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Taxonomic Issues, Life History and Stock Discrimination - Rat River Dolly Varden

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Abstract

The populations of northern form Dolly Varden that occur in Arctic Canada (Firth R./Joe Creek, Babbage R., Big Fish R., Rat R., and Vittrekwa R.) represent the only populations of this distinct taxon known to be present in Canada. Thus, these fish are of interest as a unique part of the Canadian fish fauna and care in conservation and management of these populations and their habitats are high priorities. The six populations of the northern form Dolly Varden known to be anadromous appear to represent distinct biological populations or stocks. Studies using both morphology and genetic characters have confirmed the discreteness of fish from four river systems (Firth, Babbage, Big Fish and Rat) as well as indicating that fish from Joe Creek may be distinct from those that spawn in the Firth River (Reist, 1989). Preliminary analysis of stock structure using otolith microchemistry for Firth R./Joe Creek, and Babbage R. confirms the structuring of Dolly Varden populations as determined by other methods (Babaluk et al., 1998; unpublished data). Analyses of mitochondrial DNA supports the distinctness of Rat R. fish from the north slope populations. High diversity observed within the Rat R. stock, is unexpected given diversity found in other systems in the area, and especially in view of the level of exploitation sustained by this population (the typical effects of exploitation are to reduce such variability). This finding suggests that hidden structuring may be present in the Rat R. and is consistent with the suggestion of temporally different spawning stocks.

Résumé

Les populations de la forme nordique de la Dolly Varden retrouvées dans l'Arctique canadien (rivières Firth, Babbage, Big Fish, Rat et Vittrekwa et ruisseau Joe) sont les seules représentantes de ce taxon distinct identifiées au Canada jusqu'à maintenant. Constituant ainsi un élément unique de l'ichtyofaune canadienne, une importance prioritaire doit être accordée à la conservation et à la gestion de ces populations et de leurs habitats. Les six populations de la forme nordique de la Dolly Varden connues comme étant anadromes semblent représenter des populations ou des stocks distincts au plan biologique. Des études reposant sur ces caractéristiques morphologiques et génétiques ont confirmé l'indépendance des Dolly Varden de quatre réseaux hydrographiques (rivières Firth, Babbage, Big Fish et Rat) et indiqué que la Dolly Varden du ruisseau Joe peut être distincte de ses congénères qui frayent dans la rivière Firth (Reist, 1989). Une analyse préliminaire de la structure des stocks faisant appel à la microchimie d'otolithes prélevées chez des Dolly Varden du réseau constitué par la rivière Firth et le ruisseau Joe, ainsi que de la rivière Babbage, a permis de confirmer la structure des populations de l'espèce telle que déterminée par d'autres méthodes (Babaluk et al., 1998; données inédites). Des analyses d'ADN mitochondrial étayent l'Indépendance de la population de la rivière Rat des populations de la pente nord. La forte diversité observée chez le stock de la rivière Rat est inattendue étant donné la diversité retrouvée dans d'autres réseaux de la région, en particulier à la lumière du niveau d'exploitation subi par cette population (l'exploitation a l'incidence typique de réduire une telle variabilité). Ce résultat laisse supposer qu'une structure cachée peut être présente chez la population de la rivière Rat, ce qui est en accord avec la suggestion à l'effet que les stocks frayent à des périodes différentes.

Char west of the Mackenzie River in arctic coastal rivers were originally thought to represent a distinct form (western Arctic-Bering Sea) of Arctic char (*Salvelinus alpinus*) (McPhail, 1961; McCart, 1980). Re-evaluation of taxonomic identity using morphological and genetic criteria confirmed that the char found in high gradient rivers west of the Mackenzie River including the Rat River are in fact Dolly Varden (*Salvelinus malma*) (Reist et al., 1997). The only known populations of Arctic char in this area are dwarfed populations in two land-locked lakes near the Firth River in Ivvavik National Park. Due to the taxonomic confusion, most early literature refers to riverine forms of char in this area as being Arctic char, thus care must be taken to ensure proper species identification has occurred.

For Dolly Varden in North America, two subspecies are formally recognized (Behnke, 1980) – the southern taxon, *Salvelinus malma lordi*, and the northern taxon, *S. m. malma*. These differ with respect to vertebral, gill raker and pyloric caecal counts (Behnke, 1980) as well as karyotypes (Cavender and Kimura, 1989). In addition, genetic characters indicate that the two forms are quite distinct and may have arisen at different times or from different lineages (Phillips et al., 1992). The southern form occurs from the southern drainages of the Alaska Peninsula, throughout coastal British Columbia, south to Washington. The northern form occurs in northern (Bristol Bay) drainages of the Alaska Peninsula north and west along the coast of Alaska to the Yukon north slope and western Mackenzie River delta, although a third form seems to be present in western Alaska (Reist et al., 1997). It is the northern subspecies that is present in the Inuvialuit Settlement Region and the Gwich'in Settlement Area. In addition to the taxonomic characters noted above, the two subspecies differ significantly with respect to their biology, productivity, and related aspects of biology relevant to fishery management. Given these differences, the general transfer of understanding from the southern taxon which is well-studied to the northern taxon which is not is problematic and must be conducted carefully if at all.

The populations of northern form Dolly Varden that occur in Arctic Canada (Firth R./Joe Creek, Babbage R., Big Fish R., Rat R., and Vittrekwa R.) represent the only populations of this distinct taxon known to be present in Canada. Thus, these fish are of interest as a unique part of the Canadian fish fauna and care in conservation and management of these populations and their habitats are high priorities. All of these populations, including that from the Vittrekwa R., exhibit anadromy as determined through life history studies (e.g., weirs, Gillman and Sparling, 1985; Sandstrom et al., 1997) or otolith microchemistry (Babaluk et al., 1998, and unpublished data).

The six populations of the northern form Dolly Varden known to be anadromous appear to represent distinct biological populations or stocks. That is, studies using both morphology and genetic characters (i.e., variable proteins called allozymes) have confirmed the discreteness of fish from four river systems (Firth, Babbage, Big Fish and Rat) as well as indicating that fish from Joe Creek may be distinct from those that spawn in the Firth River (Reist, 1989). Additional genetic information (i.e., sequence variation in mitochondrial DNA) confirms that these populations are all different from each other (Reist, unpublished data). Allozyme studies focussed upon Alaskan populations also indicated that populations were distinct although these only included samples from the Firth and Babbage rivers in Canada (Everett et al., 1997). Life history pattern (Reist, unpublished data), recovery of Floy-tagged fish (McCart, 1980), and genetic studies on coastal fish assemblages from Phillips Bay (Krueger et al., 1999) indicate both that Dolly Varden can migrate long distances, and that mixing of populations from different river

systems occurs along the coast during summer feeding and migrations. Krueger et al. (1999) found that fish from central Alaska, eastern Alaska and two Canadian locations (Firth and Babbage rivers) contributed about equally to the Phillips Bay mixed-stock group. Because this study did not include Dolly Varden from the Big Fish, Rat or Vittrekwa rivers, similar analyses are not possible at this time to estimate the mixing of Dolly Varden from all Canadian populations at various locations along the coast (work is underway at this time to address this issue).

Otolith microchemistry examines minute concentrations of specific elements that are incorporated in the otoliths of fish and substitute for the usual calcium present in the otolith structure. Analysis of otolith strontium concentration when correlated with the age of the fish can be used to confirm life history (i.e., anadromy or not) of particular individuals. In addition, analysis of strontium and other elements laid down in the core of the otolith (i.e., in the egg and while young fish are still in the spawning area) can be used to discriminate stocks. Preliminary analysis of stock structure using otolith microchemistry for Firth R./Joe Creek, and Babbage R. confirms the structuring of Dolly Varden populations as determined by other methods (Babaluk et al., 1998; unpublished data).

Analyses of mitochondrial DNA sequences for samples from the north slope rivers indicated that five different genetic types (labelled haplotypes) were present in the anadromous fish from the Firth, Babbage and Big Fish rivers (n=8-10 fish). Two additional types were present in the residual fish from these rivers (n=4-10 fish). For char from the Rat R. only 32% (n=47) of the fish shared two haplotypes with north slope fish; and, the remainder (68%) possessed types unique to the Rat River. This supports the distinctness of Rat R. fish from the north slope populations. Furthermore, among anadromous fish from the north slope rivers the number of haplotypes present were 4, 2, 3, and 2 respectively for Firth R., Joe Creek, Babbage R., and Big Fish R. For the Rat River, 6 haplotypes were observed in samples taken at the spawning grounds. The high diversity observed within the Rat R. is unexpected given diversity found in other systems in the area, and especially in view of the level of exploitation sustained by this population (the typical effects of exploitation are to reduce such variability). This finding suggests that hidden structuring may be present in the Rat R. and is consistent with the suggestion of temporally different spawning stocks. Further work to confirm this and to examine the genetic relationships of fish from the Vittrekwa R. is necessary.

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