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The effects of fin rot disease and sampling method on blood chemistry and hematocrit measurements of winter flounder, *Pseudopleuronectes americanus* from New Haven Harbor (1987–1990)

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Abstract

Winter flounder from New Haven, Connecticut were evaluated for fin rot disease. Blood samples collected from healthy and diseased fish were used to measure bilirubin, calcium, hematocrit, inorganic phosphorus, osmolality, and total protein. Blood measurements were significantly affected by the presence of fin rot disease and by sampling mode (bled immediately or after 18 h). A reduction in blood chemistry values was associated with fin rot disease. Logistic regression modeling was used to identify explanatory variables contributing to the fin rot outcome in winter flounder. Blood constituent levels were higher in fish bled immediately versus 18 h post-capture, especially among fish without fin rot, suggesting that a waiting period is necessary for blood values to stabilize following initial sampling stress. This study presents evidence that winter flounder blood chemistry and hematocrit measurements are affected by fin rot disease.
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Keywords: Fin rot; Blood chemistry; Hematocrit; Winter flounder

1. Introduction

The winter flounder, *Pseudopleuronectes americanus*, is a commercially and recreationally important species that inhabits the inshore coastal zone. Nearshore habitats are important spawning and nursery areas for flounder and other marine finfish and are often located adjacent to industrialized, urbanized and waste disposal zones (Thurberg and Gould, 2005). One such location, New Haven, Connecticut, is an environmentally degraded urban harbor (Robertson et al., 1991) known to contain elevated levels of organic chemical contamination (Johnson et al., 1993; Gronlund et al., 1991) and among the highest sediment metal concentrations found in Long Island Sound (Greig et al., 1977; Normandeau Associates Inc., 1979; Rozan and Benoit, 2001). Analysis of gonads from New Haven winter flounder showed elevated PCB levels (Greig and Sennefelder, 1987) while trace metal contamination of flounder liver tissue was twice that measured at other Long Island Sound locations (Greig and Wenzloff, 1977). Year-round occurrence of winter flounder in the vicinity of New Haven Harbor suggests that contaminant levels observed here, both in sediments and in fish tissues, reflect local environmental conditions (Ziskowski et al., 1987).

High frequencies of biochemical and pathological abnormalities, including fin rot disease, are known to occur in winter flounder from New Haven (Gronlund et al., 1991; Bodammer, 2000). Studies have documented a high frequency of abnormal embryo development (Perry et al., 1991), as well as decreased hatch and reduced larval size in offspring of New Haven flounder (Nelson et al., 1991). Bifurcated gill filaments in flounder, an abnormality often linked to contaminant exposure, were more common here than in other Long Island Sound locations (Pereira et al., 1992). These studies suggest that populations of winter flounder, which utilize this harbor for seasonal feeding and reproductive activities, may be deleteriously affected by the presence of contaminants (Gronlund et al., 1991).

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Between 1984 and 1992, a high prevalence of fin rot disease was detected among winter flounder from the New Haven Harbor area (Table 1). Over an eight year collection period, numbers of flounder showing signs of the condition ranged from 3% to 16% of the total catch. Fin rot or fin erosion disease is a "wasting" condition commonly observed in flatfish collected from nearshore environments (Ziskowski et al., 1987; O'Connor and Huggett, 1988) in association with degraded habitats (Murchelano and Ziskowski, 1976, 1982; Sherwood, 1982; Bodammer, 2000) and industrial pollution (Wellings et al., 1976; Mahoney et al., 1973; Newell et al., 1979). Contact with bottom sediments, where toxic chemicals, low dissolved oxygen and high microbial populations co-exist, appears requisite for development of fin rot since fin lesions generally occur first on the approximate midpoints of anal and dorsal fins (Murchelano and Ziskowski, 1982; Sindermann, 1979, 1990). Benthic-dwelling flounder live in close proximity to contaminated bottom sediments, where they remain for extended periods of time, feed mainly on benthic organisms and bury themselves in sediment when not feeding (Dawson, 1979; O'Connor et al., 1987; Khan et al., 1992; Moles and Norcross, 1998; George-Nascimento et al., 2000). Prolonged exposure of flatfish to bottom contamination may explain why they experience a higher prevalence of fin rot than pelagic round fishes (Ziskowski et al., 1987).

Winter flounder are particularly susceptible to development of fin rot disease (Mahoney et al., 1973; Murchelano 1975; Ziskowski and Murchelano, 1975; Fletcher, 1981). Fish collected from the heavily industrialized and sewage-contaminated New York Bight showed elevated fin rot (Murchelano and Ziskowski, 1976, 1982) while flounder from Boston Harbor displayed increased fin erosion after exposure to chlorinated hydrocarbon residues (DDT) (Moore et al., 1996). Evidence of fin rot disease among Gulf of Maine winter flounder suggests that fish may inhabit anthropogenically-impacted inshore areas before migrating seasonally to less polluted offshore locations (Zdanowicz et al., 1986; Ziskowski et al., 1987; Thurberg and Gould, 2005). The presence of a disease condition, such as fin rot, can be an indicator of estuarine health and may provide a means of monitoring the effects of environmental stress (Moles and Norcross, 1998). The apparent associations between signs of fin rot and sediment contamination has resulted in the proposed use of fin rot (presence and severity) as an index of pollution-induced disease in marine fish (O'Connor et al., 1987; O'Connor and Huggett, 1988). Despite the strong body of evidence linking fin rot disease symptoms to elevated bottom contamination (Sherwood, 1982), the etiology of fin rot disease remains unknown.

Table 1
Percentage of New Haven Harbor winter flounder showing signs of fin rot disease during the period 1984–1992

Year	Fish with fin rot (%)	N
1984	13.6	332
1986	14.3	168
1987	6.5	324
1988	9.7	155
1989	15.5	800
1990	10.6	360
1992	3.1	64

Environmental contamination, which contributes to the development of fin rot disease, can also impact osmotic and ionic regulation in fish (Haux, 1979; Heath, 1995). Blood chemistry and hematology measurements can reflect the biological consequences of chronic exposure to chemical contaminants (Lochmiller et al., 1989; Folmar, 1993) and may be useful indicators of sublethal environmental stress and/or disease (Bridges et al., 1976; Warner and Williams, 1977). Blood chemistry and hematology have been used to assess possible anthropogenic effects in field-collected flatfish including yellowtail and windowpane flounder (Dawson, 1990; Mercaldo-Allen et al., 2003) and to determine the impact of contaminant exposure on winter flounder in the laboratory (Dawson, 1979, 1990). Hematological and blood chemistry profiles for normal fish held under controlled conditions can provide a baseline for assessing disease or stress-related conditions (Dye et al., 2001).

Sampling methods can potentially affect blood chemistry and hematocrit measurements in fish. Collection, transport and handling stress can alter physiological processes (Haux et al., 1985). Capture methods and sampling protocols can disrupt salt and water balance affecting the continuity of blood constituent levels (Eddy, 1981). Information regarding how quickly blood parameters respond to and recover from the stress of capture and/or handling is inconsistent and may be species-specific. A lack of consensus remains concerning which sampling method produces the most accurate measurement of blood parameters. Some studies suggest that bleeding fish immediately upon collection provides the most precise assessment (Bouck and Ball, 1966; Umminger, 1970; Larsson et al., 1976; Mercaldo-Allen et al., 2003), while others suggest that immediate sampling may elevate blood parameters and advise a waiting period to allow blood parameters to return to normal before sampling (Hattingh and van Pletzen, 1974; Eddy, 1981; Bourne, 1986; Haux et al., 1985).

The high prevalence of fin rot observed among flatfish from New Haven Harbor during the 1980s prompted this investigation. This study evaluates the effects of fin rot disease on blood chemistry and hematocrit values of winter flounder from an urban harbor. Initial sampling of fish showed elevated hematocrit values among those sampled immediately, suggestive of erythrocyte swelling and a stress condition, therefore a secondary sampling mode (18 h post-capture) was initiated, to determine whether sampling protocol (immediately versus 18 h post-capture) also affects blood chemistry and hematocrit measurements in winter flounder. We used logistic regression analysis and iterative model selection to identify explanatory variables that contributed to the fin rot outcome.