GREAT LAKES FISHERY COMMISSION

1990 Project Completion Report[1]

Collection of Lamprey Tissues for Purification of Hormones

by:

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[1]Project completion reports of Commission-sponsored research are made available to the Commission's Cooperators in the interest of rapid dissemination of information that may be useful in Great Lakes fishery management, research, or administration. The reader should be aware that project completion reports have not been through a peer review process and that sponsorship of the project by the Commission does not necessarily imply that the findings or conclusions are endorsed by the Commission.

Also see the following peer-reviewed publication associated with this research:
Sower, S. A. 1990. Neuroendocrine Control of Reproduction in Lampreys. Fish Physiology and Biochemistry 8: 365-374.

FINAL REPORT

TO:	Carlos M. Fetterolf, Jr. Executive Secretary Great Lakes Fishery Commission 1451 Green Road Ann Arbor, Michigan 48105
FROM:	University of New Hampshire Durham, New Hampshire 03824
PROJECT TITLE:	Collection of Lamprey Tissues for Purification of Hormones
PRINCIPAL INVESTIGATOR:	Dr. Stacia A. Sower Department of Zoology University of New Hampshire Durham, New Hampshire 03824
PERIOD OF AWARD:	May, 1990 to October 31, 1990
AMOUNT:	$12,000

FINAL REPORT: Collection of Lamprey Tissues for Purification of Hormones

I. Specific Objectives of the Proposed Research

Our goal of this proposal was to have a major collection of various tissues from lampreys at Hammond Bay Biological Station. Various hormones would then be purified from these tissues for the identification of hormones for future physiological studies on metamorphosis, reproduction, digestion and metabolism in lampreys.

II. SUMMARY

The collection of various tissues from lampreys at HBBS was extremely successful. The collection of tissues from lampreys at Hammond Bay Biological Station provided a unique opportunity for several scientists from around the world to work in a cooperative and collaborative manner during June to July, 1990. The scientists involved in this endeavor included Dr. Stacia Sower and two graduate students (Mary Jane James and Thom Bolduc) of University of New Hampshire, Dr. John Youson of University of Toronto, Dr. Jean Joss of Australia, Dr. Erika Plisetskaya of University of Washington and Dr. Epple of Thomas Jefferson University, Philadelphia. The major tissues that were collected included 16,000 brains and pituitaries, 2000 guts and pancreas, 200 spinal cords and 50 hearts. In addition, there was a two-day workshop on June 9-10 organized by Carlos Fetterolf on "An Endocrinological Approach to Sea Lamprey Control". Twenty people attended this workshop including the Lamprey Collection Team (5 people); HBBS scientists (4 people); 5 scientists from Michigan State University, Northern Michigan University, University of Minnesota and the Winnipeg Freshwater Institute; Gary Klaxr (Marguette Biological Station); Dick Beaver (Ludington Biological Station); Carlos Fetterolf, Randy Eshenroder and Gavin Christy (GLFC-Ann Arbor). There were several presentations by the various researchers on Saturday followed by demonstrations on tissue collection at HBBS on Sunday. In addition, there was a tour at the lamprey trap on the Cheboygan River.

As a result of this collection expedition as well as the workshop, there were a few endocrinological and physiological areas that were identified that could be further researched for alternative methods in the control of sea lampreys in the Great Lakes. Two specific areas included metamorphosis and sterilization of adult male lampreys. Dr. John Youson (Canada) as a result from this summer's collection, has submitted a grant in Aug. 1990 to the GLFC entitled "Hormonal and environmental cues in metamorphosis of *Petromyzon marinus*". This grant is a collaborative study among several scientists to examine the basis for metamorphosis followed by examination of various control methods using techniques in endocrinology, biochemistry, physiological ecology, developmental biology and limnology. Another proposed method for control of sea lampreys is the use of lamprey GnRH analogs for use as sterilants in adult male lampreys. During the past few years, my laboratory has made substantial and significant progress in understanding the neuroendocrine control of reproduction in lampreys. These studies have indicated a potential method for control of sea lampreys by sterilization of male sea lampreys using a lamprey GnRH analog (antagonist). Further studies are required to identify the most effective GnRH antagonist as use for a sterilant. The advantages of using these analogs include a very inexpensive compound and that they would be non-toxic to humans.

III. Presence of endogenous opiates in the sea lamprey (report from Dr. August Epple)

Sea Lampreys have cardiovascular chromaffin cells which are located under the endothelium of the heart and larger blood vessels. These chromaffin cells are the equivalent of the adrenal medulla and related tissues (paraganglia and arterial "bodies") of higher vertebrates, and they respond to stress with the release of three catecholamine hormones: dopamine (DA), norepinephrine (NE) and epinephrine (E). As in some prenatal mammals, the specific stimuli (CO_2, pH) are blood-borne.In contrast to higher vertebrates, however, the chromaffin cells are non-innervated, and they are organized into a unique system that is under the control of specific epinephrine-producing cells . The latter are concentrated in the affluent regions of the heart., which is the ideal checkpoint for the composition of the returning systemic blood. Upon increasing CO_2 or decreasing pH concentrations in the blood, they release E, which (a) acts on the heart muscle , and (b) causes the release of NE and DA from other chromaffin cells. NE and DA act then locally on the blood vessels. In addition, findings in the Australian lamprey suggest that NE also increases the respiration rate.

Recent work in higher vertebrates, including the eel (*Anguilla rostrata*) has shown that the chromaffin cells produce, in addition to the catecholamines, also opioid peptides (enkephalins) and true opiates (codeine and morphine). The function of these substances is unknown, though some data suggest that they may be involved in the regulation of the catecholamine release from chromaffin cells. On the other hand, they may serve to "inform" the brain of the activity of the chromaffin cells.

The absence of innervation makes the chromaffin cell system of the lamprey an ideal model for basic studies on the function of the prenatal chromaffin system of mammals, and for work on the roles and interactions of enkephalins and opiates.

The purpose was to collect material to establish the presence of opiates in the lamprey chromaffin cells, and thus lay foundations for future work on the functions of these substances. The available data from other vertebrate and invertebrate species make it likely that we will succeed in confirming the presence of the opiates in the lamprey.

From a practical point of view, it may be very interesting to see how the opiates function during stress responses, and if analogs of these substances can be used to interfere with the reproductive behavior of adult lampreys .

IV. Publications

As indicated in the grant, the various tissues from this summer will be processed in the scientists' laboratories which will take a few months to 2 years for completion. As the researchers' complete the purification and physiological studies on the hormones, the authors will acknowledge the support from the Great Lakes Fishery Commission and the publications will be forwarded to the Commission.