Support for maintenance of F2 lake trout for research on morphotypic diversity

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ABSTRACT:

Sympatric ecomorphs are common in lake charr populations across North American lakes. Lake Superior is the only Laurentian Great Lake to still contain endemic lake charr ecomorphs that include leans, siscowets, humpers and redfins. The lean and siscowet ecomorphs represent shallow-water and deep-water forms respectively, and collectively comprise the largest lake charr biomass in Lake Superior. As with ecomorphs generally, it is unclear what phenotypes are the result of environmental plasticity or are heritable and have a genetic basis. Controlled laboratory rearing experiments ("common garden" rearing) offer a means of disentangling trait heritability from environmental plasticity and make it possible to more conclusively identify the mechanisms that maintain adaptive variation. A common garden rearing study of leans and siscowets was initiated in 2006 when gametes were obtained from wild leans and siscowets in Lake Superior and reared in a hatchery setting under identical environmental conditions. Initial results from those fish indicated that differences in condition factor, morphometry and lipid levels were most likely heritable traits. However, observing the same differences in a second generation produced from the parents would be more convincing since factors such as maternal effects would be removed or greatly reduced. Thus, in 2011 all possible crosses were made to produce a second generation (F2) of leans, siscowets and their reciprocal crosses, and were reared in the hatchery under the same common environmental conditions as the parents. By analyzing the F2 offspring over a 9-year period we know that lipid content, growth, and condition factor still differed significantly among lake charr crosses, reinforcing the original suggestion made from the parental line that lean and sicowet phenotypes are inherited and are not due to environmental plasticity. Further, redundancy analysis and quantitative-trait-loci (QTL) genome scans were used to identify associations between genotypes at 19,714 single nucleotide polymorphisms (SNPs) aligned to the lake charr genome and individual phenotypes to determine the role that genetic inheritance plays in ectomorph phenotypic diversity. Polygenic scores of 15 SNPs putatively associated with lipid content and/or condition factor indicated that ecomorph distinguishing traits are polygenically regulated and additive. A QTL identified on chromosome 38 contained >200 genes, some of which were associated with lipid metabolism and growth further demonstrated the complex nature of ecomorph diversity. The results of this common garden rearing study that was underway for 15 years and two generations indicate that there has been genetic assimilation of certain phenotypes in these ecomorphs and is the first study to demonstrate this in lake charr.