SCIENCE SPOT

A round-up of the latest trout science stories contributions by Andy Ferguson and Tim Jacklin

Chances of survival? It's all in the genes

Many studies of both salmon and trout (salmonids) have shown that under natural conditions farmed fish, especially from long domesticated strains, have much lower survival and reproductive success, this often being less than 10% of that of the native wild fish. The combination of survival and reproductive success, i.e. the contribution to the next generation, is referred to in biology as 'fitness'– sometimes as 'Darwinian fitness' to differentiate it from the colloquial use of the term. Importantly, hybrids between wild and farmed salmonids also show reduced fitness, this typically being intermediate between that of the entirely wild and entirely farmed fish. The lowered fitness of hybrids results in a cumulative lowering of the fitness of the wild population due to interbreeding over generations. This means that fewer young fish are produced each generation and consequently more stocking is required to maintain numbers – a vicious circle. Such findings are the result of experiments comparing groups of wild, farmed and hybrid (farmed x wild) salmonids under communal natural conditions. Because the environmental conditions are the same for all, the differences in fitness are clearly genetic, although such experiments do not tell us which specific genes are involved.

When specific genetic differences are present between wild and farmed fish, these genes can be used to follow the fate of the stocked fish and the extent to which the genes of the farmed fish are introduced into the wild population (known as the degree of introgression). Studies in many different countries have looked at the extent of introgression following long-term stocking with farmed salmonids. In general, much lower levels of farmed salmonid survival and introgression have been found than would be expected from the scale of the stocking; this indirectly reflects the much reduced fitness of farmed and hybrid fish, as well as the circumstances of stocking and the artificial nature of hatchery rearing. Many key studies on brown trout stocking have been undertaken by Michael Hansen's laboratory. They have made use of several stocking situations in Denmark involving specific farm strains. Also an historical perspective has been gained by using trout scales collected in the 1940-50s. DNA can be extracted from these scales enabling genetic changes to be determined over a 60-year period. In a recent paper they looked for evidence of differences in natural selection between wild and farmed trout (Hansen, Meier & Mensberg, 2010, Identifying footprints of selection in stocked brown trout populations: a spatio-temporal approach, *Molecular Ecology* 19, 1787-1800).

The work involved three wild brown trout populations with substantial farm-gene introgression (19-64%), together with two hatchery strains. They analysed genes at 61 different sites (loci) on the chromosomes. Some of these genes are known to be associated with specific biological traits, thus could potentially be affected by natural selection, while others have no currently known function ('neutral' genes with respect to selection). However, even these latter genes can be affected by selection indirectly as a result of selection acting on genes located adjacent to them on the chromosome ('linked genes'). Such selection is referred to as 'hitch-hiking selection'.

The study found evidence that selection was different in the farmed and wild groups as a result of the different environmental conditions that they experienced. The study also found that there was selection against 'farm genes' in the wild, finding a lower frequency of genes subject to selection compared to neutral ones in the introgressed populations. Additionally, the analysis of the scales from the 1940-50s showed the extent of genetic differentiation was greater between historical wild samples and hatchery strains compared to that between contemporary wild samples and hatchery strains, reflecting the recent admixture with stocked farmed trout. This study adds to the rapidly increasing body of evidence that demonstrates the disadvantages of stocking with domesticated farm trout strains. Fortunately in Denmark such stocking was prohibited in 2003 and now only supportive breeding (native broodstock schemes) are permitted.