

A review on fungal diseases of algae, marine fishes, shrimps and corals

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It is a well-known fact that diseases affect health, survival and recruitment of any individual susceptible for diseases. As a consequence of disease, harvests from natural resources and, in particular, those from aquaculture dwindle quite severely. While an appreciable volume of information on variety of mycotic diseases in the marine organisms is available on global scale, studies from Indian waters are, at best, very few. This review is an attempt of bringing together a set of information deemed useful for stimulating marine mycopathological investigations in our waters. The information put together here is also to highlight the importance of pathology in general and fungal diseases in particular.

[**Key words:** Fungi, parasites, pathogens, algae, corals, marine fishes, *Fusarium*, *Lagenidium*, *Siroloidium*]

Introduction

Marine fisheries and aquaculture contribute to national productivity, socio-economic development and renewable aquatic living resources. Fish and fisheries are pivotal in food security, meeting social objectives in terms of sustenance of non- or semi-skilled by providing employment and in contribution to large export earnings.

Diseases cause the largest economic losses in aquaculture and, fungal infections are second only to bacterial diseases in economic importance. Fungal infections are generally restricted to chronic, steady losses¹. Hatai & Hoshiai² indicate that there is an annual mortality rate of 50 % in coho salmon (*Oncorhynchus kisutch* Walbaum) due to the fungus, *Saprolegnia parasitica* in Miyagi Prefecture, Japan. Also, 50 % annual losses have also been reported in elver stages of eel, *Anguilla anguilla* cultured in Japan¹. Fungal infections are common among many fish species and, can prove fatal if not treated early. Scarfe *et al.*³ observed that aquaculture bio-security programs addressing aquatic animal pathogens and diseases have become an important focus for the aquaculture industry. Disease outbreaks have threatened profitable and viable aquaculture operations throughout the world. Thus, information exchange between leading experts in different countries, will have to increase for successful combating of infectious diseases.

This review on fungal diseases in marine organisms is motivated by two main factors. On global scale, studies on fungal afflictions in the marine *milieu* have been many. Yet, studies or surveys on pathogenic or parasitic fungi from the Indian waters are very scanty. Aquaculture of penaeid shrimps and many fishes is now practiced on a large scale along Indian coastal waters. Yet again, the records of mycotic infections are very limited and, in many instances, missing. Pertinent literature on some important fungal pathogens of concern in both feral and cultured populations of marine organisms is compiled here to emphasize that a basic understanding on marine fungal pathogens in our waters is needed. For this reason, recent literature on some of the most common fungal diseases in the aquatic organisms in general and marine fishes, shrimps, algae, shellfishes and corals is compiled and discussed in this review.

From fish pathologist's viewpoint, there are mycoses that hinder the function of organs and kill the fish on mass scale and also there are mycoses depriving fish body of its natural strength. Almost every freshwater fish is exposed to at least one species of fungus during its lifetime^{4,5}. Moulds, which cause mycoses, are microscopic organisms producing filamentous coatings on various substrates. It is still widely believed that mould infestation of fishes is largely a secondary phenomenon. Therefore, mycological examination ought to become an integral part of monitoring the health of the fish and, to be

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done simultaneously with the bacteriological examination. Fungi are obtained fresh from the host by taking an inoculum from the suspect tissue onto agar medium. Any mycologist interested in studying fungal pathogens would greatly benefit by referring to Rehulka⁶ for procedures on inspections of mycotic infections, isolation, cultivation, examination, preservation and experimental studies on parasitic/pathogenic fungi from aquatic organisms.

Principal fungal pathogens of fish

'Dermocystidiosis' in aquatic animals

Among the most investigated marine fungal pathogen is *Dermocystidium marinum*. In 1957 Andrews & Hewatt⁷ reported that warm-season mortality of oysters in the Chesapeake Bay was attributed to *D. marinum*. This high death rate was ascribed to increased environmental stress and warmer temperatures that aid proliferation of this fungus. The pre-1980 literature on *Dermocystidium* infections in marine organisms has been extensively covered by Kinne⁸. Although no records of *Dermocystidium* infections in Indian waters are available, it is important to note that *Rhinosporidium seeberi*, a close relative of *Dermocystidium* has recently been isolated from mucosal surfaces of human patients from southern India. Fredricks *et al.*⁹ reported a disease caused by *Rhinosporidium seeberi*, an aquatic protistan parasite causing rhinosporidiosis in human beings. Rhinosporidiosis manifests as slow-growing tumorlike masses of the nasal mucosa or ocular conjunctivae in humans and animals¹⁰.

Recent research¹¹ on *Dermocystidium* in Finland and Estonia is suggestive of its extensive host range both in freshwater and marine animals. In Finland, Pekkarinen & Lotman¹¹ recorded *Dermocystidium percae* in the fins of a perch for the first time in 1988. Because it was a poorly known parasite, information on its occurrence and life stages was obscure. The more systematic sampling suggested its occurrence to be quite significant. Pekkarinen & Lotman¹¹ suggest that its life cycle is maintained from year to year by over-wintering cysts. Young perch seem to acquire first infections in their first summer of life, and when over three-years old, possibly develop some immunity. In Estonia, in the Kasari River and the Matsalu Bay, the parasite seems to be very rare. Cysts of *D. percae*, capable of sporogenesis, were occasionally noticed also on ruff. In perch of Finland¹¹, cysts were found differing from the longish

and thin-walled cysts typical of *D. percae*. These roundish to dumbbell-shaped cysts with thicker walls are suggested to belong to a different species of *Dermocystidium*. Cysts of *D. percae* occurred in the skin of all fins, but most often in abdominal fins and rarely elsewhere. In ruff, cysts of *D. percae* were also found in the gills. Of the fins, this species favoured the first dorsal fin, but also occurred elsewhere, e.g. in the head region of perch. Cysts of *D. percae* develop from thin-walled, round plasmodium mother cells, about 10 µm in diameter, by elongating and increasing in size.

In recent years, a global decline in amphibian populations has occurred^{12,13}. A number of anthropogenic factors have been causally implicated in these declines, including habitat loss, introduction of predators, chemical pollution and climate change^{14,15}. A previously unknown fungal disease, chytridiomycosis¹⁶ has been reported as one of the causes of amphibian mass mortality associated with population declines. Such emerging infectious diseases (EIDs) are part of a growing cohort of wildlife and EIDs are implicated to threaten biodiversity globally¹⁷. It is therefore needless to emphasize that we need to begin documenting parasites and pathogens of ecological and bioresource significance. In 2003, Pascolini *et al.*¹⁸ described *Amphibiocystidium* n. gen which was earlier designated as *Dermocystidium rana*, a parasite of *Rana esculenta* in Central Italy. These authors have listed species designated to this genus (and authorities, references can be found in Palusconi *et al.*¹⁸): *Dermocystidium pusula* Pérez, 1907; *Dermocystidium ranae* Guyenot & Naville, 1922; *Dermosporidium hylae* Carini, 1940; *Dermosporidium granulorum* Bro= & Pólvora, 1951; *Dermosporidium multigranulare* Bro= & Kulda, 1954; *Dermosporidium penneri* Jay & Pohley, 1981; *Dermomycoides beccarii* Granata, 1919 and *Dermomycoides armoriacus* Poisson, 1937. References from 19-25 are also useful to get detailed information on *Dermosystemidium*. Since there are many reports on *Dermocystidium* from marine environment²³⁻²⁵, it is imperative from ecological and marine organism health point of view that a beginning to look for this pathogen be made sooner.

Oomycetosis

Infections by oomycetous fungi are among the most widely known and most widespread mycoses of fishes⁶. The Class *Oomycetes* is divided into four

orders: *Legenidiales*, *Perenosporales*, *Leptomitales* and *Saprolegniales*. Of these, Rehulka⁶ considers *Pythium* spp (*Perenosporales*), *Leptomit* spp(*Leptomitales*) and eight genera in the Order *Saprolegniales* to be parasites of concern of fishes. These are, *Achlya*, *Aphanomyces*, *Calyptralegnia*, *Dictyuchus*, *Leptolegnia*, *Pythiopsis*, *Saprolegnia* and *Thraustotheca*. The most widespread species parasitizing fish include representatives of the genera *Achlya* and *Saprolegnia*.

Saprolegnia is ubiquitous in freshwater ecosystems and is the main genus of water molds responsible for significant fungal infections of freshwater fish and eggs^{1,26}. The "saprolegniasis"^{27, 28}, though most widespread in freshwater, is not restricted to only there. It is found in all types of waters all over the world. The disease breaks out only where pathogenic strains are present (absence of saprolegniasis is ascribed to the absence of pathogenic strains). On fish, *Saprolegnia* invades epidermal tissues, generally beginning on the head or fins^{4,29} and can spread over the entire surface of the body. Visible are white or gray patches of filamentous mycelium. The spores most easily and, frequently penetrate into the fish body when surface of the skin or gills is damaged mechanically and/or by parasitic or bacterial infections and when the fish is weak.

Willoughby & Pickering³⁰ have reviewed the afflictions of *Saprolegnia* rather extensively. Salmonids become susceptible to saprolegniasis when exposed to stress. It is proposed that stress raises the corticosteroid level in the blood plasma, which suppresses inflammatory reaction and boosts protein catabolism, regulated by the corticosteroids. In the final stage of the disease, protein deficiency leads to atrophy of the skeletal muscles and suppression of collagen synthesis. Lack of collagen is reported to lead to poor regeneration of lesions on the skin³⁰.

Saprolegnia also infects moribund eggs by adhesion to and penetration of the egg membrane²⁹, and can spread from dead eggs to live eggs via positive chemotaxis¹. The species of *Saprolegnia* are reported to have two kinds of zoospores²⁹, the primary zoospore having the shape of a grain with flagella on the end, encysts short after leaving the zoosporangium. Then the cyst may die and produce a mycelium or form a secondary kidney-shaped zoospore with lateral flagella: the feathery one will point forward and the smooth one will point back. The secondary zoospore lives longer and also forms a

cyst. The cyst may proliferate owing to mycelium formation, or may produce a secondary zoospore.

There are no free-flowing primary zoospores in the fungi of the genus *Achlya*⁶. Secondary oocysts emerge from the cyst and appear at the sporangium opening. In species of the genus *Aphanomyces*, the cysts are produced in the same way as in *Achlya* but unlike the latter, the former have much thinner hyphae and the zoospores in their zoosporangium are arranged in a single line. Ulcerative mycosis (UM) is caused possibly by *Aphanomyces*^{5,31} and another condition, epizootic ulcerative syndrome (EUS) is a seasonal epizootic of wild and farmed, fresh- and brackishwater fish. Of complex infectious aetiology, it is characterized by the presence of invasive *Aphanomyces* infection and, necrotising ulcerative lesions typically producing a granulomatous response. The disease now appears endemic in southeast and south Asia, and seems to have extended to west Asia⁵.

The EUS is indistinguishable from red spot disease of eastern Australia and mycotic granulomatosis of Japan³². The EUS has been reported to occur in over 100 freshwater fish species and, to a lesser extent, in brackish water fish. The lesions typically consist of mature epithelioid granulomas centered around variable numbers of fungal hyphae. Blazer *et al.*³³ examined Atlantic menhaden from Chesapeake Bay and its tributaries. Deeply penetrating fungal hyphae surrounded by intense granulomatous inflammation are common clinical signs. In fish with raised lesions (i.e., before the necrotic material had sloughed away), hyphae can be observed penetrating through and around muscle bundles beneath areas of intact skin and muscle. The lesions caused by UM as well as EUS, attributed to *Aphanomyces invadens*^{33,34}, are quite identical. The initial sign is usually mass mortality associated with distinct dermal lesions including ulcers. Surviving fish typically have lesions of varying degrees of severity. These may appear as red-spots, blackish burn-like marks, or deeper ulcers with red centres and white rims. Some fish, especially the snakeheads, survive a long time with ulcers, that may erode so deeply as to expose the vertebrae, brain and viscera. Histological occurrences include necrotising, granulomatous dermatitis and myoositis associated with invasive, non-septate fungal hyphae, 10-20 µm in diameter³⁵. The fungus may penetrate visceral organs, such as the kidney and liver, after it has spanned the musculature²⁸.

Syndrome akin to EUS in freshwater fishes from India has been recorded³⁶. During the monsoon month of July 1997, large ulcerations (EUS?) on mullets, catfishes and cichlids in Zuari estuary were observed. The musculature was so sloughed, many moribund fishes had lost most part of their caudal musculature including caudal fin.

Branchiomycosis

Branchiomycosis is a much feared fungal disease of fishes almost all over the world⁶, especially on carp farms. The disease occurs most frequently in the warm climatic regions. *Branchiomyces* is another filamentous fungus obstructing the blood vessels in the gill filaments. Flecking on the gill filaments at a later stage becomes greyish-white and may finally drop off altogether leaving the cartilagenous support exposed. Branchiomycosis caused by *Branchiomyces sanguinis* in carp and/or tench, crucian carp and sticklebacks and branchiomycosis caused by *Branchiomyces demigrans* in pike and tench are well known⁶. The two species can be distinguished from each other by their morphological traits and by peculiarities of their development.

Branchiomyces demigrans differs from *B. sanguinis* by having thicker-walled *hyphae* and by being able to proliferate from the blood vessels to the adjacent tissue of the gills. The spectrum of hosts harbouring these fungi has recently been extended and includes also the salmonids⁶.

Laboratory diagnosis of branchiomycosis is based on the examination of the gill filaments by the compression method. Fungal hyphae are visible in the blood vessels of the gills at a 150-fold magnification under the microscope. Spores can also be identified when the diseases are in its acute stage. The affected tissues are torn into pieces on the microscope slide and examined by adding a drop of 50 % glycerol solution in water or alcohol. The branchiomyces are also well discernible in preparations from dead fish bodies decomposed by rot⁶.

Ichthyophonosis

The disease has until now been diagnosed in more than 80 fishes including high-priced salmonids among which sea fishes also figure prominently⁶. Two species: *Ichthyophonus hoferi* and *I. Gasterophilum* are the causative agents of ichthyophonosis (or, ichthyosporidiosis). Depending on the stage of the disease, different stages of development of *I. hoferi*

can be distinguished microscopically: "resting" spore, germinating spore and hyphal stage.

The latently sick fish are the causes introducing the disease easily into aquaculture environment. These fish may shed the fungus from the attacked skin or the infection may spread from their urinary tract if their kidneys are invaded³⁵. Decaying bodies of the fish killed by the disease may also be a copious source of infection. The infection is usually contracted via the digestive tract. The clinical signs depend on the intensity of invasion of the different organs²⁸. Often the fins disintegrate and, might even fall off. If the liver, kidney and spleen are invaded, they enlarge and so does the whole belly of the fish; the eyes often bulge and erode. The symptoms that accompany severe infection of the kidneys and liver include exophthalmus, distended scales and accumulation of exudate in the body cavity. If the skin is invaded, ulcers develop. No organ is safe from the disease; generally it can be said that tissues abundantly supplied with blood such as heart, spleen are most vulnerable⁶.

Afflictions caused by Hyphomycetes (Fungi imperfecti)

In recent years researchers have studied many hyphomycetous fungi with increased attention from the point of view of their possible primary pathogenicity. Some species, especially *Exophiala salmonis*, *Exophiala pisciphila* and *Ochroconis tschawytschae*, are particularly suspected in this respect. These fungi can be generally characterized by their forming either sterile mycelium or mycelium with conidiophores on which conidia (spores developing in nonsexual reproduction) are produced³⁴.

Fungal diseases reported from India in cultured shrimps

Though diseases in feral populations of shrimps are not seriously studied, there is some awareness of mycoses in cultured shrimps, owing to the losses incurred than to the interest in mycotic afflictions. Karunasagar *et al.*³⁷ suggest that nearly 500 fungal species have been isolated from marine and estuarine environment, of which a few are pathogenic to shrimps. Mostly larval stages of shrimps are affected commonly by *Lagenidium callinectes* and *Serolpidium* spp. Clinical signs such as lethargy and mortality due to fungal afflictions can be detected in protozoa and mysis stages. Usually, fungal spores and mycelia can be observed in affected tissue, particularly in gill and appendages. Mycosis is

problematic for larval stages in many hatcheries in India. Gopalan *et al.*³⁸ reported *Lagenidium marina* and *Sirolopidium parasitica* infection in *P. monodon*. Ramasamy *et al.*³⁹ reported mortalities in *P. monodon* larvae at nauplii, zoea and mysis stages. Fusariosis and black gill disease caused by *Fusarium* spp may affect all developmental stages of penaeid shrimp. *Fusarium* spp (*F. solani*, *F. moniliformae*) are opportunistic pathogens that may lead to high mortalities (90%). Disease is noticed in ponds where water quality management is poor. Fungal hyphae can be detected in affected animal tissue using light microscopy.

Fungal parasites in marine algae

A wide array of partnership between algae and fungi ranging from loose commensal association (between primitive lichens and fungi), obligate symbiotic association or, “mycophycobioses” (between systemic fungi and macroalgae), saprobic association (fungi growing on senescent to moribund algae) to parasitism where the fungi cause disease in algae. According to Raghukumar⁴⁰, fungal parasites in the marine environment appear to be relatively fewer in number than those reported as parasites in terrestrial plants and, are limited in their geographical distribution due to their range of host specificity.

Marine algae including phytoplankton and macroalgae are a diverse group of organisms ranging from unicellular to highly complex giant kelps. Among their parasites, fungi are the most dominant ones⁴⁰. While information is available on fungal pathogens of freshwater phytoplankton⁴¹⁻⁴³, such records are quite scarce from the marine ecosystems. Reports on aquatic phycomycetous fungi were published from India are those by Karling⁴⁴, Dayal & Kiran⁴⁵, Chaudhry & Agarwal⁴⁶ and Hasija & Khan⁴⁷. Inadequate knowledge-base on algal and fungal system combined with time taking field-studies and labor intensive search for fungal pathogens of algae deter many researchers from this field⁴⁰. Notwithstanding such ordeals however, quite a systematic survey of algal diseases of the Indian coast has been carried out and, some very useful techniques have been developed for algal pathology and algal-fungal interactions⁴⁸⁻⁵³.

The filamentous green alga, *Cladophora* species collected from Indian coast was reported to harbour a range of fungal parasites⁴⁸ compared to other green algae. Consistently, *Coenomyces* sp (a polycentric chytrid) was found to be always associated with

healthy alga. The alga appeared healthy and no morphologically visible symptoms of fungal infection were seen. On incubation in seawater, groups of fungal sporangia were seen emerging out of algal filaments. When the algal filaments were bleached and dead, the fungus also appeared to die with it. The fungus *Olpidium rostriferum* was also found to be associated with *Cladophora frascatii* without causing any externally distinguishable morphological changes in the host similar to that of *Coenomyces* sp. Another green alga, *Rhizoclonium* sp. also harbored both the above mentioned fungi without displaying any symptoms of disease.

Marine green algae, *Cladophora frascatii* and *Rhizoclonium* spp also regularly harbored an oomycetous fungus, *Sirolopidium bryopsidis*, displaying browning of terminal and subterminal cells of branches. Only the infected cells were filled with fungal sporangia and the neighboring cells appeared green and turgid⁴⁹.

The filamentous green alga, *Chaetomorpha media*, from western and eastern coasts of the Indian peninsula showed infection by an oomycetous fungus *Pontisma lagenidioides*^{50,51}. The infected cells appear brownish and the infection spreads from the tip downwards of the algal filament on incubation in seawater in the laboratory. Further, fungal infection resulted in weight loss and decrease in chlorophyll *a* and *b*, total carbohydrate and protein with consequent increase in phaeopigment concentrations^{51,52}.

The cells of *Cladophora*, *Rhizoclonium* and *Chaetomorpha* on incubation in seawater were filled with spindle-shaped cells moving on ectoplasmic nets of protistan, *Labyrinthula* (Phylum: Labyrinthulomycota). On death of these host cells, the fungus appeared to grow on the surface of the algal filament. Species of thraustochytrids were also isolated from these filamentous green algae besides species of green macroalgae, *Codium*, and *Ulva* spp⁵⁰. All the above described fungi except *Labyrinthula*, have not yet been cultured in any natural or synthetic media indicating their obligate nature.

An epibiotic chytrid *Chytridium polysiphoniae* on the filamentous brown alga *Sphacelaria* sp. (Phaeophyta) was recorded from southern coast of India⁵⁰. A “Olpidium-like” fungus was found to occur commonly in the terminal cells of parent plant of *Sphacelaria* sp and in the tetra-radiate propagules attached to the host as well as those which were detached⁵³. A severe infection mostly in vegetative

propagules during January 1989 caused disappearance of this alga for a few months from the rocky shores of Anjuna beach in Goa⁵³. An ascomycetous fungus *Lindra thalasiae* was isolated from *Sargassum* species from the coast of Goa and the Lakshadweep islands in the Arabian Sea^{54,55}.

The filamentous red alga *Centroceras clavulatum* (Rhodophyta), harbors an epiphytic chytrid *Chytridium polysiphoniae* found along the coastlines of Goa, the Lakshadweep Island Agatti and southern east coast of India^{49,54}. The fungus could not be cultured by using pine pollen as baits in seawater nor on killed alga suggesting its obligate parasitic nature. In experimental set up with salinity of 25 psu and temperature of 30°C healthy algae became susceptible to infection⁵⁶. A thraustochytrid *Schizochytrium* sp. and an aplanochytrium *Labyrinthuloides minuta* were isolated from living red algae *Centroceras clavulatum* and brown algae *Sargassum* and *Padina* species in Goa^{57,58}. Occasionally, *Schizochytrium* sp. was observed to grow densely on live thallus of brown alga, *Padina tetrastomatica* wherever a cuticular layer was present.

Several diatoms collected from the Arabian Sea were found to harbour the thraustochytrid *Ulkenia visurgensis*⁵⁶. The protist did not infect healthy cells but was found always in senescent and moribund cultures. A thraustochytrid species *Schizochytrium* was reported⁵⁶ as parasite on the diatom *Thalassonema nitzchioides*. It caused disintegration of the diatom cell and the fungus could not be cultured on pine pollen-seawater medium as other thraustochytrids.

Fungal diseases of oysters and corals in Indian waters

Shell disease in bivalves is reported to be due to parasitic fungi⁵⁹. These fungi also play an important role in biodegradation of calcareous substrates including animal shells. These shell-boring fungi grow in dead and living bivalve shells deriving their nutrient from the organic matrix. A shell disease of rock oyster *Crassostrea cucullata* caused by fungus *Ostracoblabe implexa* was reported by Raghkumar & Lande⁶⁰, for the first time in 1988. *Ostracoblabe implexa* is a fungus of uncertain taxonomic position causing serious conditions in European flat oyster *Ostrea edulis* and also known to infect *Crassostrea angulata*⁶¹. When the *O. implexa* grew in the shells of rock oyster, small black flecks and raised white nodules were seen on the inner surface of the shell.

Upon decalcification of the heavily infected portions, fungal mycelia with hyphae were abundant. Although Durve & Bal⁶² reported a shell disease of *C. gryphoides* from Bombay, the aetiology was/is yet unknown. It should be relevant to look for mycotic infestations and afflictions in the marine zones where pollution stresses are evidenced. Since the environmental stressors bring about abnormal environmental situations, most biotic components become vulnerable to disease causing agents.

Occurrence of fungi in healthy and diseased corals has been widely reported from the world over⁶³. From a systematic collection of corals from Andaman and Lakshadweep islands, Raghukumar & Raghukumar⁶⁴ reported *Scolecobasidium* sp from five corals (*Porites lutea*, *P. lichen*, *Montipora tuberculosa*, *Goniopora* sp and *Goniastra* sp). This fungal parasite was found to cause necrotic patches on these five of the seven corals examined. Such patches ranged from 9% in *Montipora tuberculosa* to 54% in *Goniopora* sp in the Andaman islands. A detailed investigation for the presence fungi in healthy, partially dead, bleached and pink-line syndrome affected scleractinian corals in the Lakshadweep islands has been carried out⁶⁵. Several species of fungi have been isolated from both healthy, bleached, dead and PLS-affected *Porites lutea*⁶⁵. Interestingly, the highest frequency of fungi with mostly genera of terrestrial origin, was on the partially dead corals. Among the frequently isolated flora were, *Curvularia lunata*, various species of *Aspergillus*, one species of *Cladosporium* and a mycelial yeast. Scanning electron photomicrographs revealed the presence of fungi within the carbonate skeleton and around polyps⁶⁵. From these observations it was supposed that fungi are regular skeletal-components of healthy, partially dead and diseased corals.

As is abundantly clear from the foregoing, this review is based largely on the works elsewhere. Thus this is intended mainly to highlight the existing knowledge gaps in fungal diseases of marine fishes of India. Also, this review has not covered literature on prophylaxis and/or control aspects of mycotic afflictions. Further, various environmental stresses that make the organisms susceptible for any pathogenic attack are not included here. These aspects have to be considered for an understanding of infection rates, incidences and frequency of recurrence of any given disease. This could be more meaningful when records, in particular fish

pathogenic fungi, are forthcoming. Marine mycopathology from the seas around India has to gain momentum and provide much needed information at least on fungal pathogens in fish and shellfish of economic importance.

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