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Discovery of a Major Maturity Locus in Salmon

Described as a 'sensational' finding in a national newspaper last year (1), an article in Nature (2) authored by CIGENE scientists at Ås together with their partners described a gene for fat storage that turns out to be a key determinant of age at sexual maturity in wild salmon



Atlantic salmon – Wikipedia.

Wild Atlantic salmon live most of their lives in salt water and only migrate to fresh water rivers to spawn when they have reached sexual maturity. Depending on genotype, the age of sexual maturity can be 1, 2, 3 or more years. A mature 1 year-old wild salmon weighs 1-3 kg and is 50-65 cm long while the corresponding figures for a 3 year-old wild salmon are 10-20 kg and more than 100 cm.

To gain insight into the genetics of salmon maturity, the CIGENE group led by Sigbjørn Lien together with national as well as international partners screened 1,518 wild fish from 57 different populations, including 56 populations from salmon rivers in Norway. All populations consisted of mixtures of 1, 2, 3 or more years-old fish, although the proportions varied widely. For example, fish from the Tana River (Finmark) were 65% 1 year-old, 18% 2 years-old, 19% 3 years-old and 1% more than 3 years-old while the age structure of the fish population from the Eidfjord watershed (Hordaland) was 5%, 5%, 84% and 6%, respectively. Corresponding values for fish from the Namsen River (North Trøndelag) were 37%, 32%, 30% and 7%.



Sigbjørn Lien

Genotyping was done using a 220,000 SNP chip from Affymetrix Axiom, analyzed using the Gene Titan machine (3). These analyses identified a region on chromosome 25 with extremely strong association with age at maturity, giving a p value less than 10⁻²⁰ which means that it can explain 39% of variation in age at maturity in wild salmon. One partner in the project was quoted as saying, 'We found the needle in the haystack'.

The identified region codes for a vestigial-like family member 3 gene (VGLL3) involved in the differentiation of fat-storage cells. One major allele of the VGLL3 gene is designated as early (E) because it tends to be associated with early-maturing individuals. Another major allele (L) tends to be associated with late-maturing individuals. The study identified an interesting difference between male and female salmon in relation to the E and L alleles; namely, that the L allele is recessive in EL males but semi-dominant in EL females (Fig. 1). As stated in the article, this finding 'provides a compelling mechanism contributing to the larger proportion of males

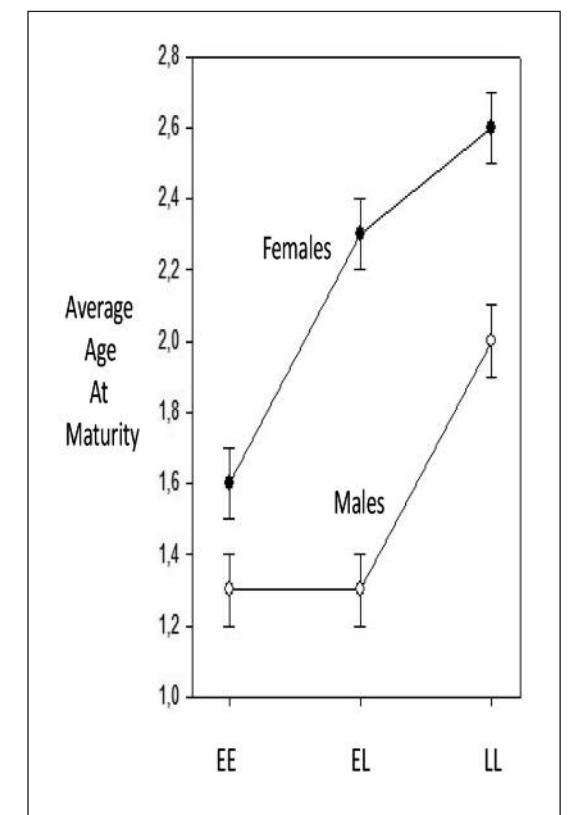


Fig. 1. Contrasting effects of E and L alleles of the VGLL3 gene on age at maturity in male versus female Atlantic salmon. Figure is redrawn from results in reference 2.

exhibiting an early maturing phenotype compared with females'. This is the 'first example of dominance reversal allowing greater optimization of phenotypes within each sex'.

References

1. Mauren A: Løste laksegåte med fiskeskjell. Aftenposten 5 november 2015.
2. Barson N et al.: Nature 528 (2015) 405.
3. Einset J: The Center for Integrative Genetics at Ås. NBS-Nytt, Nr.1, 2015.