

# New tools bring new observations of natural history

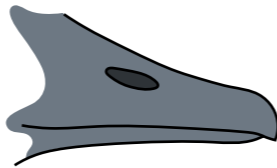
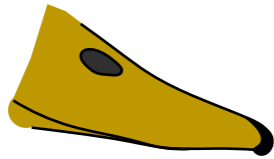


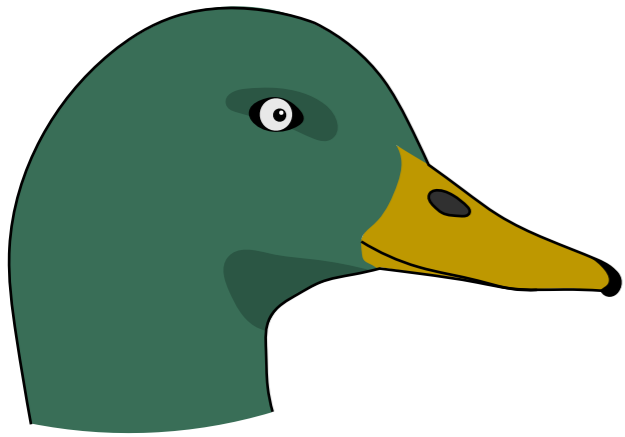
Aaron M Olsen  
Postdoctoral fellow  
Brown University

A project from my PhD

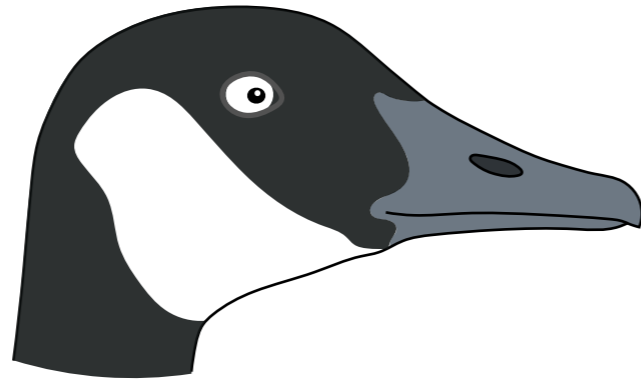
What came first, the duck or the goose?  
And what's the difference?

Which of these is a duck and  
which is a goose?

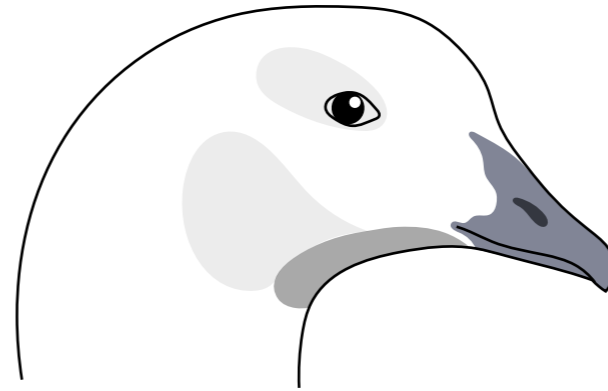




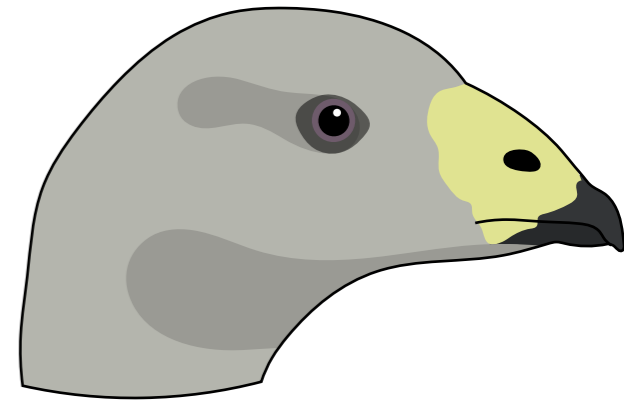
Mallard  
duck



Canada  
goose



Upland  
goose



Cape Barren  
goose



# Methods / Skills I had to acquire

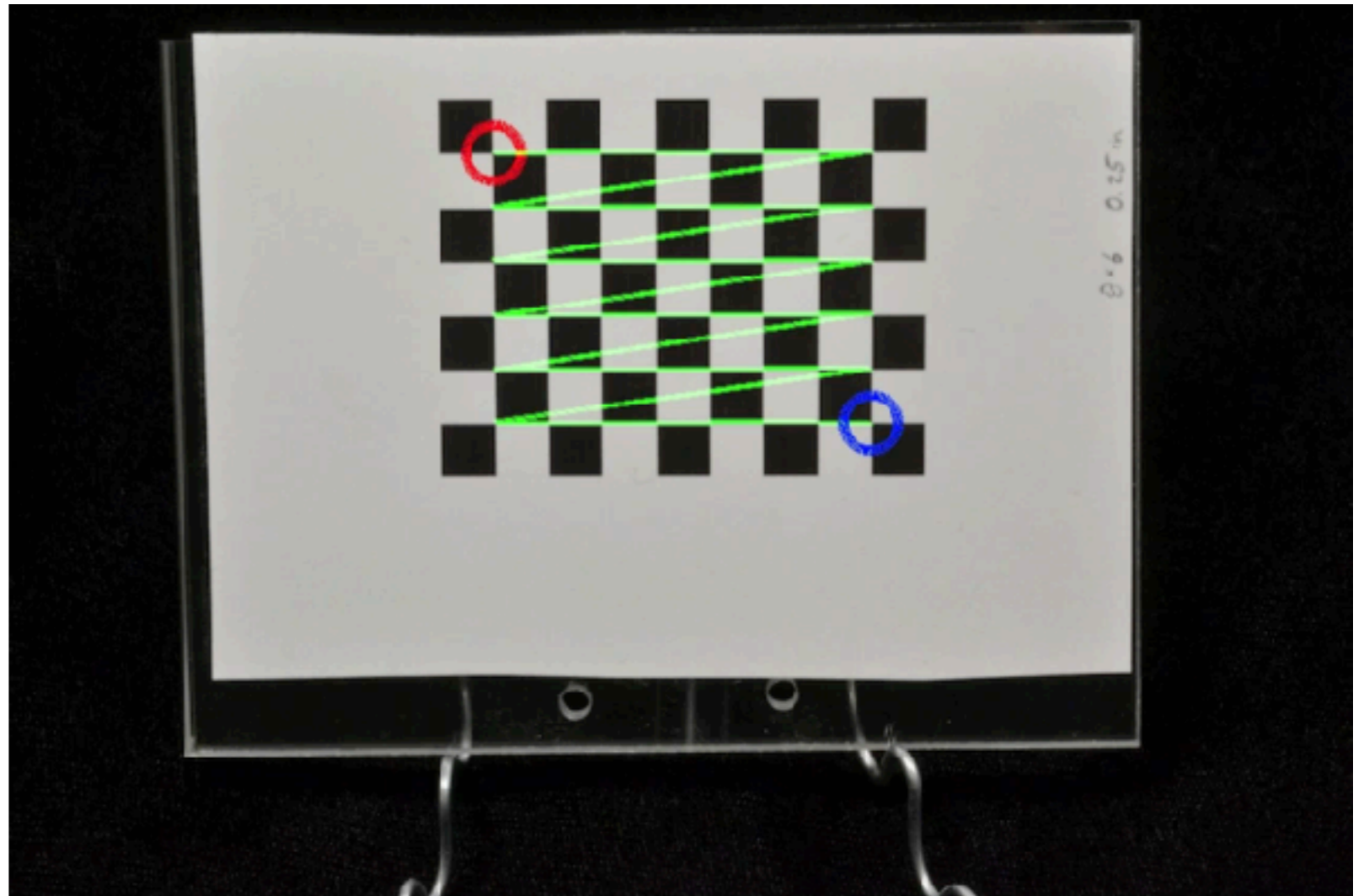
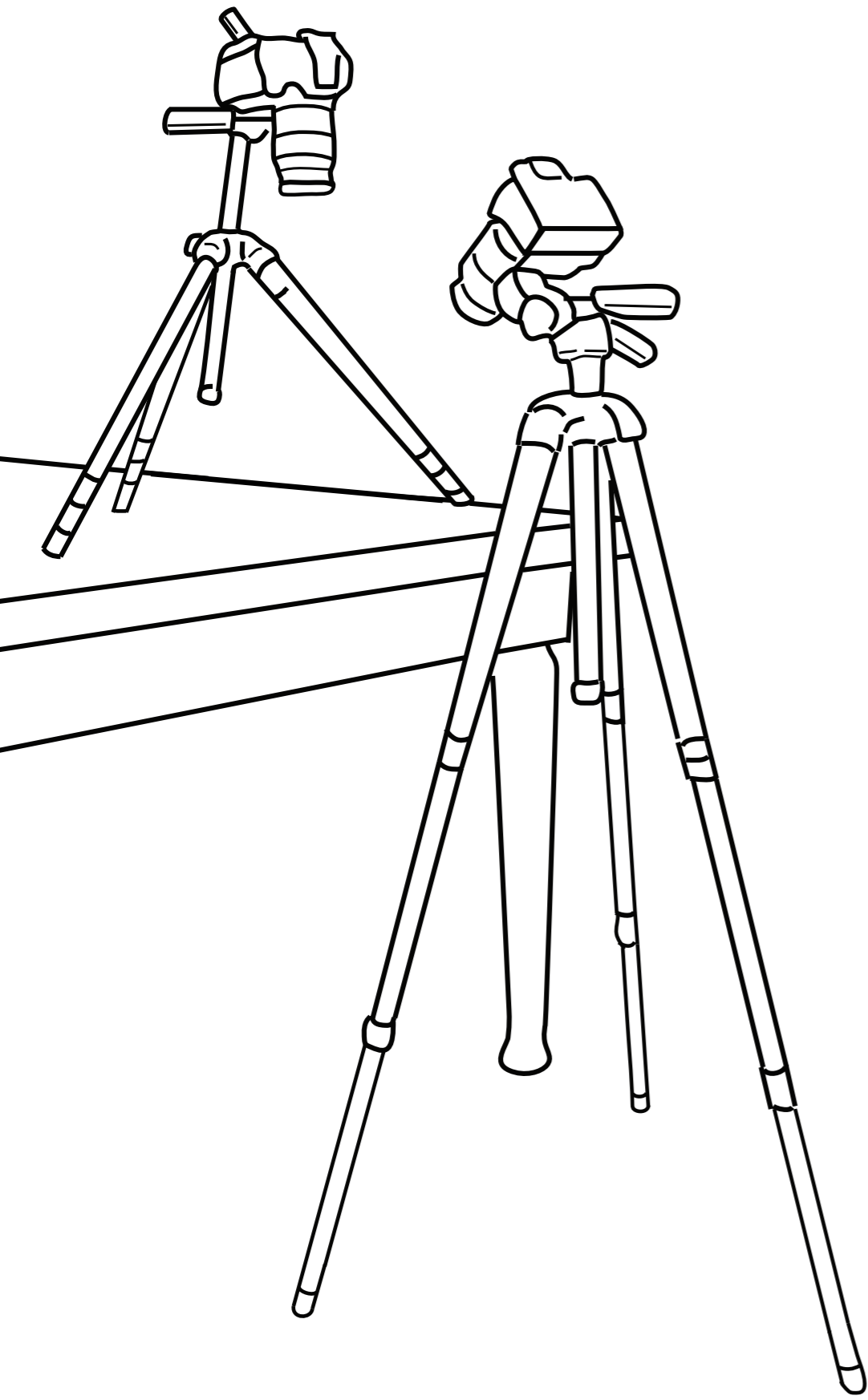
Stereo photography

Statistics (PCA, PLS, evolutionary modeling)

Data visualization

# StereoMorph

3D landmark and curve collection using stereo camera setup



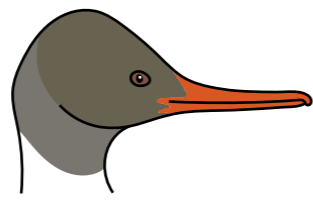
At [cran.r-project.org](http://cran.r-project.org)



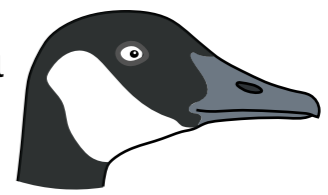


# Waterfowl beaks

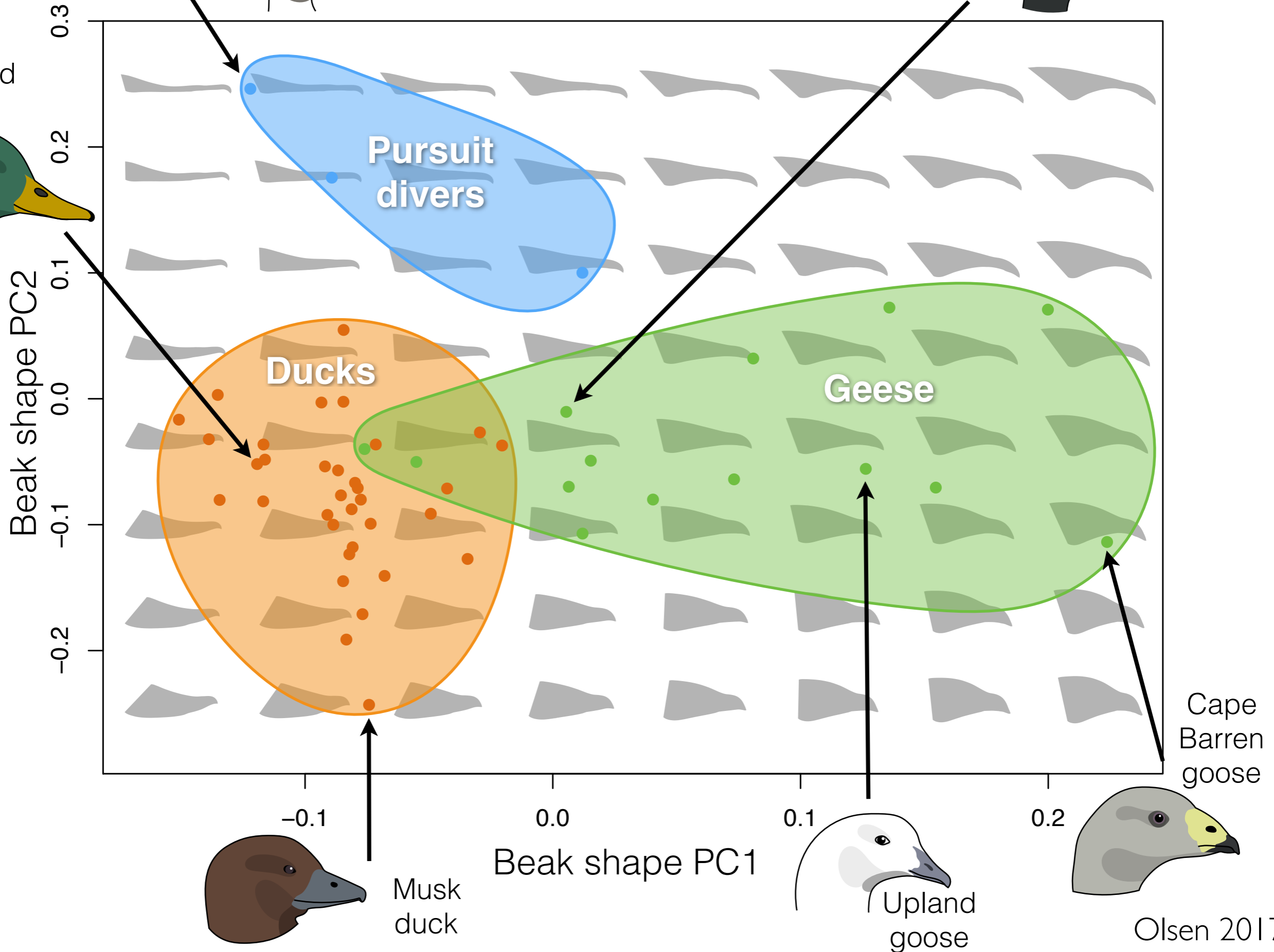
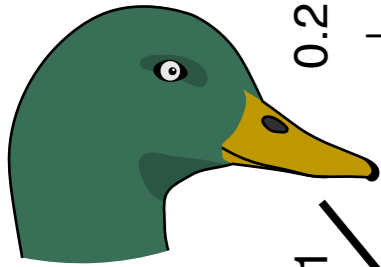
Red-breasted merganser



Canada goose



Mallard duck



Pursuit divers

Ducks

Geese

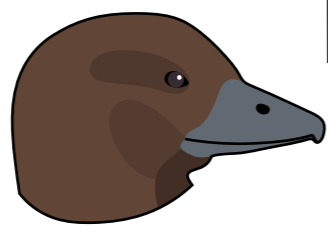
-0.1

0.0

0.1

0.2

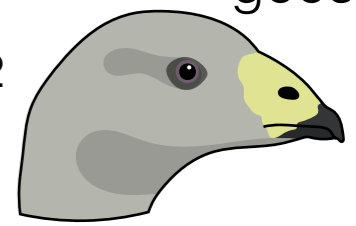
Musk duck



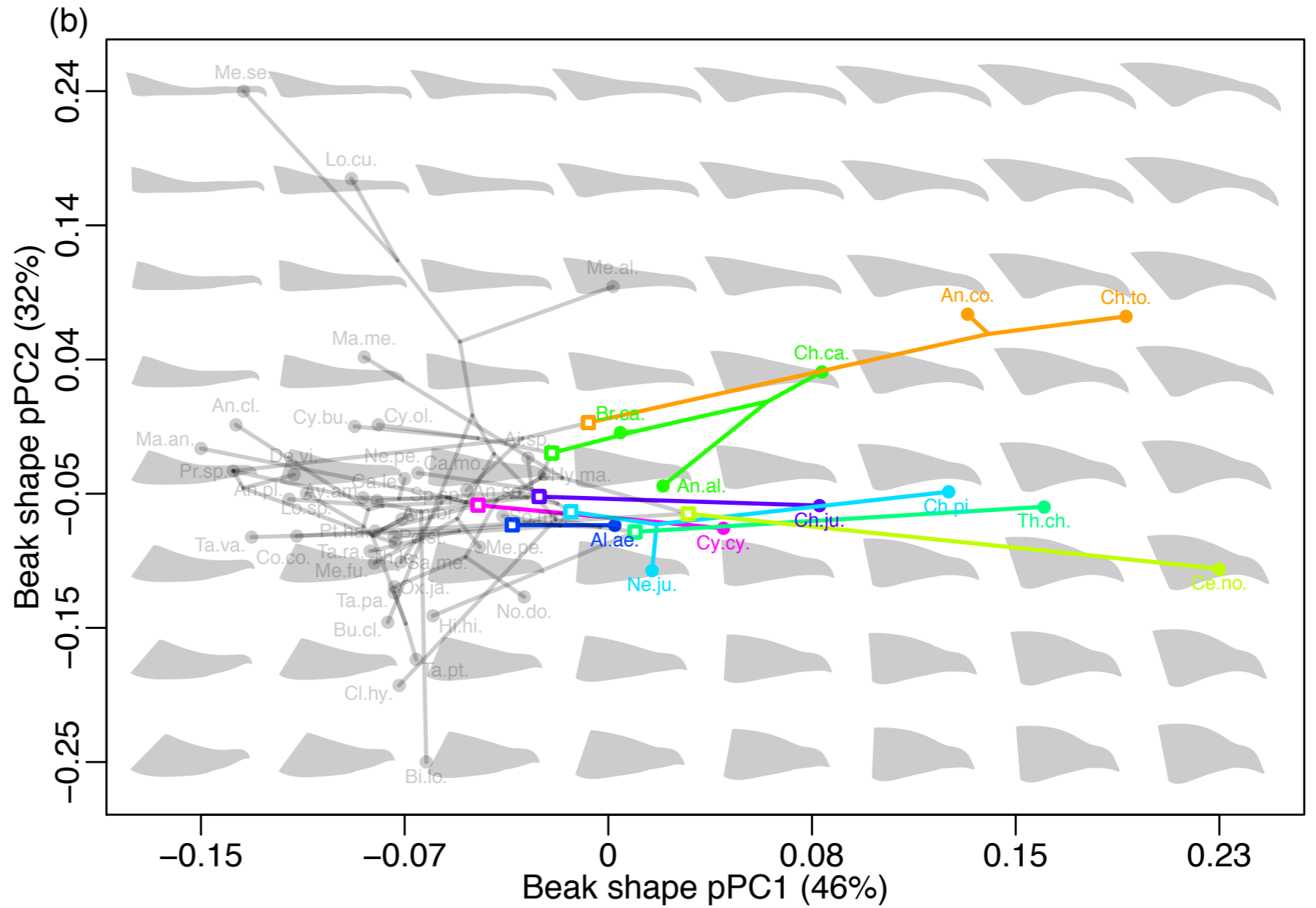
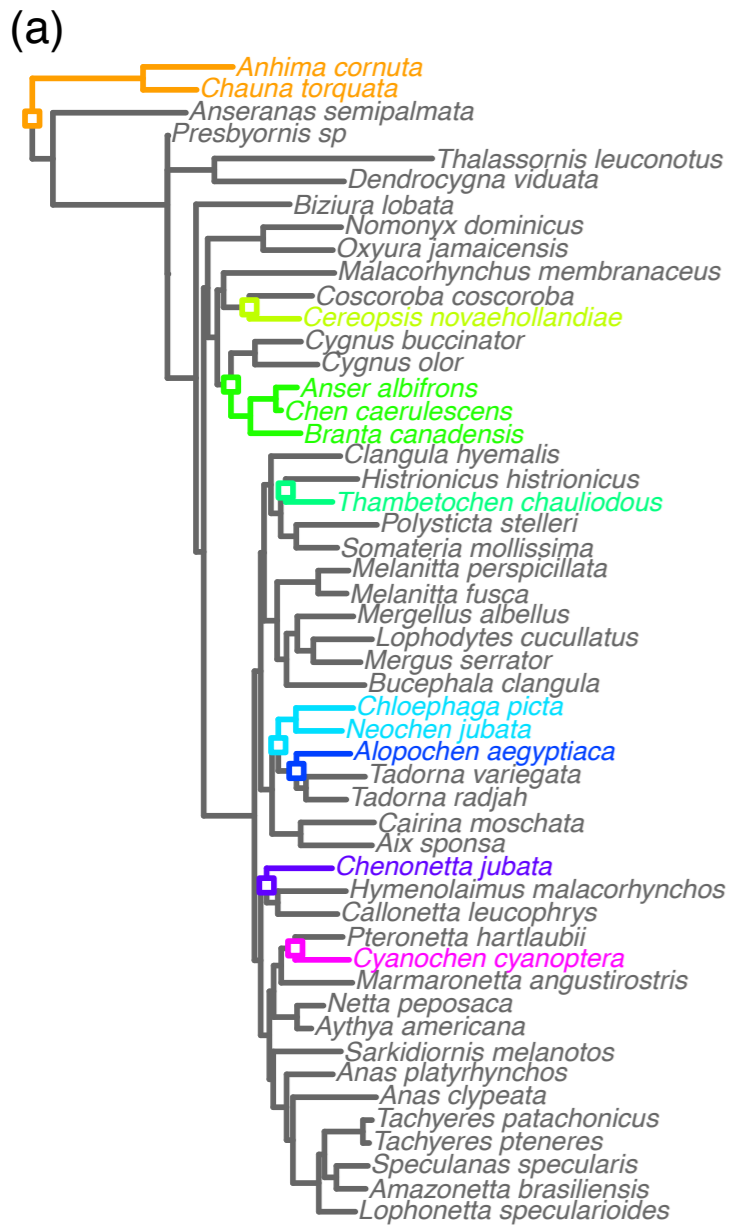
Upland goose

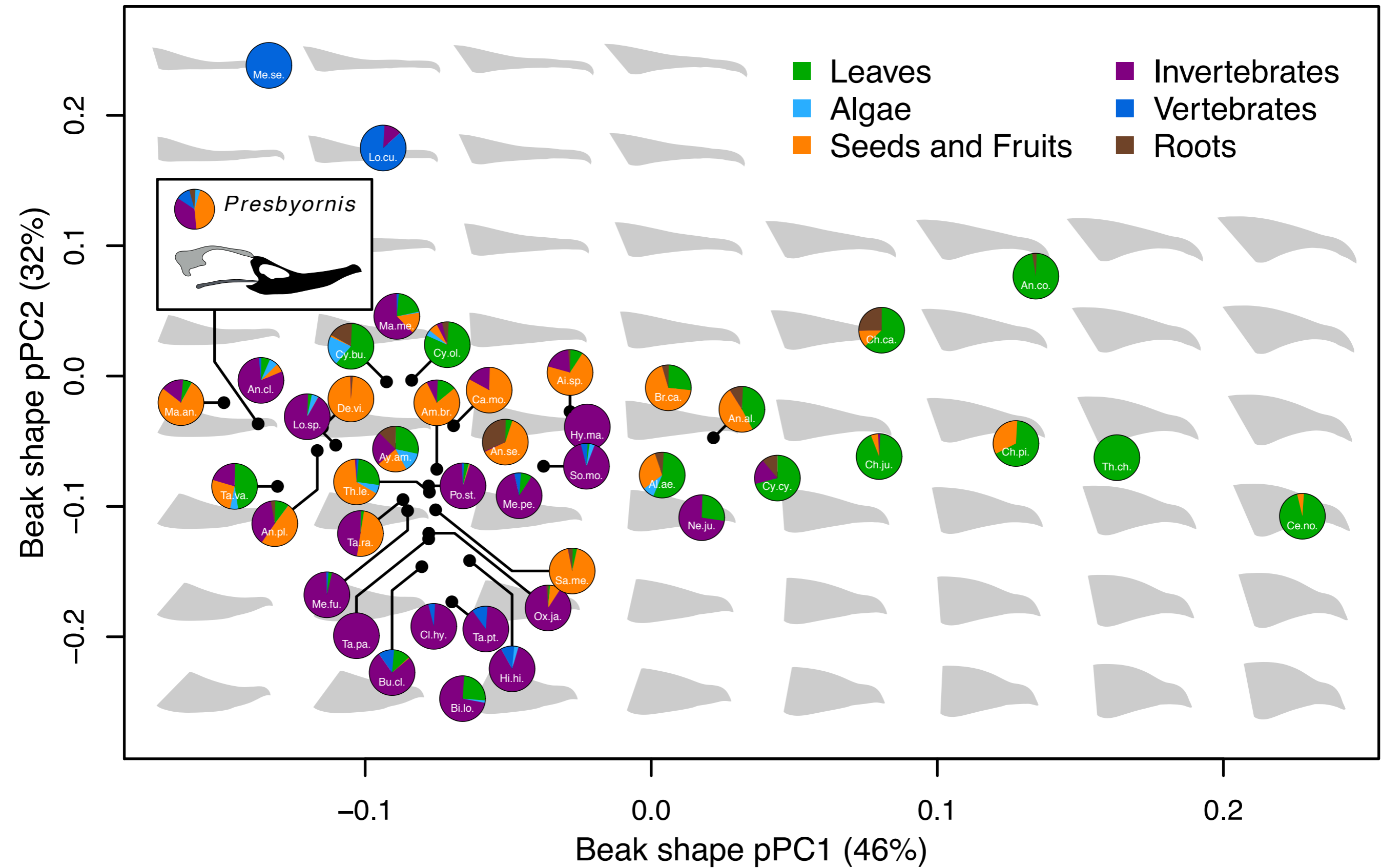


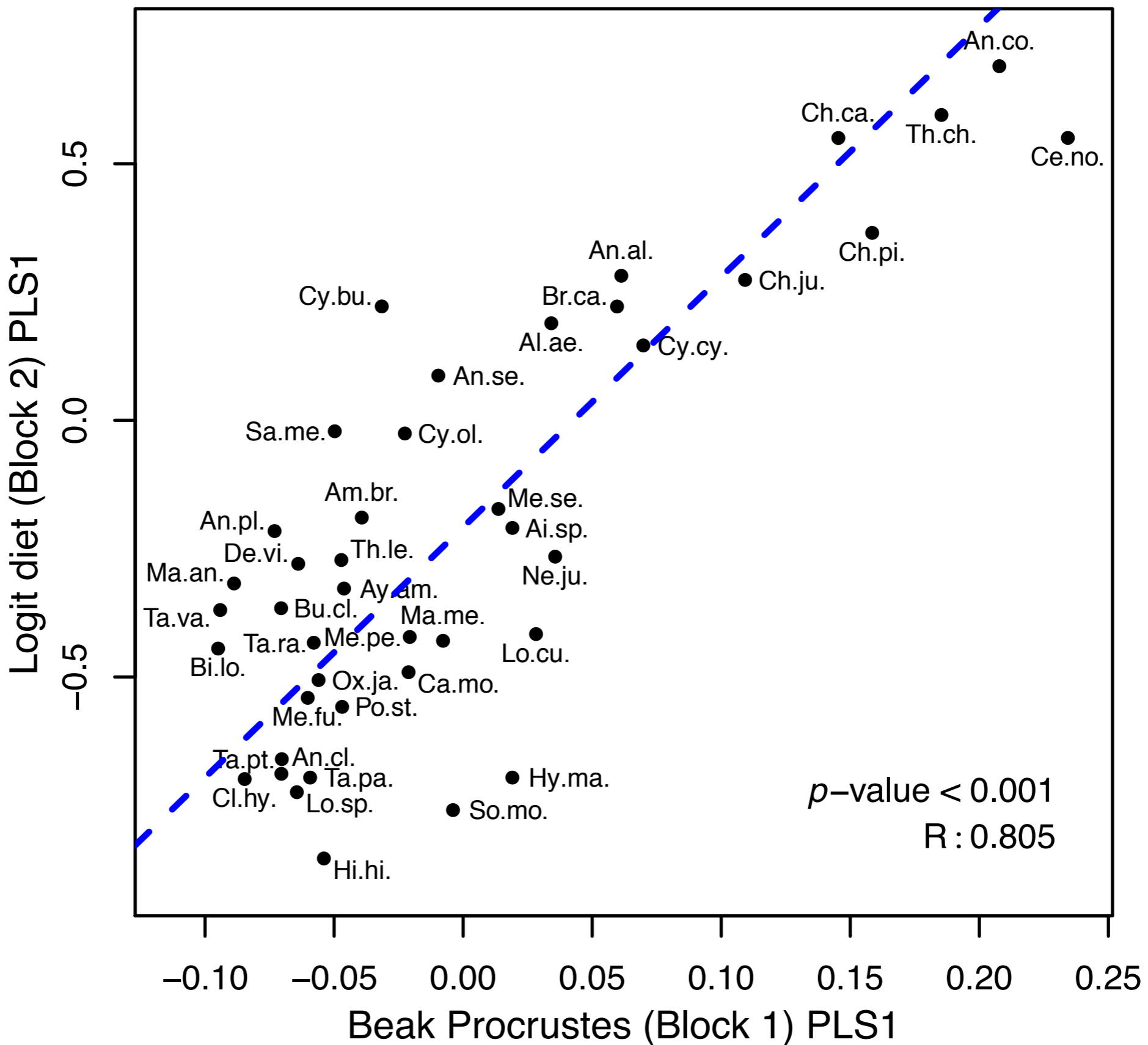
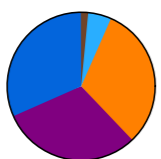
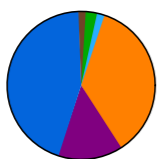
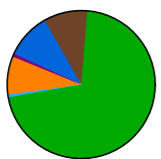
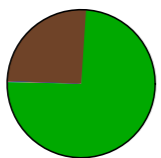
Cape Barren goose



Olsen 2017







# Conclusions

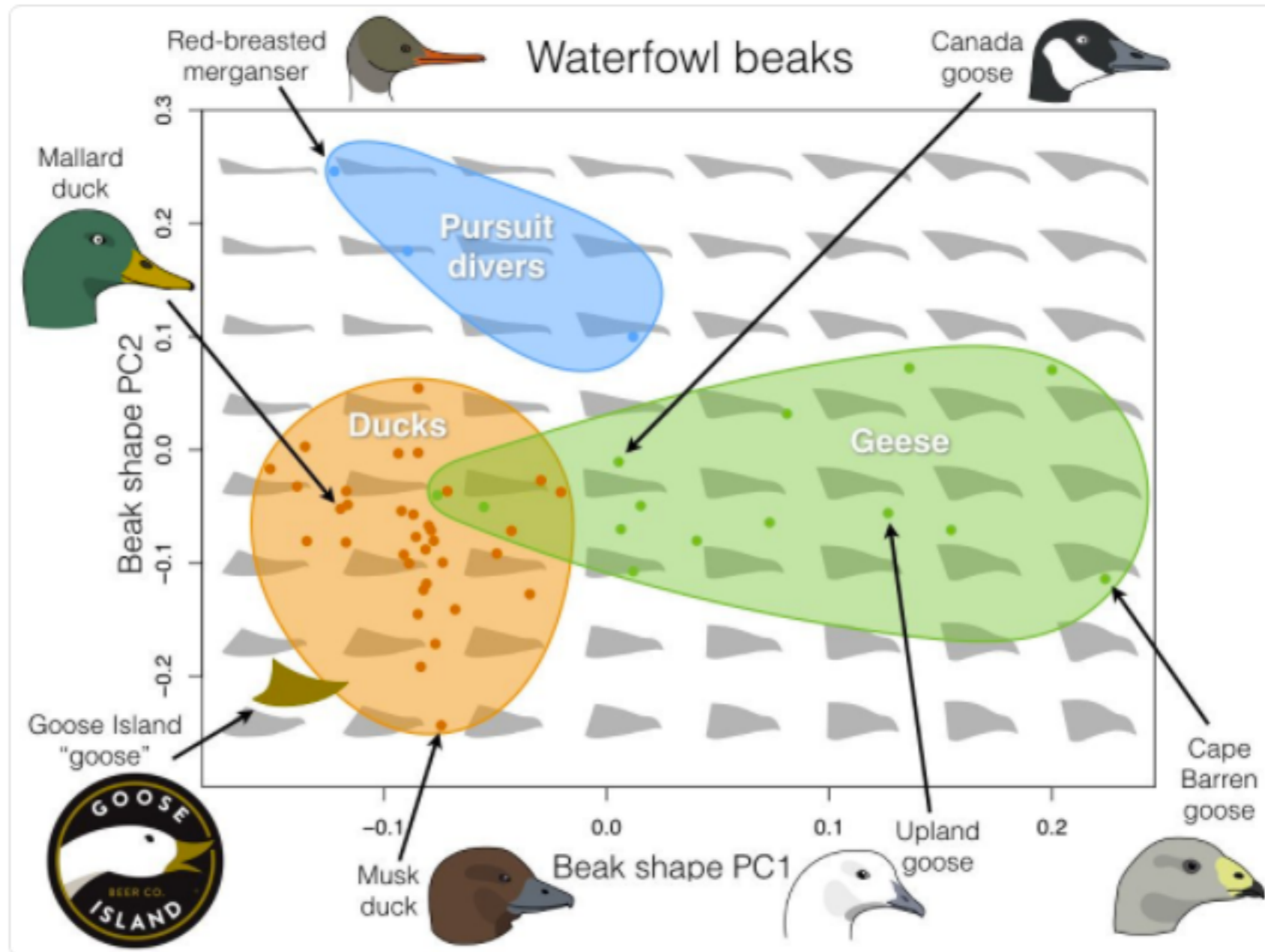
A more "duck-like" beak is probably the ancestral form whereas a more "goose-like" beak has evolved multiple times independently

The evolution of geese is associated with a shift away from a diet rich in seeds and insects and toward a more herbivorous diet



Aaron Olsen @aarolsen · May 31

Based on my new analysis of waterfowl beaks it appears that the @GooseIsland "goose" is actually a #duck! [onlinelibrary.wiley.com/doi/10.1111/13...](https://onlinelibrary.wiley.com/doi/10.1111/13...)



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40

58





**Aaron Olsen**

@aarolsen



Replying to @aarolsen @GooseIsland

As a @GooseIsland fan (my favorite #GreenLineIPA), may I suggest a more anatomically accurate logo? #birds #beer



7:36 AM - 31 May 2017

3 Retweets 15 Likes



1



3



15





**Goose Island Beer Co**  @Gooseland · May 31

Replying to [@aarolsen](#)

After much deliberation, we will henceforth be known as "Duck Island".  
[#WeAreKeepingTheLogo](#)



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17

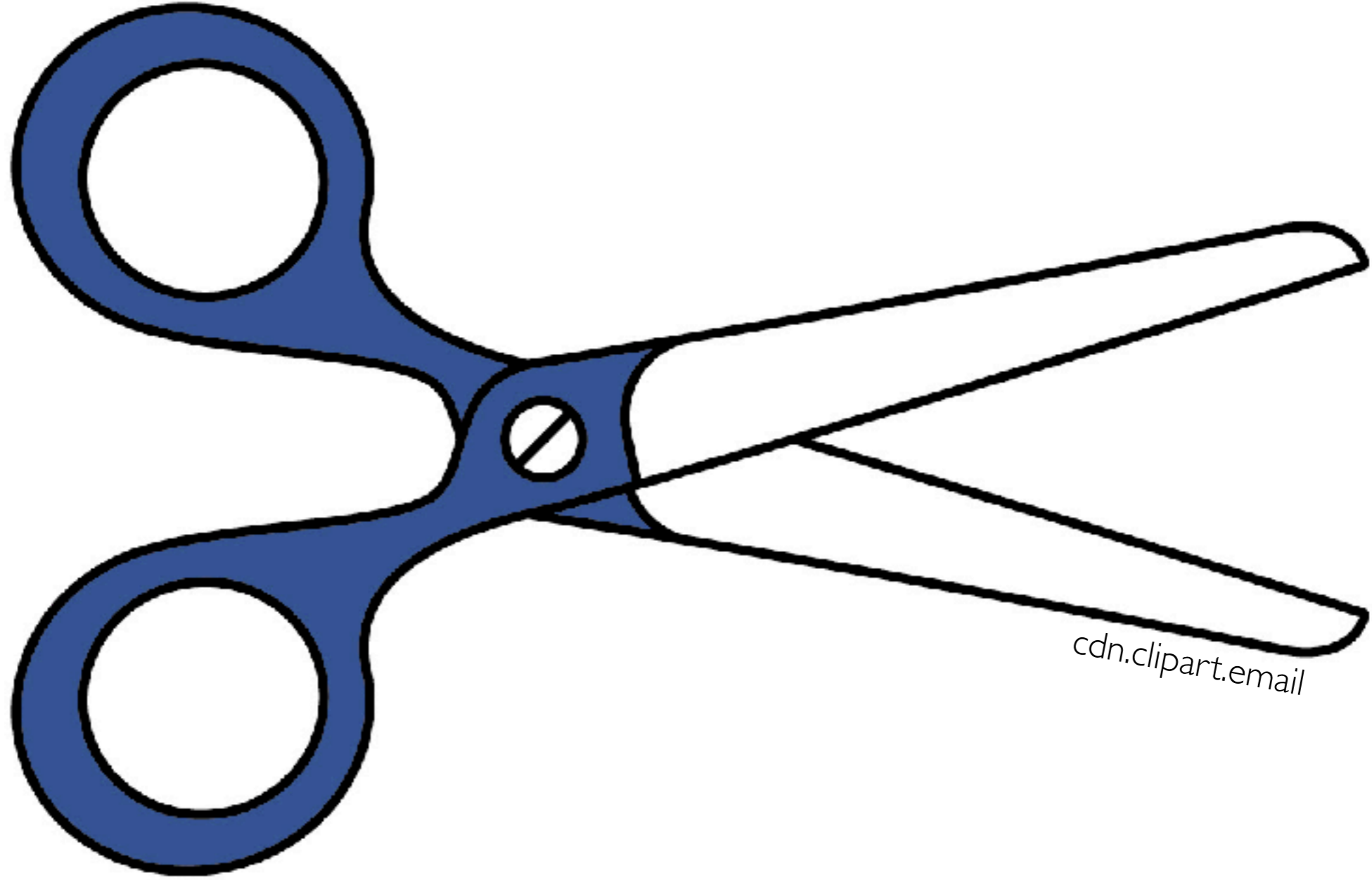




A project from my current work

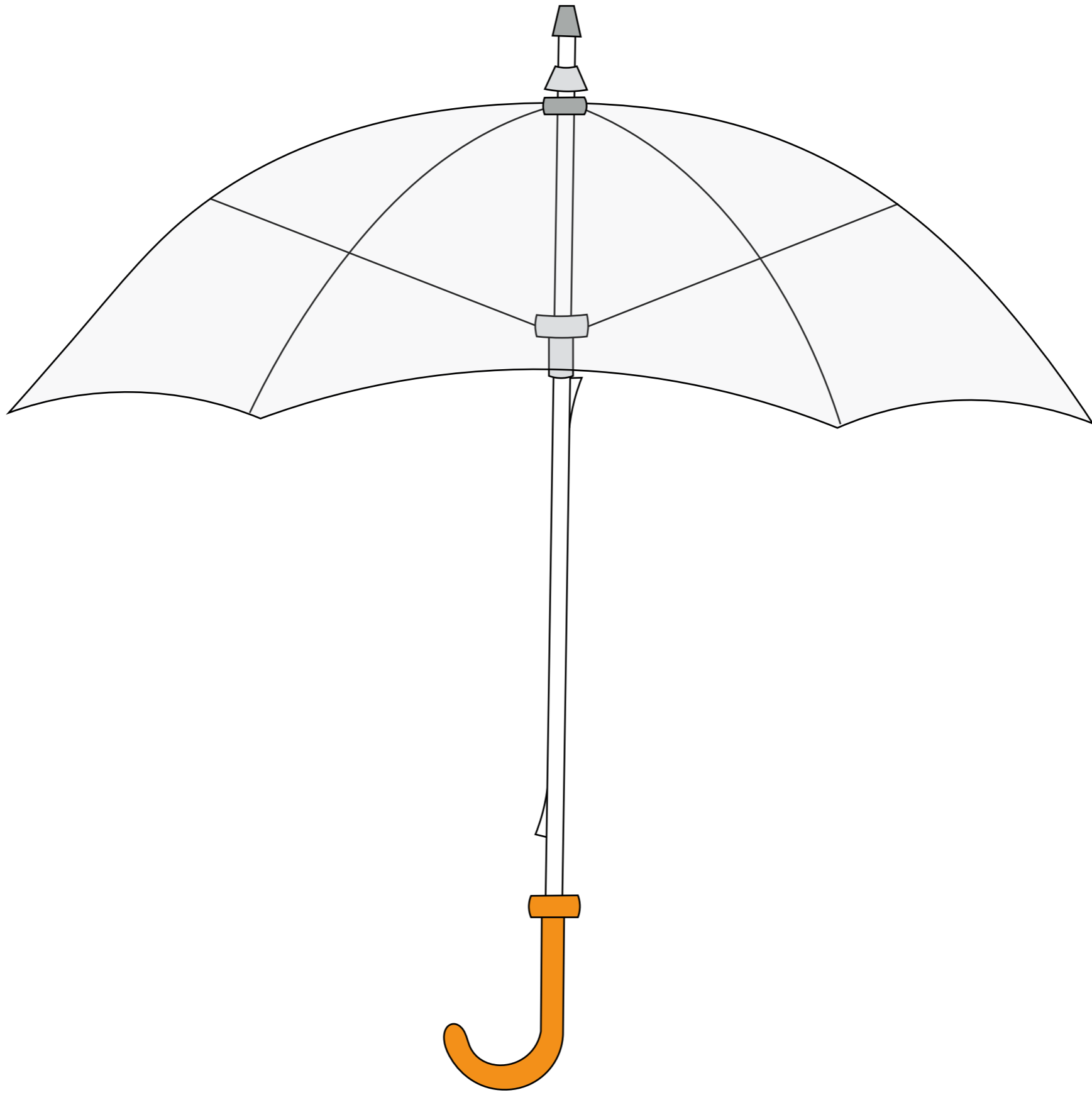
Is a fish head more like an umbrella or an arm?

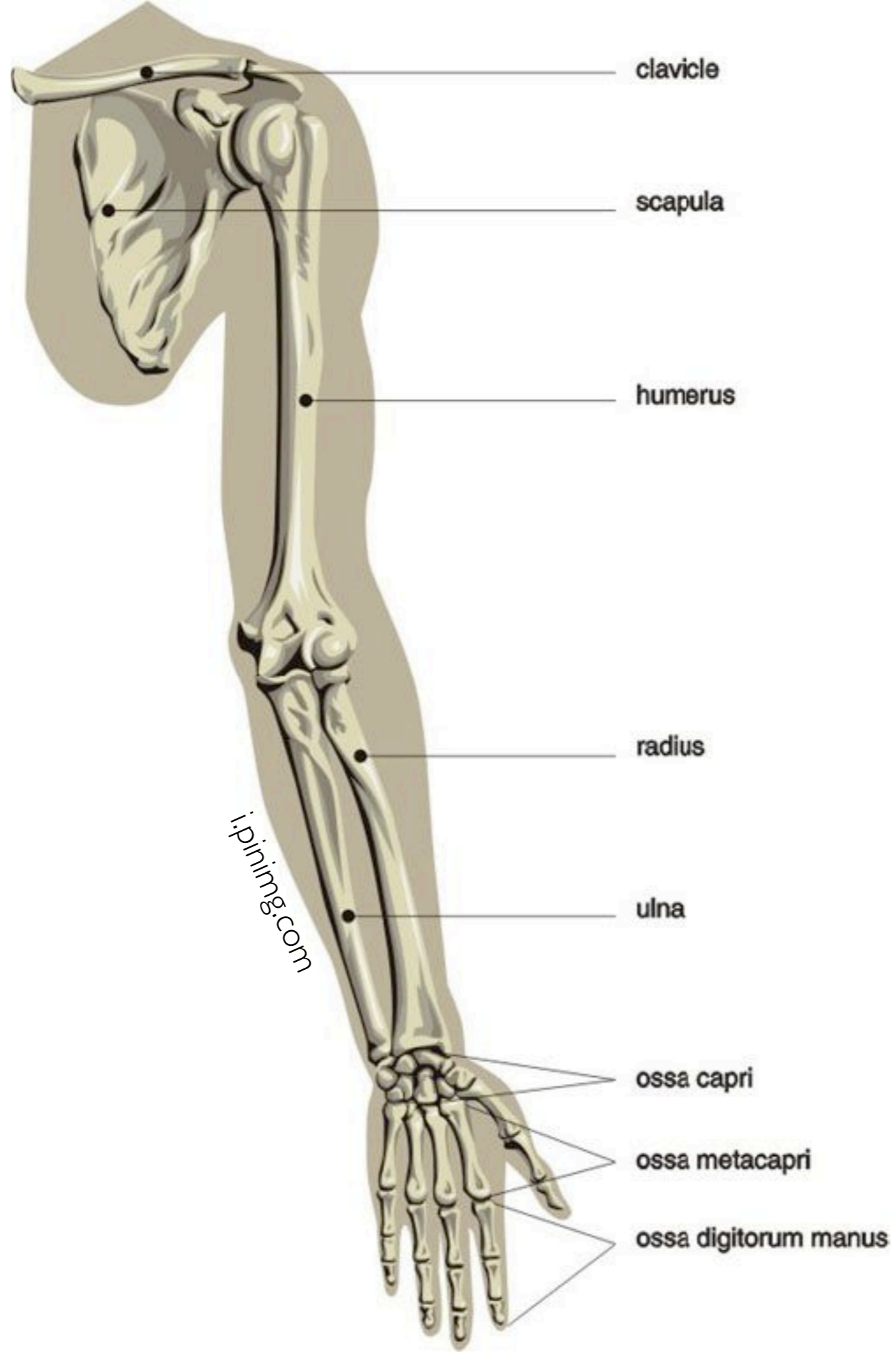
How many degrees of freedom do the following devices or systems have?

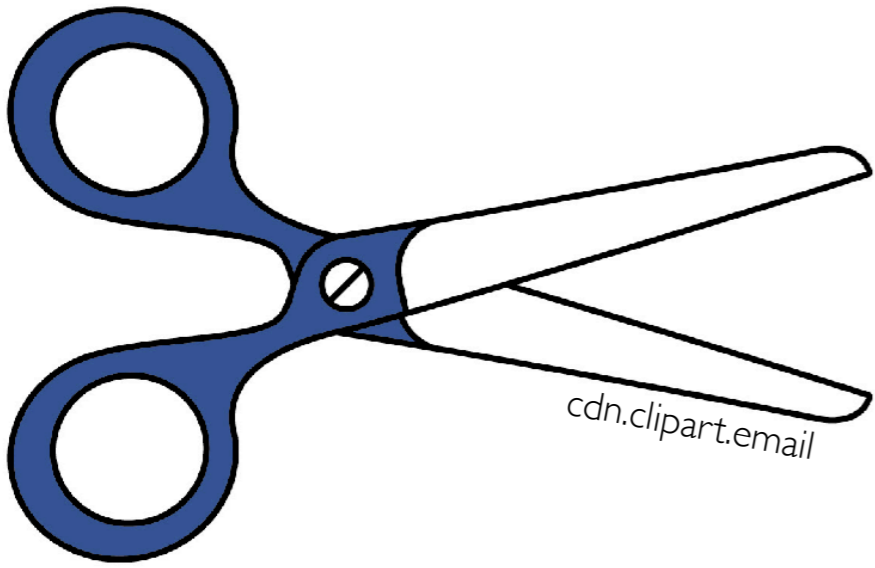


[cdn.clipart.email](mailto:cdn.clipart.email)

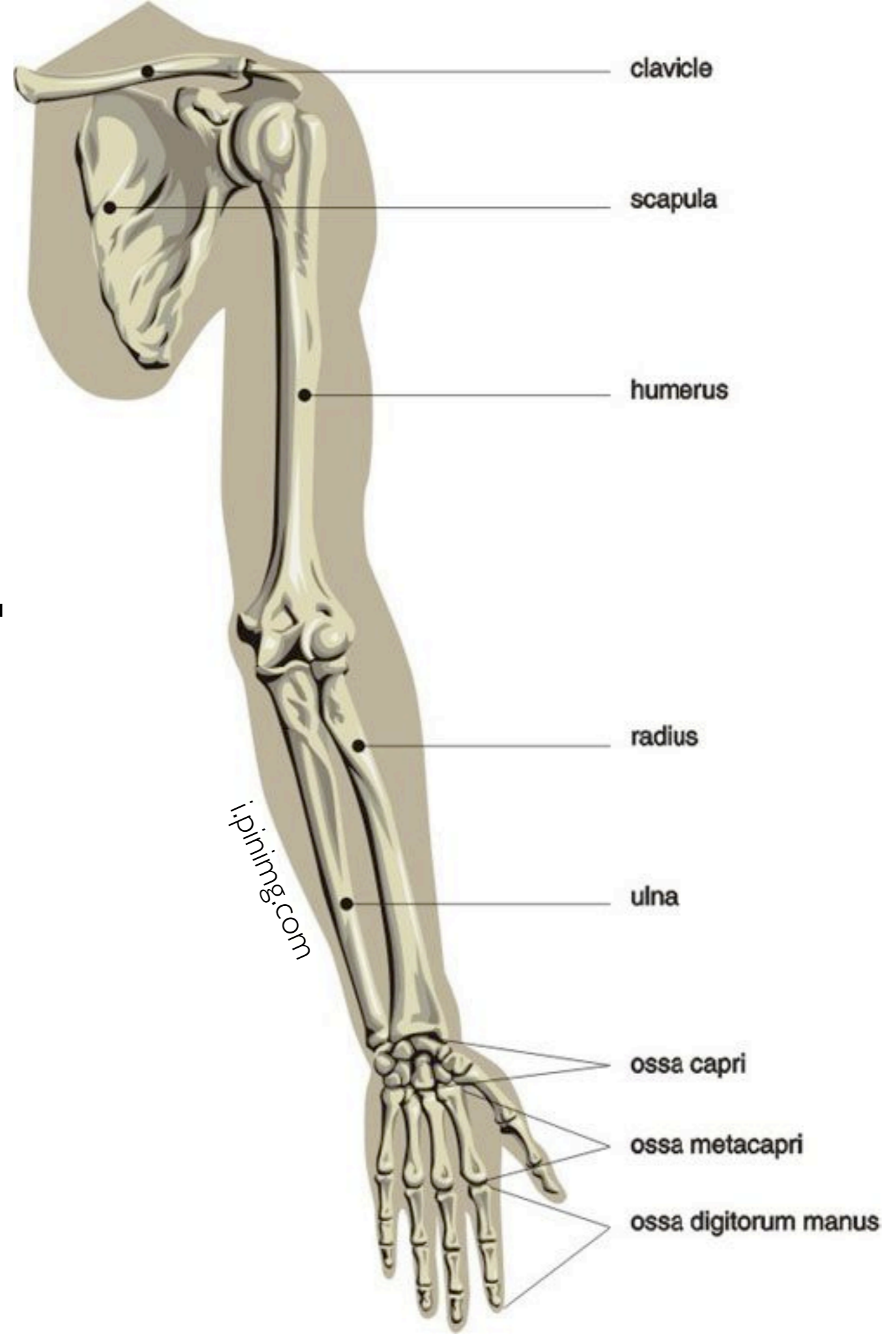








+





Robotic arm

Manuelli et al. (2019) *arXiv preprint*



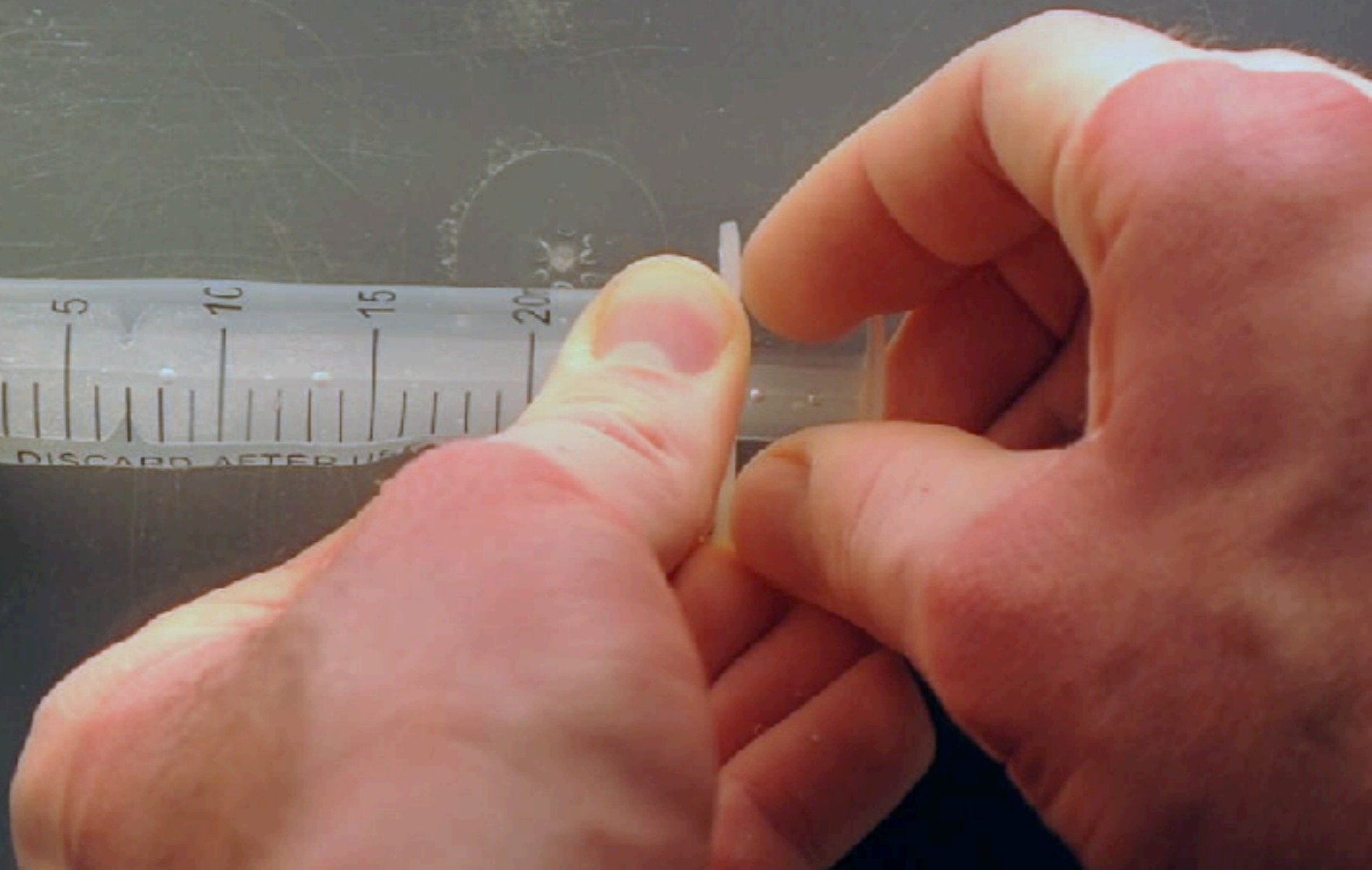
Channel catfish (*Ictalurus punctatus*)



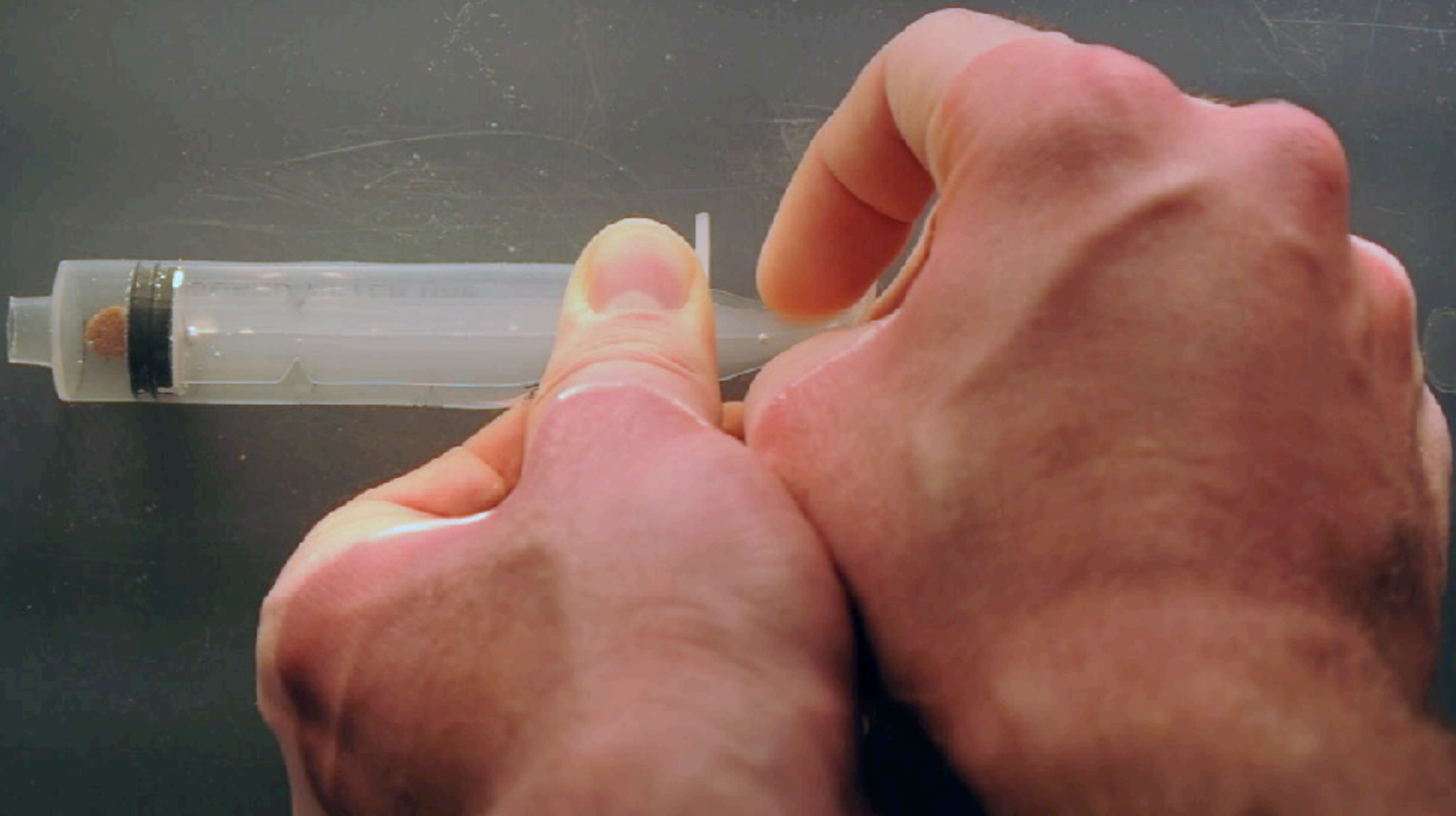


Channel catfish

Video credit: Elizabeth Brainerd





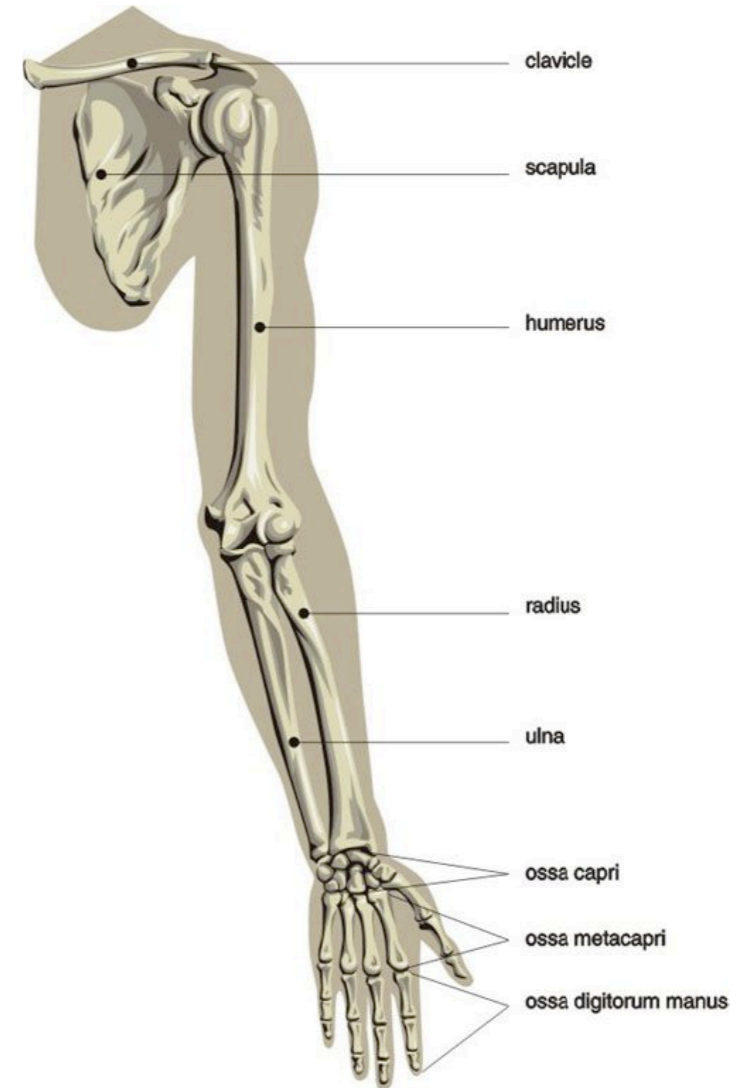


Is a fish head more like an umbrella/  
syringe or an arm?



1-2 DoFs

Simple expansion/  
compression system



>6 DoFs

Complex  
manipulation system

# Methods / Skills I had to acquire

Basic surgical techniques

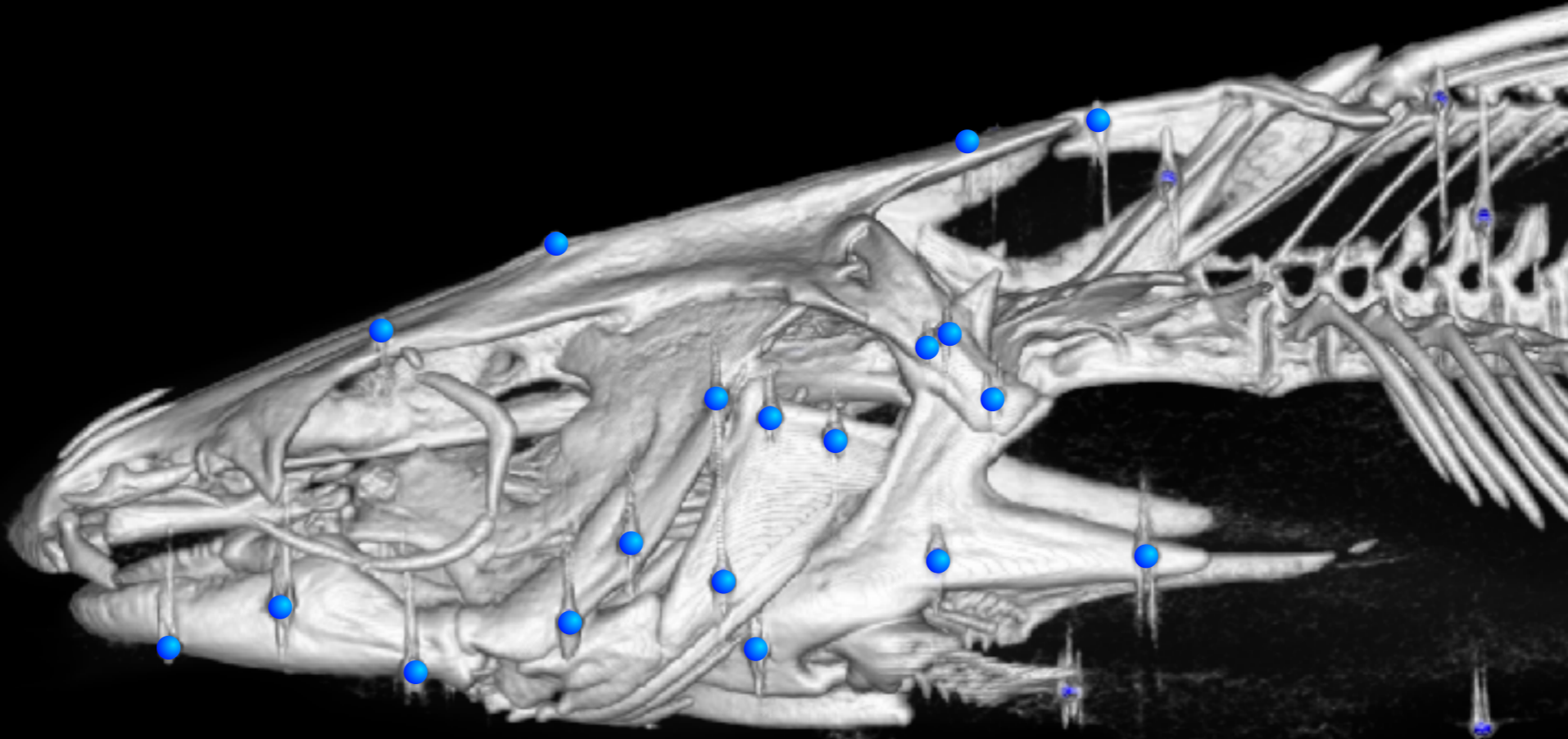
X-ray stereo videography

Mechanical modeling

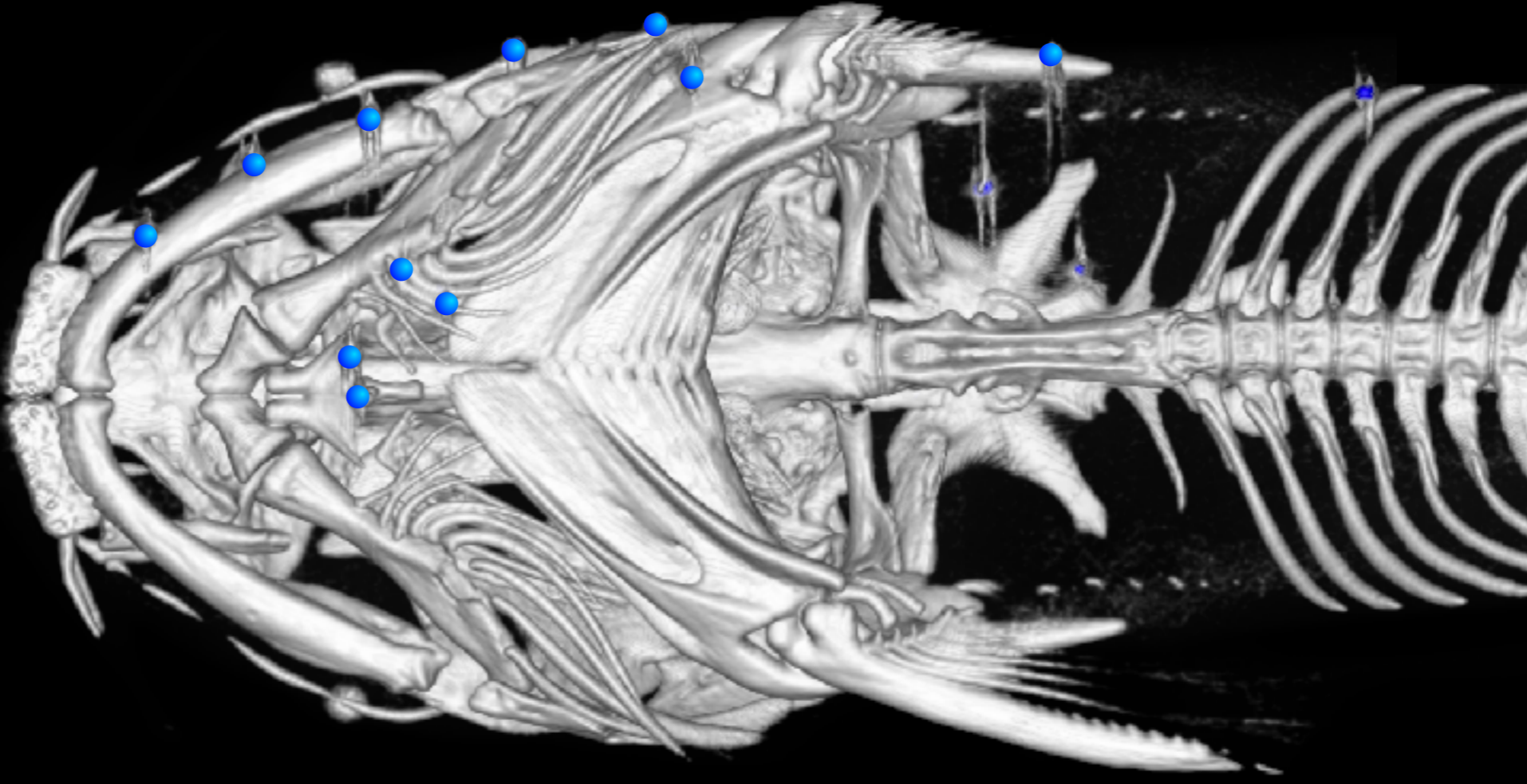
3D graphics and visualization

Marker implantation

Lateral



Ventral

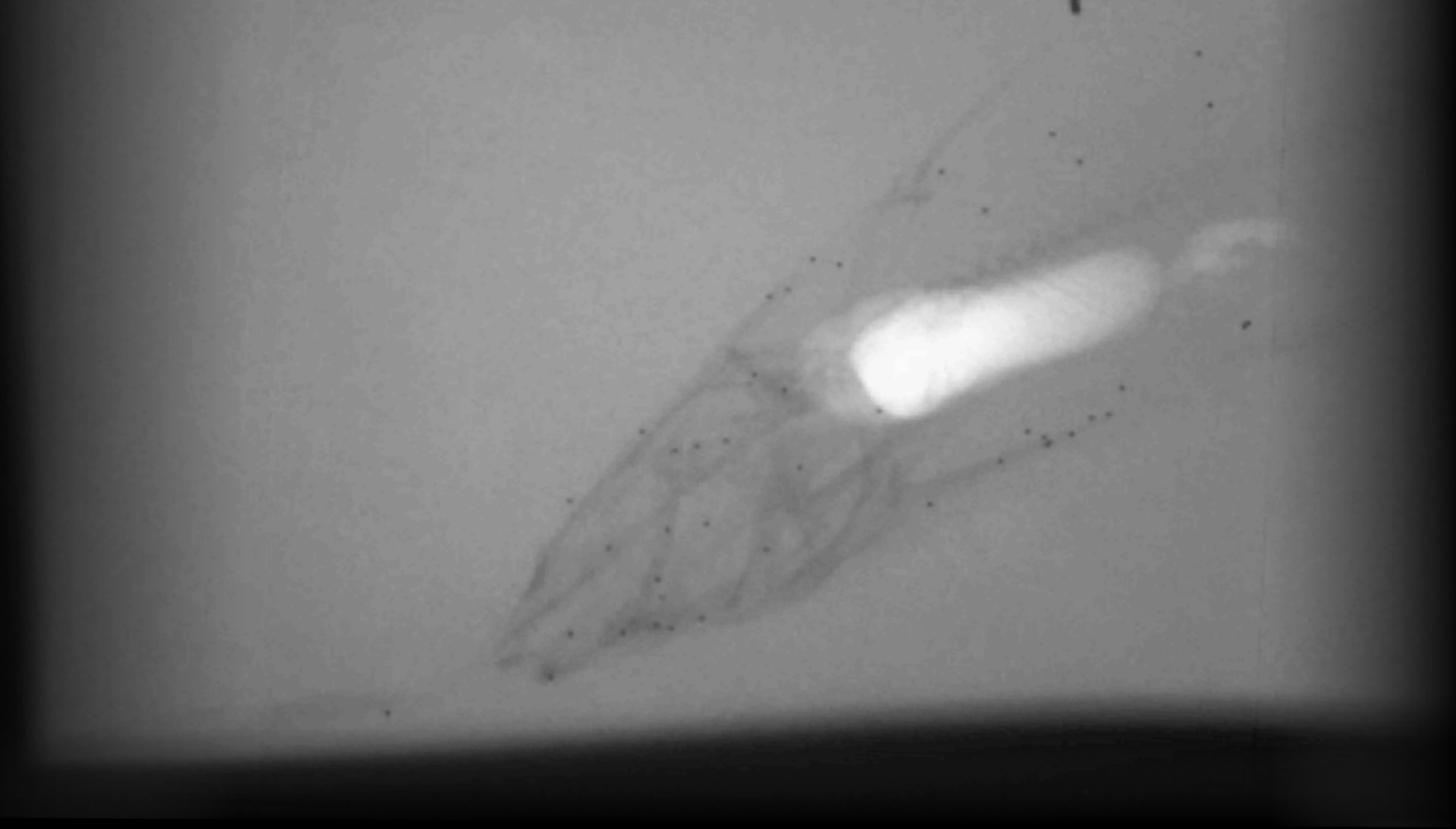




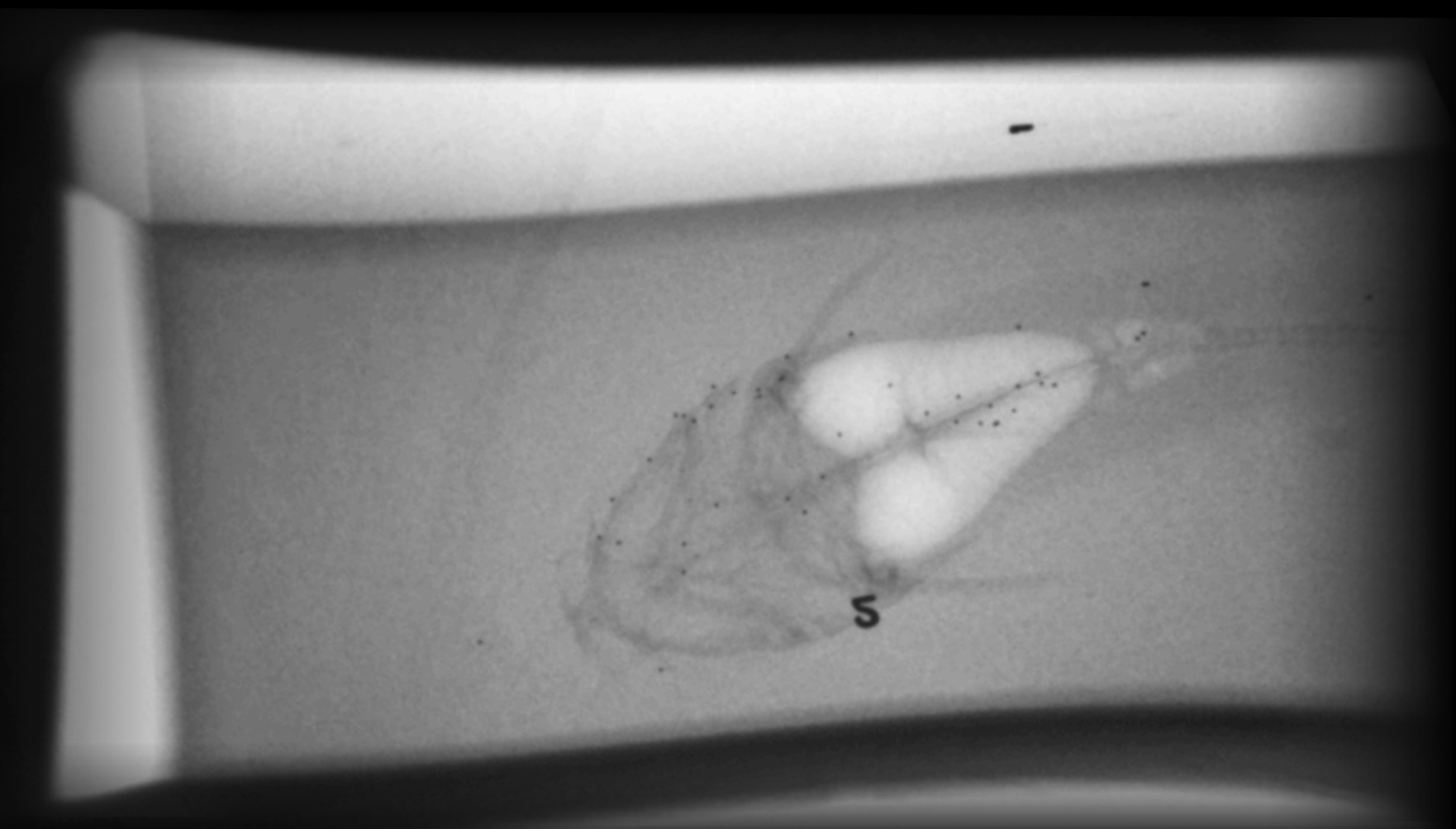


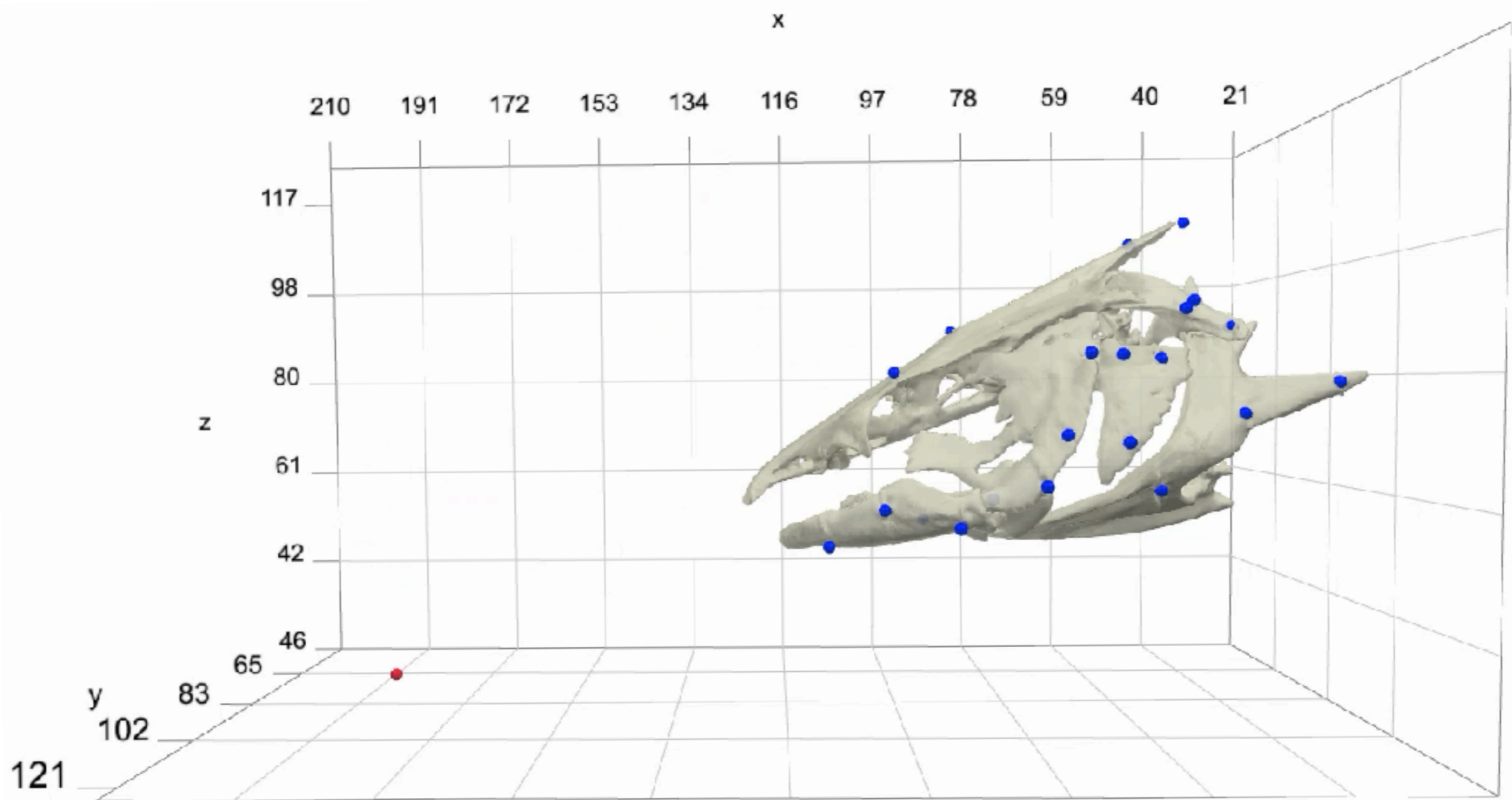
Biplanar ("two views") X-ray video

Lateral

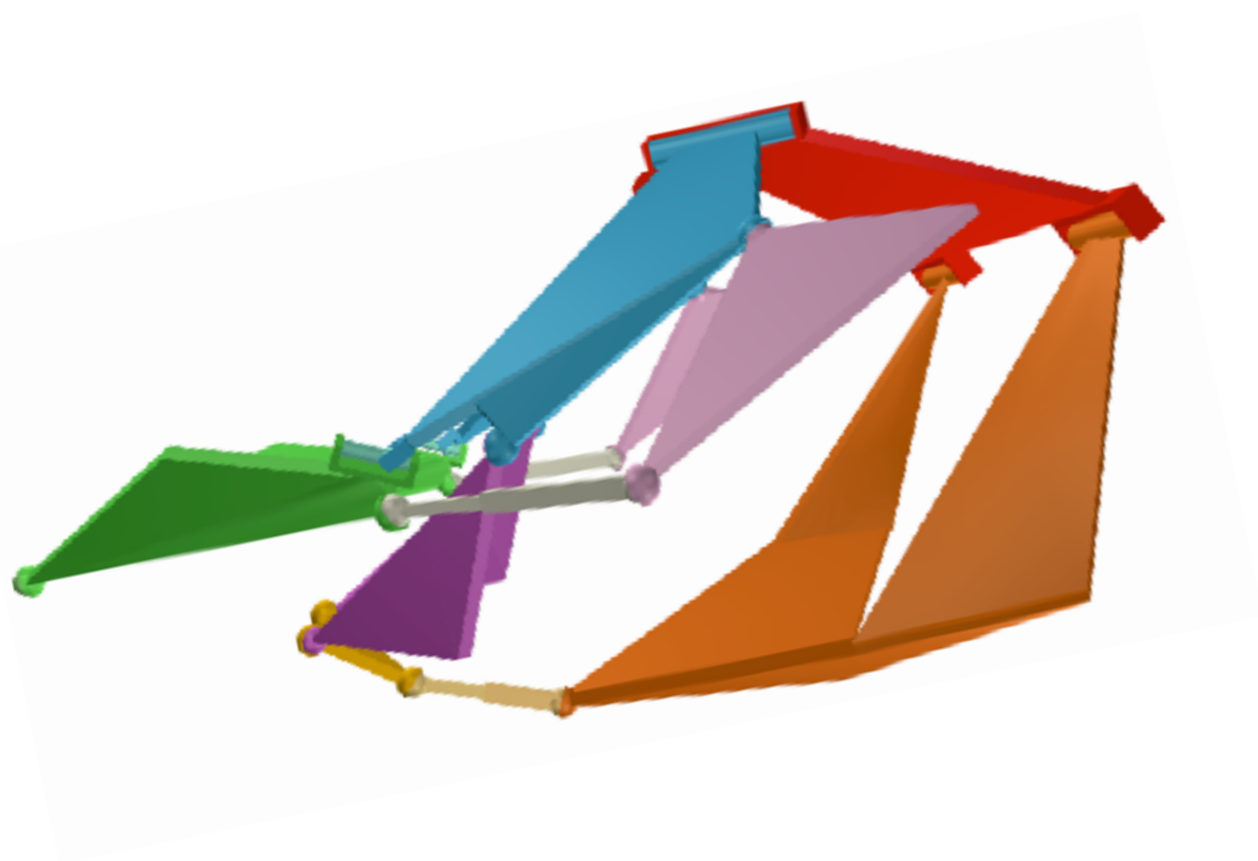
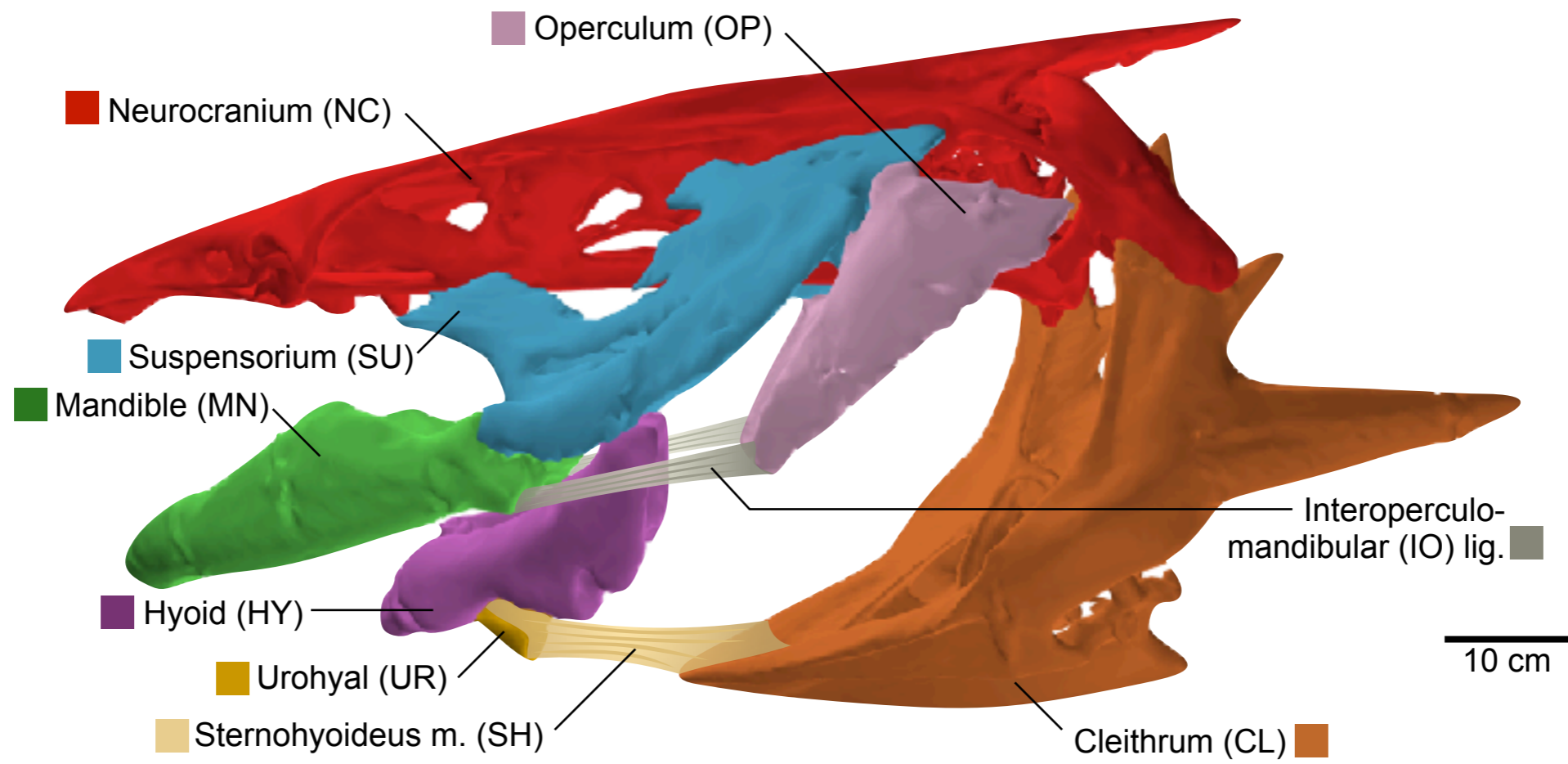


Ventral



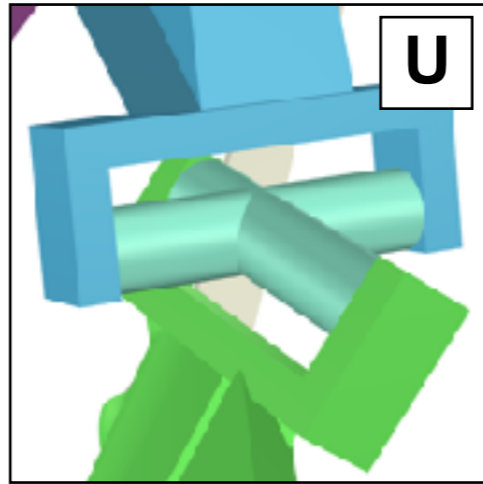


Filmed at 300 frames/sec  
Animation slowed 4x

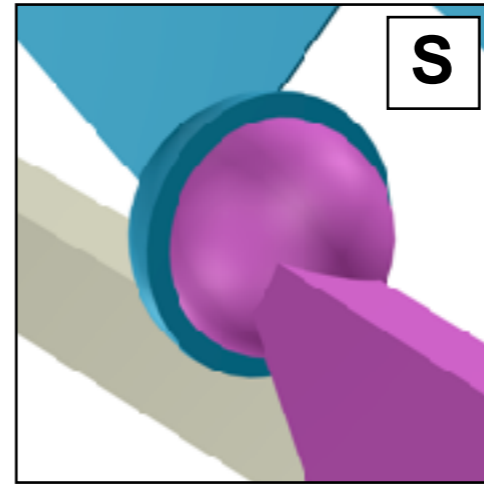




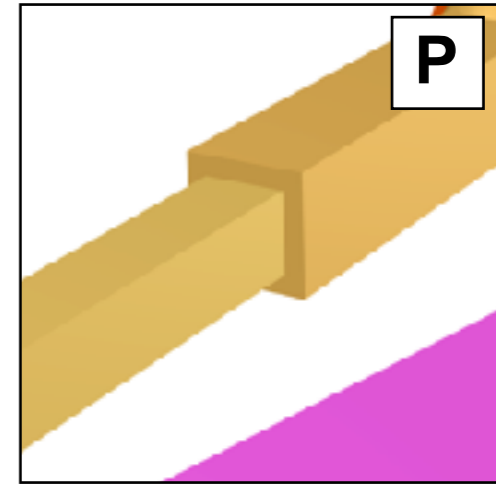
Revolute (hinge) 1 DoF



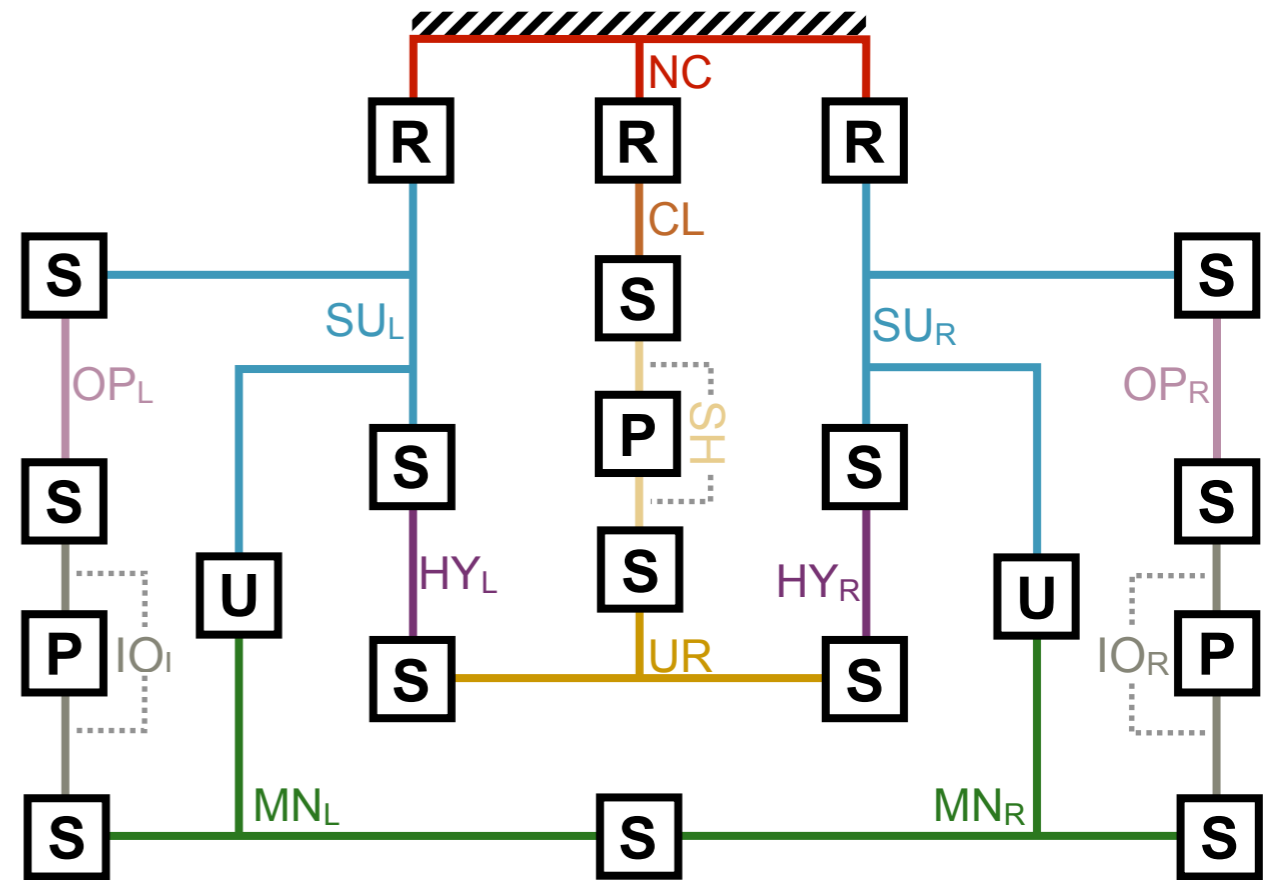
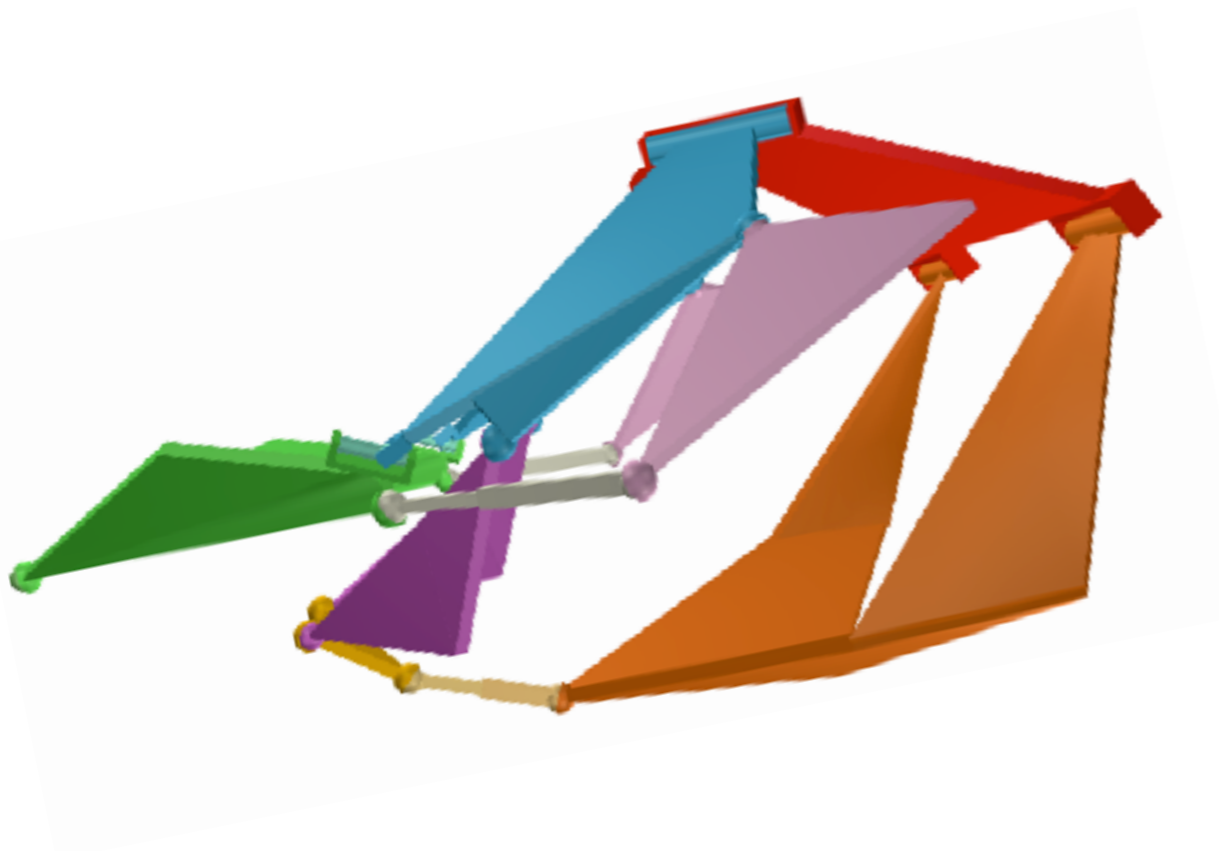
Universal (saddle) 2 DoFs

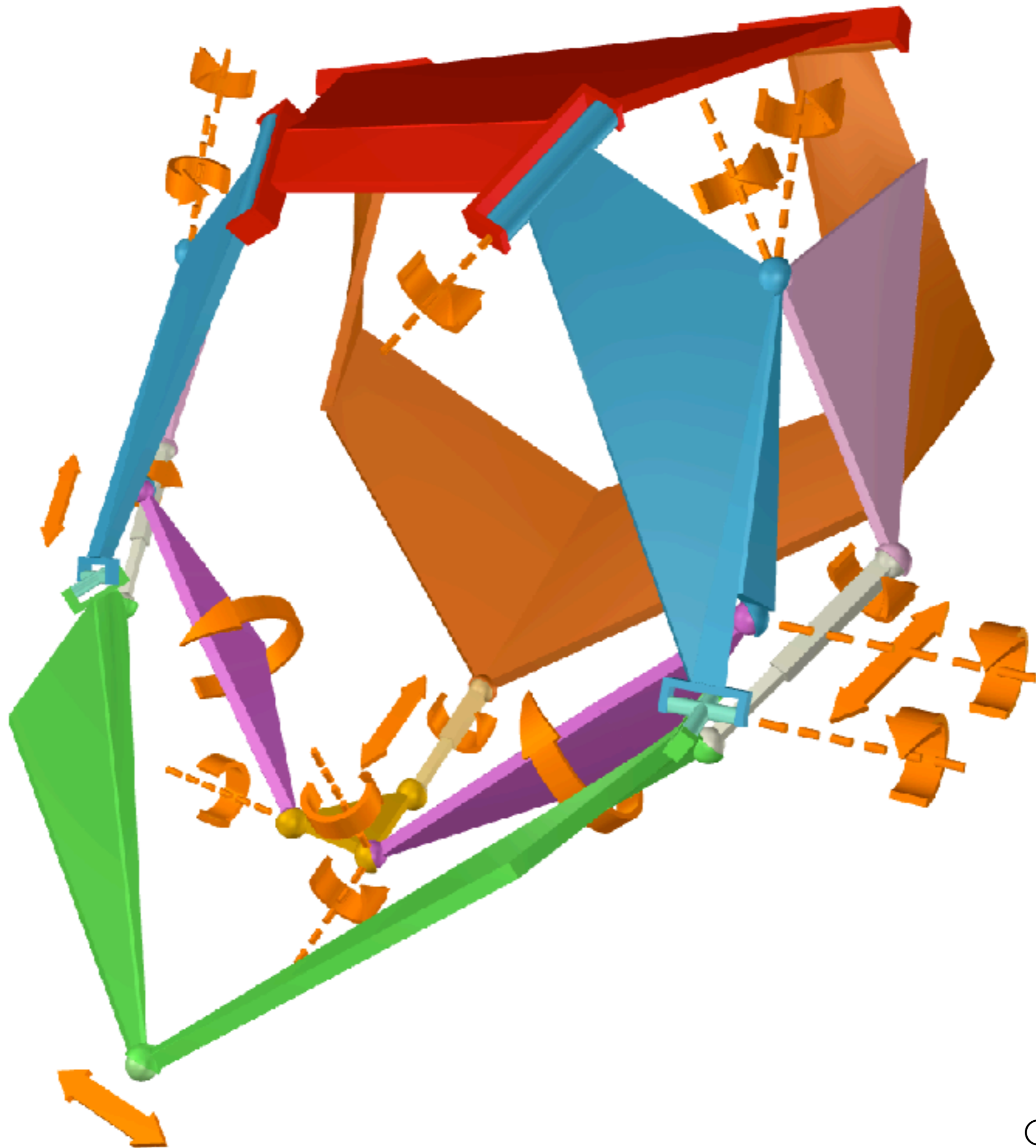


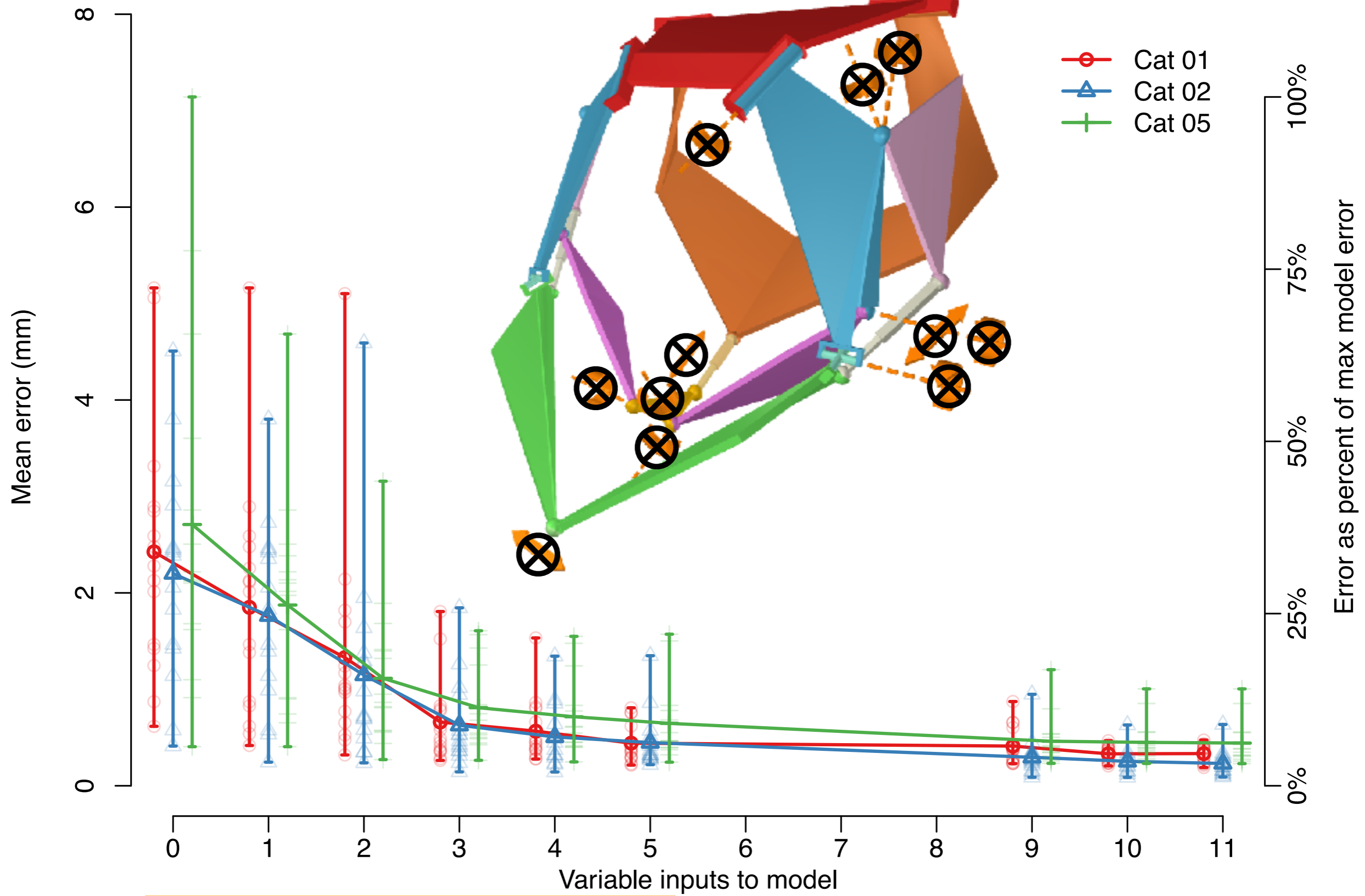
Spherical (ball-in-socket) 3 DoFs



Prismatic (sliding) 1 DoF

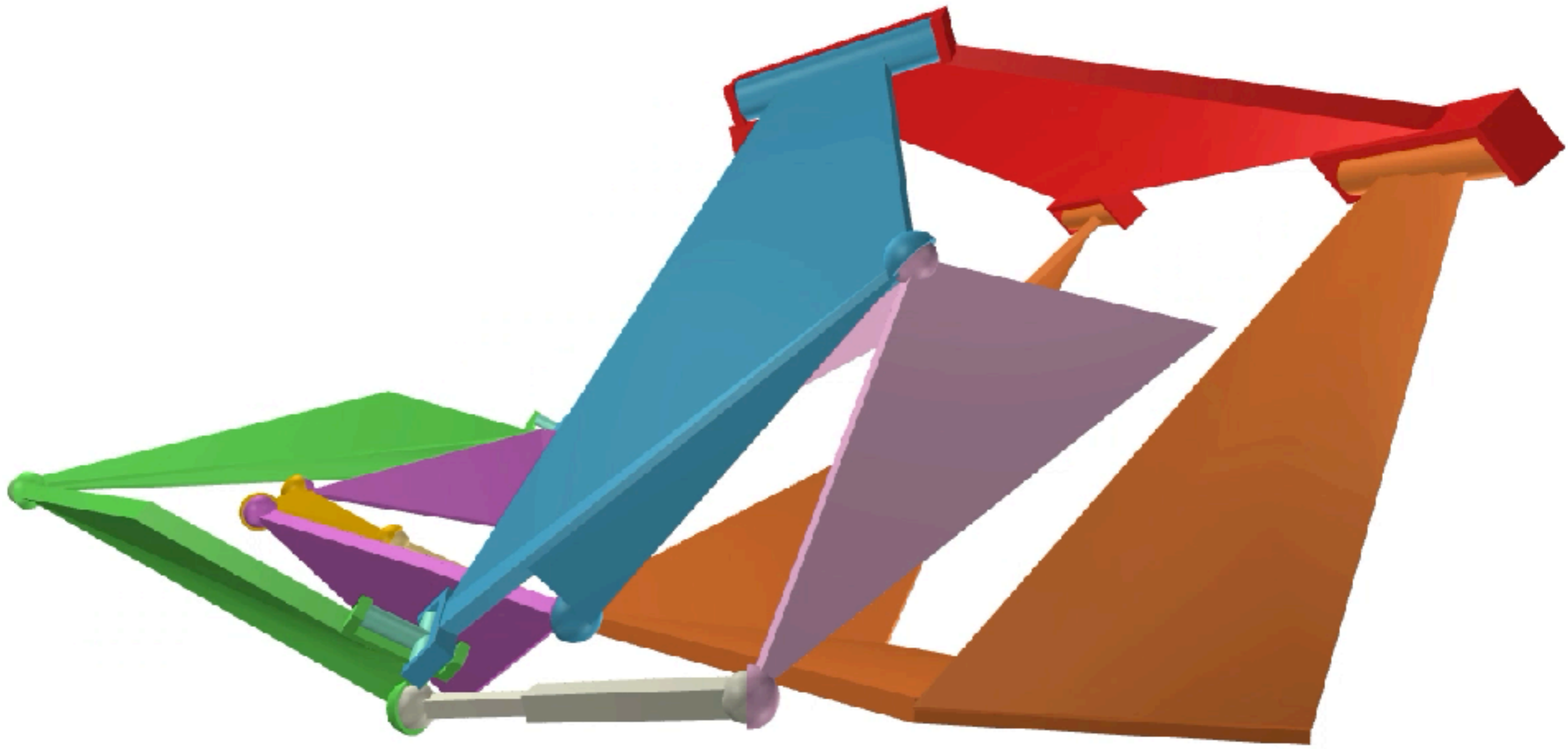






-Hy  
-Su  
-Lj  
-Op dil  
-Op flare  
-Asymm

-Sh  
-lop  
None

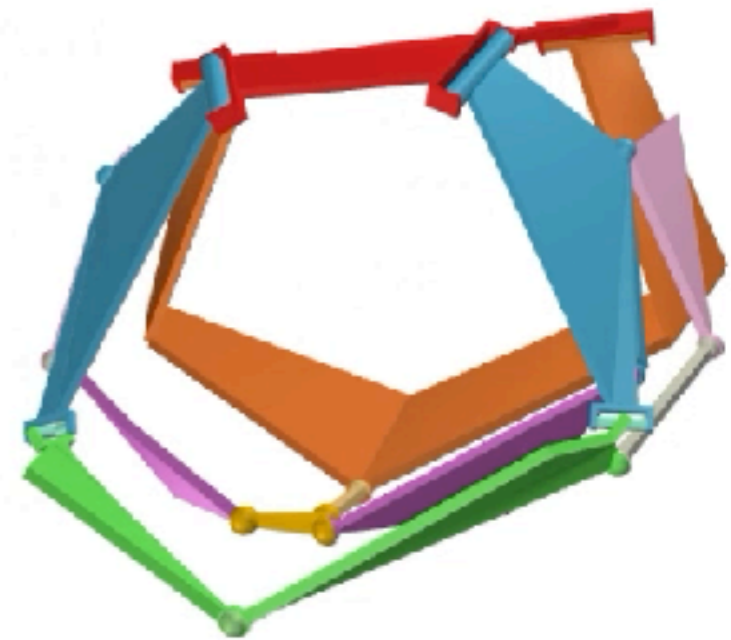






***In vivo* motion  
collected using XROMM**

(Slowed 3.3x)



**Linkage model  
driven by 7 DoFs**

Olsen et al. *in prep*

**Rostral-to-caudal wave**



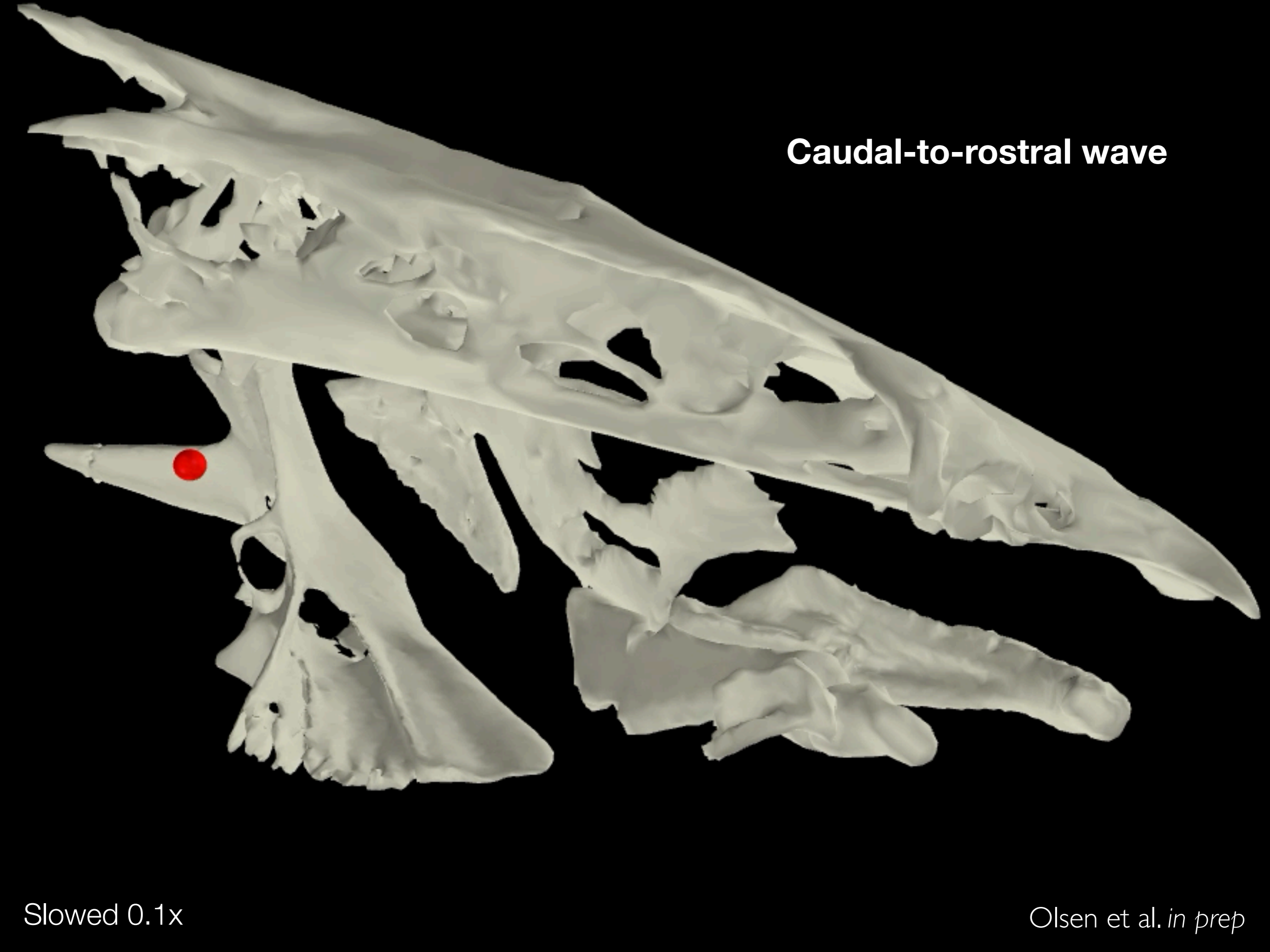
Slowed 0.1x

Olsen et al. *in prep*

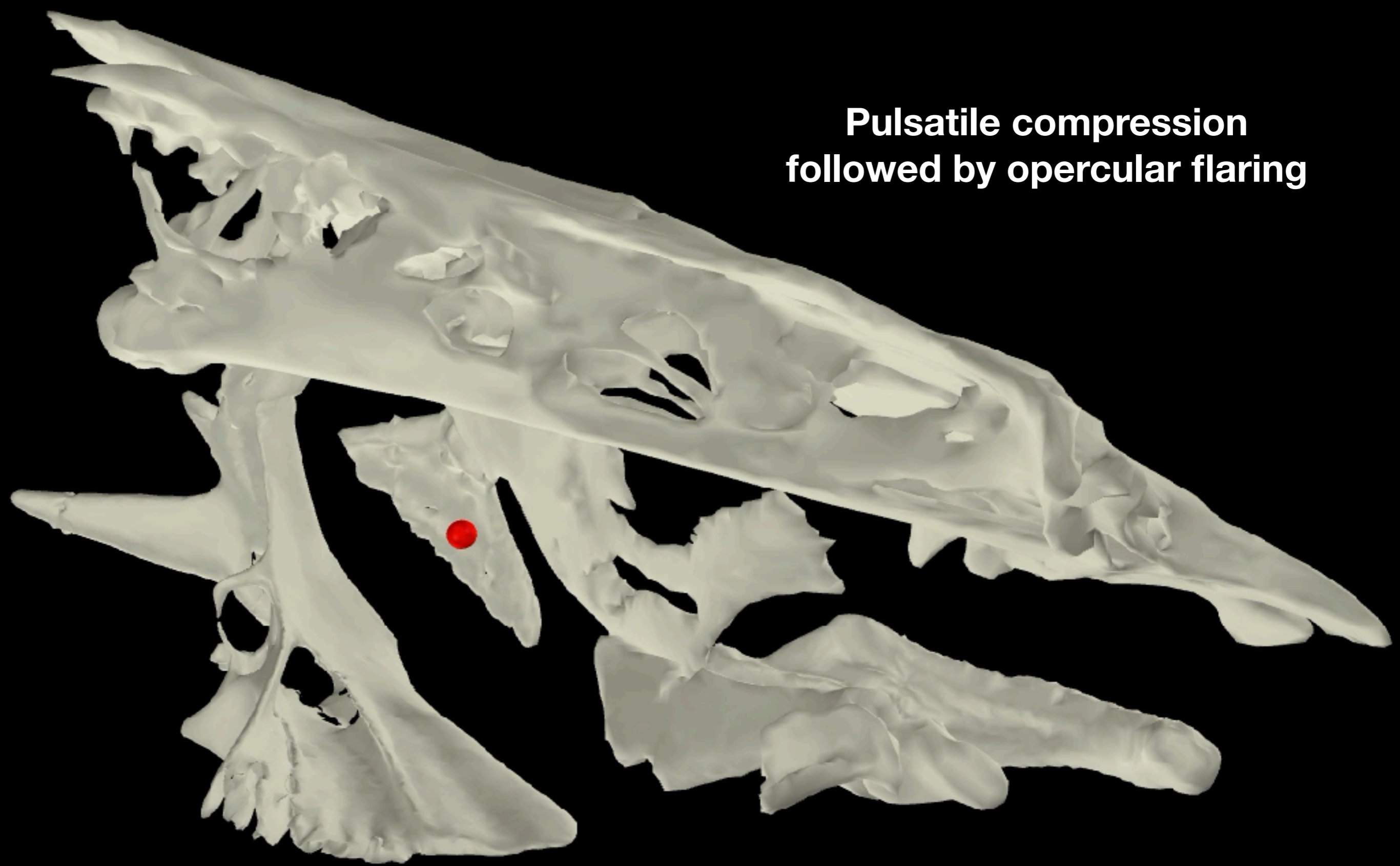
**Caudal-to-rostral wave**

Slowed 0.1x

Olsen et al. *in prep*



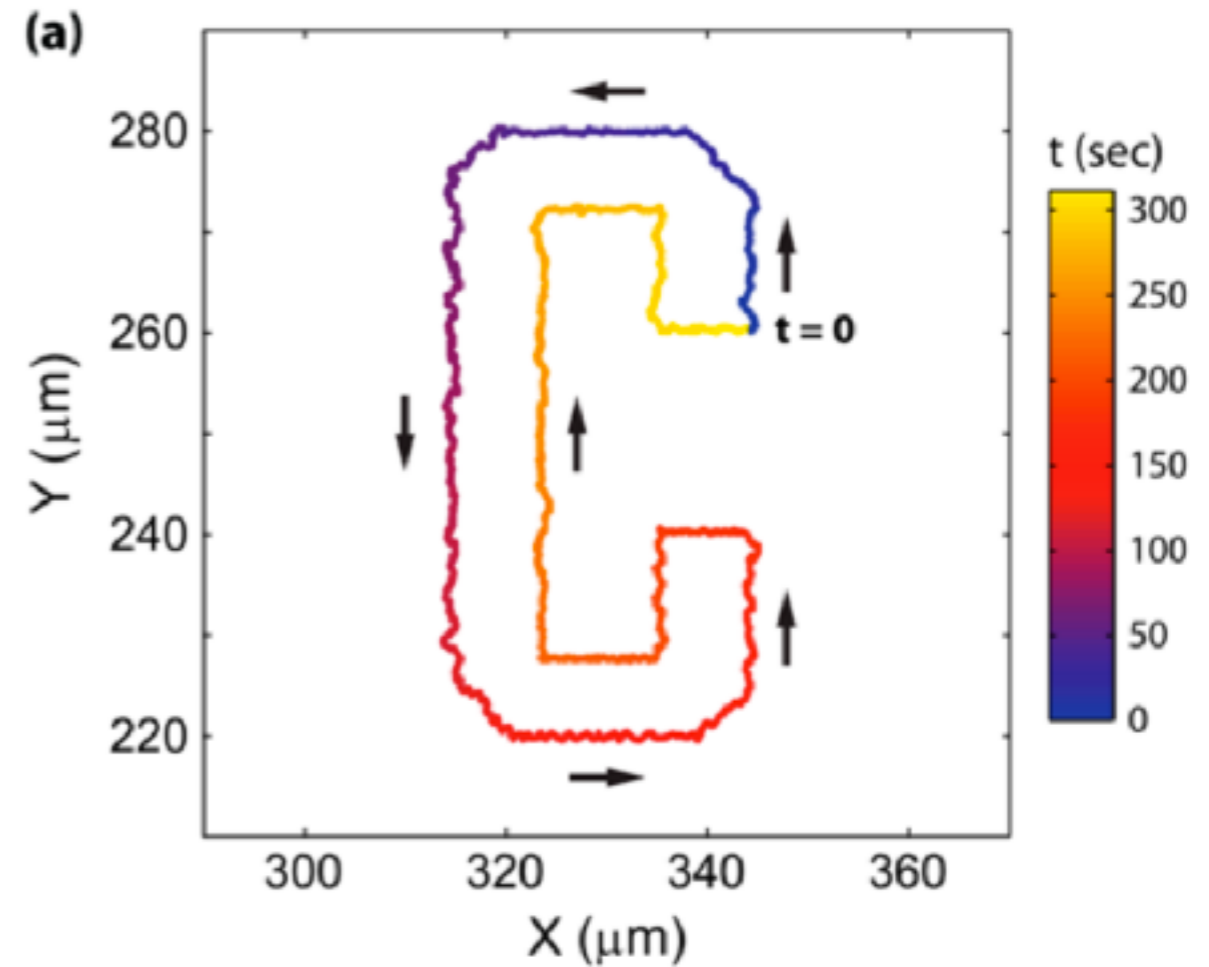
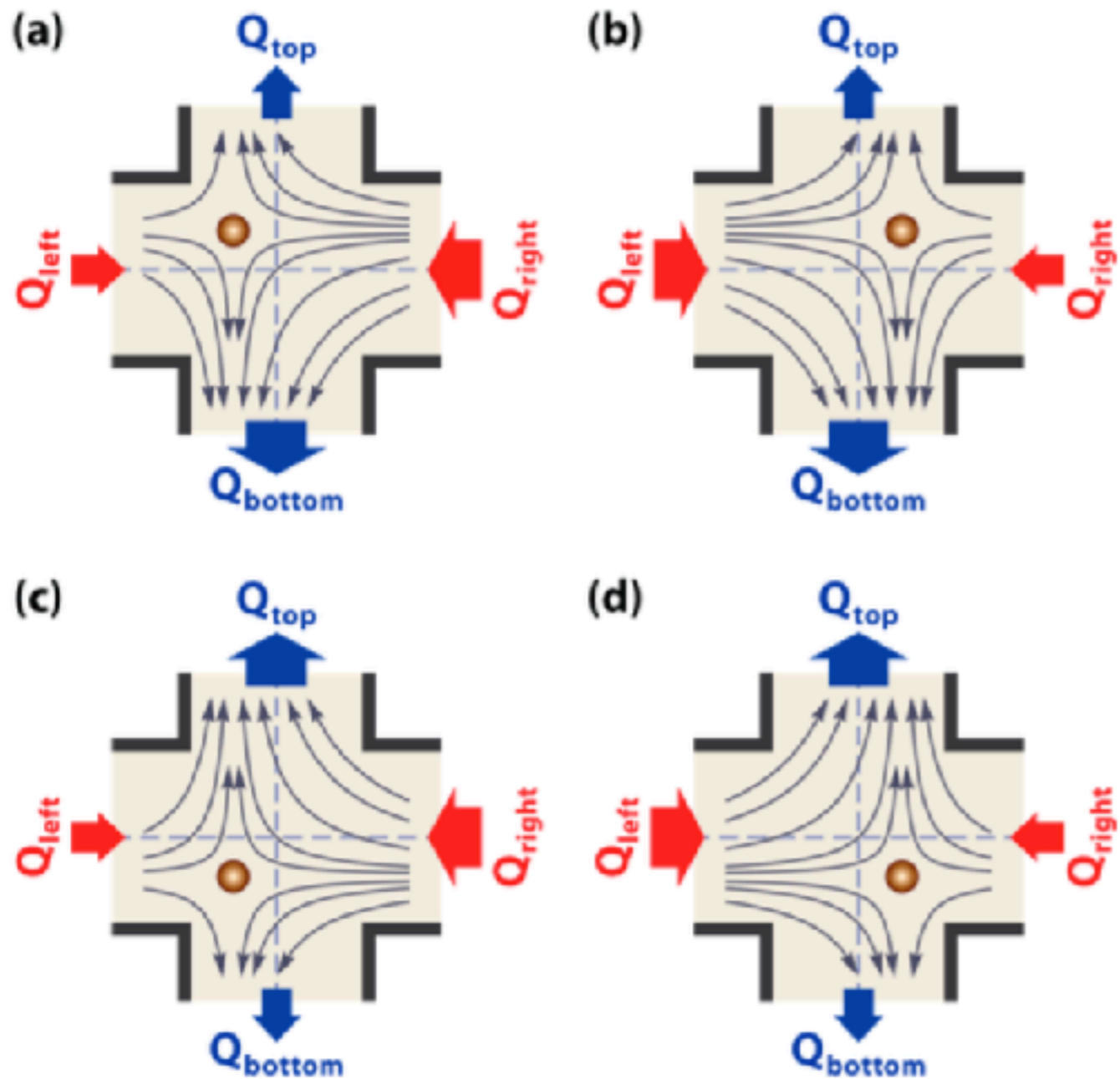
**Pulsatile compression  
followed by opercular flaring**



Slowed 0.1x

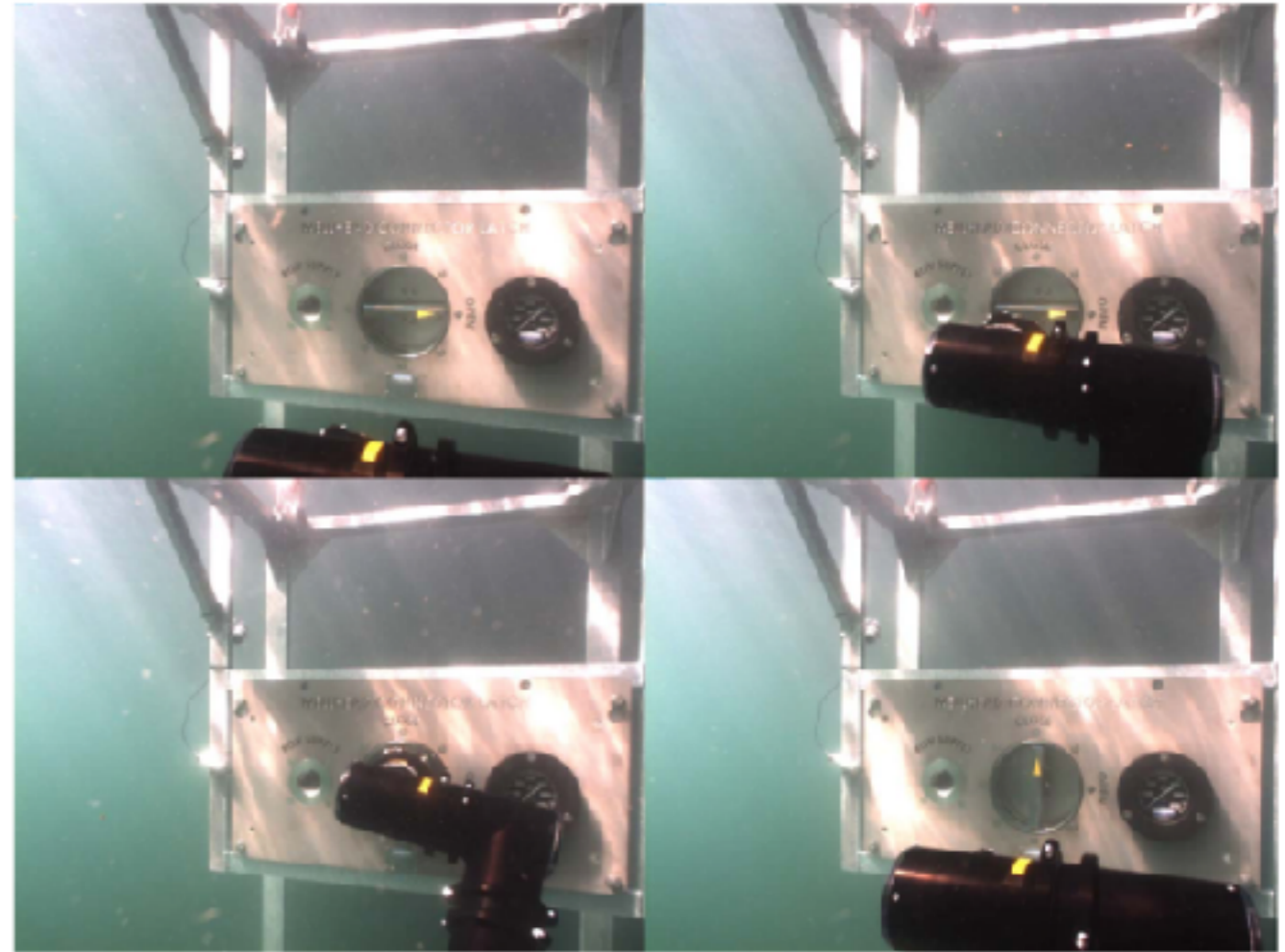
Olsen et al. *in prep*

# Potential application?



2-DoF particle positioning system using fluid flows

# Potential application?



# Conclusions

The catfish skull can be modeled as a 5-loop parallel mechanism with 5-7 DoFs used during suction feeding

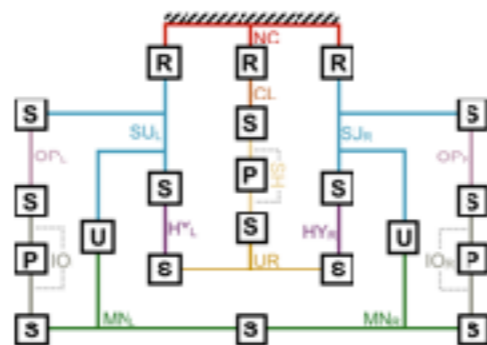
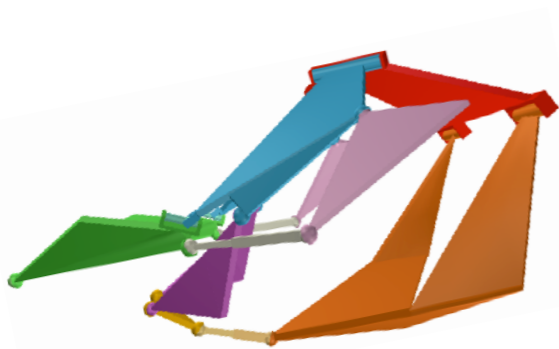
The catfish skull functions as a prey manipulation system rather than a simple expansion/compression system, more analogous to a human arm than to an umbrella or a syringe

Future directions



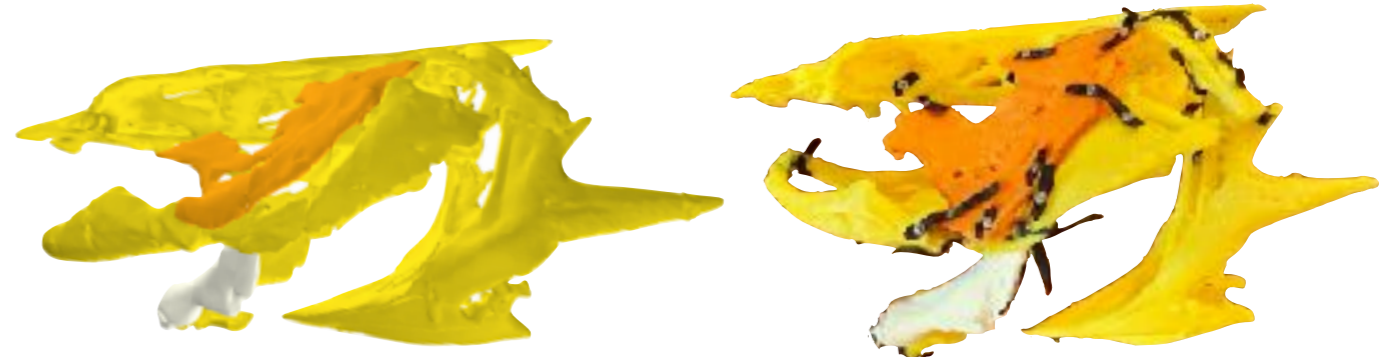
## Become a professor

Create virtual and physical models of animals (robotic animals) and use these models with live animal motion capture to better understand how animals work and move



## Start my own anatomy design company

Create "model animals" (like model ships or planes) that are anatomically accurate, kinetic, and assemble-able and assemble-able for use as toys and in anatomy teaching and surgical training



## Become a professor

### *Pros*

Stable job, decent pay and benefits

Lots of autonomy

Get to mentor students

Get to design and teach my own courses

Can do risky, exploratory research

### *Cons*

Very few job openings

Would likely have to move

More managerial position right away

## Start my own anatomy design company

### *Pros*

Total autonomy

Hands-on work (at the start)

Likely don't need to move

Potentially greater impact

### *Cons*

Risky job security

Low pay at the start

Will have to learn a lot "on the fly"

## Is a PhD and/or postdoc best for you?

Lots of career options after a PhD or postdoc (examples: STEM/tech jobs, data analytics, government research, policy work, conservation non-profits and agencies, healthcare, professor, K-12 teacher, writer, university administration jobs, starting your own business)

But for what you want to do a PhD or postdoc may not be necessary. Only do a PhD/postdoc if you *want* to do a PhD/postdoc, not just because it will get you where you want to go.

# Acknowledgements

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Brown Animal Care Facility



**BROWN**



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