

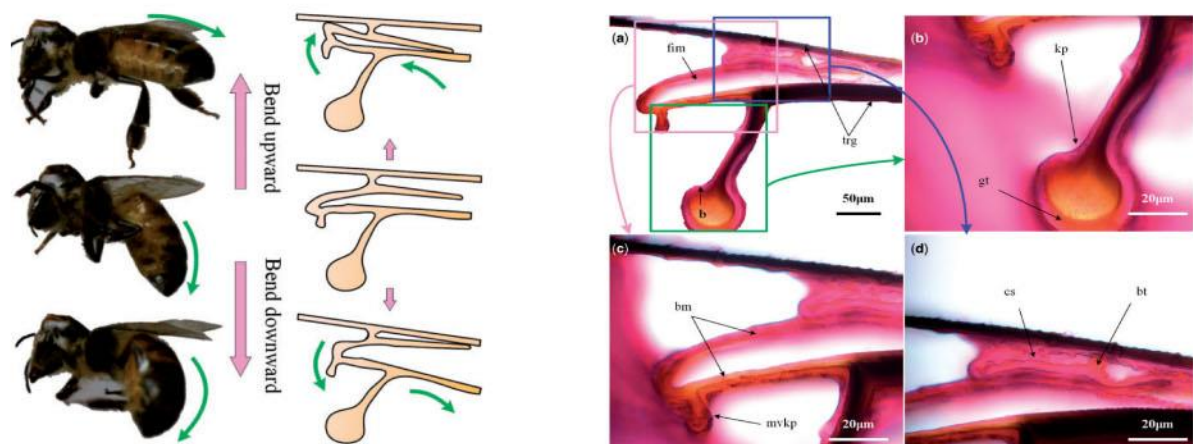
# Morphing Nose Cone Based on Honey Bee Abdomen

## Abstract

- Morphing aircraft can change its own aerodynamic profile to suit different environments.
- The nose cone is the key to changing the air resistance of the aircraft. The deformation characteristics required for the cone are very similar to those of bee's abdomen.
- Based on the abdomen of the bee, a morphing nose cone of the aircraft was designed and its kinematics was analyzed and simulated, which is vital in aerospace vehicle design.

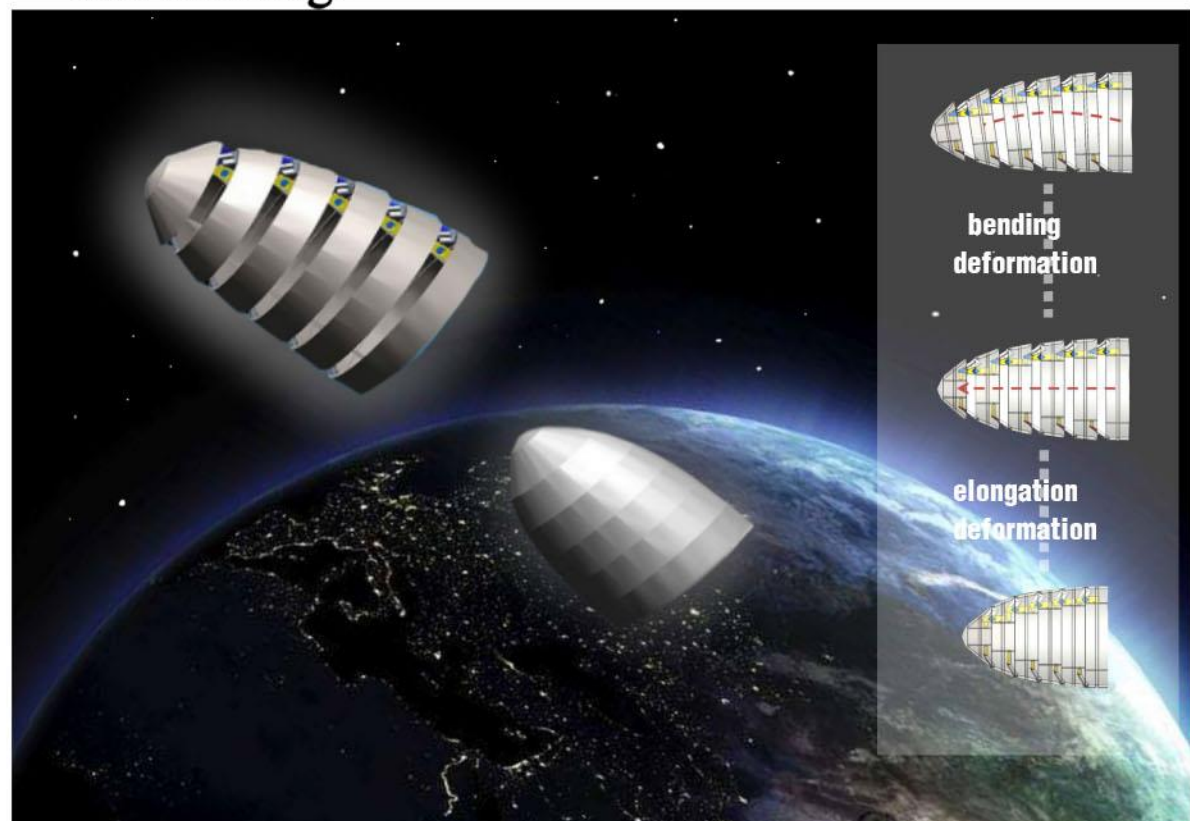
## Methods

- Observe the honey bee's abdomen to find how bees can telescope its abdomen and bend it to only one direction-downward.
- Imitate the macro structure of bee's abdomen to design the structure of the nose cone, and imitate the micro structure to design the location and form of deformation mechanism.
- Design the motion scheme of deformation mechanism with the concept of metamorphic mechanism. Then the dimension of the deformation mechanism was designed according to the design targets of deformation.
- Build the three-dimensional model of the morphing cone, and do the kinematic simulation of morphing process to choose an appropriate driving motion for this nose cone.



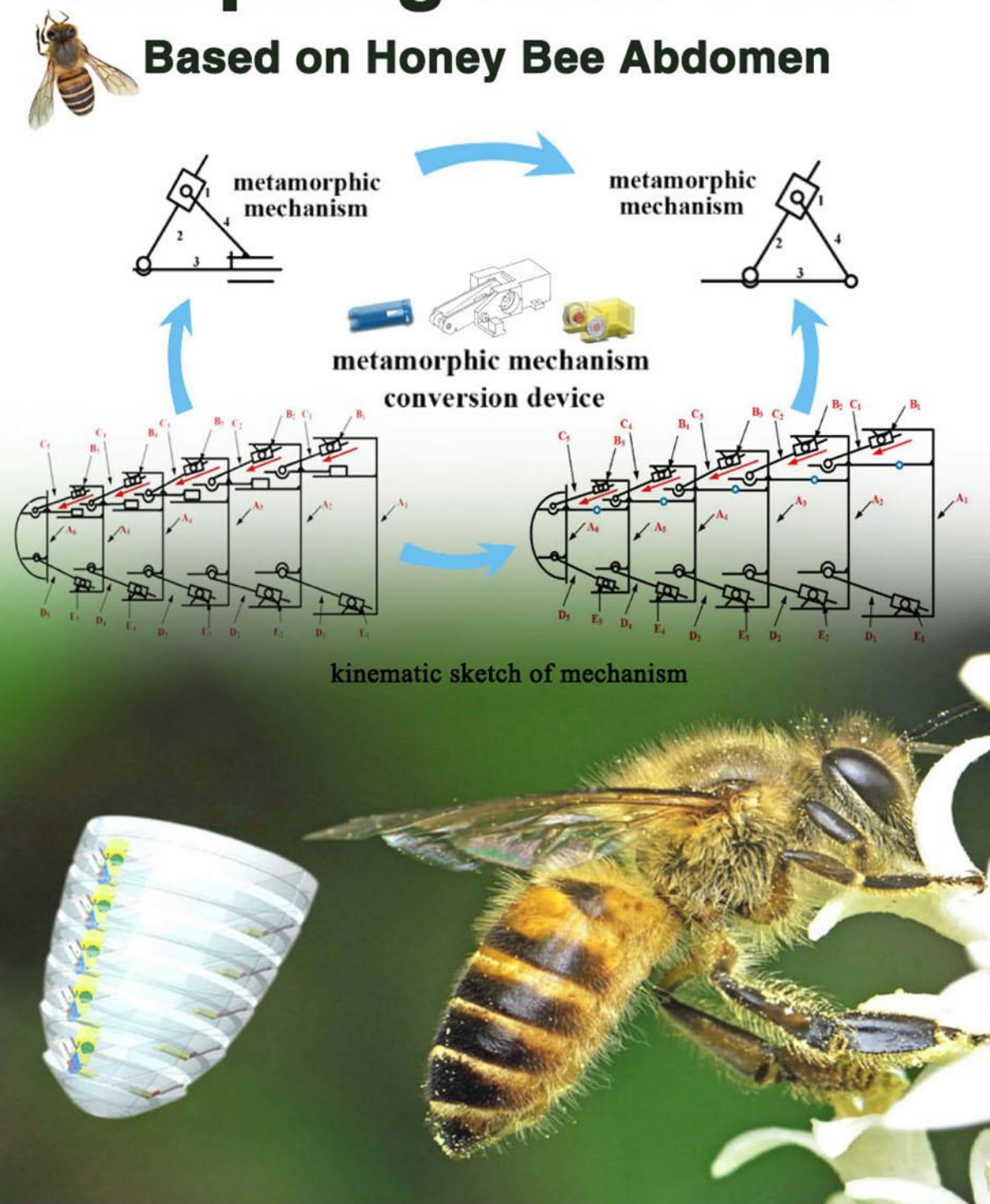
## Results

- Morphing Process: morphing of aerodynamic shape when flight environment changes, including elongation and bending.



## Morphing Nose Cone

### Based on Honey Bee Abdomen



## Results

- The assembly structure of the morphing cone was designed, including the assembly structure of the entire nose cone, the assembly structure of the configuration conversion device of deformation mechanism, the assembly structure of the locking and unlocking mechanism.
- The sinusoidal drive was selected as a reasonable driving method for the morphing process of nose cone.
- The research on folded intersegmental membrane of bee has been reported worldwide, including Discovery, Xinhua News, the headline in Tech Daily, etc. This work will significantly promote the future air-space research in China.

## Papers and Patents

- [Redacted] Critical Structure for Telescopic Movement of Honey bee (Insecta: Apidae) Abdomen: Folded Intersegmental Membrane[J]. Journal of Insect Science, 2016,16(1):79.
- [Redacted] Movement Analysis of Flexion and Extension of Honeybee Abdomen Based on an Adaptive Segmented Structure[J]. Journal of Insect Science, 2015,15(1):109.
- [Redacted] Design and analysis of bio-mimetic nose cone for morphing of aerospace vehicle [J]. Journal of Bionic Engineering, 2017, 14(2): 317-326.
- [Redacted] Morphing nose cone device based on bee's abdomen: China, 201710766420.4 [P], 2017-08-30.