).

Phylogenetic utility of protein (RPB2, β-tubulin) and ribosomal (LSU, SSU) gene sequences in the systematics of Sordariomycetes (Ascomycota, Fungi). Antonie van Leeuwenhoek 91: 327-349.

Tang, A.M.C., Jeewon, R. and Hyde, K.D. (2007b). Phylogenetic relationships of Nemania plumbea sp. nov. and related taxa based on ribosomal ITS and RPB2 sequences. Mycological Research 111: 392-402.

Tam, W.Y., Pang, K.L. and Jones, E.B.G. (2003). Ordinal placement of selected marine Dothideomycetes inferred from SSU ribosomal DNA sequence analysis. Botanica Marina 4: 487-494.

Taylor, R.M. (1982). *Marine flora and fauna of the northeastern United States*. Lichens (Ascomycetes) of the intertidal region. NOAA Technical Report NMFS Circular 446, iii+26pp.

Thompson, J.D., Higgins, D.G. and Gibson, T.J. (1994). CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position-specific gap penalties and weight matrix choice. Nucleic Acids Research 22: 4673-4680.

Thongkantha, S., Jeewon, R., Vijaykrishna, D., Lumyong, S., McKenzie, E.H.C. and Hyde, K.D. (2008). Molecular phylogeny of Magnaporthaceae (Sordariomycetes) with a new species *Ophioceras chinadaoense* from *Dracaena loueroi* in Thailand. Fungal Diversity 34: 155-171.

Tubaki, K. (1967). Studies on the Japanese marine fungi. Lignicolous group II. Seto Marine Biology Laboratory 15: 357-372.

Tubaki, K. (1973a). An undescribed halophilic species of *Scopulariopsis*. Transactions of the Mycological Society Japan 14: 367-369.

Tubaki, K. (1973b). Aquatic sediment as a habitat of *Emericellopsis*, with a description of an undescribed species of *Cephalosporium*. Mycologia 65: 938-941.

Udea, S. (1980). A mycoflora study on brackish water sediments in Nagasaki, Japan. Transactions of the Mycological Society Japan 21: 103-112.

Udea, S. (1995a). *Ecological and taxonomic studies on filamentous fungi of sediments in fresh water, brackish water and marine environment, with special reference to water pollution.* PhD Thesis, Hiroshima University.

Udea, S. (1995b). A new species of *Eupenicillium* from marine sediment. Mycoscience 36: 451-454.

Udea, S. and Udagawa, S.I. (1983). A new Japaneses species of *Neocospora* from marine sludges. Mycotaxon 16: 387-395.

Umali, T.E., Hyde, K.D. and Quimio, T.H. (1999). *Arecophila bambusae* sp. nov. and *A. coronata* comb. nov. from dead culms of bamboo. Mycoscience 40: 185-188.

Van Uden, N. and Castello-Branco. R. (1963). Distribution and population densities of yeast species in Pacific water, air, animals and kelp off Southern California. Limnology and Oceanography 8: 323-329.

Von Arx, J.A. and Müller, E. (1975). A re-evaluation of the bitunicate Ascomycetes with keys to families and genera. Studies in Mycology 9: 1-159.

Verbist, J.-F., Sallenave, C. and Pouchus, Y.-F. (2000). Marine fungal substances. Studies Natural Products Chemistry 24: 979-1092.

Vijaykrishna, D., Jeewon, R. and Hyde, K.D. (2006). Molecular taxonomy, origins and evolution of freshwater ascomycetes. Fungal Diversity 23: 351-390.

Volkmann-Kohlmeyer, B. and Kohlmeyer, J. (1992). *Corallicola nana* gen. & sp. nov. and other ascomycetes from coral reefs. Mycotaxon 64: 417-424.

Vrijmoed, L.L.P. (2000). Isolation and culture of higher filamentous fungi. In: *Marine Mycology-A Practical Approach* (eds K.D. Hyde and S.B. Pointing). Fungal Diversity Research Series 1, Fungal Diversity Press, Hong Kong: 1-20.

Vrijmoed, L.L.P., Hyde, K.D. and Jones, E.B.G. (1994). Observations on mangrove fungi from Macau and Hong Kong, with the description of two new ascomycetes: *Diaporthe salsuginosa* and *Aniptodera haispora*. Mycological Research 98: 699-704.

Vrijmoed, L.L.P., Hyde, K.D. and Jones, E.B.G. (1996). *Melaspilea mangrovei* sp. nov., from Australia and Hong Kong mangroves. Mycological Research 100: 291-294.

Walker, D.C., Hughes, G.C. and Bisalputra, T. (1979). A new interpretation of the interfacial zone between *Spathulospora* (Ascomycetes) and *Ballia* (Florideophyceae). Transactions of the British Mycological Society 73: 193-206.

Wang, Y.Z. and Hyde, K.D. (1999). *Hyponectria buxi* with notes on the Hyponectriaceae. Fungal Diversity 3: 159-172.

Wasser, S.L., Grishkan, I., Kis-Papo, T., Buchalo, A.S., Volz, P.A., Gunde-Cimerman, N., Zalar, P. and Nevo, E. (2003). Species diversity of the Dead Sea fungi. In: *Fungal Life in the Dead Sea.* (eds. E. Nevo, A. Oren and S.P. Wasser). Ruggell: 203-292.

Whalley, A.J.S. and Edwards, R.L. (1987). Xylariaceous fungi: use of secondary metabolites. In: *The Evolutionary Biology of Fungi* (eds. A.D.M. Rayner, C.M. Brasier and D. Moore). Cambridge University Press, Cambridge, UK: 423-434.

Whalley, A.J.S., Jones, E.B.G., Hyde, K.D. and Laessoe, T. (2000). *Halorosellinia* gen. nov. to accommodate *Hypoxylon oceanicum*, a common mangrove species. Mycological Research 104: 368-374.

White, T.J., Bruns, T., Lee, S. and Taylor, J. (1990). Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In: *PCR Protocol: A guide to methods and applications* (eds. M.A. Innis, D.H. Gelfand, J.S. Sninsky and T.J. White). San Diego: Academic Press: 315-322.

Winka, K. and Eriksson, O.E. (2000). *Papulosa amerospora* accommodated in a new family (Papulosaceae, Sordariomycetes, Ascomycota) inferred from morphological and molecular data. Mycoscience 41: 97-104.

Wilson, I.M. (1956). Some new marine Pyrenomycetes on wood and rope: *Halophiobolus* and *Lindra*. Transactions of the British Mycological Society 39: 401-415.

Wong, M.K.M., Goh, T.K. and Hyde, K.D. (2000). *Paraphaeosphaeria schoenoplecti* sp. nov. from senescent culms of *Schoenoplectus litoralis* in Hong Kong. Fungal Diversity 4: 171-179.

Wong, M.K.M., Poon, M.O.K. and Hyde, K.D. (1998). *Phragmitensis marina* gen. et sp. nov., an intertidal saprotroph from *Phragmites australis* in Hong Kong. Botanica Marina 41: 379-382.

Wong S.W., Hyde, K.D. and Jones, E.B.G. (1998). Annulatacaceae, a new ascomycetes family from the tropics. Systema Ascomycetum 16: 17-25.

Yaegashi, H. and Herbert, T.T. (1976) Perithecial development and nuclear behaviour in *Pyriculria*. Phytopathology 66: 122-126.

Yanna, Ho, W.H. and Hyde, K.D. (2003). Can ascospores ultrastructure differentiate the genera *Linocarpon* and *Neolinocarpon* and species therein? Mycological Research 107: 1305-1313.

Yanna, Hyde, K.D., and Goh, T.K. (1999). *Endomelanconium phoenicicola* sp. nov., a new coelomycete from *Phoenix hanceana* in Hong Kong. Fungal Diversity 2: 199-204.

Yusoff, M., Jones, E.B.G. and Moss S.T. (1994a.) A taxonomic reappraisal of the genus *Ceriosporopsis* based on ultrastructure. Canadian Journal of Botany 72: 1550-1559.

Yusoff, M., Moss, S.T. and Jones, E.B.G. (1994b). Ascospore ultrastructure of *Pleospora gaudefroyi* Patouillard (Pleosporaceae, Loculoascomycetes, Ascomycotina). Canadian Journal of Botany 72: 1-6.

Yusoff, M., Read, S.J., Jones, E.B.G. and Moss, S.T. (1994c). Ultrastructure of *Antennospora salina* comb. nov. Mycological Research 98: 997-1004.

Yusoff, M., Koch, J., Jones, E.B.G. and Moss, S.T. (1993). Ultrastructural observations on a marine lignicolous ascomycete *Bovicornua intricata* gen. et sp. nov. Canadian Journal of Botany 71: 346-352.

Zainal, A. and Jones, E.B.G. (1984). Observations on some lignicolous marine fungi from Kuwait. Nova Hedwigia 39: 569-583.

Zhang, N., Castlebury, L.A., Miller, A.N., Huhndorf, S., Schoch, C.L., Seifert, K., Rossman, A.Y., Rogers, J.D., Kohlmeyer, J., Volkmann-Kohlmeyer, B. and Sung, S.-H. (2006). Sordariomycetes systematics: An overview of the systematics of the Sordariomycetes based on a four-gene phylogeny. Mycologia 98: 1076-1087.

Zhang, Y., Fournier, J., Pointing, S.B. and Hyde, K.D. (2008). Are *Melanomma pulvis-pyrius* and *Trematosphaeria pertusa* congeneric? Fungal Diversity 33: 47-60.

Zuccaro, A., and Mitchell, J.I. (2006). Fungal communities of seaweeds In: *The Fungal Community* (eds. J. Dighton, J. F. White and P. Oudemans) CRC, Taylor and Francis, New York.

Zuccaro, A., Schulz, B. and Mitchell. J.I. (2003). Molecular detection of ascomycetes associated with *Fucus serratus*. Mycological Research 107: 1451-1466.

Zuccaro, A., Summerbell, R.C., Gams, W., Schroers, H.-F. and Mitchell, J.I. (2004). A new *Acremonium* species associated with *Fucus* spp., and its affinity with a phylogenetically distinct marine *Emericellopsis* clade. Studies in Mycology 50: 283-297.