PREFACE

This book presents current research in the study of the marine environment, including the isolation and molecular characterization of marine bacteria; the ecophysiological significance of selective feeding of hetertrophic nanoflagellates; potential impacts of seawater desalination; marine pollution and international protection studies of the marine environment.

Chapter 1 – If seawater is considered to be an inexhaustible natural resource, then desalination is a good alternative to be used in scarce areas with irregular river flows or those in which conventional water sources are insufficient or overexploited.

Leaving aside the debate regarding excessive water consumption in the developed world or the need for a consistent and simultaneous management of supply and demand of water resources, this chapter will focus on both the positive and negative impact that desalination projects have on the natural environment.

Beyond impacts directly related to the various facilities of the project (feed seawater, pumping, plant facilities, regulating reservoir, water supply system, etc.), the main impacts of desalination projects on the environment are: energy consumption and disposal of waste effluent brine into the sea.

Energy consumption is associated with the process of salt separation and pumping facilities to transport water. The ongoing technological improvements and energy recovery systems are significantly reducing this consumption.

Regarding brine, its physical and chemical properties depend on the feedwater being used and the salt removing technology. In recent years, reverse osmosis has been the most commonly used technology to desalinate seawater, with conversion rates ranging from 30% to 50%. The brine effluent is in this case characterised by an excess of salinity with the presence of trace pollutants. With few exceptions, this effluent is discharged into the sea.

Considering these circumstances, some fundamental questions arise: How does brine behave in the sea? What are the potential negative effects of brine disposal for the marine environment? What are the most vulnerable and sensitive marine ecosystems facing brine presence? How can negative impact be minimized? What are the most adequate locations and discharge systems for brine disposal? What aspects of plant design and management should be taken into account to minimize brine disposal impacts? What kind of preliminary studies and data collection are necessary? Which are the available tools for brine discharge behaviour modelling under different representative marine climate scenarios? etc.

This chapter will address all these questions to study desalination projects from an environmental point of view, focusing their attention on the brine disposal.

In agreement with the Sustainable Development principles, set up at the 1992 Ric Janeiro Conference, a methodology to minimize brine impact on the marine environment be recommended in this chapter, with the aim of making compatible the use of desalinatio an important water resource with the environmental protection of the marine environment.

The chapter aims to be all encompassing, providing information regarding the field science and marine engineering (design of disposal facilities, numerical modelling, ma climate), biology and natural environment (vulnerability of ecosystems, critical sali limits), or environmental engineering (legislation, environmental assessment, monito programmes, prevention and mitigation measures, etc.).

All of this will be discussed, while considering the most innovative aspects of the Stat the Art and taking into consideration the most recent investigations in marine environmental engineering and biological issues related with brine disposal into the sea.

Chapter 2 – This chapter will consider how the marine environment is managed protected at an international level. It will set out a brief history of how governance of marine environment has developed since the doctrine of *Freedom of the Seas* was set out Hugo Grotius in the early 1600s through to the post World War II period where developme and triggers ultimately led to a global Law of the Sea Convention. It will then specifica examine the role of the United Nations, including discussion of the 1982 Law of the Convention (LOSC), which set out to produce a comprehensive legal framework to prom the peaceful use of the oceans and its resource, together with other UN conventions related the marine environment. The chapter will then examine the role and responsibilities of International Maritime Organization (IMO) and its various committees, as the bo responsible for establishing a comprehensive framework of legislation for shipping, includi protection of the marine environment from pollution from shipping and the safety of vesse their crews and passengers, at sea. It will then examine the contribution made by a range Memoranda on Port State Control organisations (MOUs) which have a role in ensuring t vessels comply with the various international conventions established by the IMO and othe These MOUs, the first of which was established in 1982, provide a framework for ves inspections to ensure that those vessels which fail to adhere to international standards, or a sub-standard in any way, can be monitored. Vessels which are found to be sub-standard ca ultimately, be prevented from operating until all deficiencies are rectified.

Chapter 3 – Approximately 71% of the earth's surface is covered by oceans, and represe an enormous pool of potential microbial biodiversity and exploitable biotechnology or "bl biotechnology". This unexploited region resulted in an increasing interest to study mari microorganisms, the role of them in marine food webs, and biogeochemical cycling. addition, to emphasize the study of marine bacteria capable of produced different nov enzymes and metabolites, represent a potential to biotechnological applications. Diver marine microorganisms are classified into extremophiles groups, which play a main role the biodegradation of organic matter in different marine ecosystems. One of these groups, t cold-adapted microorganisms, is interesting for processes that need cold-active enzymes low temperatures, for example food processing and cold-wash laundry detergents.

In the last decade, the focus of microbial diversity has changed due to 16S rDNA housekeeping genes and metagenomic studies. As a result, the characterization of ne sequences allowed the discovery of new genera of cultivated and uncultivate microorganisms, from samples of the marine ecosystem. These new species belong to the and α-*Proteobacteria* divisions.

Within the areas of exploration to understand the diversity of marine bacteria are sub-Antarctic waters of the Beagle Channel, Tierra del Fuego, Argentina. The Beagle Channel (55°07'18" S 66°25'00" W) is located at the southern end of America and is the international border between Argentina and Chile. Coastal areas are interesting to study because they are easily accessible and the water temperature ranges between 4.5 and 10°C, optimum for cold-adapted microorganisms.

Marine bacteria were isolated from benthonic organism's intestines, and seawater samples. The samples were taken from different coastal areas of the Beagle Channel; they were enriched in modified LB medium with seawater and cultivated at 4 and 15°C. Of 296 marine bacteria isolated, 55 were characterized by ARDRA analysis, 16S rDNA sequencing, and construction of phylogenetics trees. The gene sequences allowed us to determine their association with the class *Proteobacteria,* members of the following genera: *Shewanella, Pseudomonas, Pseudoalteromonas, Serratia, Halomonas, Alteromonas, Psychrobacter.* These microorganisms showed different glycosyl hydrolases activities, within this group are cellulase, endoglucanase, exoglucanasa, xylanase, β-glucosidase, α-rhamnosidase.

In this chapter, the authors focus on the studies of marine bacteria, genes, enzymes and metabolites for biotechnological applications, as well as new cold-active enzymes applied to products whose manufacturing processes are performed at low temperatures.

Chapter 4 – Recently with advances in biochemical and molecular microbiological techniques, there has been a growing interest to assess the numerical and functional significance of microorganisms in different ecosystems of our planet. The marine biosphere consists of diverse assemblages of microorganisms with extreme variations in pressure, salinity and temperature. Heterotrophic nanoflagellates (HNF) with a size range from 2 to 20 μm are ubiquitous protozoan communities in marine environments. HNF are considered as primary consumers of bacteria and regulate the bacterial density and the phenotypic and genotypic composition of bacteria by selective grazing in marine environments. HNF mediated grazing is also an important ecological process in marine materials cycling by the production of dissolved organic and dissolved inorganic matter. Despite the pivotal role of HNF in marine microbial food web, the ecophysiological role of HNF is mostly neglected.

In this chapter, an overview of the diversity and distribution of HNF in marine environments, seasonal variation of HNF grazing rates on bacteria, the efficacy of HNF as nutrient generators, the nutritional ecology of HNF, mechanism responsible for food bacterial selection by HNF and their contribution to the enzyme pool during selective feeding on bacteria in marine environments is discussed.

Chapter 5 – The marine microbial community is still an unexplored habitat, for this reason the attention of many researchers is focused on the isolation and microbiology characterization of micro-organisms isolated from different habitats: from the polar sea, covered by ice for most part of the year, to the deep-sea hydrotherms, where the water temperature can be as high as 90 °C.

The marine habitat is very complex and heterogeneous with a unique common factor: salt concentration.

The molecular mechanisms of adaptation to the environment of an organism is reflected on different levels, with regards to gene and protein expression, which are intrinsically adapted to the particular physical/chemical state.

Amino acid composition is strictly related to environmental adaptation, in this paper, the authors present an up-to-date overview on some features of amino acid composition of

esterases and lipases from marine sources. In particular, the authors analysed enzy belonging to the Hormone-Sensitive Lipase family (HSL), isolated from psychroph mesophilic, thermophilic and hyperthermophilic micro-organisms.

Chapter 6 – The potential for petroleum aliphatic-hydrocarbon degradation of the bacteria in temperate seas was evaluated. As the possible key bacteria, *Alcanivo Marinobacter* and three taxonomically novel strains (one showed 96.6% similarity in its rRNA gene sequence to *Oleibacter marinus*; and the other two showed less than 9 respective similarity to *Teredinibacter turnerae* and *Acinetobacter johnsonii*) were isol after enrichment on crude oil in a continuous supply of Japanese seawater. In contrast to t previous results with tropical seawater, all the *Alcanivorax* isolates were closely relate *Alcanivorax borkumensis*, suggesting *A. borkumensis* to be the key *Alcanivorax* spe characterized for temperate seawater. *A. borkumensis* strains, especially two new isola showed the highest activity for both *n*-alkane and branched-alkane degradation, indica that these two new *A. borkumensis* isolates would be useful for the bioaugmentation strate The *n*-alkane-degrading activities of the *Marinobacter* isolate and *Thalassolituus oleivor* (the already known key species) MIL-1^T were the lowest, and their branched-alka degrading activities were not significant. These results, providing insights into petrole biodegradation in temperate seas, will promote the rational bioremediation strategies.

Chapter 7 – Seawater desalination is the main and reliable source of water supply for Gulf countries to sustain and allow the continuing long-term socio-economic developm Building more desalination plants and increasing water production rates appears to be answer to satisfy the rapidly increasing future water demands, with an estimated annual r of around 15%. Of all the world's multi-national bodies of water, the Gulf itself is a uniqu small scale, almost enclosed sea and its marine environment conditions are deteriorat rapidly due to substantial construction along the shores and offshore regions, which invo sea bottom dredging for material and its deposition in shallow water to extend land for hom recreation and industrial facilities, thus altering its coastline. Due to its location in subtropical, hyper-arid region, its water is naturally characterized by higher temperature a salinity leading to hypersaline conditions. Therefore, any further additional loss of water desalination plants and returned brine reject could result in increases to the Gulf's salini above the already high existing level. The potential impacts of seawater desalination evaluated using a mathematical model for a semi-enclosed sea of simple geometry.

Chapter 8 – The Menai Strait is situated between the Island of Anglesey and the mainla in NW Wales, UK. The Strait has a diverse and well-studied biological community, and many years have been the subject of intensive research by scientists from Bangor Universi and other institutions. In 2004 the Menai Strait was designated a Special Area Conservation under the EC Habitats Directive in recognition of its importance to marine life

Previous research in the Menai Strait revealed that concentrations of suspend particulate matter (SPM) are greater in winter than in summer, and also greater during t spring than the neap tide. Although a considerable proportion of SPM is organic, the majori of suspended sediments is inorganic. Surface inorganic loads appear to correlate positive with tidal range and wind direction, and negatively with temperature. There has been a slig increase in SPM loads throughout the second half of the 20th century, which is a cause concern because of its potential direct and indirect effects on the local ecology, in particul algae and juvenile fish. Here the authors present an overview of a number of potential effec of SPM on the Menai Strait ecosystem. The authors emphasise the impact on filter feeders,

particular the mussel *Mytilus edulis*, which is naturally encountered in the Strait and is the subject of a thriving commercial fishery. The authors also draw attention to the potential relevance of SPM to the biological community of mud flats and salt marshes. The dynamics of SPM in relation to the tide and other oceanographic variables is then illustrated with a detailed dataset collected over more than seven tidal cycles. The data show clear signs of SPM advection, re-suspension, flocculation and disaggregation, which can be linked to the underlying physical forcing. The authors interpret the importance of SPM for the overall ecosystem functioning and management.

Chapter 9 – The main objective of this presented work is to investigate the performance, deterioration and corrosion resistance of different types of concrete in the hot marine environment. and the possibility of introducing epoxy in concrete to improve its durability. The work covers the behavior of conventional concrete, reinforced concrete, epoxy repaired concrete, polymer concrete, polymer modified concrete, epoxy coated bars, concrete made with recycled materials and others. Different concrete mixes with different constituent materials were investigated and addressed. Durability was assessed by either subjecting concrete samples to sea water in the tidal zone or by putting the samples in the testing tanks of a specially manufactured accelerated marine durability system, where they were exposed to cycles of sea water wetting and hot air drying.

Chapter 10 – The marine environment is of particular interest because is an important sink for many chemicals, some of which accumulate in the marine food chain. Heavy metals and bio accumulating toxic substances are introduced to the sea from land-based point and non-point sources, from atmospheric fallout and during marine transport of materials. Pollution of the marine environment is a major concern to countries having coastal and marine areas to the overall maintenance and control of the coastal ecosystem. This chapter presents an overview on the importance of monitoring chemicals (inorganic and organic) present at major or minor concentrations in samples from the marine environment (seawater/estuarine water, sediments, seaweeds and marine animals used as seafood).

Chapter 11 – The existing knowledge on the sources, distribution, and composition of marine debris worldwide and its impact on marine wildlife as well as the economy, were reviewed by bringing together most of the relevant literature published so far. Marine debris (or marine litter), defined as any manufactured or processed solid material that enters the marine environment, is a greatly underestimated component of marine pollution. Although there are various types of litter, plastics (synthetic organic polymers) make up most of the marine debris worldwide. The important properties (light, strong, resistant to degradation, and low-cost) that make plastics so widely used are also the reasons why plastics are a serious hazard to the marine environment, where they gradually accumulate and may persist for decades. Most marine debris originates from land-based activities, and the main sources include storm water discharges, municipal landfills located near the coast, riverine transport of waste from landfills and other sources, discharges of untreated municipal sewage, the plastic industry and other industrial facilities, unregulated disposal of litter due to absence of waste services or landfills, tourism, all types of vessels, offshore oil and gas platforms, and aquaculture installations. Litter may concentrate on the seafloor and reaches very high densities, especially in coastal areas but also in some accumulation zones in the open sea. Densities that reach many thousands or even millions of items per hectare have been reported on the seafloor or along beaches. Marine debris is a serious threat to marine life and may negatively affect the populations of many species. The entanglement of marine species,

especially marine mammals, seabirds, turtles, fish, and crustaceans has been frequen described as a serious mortality factor. Marine species may ingest debris items (mos plastics), presumably mistaking them for prey, which has many harmful effects on th physical condition and survival. Toxic contaminants like PCBs may enter marine food cha through ingested plastics with potentially very negative effects. Drift debris can increase distribution range of certain marine organisms and assist in the invasion of alien speci which is a primary threat to global biodiversity. High marine litter densities have a potent effect on the structure of benthic communities by altering the characteristics of the lo biotope, and may act as the means for the invasion of many hard-substratum species t could displace indigenous fauna due to competition or predation. Marine debris, especia derelict fishing gear, causes substantial damage to coral reefs and coral facies.

Marine debris has a considerable economic impact, mainly due to lost tourism, reducti of commercial fish and crustaceans stocks due to ghost fishing, the time and expense rescue operations for entangled or damaged vessels, costs of clean ups of beaches and coral rocky reefs, and increased conservation costs of endangered marine species. The effect marine debris on both marine fauna and the human economy is expected to become a m prominent issue in the future as marine debris concentration in the marine environm continuously increases.