University of Manitoba

FOOD HABITS, GASTRIC DIGESTION AND FOOD CONSUMPTION RATES OF YELLOW PERCH, *Perca fluviatilis flavescens* (MITCHILL), IN WEST BLUE LAKE, MANITOBA

by

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ABSTRACT

Food habits and rates of digestion and food consumption were determined for yellow perch in West Blue Lake, Manitoba during the spring and summer of 1969 and 1970. Perch were diurnal in both swimming and feeding activity. Composition and amount of food eaten by perch varied with time of day, season and size of fish. The greatest feeding activity generally occurred during mid-morning and early evening. Chaoborus sp pupae and cladocerans tended to be eaten in early morning and late evening while benthic organisms and fishes were eaten throughout the day. Seasonally, major components of the diet of adult perch were amphipods and immature aquatic insects in spring and early summer with fishes and crayfish predominating in late summer. For juvenile perch, cladocerans and amphipods were eaten in early and late summer with amphipods and fishes predominating in mid-summer. Weight of stomach contents increased with fish weight but not in a direct proportion. Cladocerans decreased in importance in the diet with increasing fish size while fishes and crayfish increased. Of the two species of amphipods in West Blue Lake, Gammarus lacustris tended to be eaten by adult perch while Hyalella azteca were eaten by juvenile perch.

The times to 95% digestion for amphipods, sticklebacks and crayfish were estimated to be 10.5 (11.5 - 16.0 C), 36 (15 C) and 56 (20 C) hrs, respectively, by adult perch. For

juvenile perch the times were calculated to be 32 (15 C), 38 (20 C) and 72 (13 C) hr respectively. Digestion rates were related to size and structure of the food items and water temperature.

A method was devised to estimate average daily food consumption for juvenile perch from knowledge of their diurnal feeding patterns and gastric digestion rates. Estimates were 2.7, 3.5, 3.1 to 3.6% of body weight (wet weight) for June, July, August and September of 1970 respectively. Changes in these values corresponded with the mean monthly degree of stomach fulness and were independent of daylength and temperature. Comparisons of calculated calorific intake to estimated metabolic expenditures verified that there was sufficient energy available for growth and reproduction.

Amphipods formed the basic food item for perch in West Blue Lake. Cladocerans, immature dipterans, crayfish and fishes were of secondary importance while insects other than dipterans were of minor importance. Perch were classified as both secondary and tertiary consumers deriving approximately equal portions of their diet by weight from benthic and pelagic organisms (primary consumers) as well as from fishes (secondary consumers).

INTRODUCTION

Many studies, frequently with different purposes, have been carried out on the kinds and amount of food eaten by yellow perch. Some describe the food organisms present in stomachs collected at a particular time (Nurnberger, 1930; Ewers, 1934), but often food habits related to size (Allen, 1935), season (Langford and Martin, 1940) or time of day (Keast and Welsh, 1968) have been investigated. Others describe, feeding relative to food availability (Keast, 1965) and food selection (Galbraith, 1967) or interspecific competition (Dunn, 1954).

The purpose of the present study is to describe and quantify the food and feeding habits of yellow perch in West Blue Lake, where the ultimate research objective is to describe in quantitative terms, energy exchanges and pathways in this aquatic ecosystem. Initial stages of this project require knowledge of plant and animal communities within the system and their relative importance in the flow of energy through the various pathways.

In this study, I examined the food organisms in the diet of juvenile and adult perch during the spring and summer of 1969 and 1970 relative to time of day, season and fish size. In addition, I studied gastric digestion rates of natural food organisms and estimated average daily food consumption.

LITERATURE REVIEW

Pandian (1967) described food consumption, digestion, absorption and conversion as successive steps involved in the transformation of food into animal tissue. Gerking (1962) emphasized the importance of knowledge concerning the food habits of fishes in determining fish production and food utilization. In this review, only literature pertaining to the underlying principles, methods of study and factors influencing food and feeding habits, food consumption and digestion by fishes are presented with reference to yellow perch when possible. First a brief review of the biology of yellow perch is given.

Biology of the Yellow Perch

The yellow perch, Perca fluviatilis flavescens (Mitchill) Percidae, has a terminal mouth, two separate dorsal fins, a compressed green and yellow fusiform body with six to eight dark, vertical bars (McPhail and Lindsey, 1970). It is distributed throughout temperate North America where its range extends from the Lesser Slave Lake and Hudson Bay drainages, east to New Brunswick, south to South Carolina and west to Kansas. It has also been successfully introduced into many other areas. In northern Asia and Europe the yellow perch is classified as P. f. fluviatilis and is morphologically similar to the North American form. The yellow perch is essentially a lake fish, but may also inhabit slow moving rivers,

creeks and ditches. They are most numerous in open and moderate to highly fertile lakes.

Life History - Perch spawn in spring, the exact time depending largely on water temperature. Shoreward migration occurs after ice break-up, usually in April or May, at water temperatures from 2.2 to 6.8 C (Muncy, 1962). Spawning takes place at temperatures from 7 to 10 C in depths of 1 to 3 m on sand, gravel or vegetation where the eggs are laid in long gelatinous ribbons (Herman et al, 1959). Males often out number the females on the spawning grounds and are first to arrive and last to leave (Alm, 1954). On the average, females deposit 23,000 eggs with the number depending on size and condition of the fish (Sheri and Power, 1969).

The development time is usually from 8 to 10 days but depends on water temperature (Herman et al, 1959). The time between initial spawning and hatching was approximately 24 days (Echo, 1954). Houde (1969) has shown that fry are pelagic from the time of hatching while Maloney and Johnson (1957) showed that fry remained in the shallows periodically before becoming pelagic. In this period, fry tend to be evenly distributed throughout the surface layers of the lake (Faber, 1967). In mid-summer they move to the littoral regions and remain closely associated with the shore until later years when they inhabit deeper regions of a lake (Eschmeyer, 1938).

Alm (1946), on the basis of work done by Walter (1934)

and Roper (1936) distinguished three coexisting forms of perch. One frequenting vegetation close to shore and feeding on littoral organisms had a compressed body shape and vivid coloration. Another, a piscivorous form, lived in deep water, was more fusiform and had a dull coloration. The third form, living near the surface, was also dull in color but ate both fish and plankton. These three forms had different growth rates.

Migration - Yellow perch exhibit well marked seasonal and daily migrations which may vary between lakes or between locations within a lake. During ice-cover perch inhabit the mid-water regions, moving slowly in loosely associated schools (Hergenrader and Hasler, 1966). In early spring there is an inshore spawning migration which corresponds to an increase of water temperature and maturation of the gonads in adult perch (Allen, 1935). Soon after spawning, perch move into deeper water until the formation of a thermocline (Maloney, 1969). Throughout the summer perch tend to remain in the region above the thermocline with an average thermal distribution of 21 C (Ferguson, 1958). Horak and Tanner (1964) found that the depth distribution of perch increased over the summer but was not correlated with temperature. Their swimming speed increases with water temperature up to 20-25 C, and then decreases (Hergenrader and Hasler, 1967-a). They aggregate in tighter schools (Hergenrader and Hasler, 1967-b) at higher temperatures.

Perch undertake daily migrations which are probably related to feeding behaviour (Evermann and Clark, 1920), but whether these migrations are a direct or indirect response is not clear. Hasler and Bardach (1949) observed that perch in Lake Mendota migrated inshore and then parellel to shore at the six m contour from 40 to 60 min before sunset. A less clear-cut migration was observed after sunrise. Hasler and Villemonte (1953) noted that schools of perch broke up at sunset and settled to the bottom where they remained motionless. At sunrise they rose from the bottom and moved into deeper water. Scott (1955) has shown that migration patterns of perch are complicated by the presence of migratory and non-migratory young perch as well as older migratory perch, each exhibiting differences in behaviour. The diurnal activity of perch is generally bimodal with either the greatest activity at sunrise (Sieh and Parsons, 1950) or sunset (Brown and Rosen, 1957). However, Carlander and Cleary (1949) showed perch to be most active in the afternoon and early evening. In general, there is a sunrise peak in activity which tapers off and an abrupt evening peak. However, numbers caught reflect both activity and local perch abundance (Scott, 1955). Spencer (1939), by laboratory experiments, showed that perch were active only during the day and exhibit sporadic activity. Bardach (1955) has shown that the depth at which they are located during the day and the extent of the migration both depend on the depth of the

thermocline. Alabaster and Robertson (1961) demonstrated that a combination of dissolved oxygen, temperature and light influence their diurnal activity. Under the ice, perch undergo diel vertical movements with a mid-afternoon peak in activity (Hergenrader and Hasler, 1966).

Food and Feeding Habits - Pearse and Achtengerg (1920) described the yellow perch as a versatile feeder. Feeding usually takes place on or near the bottom but has also been reported to feed in mid-water (Keast and Webb, 1966), and on occasion at the surface (Coots, 1956). With their sharp, backward-directed teeth, perch are efficient predators, but their slender gill rakers also enable them to filter small organisms such as zooplankton. Turner (1920) described young perch as generalized feeders since they are limited to small food organisms.

Variations in available food organisms in different parts of its range make compilation of a dietary list difficult. However, certain generalizations may be made. Size of perch is a major factor in determining feeding habits in a given habitat. Nurnberger (1930) reported that the food of perch from 17-50 mm was largely zooplankton; while those from 50-100 mm fed on insects, and those from 100-390 mm fed on fish and crayfish. Allen (1935) found a gradual transition in diet as perch became older. Perch less than 165 mm fed on zooplankton, those from 115-190 mm fed on bottom organisms and those greater than 165 mm fed on fish. Turner (1920), Tharratt (1959) and Antosiak (1963) had similar results with

local variations. Diet of young-of-the-year perch is predominately zooplankton (Pycha and Smith, 1954; Maloney and Johnson, 1957). Greatest variation occurs in adult perch where the various dominant food organisms were crayfish (Eschmeyer, 1937; Harlan and Speaker, 1951), Entomostraca (Pearse and Achtenburg, 1920), fish (McCormack, 1970). Cannibalism is also very common in larger fish (Coots, 1956). Allen (1935) found that larger fish had a greater percentage of empty stomachs.

Seasonal changes in food habits of perch were largely influenced by changes in food abundance and the regions inhabited (Pearse and Achtenburg, 1920). Greatest stomach volumes were found in early spring, and smallest in winter (Seaburg and Moyle, 1964). Fisk (1953) reported insects to be dominant in winter and spring, with fish dominant in summer and autumn. In constrast, McCormack (1970) found amphipods to be the dominant food in spring, plankton and fish in summer, and plankton in fall. Feeding of perch in winter is less diversified and cannibalism increases (Antosiac, 1963). Moffet and Hunt (1945) found that the volume of stomach contents were small in winter with zooplankton, immature insects and fish being the major items in the diet. In addition, the frequency of empty stomachs was higher in the winter (Allen, 1935). Pearse (1918) reported that perch were active winter feeders, but feeding was suspended to spawning.

Keast and Welsh (1968) showed that perch had a diurnal feeding pattern with two peaks, each coinciding with activity.

Stomach weight was greatest during the evening peak and the same food organisms were ingested all day. Keast and Welsh (1968) and Muncy (1962) found that the frequency of empty stomachs was greatest at night.

Sexual differences in feeding behaviour between sexes of mature perch have been observed by Tharratt (1959) and Eschmeyer (1938) due to differences in distribution caused by temperature preferences. Males fed on the bottom and females in open water.

Local variations of substrate and vegetation may influence the food habits of perch. Turner (1920) found differences in stomach contents between stations, whereas Ewers (1934) found little variation. Pearse and Achtenburg (1920) described differences in food habits related to depth and diurnal variations in catches which indicated feeding in deep water prior to an onshore feeding migration.

Feeding Habits of Fishes

Feeding is a basic function of an organism since through ingested food, energy is provided to respire, grow and reproduce (Nikolsky, 1963). One studies food habits of fish species to understand the qualitative and quantitative connection between fish and their food organisms. The type of feeding varies among species making generalizations difficult. However, fish can generally be grouped into herbivorous, detritophagus and carnivorous feeders with each species adapted to feed on a particular food or a variety of foods by its