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Final Report
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In the course of Apollo and Kosmos flights, embryos of Fundulus heteroclitus at various stages of development (32, 66, 128, and 216 hours) were exposed to space flight conditions.

The objective of the study here reported was to ascertain whether fish hatched from these embryos displayed locomotor behavior different from that of control fish of the same age. Since locomotor behavior is under complex control of the central nervous system, environmental changes affecting that system are reflected in changes in that behavior as has been previously demonstrated in this laboratory. The difficulties of quantifying highly variable locomotor behavior in fish, an essential requirement if it is to be used as a bioassay, were overcome by the use of an electronic monitoring technique described earlier. A cylindrical tank, 2 m in diameter, 30 cm deep, is divided into 16 compartments by 50 cm-long, hollow-walled dividers which extend radially from the periphery of the tank leaving an unobstructed central area, 100 cm in diameter. An array of banks of phototransistors and sources of near infrared light, placed behind vertical windows in the hollow dividers, forms electronic gates at the entrances of the 16 compartments. An electronic interface with a paper tape punch allows for the recording of entries and exits of each compartment and the time of these events. This record is transposed to magnetic tape. From these data the frequency distribution of entries and sojourn in each compartment, the overall activity, the locomotor pattern (sequence of compartments entered), and velocity are computed. The monitor tanks are supplied with synthetic seawater which enters from the periphery of each compartment and leaves the tank through a

central standing pipe. Environmental conditions are approximately constant.

The investigation was severely hampered by accidental mortality of some fish stock at the NASA holding facilities, greatly reducing the number of fish available for testing. Toward the end of the investigation it became known that, while in flight, some of the Kosmos fish had been accidentally exposed to a toxic substance in a label adhesive which had diffused through the plastic bags used for holding the embryos. The effects, if any, of this exposure on the locomotor behavior of the fish hatched from the embryos exposed to the toxic substance are not known.

Within these limitations, the results of the investigation can be summarized as follows.

Apollo fish

Fish from none of the three categories (embryos of 32, 66, and 216 hours) comprised in this group displayed significantly different locomotor behavior from controls as expressed by angles of turns, left- and right- "handedness", average angle size, distribution of pathways in the tank and their sequence over time.

Kosmos fish

These fish, of which only 8 survived the toxicity accident mentioned, originated from embryos which had been exposed to flight conditions when 128 hours old. The locomotor behavior of these animals, most sensitively

expressed by the sequence of pathways made in the tank, over time, was very highly significantly different from that of their controls. The difference represents vastly different turning and orientation behavior in the experimental fish. Whether this vast difference in behavior is caused by temporary exposure to a toxic substance from the label adhesive or to the effects of flight conditions (or both) cannot be ascertained without new experiments in space. Should the results be due entirely to the effects of flight conditions, an explanation must be found for the fact that the behavior of Apollo fish did not differ from that of the controls. A possible explanation might be that the 128-hour stage represents a critical or more sensitive phase of development during which flight conditions affect specifically neural and/or muscular elements used in locomotor behavior.