

## Introduction

Ski jumping is a sport that involves a high degree of risk and as such, a high degree of training, to experience a sense of flight not possible to human under normal circumstances. With that in mind, ski jumpers are not the only professional gliders in the world. In the animal kingdom there are many examples of animals evolving unique physiology to achieve a degree of flight. This is a look into the methods employed by ski jumpers compared to the morphology and behavioral adaptations of gliding snakes and tree frogs.

## Objectives

- Identifying the how prolonged gliding in human ski jumping is produced without proper physiological structure and rules around competition
- Examine the physiological adaptations in a sample of gliding animals that human do not possess
- Understanding common practices between human and animal jumping and gliding practices

## Methods

Information was gathered from sources available to the U.N.B.C. library, online resources, and personal inquiry. These include the rules and regulations for competition behavior and equipment for ski jumping for international completions and animal biology and morphology. The literature reviewed was chosen based on the data available and relevance to the project.

## Results

- Ski jumpers have no direct adaptations to fly or glide but use equipment and body positioning to create lift and reduce drag
- While in flight, adjustments are made with hands, held to the sides of the body and used to make small corrections.
- The ski position and size allows for needed speed, and added surface area to the body, adding to both stability in flight and a chance to gain more lift.

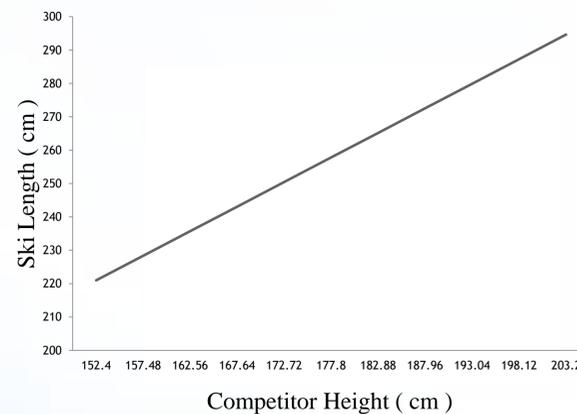


Fig.1 Maximum Allowed Ski Length For a Male Competitor of Body Mass Index 21

- The flying snake genus *Chrysopelea* have a unique mechanism that allows them to glide through the air.
- Using muscles to splay out the rib cage they create a concave surface on the underside of their body.
- While in flight the snakes produce an undulating motion, which may be used to increase stability or may simply be a habituation performance with motion.



*Chrysopelea paradisi*. Photo by Tim Laman, National Geographic.



*Rahcophorus nigropalmatus*. Photo by Tim Laman, National Geographic.

- Flying frogs use enlarged toes pads, webbed feet, dorsoventrally flattened bodies to add surface area and create lift.
- The weigh of the frogs trends towards lower if they are a gliding frogs
- When trying to glide the frogs, *Rahcophorus nigropalmatus*, spread their legs and toes to increase the surface available to increase lift.

## Discussion

The methods employed but all gliders is similar, a method to increase surface area and reduce drag. The morphology of flying snakes and frogs involves a light weight and thin surface area in combination with behavioral changes to create a lift force. The human ski jumpers create this almost exclusively through behavior, using body positioning to create left with only skis adding any surface area. There are rules in place to as the weigh of ski jumpers so that they do not become unweigh.

## Results

Humans can increase lift through body positioning but require equipment to reach speeds needed and have no direct physiological adaptations to aid in gliding. Snakes use mostly physiological adaptations, using their unique structures to glide through the air. Frogs use a more combined approach, using both the physiological adaptations of their feet and body and the behavioral stretching of limbs to increase surface area and control flight. Humans could increase flight time by using surface area increasing suits, such as "Squirrels" suits but in competitions only specific skintight uniforms are allowed that would allow no advantages. As a result it is solely on position and take off that the human ski jumpers are reliant on for gliding.

## References and Photo Resources

- Dudley, R., Byrnes, G., Yanoviak, S. P., Borrell, B., Brown, R. M., & McGuire, J. A. (2007). Gliding and the functional origins of flight: biomechanical novelty or necessity?. *Annual Review of Ecology, Evolution, and Systematics*, 179-201
- Holden, D., Socha, J. J., Cardwell, N. D., & Vlachos, P. P. (2014). Aerodynamics of the flying snake *Chrysopelea paradisi*: how a bluff body cross-sectional shape contributes to gliding performance. *The Journal of Experimental Biology*, 217(3), 382-394.
- International Ski Federation Ski Competition Equipment Rules and Regulations, September 2013. Available online at : [http://www.fis-ski.com/mm/Document/documentlibrary/NordicCombined/04/30/53/CompetitionEquipment\\_1314\\_30.09.2013\\_clean\\_English-L\\_Neutral.pdf](http://www.fis-ski.com/mm/Document/documentlibrary/NordicCombined/04/30/53/CompetitionEquipment_1314_30.09.2013_clean_English-L_Neutral.pdf)
- McCAY, M. G. (2001). Aerodynamic stability and maneuverability of the gliding frog *Polypedates dennysi*. *The Journal of experimental biology*, 204(16), 2817-2826.
- Müller, E., & Schwameder, H. (2003). Biomechanical aspects of new techniques in alpine skiing and ski-jumping. *Journal of sports sciences*, 21(9), 679-692.
- Socha, J. J., & LaBarbera, M. (2005). Effects of size and behavior on aerial performance of two species of flying snakes (*Chrysopelea*). *Journal of experimental biology*, 208(10), 1835-1847.
- Socha, J. J., O'Dempsey, T., & LaBarbera, M. (2005). A 3-D kinematic analysis of gliding in a flying snake, *Chrysopelea paradisi*. *Journal of Experimental Biology*, 208(10), 1817-1833.
- Oliver, J. A. (1951). "Gliding" in Amphibians and Reptiles, with a Remark on an Arboreal Adaptation in the Lizard, *Anolis carolinensis* Voigt. *American Naturalist*, 171-176.
- Virmavirta, M., Kivekäs, J., & Komi, P. V. (2001). Take-off aerodynamics in ski jumping. *Journal of Biomechanics*, 34(4), 465-470.
- Burty, Simon. Simon Ammann, 2010 Sports Illustrated. Available at : [http://sportsillustrated.cnn.com/2010/olympics/2010/writers/phil\\_taylor/02/16/skinny.ski.jumpers/](http://sportsillustrated.cnn.com/2010/olympics/2010/writers/phil_taylor/02/16/skinny.ski.jumpers/)
- Laman, Tim. *Rahcophorus nigropalmatus*, 2010 National Geographic. Available at : <http://animals.nationalgeographic.com/animals/amphibians/wallaces-flying-frog/>
- Laman, Tim. *Chrysopelea* In Singapore Zoo, 2010 Natiaol Geographic. Available at : <http://news.nationalgeographic.com/news/2010/11/101124-flying-snakes-fly-science-darpa-dod-socha/>