Oxygen consumption and nitrogen excretion in mullet, Rhinomugil corsula (Hamilton), with special reference to swimming speed

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Abstract. An attempt is made to study the oxygen consumption, CO₂ output and the nitrogen excretion of the freshwater mullet Rhinomugil corsula. It is found that whereas the O₂ consumption, the CO₂ output and the respiratory quotient decreased with increase in the duration of exercise, the NH₃-N and total-N excretion showed the opposite trend.

Keywords. Oxygen consumption; nitrogen excretion; freshwater mullet; carbon-dioxide output.

1. Introduction

The relation of oxygen consumption to activity has been studied extensively (Spoor 1946; Wohlschlag 1957; Beamish 1970; Brett 1964, 1965; Smit and others 1965) and these results can be used to determine the level of metabolism only on the assumption that energy is derived exclusively from aerobic sources. Although anaerobic metabolism in fish forced to swim has not been investigated (Brett 1965; Kutty 1968, 1969, 1972; Beamish 1968; Smit et al 1971; Webb 1971; Karuppannan 1972) Kutty (1968) studied the changes of respiratory quotient (RQ)* in relation to swimming speed and duration of exercise in goldfish and rainbow trout. Kutty (1972) and Karuppannan (1972) studied the RQ and ammonia excretion in Tilapia mossambica exercised for hours together, and observed that while anaerobic energy utilisation was high during the initiation of exercise, protein utilisation increased with the increase in the duration of exercise. The object of the present study has been to find out the extent of anaerobic metabolism in the freshwater mullet, Rhinomugil corsula, exercised continuously for 5 hr at various swimming speeds. An attempt to judge the extent of protein utilisation and relation of NH₃-N and total-N excretion in exercised fish has also been made.

*RQ = CO₂ Output (vol)/O₂ consumed (vol)
2. Materials and methods

The freshwater mullet, *R. corsula*, ranging from 15.7 to 20.3 cm body length and from 32.5 to 56.7 g body weight, were acclimated to 30°C ± 0.5°C in glass tanks. The fish were fed on a formulated diet containing rice-bran and groundnut oil cake in the ratio of 2:1 (Narayanan 1974). The experiments were done at the acclimation temperature.

The experiments were performed in Blazka’s respirometer (Blazka et al. 1960; Smit 1965) made on transparent acrylic plastic, perspex. In the apparatus the fish were forced to swim against the water current created by a propeller, attached to an electric motor. By regulating the speed of the motor the water inside the swimming chamber is recirculated at different current speeds. Four different swimming speeds were chosen for the present study, namely, 20, 38, 61 and 77 cm/sec.

The fish acclimated at the test temperature was starved for 24 hr (Beamish 1964; Brett 1964) prior to the experiments. It was then kept for 12 hr in the respirometer to eliminate the handling effect. The swimming chamber was partly covered by a black plastic curtain to safeguard the fish from external disturbances. The fish medium used in this study was decarbonated water (Karuppannan 1972; Kutty and Peer Mohamed 1975; Narayanan 1974) which enabled the accurate carbon dioxide measurement. The fish was trained to swim for a few minutes immediately after introducing it into the swimming chamber. Most of the fish tested took easily to swimming in the chamber.

The determination of O₂ was done by unmodified Winkler method (APHA 1965). 25 ml of the samples were used for analysis.

The total carbon dioxide was analysed by Maros-Schulek technique as modified by Kutty et al. 1971. In this method 50 ml of the samples were used for analysis and this method proved adequate for accurate measurement of total carbon dioxide in water.

Samples were analysed for ammonia following the method described by Kutty (1972), which is in general agreement with Stroganov (1962) and APHA (1965). 50 ml of the samples were distilled and nesslerised and ammonia contents were determined by Spectronic-20 at a wavelength of 420 mλ. Total-N in water was measured by micro-Kjeldahl method. 25 ml of the samples were digested with digestion mixture and 5 ml of concentrated sulphuric acid and subsequently determined the total-N using micro-Kjeldahl apparatus.

3. Results

The consolidated data are presented in table 1 and the plots of oxygen consumption, CO₂ output and RQ against swimming speed are shown in figure 1; the closed circles are the values of the first hour (short-time exercise) readings and the open circles are the 5th hr (long-time exercise) readings. The rate of NH₃-N and total-N excretion, quotients of NH₃-N excretion, percentage of NH₃-N in total-N are plotted against swimming speed in figure 2. From figure 1 it is evident that both the O₂ consumption and CO₂ output decrease with the duration of exercise as observed earlier in other teleosts (Brett 1964; Smit 1965; Kutty 1968; Karuppannan 1972). Oxygen consumption increases with swimming speed at