OXYGEN CONSUMPTION IN THE WORM EEL
MORINGUA LINEARIS (GRAY) IN RELATION TO SIZE AND SALINITY

BY A. SUBRAMANIAN

(U.G.C. Centre for Advanced Study and Research in Marine Biology, Porto Novo)

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ABSTRACT

Oxygen consumption in relation to weight and in relation to salinity was investigated in Moringua linearis.

For all sizes investigated oxygen consumption was minimum in 18.8% salinity and increased in higher as well as in lower salinities investigated.

The changes in metabolic rate in relation to salinity are ascribable to osmotic stress.

INTRODUCTION

In estuaries and backwaters, salinity as an ecological factor assumes greater importance than in other aquatic environments. The functional properties of animals in estuaries require constant adjustments to the continually changing salinity in the external medium. Generally speaking, animals living in brackish water and estuaries show greater salinity tolerance than animals inhabiting sea and freshwater.

It is generally known that in many euryhaline animals oxygen consumption is related to salinity. To be able to live indefinitely in a brackish-water environment, animals should be capable of either osmoregulation or of tolerating wide changes in the concentration of the body fluids.

There is a fairly extensive literature on the relation between metabolism and salinity in brackish-water animals. But there is little information regarding oxygen consumption in fishes in relation to salinity. Busnel et al. (1946) found that the salinity of the external medium is a second factor influencing respiration in the fry and alevins of the rainbow trout. However, Gordon et al. (1965) found that oxygen consumption was unaffected
by salinity in *Periophthalmus sobrinus*. There is need for carefully conducted experiments on oxygen consumption in brackish-water animals. The present study is on respiration in relation to salinity and also to size in the small worm eel, *Moringua linearis*, inhabiting estuarine mud-flats.

**Material and Methods**

The salinity in the habitat of eel shows a wide range of variation being as low as 0.5% during flood, and going up to 29.0% at other times during high water. The specimens were maintained in the laboratory in aquaria containing water collected from the natural habitat. The salinity of this water at the time of collection was 18.8%. The eels were directly transferred from the medium in which they were brought and allowed to remain for 30 minutes in the new medium to minimise the effect of handling before experiments were started. The experimental duration in each case was one hour. Thirteen specimens of different sizes were taken and respiratory measurements were carried out by Winkler’s method. The respiration of each of these specimens was estimated in water samples of five different salinities, viz., 32.2%, 24.6%, 18.8%, 9.7% and 1.8%. The water samples of above salinities were collected from the sea and Vellar estuary and stored in carboys. For each set of experiments oxygen content of water was kept constant by aeration. All experiments were carried out at 30°C. Analysis of covariance was carried out and the level of significance determined for the data on the relation of the respiratory rate to body size.

**Observations**

The observations are shown graphically. In one series (Fig. 1) the metabolic rate of fish in relation to size is shown for different salinities by plotting the logarithm of rate of respiration against the logarithm of its body weight. It will be observed that the slope of the regression line for oxygen consumption in relation to weight varies in different salinities. In a salinity of 18.8% it is 0.86. The slope increases in both lower and higher salinities. This would mean that the rate of change of metabolism in relation to that of weight is greater in salinities higher as well as lower than in 18.8%.

Fig. 2 shows the relation of oxygen consumption plotted against salinity for different weights of the fish. It will be seen that absolute oxygen consumption is generally lower in 18.8% than in higher and lower salinities except in F & K where the higher salinity does not have the same effect as in other instances. The graph is on an arithmetic scale and intended only
Oxygen Consumption in M. linearis (Gray) in Size and Salinity

Fig. 1. Rate of oxygen consumption in relation to increase in weight in different salinities.

Fig. 2. Oxygen consumption per unit weight in different salinities— for different sizes.
to show the trend of influence of each salinity on different sizes and does not seek to establish a quantitative relationship. The effect of salinity on absolute oxygen consumption is similar for the different sizes though not quite uniform.

Covariance analysis of the data for the effect of different salinities on the metabolism was carried out and found to be significant at 1% level.

**Discussion**

Animals in a variable brackish-water environment are able to live indefinitely either because they can regulate the concentration of their blood independently of the environment, *i.e.*, they can osmoregulate, or because they can tolerate large changes in the concentration of the body fluid. *Moringua linearis* can osmoregulate as my investigations (unpublished) have shown. The changes in total osmoconcentration cause increase or decrease in metabolic rate.

The metabolic rate of fish in relation to size gives a straight line when the logarithm of the rate of respiration is plotted against the logarithm of body weight. For most species for which data are available (Fry, 1957), the slopes relating the logarithm of the rate of metabolism to the log of body weight are of the order of 0.85 (Job, 1955). The data for *Moringua linearis* gives a slope of 0.86, in a salinity of 18.8%, which may be considered as the normally tolerated salinity. This was the salinity of the natural habitat where the animal was collected. However, in the natural habitat, the annual range of variation in salinity is between 0.5% to 29.0% as stated earlier. Salinities beyond the normal modify the relationship between metabolic rate and weight.

The relation between the increase in weight and the rate of metabolism varies in different salinities. To put it in another way, the slope of the regression line shows that in different salinities the rate of increase of oxygen consumption in relation to increase in weight is modified.

Kinne (1964) has shown that papers which report carefully registered responses to reasonable stress situation reveal that metabolic rates may be (a) higher in sub-normal salinities and lower in supra-normal salinities, (b) higher in both sub- and supra-normal salinities, (c) lower both in sub- and supra-normal salinities, or (d) essentially unaffected. The present instance, *i.e.*, *Moringua linearis*, comes under category (b), the metabolism being higher both in sub- and supra-normal salinities. In *Ocypode quadrata*
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(Flemister and Flemister, 1951), Palaemonetes varians (Lofts, 1956) and Metapenaeus monoceros (Rao, 1958) it has been reported that oxygen consumption is minimal in the natural medium and the uptake increases in more concentrated and also in more dilute media. Lofts (1956) and Rao (1958) have pointed out that oxygen consumption in these cases is governed by osmotic stress.

It is evident from the present investigation that the metabolism of Moringua linearis is efficient without special effort in a salinity of 18.8%, which may be regarded as the normally tolerated medium. In conditions other than normal the animal makes special metabolic effort to prevent osmotic inconvenience. This osmoregulatory complex, as Kinne (1964) has shown, may involve not one but several organs and organ systems in fishes and crustacea.

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