



INTRODUCTION

Marine vertebrate zoonoses: an overview of the DAO Special Issue

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ABSTRACT: The role of marine birds, mammals, turtles and fish as vectors of infectious agents of potential risk to humans can be examined from a variety of perspectives. The studies in this DAO Special include a broad survey of multiple agents and species, a sequencing study of *Giardia intestinalis* haplotypes known to be pathogenic to humans, an assessment of risks to humans working with marine mammals, a source tracking study using *E. coli* ribotypes, studies of regional *Salmonella* and *Brucella* epizootiology, a serology survey and a case report of a herpes simplex infection in a dolphin. Additionally, a recently published study (Venn-Watson et al. 2008; Dis Aquat Org 79:87–93) classifying pure cultures of bacteria from a captive dolphin colony also pertains to this theme. These studies raise the following questions: whether the presence of zoonotic agents in marine vertebrates represents a risk to other marine vertebrates, humans, or both; what are the routes by which these marine vertebrate zoonotic infections are acquired and circulated in the marine ecosystem; to what degree are such agents subclinical versus causes of overt disease in marine vertebrates; what are the subsets of the human population most likely to be affected by such infections; and which human health preventive measures would seem reasonable?

KEY WORDS: Zoonosis · Marine · Vertebrate

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This DAO Special focuses on various aspects of zoonoses within marine vertebrates. The risk of acquiring disease from marine mammals has been a concern for humans who have hunted and consumed cetaceans and pinnipeds over the millenia as subsistence hunters. Today, direct consumption of marine vertebrates raises concerns primarily with respect to organochlorine and heavy metals contamination (Bjerregaard & Hansen 2000) but it remains a potential route for disease transmission from marine mammals to humans in various parts of the world, especially for native subsistence hunters. However, this DAO Special does not address the issue of direct consumption. It focuses more on the status of various agents and hosts and risks to those hosts and associated humans. There is increasing interest in the risk associated with contact between humans and animals during recreational activities and professional work. The manuscripts here describe studies that have focused on the microbial ecology of various pathogens in diverse marine mam-

mal and bird populations which may also represent potential human health risks. One paper summarizes the risks of occupational exposure to marine mammals.

The Stoddard et al. (2008) study documents a high prevalence of a variety of *Salmonella* serovars with zoonotic potential in sea lions and elephant seals in the Channel Islands, California, USA, but a much lower prevalence of serovars in Puget Sound, Washington, USA. Antibiotic resistance in the isolates was very rare, in dramatic contrast to the situation reported in another paper in this issue for isolates of diverse other bacteria from free-ranging marine mammals on the US NE coast (Bogomolni et al. 2008). Stoddard et al. (2008) caution people handling such animals to be aware of the zoonotic risk, especially in California, where the prevalence seems unusually high, and they discuss the potential sources of these *Salmonella* infections in terms of island land-mammal populations.

In a paper related to this DAO Special, an analysis of the bacterial agents most likely causing the morbidity

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and mortality in a captive dolphin colony was reported (Venn-Watson et al. 2008). Their primary agenda was to recognize agents of a potential threat to a high-value captive colony of defense dolphins. The authors focused on individual pathogens that could be responsible for severe infection and described a broad spectrum of multiple agents of unlikely etiological significance. They concluded that 'sole bacterial primary pathogens are not a significant cause of mortality-associated epizootics in our population' (Venn-Watson et al. 2008, p. 92). These findings raise anew the question of whether mixed infections are significant determinants of morbidity and mortality.

A broad survey of live, stranded, and bycaught marine mammals and birds from the US NE coast (Bogomolni et al. 2008) revealed precisely the kind of diverse bacterial flora predicted by Venn-Watson et al. (2008), with the greatest diversity being shown in oropharyngeal and cloacal swabs. In addition, isolates of significant clinical potential were also regularly obtained from routine cultures of the pleural and peritoneal spaces. Resistance to multiple antibiotics was common in many of the isolates. The study also used targeted PCR screens to show significant prevalences of *Giardia* and *Brucella*. The high prevalence of *Brucella* in birds is of particular interest.

Giardia amplicons from positive samples identified by Bogomolni et al. (2008) were genotyped (Lasek-Nesselquist et al. 2008), revealing the presence of potentially human-infecting *G. intestinalis* haplotypes in the fecal material of dolphins, porpoises, seals, gulls, eiders, and a shark. These observations turn the Bogomolni et al. paper from what was initially a survey of potential risk, into a paper which focuses, at least for *Giardia*, on real sources of concern. The role of lower marine organisms, water masses, beach sand, bird feces, and other potential intermediate steps in the natural history of *G. intestinalis* becomes a much broader area of inquiry due to the results of this study. The Nelson et al. (2008) ribotyping study suggested that gulls obtain fecal bacteria from wastewater and landfill trash, which they may transport to recreational beaches and waters, although the huge volume of direct human and animal fecal discharge into global watercourses is perhaps of considerably more importance (Fayer et al. 2004).

Prenger-Beringhoff et al. (2008) report on the incidence of *Brucella* species in marine mammals for the German North Sea. They discovered that the highest prevalence was in harbour seals *Phoca vitulina*, mostly of *Brucella pinnipedalis*. The presence of this organism was primarily associated with verminous bronchopneumonia. Correlation of symptoms with the presence of particular microbes is an important aspect of establishing the role of marine animals as vectors of zoonotic disease.

In this DAO Special there is also the first report of a herpes simplex-like infection in a stranded dolphin with a non-suppurative encephalitis (Esperón et al. 2008). The authors conclude that further work is required to establish the role of this virus as the etiologic agent of the observed pathology. A serological survey of bearded seals from St. Lawrence Island, Alaska, USA (Calle et al. 2008) found no antibodies to *Brucella* spp., phocine distemper virus, influenza A virus, or caliciviruses, although one seal did have a low titer to *Leptospira interrogans* serovar *grippotyphosa*.

A retrospective study of workers exposed to marine mammals (Hunt et al. 2008) found that the major risk factors for humans were prolonged and frequent exposure, direct contact with live animals, and contact with biologic material.

Thus, organisms that can pose human health risks are widespread in marine vertebrates. These organisms also likely cause health problems for marine animals. To understand the nature of health risks for marine animals and humans, future studies are needed to establish the source of these zoonotic microbes in the marine environment. This includes the potential for prey items to serve as a link between terrestrial contamination and marine food webs. Epidemiologic studies are also necessary to assess the impact and spread of these diseases between and within marine animal groups, with an emphasis on the impact of long-distance migration and foraging that is often the norm for many of these animals. In this way, we will gain a better understanding of the very complex relationships between infectious diseases that can affect humans and those that affect marine vertebrates. It is perhaps no surprise that human activities pose a greater threat to marine vertebrate health than vice versa, and that while the proximate concern may be the risk of humans acquiring infectious agents from marine vertebrates, the ultimate issues lie with the need to modify human activities on many scales.

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