Roles of Skeletal Muscles and Fins in Body Tilting of Carp Fishes

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Abstract: This study was performed to define the mechanism responsible for body tilting in carp fishes. Dorsal light response (DLR) was induced in carp fishes in microgravity (μ-G) environment, which was created by the parabolic flight of a jet airplane. The DLR was also induced in labirynthectomized carps in 1-G environment. Electromyograms (EMGs) of the flexor and levator muscles, responsible for the movement of pectoral fins, and the middle portion of the lateral red muscle, responsible for movement of tail fin, were recorded. Results suggested that tail fin may play the major role for tilting, since EMG activity of the right lateral muscle was increased during body tilting toward right in response to change of the direction of light from the top to the right. It was further suggested that pectoral fins may play an auxiliary role for maintenance of posture.

Key words; Dorsal light response, Microgravity, Labirynthectomy, Electromyogram, Fin activity

I. Introduction

Carp fishes usually orient their posture based on vestibular and visual inputs. Removal of gravitational input in μ-G environment and/or bilateral labyrinthesctomy induces the postural changes due to the DLR. However, the mechanism for the postural changes caused by DLR is poorly understood.

Therefore, the current study was performed to determine the role(s) of the specific muscles for DLR by measuring EMG.
II. Methods

Recording of EMG. Bipolar electrodes were implanted in the flexor and levator muscle and the middle portion of the lateral red muscle of carp fishes. The electrode wires were connected to an amplifier and EMG activities were recorded throughout the 1-hour parabolic flight experiment.

Parabolic flight. The changes of gravity levels (0~2-G) were created by the parabolic flight of a jet airplane (Gulfstream-II, Diamond Air Service, Japan). The μ-G environment was obtained for approximately 20 sec in each parabolic flight.

Induction of DLR. The postural changes of carp fishes due to the DLR were induced by changing the direction of light from the top to the right or left during exposure to μ-G or 1-G environment in bilaterally labyrinthectomized carp.

III. Results and Discussion

Carp fishes clearly tilted their body toward the light due to the DLR in μ-G, not in 1~2-G, environment. And EMG activities of the flexor and levator muscle and the middle portion of the lateral muscle were increased during μ-G, even when the light was maintained at the top. Such responses of EMG patterns were not observed in hyper-G environment. These phenomena may be induced in response to sudden exposure to hypo-gravity and/or turbulence of water. But, increase of EMG in the right lateral muscle was noted during body tilting toward the right direction in intact carp exposed to μ-G and in bilaterally labyrinthectomized carp in 1-G environment. These results suggest that tail fin may play the major role for tilting and pectoral fins may play an auxiliary role for maintenance of posture.