Chapter 1

Introduction

1.1 Introduction to Antarctica

1.1.1 Terrestrial biogeographic zones of Antarctica

The terrestrial ecosystem of the southern pole is cover very small percentage (about 0.32%) of the continent region (Convey *et al.*, 2008) (Figure 1.1). According to Convey (2001), Antarctic continent is divided in to three biogeographic zones, namely Subantarctic, Maritime Antarctic and Continental Antarctic.

Firstly, the Sub-Antarctic zone comprises of a number of southern ocean isolated islands and archipelagos are representing the sub-Antarctic region. There is no seasonal pack or fast ice influences (except of South Georgia), with low air temperature and positive year-around in the most of the islands, in addition to the high precipitation.

The second zone is Maritime Antarctica which includes the western coastal regions of Antarctic Peninsula to Alexander Island, along with the Scotia Arc Island archipelagos, the isolated Bouvetøya and Peter I Øya. The maritime region have a positive mean air temperature for up to 4 month of the year, while both summer maxima and winter minima are buffered by the surrounding ocean, with possibility of thaws in all winter months. The South Sandwich archipelago and Bouvetøya mutually with similar areas on Deception Island of South Shetland Islands and Victoria Land of continental Antarctic, are distinctive areas in Antarctica because of being geologically recent and active volcanic islands, with unique biological communities associated with the geothermal activity. However, precipitation is generally high.

Thirdly, the greater zone called Continental Antarctica, including East Antarctica, Balleny Islands and eastern side of the Antarctic Peninsula. This zone includes exposed coastal regions similar to those of the maritime Antarctic and inland nunataks with positive mean air temperatures was achieved for 1 month in these coastal regions. Nevertheless, terrestrial habitats are of limited extent and great isolation, except the Dry Valley region of Victoria Land. However, air temperatures rarely, if ever, become positive even for short periods in summer.

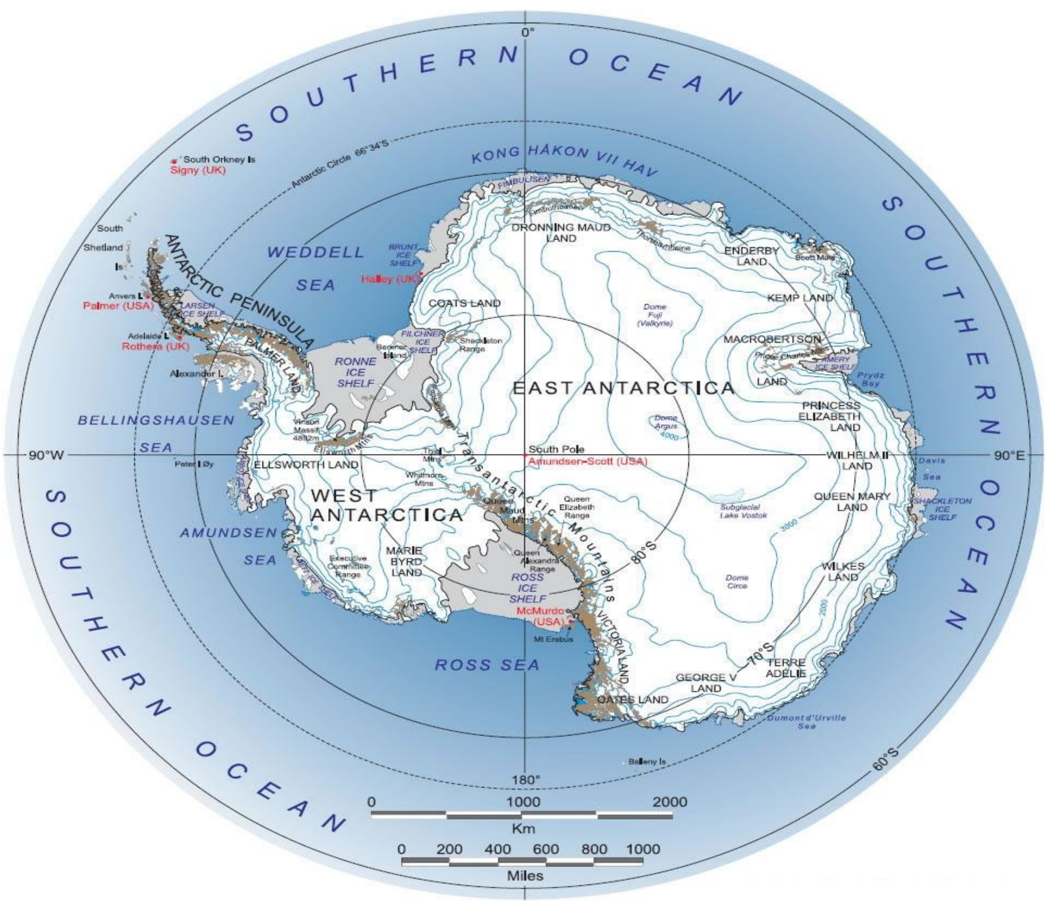

Figure 1.1 Geographic map of Antarctica. Brown coloured areas: Ice-free regions, White coloured areas: Ice sheet and Gray areas: present Ice shelf regions. Customized photograph adopted from [www.geology.com/worldantarctica-map/html].

1.1.2 Terrestrial Microbial life

Antarctic continent bionetwork or natural balances have been dominated by microorganisms more than other continents in the planet (Wynn-Williams, 1996). Antarctic microorganisms demonstrate high levels of adaptation and ability to withstand extreme conditions which are significantly constitute limiting factors for plant and animal life. For instance, low temperature, low water availability, frequent freeze–thaw cycles, strong winds with low annual precipitation, in addition to the high sublimation and evaporation, and high incidence of solar, especially the ultraviolet radiation (Wynn-williams, 1996; Bradner *et al.*, 2000; Brett *et al.*, 2006 and Ruisi *et al.*, 2007). Microorganisms have essential roles in the processes of primary colonization and stabilization of mineral soils, leading to secondary colonization and succession by other microbiota (Convey, 2001).

Despite not much is known on the Antarctic terrestrial microbial communities, recent important study was focused on the ecology of those systems (Yergeau *et al*. 2006). Wynn-Williams (1996) have reviewed this issue clearly, putting autotrophic cyanobacteria and algae as the primary colonist's communities, followed by bacteria, fungi, and protozoans secondarily. Thus, these ecosystems may also occupy cryophilic in between ice crystals, and endolithic within surface of rock matrix habitats (Wynn-Williams, 1996). However, communities like algae and cyanobacteria were found to develop filaments and mats within water bodies and the superficial layers of humid soils. These communities are significantly colonize within the maritime region, and are often a climax community of the continental zone. As reported there is no evidence of life on the surface of soils or rock of large parts of Dry Valleys, continental Antarctica (Convey, 2001). Moreover, in term of association, the most successful association in Antarctica is the lichen symbioses of fungi and algae, and other organisms such as bacteria and nonlichenized fungi have been found to be associated with them. However, till now we do not understand the functional significance of these supplementary associated organisms (Onofri *et al.*, 2007).

Little detailed information is known about the soil bacterial communities in Antarctica. A relation has been observed between the soil nature, nitrogen content, water availability and type of plant cover, and between the bacterial quantity, activity and community structure. In the same way, observation has made on the bacterial activity was found to be controlled basically by short-term patterns of temperature, moisture, and secondly by the supply of soluble carbohydrates, amino acids and the availability of organic matter, excluding the N and P were not found to be influent. Among the few molecular surveys of three the biogeographic zones, survey suggested that, percentage of novel psychrophilic taxa potentially correlated with mineral soil of low density bacterial-communities (Yergeau *et al.*, 2006).

On the other hand, couples of decades ago, Antarctic regions have been screened for the presence of bacteria, archae and algae more than fungi. However, fungi are recently shown not only able to sustain, but also to propagate successfully at different extreme environmental conditions such as hypersaline waters, dry rock surfaces, and ocean depths (Gundecimerman *et al.*, 2003). Fungal communities have been observed to be more abundant in sub-Antarctic islands, more humid and temperate, as compared to other Antarctic regions. Similarly to the bacteria, fungal abundance on the sub-Antarctic Signy Island was has been correlated to the organic matter, soil water content, pH and total nitrogen (Yergeau *et al.*, 2006). Cryptoendolithic communities constitute very simple communities comprising only a few species of antarctic cryptoendolithic microorganisms. While, ‘‘lichen dominated community’’ is the most common and well-studied communities found in sandstone (Ruisi *et al.*, 2007). However, observation of several studies have made on antarctic fungal communities are dominated by psychrotolerant, rather than psychrophilic fungi, expecting that tolerance of some fungal communities to the cold results in diverse fungal assembly (Yergeau *et al.*, 2006). Moreover, a recent molecular survey showed there is no increase in the eukaryotic diversity along the Antarctic regions and compare between the diversity of the lower eukaryotic in continental and maritime Antarctic (Yergeau *et al.*, 2006).

1.1.3 Biodiversity of terrestrial microfungi

Antarctica terrestrial ecosystems include a wide range of habitat from the desert of the continent to the relatively warm sub-Antarctic (Vishniac, 1996). Therefore, the distribution of fungi in Antarctica is related to the distribution of different substrata such as soils, rocks, bird feathers and dung, vegetation (which consists of plants), bryophytes, and lichens. The distribution also correlated to the distribution of scientific research stations (mainly scattered along the coast of the continent) which their environs have been most extensively investigated (Ruisi *et al.*, 2007). Correspondingly, terrestrial microfungi biodiversity increases with the accessibility of energy and water **(**Vishniac, 1996). It is well-known most of the filamentous fungi and yeasts are cosmopolitan species; some fungi are termed indigenous, fast sporulating forms, able to conclude their life-cycles in very short time, psychrophilic, even some are psychrotolerant; whilst the other are propagules transported to Antarctica but unable to grow under the Antarctic conditions (Ruisi *et al.*, 2007).

According to Malosso *et al.* (2006), “The environment is still too severe to support a diverse biota”. Wynn-Williams (1996) described the microbial species richness is generally more restricted than in temperate regions. Nevertheless, species diversity may be low while metabolic flexibility is high so that a few strains can provide most necessary functions. Moreover, Vishniac (1996) hypothesized that yeasts probably predominate on continental Antarctica, while other microfungi usually predominate in maritime and sub-Antarctica. Therefore, a long list of fungal species, including yeasts, colonizes nearly all terrestrial environments occurring in Antarctica representing a broad variety of taxa providing a diverse gene pool (Wynn-Williams, 1996). It is not easy to accurately detail on the biodiversity (due to the identification problems). The accuracy of a biodiversity index depends upon correct identification. Beside the discrimination problem of what organisms are truly indigenous? And this is troublesome as fungal spores are readily air-borne (Vishniac, 1996).

Within the Continental Antarctica, colonization by filamentous microfungi has been clearly demonstrated only in protected terrestrial habitats (Onofri, 1994). Some habitats may offer physical protection as well. Therefore, the most frequently reported genera are typically those among the well-known airspora. So far, the majority of microfungi reported are cosmopolitan hyphomycetes (Onofri, 1994). Coming first, *Cladosporium* species are the most frequently reported and *Dendryphiella salina* is second most frequent recorded. Species of *Aspergillus, Penicillium, Neurospora, Chaetomium, Malbranchea, Mucor, Myceliophthora and Paecilomyces* are also of the more frequently reported psychrotolerant microfungi from cold soils. However, *Thelebolus microspores,* the psychrophilic ascomycete has been frequently isolated from skua and penguin dung and from soil frequented by birds, which it look indigenously Antarctic fungi (Corte *et al.,* 1993). Although, the mainly abundant keratinophiles, *Chrysosporium* sp., in addition to the mesophilic hyphomycete *Geomyces pannorum* have been isolated so frequently in association with appropriate substrates for a highly keratinophilic fungus as a cosmopolitan, also has been confirmed as indigenous antarctic microfungi. Moreover, the frequent isolation of the best known as cosmopolitan, toxigenic plant and occasionally human pathogens *"Phoma herbarum"* from soil is unusual (Vishniac, 1996).

On the other hand, maritime and sub-Antarctica biodiversity are more easily assessed compared to continental Antarctica. Some of the microfungal species isolated from maritime and sub-Antarctica are listed in Table 1.1 such as, *Acremonium* sp., *Geomyces* sp., *Mortierella* sp., *Phoma exigua*, *Mucor hiemalis*, *Phialophora* sp. and *Penicillium* sp.

Table 1.1 Identified microfungal species reported from terrestrial habitats of maritime and sub-Antarctica (Vishniac, 1996).

Microfungal Species Name

Acremonium antarcticum	*Lichenoconium xanthonae*
Acremonium butyri	*Mortierella alpina*
Acremonium cerealis	*Mortierella gamsii*
Acremonium psychrophilum	*Mortierella minutissima*
Acremonium rutilum	*Mortierella parvispora*
Acremonium strictum	*Mortierella turficola*
Acremonium terricola	*Mucor hiemalis*
Acremonium zonatum	*Ovadendron sulfureo-ochraceum*
Acrodontium antarcticum	*Paecilomyces variotii*
Alternaria alternata	*Penicillium brevi-compactum*
Alternaria chlamydospora	*Penicillium chrysogenum*
Ascochyta stilbocarpae	*Penicillium cyclopium*
Aspergillus sydowi	*Penicillium series frequentans*
Aureobasidium pullulans	*Penicillium glabrum*
Botrytis cinerea	*Penicillium series granulatum*
Camarosporium metableticum	*Penicillium janthinellum*
Chalara antartica	*Penicillium lilacinum*
Chalara constricta	*Penicillium series ramigena*
Chaunopycnis alba	*Penicillium series roqueforti*
Chaunopycnis ovalispora	*Penicillium series viridicatum*
Chromelosporium ollare	*Penicillium waksmanii*
Chrysosporium indicum	*Phialophora alba*
Chrysosporium keratinophilum	*Phialophora hyaline*
Cladosporium cladosporioides	*Phialophora malorum*
Caldosporium herbarum	*Phialophora melinii*
Caldosporium sphaerospermum	*Phialophora dancoi*
Cunninghamella antarctica	*Phoma exigua*
Cunninghamella echinulata	*Rhodesiopsis gelatinosa*
Diheterospora chlamydosporia	*Stagonospora ischaemi*
Doratomyces nanus	*Stephanosporium cerealis*
Epicoccum purpurascens	*Tolypocladium cylindrosporum*
Fusarium lateritium	*Tolypocladium nubicola*
Geomyces cretaceous	*Tricellula aquatic*
Geomyces pannorum	*Trichocladium opacum*
Geomyces vulgare	*Trichophyton terrestre*
Gliocladium roseum	*Trichurus spiralis*
Helicoon reticulatum	*Volucrispora graminea*

1.1.4 Role of antarctic fungi in polar ecosystem

The exceptional environmental condition harshness of terrestrial antarctic generates simple structural ecosystem, dominated by the microbes (Yergeau *et al.*, 2006). Universally, fungi serve as one of the principal decomposers in ecosystems, returning various important elements such as carbon and nitrogen back to the environment thus preventing them from becoming tied up in organic matter. In Antarctic ecosystems, fungal taxonomic diversity is relatively poorly characterised and even less is known about the function of fungal taxa in C and N cycling (Ludley and Robinson, 2008). Lack of knowledge on fungal contributions to ameliorate the antarctic soil lead Vishniac (1996) to describe it the simple way: “the prey of predators eats the predators themselves”, meaning the population densities of Antarctic fungi represent the balance between reproduction and the activities of zymivorous and other fungivorous nematodes as well as death from other causes **(**Vishniac, 1996).

As fungi are well-known as biodegraders, litter decomposition is the major role of filamentous fungi in Antarctic terrestrial ecosystems. Representing the most investigated cellulose and lignin degraders. However, no specific detail on the contributions of filamentous fungi and their products to soil amelioration, a role they share with bacteria in temperate soils. In spite of that, detailed information on which parasymbiotic and mycosymbiotic fungi of the cryptoendolithic lichens make rock weathering by producing oxalic and lichen acids is not available, but hypnotized that, they do have a role in the organic substance production to the soil **(**Vishniac, 1996).

Conversely, yeasts are not usually credited with a major role in biodegradation in Antarctic terrestrial ecosystems **(**Vishniac, 1996). Basidiomycetous yeasts are capable, but not limited, to use simple sugars. They reported to associate with bryophyte communities and are supposed to influence the bryophytes to release dissolved organic C as result of freeze–thaw cycles damage (Ludley and Robinson, 2008). Basidiomycetous yeasts are typically known to release extracellular proteases, laccases, hemicellulases, and pectinases, which then use the hydrolyzed product as source of carbon. However, while they are not lignin degraders, some Cryptococcus strains utilize aromatic compounds produced by lignin biodegradation. Moreover, there are phylloplane yeasts outcompeted microfungi on at least some occasions in the sub-Antarctic, as reported the dominant microflora of some living grass leaves on South Georgia and Macquarie **(**Vishniac, 1996).

Again, the information on the role of basidiomycetes yeast in carbon cycling is fragmentary, and anamorphic ascomycetes, particularly *Cadophora* sp., are seems to playing a predominant role in wood decomposition (Ludley and Robinson, 2008). Since the agents responsible for terrestrial biodegradation on the Antarctic continent are yet unknown, better understanding of fungal biodiversity and activity would help to use adjusting the ecosystem functional models **(**Vishniac, 1996).

1.1.5 Impact of climate changes on antarctic terrestrial life

Decades ago, growing interest of geological recording on polar climate has been observed (Thorn and DeConto, 2006). Studies have been used the terrestrial biology of Antarctica to test or support predictions linked with climate change. Now, a number of recent and extensive reviews of the findings of these studies are warning about climatic change classify it as the great threat to biodiversity (Convey, 2001 and 2006).

Antarctic climate changes affecting four biotic variables, including: temperature increase, water (precipitation and melt), solar radiation and atmospheric carbon dioxide concentration. Parts of Antarctica, with the reference to temperature factor, particularly the Antarctic Peninsula and Scotia Arc, are currently amongst the fastest rates of warming globally recorded. Obviously, harsh environmental condition will be reduced allowing longer active season, faster growing and shorter life cycle which lead to increase population density. Other features consider to significantly affecting terrestrial biota, are the upper and lower extremes and diurnal and annual ranges besides rates of temperature change. Consequently, water availability, which could be even more critical than temperature itself, as it regarded to the distribution of terrestrial biota. Although the reverse consequences could be directly as a result of decreased water input, or indirectly according to the interaction between increased water and temperature giving advance of great evaporation and desiccation stress (Convey, 2006). Subsequently, Continental Antarctica is constantly uncovered to the ozone hole. Therefore, much of the maritime Antarctic is regularly exposed to it is depletion effects. While the effect on sub-antarctic islands is for short periods. During spring, increase in the biologically affective ultra violate (UV) radiation, due to the depletion of stratospheric ozone, considered one of the most significant negative environmental impact (Arcangeli *et al.*, 1997). Particularly, exposure to the UV-B (280 to

315 nm) radiation has been suggested to limit the fungal growth. Hughes *et al.* (2003), tested the effects of solar radiation, and UV-B in particular, on the growth of five Antarctic terrestrial fungi, *Geomyces pannorum*, *Phoma herbarum*, *Pythium* sp., *Verticillium* sp. and *Mortierella parvispora*, these study find that, solar UV-B reduces the growth of soil fungal in the Antarctic terrestrial environment. Lastly, although increasing levels of CO_2 are recorded across Antarctica.

On the other hand, indirect effects of climate change associated with precipitation patterns and increased water availability, due to melting, are maybe even great implications on the antarctic ecosystem. Similarly, indirect temperature effect such as changes in vegetation density and other associated soil biophysical properties are thought to be further significant than the direct temperature cause on soil-born microorganisms. In fact, considering the decrease in bacterial abundances with increased latitude of antarctic terrestrial to be related to decrease in vegetation density (C and N), rather than direct effect of climate change (Yergeau *et al.*, 2006).

Consequently, in the International Polar Year (IPY) 2007-2008, IPY committee proposed and endorsed an integrated program called Microbiological and ecological responses to global environmental changes in Polar Regions (MERGE). MERGE meant to give scientific achievements regarding three main issues: (1) Prokaryotic and eukaryotic organisms in terrestrial, lacustrine, and supraglacial habitats were targeted according to diversity and biogeography (2) Food webs and ecosystem evolution and (3) linkages between biological, chemical, and physical processes in the supraglacial biome (Naganuma and Wilmotte, 2009).

Concluding with Convey's (2006) inspection, "unlike most areas of the planet, Antarctic terrestrial habitats are protected from sources of alien colonisation by their very remoteness, meaning that in general the response of indigenous biota to changing climate can be considered separately from that to increased competition from colonizing species. The synergy between Antarctic climate change, reducing the barriers to establishment, and human activity, increasing import of exotic species, may soon act to destroy this protective barrier".

1.2 Influence of fungal ecology in the search of novel bioactive natural products

Always, there is a continuous need of discovering new pharmaceuticals substances (from natural resources) in order to treat newly showing up diseases (Butler, 2005). Microorganisms represent the largest reservoir of less described biodiversity and relatively little is known about their ecosystems, and hence they possess the greatest potential for the discovery of new natural products (Nichols *et al.*, 2002). Many researchers believe that the search for bioactive agents from fungi can be supported by the application of ecological rationale (Gloer, 2007), by realizing how generally invisible (but ever-present) fungi interact with their environment, and how they manage to survive with the accessible resources (Gracia *et al.*, 2007).

In the same way, Raghukumar (2008) proposed the focus of fungi in special ecological niches, as a basic understanding of the ecology would help to reveal the novelty of an organism and its properties. Extreme fungi, for instance, Antarctica fungi, with ability to withstand the elevated low temperatures, hypersaline waters, and hydrostatic pressure etc… increase their potential towards production of bioactive molecules. Füllerbeck *et al*. (2006) stated that the discovery of novel natural products has increased since the exploration of ecologically ‘unusual’ habitats, such as, habitat with extreme conditions; wide range of salinities, high pressure and extreme low temperature.

Extremophile fungi draw significant attention due to their importance in biogeochemical nutrient cycling, ecological role and biotechnological potential (Gracia *et al.*, 2007). Therefore, exploring further for extreme fungi in remote places of the planet, where people have not described much on their biodiversity, could provide the potential for discovering new types of fungi, where fungi possess a great potential for the discovery of novel natural products. Likewise, during the past two decades, there has been an increase in researches on cold-active micro-organisms, generally known as psychrophiles, driven by the realization that they and their enzymes have a great potential for exploitation in biotechnology (Russell, 2006). Interestingly, Jensen and Fenical (2002) explain that some metabolites produced by marine fungi also occurred amongst terrestrial fungi but they produced their unique secondary metabolites or chemical defence possibly because of an adaptation to distinct environment pressures and to survive in fungal competition for a substrate.

Engagement of several biotechnological companies in bioprospecting in the extreme environments has been increase up. By focusing on extremophiles microorganisms for their biodiversity, stress proteins, thermostable and cold-tolerant enzymes, metal-tolerant enzymes, novel secondary metabolites, highly solvent-tolerant enzymes for application in degradation of xenobiotic compounds and bioremediation potentials (Raghukumar, 2008). Some of the famous examples of the commercial products gained from extremophiles microorganisms are: Colorants, surfactants, detergents supplemented with enzyme, antioxidants, industrial enzymes, vent polymerase and the famous thermostable enzyme *Taq* polymerase (Raghukumar, 2008).

1.3 Natural products on extremophiles fungi

1.3.1 Importance of natural products

The growing incidence of infectious diseases is becoming a worldwide problem (Oh *et al.,* 2006). In spite of immeasurable revolution in medicine and introduction of advance technologies in treating diseases, infectious diseases yet responsible for quarter of deaths worldwide and nearby half of death cases in the developing countries. Besides sexually transmitted diseases, hospital-acquired diseases and other tropical diseases playing part of the universe disability obligation. However, antimicrobial resistance problem involve in rise of the mortality and morbidity rates. Limited life spans of antimicrobial agent because of misuse demand the efforts to search for the antimicrobials agents effective against microorganisms continually (Abbas *et al.*, 2008). However, visible decline in the development of novel antimicrobial agent to fight resistant pathogens reported (Williams, 2002).

Natural resources especially plant and microorganisms have been a source of many compounds and countless modern drugs have been isolated and developed from natural resources (Oh *et al.*, 2006 and Abbas *et al.*, 2008). So far, natural products among the most important lead compounds and therapeutic agents in medicine (Slayers *et al.*, 2001), beside, the recommendations of using synthetic form and awareness of potential risk of using phytochemicals forms of antimicrobial agents stated by (Abbas *et al.*, 2008). About 200,000 natural metabolites with bioactive properties were introduced. For instance, approximately 52 % of the newly introduced chemicals universally from 1981 till 2002 were natural products or natural product derivatives (Suryanarayanan *et al.,* 2009).

1.3.2 Why fungi?

During the late Victorian period, and since the observations related to the important phenomena of microbial antagonisms, fungi were known for their great supposed curative properties (Slayers *et al.*, 2001). Interestingly, going back as far as the ancient Greeks, filamentous fungi have been recommended in folk medicine for the treatment of minor infections (Wainwright, 2008). In the middle of the most fascinating properties of fungi is the ability of producing a diversity of so-termed secondary metabolites that exhibit a wide range of biological activities as stated by Slayers *et al.* (2001). In the same way, Suryanarayanan *et al.* (2009) stated that fungi are among the most important groups of eukaryotic organisms that possess metabolites that could be used for clinical and agricultural applications as well.

Adrio and demain (2003), Stated that, 22% of 12,000 known antibiotic in 1995, could be produced by filamentous fungi including the most prominent natural penicillin G, biosynthetic penicillin V, semisynthetic penicillins and semisynthetic cephalosporins. More recently the report of Pela´ez (2005), approximately 1,500 metabolites of produced by fungal have been reported to have antitumor or antibiotic activity during the period from 1993-2002. Examples of recently approved drugs of fungal origin are micafungin, an anti-fungal metabolite from *Coleophoma empetri*, Cefditoren pivoxil a broad spectrum antibiotic derived from *Cephalosporium* sp., derivatives of fumagillin, an antibiotic produced by *Aspergillus fumigatus*, immune suppressive Mycophenolate from of *Penicillium brevicompactum*, and Illudin-S, a sesquiterpenoid from *Omphalotus illudens* exhibit anti-cancer activities (Suryanarayanan *et al.*, 2009).

Eventually, According to Hawksworth (2004), we only know about 7% of the estimated 1.5 million fungal species. However, only a small number of these have been explored for economically important metabolites production (Suryanarayanan *et al.*, 2009). Accordingly, it is very reasonable to renew the efforts isolating and screening fungi around the world expecting novel valuable metabolites.

1.3.2.1 Fungal account on the biological activity

Bioactivity or biological activity has been defined as a term describing the beneficial or adverse effects of a given agent upon living organism or tissue. Bioactive compounds are representing an important group of so-called secondary metabolites, a non-growth associated secretions of microorganisms including fungi, produced under normal circumstances during the stationary phase of the normal growth curve of batch culture.

The biological activity of an ecological metabolite has been optimized by progression to affect a target organism in a way advantage to the producer fungi, is the simplest scenario of bioactive compounds. Structural variability and their biological activities of these compounds have attracted the scientist to search for lead structures in the fungal cultures extracts (Karlovsky, 2008).

Natural product screening programs around the world has been reported only between 1993-2002 more than 1,500 novel compounds from fungal origin (Pela´ez, 2005). Cabello (2001) reported a novel antifungal (glucan synthesis inhibitors) acidic steroid compound named Arundifungin, produced by fungi *Arthinium arundinis* and was found to inhibit the growth of *Saccharomyces cerevisiae*. However, Pieckov´a and Roeijmans (1999) reported the bioactivity studies of nine fungal strains of *Dichotomomyces cejpii* and they found that they produced secondary exo- and endo-metabolites with antimicrobial activity against Gram-negative and Gram-positive bacteria, yeasts and moulds and with a toxic effect against animal organs in vitro. Moreover, cFMS receptor kinase is a therapeutic target with relatively few inhibitors described to date. In screening against a library of fungal extracts, Oyama *et al.* (2004) isolated from *Coleophoma* sp. a novel metabolite undecylresorcinol dimer that selectively inhibited this kinase and also known metabolites balanol and altenusin with novel potencies and selectivities.

1.3.2.2 Biological activity of antarctic fungi

Cold-adapted microorganisms including fungi are obviously unique because in spite of internal temperature closes to that of their surroundings and it is strong negative effect on biochemical reactions, they not only survive but breed and grow successfully. Exhibits metabolic fluxes more or less comparable to those exhibited by closely related mesophilic species living at moderate temperatures (Zecchinon *et al.*, 2001).

To our knowledge, to date studies on the bioactivity of antarctic soil microfungi were few. The only three literatures found were reviewed here. Firstly, Su *et al.* (1995) have successfully isolated the antibiotic C3368-A (CA), produced by fungus from Antarctic soil sample. CA significantly inhibited the nucleoside-transportation of mice carcinoma cells and potentiated the inhibitory effect of MMC against colon carcinoma 26 in mice. On human, CA synergistically inhibited the oral epidermoid carcinoma KB cells and markedly enhanced the inhibitory effect on the proliferation of human hepatoma BEL-7402 cells. Su *et al.* (1995) suggested the use of the newly found nucleoside-transport inhibitor, in potentiating the effect of antitumor drugs.

Secondly, well-known Exopolysaccharide (EPS) identified to possess a bioactive role, rheological behavior and high stability at high temperatures within a broad pH range and at high ion concentrations. An increasing attention has been paid to EPS of microbial origin recently as a valid alternative to polysaccharides of plant and algal origin. Because of their independent of seasonal variations and relatively easy with the downstream processing, microbial EPS are more valuable in pharmaceutical industries, in addition to the cosmetic, food technology, and oil recovery (Selbmann *et al.*, 2002). Selbmann *et al.* (2002) successfully isolated the filamentous fungus *Phoma herbarum* CCFEE 5080 isolated from continental Antarctica soil was tested for exopolysaccharide (EPS) production. Assuming that the adaptation of *P. herbarum* CCFEE 5080 to the Antarctic soil microclimatic environment might be related to the EPS production ability. Never the less, no evidence exists of a possible relation between EPS production and advantages in surviving in extreme environments (Selbmann *et al.*, 2002).

Lastly, the most recently report of Li *et al.* (2008), five novel bioactive asterric acid derivatives compounds from the antarctic *Ascomycete* fungus *Geomyces* sp. have been isolated and elucidation of these metabolites structure were done by NMR spectroscopy. Li *et al.* (2008) stated that "Compound 7 displayed antifungal activity against *Aspergillus fumigatus*, whereas 8 showed antimicrobial activities against Gram-positive and Gram-negative bacteria".

Last of all, scanty works carried out so far on the bioactivity of Antarctic fungi, beside there was no mention of which part of Antarctica harboring those species with bioactivity? Antarctic fungi could be an outstanding source of novel biologically active natural products, which may be considered as potential new drug leads useful for the treatment of human diseases.

1.4 The research objectives

- To record the occurrence of microfungi in Deception Island, Wilhelmina Bay and Yankee Bay.

- To examine the occurrence of thermophiles microfungi in the volcanic soil of Deception island.

- To screen for presence of antimicrobial activity of Antarctic fungi.

- To determine quantitatively the antimicrobial activity of selected species.