

**SWIMMING AND METABOLIC PERFORMANCE
OF HIGH DESERT REDBAND TROUT**

Gamperl, A. Kurt
Dept. of Organismal Biology, Portland State University.
P.O. Box. O751, Portland Oregon, USA. 97207-0751.
Phone 503-725-5772; Fax 503-725-3888;
E-mail: gamperlk@pdx.edu.

H.A. Faust
PSU, fausth@pdx.edu
K.J. Rodnick
Dept. of Biol. Sci., Idaho State University, rodnkenn@isu.edu
H.W. Li
Dept. Fish and Wildlife, Oregon State University, Hiram.Li@orst.edu

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Introduction

Redband trout are a native, loosely classified, subspecies of rainbow trout known variously as *Oncorhynchus mykiss newberii* and *Oncorhynchus mykiss gairdneri*. Though widely distributed throughout Oregon, Washington and Idaho, 11 redband trout populations have disappeared and 10 others are presently at risk (Nehlsen *et al.* 1993). It is widely believed that redband trout populations have declined as a result of poor land use practices that resulted in elevated stream temperatures. However, there is anecdotal evidence that redband trout commonly hold position in streams above 24 °C, and data on trout species from the Southwest indicate that the critical thermal maxima of trout from arid zones is in excess of 28 °C (Lee and Rinne, 1980). Before effective management plans for the redband trout can be developed, it is important to determine whether distinct population segments exist, and to characterize the effect of elevated stream temperatures on the physiology of this unique species. We measured swimming performance, metabolic parameters and thermal preference in two populations of redband trout from the High Desert Ecoregion of Oregon; both from streams with thermal regimes

where daily fluctuations in water temperature can exceed 10° C. The first study area was a “cold” stream site, the Little Blitzen River, which rarely experiences maximum summer temperatures above 18°C. The second study area, Bridge Creek, was a “warm” stream site where maximum summer temperatures typically reach or exceed 24°C.

Methods

In order to minimize capture stress and injury, juvenile redband trout were collected by volunteer anglers using dry flies and barbless hooks, and kept in stream cages for 2-7 days prior to experimental use.

Experiment #1: 12 – 14 °C

A modified critical swimming speed (U_{crit}) test was performed stream-side using Blatzka type swim-tunnel respirometers (volume 6.8 l; Univ. of Waterloo) to determine the swimming and metabolic capacity of individual fish. In this protocol, the current velocity was increased by 10 cm s⁻¹ every 20 minutes until swimming speeds of 10 to 40 cm s⁻¹ were achieved, and by 5 cm s⁻¹ thereafter until the fish exhausted. At each swimming speed, oxygen consumption was measured for 6–10 minutes, beginning 3 minutes after swimming speed was increased.

Experiment #2: 24 °C

The influence of temperature on routine metabolic rate was assessed at 0.5 bl s⁻¹ by measuring oxygen consumption as stream water temperature was increased (approx. 2° C per hour) from 12 °C to 24 °C. After routine levels of oxygen consumption were measured at 24 °C for each fish, fish were given a modified U_{crit} test, as described in Experiment #1.

For these experiments, statistical analyses comparing metabolic variables and swimming performance between and within groups were performed using ANCOVA, with body mass or length as the covariate.

Temperature Preference

Thirty-six hours after transport to Portland State University (PSU), temperature preference was determined by placing fish in a thermal gradient belonging to Dr. L. Crawshaw. The thermal gradient was composed of 9 lanes (2.5 m long; 28 cm wide; 10 cm deep), each equipped with thermocouples every 25 cm. Temperature within each lane ranged from approx. 8 to 30 °C. Thermal preference was determined as the average temperature selected during the 4th experimental hour. Preliminary experiments revealed that selected temperature was not affected by longer acclimation periods. Preferred temperature was compared between the Bridge Creek and Little Blitzen fish using ANOVA.

Results and Discussion

The metabolic power and swimming ability of these redband trout were comparable to those reported for other wild salmonids of similar size (Beamish, 1978, Brett and Glass, 1973). Trout from both populations swam well at 24 °C. However, test temperature had a differential effect on swimming performance and metabolism in these two populations:

- 1) trout from the Little Blitzen River, with a colder summer thermal history, had similar values for metabolic power and swimming performance at 12 – 14 and at 24 °C;
- 2) fish from Bridge Creek, with a warmer summer thermal history, had significantly lower values of metabolic power and swimming performance at 12 - 14 as compared with 24 °C; and
- 3) the swimming performance of Bridge Creek trout was significantly better than that of fish from the Little Blitzen River at 24 °C.

Although these data indicate that redband trout can tolerate short exposures to water temperatures up to 24°C, and suggest that thermal history can significantly influence the temperature sensitivity of swimming and metabolic performance, trout from both populations selected water temperatures of approx. 13°C.

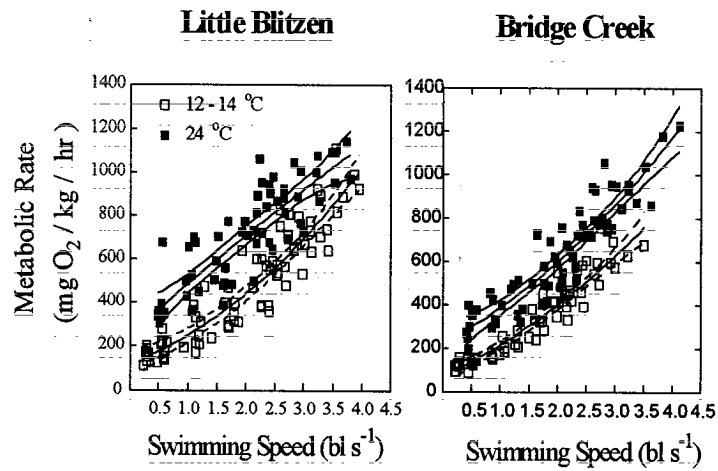


Figure 1. The relationship between swimming speed and metabolic rate for juvenile redband trout at 12 – 14 and 24 °C. Each data point represents an individual fish at a particular swimming speed. Experiments at 12 – 14 and 24 °C were performed on separate groups of fish. The lines drawn through each data set represent 2nd order regressions with 95% confidence limits.

Table 1. Resting MO_2 and metabolic power were measured as $\text{mg O}_2 \text{ kg}^{-1} \text{ hr}^{-1}$ (*) Indicates a significant difference ($P < 0.05$) between streams, within each temperature; (#) indicates a significant difference ($P < 0.10$) between streams, within each temperature; (+) indicates a significant difference ($P < 0.05$) between temperatures, within each stream.

	Length (cm)	Resting MO_2	Metabolic Power	Ucrit (cm s^{-1})
BRIDGE				
12-14 °C (N = 8)	$20.3 \pm 0.9^*$	$122 \pm 8^+$	$450.6 \pm 44^{+\#}$	$51 \pm 3^+$
24 °C (N = 7)	$21.4 \pm 0.9^*$	304 ± 28	633 ± 69	$62 \pm 3^*$
BLITZEN				
12-14 °C (N = 9)	17.6 ± 0.5	$165 \pm 12^+$	661.5 ± 47	55 ± 3
24 °C (N = 9)	18.8 ± 0.4	383 ± 38	576.6 ± 47	49 ± 4

Acknowledgements

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