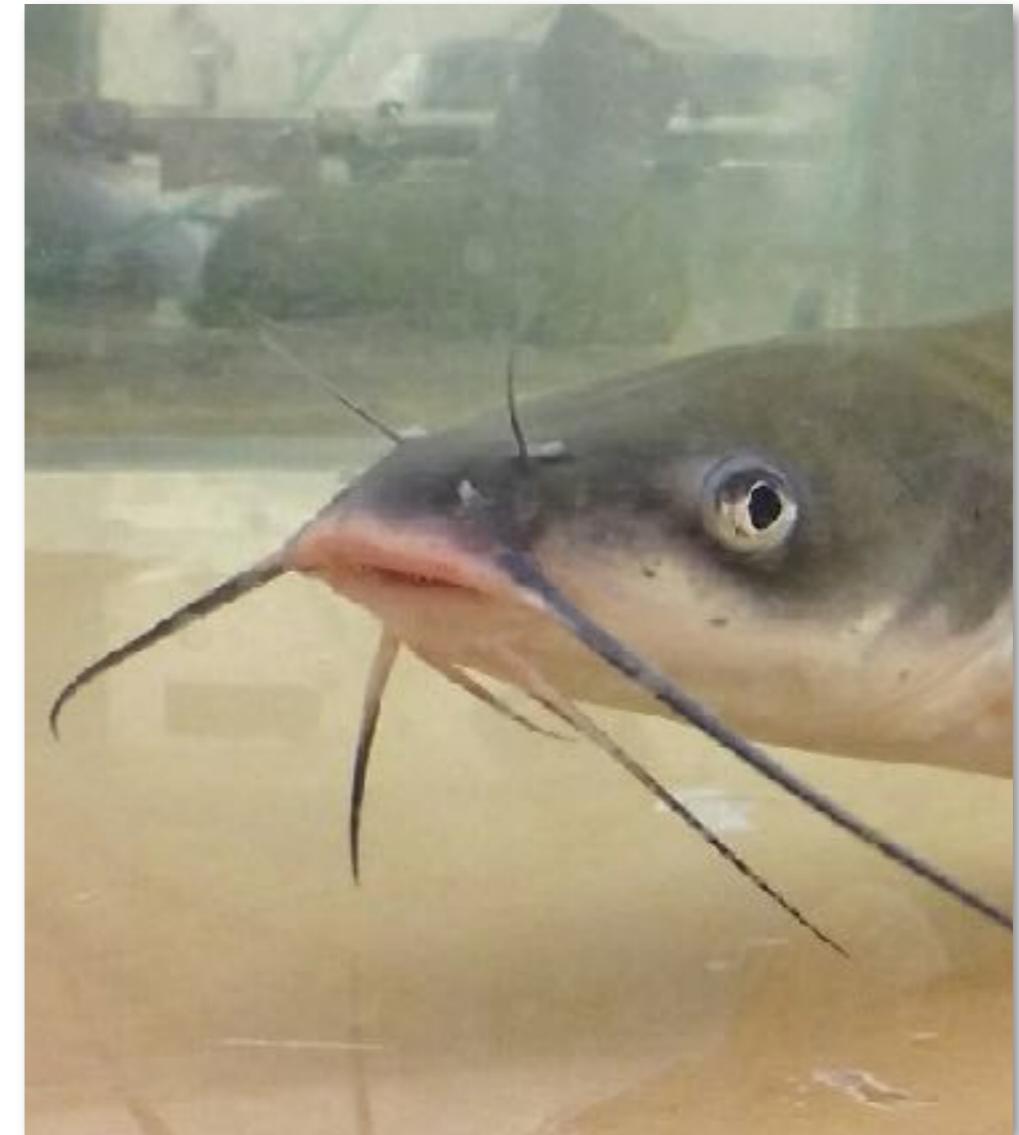
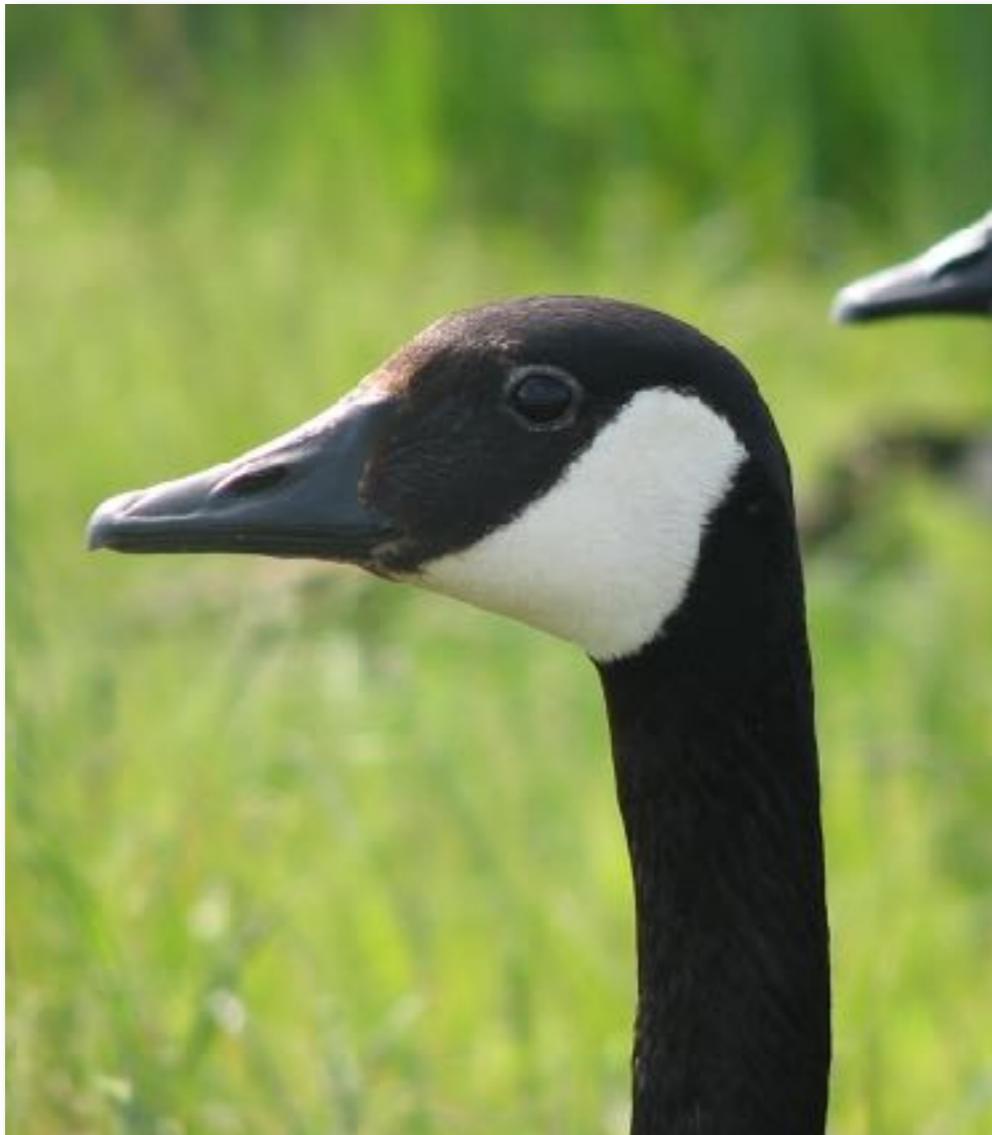


New tools bring new observations of natural history

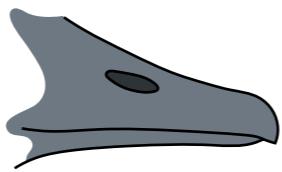
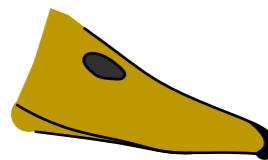


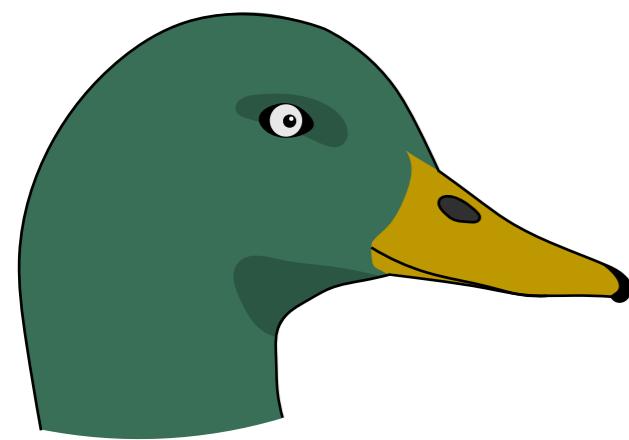
Aaron M Olsen
Postdoctoral fellow
Brown University

A project from my PhD

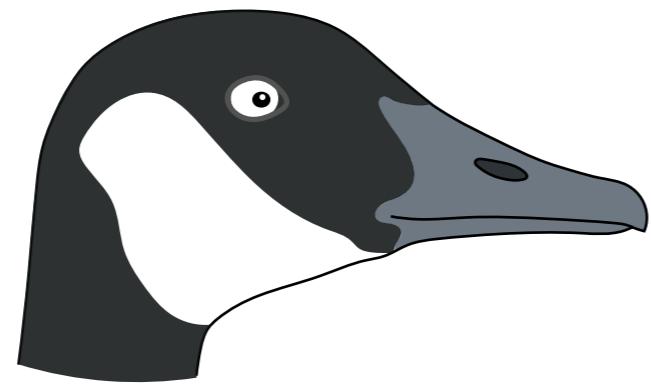
What came first, the duck or the goose?
And what's the difference?

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

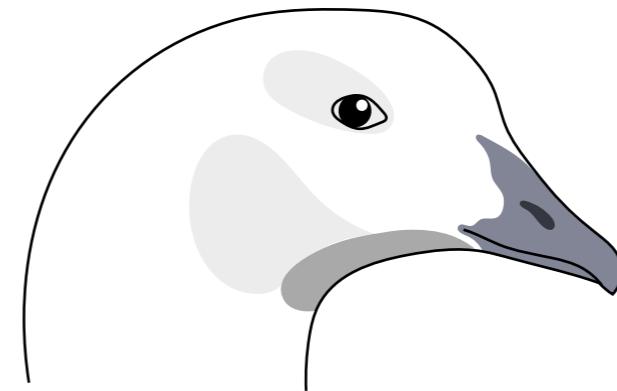




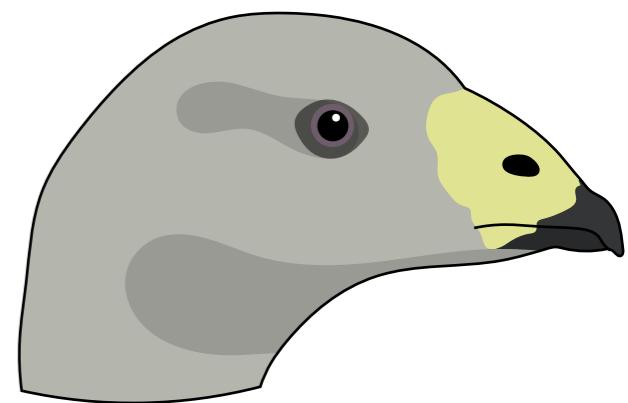
Mallard
duck



Canada
goose



Upland
goose



Cape Barren
goose

Waterfowl have diverse beak shapes



Photo credits: Dick Daniels, Rick and Nora Bowers, Philippe Boissel, Mila Zinkova, Ken Billington, ibc.lynxeds.com Adrian Pingstone, Laura Whitehouse, audobonbirds.org, projectnoah.org, JJ Harrison, wikimedia.org

Methods / Skills I had to acquire

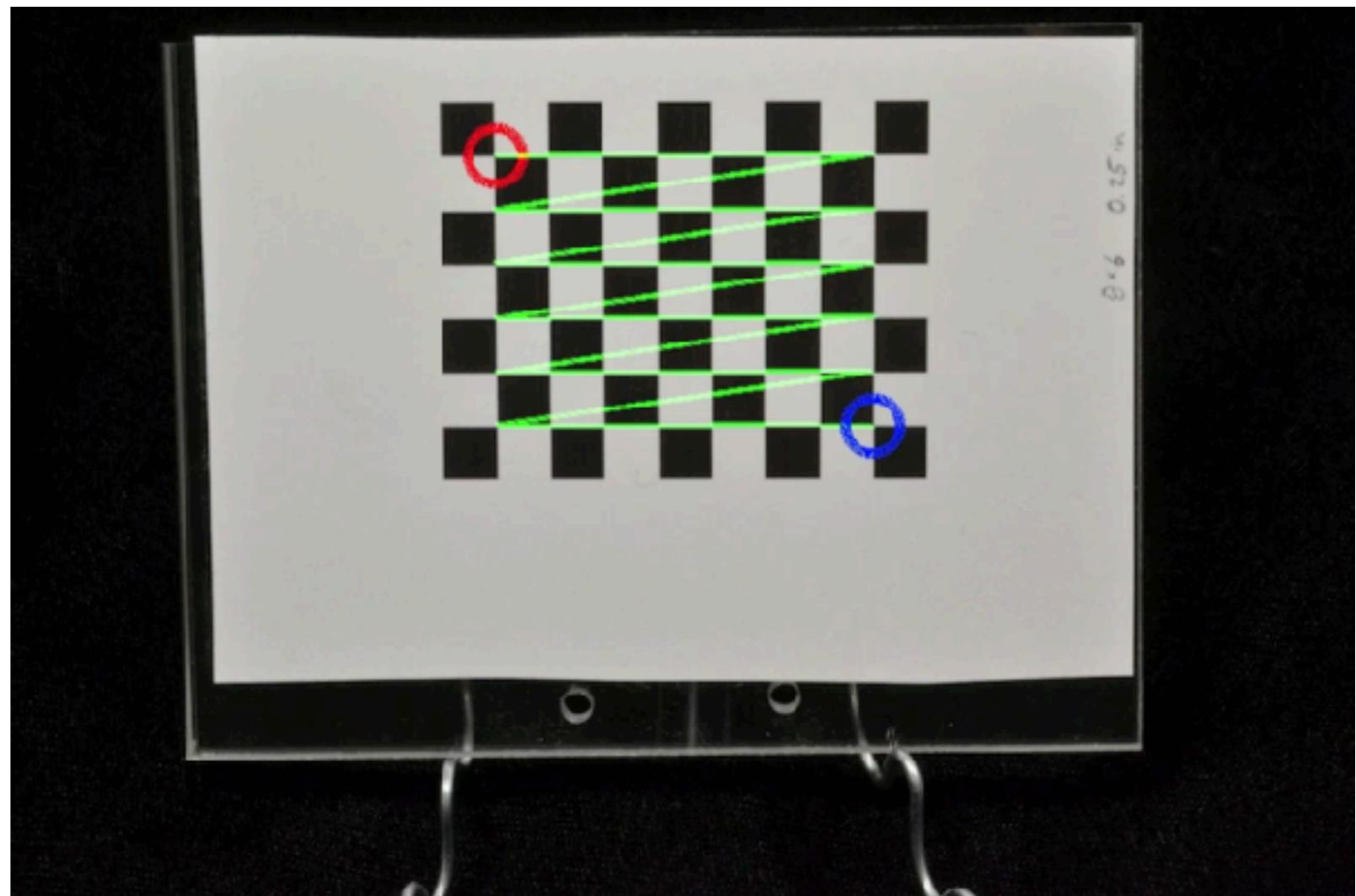
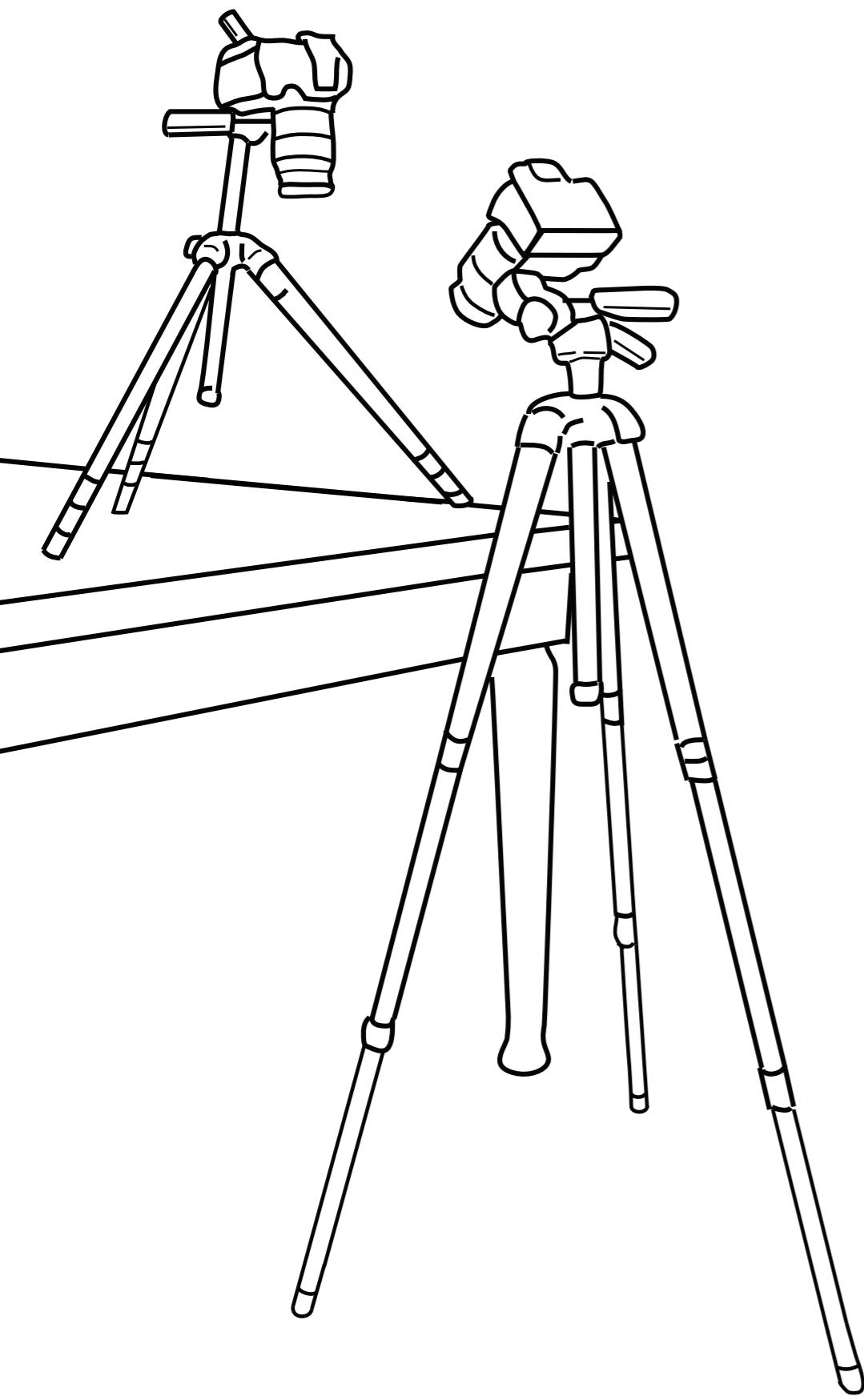
Stereo photography

Statistics (PCA, PLS, evolutionary modeling)

Data visualization

StereoMorph

3D landmark and curve collection using stereo camera setup

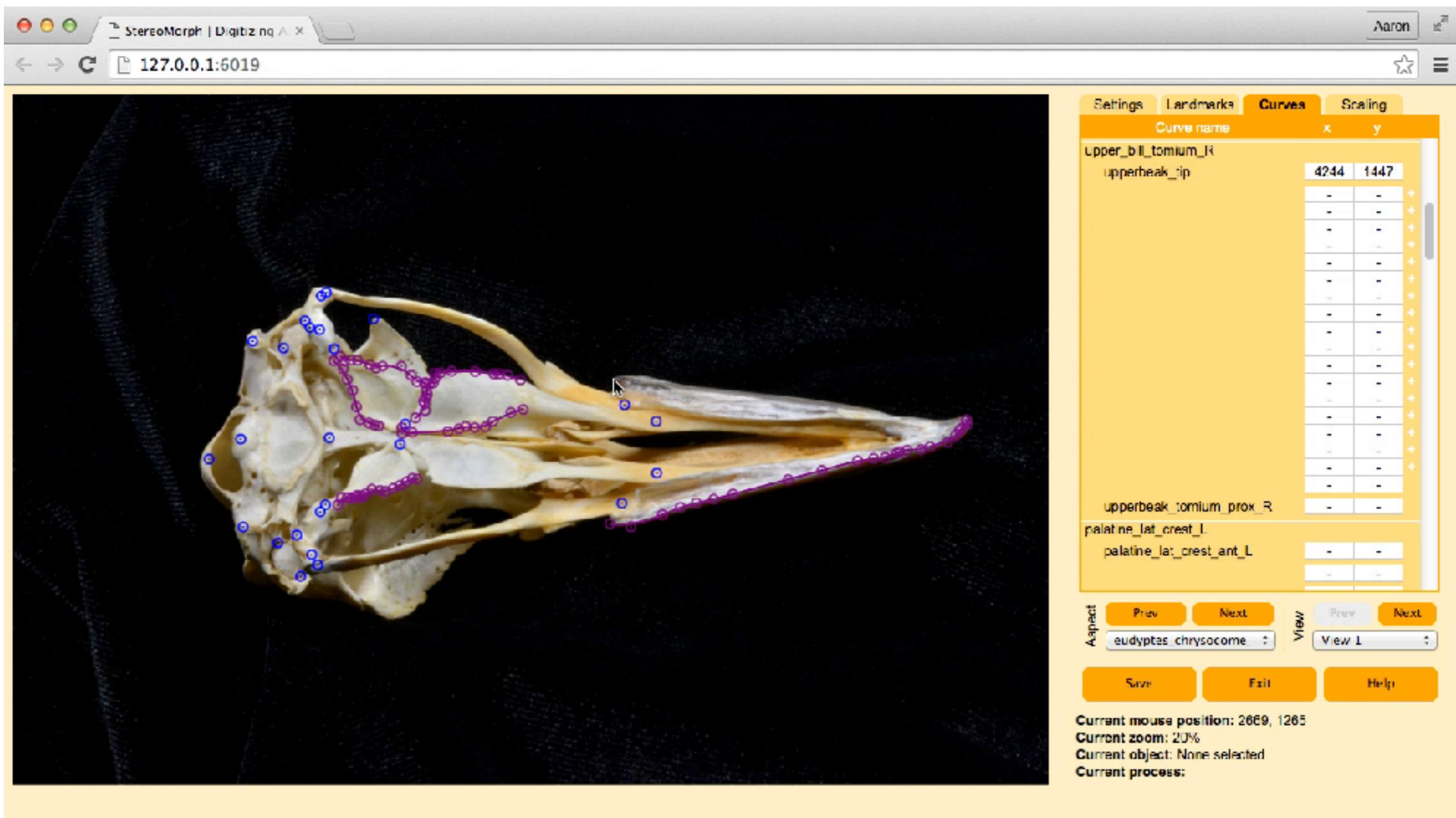


At cran.r-project.org

Olsen & Westneat 2015

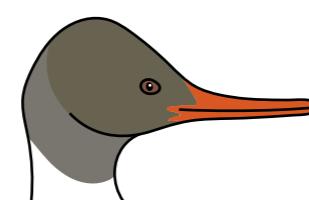
StereoMorph

3D landmark and curve collection using stereo camera setup

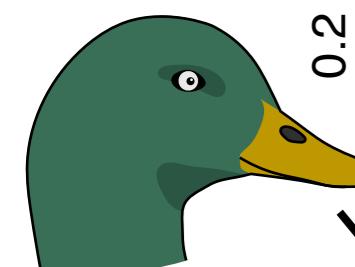


Waterfowl beaks

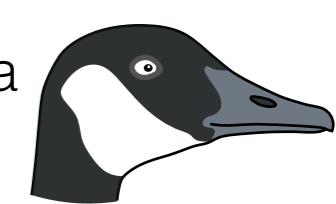
Red-breasted
merganser



Mallard
duck



Canada
goose



Pursuit
divers

Beak shape PC2

0.3

0.2

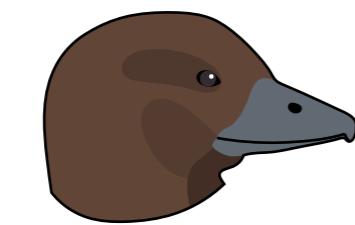
0.1

0.0

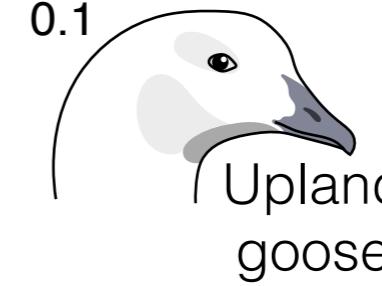
-0.1

-0.2

Beak shape PC1



Musk
duck



Upland
goose

Olsen 2017

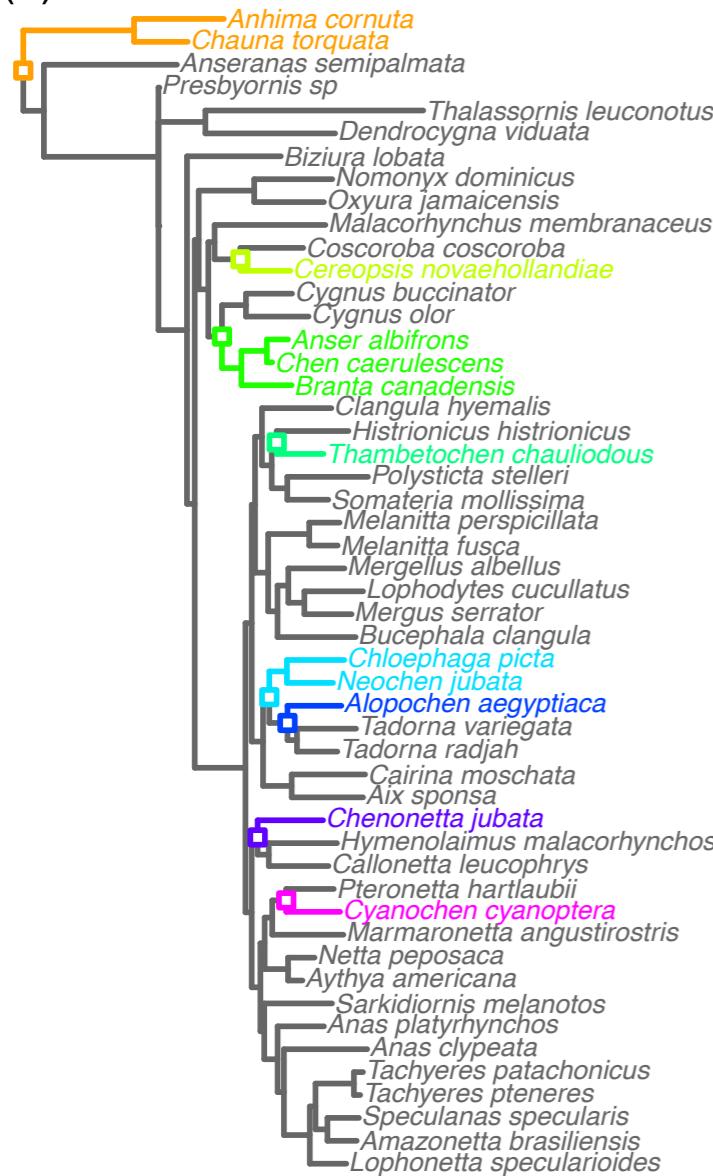
Geese

Ducks

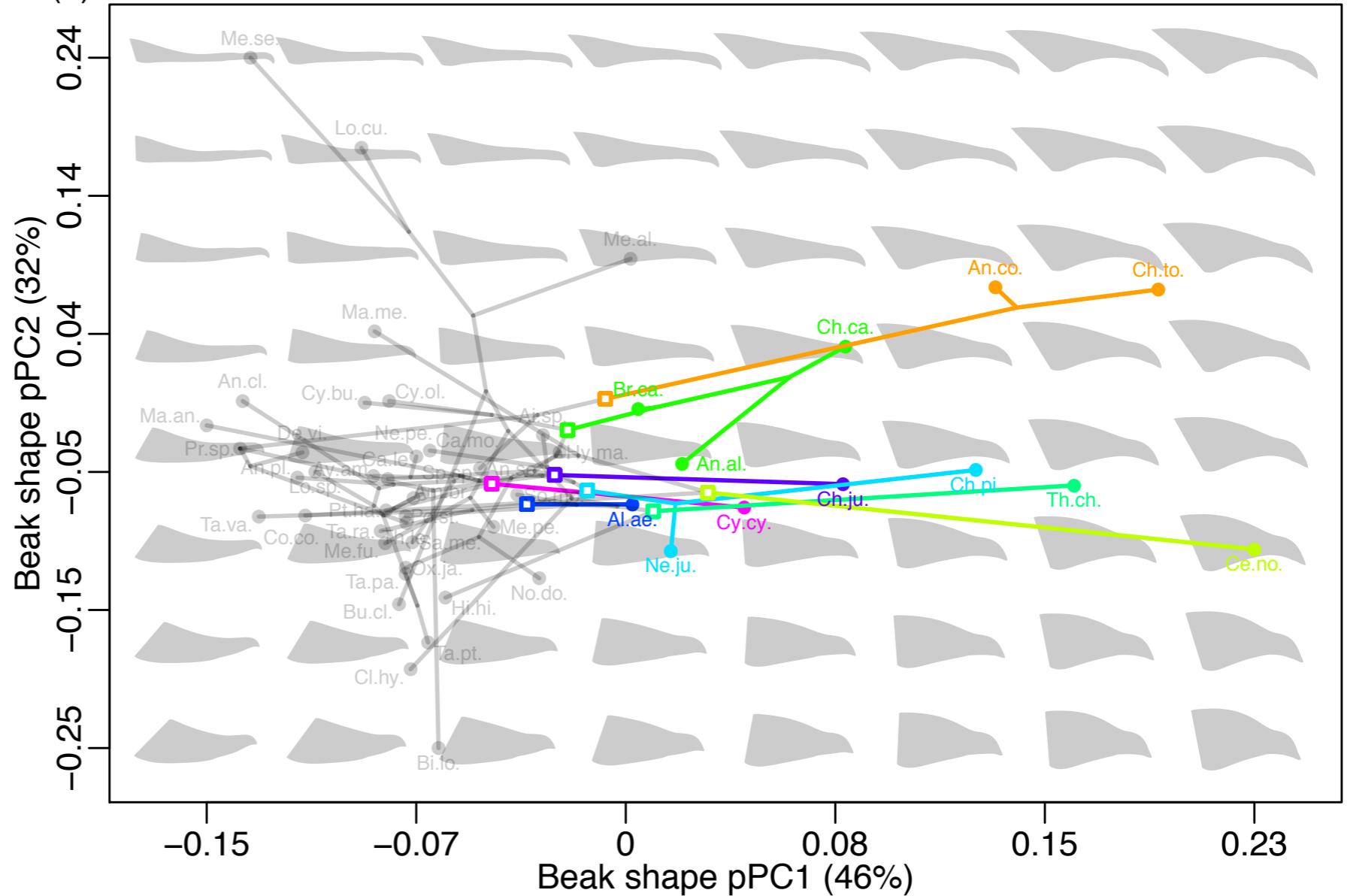
Cape
Barren
goose

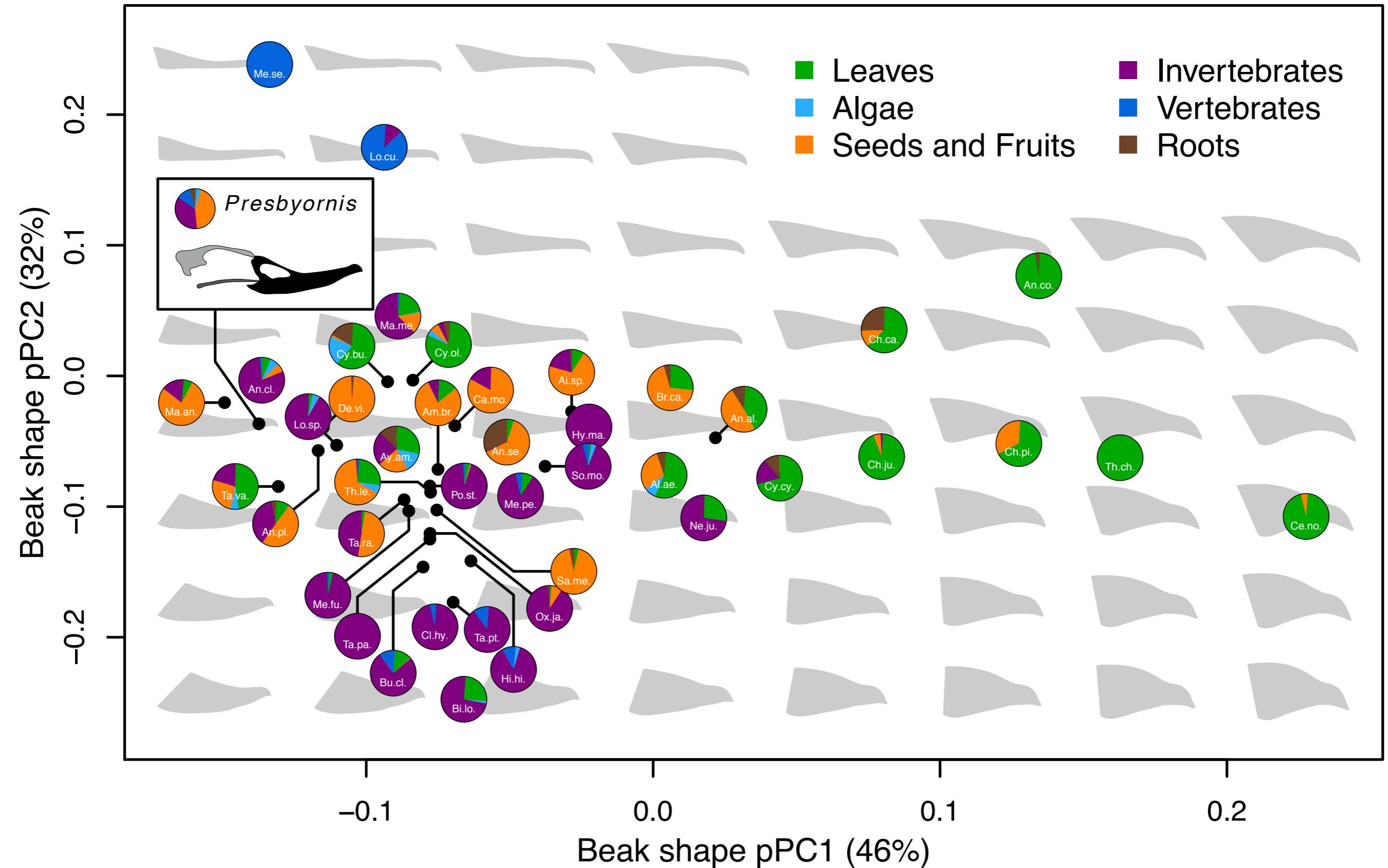


(a)

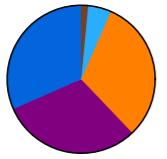
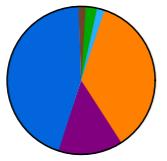
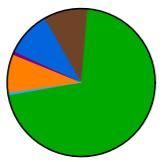
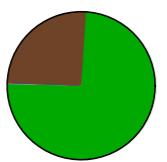


(b)

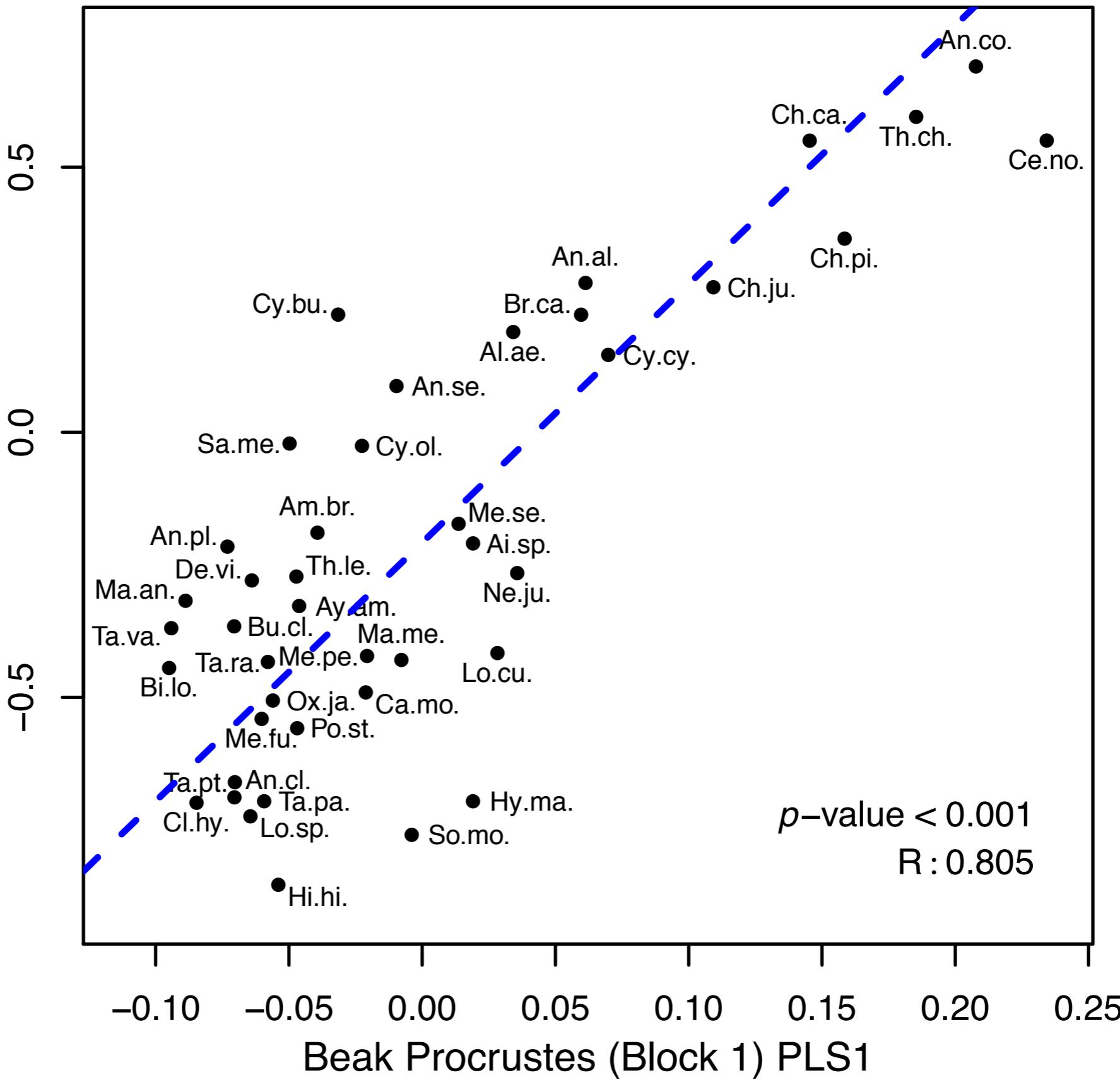




Olsen 2017



Logit diet (Block 2) PLS1



Conclusions

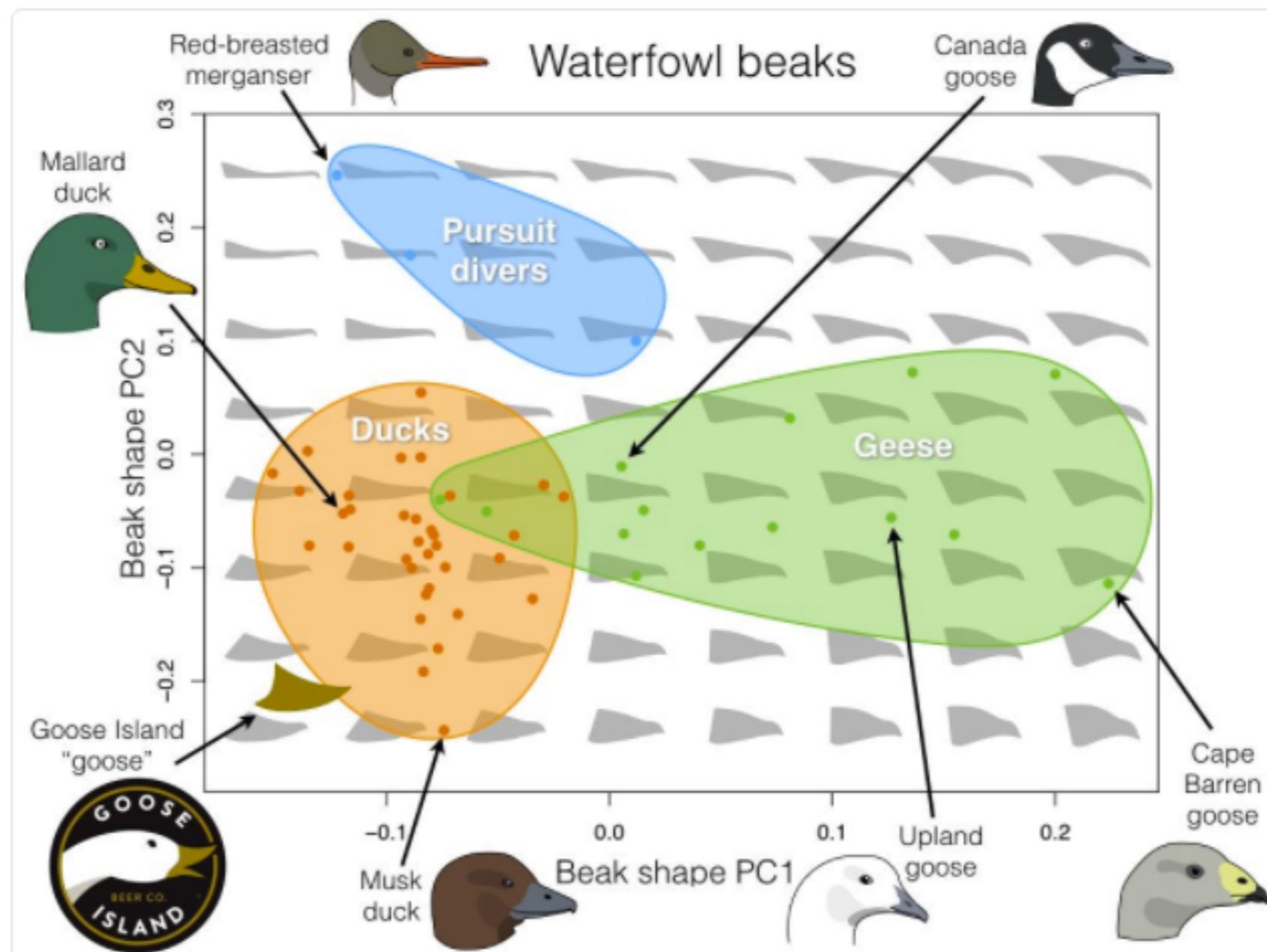
A more "duck-like" beak is probably the ancestral form whereas a more "goose-like" beak has evolved multiple times independently

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 @Gooselisland "goose" is actually a #duck! onlinelibrary.wiley.com/doi/10.1111/13...



7



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](#)



Current logo



More anatomically
accurate

7:36 AM - 31 May 2017

3 Retweets 15 Likes



1



3



15





Goose Island Beer Co @GooselIsland · May 31

▼

Replies to [@aarolsen](#)

After much deliberation, we will henceforth be known as "Duck Island".

[#WeAreKeepingTheLogo](#)



1
7

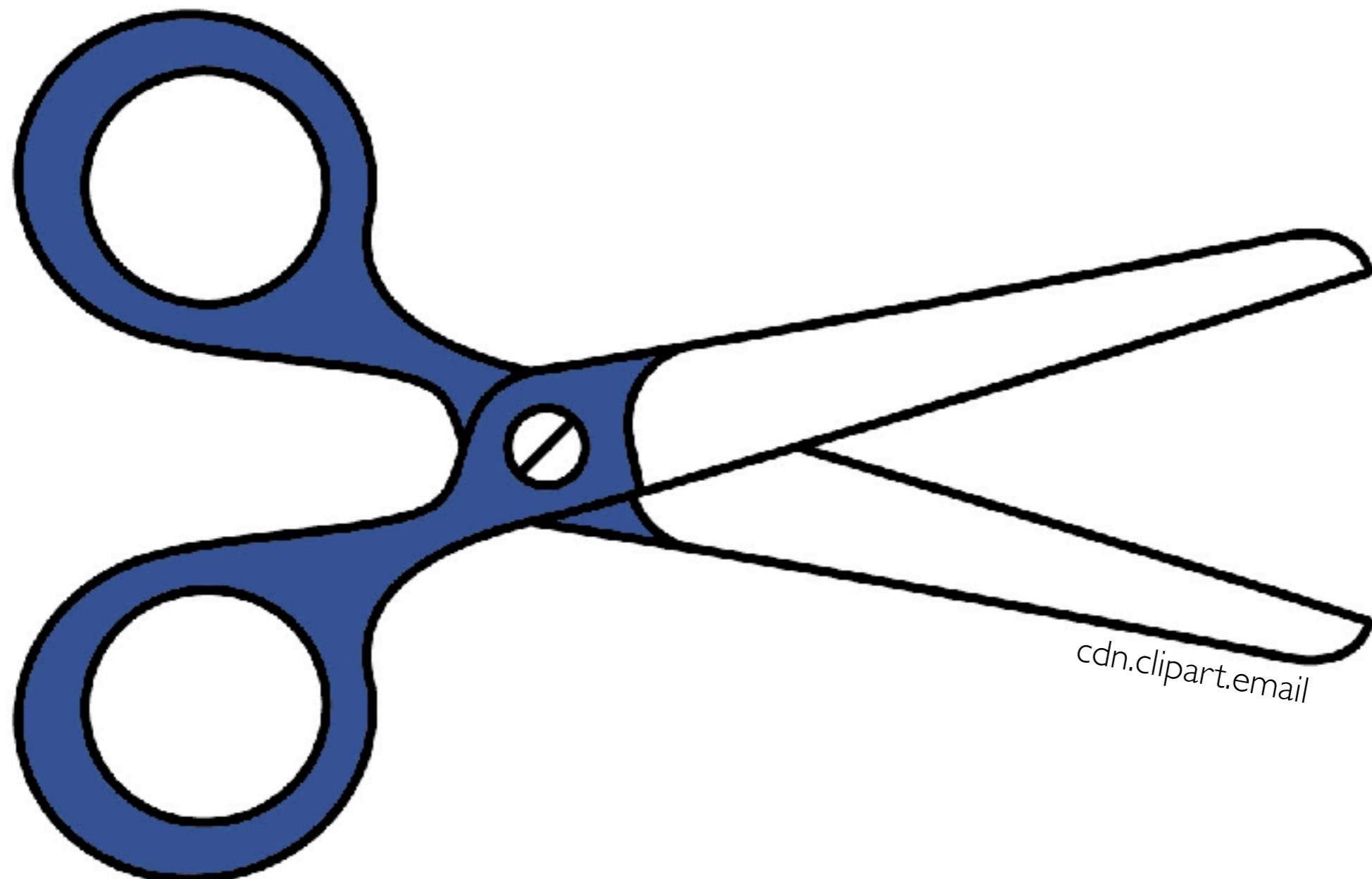
17



A project from my current work

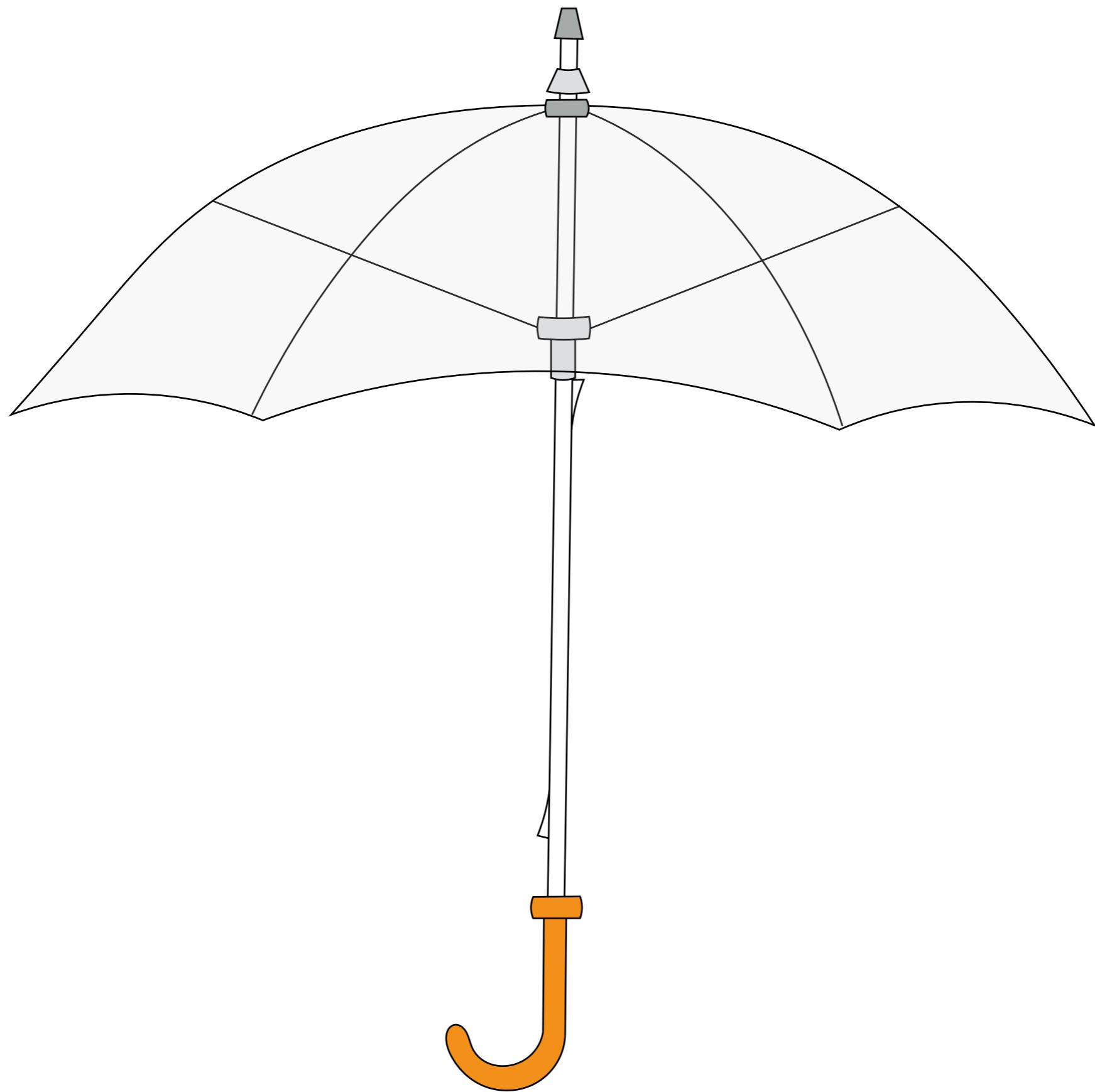
Is a fish head more like an umbrella or an arm?

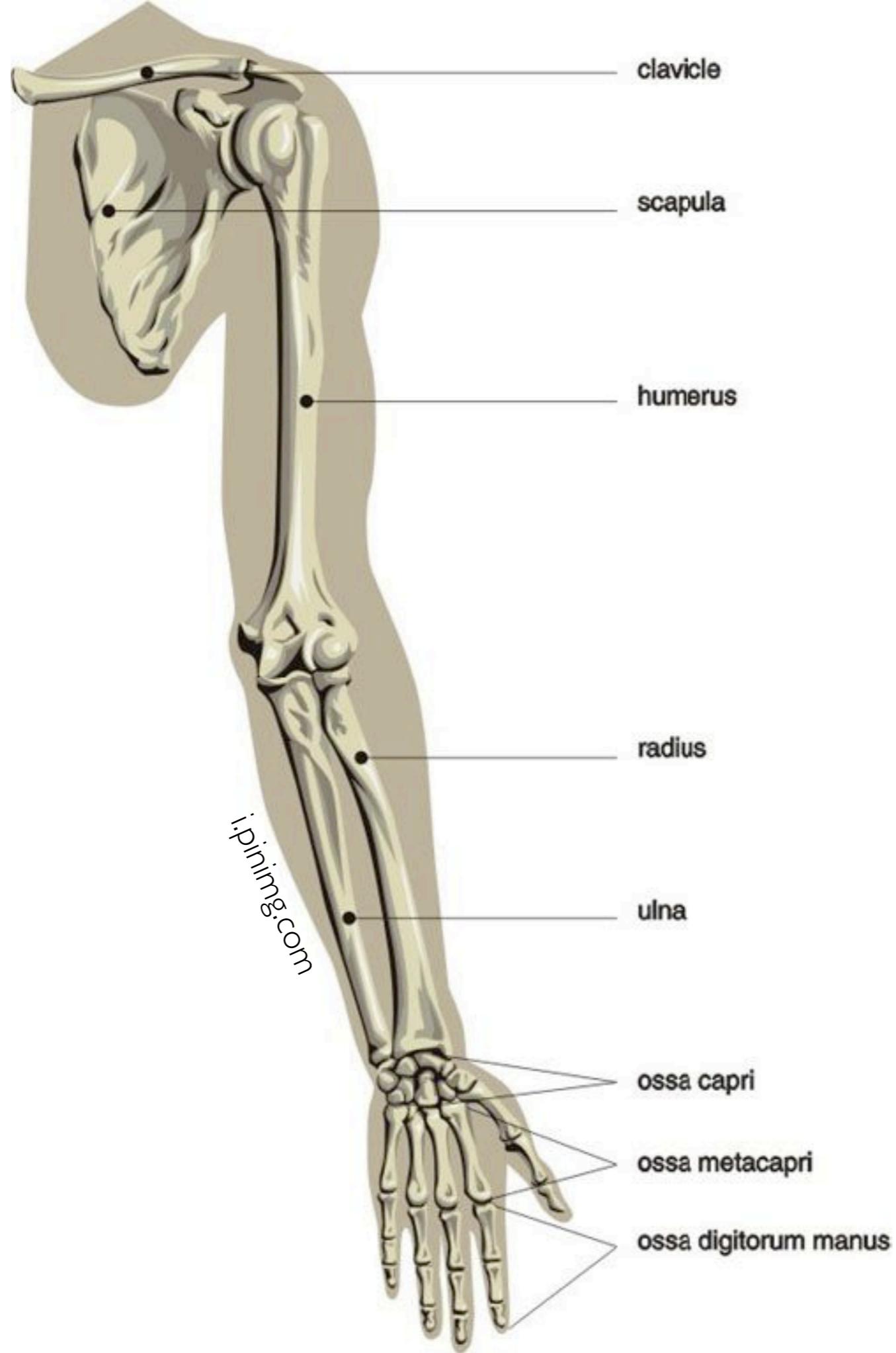
How many degrees of freedom do the following devices or systems have?

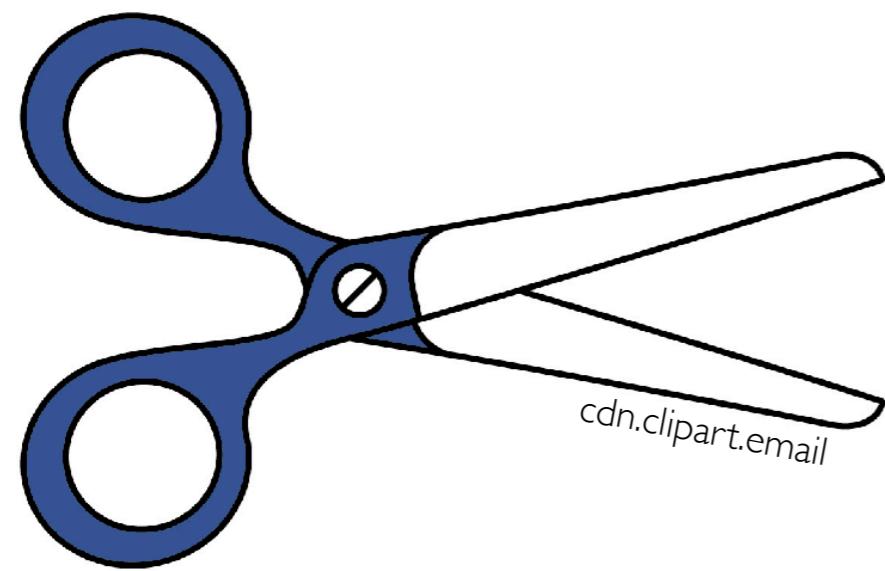


cdn.clipart.email

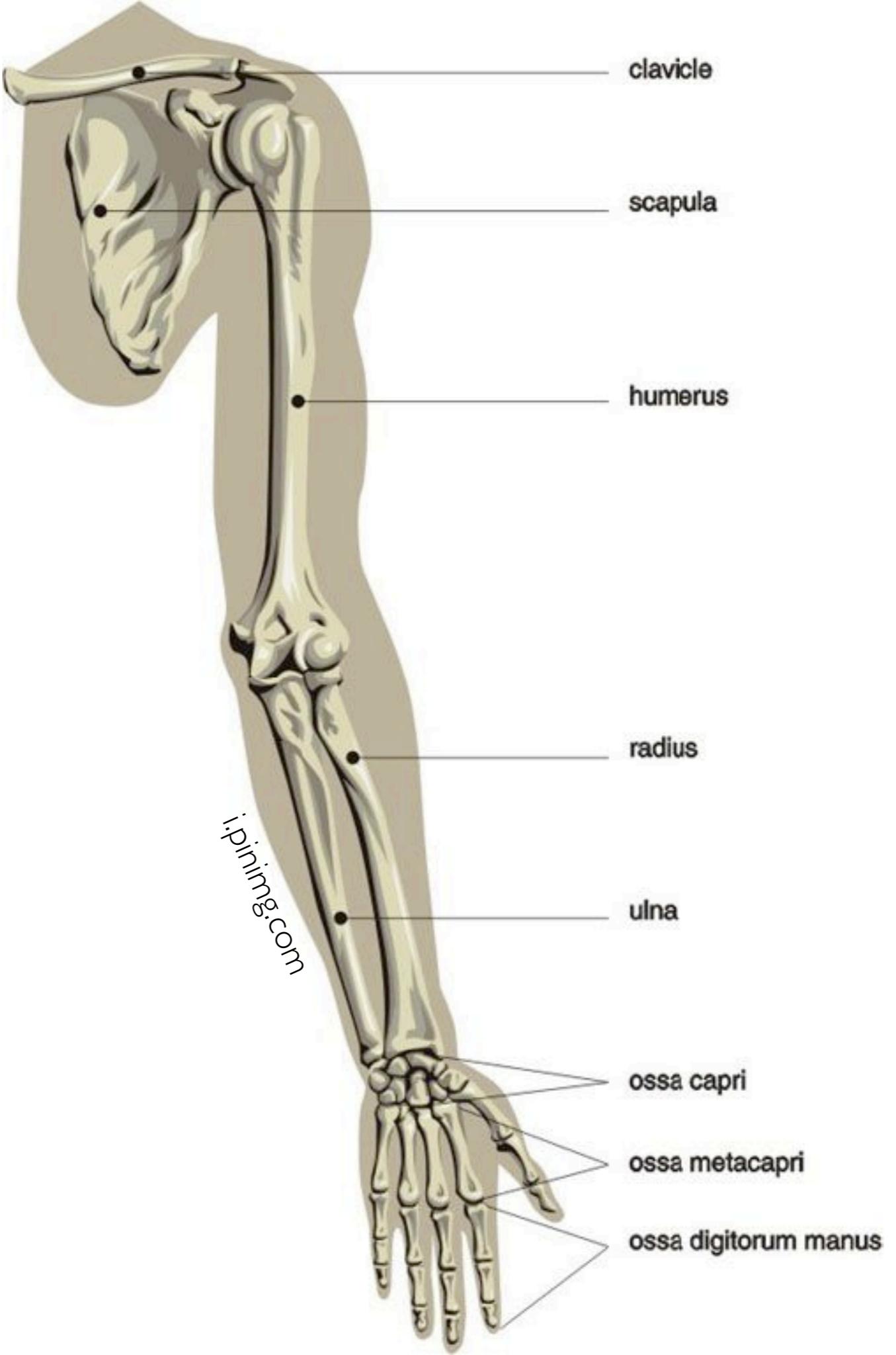








+





Robotic arm

Manuelli et al. (2019) *arXiv preprint*

Channel catfish (*Ictalurus punctatus*)



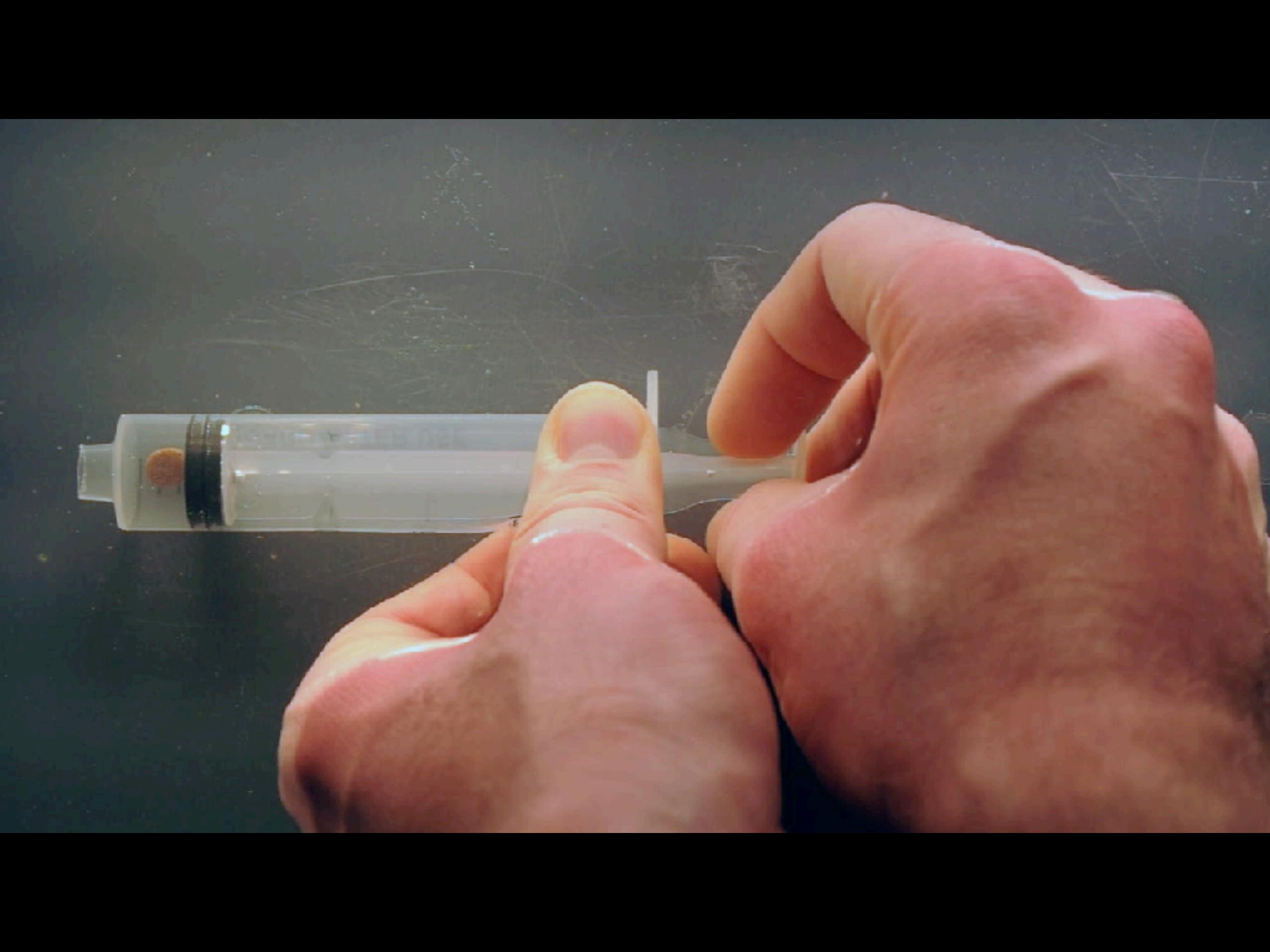


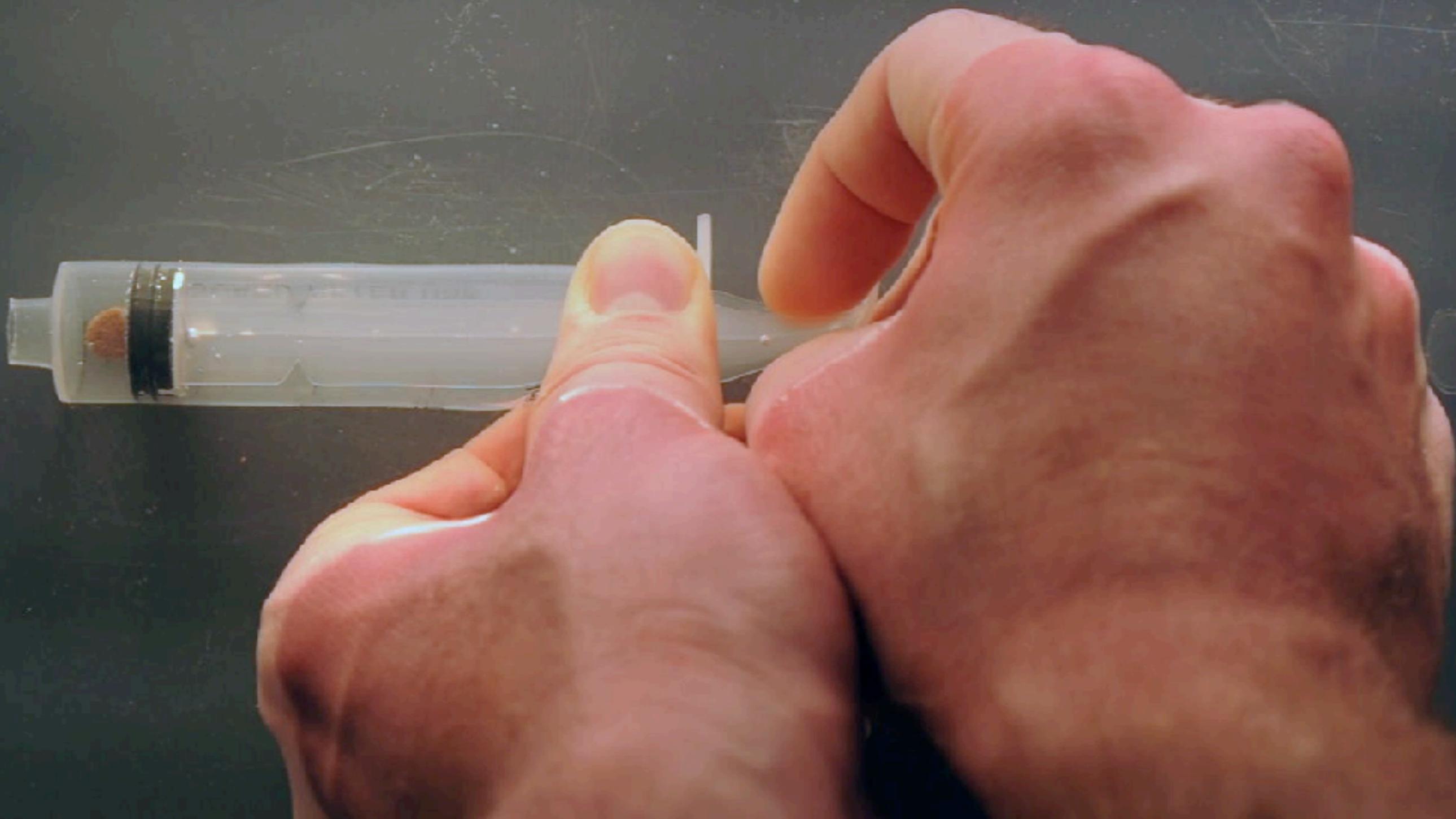
Channel catfish

Video credit: Elizabeth Brainerd



5
10
15
20
DISCARD AFTER USE



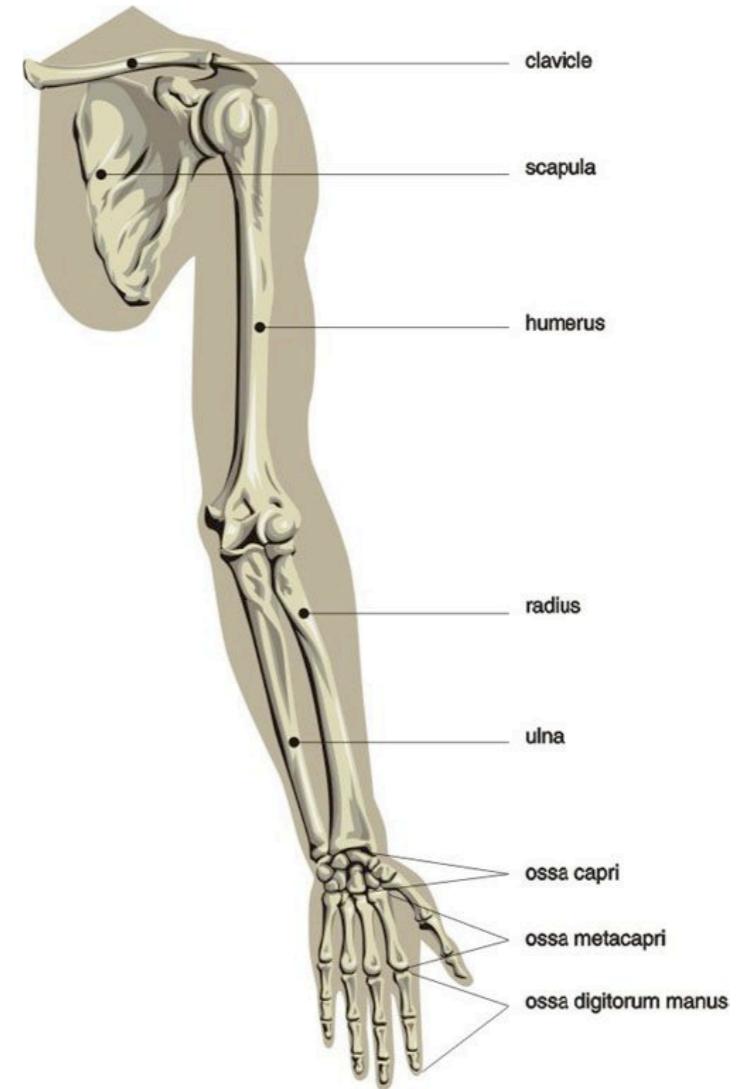


Is a fish head more like an umbrella/ syringe or an arm?



1-2 DoFs

Simple expansion/
compression system



>6 DoFs

Complex
manipulation system

Methods / Skills I had to acquire

Basic surgical techniques

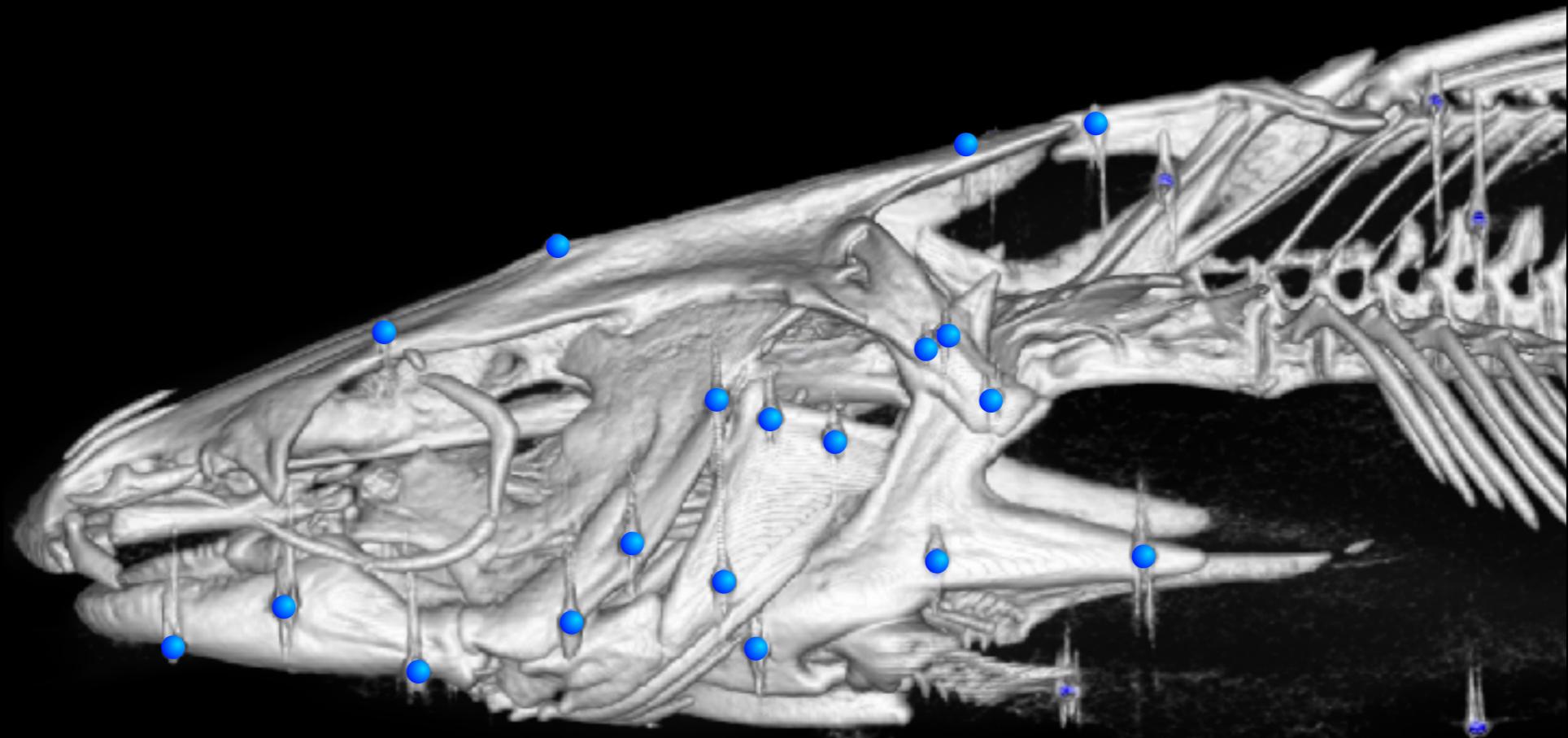
X-ray stereo videography

Mechanical modeling

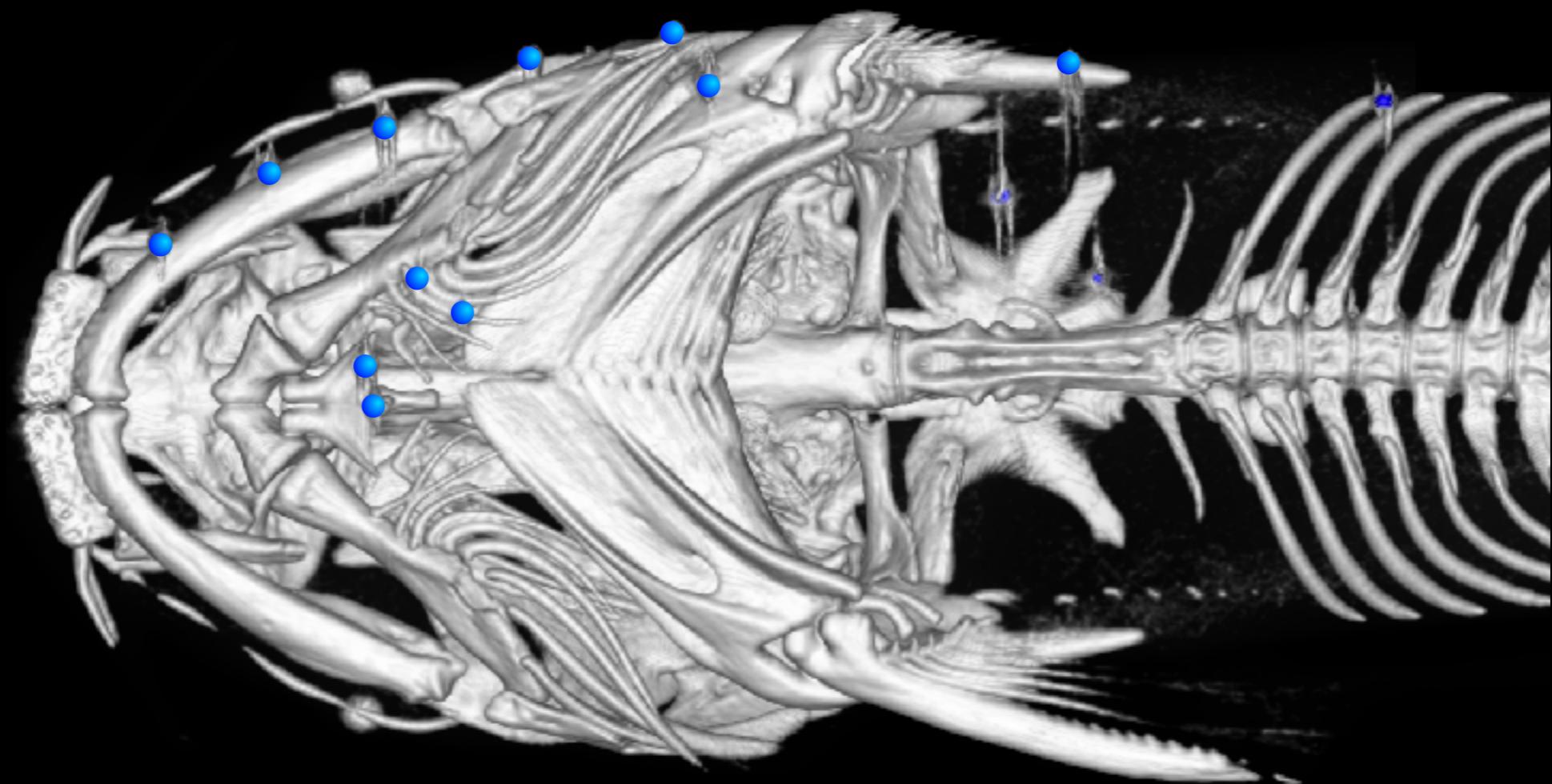
3D graphics and visualization

Marker implantation

Lateral



Ventral



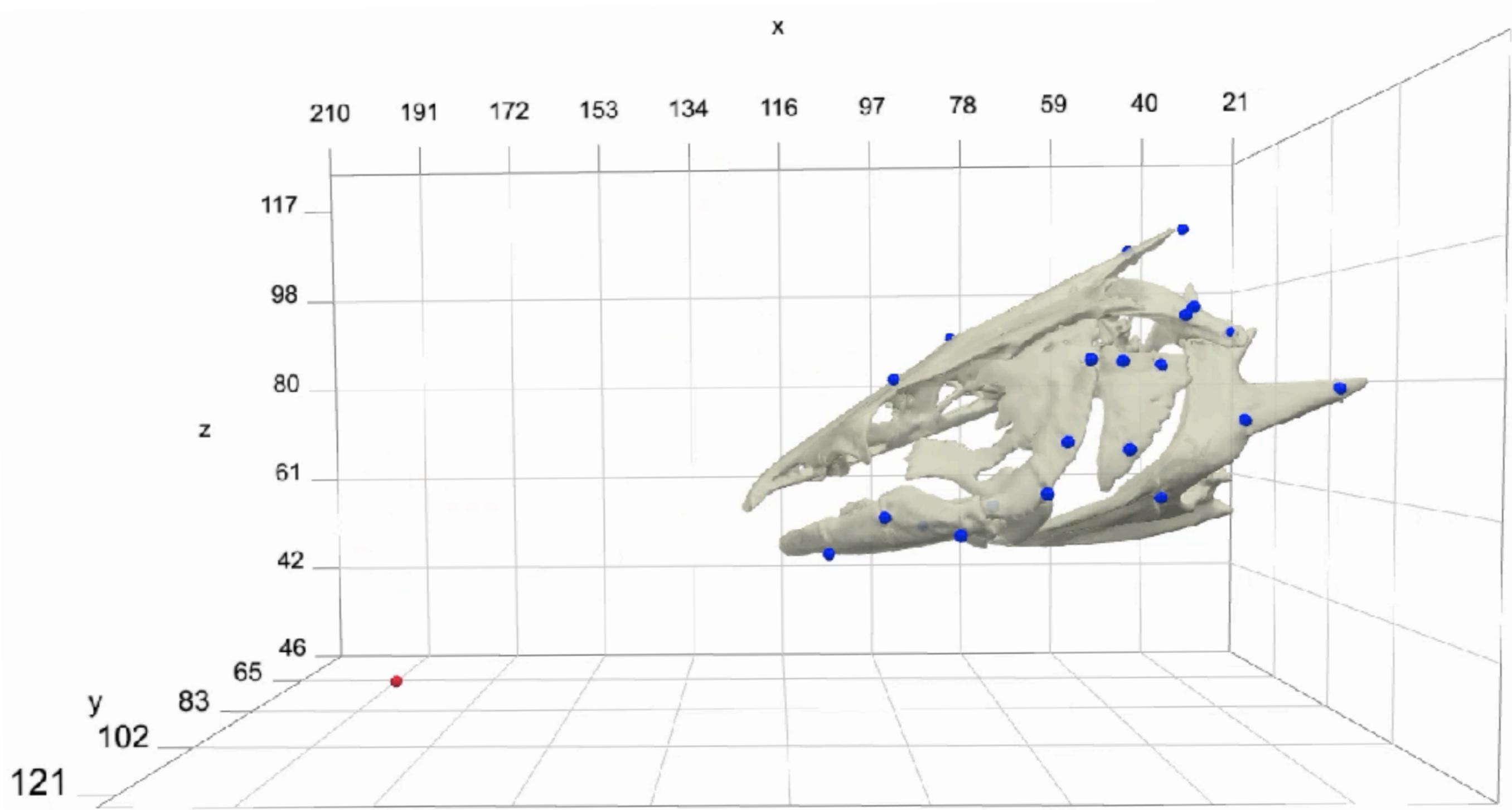


Biplanar ("two views") X-ray video

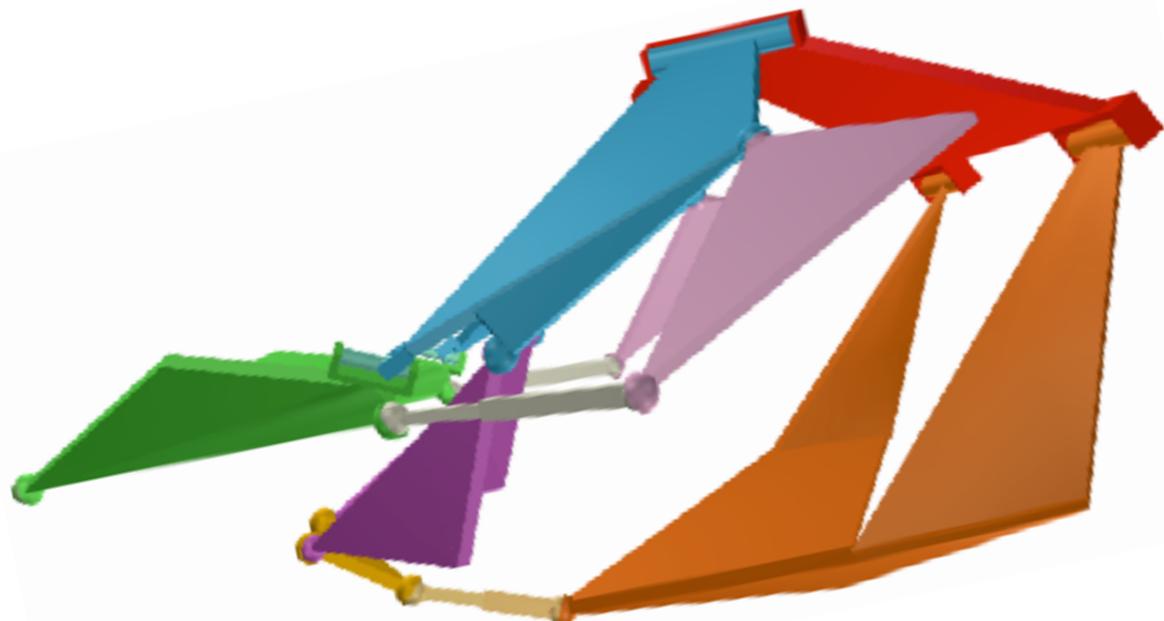
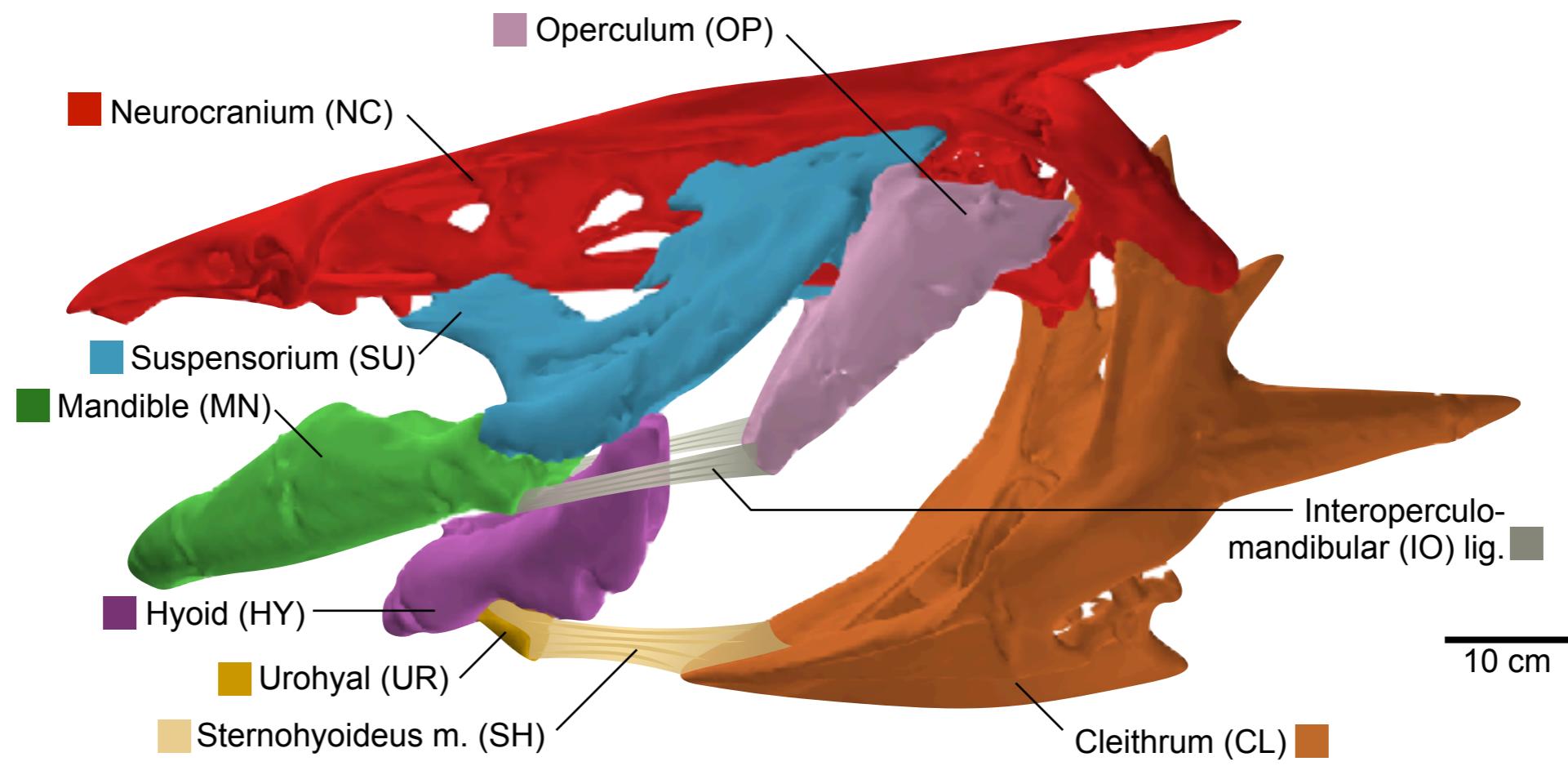
Lateral

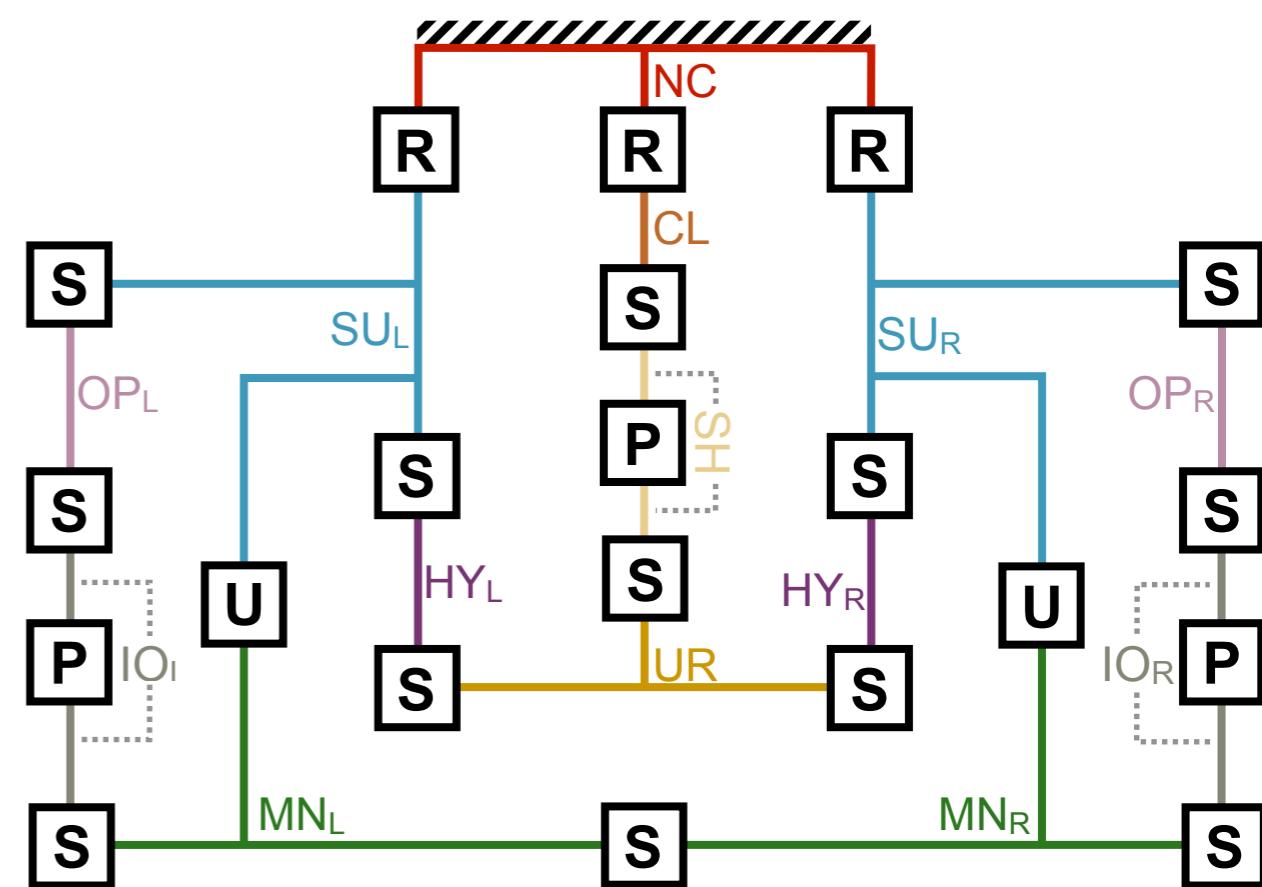
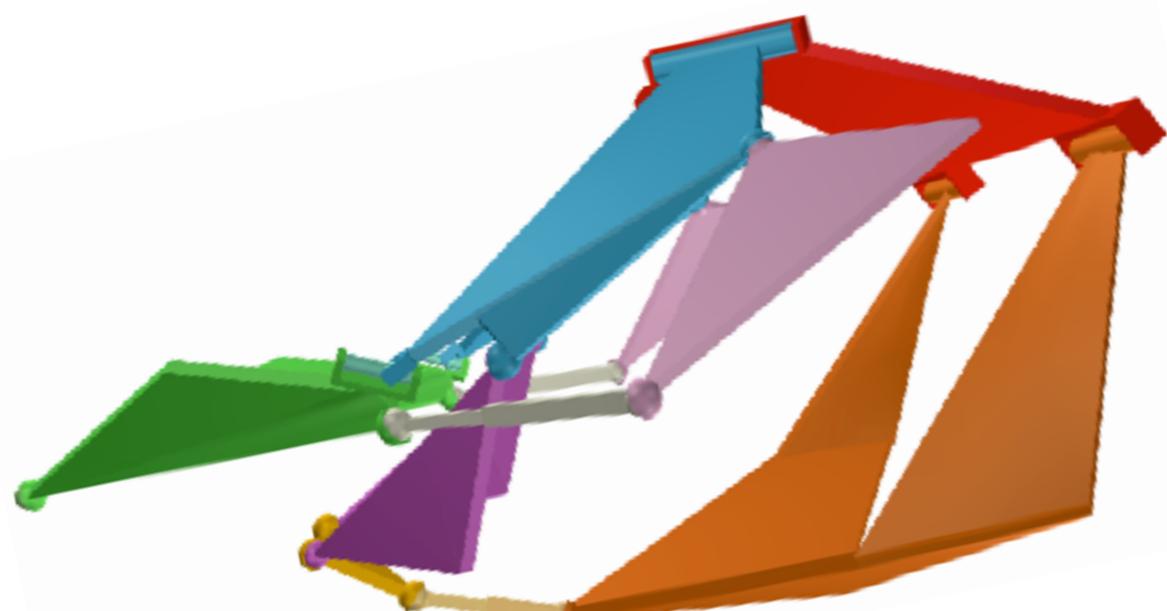
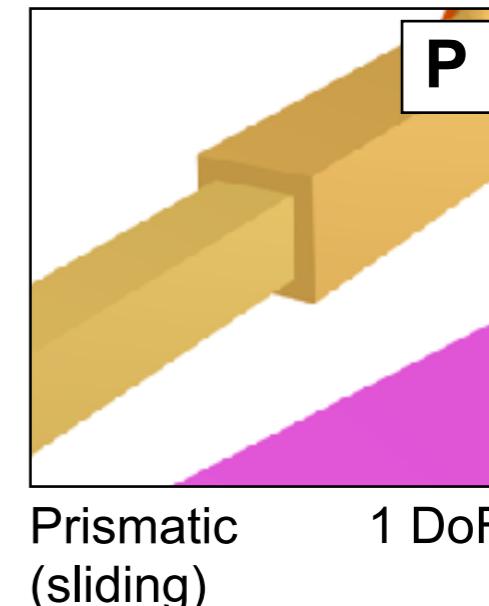
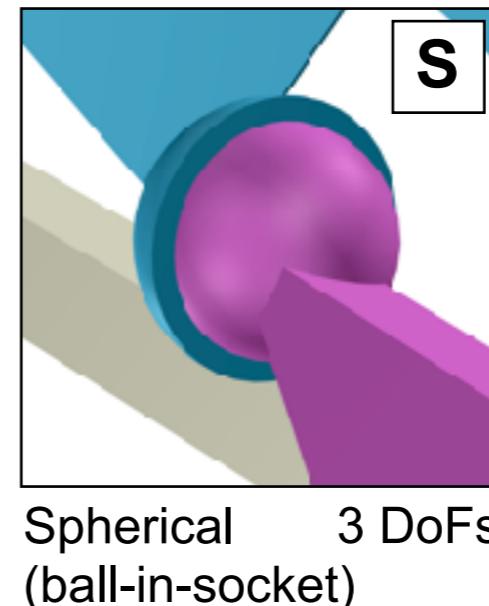
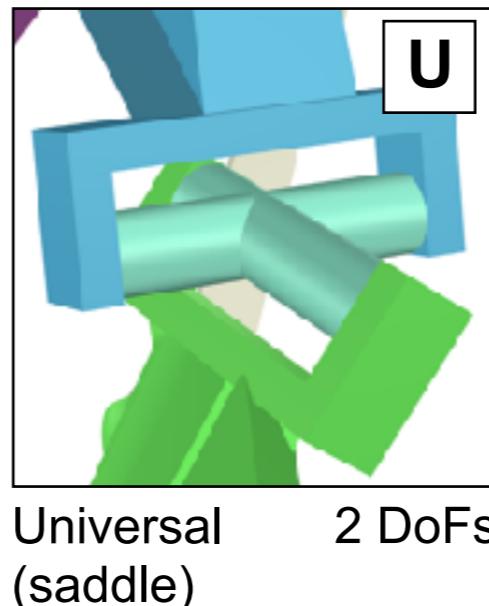
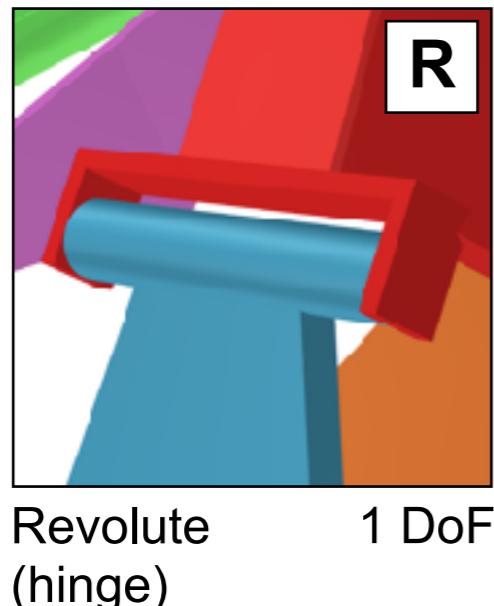
Ventral

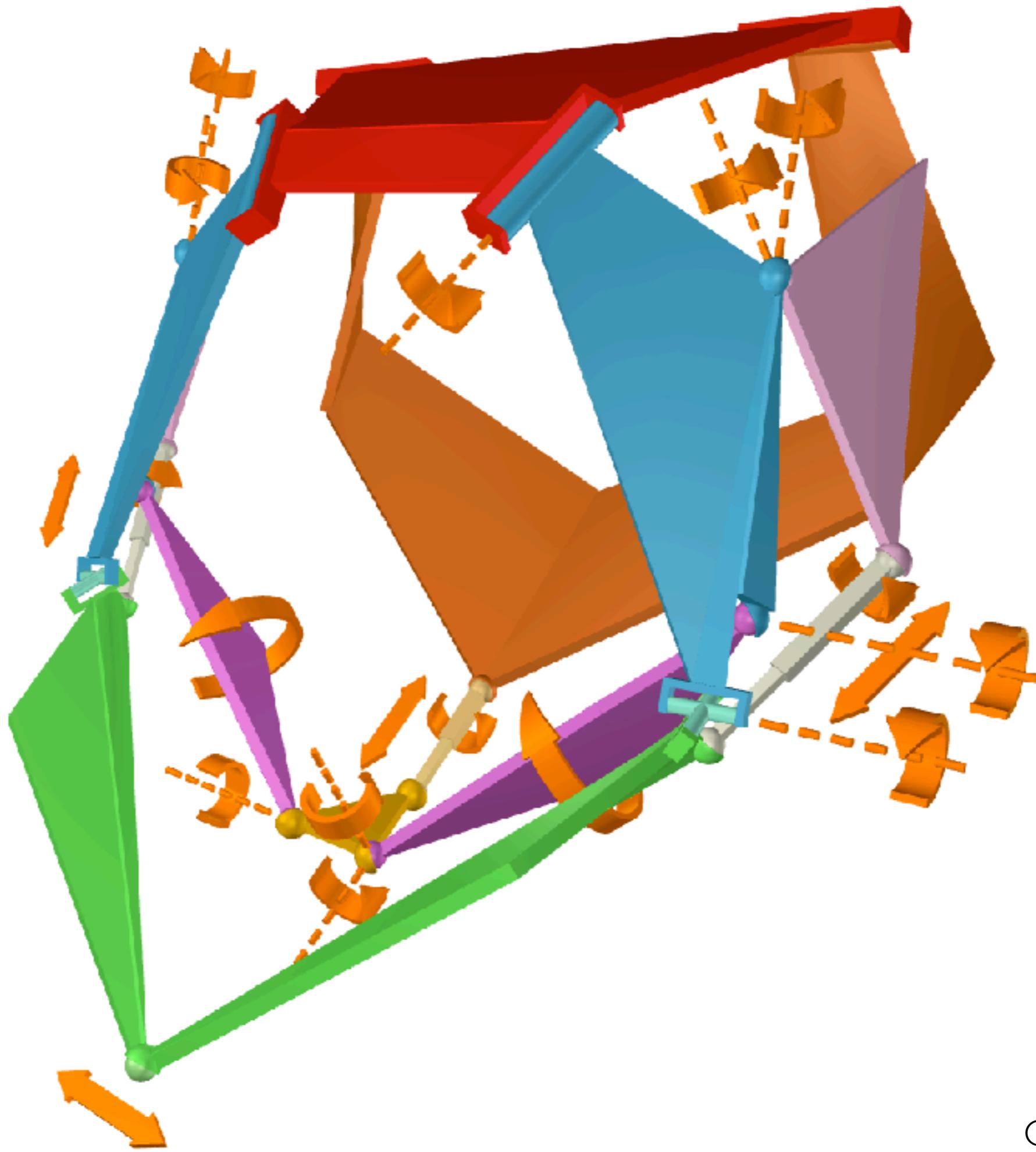
5

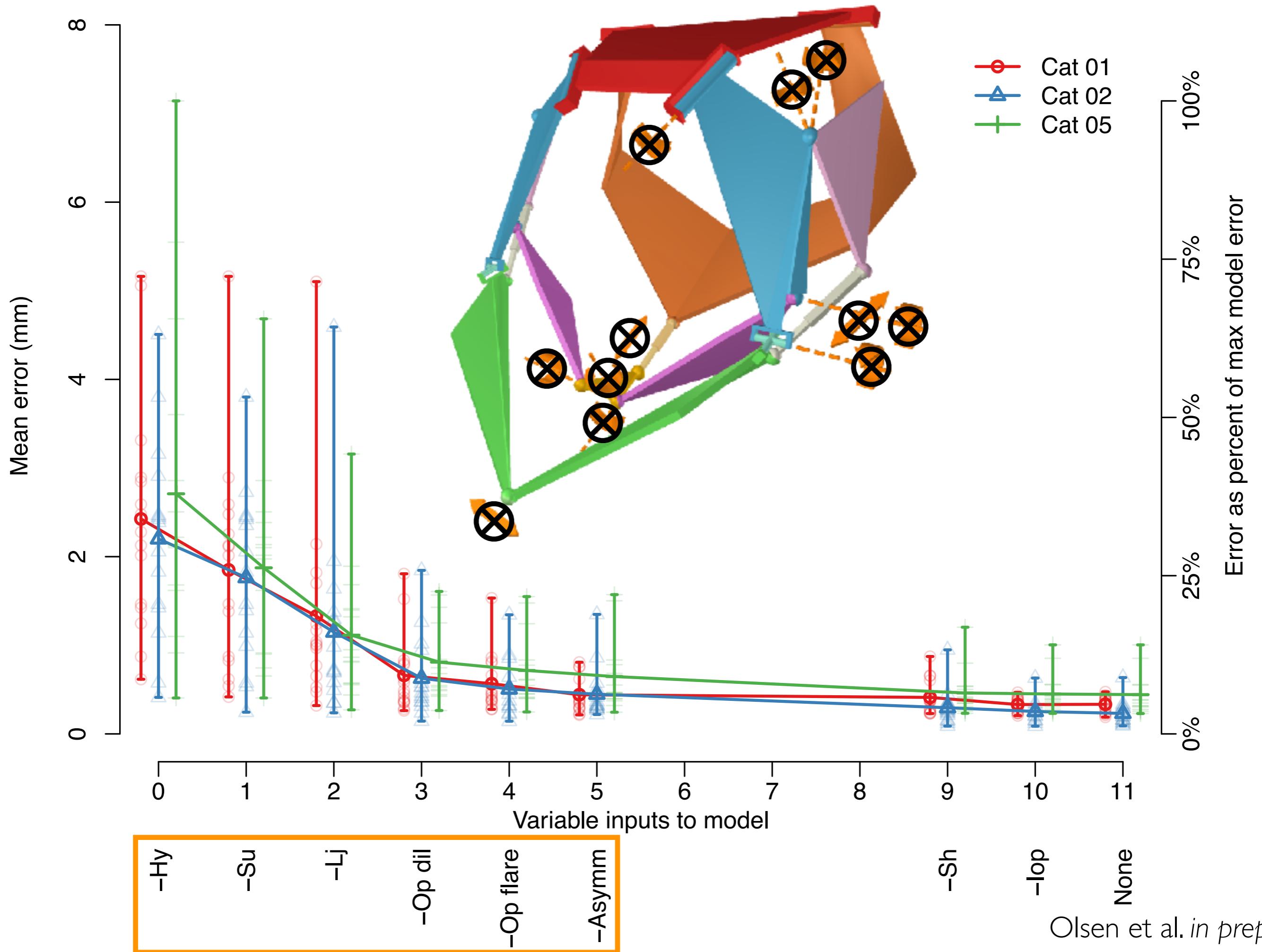


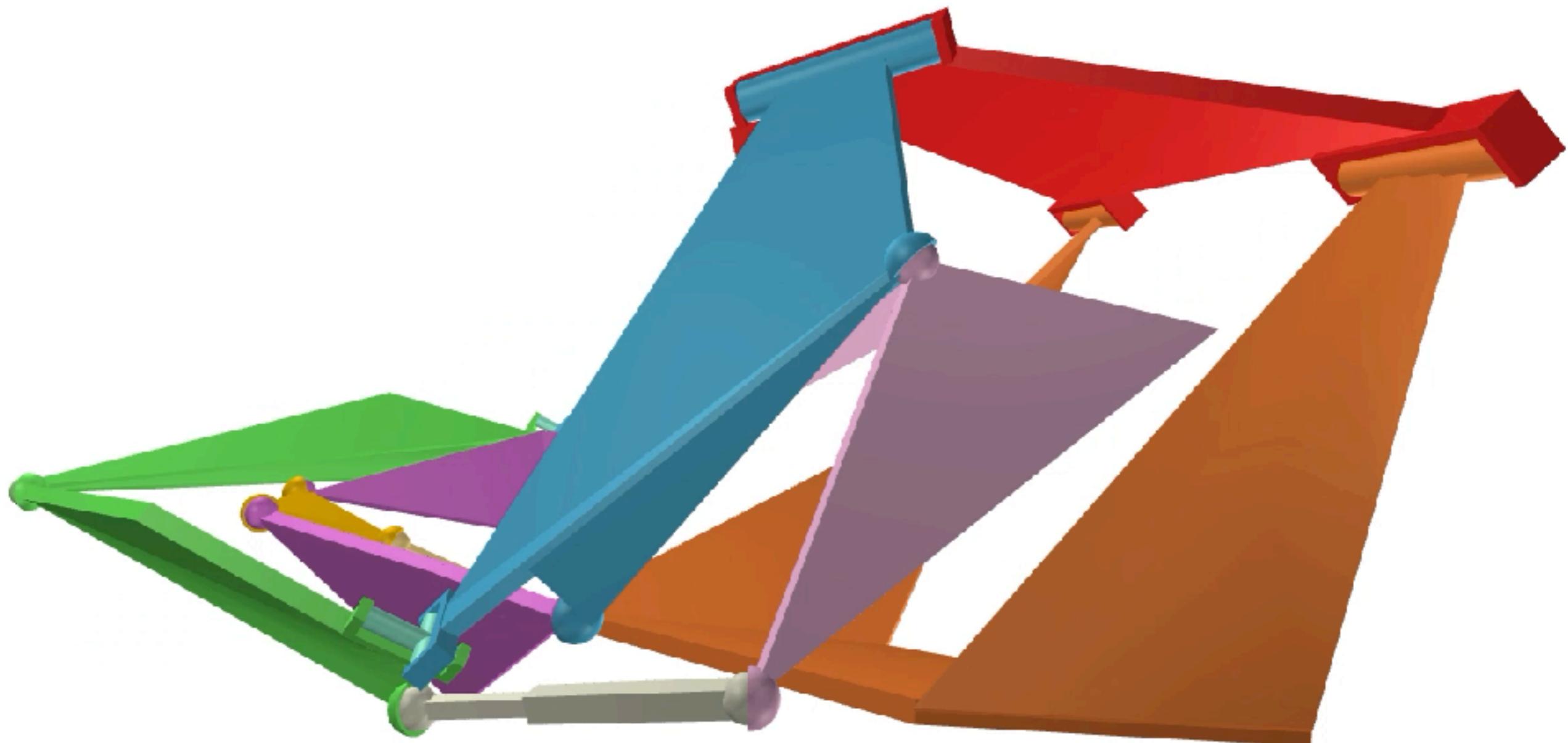
Filmed at 300 frames/sec
Animation slowed 4x













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

(Slowed 3.3x)

**Linkage model
driven by 7 DoFs**

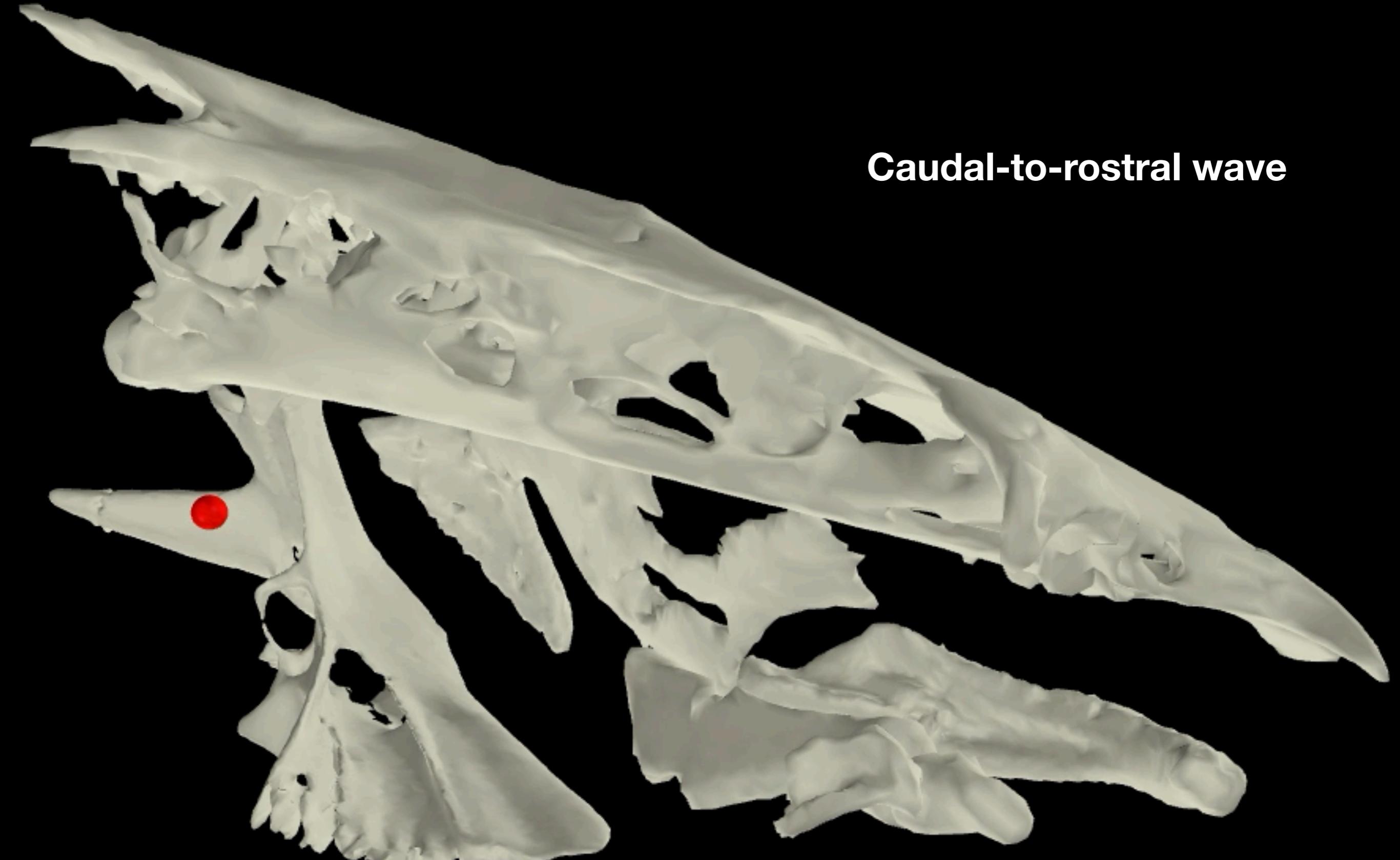
Olsen et al. *in prep*

Rostral-to-caudal wave



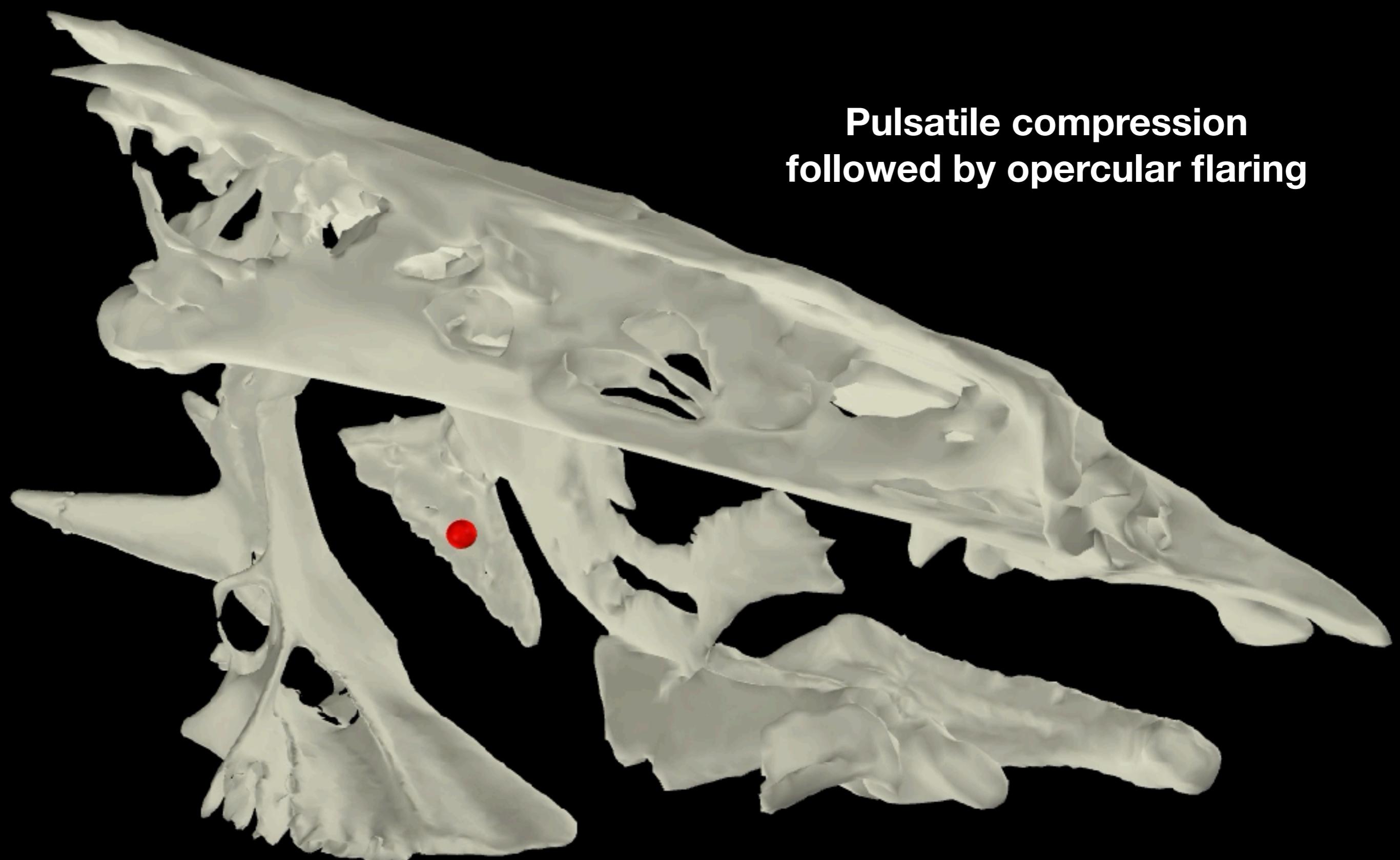
Slowed 0.1x

Olsen et al. *in prep*

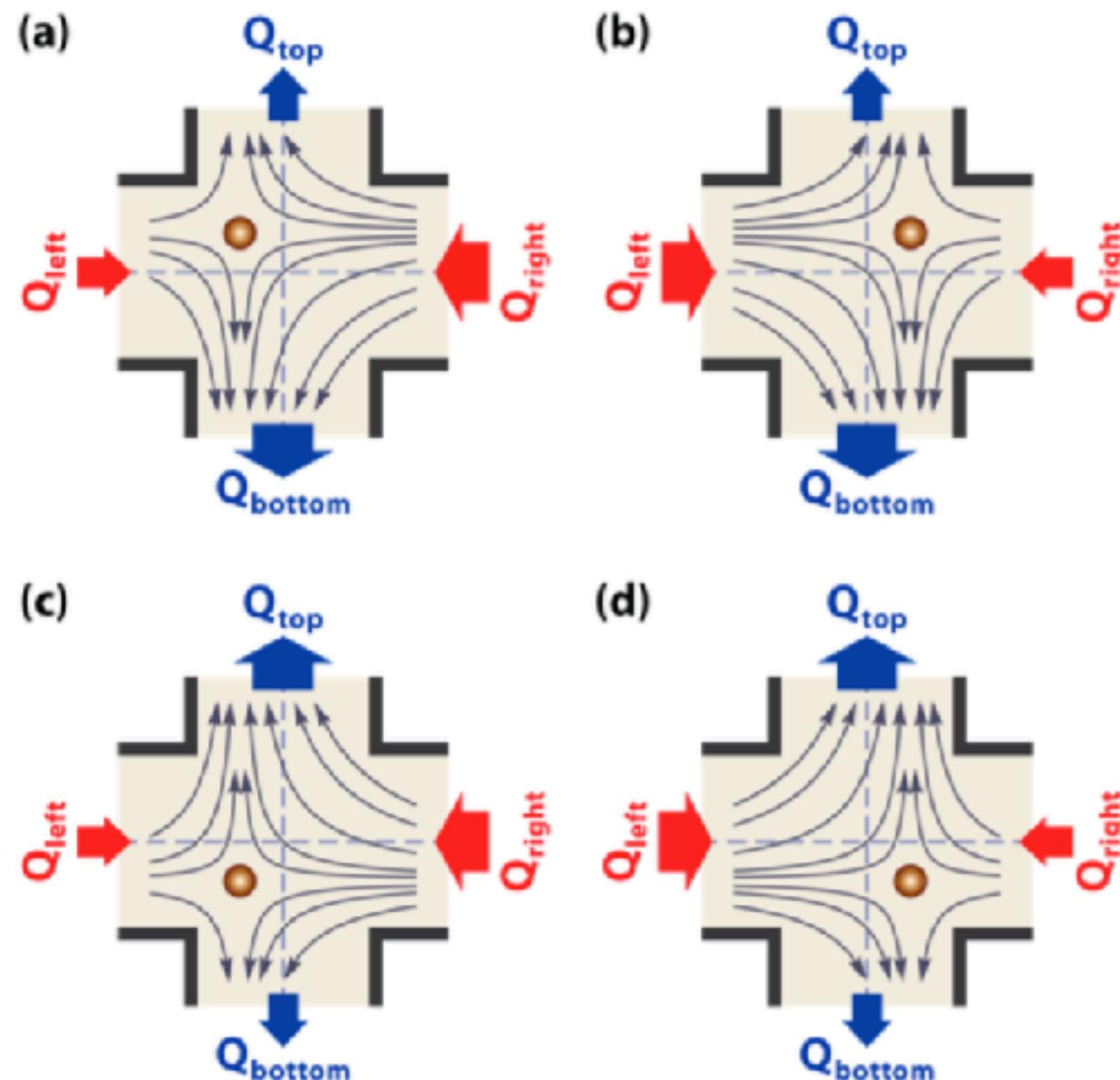


Caudal-to-rostral wave

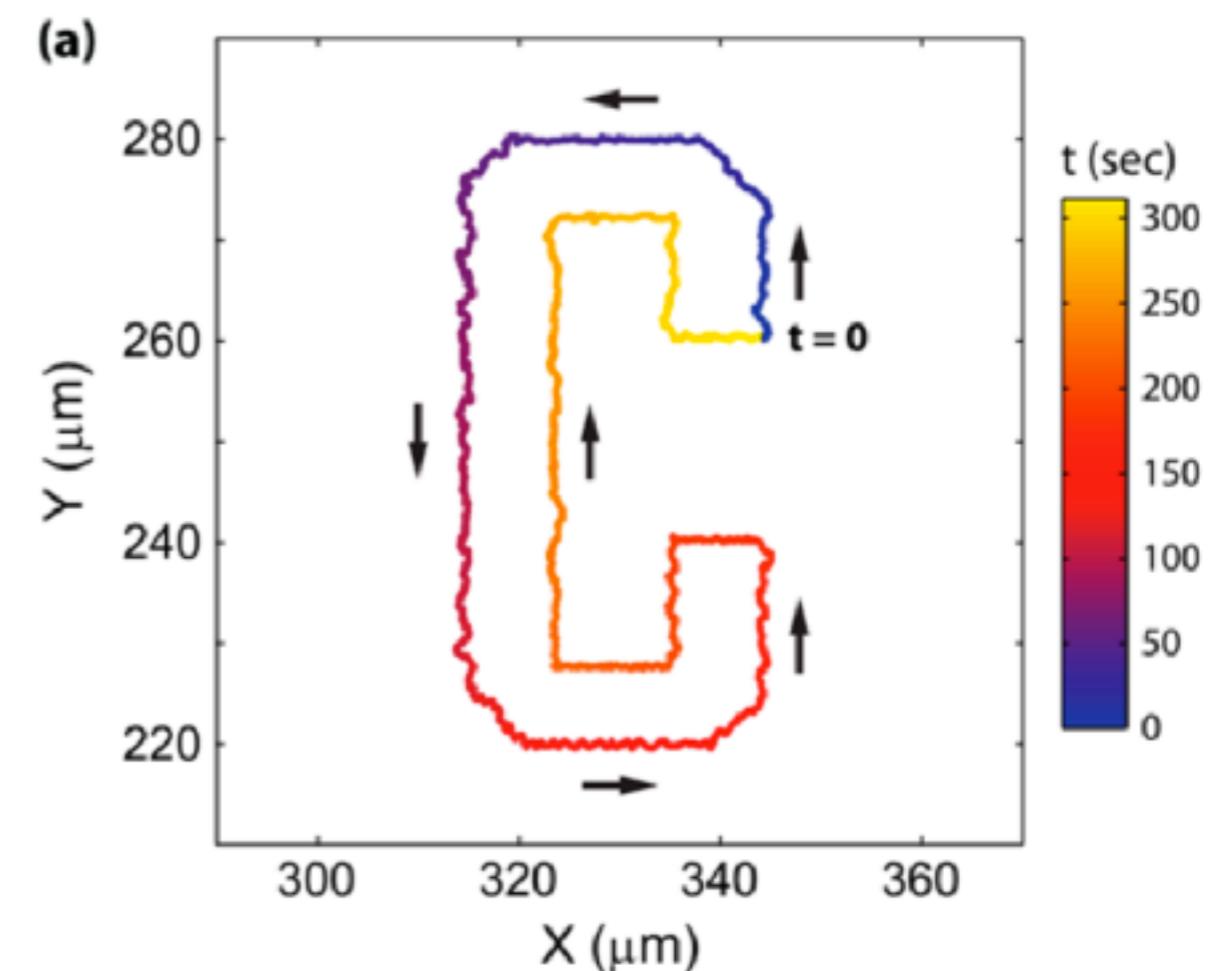
Pulsatile compression
followed by opercular flaring



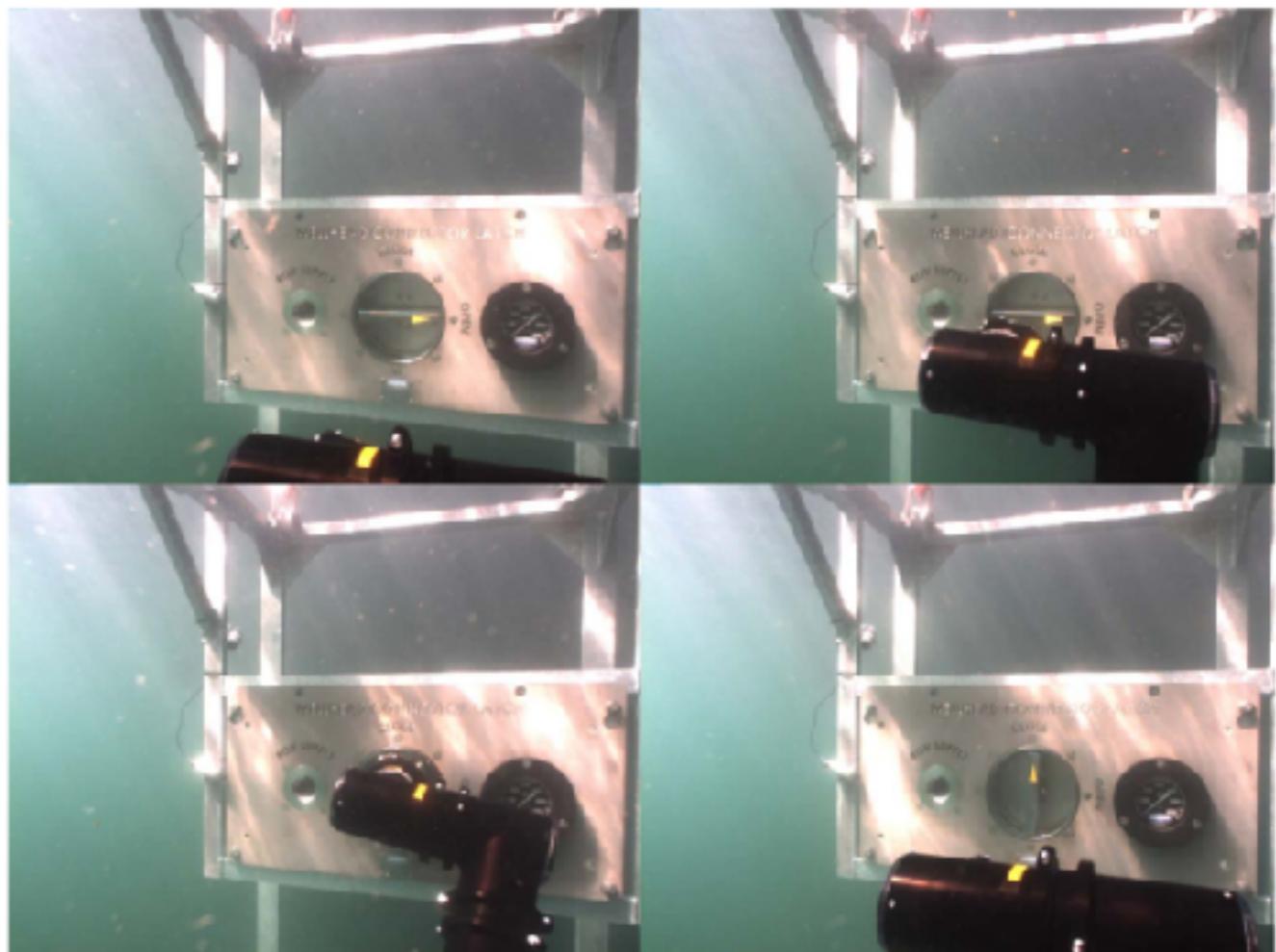
Potential application?



2-DoF particle positioning system using
fluid flows



Potential application?



Conclusions

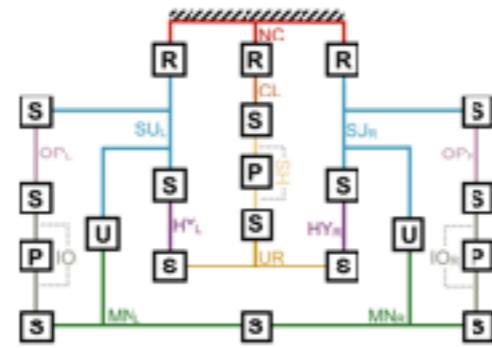
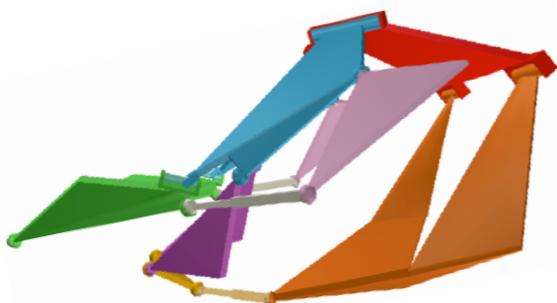
The catfish skull can be modeled as a 5-loop parallel mechanism with 5-7 DoFs used during suction feeding

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

Beth Brainerd
Erika Tavares
Alejandro Romero
Ariel Camp
John Capano
Yordano Jiménez
JJ Lomax
Elska Kaczmarek
Hannah Weller
Patricia Hernández

Lara Helwig
Tara Bozzini
Bianca Obiakor
Mariah Nuzzo
Shahn Thaliffdeen
Connor Johnson
Chahat Rana
Brown EEB Department
Brown Animal Care Facility



Funding Sources

NSF PRFB DBI-1612230

NSF IOS-1120967

Bushnell Fund