Sea Lice - Could They Act As Disease Vectors?

Question: Apart from the direct damage that may be caused by sea lice, could these parasites also act as disease vectors allowing diseases to be transferred back and forth between wild and farmed salmon?

Answer: Continuing research to determine if sea lice have any potential impact regarding significant disease transmission is ongoing and important. The concern that diseases in farmed salmon may pose a risk for wild salmon has been frequently voiced although studies have shown that all the pathogens found in farmed fish are enzootic in wild salmon populations (8). Although it has not been demonstrated that sea lice pose additional risks as disease vectors for either farmed or wild salmon in British Columbia, several studies have evaluated this potential.

Most research has attempted to determine what influence sea lice (*Lepeoptheirus salmonis)* originating from farmed salmon may have on wild salmon populations. We also know that infective stages of sea lice are transmitted from returning wild adult salmon to out-migrating juveniles and that naive farmed salmon pick up sea lice from these heavily-laden adults. Over the last several years, work has begun to be focused on whether sea lice from farmed salmon may negatively impact wild salmon by acting as vectors for viral and bacterial diseases. The results from such work are also important to salmon farmers who are interested in protecting their stock from diseases existing in the wild.

Secretions from the salmon louse and its feeding activity may permit invasion by secondary pathogens. The presence of such pathogens in or on sea lice indicates that, although the louse may mechanically spread the agent, it does not demonstrate that the parasite is a significant disease vector. Sea lice could potentially make the fish more susceptible to disease but, also, fish in the early stages of disease may be more susceptible to settlement by sea lice (2).

To determine the level of risk of disease transmission between two populations (wild and farmed), it is essential to know the presence of disease in each, and the survival of the pathogen between the populations. In general, very little is known about the health of wild salmon but, through frequent monitoring, much more information is available regarding the health status of farmed salmon.

Viruses

In spite of extensive and regular monitoring, **Infectious Salmon Anemia** (ISA) virus has never been found in BC.

It was noted in Scotland during an ISA outbreak in 1998-1999 that sea lice had often increased before the outbreak and molecular evidence has suggested the presence of ISA virus on sea lice from ISA-positive fish (10). Sea lice appear to enhance transmission of the ISA virus from infected to susceptible fish. *Lepeophtheirus salmonis*

has been shown to carry the virus passively on its surface and in its digestive tract, although transmission of the disease by sea lice has not been demonstrated. It is not known whether the ISA virus is able to reproduce itself in the sea louse but this is considered only a remote possibility as viruses are usually very host specific.

Sockeye salmon can be infected with **Infectious Hematopoietic Necrosis** (IHN) virus without dying or showing evidence of disease and may spread the virus to susceptible farmed Atlantic salmon. IHN is spread via direct contact with infected fish but is also transmitted through the water in which it is able to survive for at least one month. Additional research has shown that IHN virus can be acquired by sea lice and remain *associated* with these parasites for up to 24 hours (3). Additional studies indicate that sea lice act as mechanical, rather than biological, vectors (12).

Bacteria

Aeromonas salmonicida has been isolated in sea lice and marine plankton samples taken from a fish farm experiencing an outbreak of furunculosis and it has been hypothesized that salmon lice may be an important mechanism for introducing pathogens such as *A. salmonicida* onto fish farms (5, 7). Experimentally, *A. salmonicida* was transmitted from infected Pacific salmon to non-infected Atlantic salmon via sea lice, suggesting that sea lice are able to transmit pathogenic bacteria (6). *A. salmonicida* has been transferred from experimentally-infected *Lepeophtheirus salmonis* to Atlantic salmon (9).

Several other bacteria (*Tenacibaculum maritimum, Pseudomonas fluorescens,* and *Vibrio* spp.) have also recently been identified from motile *L. salmonis* (1).

Summary

A distinction must be made between an agent capable of mechanically transmitting a pathogen (acting as a fomite) versus a biological vector (agent that is *necessary* for its transfer); a rubber boot may act as a fomite and physically transmit pathogens short distances. A biological vector, however, not only transmits the pathogen *but also supports its survival*; for example, bats can act as biological vectors for the rabies virus. In some cases, a biological vector may actually be necessary for an agent to complete its life cycle; a mosquito is necessary for the replication of the parasite that allows malaria to develop to an infectious stage. A mechanical vector, of course, is much less important in disease spread.

Sea lice have been shown experimentally to be capable of mechanically transferring ISA and IHN viruses and some fish bacterial pathogens. There is, however, no indication or evidence that such mechanical capability is important or significant regarding potential disease transmission between farmed and wild salmon in British Columbia.

For sea lice to act as important disease vectors, the disease must, of course, occur either on the farm or in the wild. While we know little about health / disease in wild Pacific salmon, good information is available regarding the health of farmed salmon in British Columbia, to wit:

- ISA virus has never been found in wild or farmed salmon in BC in spite of extensive and regular monitoring. Natural outbreaks of disease have only been recorded in farmed salmon and it is predominantly a disease of Atlantic salmon. Transmission through sea lice has been suggested and vertical transmission may occur (11). Stringent controls placed on egg imports into British Columbia (under previous regulations as well as new Regulations under the federal *Health of Animals Act*) provide strong assurances that there is very little likelihood of introducing ISA into BC.

- Sockeye salmon can be infected with IHN virus without dying or showing evidence of disease and may be responsible for spreading the virus to susceptible farmed Atlantic salmon. As a result of previous incursions of IHN, a new sub-unit vaccine was developed to protect farmed Atlantic salmon. Regular monitoring of farmed salmon, including highly-sensitive molecular testing, is able to provide a rapid and clear indication of its presence. This virus has not been suspected or identified in BC farmed salmon since 2004.

- *Aeromonas salmonicida* has been isolated from sea lice and marine plankton on a salmon farm experiencing an outbreak of furunculosis. Experimentally, it has been shown capable of transmission via sea lice. Since farmed salmon in BC are all vaccinated before they leave freshwater sites, however, disease caused by this pathogen (furunculosis) has largely disappeared on salmon farms.

- *Tenacibaculum maritimum* has infected wild Pacific salmon but*, on aquaculture sites*, has only affected Atlantic salmon (primarily smolts shortly after their introduction to saltwater). As the agent is an environmental contaminant, the presence of sea lice, although capable of mechanically transmitting the bacterium, is unlikely to increase the possibility of infection.

- A thorough review of farmed fish health records in BC over the last five years demonstrates that *Pseudomonas* sp. and *Vibrio* (*Listonella*) sp. infections occur at very low levels. Sea lice, acting as fomites, are highly unlikely to provide any additional risks for potential disease spread between farmed and wild salmon.

  While it is always dangerous to extrapolate science done on different species in different areas, work on wild Atlantic salmon in Europe has not demonstrated significant enhanced mortality in sea lice-infected salmon smolts versus

protected fish (4). This also suggests a correspondingly reduced importance of sea louse-associated concomitant pathogens for parasitized smolts.

Conclusion:

To date, sea lice have been shown - with the possible exception of *Aeromonas salmonicida* - capable only of *mechanically* transferring certain specific pathogens i.e. acting as fomites rather than biological vectors. Further, the pathogens that have been shown to be transmitted via sea lice either do not occur in BC (ISA) or have been eliminated on aquaculture sites through vaccination and good management protocols (*Aeromonas salmonicida).* Good management protocols and vaccination have likely also been primarily responsible for the absence of IHN in BC since 2004. Other pathogens are common environmental agents (*Tenacibaculum maritimum*) or occur at such low levels (*Pseudomonas* sp., *Vibrio* sp.) as to effectively eliminate additional risks that may be hypothesized to occur via sea lice vectors.

Continuing research to determine if sea lice could have any potential impact regarding disease transmission is important and ongoing. To date, however, it has not been demonstrated that sea lice pose additional risks as disease vectors for either farmed or wild salmon in British Columbia.

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