VIII. OXYGEN-CONSUMING CAPACITY OF THE GILL-TISSUE OF CERTAIN INDIAN TELEOSTS

It is well known that the respiratory activity of animals depends upon several factors, such as the nature of the habitat in which the animal lives, the nature of its blood or the internal environment, its respiratory organs, its locomotory activity, general metabolism etc. Among the crabs for instance, their respiratory behaviour in relation to the oxygen consumption of the whole animal as well as the gill-tissue is high in terrestrial species and decreases progressively as the habitat approaches ocean depth (Vernberg-1956). According to a number of investigators including Willmer (1934), Das (1940) and Carter (1951), both oxygen and carbon dioxide present in the medium influence the respiratory activity of certain fishes and the rate of breathing decreases with increasing concentration of carbon dioxide present in the medium (Irving *et al*-1939, Fry & Black -1939, Heilbrunn-1952). According to the experiments conducted by Willmer (1934) and others, air-breathing fishes are less sensitive to this concentration of carbon dioxide in the medium. Very little is known however about the functional efficiency of the gill-tissue of fishes, and it is not known whether the oxygen consuming capacity of the gill-filaments is same or not in water- as well as air-breathers.

An attempt has therefore been made to find out manometrically, using the Warburg manometric apparatus, the oxygen-consuming capacity of the gill-tissue of the following fishes comprising both water- and air-breathers :-

Air-breathers

A. Habitual

1. *Heteropneusteus fossilis* (Bloch)
2. *Ophiocephalus punctatus* (Bloch)

B. Occasional

3. *Notopterus notopterus* (Pallas)

Water-breathers

4. *Barbus sarana* (Ham.)
5. *Barbus chola* (Ham.)
6. *Cirrhina reba* (Ham.)
7. *Cirrhina mrigala* (Ham.)
8. *Labeo rohita* (Ham.)

THE TECHNIQUE EMPLOYED

The technique employed here is that of Warburg as modified by Hawk *et al* (1949) and Umbreit *et al* (1951).

All the fishes investigated were collected from small tanks situated round about Baroda. The animals were caught alive and immediately transferred to suitable containers provided by the Fisheries Department. These fishes were transferred at the earliest opportunity to a large Laboratory aquarium and were allowed to remain for sufficient time in the aquarium so as to enable them to return to the normal conditions as far as possible. The gill-filaments used during the investigations were separated from the fish almost immediately after the fishes were taken out of water. The separated gills were immediately immersed in Ringer's solution kept in the watch glass. Also during the separation of the gills, Ringer's solution was poured on them to keep them alive. The watch glass containing the gills was kept on an ice-slab. At this stage, the film of blood which settled on the gills was carefully removed and the gill arch was separated from the gill-filaments. These filaments were momentarily drained with the help of a soft filter paper and about 40-60 mg. of gill-filaments were quickly weighed on a torsion balance. As soon as the weighing was over, the filaments were immersed in 2.0 cc. of Ringer's solution with phosphate buffer which was earlier poured into Warburg reaction-flask avoiding the centre-well.

The Ringer's solution and the phosphate buffer used during this piece of investigations were prepared as follows :-

1. The following solutions were prepared first :-
   A. 3.25 gm. of $NaCl$ in 500 cc. of distilled water.
   B. 1.0 gm. of KCl in 100 cc. of distilled water.
   C. 2.0 gm. of $CaCl_2$ in 100 cc. of distilled water.

A mixture was now prepared by taking 480 cc. of solution A, 10 cc. of solution B and 10 cc. of solution C. This mixture was used as Ringer's solution. This solution which is used for frog-tissue as mentioned by Rogers (1938) was also used during the current investigations. It gave satisfactory results.

-.2. The buffer phosphate was prepared by first making the following preparations :-

A. 2.72 gm. of KH_2PO_4 in 100 cc. of distilled water.

B. 0.8 gm. of NaOH in 100 cc. of distilled water.

50.0 cc. of the solution A, 18.0 cc. of the solution B and 132.0 cc. of distilled water were now mixed. This mixture has a pH value of 6.7 and corresponds with that of the blood of majority of fishes (Willmer-1934, & Prosser et al - 1950). Phosphate solutions with different pH values were tried and the one having pH value 6.7 as prepared above, gave satisfactory results.

To every 10.0 cc. of Ringer's solution, 1.0 cc. of phosphate solution was mixed. This mixture was used as the medium in which the gill-filaments were immersed during the experiment.

After transferring the gill-filaments to the Warburg reaction flask, its centre well was filled with 0.25 cc. of

40 % KOH. A small square piece of starch-free Whatman filter paper number 40, folded in the fashion of a fan was placed in the centre well. The flask was now attached with the manometer. (The entire apparatus is now known as Warburg constant volume respirometer.) The flask was later filled with oxygen by carefully passing a slow and steady stream of this gas for about 3 minutes through the open side of the flask. The respirometer was now fixed to the shaking mechanism filled previously with water. Another flask filled previously with 2.0 cc. of distilled water, but containing no tissue was attached with another manometer, and also fixed on to the shaking mechanism. This was used as thermo-barometer.

About 10 minutes were allowed to lapse after the shaking mechanism was brought into operation. The temperature of the water which was earlier poured into the shaking mechanism was noted at this stage. The manometers were adjusted and readings were taken at the intervals of 5 minutes. It may be mentioned here that the rate of oxygen-consumption was not uniform and that it decreased gradually. In very rare cases the tissue was found to respire after 15 minutes and the tissue stopped breathing even earlier.

RESULT

Atleast 6 observations were recorded for each fish. The results obtained are as follows :-

Name of the fish	Oxygen consumed by the gill-tissue In cc./gm./Hr.
1. Heteropneusteus fossilis	2.56 to 5.51
2. Ophiocephalus punctatus	3.50 to 5.53
3. Notopterus notopterus	3.81 to 6.31
4. Barbus sarana	3.92 to 5.66
5. Barbus chola	2.48 to 4.66
6. Cirrhina reba	3.00 to 4.41
7. Cirrhina mrigala	3.06 to 6.46
8. Labeo rohita	2.75 to 6.82

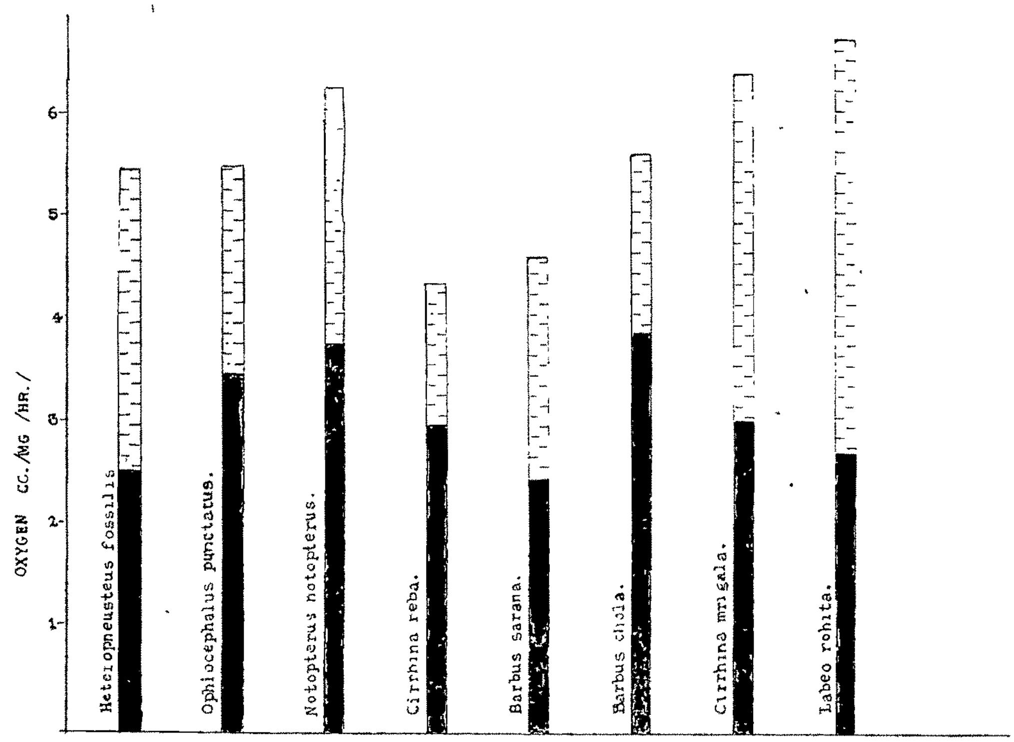

Fig.67. Histogram showing oxygen consumed in cc. by the gill-tisue per hour per gm. body weight in the fishes investigated.

DISCUSSION

As stated earlier all the fish investigated in this piece of investigation belong to similar habitats, viz. small tanks containing not very clean water. No marine fishes could be tested for the oxygen-consuming capacity of their gills. Under the circumstances it cannot be stated with certainty that the figures hold good for all the types of fish as such. It is likely, as is the case in crabs (Vernberg-1956), that the rate of consumption of oxygen differs with fishes living in different habitats.

Though all the fishes investigated during the present investigations as far as their breathing habits are concerned, fall under two categories, viz. air-breathing and water-breathing fishes, their habitats are similar. The oxygen consuming capacity of the gill-filaments estimated in cc. per gm. weight per hour, varies from 2.56 to 6.31 in air-breathers. The corresponding figures for water-breathers vary from 2.48 to 6.46. It means that the cellular respiration of the gill-filaments is the same for both the categories of fishes.

CONCLUSION

The finding of this piece of investigation is that no detectable difference exists in the oxygen-consuming capacity of the gill-filaments of water- and air-breathing teleosts.