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 *Pitx1* 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 (O_2) 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 O_2 equilibrium curve (P50 from approximately 24 to 123 mm Hg with an increase in PCO_2 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

C. Rankin, (Huddersfield University); S. Madsen, (University of Southern Denmark); A. Lafont, M. Fouchereau-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 CO_2 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 Ca^{2+} and Mg^{2+}), 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^-/HCO_3^-), 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 hypercarbia (2%, 6% and 10% CO_2, 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., $pH \leq 7$ at 10% CO_2 in 3 h), but significant compensation occurred within 48 h. Interestingly, $[HCO_3^-]$ in the blood reached as high as 100 mM, the greatest level of HCO_3^- 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 HCO_3^- 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*)

S. Huang, D. Baker, P. Schulte, T. Wu, S. Balfry, (University of British 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