

## X. SUMMARY AND CONCLUSIONS

1. A study of the haemoglobin concentration of the blood of the air-breathing teleostean fishes based on the estimation of iron, shows that the amount of haemoglobin present per cc. of the blood of the air-breathing fishes is higher than that in the non-migratory water-breathing fishes. In the water-breathing fishes investigated, the iron content per 100 cc. of the blood varied from 16.13 mg. to 27.52 mg. The corresponding figures for the air-breathers varied from 29.41 mg. to 40 mg. It means that the oxygen-loading capacity of the air-breathing fishes seems markedly higher than that of the water-breathers.

2. A comparatively thick covering of the mucus on the gill-filaments seems to be a special feature of the air-breathers. This covering seems to serve as a protection against desiccation when these fishes move out of water. It is interesting to note that atleast one water-breather, Wallago attu, which is known to survive out of water for a fairly long time, is provided with a covering of the mucus on gill-filaments.

3. A comparative study of the extent of gill-surface made in a number of fishes comprising both water-breathing and air-breathing teleosts, revealed that the habitual

air-breathers possess significantly less extent of gill-surface than the water-breathers and the occasional air-breathers. The gill-surface per unit volume in water-breathers was found to range from 132.67 sq.mm. to 165.9 sq.mm. While, the corresponding figures for habitual air-breathers were from 56.8 sq.mm. to 98.1 sq.mm. In the occasional air-breathers examined, the gill-surface per unit volume varied from 148.68 sq.mm. to 163.9 sq.mm.

4. No detectable difference seems to exist in the capacity of the cellular respiration between the gill-tissue of water-breathers and air-breathers living in similar habitats. This capacity estimated in cc. per gm. weight of the tissue per hour varied from 2.56 to 6.31 in fresh-water water-breathers. For the fresh-water air-breathing forms this value varied from 2.48 to 6.46.

5. A study of the muscles concerned with inspiration and expiration among the fishes shows that functionally, these muscles can be divided in both the water-breathers as well as air-breathers, into three groups, viz. (i) the mandibular, (ii) the opercular and (iii) the branchial. A good deal of variation exists in their disposition. No special modifications in the disposition of the respiratory muscles have taken place as a result of the change in the respiratory habit of the fishes. Nevertheless, one significant change in the mode of operation is noted in at least one

air-breather, Ophiocephalus. This fish is observed to employ at times during aerial respiration the same passage for inspiration as well as expiration, which seems to suggest a higher level in the evolution of the breathing habit.

6. The air-breathing fishes are observed to be distributed over a number of families and the aerial respiratory organs possessed by them are of diverse types.

7. It is pointed out that the theory of the paucity of oxygen in the medium as the prime causative stimulus for the origin of the air-breathing habit, is not unquestionable.

8. It is suggested that the cause of the origin of the air-breathing habit has to be looked for in the general evolutionary trends of all organisms towards absorbing atmospheric oxygen. In effect it means that certain adaptive mutants appeared among the ancestral water-breathers and they survived while the unfavourable variants succumbed.

9. On account of the fact that the reduction in the gill-surface and an increase in the oxygen-fixing capacity of the blood is a common factor for all air-breathers, it is suggested that specific sets of mutations must have brought this significant end result. On the other hand it is surmised that the mutants which resulted in the air-breathing organs must have been of diverse types since the end results are so varied.

10. This study has revealed the possibility that surface reduction in the gills took place as a retrograde step, while the increase in the oxygen-fixing capacity of the blood and the acquisition of the accessory respiratory organs occurred as a progressive one, simultaneously in the ancestors of the air-breathing fishes. This combination of change constitutes one of the most interesting examples of the Cuvierian principle of functional correlation in evolution.