GYPSY MOTHS AND AMERICAN DOG TICKS: SPACE PARTNERS

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During the flight of Skylab IV (86 day orbital flight around the earth), the effects of zero gravity on the diapause (hibernation) of gypsy moth, Lymantria dispar (Linnaeus), eggs was studied. The rationale was that the intracellular organization of the embryonic brain and membrane permeability might be disturbed by zero gravity so that the normal obligatory 6-9 month egg diapause might be prematurely broken.

This study was described by Sullivan et al (1974); the following extract summarizes the results. "Five hundred eggs collected from nature at State College, PA, on Oct 1, 1973 (estimated to have been layed the 1st or 2nd week in July), were labeled wild, held at 4°C from Oct. 2-30, and placed in the space package. Five hundred eggs layed from Sept. 1-9, 1973, by a laboratory reared strain, 2nd generation, at the Methods Development Laboratory, USDA, APHIS, Otis Air Force Base, were fully embryonated by Oct. 10, were chilled at 4°C from Oct. 10-26, labeled tame, and and placed in the space package. The total weight of the package (Egg Demonstration Vial Assembly, EDVA) was less than 1 oz (28.3 g). A similar ground control was packaged in the same manner. The EDVA was taped to the IMSS locker in the orital workshop at ward room entrance and 1 crewman made daily observations of the EDVA to ascertain egg hatch. A small but significantly greater number of insects hatched when exposed to zero gravity in Skylab 4 than when maintained as ground control (7 vs 0); however, more work is required to demonstrate conclusively the principle tested.

After return to earth, most of the remaining Skylab 4 and ground control eggs were conditioned to induce hatching by either placing them at 4°C for 30-120 days and returning them to 22°C, or by holding them at 22°C for the duration of the experiment. A total of 10 gypsy moth eggs hatched and 1 insect, a female flown in Skylab 4, survived to the adult stage at Otis, MA, and was mated to a normal male. The resultant egg mass was conditioned at 4°C for the normal period of time, but there was no hatch when returned to 22°C; the hatch in the control egg mass was 22%.

"Astromoth I" was returned to Beltsville and studied by Dr. Edward L. Todd, Lepidoptera Specialist at the National Museum. He stated that the specimen was normal, larger than usual, but within normal limits.

Electronic micrographs of the sections through the brain of the embryos from

eggs that were subjected to conditions in space were compared with similar sections prepared from ground controls. In the limited number of sections examined, it appeared that small osmophilic granules were more numerous in the cytoplasm of cells from insects that were not on the Skylab mission than in those that were. This osmophilic material could represent neurosecretory substances. This suggests that some feature of the space flight--in particular weightlessness--may have resulted in a release of neurosecretory material, since a similar reduction was not noted in controls maintained under atmospheric conditions similar to those on Skylab. Because of the limited number of samples--5 from each experimental group were subjected to microscopy--this conclusion must remain a tentative one, to be further tested in future space flights." According to Loeb and Hayes (1980) a method has been developed for studying brain neurosecretions during diapause and diapause breaks in embryonated larvae of the gypsy moth.

Eleven years have passed and the development by NASA of the small self-contained payload program for shuttle missions has made available a research payload container that is suitable for our type of experiments. New packets of gypsy moth eggs and possibly engorged female American dog ticks, Dermacentor variabilis (Say), and cartridges of jelled agar will be secured to and rolled in a stiff cotton mesh, placed in a nylon mesh bag, and packed into a Get Away Special (GAS) container without the use of a support structure. The cartridges of jelled agar will maintain the humidity within the sealed canister. A Tattletale® thermograph will form the core of the experimental package.

Engorged female American dog ticks overwinter in diapause, which is normally broken in late March by increased photoperiodism. For this experiment, engorged female ticks will be induced into a prearranged diapause, beginning in August rather than as normally occurs in October. Under controlled laboratory conditions, the female ticks should begin oviposition when daylength exceeds 10 hours. The affects of weightlessness plus total darkness for the duration of containment may alter the photoperiod requirement needed for oviposition. Also, the effects of weightlessness may alter physiological and reproductive functions.

The objectives are: (1) to reevaluate the effects of zero gravity on the termination of diapause/hibernation of embryonated gypsy moth eggs, (2) to determine the effect of zero gravity on the ovipositions and subsequent hatch from engorged female American dog ticks that have been induced to diapause in the laboratory, and (3) to determine whether morphological or biochemical changes occur as a result of the exposure in Skylab, after questions posed in objectives (1) and (2) are answered.

References

Loeb, M. J. and D. K. Hayes. 1980. Neurosecretion during diapause and diapause development in brains of mature embryos of the gypsy moth, Lymantria dispar. Ann. Entomol. Soc. Amer. 73(4):432-436.

Sullivan, W. N., D. K. Hayes, M. S. Schechter, T. McIntyre, D. R. Morrison and M. Fisher. 1974. Space studies with insects. Bull. Entomol. Soc. Amer. 22(1):15-16.