

IMMUNE-ENDOCRINE INTERACTIONS DURING FINAL MATURATION AND
SENESCENCE OF SPRING CHINOOK SALMON

Alec G. Maule and Robin M. Schrock
National Biological Survey
Pacific NW Natural Science Center
Columbia River Research Laboratory
Cook, WA 98605 USA

Martin S. Fitzpatrick and Carl B. Schreck
Oregon Cooperative Fishery Research Unit
Oregon State University
Corvallis, OR 97331 USA

Introduction

Adult Pacific salmon (*Oncorhynchus* spp.) present a unique model for immune-endocrine interactions because the processes of sexual maturation and senescence occur simultaneously. We examined: (1) the ability of peripheral blood leukocytes (PBLs) to generate specific antibody-producing cells (APC) and (2) lysozyme activity in skin, nares, mouth, intestinal mucus, and in serum from the primary and secondary circulation in adult spring chinook salmon (*O. tshawytscha*). We also measured concentrations of steroid hormones in primary and secondary circulation and cortisol receptors in PBLs.

Results and Discussion

Plasma concentrations of the stress hormone cortisol were high (> 200 ng/ml) compared to that of unstressed juvenile salmon (Maule et al. 1989); cortisol decreased (< 175 ng/ml) in fish held under constant environmental conditions. However, these values may not reflect true resting levels because of stress associated with collecting fish and the sublethal doses of anesthetic used (Barton et al., 1986). APCs were low (≤ 250 APC per culture) in fish sampled during their migration, but increased significantly (≥ 400 APC per culture) when fish were held in constant environmental conditions. While the APC response was not sexually dimorphic, concentrations of several sex steroids were correlated with APC in females but not males (Table 1). Lysozyme activity was significantly higher in mucus from skin, nares and vent than in serum from primary or secondary circulation (Table 2).

Table 1. Correlation coefficient (R) and level of significance (P) of simple linear regressions of steroid hormones and in vitro APC for female and male adult chinook salmon.

Hormone	Females (n = 58)		Males (n = 26)	
	R	P	R	P
Cortisol	-0.351	0.007	0.010	0.962
Androstenedione ^a	0.718	<0.001	-0.143	0.490
17 β -Estradiol ^a	0.465	<0.001	-0.330	0.100
Testosterone	0.471	<0.001	0.309	0.126
11-Ketotestosterone ^a	0.361	0.005	0.306	0.129
DHP ^b	-0.050	0.708	-0.017	0.939

a - mean values differ significantly between females and males

b - 17 α , 20 β -dihydroxy-4-pregnen-3-one

Table 2. Lysozyme activity (Mean \pm SE; μ g/ml) of various bodily fluids collected from adult spring chinook salmon at Carson National Fish Hatchery in 1993. Sample sizes are in parentheses.

Date	Plasma	2 $^{\circ}$ Circ. ^a	Vent ^b	Skin	Nares	Mouth
Jun. 17	25 \pm 3 (8)	26 \pm 1 (14)	1,713 \pm 338 (11)	766 \pm 141 (10)	2,004 \pm 269 (12)	1,144 \pm 11 (12)
Aug. 10	14 \pm 1 (14)	25 \pm 1 (17)	210 \pm 52 (8)	308 \pm 37 (8)	n.d.	n.d.

a - plasma from the secondary circulation was collected from the lateral cutaneous vessel.

b - vent sampling methods were not the same for the two dates.

n.d. - not determined.

Lysozyme activity in mucus and primary circulation decreased significantly during the two months prior to spawning; however, lysozyme activity in the secondary circulation remained constant (Table 2). High pre-spawning mortality of Pacific salmon may be the result of this reduction in lysozyme activity.

References

- Barton, B.A., C.B. Schreck, and L.A. Sigismondi. 1986. Multiple acute disturbances evoke cumulative physiological responses in juvenile chinook salmon. Transactions of the American Fisheries Society 115: 246-251.
- Maule, A.G., R.A. Tripp, S.L. Kaattari, and C.B. Schreck. 1989. Stress-induced changes in glucocorticoids alter immune function and disease resistance in chinook salmon (*Oncorhynchus tshawytscha*). Journal of Endocrinology 120:135-142.