The Space Congress® Proceedings

1983 (20th) Space: The Next Twenty Years

Apr 1st, 8:00 AM

Planaria Regeneration in Zero-Gravity

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PLANARIA REGENERATION IN ZERO GRAVITY (GETAWAY SPECIAL PROGRAM)

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ABSTRACT

The following is a report on an experimental package designed for the Getaway Special, GAS, Program. The original idea was thought of in 1982 and a preliminary presention was made at the 19th Annual Space Congress. Since that time, the experimenter has, through speaking with several experts in the field of zoology, come up with a number of changes and better methods for making and carrying out the experiment.

The experiment calls for a comparison of the process of regeneration of body parts on cut Planaria worms between a group on earth with normal conditions of gravity and a group in space with conditions of zero gravity. The experimenter hopes that the information obtained will help in leading to an understanding of the effects of zero gravity on regeneration of any tissue, including, for example, human nerve tissue. It is also hoped that furthur studies on future flights will be made regarding this matter.

INTRODUCTION

The experimenter became interested in working with Planaria while making a fourth grade science project for the Broward County Science Fair. At that time, an experiment was done in order to see which conditions would be best for regeneration of body parts on cut worms. Planaria were cut into head and tail sections and placed in containers with different temperatures. Different types of water were also used as part of the experiment. By the end of the time it took for regeneration to take place in all of the worms, it was found that temperatures of around 80°F. and the use of simple aged canal water brought about quicker results than cold water or store bought purified water. The project was completed in 1981.

Later that year, the experimenter was presented with an introductory package of entry for the Getaway Special Program. Having recently completed the previous experiment, the idea came up that researching these abilities to regenerate in conditions of zero gravity could prove interesting and perhaps lead to the discovery of important scientific information. A brief summary was sent in presenting the experiment to the Getaway Special Program supervisors and a preliminary presentation was made in April of 1982 at the 19th Annual Space Congress. In September of 1982, a letter was received indicating that plans for the experimental package should be continued and updated.

Over the next several months, a number of university professors, as well as experts in the field of zoology, were contacted for their advice regarding the best way to carry out the experiment. With their help, many decisions were made as to what the package should contain and what ways would be best to determine regenerative growth of the worms.

Ideas for the measurement of regeneration went from the use of radioactive tracer elements to simple visual measure with the use of an ocular micrometer on a microscope. For reasons of cost and simplicity, the use of a binocular microscope of at least 35X with an ocular micrometer for measuring growth was decided upon. It was pointed out that regenerative growth could be visually measured because of the difference in pigmentation between the newly regenerated cells and old body cells.

Planaria have long been used for studies of regeneration. They are easily obtained and are not difficult to work with. In addition, the requirements for weight and space can easily be met.

As of the time of this writing, actual final package design was not complete, but the materials and procedures for carrying out the experiment were known.

PROCEDURES

Basically, the experiment involves cutting Planaria into head and tail sections and allowing them to regenerate. One group of worms would be taken on board the Shuttle so as to expose them to zero gravity conditions while they were regenerating. At the same time, a second group would be kept on earth.

The cutting of the worms would have to take place as close to launch time as possible since it would be very difficult to design a way of cutting that could be built into the package itself. After the worms were cut, they would be placed into a cylinder shaped container that would be partitioned into three sections. A number of cut worms would be placed into each section of the container. An identical container would be set up, but it would remain on earth.

The containers would be filled with water for the Planaria to live in. On top of the package would be a series of automated timing devices that would be set to push plungers containing a fixative so that the worms could be killed and preserved at set times for each section. Worms in the Shuttle and on earth would be killed and preserved at exactly the same times. The preserving fluid could be one like formalin.

At pre-set times, a section of worms on earth as well as in the Shuttle would be preserved. The times could be at the end of five days for the first section, ten days for the second section, and twenty days for the third section. This would allow enough time for a full study of the regeneration process until completion. Times may have to be changed based on the length of the mission.

When the package was returned to earth, the worms would be studied with a binocular microscope as described in order to measure the actual amount of regeneration that occurred. The difference in pigmentation between newly regenerated cells and old cells should be visual enough to allow for study and comparison.
It should be pointed out that package design as well as the actual cutting of and preserving of the worms in space would be much cheaper and simpler if the package could be placed in the orbiter cabin itself. This would avoid the need of a timing device on the plunger as the astronauts themselves could do this part of the experiment. They could even cut the worms on board after launch so that the problem of placing the container on the Shuttle too soon could be eliminated. This would especially be a factor if the experiment had to be loaded in the Shuttle many weeks before launch. This would cause full regeneration before actual lift-off and exposure to zero gravity.

PROJECT REQUIREMENTS

The following is a list of requirements that will be necessary in order to carry out this experiment successfully:

Temperature: The temperature of the packages both on earth and in the Shuttle should be kept between 75°F. and 90°F. if at all possible. Any changes in the temperature in the Getaway Special container must be matched on earth with the control worm package. Insulation and a thermostatic temperature regulator may be necessary.

Air Pressure: One atmosphere of pressure must be kept at all times.

Weight: The weight of the package should be less than 60 pounds and should present no problem.

Volume: The 2.5 cubic foot container should be sufficient for this package. The actual package will be a cylinder with a diameter of 19 inches or less and a layer of insulation that will fill up the remaining area in the GAS container. The height of the package containing the worms will be about 3 inches with the timers and plungers on top of this.

Worm Container Design: The container for the worms will be a cylinder 19" in diameter and will be divided into three sections as described. These three sections can then be sub-divided into three smaller sections if study on the effects on different types of species is desired.Automatically operated timers and plungers for fixatives will be on top of the package. The experiment will be entirely insulated. It will mount on the mounting plate with machine screws.

Fixative Injecting Device: A timer attached to a plunger will be necessary so as to be able to kill and preserve the sections of worms at the correct time.

Electricity: Enough power will be needed to run the timer and possibly the temperature control thermostat.

Lateral Load Support: This will be provided by the insulating material.

Insulation: This is required due to the fact that the temperature must be kept between 75°F. and 90°F. in order to keep the worms alive.

Safety Considerations: Proper and safe insulating materials must be chosen. This also goes for the selection of preserving fluid.

SUMMARY

This experiment could provide valuable information regarding the effects of zero gravity on regeneration. The experiment does not take up much room and does not have much weight. It could easily fit into the GAS container.

The limitations set by the GAS program could present some problems, however. The worms cannot be loaded on board the Shuttle too far in advance or they will completely regenerate before they can be exposed to zero gravity. Also, temperatures in the area of the GAS container will not allow for the worms to survive without some sort of temperature control device. Insulation may help solve this problem.

Many of the problems could be eliminated if the experiment were to be placed in the Shuttle cabin itself. Here, the environment is made for survival of living things. If the astronauts themselves could bring the package on board, or a technician could place it in the cabin close to the time of launch, the worms will not have regenerated before lift-off. It would be even better if the astronauts could actually cut the worms after being placed in orbit for maximum exposure to zero gravity during regeneration.

Having the experiment package in the cabin would also eliminate the need for timing devices on the fixative plunger. This could easily be done by hand at a great savings in cost of design.

In short, although the package could possibly go into the GAS container, it may be better designed for being taken as an in-cabin experiment, such as on board a Spacelab mission.

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ACKNOWLEDGEMENTS

Dr. G.H. Dalrymple, Biology Dept., Florida International University.

Mr. W.R. Pendergrass, Carolina Biological Supply Company.

Mr. J. Ralph, I.B.M.

Dr. E. Rich, Biology Dept., University of Miami.