

## INTRODUCTION

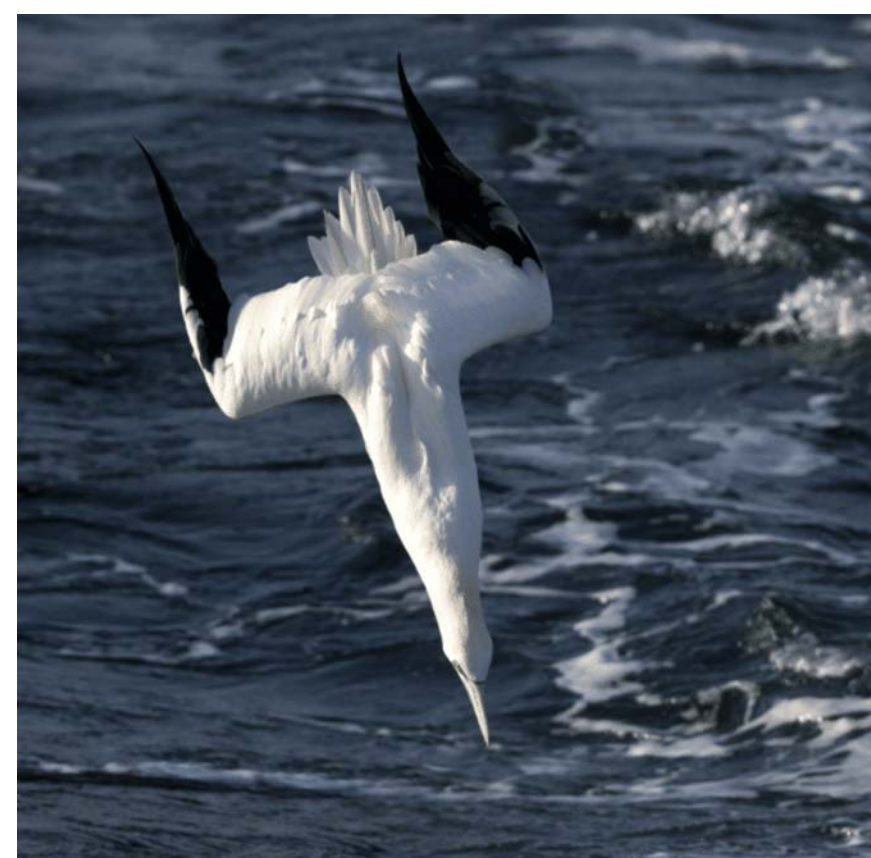


Fig. 1: Northern Gannet mid-plunge

- Diving birds can withstand repeated high-speed water impacts. For example, Northern Gannets reach impact speeds exceeding 60 mph (Lee, 1981).
- The neck structure appears to be unable to withstand such forces, being susceptible to buckling due to its long, slender, segmented, and bent nature upon impact, see Figure 2.



Fig. 2: Chang et.al.(2016) Scan of gannet neck as positioned during impact

- Previous work has investigated how compliance changes water entry forces and showed that there are no significant losses, but instead significant gains in lowering impact force when introducing compliance, see Figure 3.
- The goal is to investigate the effect of segmentation and muscular structure on wave propagation through the neck.

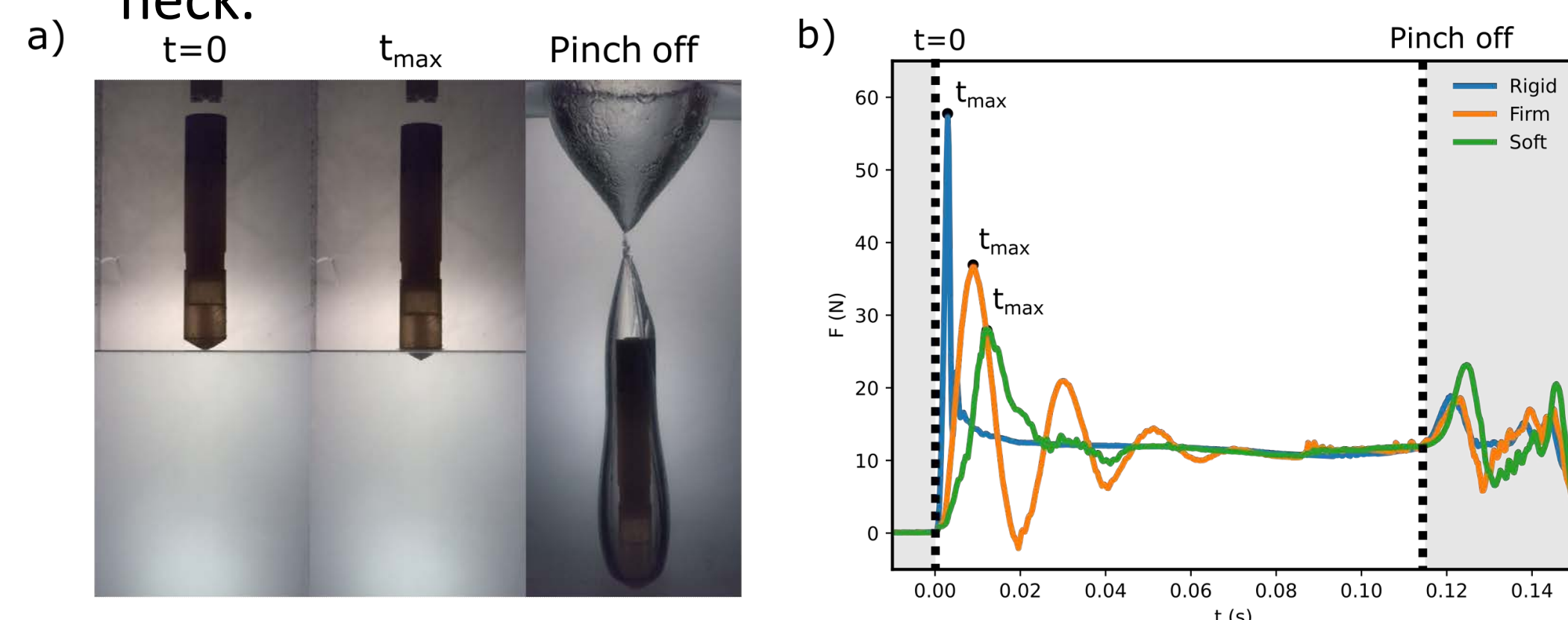


Fig. 3: a) Water entry time points. b) Force evolution of the body of the projectile.

## METHODS

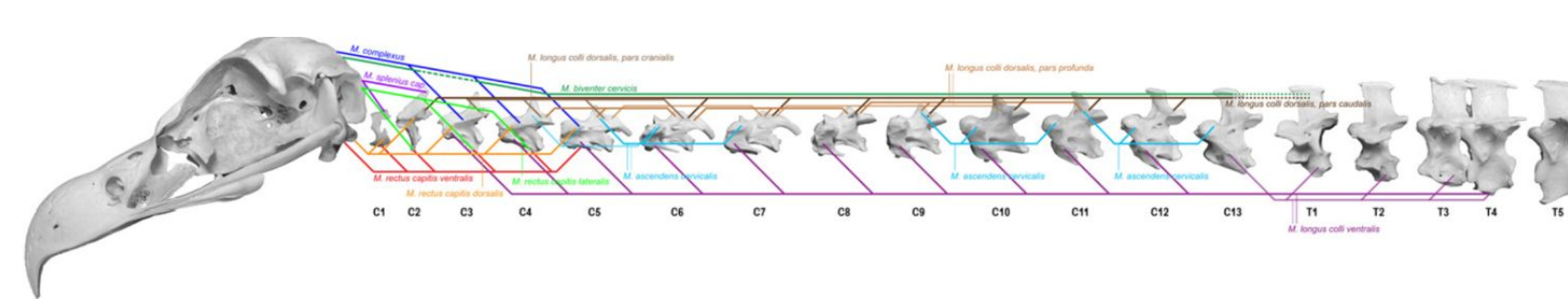


Fig. 4: Cinereous vulture (*Aegypius monachus*) neck muscle structure  
Bohmer(2020)

- Kuroda (1962) and Bohmer (2020) demonstrated the strong correlation between muscle connections, feeding behavior, and their complexity, see Figure 4.
- The intricate shape of vertebrae and muscular connections is simplified to develop a physical model.
- Consequently, experimental investigation is conducted to calibrate our mathematical model, see Figure 5.

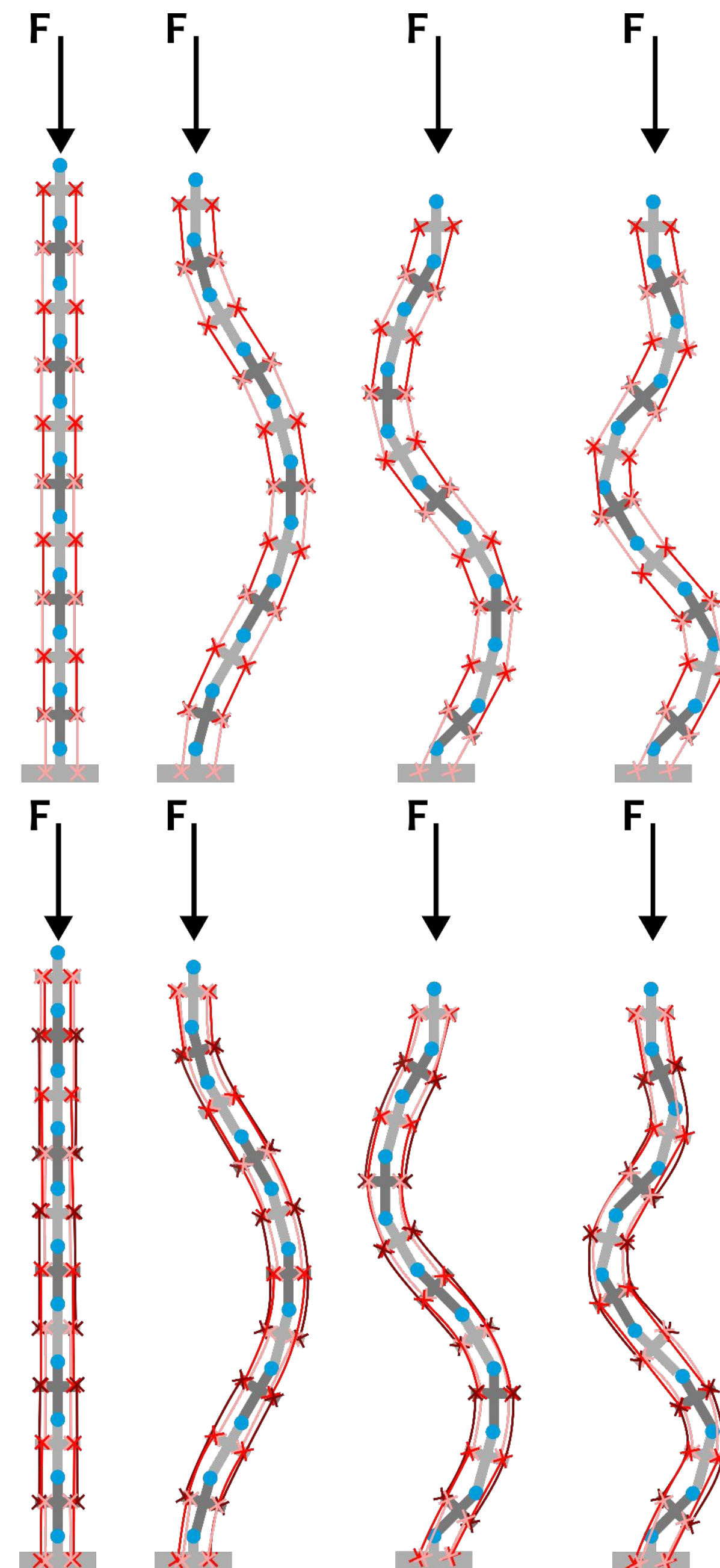


Fig. 5: Two simple muscle configurations

## DISCUSSION

- Vertebrae are simulated using laser-cut plates stacked to create diverse musculature connections.
- Muscles will be replicated using nonlinear elastic cords, see Figure 6.
- Impulse testing will involve a striker imparting an impulse to the system, that will be tracked by utilizing high speed optical tracking techniques.

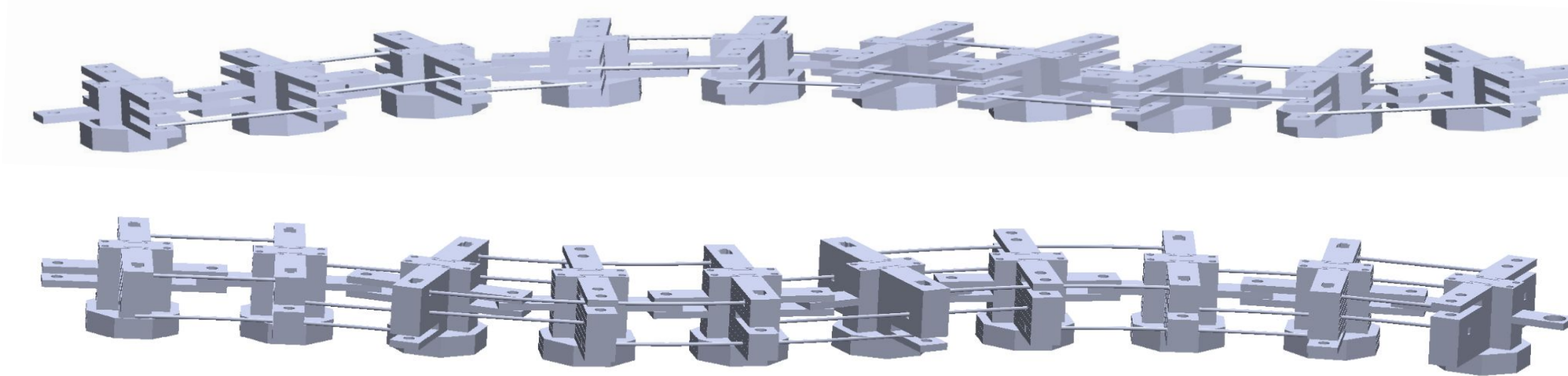


Fig. 6: Computer renderings of two simple configurations

- The hypothesis suggests that experimentally investigating the effect of initial configuration and muscle connections will provide insights into how diving birds can absorb high velocity impacts.

## ACKNOWLEDGEMENTS

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## LITERATURE

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