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Hydrodynamic Imaging of the Surroundings by the Lateral Line of the Blind Cave Fish *Anoptichthys jordani*

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1. Introduction

It is known that certain fish that have been blinded are still able to avoid collision with stationary objects such as the aquarium wall (Dijkgraaf 1962). Congenitally blind fish, like the blind cave fish *Anopthichthys jordani*, can swim around in their environment as surely as fish with vision.

Behavioral experiments on this fish (von Campenhausen et al. 1981; Weissert and von Campenhausen 1981) have shown that it is able to detect and recognize stationary objects, such as bars arranged in different patterns. It is proposed that this capability of the blind cave fish is achieved with the aid of the lateral line system. When the fish glides through the open water, a flow field is set up around its body due to the displacement of water at the head and suction in the tail region (Fig. 10.1). When the fish glides in the vicinity of an obstacle, the flow field will be altered in a characteristic way that depends on the geometry and dimensions of the obstacle. The alteration of the flow field will give rise to an alteration in the water displacement at the skin of the fish, and this can be perceived by the fish with the aid of its lateral line system.

The aim of this chapter is to discuss how these alterations in water displacement can create an image of an object—e.g., a cylindrical bar—on the skin of the moving fish and how this information could be spatially and temporally mapped by the lateral line system. These questions were investigated by determining mathematically the spatial and temporal course of water displacement on the skin of the fish when gliding in the vicinity of an obstacle. The mathematical treatment of this problem was done for the two-dimensional case. This case is applicable for a fish with a dorsoventrally flattened body shape and, in particular, for the midtrunk region along its side.

2. Mathematically Modeling Hydrodynamic Interaction Between Two Bodies

The flow field around a fish gliding in open water can be simulated by a constant flow with the same velocity as the fish but in the direction opposite to its

S. Coombs et al. (eds.), *The Mechanosensory Lateral Line*

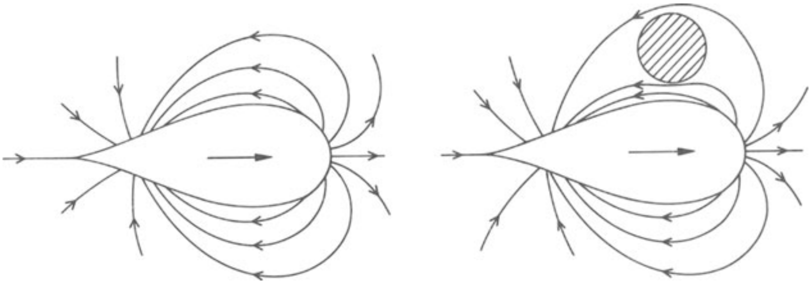

FIGURE 10.1. Schematic diagram of the flow field around a gliding fish. Left: in open water. Right: passing an obstacle. (From Hassan 1985.)

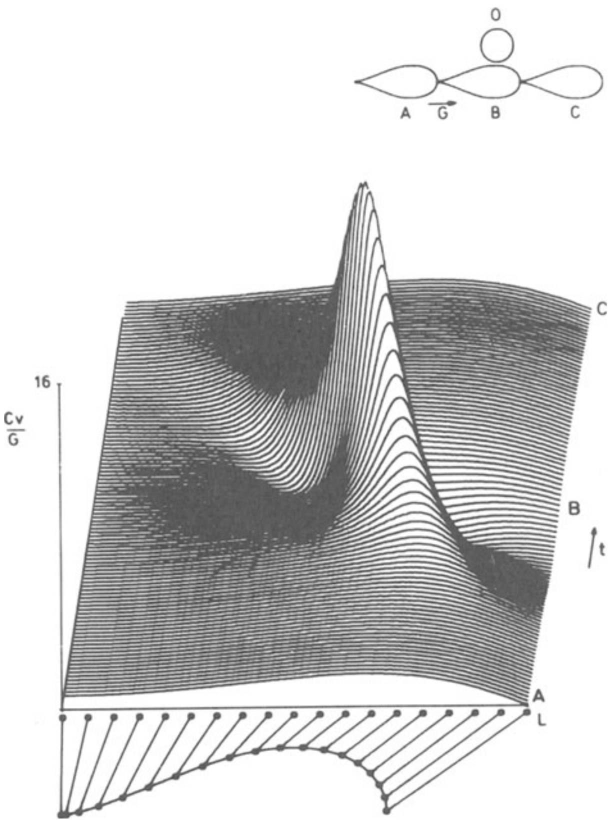

FIGURE 10.2. Flow velocity distribution on the surface of a fish gliding past a stationary obstacle upper inset. The vertical axis is the flow velocity (Cv) divided by the gliding velocity of the fish (G). Horizontal axis (L): the contour of the side of the fish facing the obstacle stretched to a straight line . Points on this axis connect to the corresponding points of the fish's side drawn below the axis. t: Time. (From Hassan 1985).