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A Study on the Role of the So-called Intestinal Respiration of the Loach in Defecation

T. KOYAMA *

(Department of Fisheries, Faculty of Agriculture)
Tokyo University

The lung in higher vertebrates is homologous to the swim-bladder in fish, since the both have developed from the invagination on digestive tracts. Much attention therefore has been payed on the relationship between respiratory function and digestive tracts.

Especially the habit of the loach called intestinal respiration has been regarded as one of the special types on the way of the evolution of respiratory function, as well as one of the interesting types of adaptation, and intensively investigated.

BAUMERT (1853) showed that the air staying in digestive tracts was poor in O₂ and richer in CO₂. And it was shown by SUYEHIRO (1933) that air was swallowed actively and forcedly into the digetive tracts.

Some speciality resulting from the adaptation was very naturally expected in the physiological behavior of the digestive tracts. And it seemed possible that feces were pushed out through the posterior passage with air swallowed for intestinal respiration, since the feces of the loach were always found in vague mass of indefinite form. From this point of view an experiment was carried out and the results are as follows.

Procedure and Results

In order to prevent loach from swallowing air, the vessel in which some loach after sufficient feeding were kept was covered with a cotton net and sunk on the waterbottom of a bigger vessel. The inner vessel was supplied with fresh water from water-works of the laboratory (Fig. 1). A day after shutting up the fish, some of them were found dead. Through dissection feces was found even in the

* Present address : The Research Institute of Applied Electricity, Hokkaido University.

intestinal lumen which otherwise remains empty. This experiment was carried out in summer. The temperature of the tap-water employed was extraordinarily high.

A little volume of water colored with carmine was forced into the digestive tracts through a pipette inserted into the esophagus, and the fish was kept under the condition same as described above. After a day or two the fish was observed to be entirely normal. The colored water, however, was never noticed to be forced out, until the net was removed and air was swallowed for intestinal respiration. As soon as air was swallowed the colored water was jetted out of the anus into the medium-water and the red color was obviously noticed.

In addition each part of digestive tracts, i.e. stomach, coiled intestine regarded as corresponding to duodenum, and straight intestine with thin wall, highly developed in capillary of blood vessel, was sectioned separately, and the movement of each of them was tested in physiological saline water.

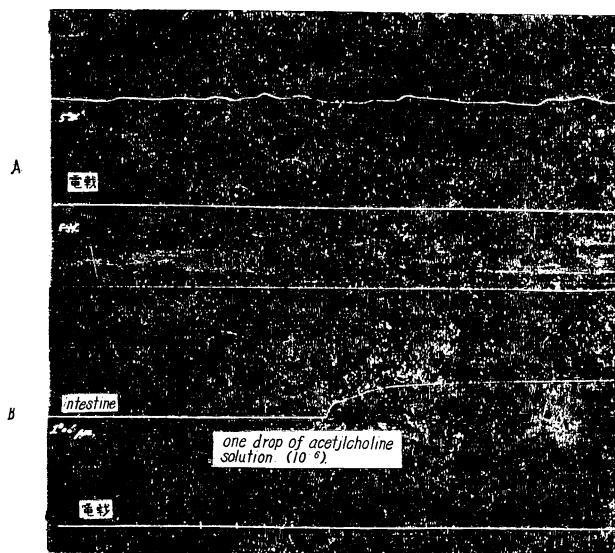


Fig. 2. Traces of the movement of preparates. A: that of stomach. B: of straight intestine. The trace above shows the movement of preparates, the trace below shows the electrical stimulation (single shot, 3 Volt.)

From the results mentioned above it may be concluded as follows. The peristaltic movement occurs in the stomach and coiled intestine readily but not in the straight intestine. The food ingested will be forced afterwards, being digested and absorbed, through the peristaltic movement of the wall of the stomach and coiled intestine, of which surfaces are increased by folding and coiling. At the anterior part of the

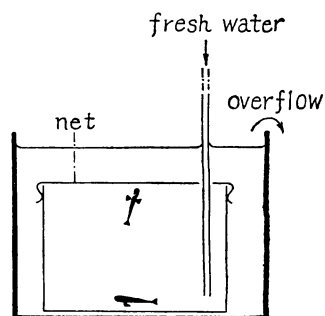


Fig. 1. To reach watersurface and swallow air is impossible since the inner vessel is covered with a cotten net.

It was observed that the stomach and coiled intestine preparations contracted rhythmically spontaneously or through addition of dilute acetylcholine solution as well as through electrical stimulation (Fig. 2A), the preparation of straight intestine, however, did not move even by electrical stimulation, but only shortened through addition of dilute acetylcholine solution (Fig. 2B). Rhythmical contraction as observed in the stomach and coiled intestine, was never observed in the straight intestine.

Discussion

straight intestine, however, it will be pushed out by the swallowed air, since there is no fold on the internal surface of the straight intestine, against which the smooth "slide out" of feces would be impossible. Thus the lumen of the straight intestine, where some part of O₂ contained in swallowed air is presumably taken in, is always free from feces and filled with swallowed air.

The intestinal respiration is regarded as an accessory function for adaptation to the inadequate circumstance. On the way of adaptation it has become indispensable for defecation at least in acute cases, though this can be achieved with another function, if loaches are kept much longer under the condition, where the intestinal respiration is impossible.

Summary

It was found that the material in the digestive tracts of the loach is pushed out of anus only while the so called intestinal respiration is possible, at least in acute cases. It seems probable that rhythmical contraction does not take place readily in straight intestine. And the following was concluded. The ingested food is possibly forced backwards through the movement of the wall of the stomach and coiled intestine. When it reached the anterior part of the straight intestine, it will probably pushed out of the anus by the swallowed air, i. e. through the intestinal respiration. The habit called intestinal respiration plays an important role not only for O₂ up-take but for defecation.

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Literature

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