Determination of the Threshold of Gravity for the Susceptibility to Kinetosis in Fish - a Centrifuge Experiment in the ZARM Drop-Tower employing gradually reduced Gravity

R. Anken, **R. Hilbig**

Zoological Institute, University of Stuttgart-Hohenheim, Garbenstr. 30, D-70593 Stuttgart, Germany

In the course of earlier experiments at diminished gravity conditions, we have successfully used larval cichlid fish (Oreochromis mossambicus) as a vertebrate model system in investigating the basic cause of susceptibility to motion sickness (kinetosis). It was observed that most animals of a given batch reveal kinetoses (i.e., performing looping responses/LR or spinning movements/SM) at high quality microgravity (10-6g, ZARM drop-tower), whereas comparatively few individuals swim kinetotically at low quality microgravity (LQM; 0.03-0.05g) during parabolic aircraft flights (Anken and Hilbig, Microgravity Sci. Technol. 15: 52-57, 2004). In order to gain further insights into a possible threshold of gravity for inducing motion sickness, animals were subjected to drop-tower flights within a centrifuge. The levels of gravity applied ranged from 0.009g until 0.3g. The lowest level of gravity under which (few) normally swimming fish were observed ranged around 0.015g. Since this is a very low level of gravity, the normally swimming fish have to be considered to be either extremely sensitive to any force of gravity in order to use it as a cue for postural control, or, they use cues other than the residual gravity for maintaining equilibrium. Most of the remaining, kinetotically swimming animals showed LR, whereas few exhibited SM. With increasing gravity, the ratio of normally swimming and spinning specimens increased, accompanied by a decrease in the number of looping larvae. Regarding the ratio, a shift from LR to SM took place at around 0.02g. At 0.3g, all animals behaved normally. G-levels around 0.3g occur in natural currents. We therefore presume, that it was a selection factor for fish during evolution to be able to manage equilibrium with only some 0.3g of residual environmental gravity. In order to gain insights into a possible morphological basis of motion sickness susceptibility, inner ear otoliths were dissected and the sizes of left vs. right stones were plotted. As a matter of fact, the variability of any parameter is highest, when a respective analysis covers 100% of the individuals of a given population. Consequently, the highest variablity in otolith size was found in fish at 1g (100% swimming normally). Variability was also high in fish swimming kinetotically at 0.009g (some 90% of the individuals of a given batch reveal kinetoses). Applying various levels of gravity between 0.009g and 0.3g, variability of otolith size was found to be lower, depending on the kind of behaviour (LR, SM or

normal swimming). Moreover, it was found that the respective regression coefficients varied between spinning, looping and normally swimming animals at a given G-level. Summarizing, these data indicate that the size of otoliths and their possible asymmetry play a major role in spatial orientation and as well in kinetosis susceptibility.
Acknowledgement: This work was financially supported by the German Aerospace Center (DLR) (FKZ: 50 WB 9997/50 WB 0527).