DOES ADULT LIFE HISTORY ACCOUNT FOR VARIOUS PHYSIOLOGICAL/BIOCHEMICAL DIFFERENCES BETWEEN THE NONPARASITIC AMERICAN BROOK LAMPREY (*LAMPETRA APPENDIX*) AND THE PARASITIC SEA LAMPREY (*PETROMYZON MARINUS*)?

John H. Youson
Department of Zoology and the Division of Life Sciences, University of Toronto at Scarborough, Toronto, Ontario, Canada M1C 1A4
Phone 416-287-7397; fax 416-287-7676; youson@utsc.utoronto.ca

EXTENDED ABSTRACT ONLY - DO NOT CITE

The life cycle of lampreys consists of larva, juvenile, and reproductive adult periods. The larva period is comprised of a growth phase and a metamorphic phase with the latter being a time when some larval genes are suppressed and adult genes are expressed. Adult life history is species specific with juveniles of some species immediately entering an interval of feeding (parasitic species) before sexual maturation. In others, juveniles commence sexual maturation almost immediately following the completion of metamorphosis without ever feeding (nonparasitic species). Some extant parasitic and nonparasitic species show a close genetic relationship, for they are likely derivatives of the same parasitic ancestor; they are referred to as paired or satellite species. The present view is that the nonparasitic adult life history is most recent and that it may have been a consequence of natural selection for a protracted larva period (Youson, 2002a).

Juvenile sea lampreys (*Petromyzon marinus*) have parasitized native teleosts in the Great Lakes of North America and are partly responsible for the dramatic decline of sport and commercial fisheries in this watershed. As in other lamprey species, larvae of sea lampreys are filter feeders in freshwater streams and their presence in this watershed is only problematic when they complete their metamorphosis. To inhibit or to redirect the metamorphosis of larvae is one approach to sea lamprey control (Youson, 2002b). The working hypothesis of the present study is that nonparasitic lamprey species contain the clues that will

allow us to redirect sea lamprey adult life history. An investigation that compares the physiological and biochemical requirements of parasitic- with nonparasitic-adult life history could yield these clues. Since sea lampreys are not members of a paired species, the comparison was made with sea lampreys and the American brook lamprey (*Lamptera appendix*). To date, comparisons have been made of the temporal expression of the genes for the pituitary prohormone, proopiomelanocortin (POMC), and the nature and timing of appearance of a leptin-like protein and a serum protein (albumin). The data are discussed in terms of their relevance to variations in adult life history.

POMC is represented as two genes in lampreys, POC (proopiocortin) and POM (proopiomelanotropin), with the former coding primarily for adrenocorticotropin and the latter for mainly melanocyte-stimulating hormone. A 93% and 95% nucleotide identity is shared between POC and POM, respectively, of the two species (Heinig, Keeley, and Youson, unpublished data). Since the sea lamprey and *L. appendix* represent lamprey genera that diverged early, POC and POM genes have had little selective pressure during lamprey evolution. Northern blot analysis of pituitary RNA with species-specific cDNAs of both POC and POM revealed differential expression within species and between species during their life cycles. In both species, maximum levels of POC expression were observed in prespawners, but gene expression in late metamorphosis in *L. appendix* was equivalent to that in juvenile sea lampreys. In general, POM expression was higher during *L. appendix* metamorphosis than in sea lamprey metamorphosis, however, the last stage of *L. appendix* metamorphosis had equivalent POM expression to that of the juvenile sea lamprey. The data from POC and POM expression indicate that elevation coincides with the time of sexual maturation, a process that begins earlier in *L. appendix*.

Metamorphosis in sea lampreys occurs in larvae when they reach a critical size and physiological state (Youson, 2002a,b). Adequate fat stores are an essential physiological requirement and when they are attained, metamorphosis takes place. To see whether the adipose tissue yields a signal (hormone) that is a cue to metamorphosis, a search was made for the existence of a leptin-like protein in the sea lamprey using a leptin antibody (Ob Sc) and Western blotting (Yaghoubian et al., 2001). Comparisons were made with *L. appendix*. A 65 kD protein in the sera of larvae and metamorphic stages of sea lampreys was immunoreactive with an Ob Sc antibody, but sera of spawning-phase sea lampreys and both larva and adult brook lampreys were negative. These data, coupled with the fact that adipose tissue from early metamorphic sea lampreys contains a 16-17 kD protein immunoreactive to the Ob Sc antibody (mammalian leptin is 16 kD), imply that a leptin-like protein may be involved in sea lamprey metamorphosis, but not metamorphosis of *L. appendix*.

Sea lampreys have two different albumin-like serum proteins (AS and SDS-1) during the course of their life cycle. AS is the predominant protein in larvae and metamorphosing individuals but it is eventually replaced by SDS-1 in adult life, with the latter becoming the predominant serum protein in spawning-phase adults. Larvae of *L. appendix* have a serum protein (LAS) that is antigenically similar to AS (Danis et al., 2000). Unlike AS, however, LAS disappears in the serum before the completion of metamorphosis and there is no serum protein in adult *L. appendix* that is antigenically similar to SDS-1 of adult sea lampreys. In fact, there is no major serum protein in adult *L. appendix.* Since albumins are important in most vertebrates for the maintenance of colloid osmotic pressure and the transport of various ligands, this raises questions on how the adult *L. appendix* compensates for the loss of these functions. The relationship between the absence of an albumin-like protein in adults and nontrophism during metamorphosis and adult life in *L. appendix* needs further investigation.

The present report describes differences in three physiological/biochemical parameters during the life cycle of a nonparasitic and a parasitic species. These differences may be related to differences in their adult life histories. There is a need to examine these same parameters in more closely related species, such as in a paired species that have genetic links to a common ancestor.

References

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