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PHENOTYPIC VARIATION IN THE LAKE WHITEFISH AS INDUCED BY INTRODUCTION INTO A NEW ENVIRONMENT

by

JOHN S. LOCH

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ABSTRACT

Morphometric and biochemical traits of a transplanted and parent population of lake whitefish are compared. Body proportion measurements were compared using analysis of covariance; meristic traits were compared using Student's 't' test and the Mann Whitney U test. Factor analysis was used whereby all morphometric traits could be compared by the same statistical method; location and sex were used as additional variables.

Most morphological traits differed, notably gillraker length. Gillraker length was correlated with percentage benthic food eaten. Abrasion of the gillraker is offered as an explanation. Electrophoretic phenotype frequencies for isozymes of L-glycerol-3-phosphate dehydrogenase differed between the parent and transplanted populations.

The morphometric differences could be due either to genetic differences or environmental effects or a combination of the two.

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INTRODUCTION

The whitefishes, family Coregonidae, are infamous for their taxonomic problems due to the immense variation shown within various member 'species', especially the "*Coregonus clupeaformis* complex" and the "*Coregonus artedi* complex" (McPhail and Lindsey, 1970). This variation can be attributed partly to the phenotypic plasticity of the group (Dymond, 1943; Svardson, 1950) and partly to the complex geologic history of the northern temperate areas they inhabit (Lindsey *et al.*, 1970).

A recent transplantation of the Lake Whitefish, *Coregonus clupeaformis* (Mitchill) from Clearwater Lake, Manitoba, to Lyons Lake, Manitoba, has provided an excellent opportunity to study, in a natural situation, the range of phenotypic changes that can be induced by the environment. This plasticity is investigated through a morphological and biochemical comparison of the two populations. These comparisons are intended to locate conservative traits useful in defining the species.

DESCRIPTION OF STUDY AREAS

Clearwater Lake (Atikameg) lies just off the edge of the Precambrian shield, thirty-two kilometres (20 mi.) north of the town of The Pas, Manitoba. The lake is part of the Saskatchewan River drainage system.

Lyons Lake lies on the edge of the Precambrian shield two kilometres west of the Ontario border on the Trans Canada Highway. It is a headwater lake, receiving no permanent inflow of water; Lyons drains northerly into Hunt Lake by a stream 1 km. long with an overall gradient of approximately one metre. Hunt Lake is tributary to West Hawk Lake by a shallow, short (30 metres) stream with a 20% grade. The entire area is part of the larger Winnipeg River drainage system.

In addition to whitefish, the Lyons Lake fish fauna is comprised of the introduced splake (*Salvelinus fontinalis* x *Salvelinus namaycush*), yellow perch (*Perca fluviatilis*), the northern pearl dace (*Semotilus margarita*), and an unknown type of darter.

Lyons Lake and Hunt Lake were poisoned with rotenone in June, 1952 and June, 1954 respectively. Both lakes were repoisoned in 1959 as the original poisoning was incomplete. In 1960, seven thousand whitefish were transferred from the Whiteshell Trout Hatchery to Lyons

Lake. These fry were offspring of Clearwater Lake whitefish whose fertilized eggs had been transferred to the hatchery for over-winter rearing.

A fine steel grate was placed in the outflow of Hunt Lake in 1959 to prevent entry of fish from West Hawk Lake (which has a natural whitefish population). Two yearling whitefish which were taken in Hunt Lake in 1961 are considered to be strays from Lyons as yearling whitefish of similar size were taken in Lyons at the same time. There are no other records of whitefish in Hunt Lake. Therefore, whitefish from Lyons Lake are considered to be all of Clearwater Lake whitefish ancestry.

In conclusion, since whitefish have been planted in Lyons Lake only once, in 1960, and since six years appears to be the maximum lifespan of whitefish in Lyons Lake, yearling whitefish which were captured in 1970 can be regarded as evidence that a self-reproducing population of at least three generations has been established.

METHODS AND MATERIALS

The two populations were sampled as outlined in Table 1. Limnological data were collected at the same time.

Plankton samples were taken using a No. 10 Wisconsin type plankton net at the deepest known point on each lake. One vertical tow was taken at each sampling time. The bottom fauna was sampled using a six-inch Ekman dredge. All macroscopic organisms were removed and preserved in 40% isopropyl alcohol for identification and quantitative study. The sampling scheme involved a randon stratified sampling method: the lakes were divided into strata (Lyons: 0-5 m., 6-10 m., 11+ m.; Clearwater: 0-10 m., 11-20 m., 21+ m.) and random samples were taken within each stratum. The number of samples for each stratum was determined by considering the percentage area of the lake that stratum occupied and the density of benthic fauna in each stratum as determined by a preliminary survey. The overall estimate of the population of each organism was determined after Snedecor *et al.* (1967:520). Weights of 'benthic' and 'pelagic' forms were taken, each sample being blotted 'dry' before weighing to remove excess fluid.

Fork length, weight and sex of the whitefish were recorded at the time of capture; scales for age determination

TABLE 1.

OUTLINE OF SAMPLING FOR WHITEFISH IN LYONS LAKE AND CLEARWATER LAKE

Date	Lake	No. Fish	Size Interval (cm.)	Fishing Gear	Net Size[a] and No. Units	Stretched Mesh Size (mm.)
21/05/70	Lyons	71	23 - 40	monofilament gill net	1(8x15m.)	25,38,50,63,75
14/06/70	Clearwater	38	23 - 45	monofilament gill net	1(8x15m.)	25,38,50,63,75
21/07/70	Lyons	45	32 - 42	monofilament gill net	1(8x15m.)	38,63,75
04/08/70	Clearwater	40	30 - 53	cotton gill net	1(3x90m.)	75,93,106,119,13
05/08/70	Clearwater	28	24 - 42	monofilament gill net	1(8x15m.)	63,38,38,75
11/08/70	Lyons	24	28 - 43	monofilament gill net	2(8x15m.)	25
24/10/70	Clearwater	175	32 - 47	pound net		50
03/11/70	Lyons	118	26 - 42	monofilament gill net	4(2x8m.)	19,38,50,63,75

[a] Dimensions of each net (depth x length)

were removed from the dorso-lateral surface of the fish directly below the dorsal fin above the lateral line; the entire stomach was removed by severing the esophagus and pylorus and then was placed in 10% formalin. Fish were preserved in 10% formalin and then later transferred to 40% isopropyl alcohol.

Stomach contents were divided after Kliewer (1970) into two general categories: 'benthic' (those organisms that are almost exclusively benthic) and 'pelagic' (those organisms that are partially or totally pelagic). That portion of the 'pelagic' category which comprised pelagic Cladocerans and Copepods was recognized as a third category, 'Crustacean'. Percent settled volume was used as a measure of quantity. No separation of stomach contents on a basis of particle size was performed. Only the May and July (Lyons) and June and August (Clearwater) samples were analyzed.

Age determinations from scales were done by the author following standard techniques (Lagler, 1956). Regressions of fork length on scale radius were made for Lyons and Clearwater regardless of sex using the Lee method (Lagler, 1956). The expected fork lengths for the 1965 year class were calculated from the average annuli. These fork lengths were plotted against age for the two lakes as an approximate measure of growth rate.

The length-weight relationship was investigated by regression of log weight on log fork length using natural logarithms. Weights and lengths were those determined at time of capture, rather than after preservation. All values from the June, July and August samples were used in the calculation of the regressions. The two regressions were compared by analysis of covariance (Snedec or *et al.*, 1967; Appendix II). Possible sexual dimorphism was investigated by comparing sexes within lakes, then treating the analyses by lake if there were no differences between sexes or treating by sex, if there were differences.

The following measurements were made on preserved specimens from the July and August samples according to Hubbs and Lagler (1964): caudal peduncle depth (CPDEP), dorsal fin length (DORSL), anal fin length (ANALL), pectoral fin length (PECTL), ventral fin length (VENTL), adipose fin height (ADIPH), head length (HEADL), snout length (SNLEN), postorbital (POSTO), upper jaw (UPJAW), and occipital width (OCCWD); the measurements for snout to occipital distance (SNOCC), dorsal to adipose distance (DLADP), adipose to caudal distance (ADPCL), pectoral to ventral distance (PECVL), and ventral to anal distance (VLANL) were made after Koelz (1929); the measurements for fork length (FORKL), and pectoral origin (SNPEC) were made following Lindsey (1963); interorbital width (IORWD) and occipital depth (OCCDP) were taken from