PREFACE

This book presents topical research from across the globe in the study of the biology, habitats and threats to aquatic animals. Topics discussed include the acoustic ecology of pinnipeds in polar habitats; the immunotoxicological reactivity of hemocytes of juvenile mudcrabs; the potential threat of genotoxic metals to marine mammal health; toxic contaminants in aquatic medium concerns and the role of bacteria in the chilled storage and cryopreservation of sperm in aquatic animals.

Chapter 1 - The Arctic and Antarctic share a strong seasonality of light and temperature extremes that create similar selective pressures for animals living in these two polar and associated sub polar regions. There is significant evidence that Arctic ice conditions are rapidly deteriorating due to global climate change and evidence that Antarctic ice is also changing. Sub polar regions experience a seasonal ice cover with an added dynamic range of environmental conditions often exceeding that at the poles. In polar and sub polar waters, the presence of sea ice dominates the physical environment for an extended period of time. This strongly influences pinniped distribution, reproductive strategies, foraging ecology, and acoustic behavior. In both polar regions, seals have distinctly different underwater vocal repertoires associated with breeding and an airborne repertoire associated with mother and pup communication. In this chapter, a comparative approach is taken to relate the underwater acoustic behavior of polar pinnipeds (phocids and walrus) to their ecology and aspects of their sea ice habitat. Understanding the commonalities and differences in the spatial, spectral, and temporal characteristics of vocalizations from species with comparable biologies relative to local sea ice conditions may provide insights into the acoustic ecology of pinnipeds in polar habitats.

Acoustic ecology describes the interaction between an animal and its environment as mediated through sound and is determined by the species' behavioral ecology, but also by biotic and abiotic factors of the environment. Insight into acoustic ecology may therefore provide information on the potential direct and indirect impacts of polar climate change on pinnipeds. Loss of sea ice will likely affect polar pinniped distribution and breeding activities; both of which can be detected through long-term passive acoustic monitoring.

One of the secondary effects of sea ice loss is the impact to the polar acoustic soundscape (i.e., the acoustic environment). The communication system of polar pinnipeds, which permeates critical life functions like breeding, evolved in an acoustic environment dominated by ambient noise levels associated with seasonal ice cover. Changes in ice dynamics will likely be accompanied by shifts in habitat use by both marine animals and humans which will lead to a corresponding change in the acoustic soundscape. The combined impacts of these effects is unprecedented, but the knowledge gained from a comparison of pinniped acoustic ecology between the Arctic and the Antarctic will lead to a better understanding of the relationship between ice seals and their changing environment.

Chapter 2 - Sundarbans Biosphere Reserve of India supports a wide range of flora and fauna. Ecologically, this reserve is a mangrove forest with numerous estuarine creeks. Mudcrab *Scylla serrata* (Crustacea: Decapoda) is an important member of estuarine habitat of Sundarbans. Indiscriminate collection of juvenile crab seeds and contamination of estuarine water pose a serious threat for this aquatic animal. Generally invertebrates including mudcrab lack adaptive immune system and depend on innate immune defense to combat pathogen and toxin . Cellular immune response involved the recruitment of immunocompetent hemocytes capable of performing adhesion, aggregation, phagocytosis, generation of intracellular cytotoxic molecules etc. In this chapter, spectrum of innate immunological reactivity was examined in juvenile mudcrab under the exposure of arsenic, a toxic metalloid of aquatic environment. Experimental juveniles were exposed to 1, 2 and 3 ppm of sodium arsenite for 1, 2, 3 and 4 days in controlled laboratory condition. Total hemocyte count is a stress indicator of pollution which was enumerated both in the control and arsenic exposed *S. serrata.* Crabs exposed to sodium arsenite expressed an alteration in total hemocyte density. Aggregation and adhesion of hemocytes are metabolic behaviours whereas phagocytosis is a classical immunological response of hemocytes and arsenic exposure yields a dose responsive decrease in aggregation, adhesion and phagocytosis against the

control indicating perturbation of blood cell hemeostasis, alteration of hemocyte surface characteristics and immune suppression. Capability of generation of cytotoxic molecules like superoxide anion and nitric oxide are reported as a potential strategy of immunological defense against pathogen invasion. Disruption of hemocyte density, adhesion, aggregation, phagocytosis and increment of cytotoxic response may lead to a state of alteration of immunity. Arsenic induced alteration of immune status may impart a state of vulnerability in juvenile crab inhabiting the toxic aquatic environment. Such a situation may reduce the ecological fitness of mudcrab to combat against the toxic challenge caused by arsenic pollution.

Chapter 3 - Ocean pollution has emerged as one of the greatest threats to marine animal heath with recent data showing that metal pollution has reached even the remotest ocean regions. Marine mammals are at particular risk as they integrate all possible routes of exposure: inhalation, ingestion and dermal pathways. Many marine mammals have become critically endangered and are failing to recover. Marine mammals are important species for ecosystem health and for the economies of coastal communities. Moreover, they are charismatic species that capture people's attention and remind them of the importance of the ocean environment. Understanding them and the threats that face them is a key need in protecting the ocean environment.

The authors have been pioneering the study of metals, particularly genotoxic metals as particular threat to marine mammal health. Marine mammals are exposed to metals and if these metals can damage DNA in these animals, the consequences could impact both the individual, through metal-induced disease, and the population as a whole, by impairing reproduction.

In this chapter, the authors focus on chromium as a representative genotoxic metal and describe the levels of Cr in tissues from free ranging, healthy whales considering both toothed and baleen whales. They then determine the genotoxic effects of Cr in cultured whale cells and compare genotoxic doses to tissue levels. The chapter discusses the potential threat of genotoxic metals, like chromium, what the sources of exposure are in the marine environment, and compares the data to effects seen in humans and laboratory animals.

Chapter 4 - In this chapter the authors review the current knowledge about the usage of *Hyalella* genus as a bioindicator using reproductive and biochemical markers to assess damage, as well as threats (pesticides, heavy metals and endocrine disruptors) that could lead the significant alteration of the physiological pattern of these animals. Biochemical markers have the advantage of demonstrating a rapid response from animal to stress, while the

reproductive show a high biological and ecological significance, because they demonstrate long-term effects that may lead to population extinction, and indicate the degree of sensitivity. *Hyalella* are common genus in the Americas, with 51 described species found in a variety of freshwater habitats, often cling to the vegetation, swim in the water, or burrow in the sediment where its constitute important links in the food web, serving to transfer energy from basic recourse (detritus and algae) to higher-level consumers. The structure of natural communities, the richness and diversity of species, and the interactions among them have profound implications for ecosystem functioning, modulating the fluxes of energy and materials within and among environments. The human activities have directly or indirectly added novel stressors to natural aquatic ecosystems which have the potential for affecting the structure and function of natural communities and among this stressor we can list the pesticides, the heavy metals, and home and industrial sewage that have been reported to cause dramatic changes in freshwater environments. Recently, a great deal of attention has been devoted to the use of physiological and energetic processes of non-target organisms as sensitive indicators of toxic stress. We discuss the current information on these crustaceans amphipods as models for ecotoxicology and describe areas of future research.

Chapter 5 - There is a serious concern about the disposal of hazardous substances in to the aquatic medium. Toxic contaminants such as Polycyclic Aromatic Hydrocarbons (PAHs) and Polychlorinated Biphenyls (PCBs) are ubiquitous global contaminants that affect both the quality of water and the hygiene of aquatic organisms. Toxicity mediated through these contaminants occurs through the cytoplasmic protein called Aromatic Hydrocarbon Receptor (AhR) which is bound to two other proteins: HSP90 and XAP2. Upon binding with the contaminant AhR translocates to the nucleus, where they dissociate from HSP90 and XAP2, and forms a heterodimer complex with bHLH-PAS and the AHR nuclear translocator (ARNT). Together, they bind to Xenobiotic (contaminants / Aromatic hydrocarbons) Responsive Elements (XRE) to regulate the expression/ induction of Cytochrome P4501A (CYP1A). Thus, the induction of CYP1A through the activation of AhR has been used as a biomarker for exposure to organic pollutants in various aquatic organisms ranging from invertebrates to vertebrates. CYP1A activity has been most extensively analyzed using the ethoxyresorufin O-deethylase (EROD) or aryl hydrocarbon hydroxylase (AHH) assays. In this chapter, the author describes the molecular mechanism of AhR mediated CYP1A induction in aquatic organisms and how it could be applied as a suitable biomarker for the early detection of organic pollution in an aquatic environment.

Chapter 6 - Bacterial contamination is considered a major issue for the management of sperm preservation in aquatic animals. Chilled storage and cryopreservation of aquatic animal sperm have been used to meet the growing demand for seeds. Chilled storage of sperm has been effectively used in a number of fish, but in marine invertebrates has been limited to shrimp, lobster, echiura and shellfish. Successful and reproducible cryopreservation has proven to be a reliable method for preserving genetic lines of fish for aquaculture and conservation, but among invertebrates is limited to polycheates, cnidaria, crustaceans (shrimp and crab), shellfish (oysters, hard clams and abalone) and echinoderms (sea urchin and sea cucumber). Few studies have documented changes in bacterial type and number during chilled storage or cryostorage. Access of good quality chilled-stored or cryopreserved sperm is necessary for the management of risk associated with sperm preservation. The presence of bacteria in sperm of aquatic animals can result in deleterious effects on sperm quality and viability if left uncontrolled. Potential pathogens present on the preserved sperm of aquatic animals may affect the health of broodstock and offspring. This paper summarizes the current knowledge pertaining to bacterial contamination of aquatic animal sperm, including bacterial types and sources of contaminants, and gives an overview of the incidence of bacterial contamination, biosecurity and risk assessment and effects of bacterial contamination on offspring quality. These ideas, if taken into account in commercial aquaculture and conservation of aquatic animals, are almost certain to increase the value added or protection of at least some cultured species. Microbial contamination risk of chilled-stored or cryopreserved sperm after short-term or long-term storage is discussed. Future direction and new avenues of future research on chilled storage and cryopreservation of sperm in aquatic animals are proposed.