

## THE PHYSIOLOGY OF TRIPLOID FISH

Tillmann J. Benfey  
Department of Biology, University of New Brunswick  
Fredericton, New Brunswick, Canada E3B 6E1  
tel (506) 452-6293; fax (506) 453-3583; e-mail benfey@unb.ca

S. Currie (Mt. Allison University), C.A. Hyndman (UNB Saint John),  
J.D. Kieffer (UNB Saint John), R.A. O'Keefe (UNB Fredericton) and  
D.Y. Schafhauser-Smith (UNB Fredericton)

### EXTENDED ABSTRACT ONLY - DO NOT CITE

#### Introduction

Triploid fish are interesting models for physiological research for two principal reasons: they are sterile yet show varying degrees of gonadal development, and they have larger but fewer cells in most tissues and organs (Benfey, 1999). Their sterility makes triploids of interest for aquaculture as a means to prevent declines in flesh quality associated with sexual maturation and to ensure that any fish which may escape from culture facilities are not able to reproduce in the wild. However, experiences with triploid salmonids in commercial aquaculture have generally not been good (e.g., Benfey, 2001). They tend to have reduced growth and survival compared to diploids, and give the appearance of being chronically stressed. Our research on triploid salmonids focuses on developing a better understanding of their basic physiology, in the hope that this will lead to improved utilization of triploids in commercial aquaculture. This paper summarizes some recent results with triploid brook trout, *Salvelinus fontinalis*.

#### Reproductive Physiology

Triploid females have minute ovaries at the age of first spawning in diploids (Benfey, 1999). However, as they get older, triploid females recruit small numbers of follicles into vitellogenic growth but these follicles are variable in size and appear develop asynchronously (Schafhauser-Smith and Benfey, 2002a). Experiments conducted *in vitro* have shown these follicles to be endocrinological competent, as evidenced by the secretion of 17 $\beta$ -estradiol in response to testosterone, cholesterol and/or gonadotropin stimulation (Schafhauser-Smith and Benfey, 2002b). A long-term estrogen therapy experiment conducted *in vivo* failed

to increase the number or size of developing follicles in triploid females, but did induce hepatic vitellogenin synthesis and secretion into the blood, as well as reducing blood haemoglobin levels (Schafhauser-Smith and Benfey, 2002c). Taken together with earlier research on pituitary and liver function in triploid coho salmon (*Oncorhynchus kisutch*) (Benfey et al., 1989), this suggests that the endocrine systems associated with ovarian development are fully competent in triploid females but lack the appropriate signals for ovarian development to occur, presumably due to the small number of developing follicles.

### **Exercise Physiology**

Triploids and diploids appear to have equivalent aerobic capacities (Stillwell and Benfey, 1997), but triploids have lower oxygen consumption rates when swimming aerobically in a respirometer (Stillwell and Benfey, 1996) and during recovery from exhaustive exercise (Hyndman et al., 2002a). The question arises as to whether the decrease in red blood cell surface area to volume ratio affects cellular oxygen consumption rates in triploids, but this does not appear to be the case: oxygen consumption rates of triploid blood are not significantly different from diploid rates ( $1.87 \pm 0.51$  vs.  $1.67 \pm 0.28$  nmol/ml/min/g Hb, respectively; Currie and Benfey, unpubl.). The overall responses to exhaustive exercise at 9°C are similar in triploids and diploids, although triploids recover more quickly from acidosis, muscle ATP depletion and muscle lactate accumulation (Hyndman et al., 2002a). At 19°C, on the other hand, triploids exhibit high (90%) mortality within 4 hours of exhaustive exercise (compared to no mortality in diploids) and demonstrate reduced anaerobic capacity as reflected by an absence of phosphocreatine depletion and slower muscle ATP recovery and lactate elimination (Hyndman et al., 2002b). These results help explain the previously demonstrated reduced tolerance of triploid rainbow trout (*O. mykiss*) to elevated temperatures (Ojolick et al., 1995).

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