Vibriosis caused by *Vibrio anguillarum* and *V. ordalii*

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1 Disease name

Vibriosis. While the term “vibriosis” may correctly be used to describe diseases caused by a wide variety of related *Vibrio* species, this leaflet describes “classic vibriosis”, i.e. infections caused by the very close relatives *Vibrio anguillarum* and *V. ordalii*.

2 Aetiological agent

*Vibrio anguillarum* and *V. ordalii* are so closely related that they may well comprise two biovariants of a single species. Indeed, *V. ordalii* was originally described as *V. anguillarum* biotype II (Schiewe and Crosa, 1981) prior to its description as an independent species (Schiewe *et al.*, 1981). Both are members of the family *Vibrionaceae* within the *Gammaproteobacteria*. The previously “grey” taxonomic position of *V. anguillarum* has recently been resolved with the proposed return of this bacterium to the genus *Vibrio* from the genus *Listonella* (Thompson *et al.*, 2011). Thus far, 23 different serotypes have been identified in *V. anguillarum* (Pedersen *et al.*, 1999). In addition, isolates not corresponding to known serotypes are still commonly identified, mainly from environmental sources, but also occasionally from fish species newly introduced to aquaculture. The majority of *V. anguillarum* isolates identified in association with disease in finfish belong to serotypes O1 and O2 (including various subserotypes). However, serotype O3 has also been associated with disease in a range of fish species, including European sea bass (*Dicentrarchus labrax*), Asian ayu (*Plecoglossus altivelis*), eels (*Anguilla Anguilla*; Tiainen *et al.*, 1997) and salmonids in Chile (Silva-Rubio *et al.*, 2008). Evidence also exists for a degree of host-species specificity within certain serotypes of *V. anguillarum* (Myhr *et al.*, 1991). As novel sero-/genotypes may be identified on introduction of new fish species to aquaculture (Mikkelsen *et al.*, 2011), we may expect the serotype diversity of *V. anguillarum* isolated from farmed fish to increase, as aquaculture expands and diversifies.

The establishment of *V. ordalii* as an independent species (Schiewe *et al.*, 1981) was based on phenotypical differences and DNA/DNA hybridisation. Available whole genome sequence information from a fish pathogenic *V. ordalii* now indicates an extremely high relationship between these species, but identified a considerably smaller genome in *V. ordalii* compared to *V. anguillarum* (Naka *et al.*, 2011). This suggests that *V. ordalii* may be undergoing genomic degradation consistent with evolutionary progression from an environmental towards an obligate pathogenic lifestyle (Naka *et al.*, 2011). Recently, strains phenotypically consistent with *V. ordalii*, but phylogenetically more closely related to *V. anguillarum*, have been identified in farmed cod in Norway (Steinum *et al.*, 2016) and farmed lump sucker in both Norway and the United Kingdom (Colquhoun, unpublished data).
3 Susceptible species

Many different species of farmed fish (Austin and Austin, 2007), both marine and anadromous, appear susceptible to the disease. Epizootics in wild marine fish species also occur regularly, e.g. in saithe (Pollachius virens; Egidius, 1987) and big-scale sand smelt (Atherina boyeri; Yiagnisis et al., 2007). Originally described as a pathogen of eels (Bergmann, 1909), many marine fish species and both Atlantic and Pacific salmonid species are at risk, with rainbow trout (Oncorhynchus mykiss) appearing particularly susceptible (Lillehaug et al., 2003). Vibriosis outbreaks have been reported in many diverse aquaculture species, including, but not limited to, Asian ayu, European sea bass, Gilthead sea bream (Sparus aurata), turbot (Scophthalmus maximus; Larsen et al., 1994), and Atlantic cod (Gadus morhua; Colquhoun et al., 2007).

4 Geographical distribution

Vibriosis caused by V. anguillarum has a worldwide distribution in temperate waters, having been described in Europe, Asia, the Americas, and Australasia (Munday et al., 1992; Austin and Austin, 2007; Silva-Rubio et al., 2008). V. ordalii is less frequently identified, and may have a more limited distribution, having been described in North and South America, Japan, Australasia (Schiewe and Crosa, 1981; Wards et al., 1991; Colquhoun et al., 2004), and more recently in Norway (Anonymous, 2006).

5 Disease aetiology

As with all infectious diseases, vibriosis is the result of the interplay between pathogen, host and the environment. Water temperature is undoubtedly one of the major factors related to vibriosis outbreaks, with most cases involving wild and farmed fish associated with rising and relatively high water temperatures during the summer months in temperate areas (Lillehaug et al., 2003). The general association to high water temperatures is related to increased bacterial virulence/activity, but also to increased stress and reduced immunological capability in affected fish populations. Handling of fish during, e.g. grading or, paradoxically, vaccination, may also tip the balance in favour of the pathogen, resulting in the outbreak of disease.

6 Significance

Vibriosis was previously a significant problem in farmed salmonids, but its impact in salmonid culture has been drastically reduced due to the development of effective vaccines and vaccination procedures. The disease remains problematic in the marine fish-farming industries of many countries surrounding the Northern Atlantic, Mediterranean countries, and Asia/Oceania.
7 Clinical signs and pathology

Vibriosis can be generally described as disseminated systemic infections, for which the macroscopically visible, and non-specific external signs may include necrotic lesions and varying degrees of cutaneous haemorrhage on both body and fins, with or without exophthalmia. Internally, extensive inflammation, haemorrhage, and often ascites may be observed. While diseases caused by *V. anguillarum* and *V. ordalii* are very similar, infections caused by *V. ordalii* appear less virulent (Hjeltnes, 1993; Austin and Austin, 2007).

8 Control measures and legislation

While antibiotics are commonly used to treat acute outbreaks of vibriosis (Lillehaug *et al.*, 2003; Colquhoun *et al.*, 2007), often with good effect, there is no doubt that vaccination represents the most effective means of controlling vibriosis in aquaculture. Vibriosis vaccines were among the first vaccines developed for aquaculture use, and generally provide high levels of protection (Colquhoun and Lillehaug, 2014). Currently available vibriosis vaccines include both products for immersion- and injection-vaccination. Although intraperitoneal vaccination is generally acknowledged to provide better and longer-lasting protection, the process is relatively expensive, and requires the vaccinated fish to be above a minimum size, dependent on fish species, but generally > 10 g. The choice of administration route is therefore based on the type and size/developmental stage of the fish, as well as the value of the fish to be vaccinated. In European marine aquaculture of salmonids, the use of adjuvant polyvalent vaccines, including *V. anguillarum*, renders injection as the method of choice.

The *Vibrio* agents causing disease in aquaculture have an approximate worldwide distribution, and there are no particular regulatory concerns connected to outbreaks of vibriosis or the demonstration of *V. anguillarum* or *V. ordalii* in fish.

9 Diagnostic methods

Diagnosis of vibriosis is generally based on a combination of macroscopic and histological observations, combined with the culture of the aetiological agent as the central diagnostic element. Culture of both *V. anguillarum* and *V. ordalii* is relatively easily achieved, normally by streaking from kidney tissues on general purpose media, such as Tryptone Soya Agar (TSA), Heart Infusion Agar (HIA), or Blood agar (BA). The presence of NaCl is required for growth, but the concentration of NaCl found in most general purpose agars (i.e. 0.5%) is sufficient.

10 References


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### Figures

Figure 1. Juvenile farmed Atlantic cod, *Gadus morhua*, displaying bilateral exophthalmos and erythema of the head and fin-bases, associated with *Vibrio anguillarum* infection. Photo: Arthur Lyngøy, Fiskr AS.
Figure 2. *Vibrio anguillarum* serotype O2b cultured on blood agar containing 2% NaCl, displaying relatively large (4–5 mm) colonies, which display a clear area of haemolysis under individual colonies. Photo: Norwegian Veterinary Institute.

Figure 3. A *Vibrio ordalii*-like strain isolated from farmed Atlantic cod, *Gadus morhua*, cultured on blood agar containing 2% NaCl, displaying very small (< 1 mm), non-haemolytic colonies. Photo: Norwegian Veterinary Institute.

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