also use prolactin inhibitors as a control. It has also been propounded that
spine reduction in nature due to exogenous calcium concentrations is an
example of genetic assimilation, where environmental cues are
genetically fixed. If this is the case it is possible that reduced calcium
in the environment will lead to reduced expression of Ptx1 in developing
fish, which we will also investigate.

**A4.20**

**Characterization of the hemoglobin and red blood cell system in the copper rockfish, *Sebastes caurinus***

J.L. Rummer, M. Regan, C.J. Brauner, (University of British Columbia)

The North American Pacific coast harbors almost 100 rockfish
species, some of which are the most long-lived teleosts (and
vertebrates) on record! The combination of being long-lived, slow-
growing, deep-dwelling, and genetically isolated makes rockfish a
prime candidate for conservation and fascinating for physiological
research. We investigated hemoglobin (Hb) oxygen (O2) binding
properties, the Root effect, and the b-adrenergic red blood cell (RBC)
response in copper rockfish, *Sebastes caurinus* (260–680 g wet
weight). *In vitro*, copper rockfish RBCs possess a pronounced Bohr
effect (B = −1.2) resulting in a substantial right shift in the O2
equilibrium curve (P50 from approximately 24 to 123 mm Hg with an
increase in PCO2 from 3.8 to 15.2 mm Hg, respectively). The Root
effect is substantial, and onset is initiated near resting in vivo pH
values. Our data are in agreement with the only other published study
to date where the Root effect was characterized with respect to depth
distribution and swimming activity in seven different *Sebastes* species.
Finally, as expected, the RBC stress response is b-adrenergic and
results in significant RBC swelling, elevation of intracellular pH, and
reduction in extracellular pH. Our data provide a foundation for
understanding respiratory physiology of an interesting deep-water,
advanced teleost. Unfortunately, rockfish are severely over-fished and
highly prized in Asian markets. Currently, copper rockfish are being
investigated as a candidate species in aquaculture, which will not only
help meet commercial demand for this species while simultaneously
reducing fishing pressure in wild stocks, it will provide easy access to
an intriguing group of fish for further scientific investigation.

**A4.21**

**Effects of silvering and maturation on acclimation to sea water in the European eel, *Anguilla anguilla L***

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Southern Denmark); A. Lafont, M. Foucherou-Peyron, (Museum
National d’Histoire Naturelle); A. Palstra, G. Van den Thillart, (Leiden
University)

The yellow stage of the European eel metamorphoses into the silver
stage prior to the downstream and trans-oceanic spawning migration.
Possible similarities with salmonid smoltification were investigated.
Both yellow and silver eels from several geographical locations and
habitats ranging from landlocked freshwater (FW) to brackish water
were successfully acclimated to sea water (SW). Following direct FW
to SW transfer, plasma osmolality increased, stabilised between 24 and 48
h at about 133% of the FW value and then declined. Gill Na+, K+-
ATPase activity did not change significantly during this period. Plasma
osmolality at 36h after transfer (Os36h) was therefore used as an
indication of osmoregulatory capability. When eels from the same
locality were compared, silver eels showed significantly lower Os36h
values than yellow eels. Eye size increases during silvering. There was a
significant (p<0.01) negative correlation between ocular index (a
measure of relative eye diameter) and Os36h, suggesting that the
process of silvering does improve marine osmoregulatory capability.
Mature eels have never been observed in the wild but maturation can
be induced by hormonal treatment in SW. No significant changes in
branchial Na+, K+-ATPase activity or plasma ionic concentrations
(apart from increases in calcium and magnesium ion concentrations in
females, as expected due to rising plasma vitellogenin concentrations)
were observed during artificially-induced maturation. Eels were thus
able to maintain normal marine osmoregulation until ovulation.

**A4.22**

**Acid-base regulation during exposure to elevated environmental CO2 in an osmoconformer, the
Pacific Hagfish (*Eptatretus stoutii*)**

D. Baker, J. Rummer, B. Sardella, C. Brauner, (University of British
Columbia)

The ancient hagfish is an osmoconformer, with possibly the most
unique blood ionic composition of all craniates. It is known to partially
regulate levels of some divalent cations in the blood (ie Ca2+ and
Mg2+), but Na+ and Cl− levels in particular are very similar to
seawater. Acid-base disturbances in fish are usually corrected through
acid-base relevant ion transfer at the gills (ie Na+/H+ or Cl-/HCO3−),
ultimately affecting plasma Na+ and/or Cl− levels. Based upon the
feeding behaviour of hagfish, large metabolic and/or respiratory
acidoses are likely experienced: however, nothing is known about this
osmoconformer’s ability to acid-base regulate, which would require
some degree of Na+ and/or Cl− regulation. We exposed Pacific
Hagfish, *Eptatretus stoutii*, to three levels of environmental hyper-
carbia (2%, 6% and 10% CO2, balance air), and extra- and intracellular
acid-base status were monitored up to 96 h of exposure. At all levels
of hypercarbia, a pronounced acidosis was observed (e.g., pH ≤ 7 at
10% CO2 in 3 h), but significant compensation occurred within 48 h.
Interestingly, [HCO3−] in the blood reached as high as 100 mM, the
greatest level of HCO3− accumulation observed in any vertebrate
exposed to short-term hypercarbia. Thus, although the hagfish is a text
book example of an osmoconformer, it is one of the most effective
vertebrates in dealing with a respiratory acidosis. The ability to
accumulate such high levels of HCO3− is likely associated with the
high levels of plasma Cl− and stuff.

**A4.23**

**Effect of dietary canola oil level on ion regulatory
development and immunological status of spring
chinook salmon (*Oncorhynchus tshawytscha*)**

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Columbia); D. Higgs, B. Devlin, (DFO); C. Brauner, (University of
British Columbia)

Pre-smolt spring Chinook salmon, an important aquaculture species,
were fed a diet where supplemental anchovy oil had been partially
replaced with canola oil. Fish were fed to satiation for 30 weeks with
isoenergetic and isonitrogenous steam pelleted dry diets in which canola
oil constituted one of 0%, 25%, 50%, or 75% of the total dietary lipid
content. This feeding trial was conducted to evaluate the effects of this