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THE EFFECT OF TEMPERATURE ON LARVAL FISHES

by

J. H. S. BLAXTER

(Scottish Marine Biological Association, Dunstaffnage Marine Laboratory, P.O. Box 3, Oban, Argyll PA34 4AD, Scotland)

ABSTRACT

The influence of temperature on fish eggs and larvae is briefly described from an autecological viewpoint. Temperature may have lethal or sub-lethal effects as well as pacing metabolism, other physiological responses and behaviour. It influences body size, growth, differentiation of muscle and meristic characters. Increase of temperature, as would occur with global warming, will change the timing of ecological events such as the spring plankton outburst so influencing the match or mismatch of larvae with their food supply and their predators.

KEY WORDS: temperature, larval fish.

INTRODUCTION

The prospects of global warming over the next decades have re-awakened the interest of physiologists in temperature in the hope of predicting what effect a rise of temperature of a few degrees Celsius might have on the biotope. Aquatic poikilothermal animals, especially in large lakes or in the sea, are buffered against short-term and even seasonal changes of temperature and are consequently more stenothermal - and therefore potentially more vulnerable - than their terrestrial counterparts.

Estimates of the extent of global warming are very variable because the meteorological models are crude. It seems likely, however, that average air temperatures will rise more in higher latitudes than nearer the equator; by the year 2050 the estimates range from 1.5 deg C to 3.5 deg C, this range increasing the further the predictions of the present models are projected into the future (D.O.E., 1989).

Some of the earlier work on temperature was done by physiologists interested in relating its immediate effect to rates of biochemical reactions and diffusion as well as more complex biological processes. These include development, muscle contraction, nerve conduction and locomotor performance, and the mechanisms underlying tolerance to high and low temperatures. The eggs and larvae of fishes are of particular interest because it is generally held that younger stages are more susceptible to potentially harmful environmental effects than

older individuals, and because they are so important for the recruitment of new fish into the population.

Within the constraints of the limited space available it is proposed to list the effects of temperature on the autecology of fish eggs and larvae and then to discuss the available information in terms of larval ecology. Following FRY (1947), temperature effects on the early life stages of fish may be divided into five categories:

Lethal – destroying organisms, including sub-lethal, less drastic effects,
Controlling – pacing metabolism, other physiological responses and behaviour,
Directing – stimulating orientation responses,
Limiting – restricting activity and distribution,
Masking – interacting with other environmental factors.

Since nothing is known about limiting and masking effects of temperature on the young stages of fishes, this account will deal, in turn, with the first three categories.

LETHAL EFFECTS

Underlying the normal (presumably genetically based) lethal temperature limits of a species there is an optimum range, which may change seasonally and within which the species normally resides. In large bodies of water it is not common to hear of cases of temperature-induced mortality. In the exceptionally cold winter of 1963, however, there was evidence of a high mortality of fish in the southern North Sea (WOODHEAD, 1964a,b).

Experiments show that the lethal temperature depends on:

(a) the previous temperature 'history' of the organism (*i.e.* the acclimation temperature),
(b) the time of exposure to the test temperature,
(c) the rate at which the test temperature is applied,
(d) the presence of other harmful or beneficial factors such as salinity, oxygen level or pollutants.

Three simple examples of lethal temperature experiments are shown in fig. 1 for herring, menhaden and *Bairdiella* using the LC_{50} criterion - the temperature causing 50% mortality after exposure for 24 h. For the herring both upper and lower LC_{50}s were established but in all three species the effect of acclimation temperature was tested, showing, as expected, higher lethal temperatures at higher acclimation temperatures and lower lethal temperature at lower acclimation temperatures. The herring is a temperate marine clupeoid, the menhaden is a temperate marine clupeoid from more southern latitudes with the