Self-burial Mechanism of *Erodium Cicutarium* and Its Potential Application for Subsurface Exploration

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Abstract. *Erodium cicutarium L.* plants disperse their seeds by a combination of two dispersal strategies: explosive dispersal, and self-burial dispersal. As the fruits dry, the stresses developed in the structure cause the sudden separation of the seeds that fly away from the plant. Then, once on the ground, the seeds respond to variations in the external humidity : their dispersal unit, is helical when dry and linear when wet. The day-night cycle of humidity results in a coiling and uncoiling motor action, that moves the seed across the surface and into the ground. The present study aims at getting a deeper insight into the self-burial strategy of *Erodium cicutarium* in order to implement this ability into mechanical structures that relying on changes in the external parameters (such as light, temperatures or humidity) can achieve passively the same goal.

Keywords: Hygroscopic movement, self-burial, subsurface exploration.

Seed dispersal represent an excellent source of inspiration for developing a new generation of biomimetic technologies. Plants evolved methods to improve their chance of success in many different environments, and their seeds can have wings to fly or buoyant structures to surf water. *Erodium cicutarium L.* plants are characterized by two coupled dispersal strategies: an explosive dispersal to fly the seeds away from the plant and a self-burial strategy of the seeds, that increase the chance of a safe germination [1]. Both these movements are possible thanks to hygroscopic tissues, that generate passive movement via changes in the hydration of the cell walls. As far as the self-burial strategy might concern, each seed has a special dispersal unit (the awn) that, once on the ground, respond to variations in the external humidity and change its configuration accordingly: the awn is helical when dry and linear when wet. The day-night cycle of humidity results in a coiling and uncoiling motor action, that, combined with other accessory structures, moves the seed across the surface and into the ground [2] [3].

The present study aims at getting a deeper insight into the self-burial strategy of *Erodium cicutarium* in order to implement this ability into mechanical

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structures that relying on changes in the external parameters (such as light, temperatures or humidity) can achieve passively the same goal. At the moment we are testing the performance of the seed in several experimental situations: different soil textures, modified seeds, and contribution of the launch. The self-burial behavior will be discussed in light of its potential application for biomimetic technologies such as penetrators for subsurface investigation. Our preliminary results reveal that given the small size and weight of the seed, it is reasonable to think that the system doesn't need high axial force applying a motion that requires no additional steady coupling with the surface. A system with this characteristics could be very useful in low gravity environments (such as asteroids, moons, and small planets) providing a different solution to the set of unconventional penetrators developed to address this scope [4]. Providing probes and sensors with this behavior would facilitate the exploration of the surface underneath regolith providing information related to the geology of the soil, the temperature or simply dig themselves to find shelter from the space environment for long term monitoring of specific targets of the environment.

Fig. 1. The morphology of the seeds of Erodium cicutarium (Photo courtesy of Steve Hurts @ USDA-NRCS PLANTS database

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