

**ASPECTS OF SIZE AND GROWTH IN THE DIVERGENCE  
OF NEW SALMON POPULATIONS**

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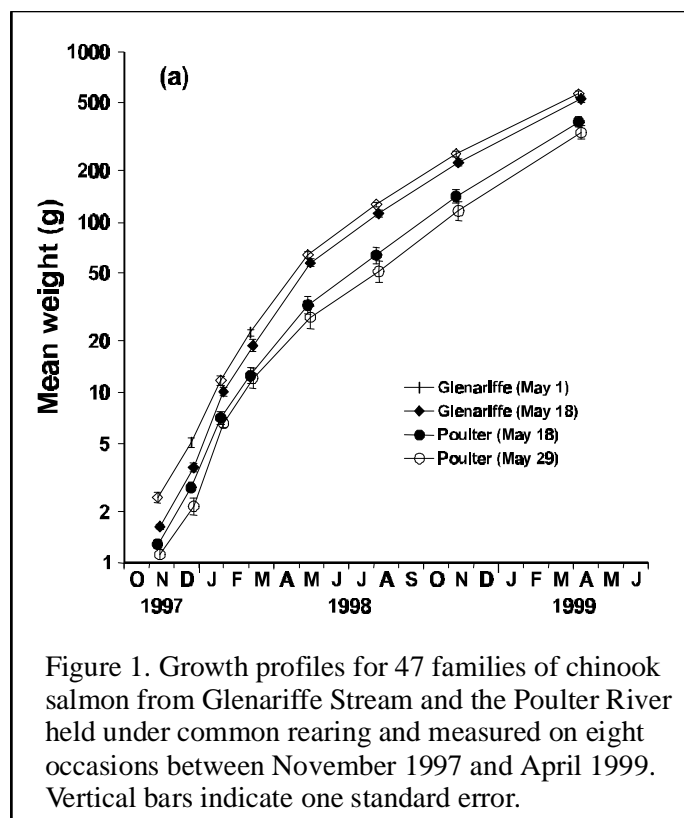
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**EXTENDED ABSTRACT ONLY – DO NOT CITE**

Studies in the past few decades have demonstrated the potential for life history evolution to occur on contemporary time scales in fishes and other animals (see Hendry and Kinnison 1999 for review), though few studies have documented such divergence under relatively natural conditions of colonization and continued gene flow. We suggest that among the traits initially contributing to divergence are characters, such as growth rate, that are pivotal to early phenotypic divergence through their wide ranging interactions with environment, development and other characters. Here, we demonstrate recent genetic divergence in growth patterns among new populations of salmon and discuss the implications of this evolution to broader divergence in their overall life history patterns.

In order to assess genetic divergence, we compared juvenile growth patterns under common rearing for two New Zealand populations of chinook salmon (*Oncorhynchus tshawytscha*), the Glenariffe Stream and Poulter River populations. These two populations were formed by straying following initial introduction of the species to another river system in the early 1900s, and other studies indicate that some gene flow persists among rivers (e.g., Quinn et al., 1996). In the wild, peak spawning in the Poulter River occurs 2-3 weeks later than in Glenariffe Stream, and scale patterns indicate that the majority of Poulter salmon migrate to sea after spending a full year in freshwater (i.e., “stream-type”), whereas the majority of Glenariffe fish migrate to sea in their first year



(i.e., “ocean-type”). Differences in spawning date and subsequent hatching and emergence times, may have significant implications for subsequent growth

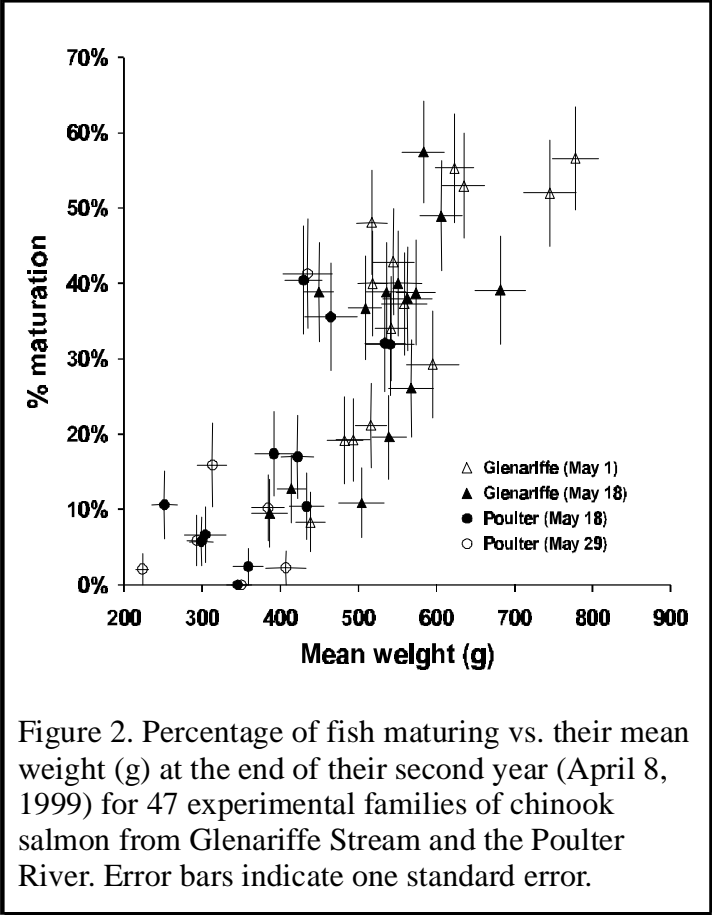
opportunities (in the wild or hatchery). Thus, in addition to comparing growth patterns for fish spawned on a common date, we also quantified the influence of spawning time on growth within populations.

We established four groups of full-sib families of Glenariffe or Poulter origin in May (autumn) 1997. The four groups corresponded to peak spawning in Glenariffe Stream (1 May – 14 families), late spawning in Glenariffe Stream and peak spawning in the Poulter River (18 May – 14 families for each population), and late spawning in the Poulter River (29 May - 7 families). Egg size was recorded for each family and they were in turn incubated, hatched and reared through two years under shared conditions. Over this period we quantified time to hatching, mean family weight on eight dates and the incidence of male maturation at two years of age. Rearing and trait measurements were similar to those of Kinnison et al. (1998a, b).

Neither egg size nor time to hatch differed between the two populations, but substantial differences in mean family weight were apparent 6 months after fertilization, and persisted throughout the study (Figure 1). Differences in growth rates from 12 to 24 months were observed but were relatively small, suggesting that most of the divergence in size and growth occurred during the first six months of life, though a growth rate inversion occurred in the second year resulting in slightly higher growth rates of Poulter fish. We also observed differences in mean weight for the same population spawned 11 to 17 days apart, but these did not persist beyond 7 months.

Slower growth in the population with more post-yearling migrants is consistent with life history patterns for “stream-“ and “ocean-type” chinook populations in their natural range (Taylor, 1990). This pattern also fits with expectations for selection on growth rate when 1) appreciated growth determines whether individuals smolt (Thorpe, 1989), and 2) subsequent survival is size or timing dependent (e.g., salinity tolerance: Kinnison et al., 1998b). For example, in a growth-limited environment genetically fast-growing fish may smolt in their first year but have low fitness due to their relatively small size, thus favoring genetically slower growing fish that smolt later. Divergence in growth likely contributes to other aspects of divergence among populations due to genetic and developmental correlations. Significantly more Glenariffe males matured at age 2 than Poulter males, consistent with higher growth promoting a higher incidence of maturation within and among experimental groups (Figure 2).

Our results provide evidence of evolutionary divergence in growth patterns between partially isolated salmon populations over c. 30 generations since their initial colonization. We contend that these genetic differences are due to the interaction between genetic and environmental influences on growth potential when development and survival are growth dependent. Divergence in growth also contributes to phenotypic divergence in other characters (e.g., incidence of



juvenile migration types and adult maturation in a given season) and may thus represent a pivotal trait in shaping initial, and perhaps long-term, life history patterns among populations.

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