INSTITUTIONEN FÖR BIOLOGI OCH MILJÖVETENSKAP

Gastrointestinal motility and blood flow in teleosts during digestion and osmoregulation

Jeroen Brijs
Institutionen för biologi och miljövetenskap
Naturvetenskapliga fakulteten

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DISSERTATION ABSTRACT

Teleost fishes occupy virtually every aquatic habitat on earth and as a group face a wide range of environmental challenges in their natural habitats, as well as during their life histories. In order to survive and thrive in the face of these challenges, it is essential for them to maintain homeostasis, as well as to acquire and assimilate energy. For this to occur the gastrointestinal tract must function effectively and efficiently, which is achieved through a wide range of processes including tightly regulated gastrointestinal motility and blood flow responses. The overall aim of this thesis was to provide further insight into the importance of gastrointestinal motility and blood flow in teleosts by focusing on their role during digestion and osmoregulation.

Using a combination of methods, a range of propagating and non-propagating *in vivo* intestinal motility patterns were documented in shorthorn sculpin (*Myoxocephalus scorpius*) and rainbow trout (*Oncorhynchus mykiss*). Pre-prandially, both species of teleosts displayed a rhythmic, anally propagating motility pattern resembling and most likely sharing a similar 'housekeeper' function as mammalian migrating motor complexes. Following the ingestion of food, this motility pattern was reduced and replaced by irregular contractile activity in the shorthorn sculpin, whereas it persisted in the rainbow trout, which most likely reflects the differences in feeding strategy between the two species (*i.e.* intermittent *vs.* continuous feeders, respectively).

Gastrointestinal motility also plays an important role in osmoregulation. Euryhaline rainbow trout rapidly initiated a drinking response in order to maintain water balance when transitioning from freshwater to seawater. To promote water absorption in the intestine, imbibed seawater was substantially desalinated in the oesophagus. This was followed by a gradual increase in the contractile activity of the intestine, which plateaued after ~2 days to remain at a significantly elevated level in fully seawater-acclimated individuals. It seems that the teleost analogue of the mammalian migrating motor complexes may also play an osmoregulatory role, as their frequency was significantly higher in seawater. This motility pattern may be necessary for transporting and mixing imbibed seawater in an optimal manner for ion and water absorption, as well as preventing the mucosal accumulation of carbonate precipitates taking place in the intestine of teleosts living in the sea.

Furthermore, a raft of circulatory modifications occurs in rainbow trout heading to sea. Gastrointestinal blood flow, cardiac output and stroke volume began to increase after ~2 days in seawater and reached a level two-fold higher than in freshwater after 4 days, which was maintained in fully seawater-acclimated trout. The up-regulation of these cardiovascular processes is most likely essential for the maintenance of osmotic homeostasis and acid-base balance for teleosts living in the sea. My findings also suggest that the increased blood flow is mainly required for the transportation of products such as ions, water and metabolic wastes, as standard metabolic rate was not significantly affected. Furthermore, seawater-acclimated trout were still able to further increase gastrointestinal perfusion following a meal, although there were strong indications that these individuals were approaching their maximum threshold.

In conclusion, the findings of this thesis enable a greater insight into the importance of gastrointestinal motility and blood flow during the processing of food and maintenance of osmotic homeostasis, which ultimately underlies the relative fitness of marine and euryhaline teleosts living in the sea.

Keywords: teleosts, intestine, motility, blood flow, freshwater, seawater, feeding