

**LINKING DIFFERENCES IN CONSUMPTION RATES
AND GROWTH EFFICIENCIES
TO INTRINSIC ENERGY DEMANDS
OF MIGRANT AND RESIDENT
BROOK TROUT (*SALVELINUS FONTINALIS*)**

G.R. Morinville
CIRSA-GRIL: McGill University : Department of Biology,
1205 Ave. Dr. Penfield, Montreal, QC, Canada, H3A 1B1.
Phone: (514)398-4096, Fax: (514)398-5069,
E-mail : gmorin@po-box.mcgill.ca

J.B. Rasmussen
CIRSA-GRIL: McGill University : Department of Biology
E-mail : jrasmu@bio1.lan.mcgill.ca

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Introduction

In some salmonids such as Atlantic salmon (*Salmo salar*), brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*), individuals within a given population can be observed to segregate into morphs of varying life history strategies. The differences in life history strategies may be linked to differences in energy budgets, or in energy allocation strategies (Tucker and Rasmussen, 1999; Forseth *et al.*, 1999). In populations of brook trout where the sea is relatively accessible, anadromy has evolved. However, only a partial migration (Jonsson and Jonsson 1993) is observed, resulting in populations composed of both migrants and residents. In such populations, a growth dichotomy is observed; when individual migrants (after migration) and residents of the same age class are compared, the former are much larger in size.

We investigated the possible mechanisms of partial migration using a bioenergetic approach. Estimating the energy intake and coupling this to growth

allows for an analysis of the energetic performance of fish with different life history strategies. We tested the hypothesis that migrant trout have higher annual consumption rates, but lower growth efficiencies than resident brook trout. Given that migrants and residents have different energy demands, reflected by total metabolic costs, the key to identifying the processes governing partial migration may lie in the possible variations of intrinsic standard metabolic rates (SMR) and/or activity rates (swimming and foraging costs, or 'swimmaging'). It is thus hypothesised that migrants have higher SMR and/or swimmaging costs compared to residents. There are some indirect indications that a link could exist between metabolic rates and life-history strategies in Atlantic salmon (Metcalf *et al.*, 1995; Metcalf *et al.*, 1992). Attempting to identify a link directly in the field may allow for new approaches in studying the partial migratory behaviour in fish populations.

Methods

Our study was conducted in the Ste. Marguerite River system (48°20'N, 70°00'W) in the Saguenay region of Quebec, Canada during the summer of 1998 and 1999. Both migrant and resident trout are relatively abundant in this system. Anadromous brook trout have been observed to migrate as young as 1+ (pers. obs.). In 1998, migrants were defined as those captured moving downstream in Alaskan traps installed on three secondary streams (Morin, Allaire and Epinette) of the Ste. Marguerite River as they moved downstream. In 1999, fish captured in the trap were tagged and released approximately 30m upstream. Only fish captured twice in the trap were deemed true migrants. Resident brook trout were captured by electrofishing immediately after the end of the migration period.

Both consumption rates estimated using the ¹³⁷Cs mass balance model (Rowan and Rasmussen, 1996), and growth efficiencies (ratio of growth to consumption) were determined for individual migrant and resident brook trout. Individual ages and growth rates were determined using otoliths (V. Theriault, unpub. data).

In an attempt to elucidate the possible metabolic differences between migrants and residents, both cytochrome-c-oxidase (CCO) and lactate dehydrogenase (LDH) activity were measured as surrogates of SMR and swimmaging costs, respectively. Both of these analyses were performed *in situ* on fish captured during the summer of 1999. Fish were kept alive until dissections were

performed. Liver tissues (for CCO analysis) were immediately frozen in liquid nitrogen and muscle tissues (for LDH analysis) were frozen in a -80°C freezer.

Results and Conclusions

Preliminary results suggest that, as predicted, 1+ Morin migrants have higher consumption rates, but lower growth efficiencies than 1+ Morin residents. Furthermore, the differences in energy intakes were associated with distinct energy demands; that is, migrants had higher SMR than residents at the time of migration. Similarly, regarding the effect of swimming costs, we expected to see a difference between migrants and residents, whereby migrants would have higher swimming costs than residents. However, at the time of migration, higher LDH activity is observed in the residents as compared with migrants. It is thus not certain whether the enzymatic differences observed were due to the process of migration (ie. smoltification) or whether these differences should always be expected. The link between energy strategies and life history patterns may not be so clear.

References

- Forseth, T., T.F. Næsje, B. Jonsson and K. Hårsaker. 1999. Juvenile migration in brown trout : a consequence of energetic state. *J. Anim. Ecol.* **68** : 783-793
- Jonsson, B. and N. Jonsson. 1993. Partial migration : niche shift versus sexual maturation in fishes. *Rev. Fish Biol. Fish.* **3** : 348-365
- Metcalf, N.B., A.C. Taylor and J.E. Thorpe. 1995. Metabolic rate, social status and life-history strategies in Atlantic salmon. *Anim. Behav.* **49** : 431-436
- Metcalf, N.B., P.J. Wright and J.E. Thorpe. 1992. Relationships between social status, otolith size at first feeding and subsequent growth in Atlantic salmon (*Salmo salar*). *J. Anim. Ecol.* **61** : 585-589
- Rowan, D.J. and J.B. Rasmussen. 1996. Measuring the bioenergetic cost of fish activity in situ using a globally dispersed radiotracer (^{137}Cs). *Can. J. Fish. Aquat. Sci.* **53** : 734-745

Tucker, S. and J.B. Rasmussen. 1999. Using ^{137}Cs to measure and compare bioenergetic budgets of juvenile Atlantic salmon (*Salmo salar*) and brook trout (*Salvelinus fontinalis*) in the field. Can. J. Fish. Aquat. Sci. **56**: 875-887

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