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REDUCTION OF SOLAR VECTOR MAGNETOGRAPH DATA USING A MicroMSP ARRAY PROCESSOR

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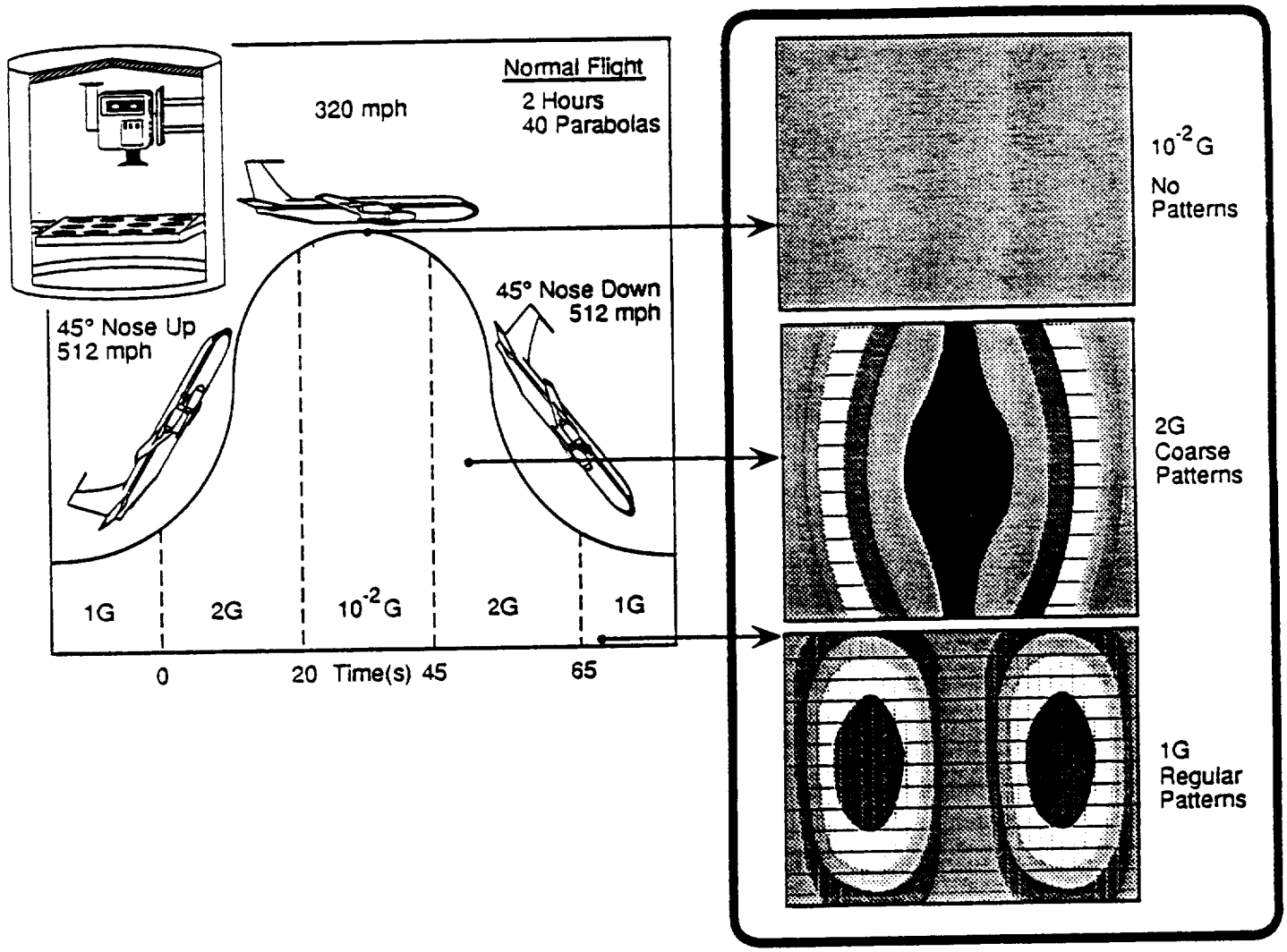

Figure 2. Schematic of aircraft parabolic flight to achieve variable gravity simulation and summary of results for protozoan and algal bioconvective patterns. The inset upper left shows a schematic of the flight apparatus. Components of the apparatus include a protective cylindrical housing; a singly mounted, plexiglass tray with 12 wells for shallow cultures; inclined illumination from the side; and a cinecamera. Flight samples included *Tetrahymena* at a concentration of 2.2×10^5 ml^{-1} and *Polytomella* at concentrations of 1.7×10^6 ml^{-1}, 3.2×10^6 ml^{-1}, 7×10^6 ml^{-1}.

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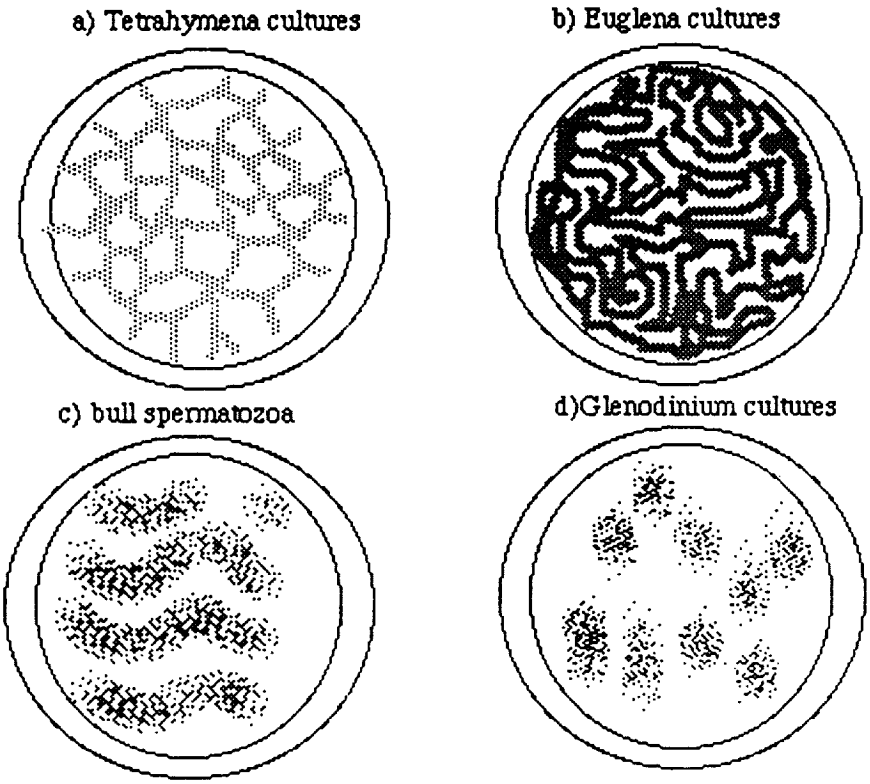
Figure 3. Bioconvection patterns of Spermatozoa

of the fluid density model.

Planned Future Work

This study performed a definitive test of bioconvective patterns which explains earlier conflicts of these theories in the literature. As an extension of this work (/which dealt with collective behavior), a variable test of individual spermatozoa is planned. The objective will include a definitive test of sperm orientation in a velocity gradient (e.g. upstream or downstream orientation).

Figure 1. Bioconvective patterns which arise spontaneously in randomly swimming microorganisms



BACKGROUND

Spermatozoa, protozoa, and algae form macroscopic patterns somewhat analogous to thermally-driven convection cells. These bioconvective patterns have attracted great interest recently in the fluid dynamics community, but whether in all cases these waves were gravity- driven was unknown. The literature documents two conflicting theories, one gravity dependent (fluid density model), the other gravity independent (wave reinforcement theory). Under the wave reinforcement theory, organisms align their movements in concert, such that either their swimming strokes beat in phase or their vortices entrain neighbors to follow parallel paths. In contrast, under various fluid density models, small concentrated regions of organisms sink unstably. By observing pattern formation during low and high-gravity parabolas aboard the KC-135 research plane, a definitive existence test of bioconvective patterns was achieved. It appears that macroscopic pattern formation is consistent with the wave reinforcement hypothesis for spermatozoa and fluid density models for protozoa and algae.

Summer Research Objectives

In support of NASA/Marshall Space Flight Center Director's Discretionary Funded proposal entitled "Bioconvection in Swarming Microorganisms" (Helen Matsos,ES76,P.I/David Noever,USRA,C.I.), the primary research objectives of the summer faculty fellow were to 1) assist in sample collection [spermatozoa] and preparation for the KC-135 research experiment; and 2) to collaborate on ground testing of bioconvective variables such as motility, concentration,

morphology, etc., in relation to their macroscopic patterns.

Materials and Methods

Sealed (1.25 in diameter) chambers were used to eliminate fluid movement and surface tension effects anticipated during high- to low-gravity transitions. To allow for the observed pattern dependence on fluid height, three well-depths were flown for each protozoan and algal culture: 0.17, 0.25, 0.33 inches deep. Duplicate arrays were prepared for adjacent observation. Sample size and concentration were dictated by the flight hardware and time constraints to maintain viable anaerobic cultures and high speed motility. To facilitate transport and the utilization of spermatozoa aboard the KC-135 located at JSFC, unextended and undiluted semen was placed in 1.5 ml polypropylene microcentrifuge vials and stored in a Hamilton-Thorn Equitainer System. Sperm motility was preserved at 5oC until time of test.

Results

Macroscopic patterns of motility persisted in spermatozoa during all phases of variable gravity testing. In contrast both protozoa and algae showed a decreased in pattern wave number and fineness when subjected to 1.8 g. During low gravity phases, however, patterns in both protozoa and algae rapidly dispersed. Hence pattern formation of spermatozoa in variable gravity is consistent with predictive outcomes of the wave reinforcement hypothesis, while for the selected algae and protozoa, bioconvective patterns are consistent with the predictive outcome