

# *Tragopogon dubius*, Considerations on a Possible Biomimetic Transfer

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**Abstract.** *Tragopogon dubius* is a small herbaceous plant that uses the wind as dispersal vector for its seeds. The seeds are attached to stalked parachutes which increase the aerodynamic drag force on the seeds. This decreases their rate of descent, and hence increases the total distance traveled. The relatively large natural parachute of *Tragopogon dubius* is an ideal model in a biomimetic structure owing to its relative large size, sturdy and robust structure, and the hierarchical distribution of its fibers. The present contribution describes some preliminary results on the structural properties and aerodynamical behavior of this seed, with the goal of developing new stream of designs of lighter or more robust parachute for possible extra-terrestrial purposes.

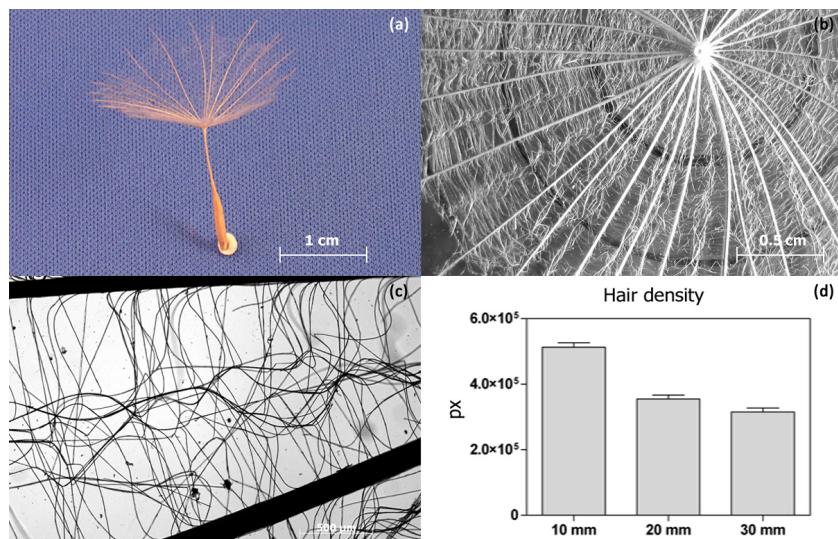
**Keywords:** Plumed seeds, aerodynamics of seeds, wind dispersal, papus morphology, plant biomechanics.

Dispersal of seeds away from the parental plant is very important to reach new habitats and to survive in changing environmental conditions. For these reasons, plants invest in a variety of strategies to exploit the most abundant form of energy available (i.e. wind, water, animals).

*Tragopogon dubius*, provides its seeds with probably the biggest parachute available in nature [1], and it achieves its final size by two hierarchical orders of branching: primary and secondary fibers arranged as shown in Fig.1. In a windy atmosphere, the horizontal distance travelled by plumed seeds is greatly influenced by the wind speed. For a lower wind speed, vertical descent velocity remains a good indicator of the horizontal flight capacity, but an increase of wind will result in an exponential increase of the horizontal dispersal distance [2]. This change in the flight behavior has not been fully explained, and a more thorough investigation could reveal some advantageous properties that have not been characterized yet.

The present contribution describes some preliminary results on the structural properties and aerodynamical behavior of the parachuted seed of *Tragopogon*, with the goal of developing new stream of designs of lighter or more robust

parachute for possible extraterrestrial purposes. Space exploration requires simple solutions which maximize adaptability and robustness together with weight and size constraints. It also places additional challenges due to uncertain and unpredictable environmental conditions. Sending a swarm of sensors to explore atmosphere endowed celestial bodies has been proposed before [3] [4], and provide them with aerial-platforms derived from the cone-shaped parachute of *Tragopogon* could give some advantages. In the present contribution we are focusing on three main points in the model: the distribution of the fibers, the structural properties of the main ribs, and the overall aerodynamic behavior of the structure. The hierarchical distribution of its fibers could lead to a reduction of the mass required for the parachute. Furthermore, the cone-shaped parachute could have a better aerodynamic stability in a windy atmosphere and it will naturally tend to recover its orientation after being destabilized by strong gusts.



**Fig. 1.** (a) Plumed seed of *Tragopogon dubius*; (b) Optical scanned image of the natural parachute; (c) The fine mesh of the secondary hairs; (d) Secondary hairs density

## References

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