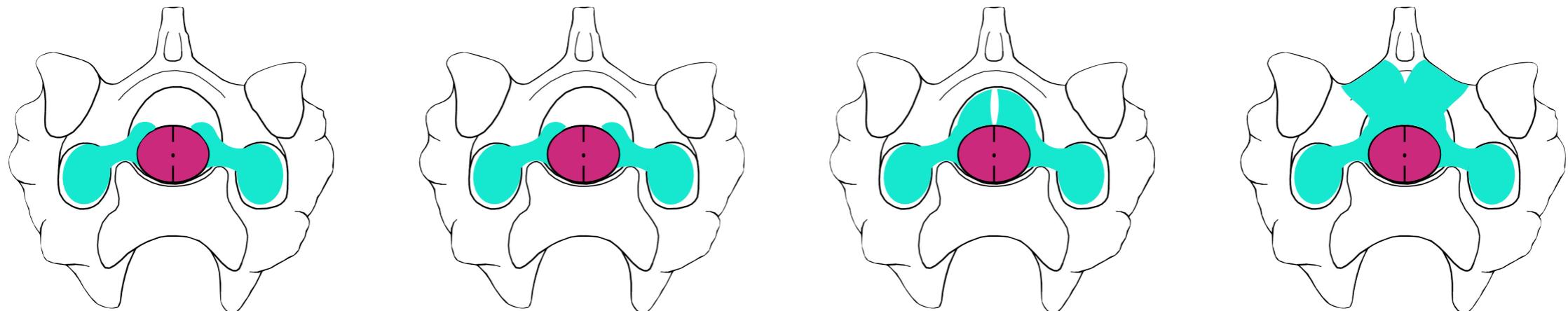


A CT-based Survey of Supramedullary Diverticula in Extant Birds

Dr. Jessie Atterholt^{1,2} & Dr. Mathew Wedel¹

¹Western University of Health Sciences, Pomona, CA, USA

²Raymond M. Alf Museum of Paleontology, Claremont, CA, USA



lungs & trachea

air sacs &
diverticula

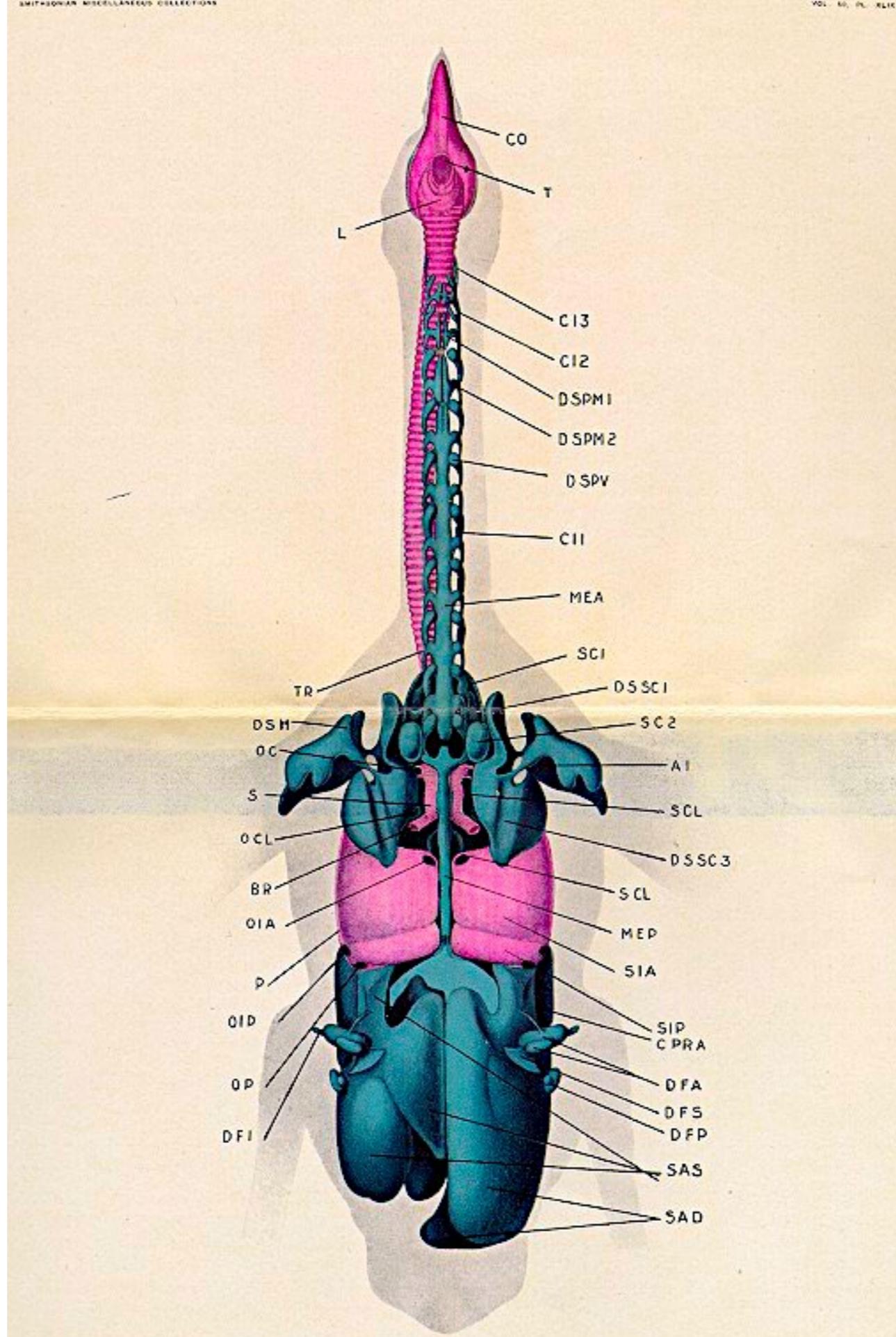


FIG. 12 DORSAL VIEW OF THE AIR-SACS THAT LIE BETWEEN THE SOFT PARTS AND THE LUNGS.
(THE LATTER ARE REPRESENTED AS TRANSPARENT).

(Müller, 1908)

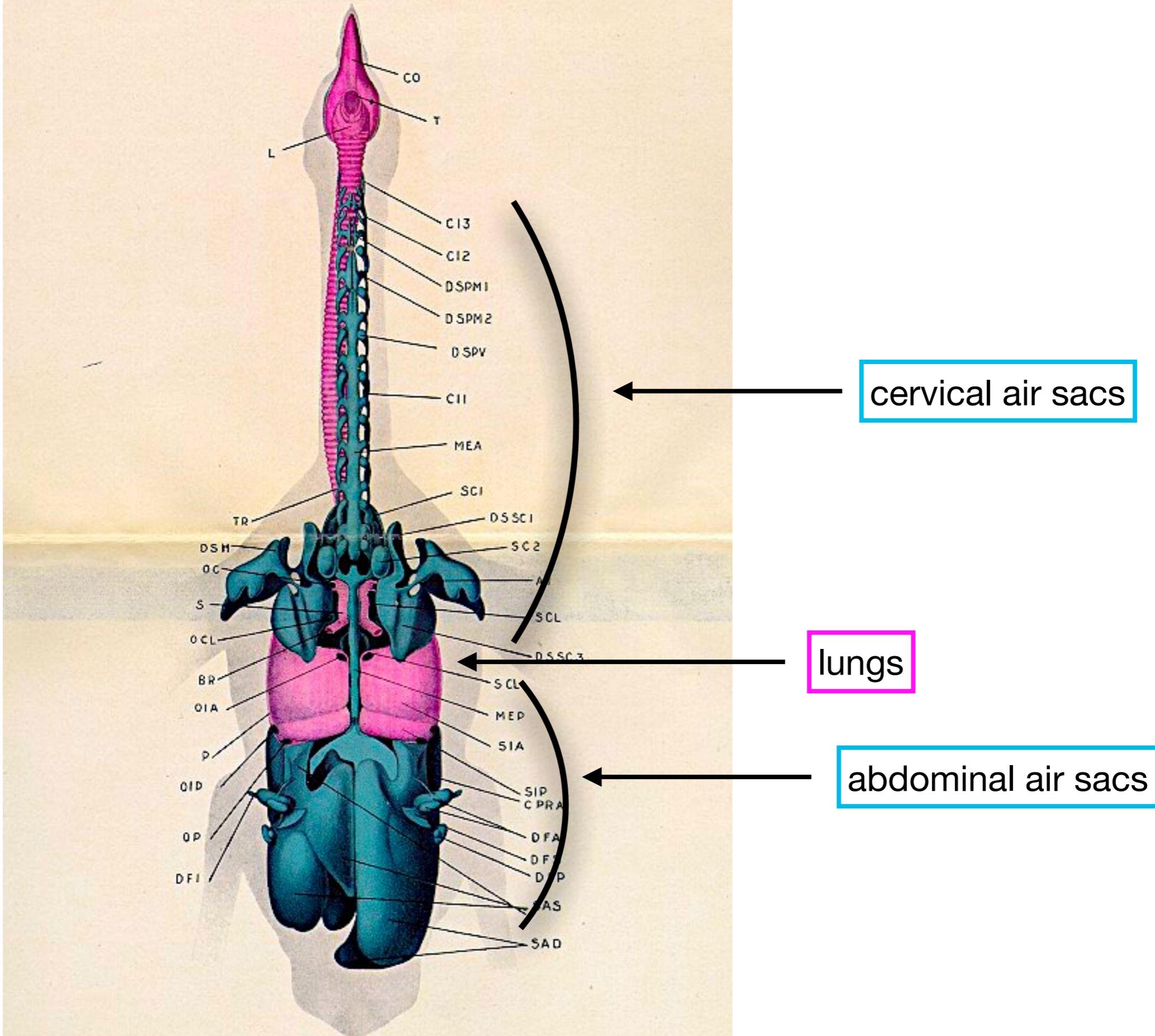
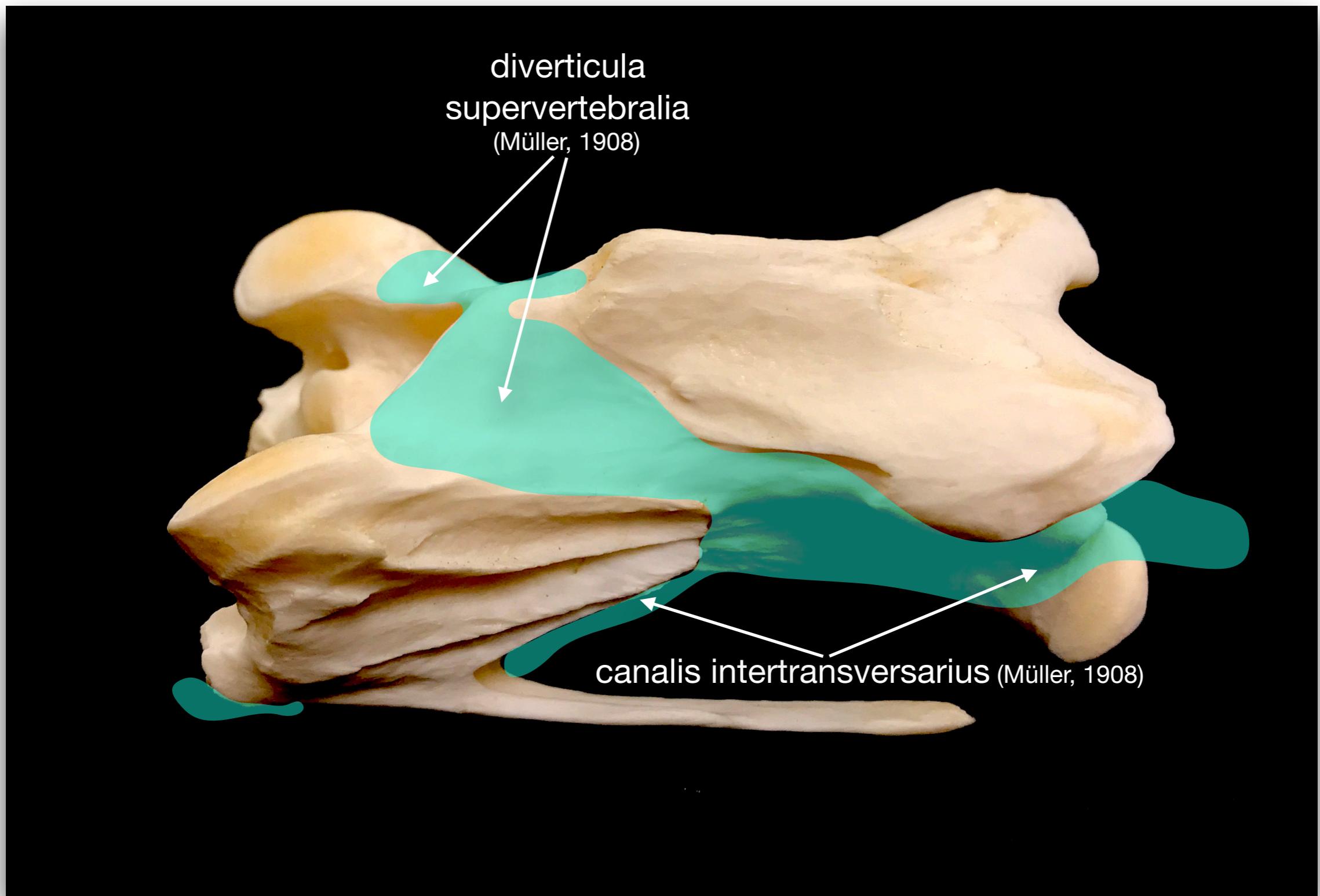
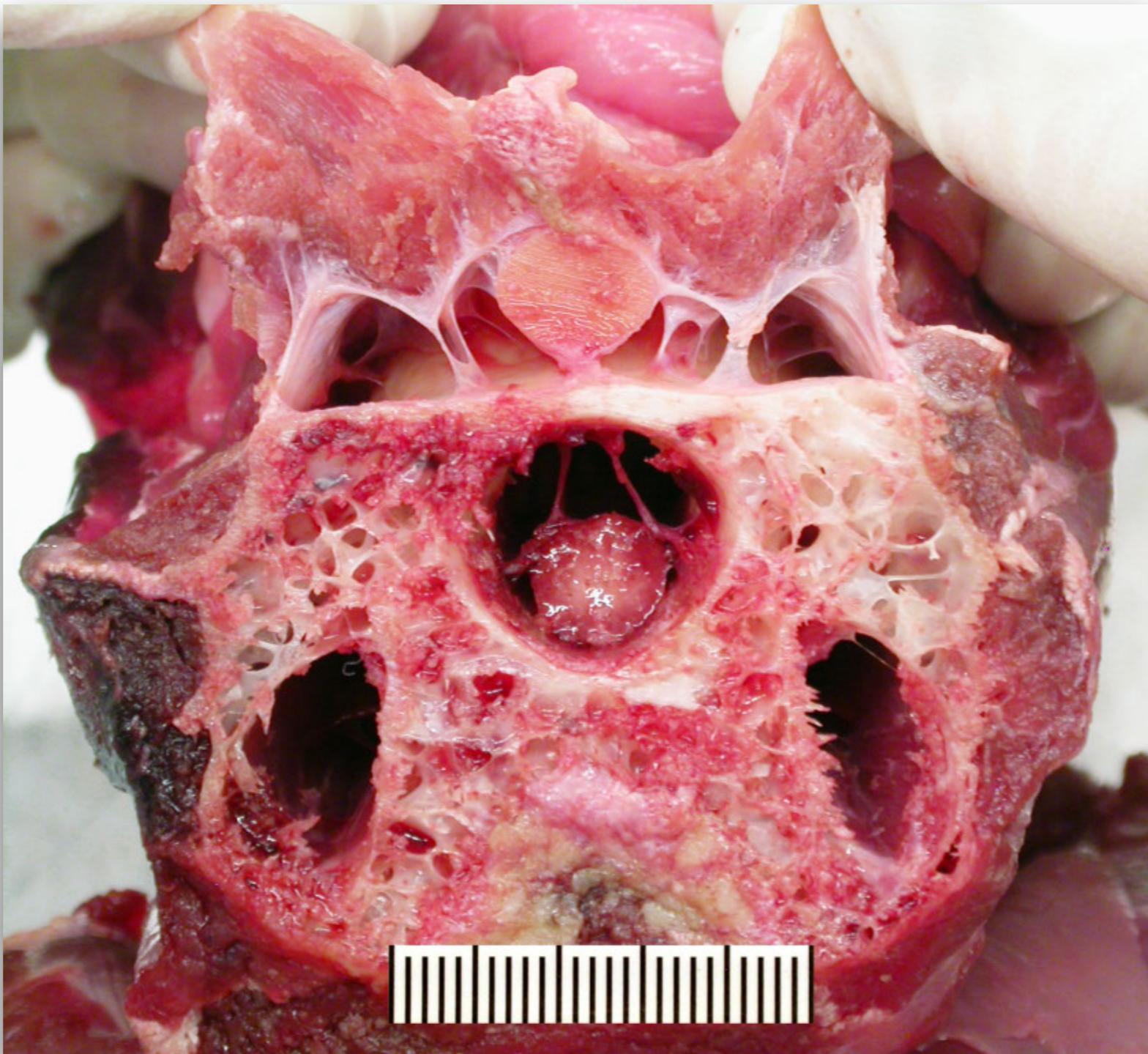


FIG. 12 DORSAL VIEW OF THE AIR-SACS THAT LIE BETWEEN THE SOFT PARTS AND THE LUNGS.
(THE LATTER ARE REPRESENTED AS TRANSPARENT).

(Müller, 1908)





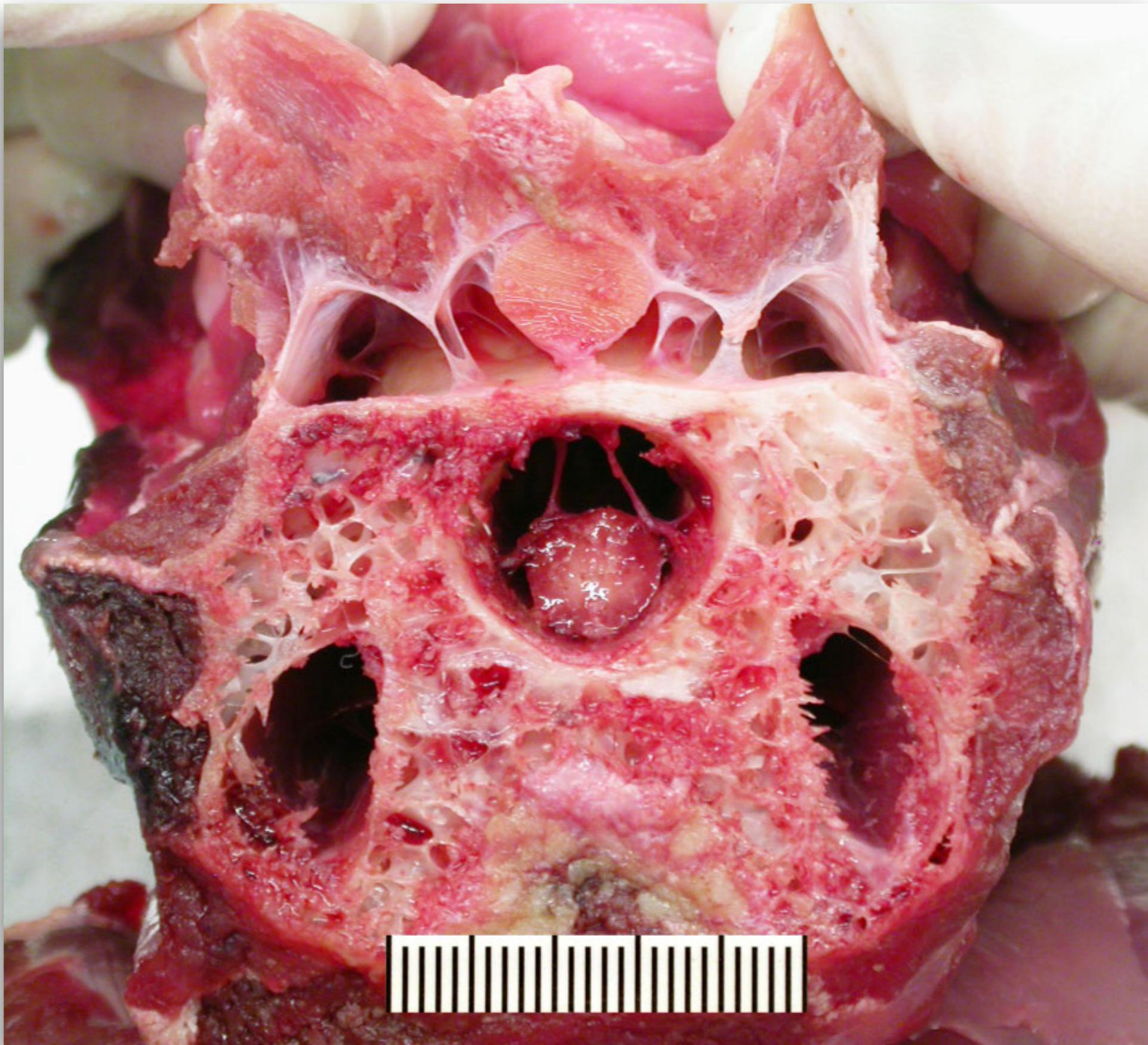
Supramedullary Airways:

- diverticula branching from lungs & air sacs
- inside vertebral canal
- above spinal cord

supramedullary
airways

spinal cord

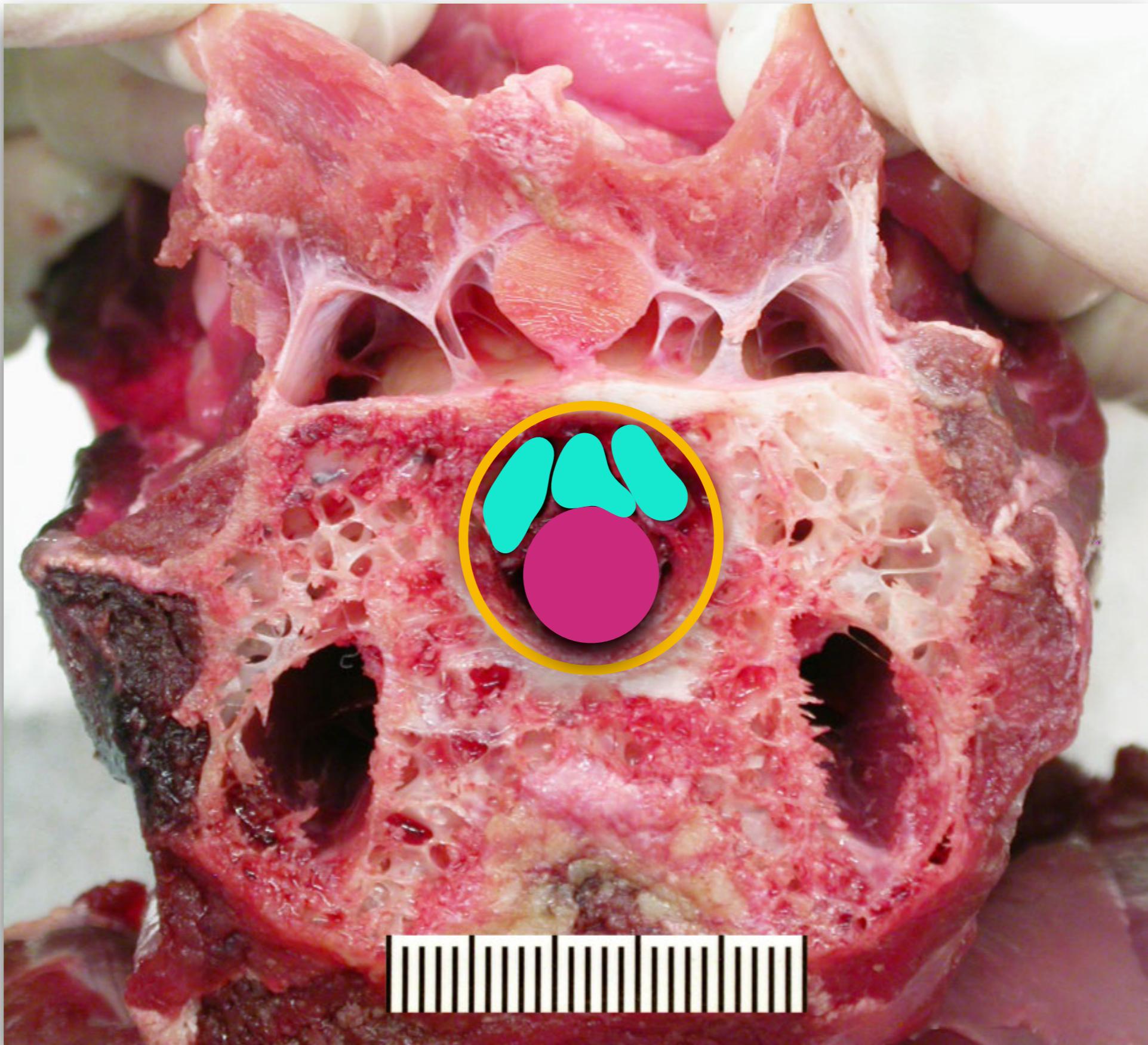
vertebral
canal



supramedullary
airways

spinal cord

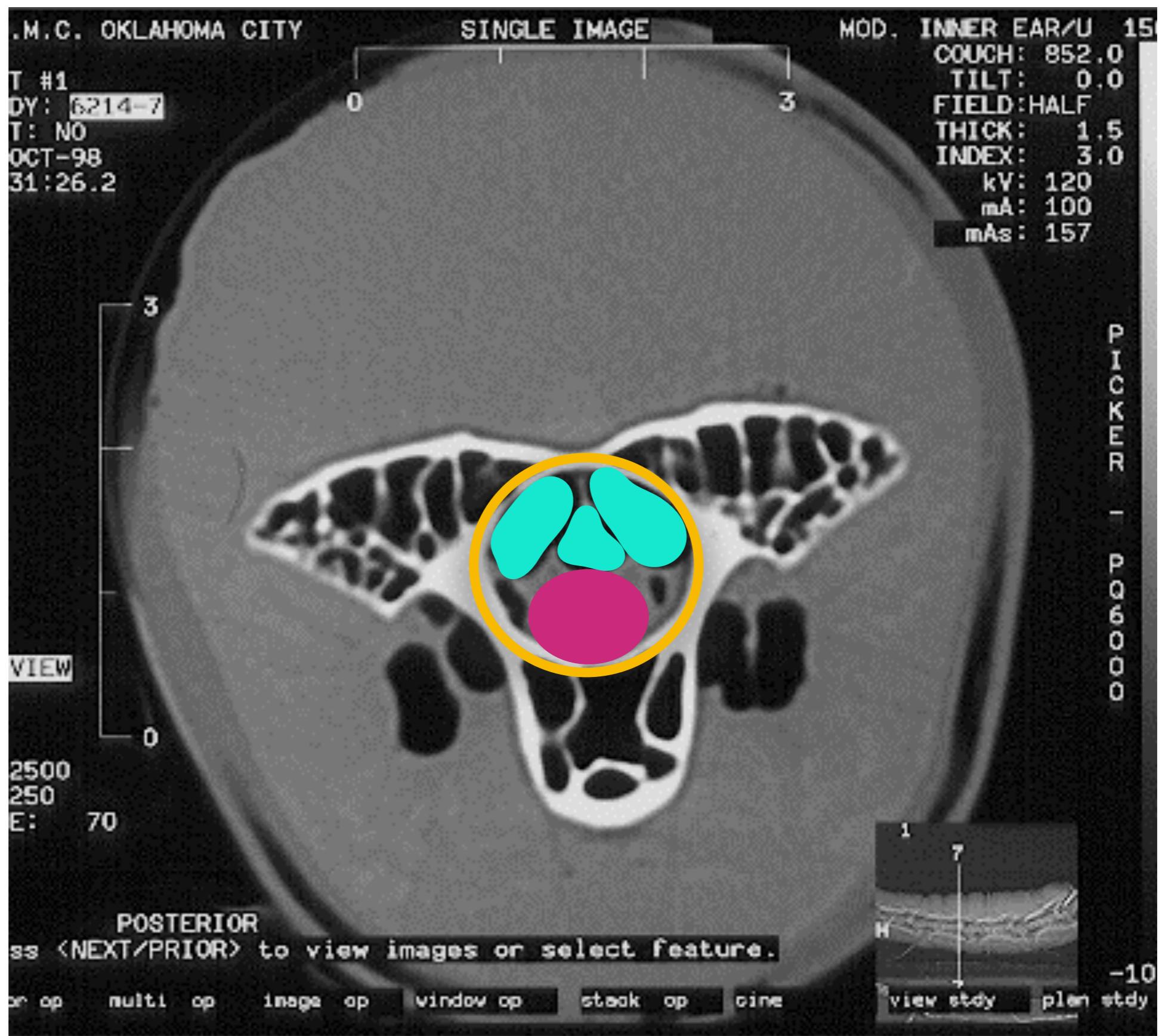
vertebral
canal



supramedullary
airways

spinal cord

vertebral
canal



M.C. OKLAHOMA CITY

SINGLE IMAGE

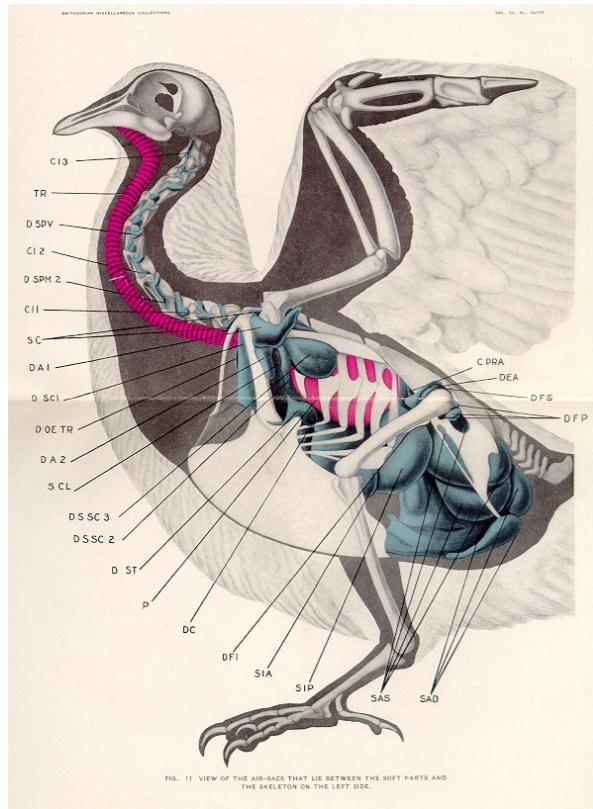
MOD. INNER EAR/U 15

T #1
DY: 6214-7
T: NO
OCT-98
31:26.2

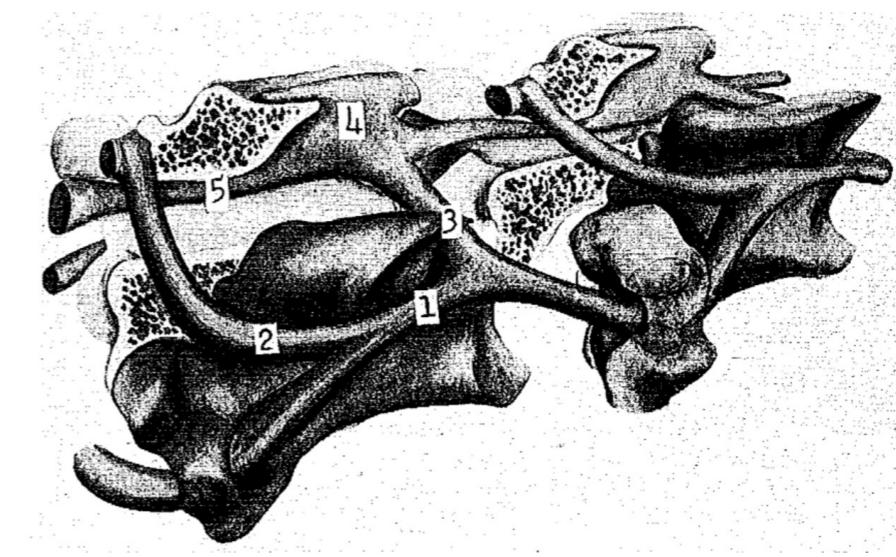
COUCH: 852.0
TILT: 0.0
FIELD: HALF
THICK: 1.5
INDEX: 3.0
kV: 120
mA: 100
mAs: 157



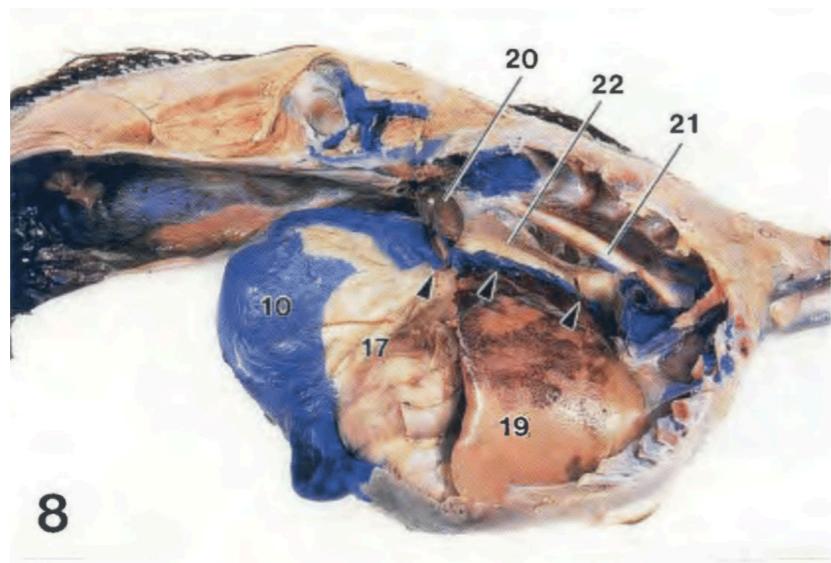
Research on Supramedullary Airways



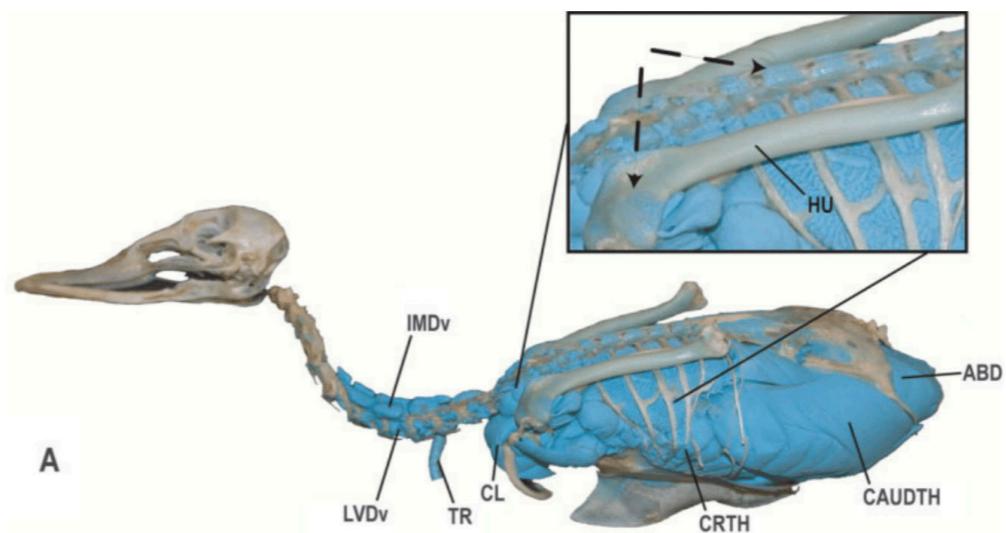
Müller (1908) –
pigeon



Cover (1953) – turkey

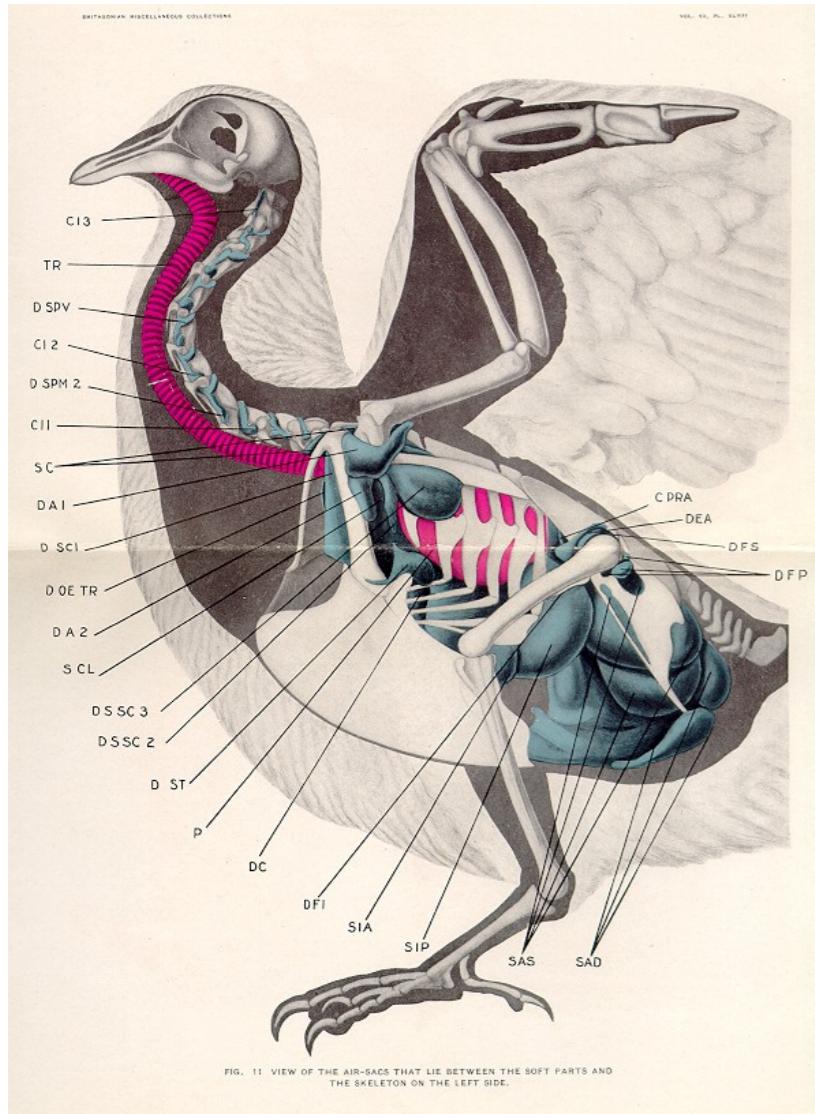


Bezuidenhout et al. (1999) – ostrich

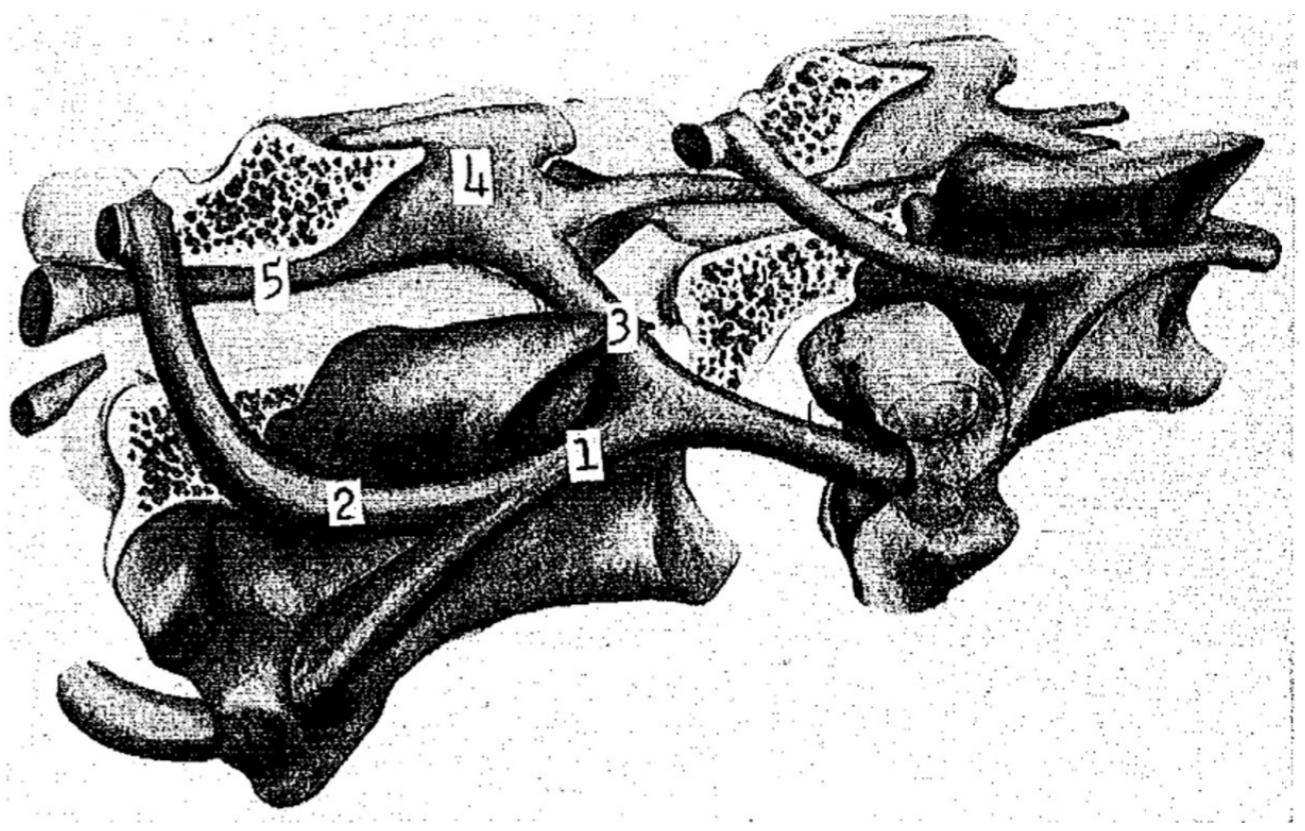


O'Connor (2006) – general description

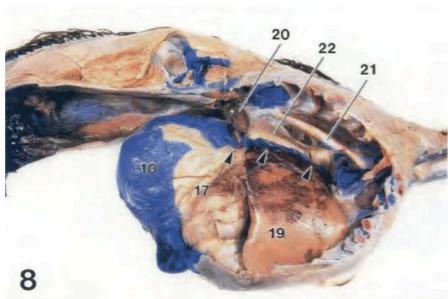
Research on Supramedullary Airways



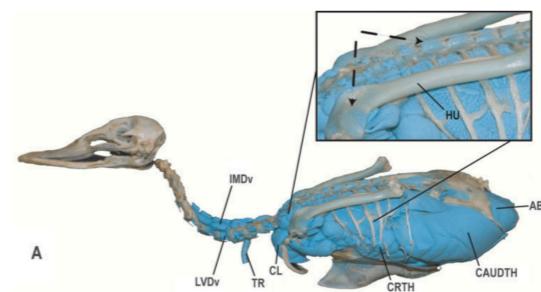
Müller (1908) –
pigeon



Cover (1953) – turkey

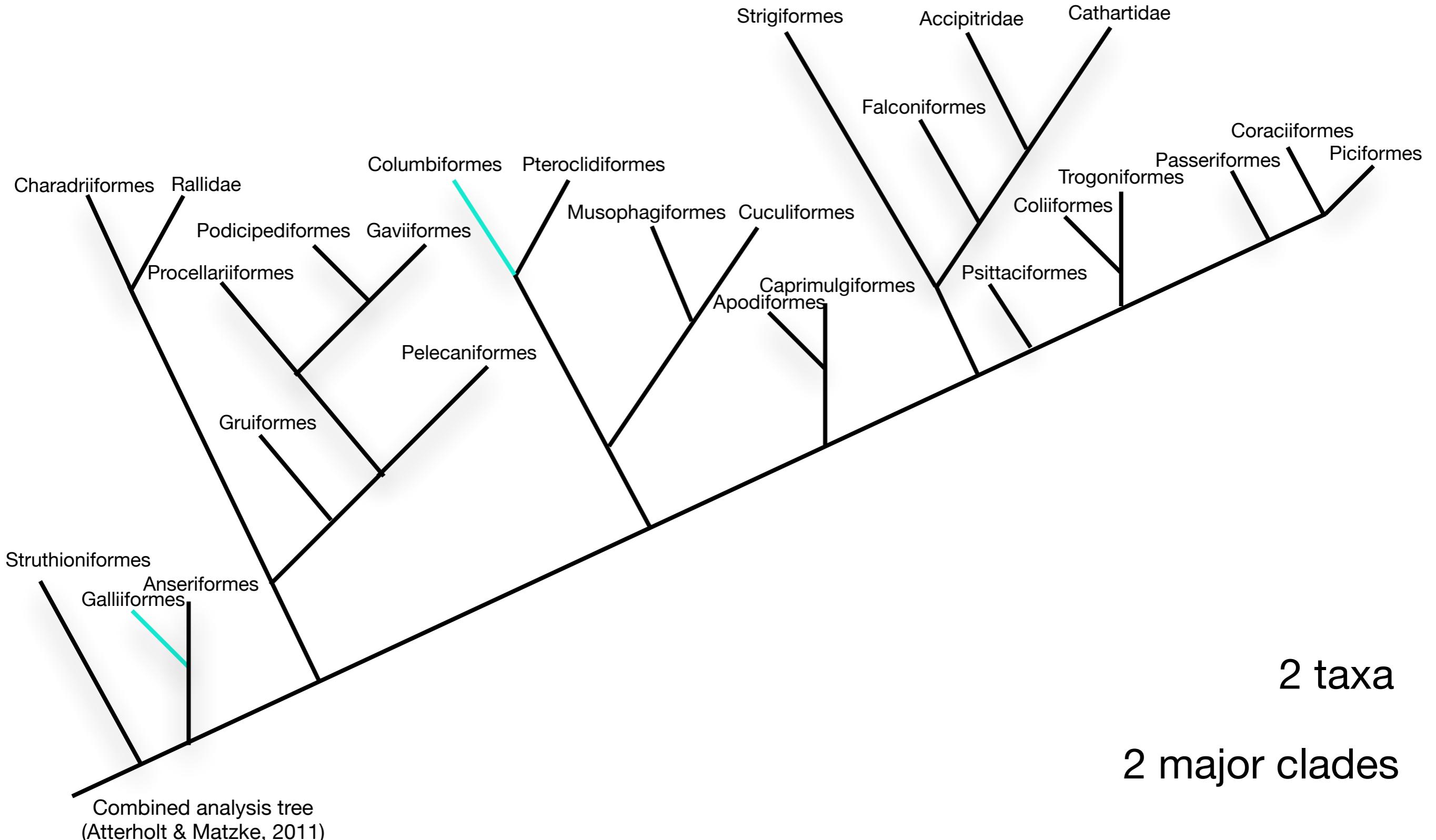


Bezuidenhout et al. (1999) – ostrich

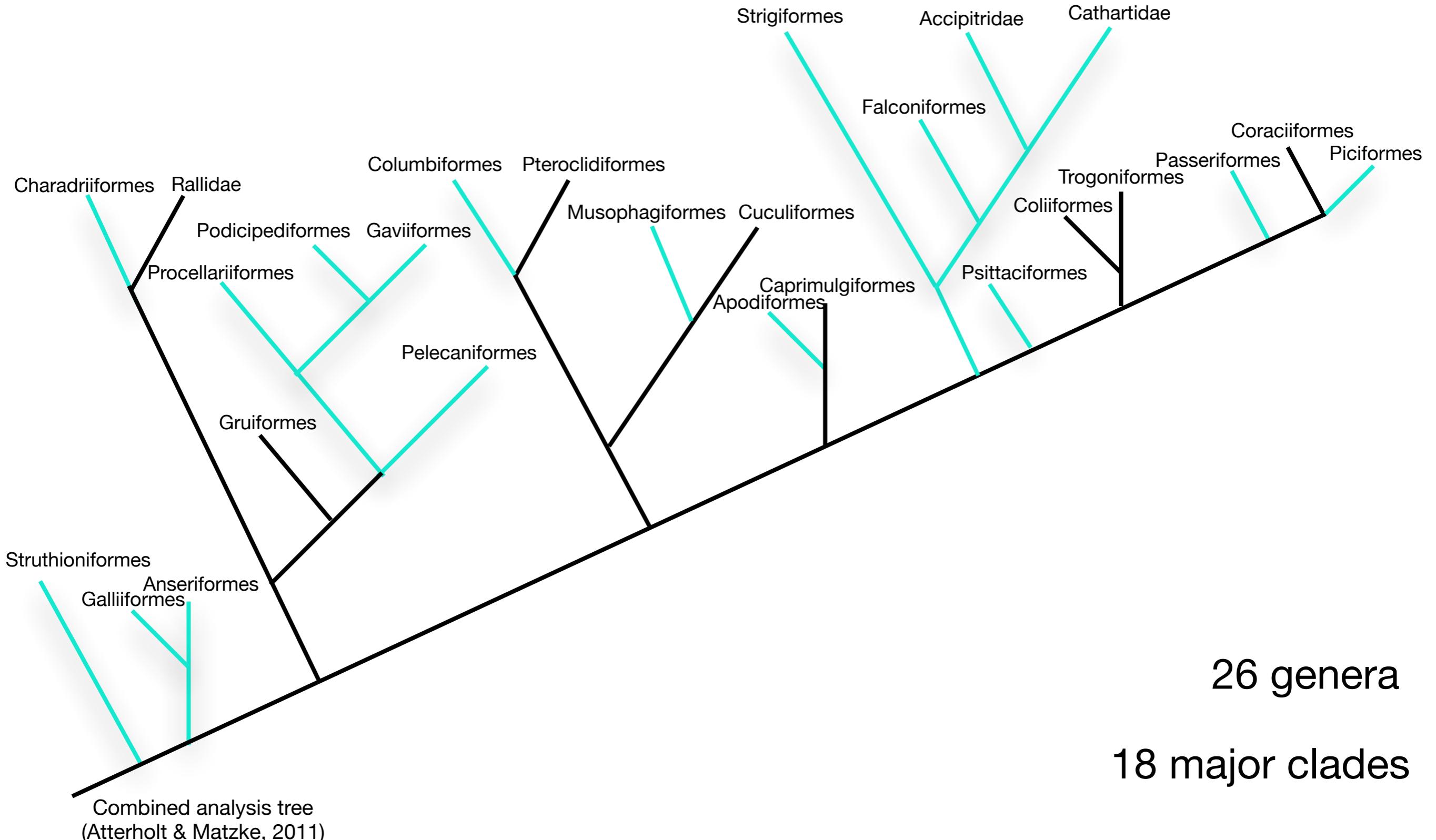


O'Connor (2006) – general description

Prior Phylogenetic Sampling



Broad Phylogenetic Sampling



Supramedullary Airways Present



Anas platyrhynchos
(Anseriformes)



Musophaga violacea
(Musophagiformes)



Zenaida macroura
(Columbiformes)



Meleagris gallopavo
(Galliformes)



Puffinus griseus
(Procellariiformes)



Bubo virginianus
(Strigiformes)



Struthio camelus
(Struthioniformes)



Calypte anna
(Apodiformes)



Falco sparverius
(Falconiformes)



Buteo jamaicensis
(Accipitriformes)



Cathartes aura
(Accipitriformes)



Uria aalge
(Charadriiformes)



Larus occidentalis
(Charadriiformes)



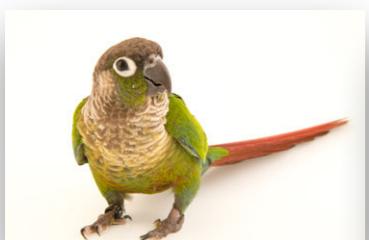
Phalacrocorax penicillatus
(Suliformes)



Pelecanus occidentalis
(Pelecaniformes)



Nycticorax nycticorax
(Nycticoracidae)



Pyrrhura molinae
(Psittaciformes)



Eclectus roratus



Melozone crissalis



Aphelocoma californica



Psaltriparus minimus
(Passeriformes)



Turdus migratorius

Supramedullary Airways **Absent**



Gavia immer
(Gaviiformes)



Gavia pacifica
(Gaviiformes)



Gavia adamsii
(Gaviiformes)



Aechmophorus occidentalis
(Podicipediformes)



Dryobates nuttallii
(Piciformes)



Melanerpes formicivorus
(Piciformes)

Supramedullary Airways **Absent**



Aechmophorus occidentalis
(Podicipediformes)



Gavia pacifica
(Gaviiformes)

diving taxa

Supramedullary Airways **Absent**



Dryobates nuttallii
(Piciformes)



Melanerpes formicivorus
(Piciformes)

???

Diving Taxa



Aechmophorus occidentalis
(Podicipediformes)



Phalacrocorax penicillatus
(Suliformes)



Gavia pacifica
(Gaviiformes)

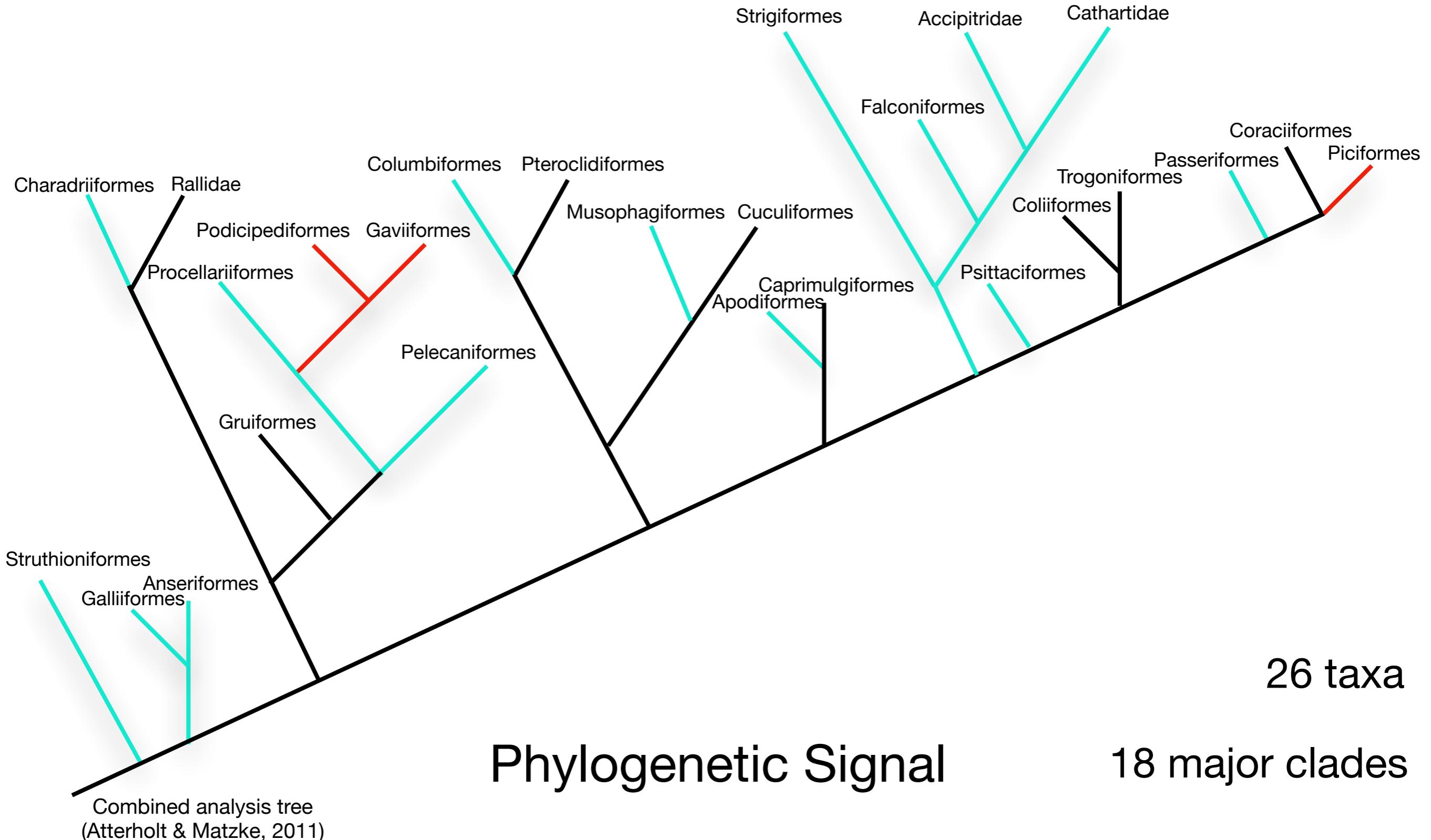
Supramedullary
Airways **Absent**



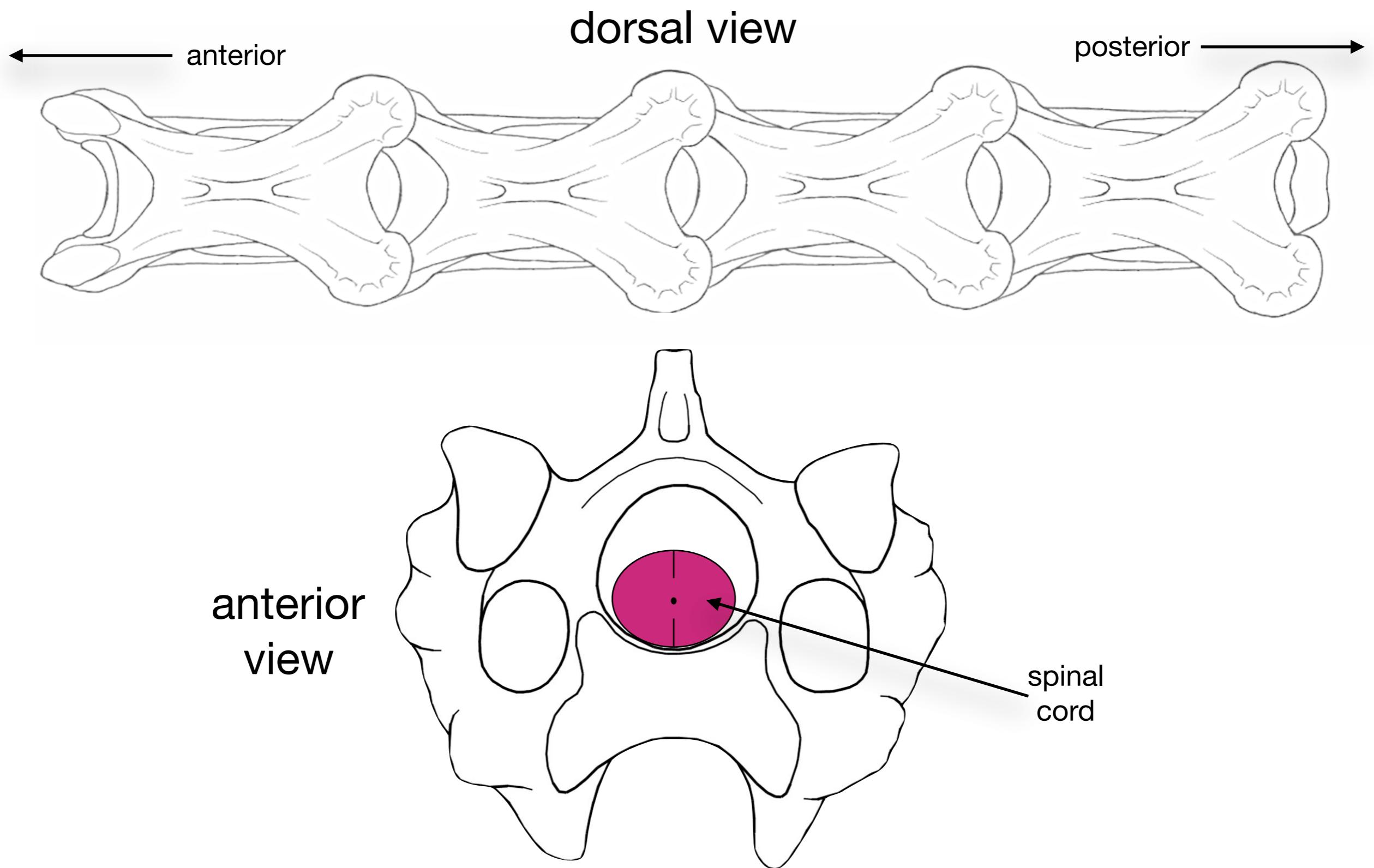
Uria aalge
(Charadriiformes)

Supramedullary
Airways **Present**

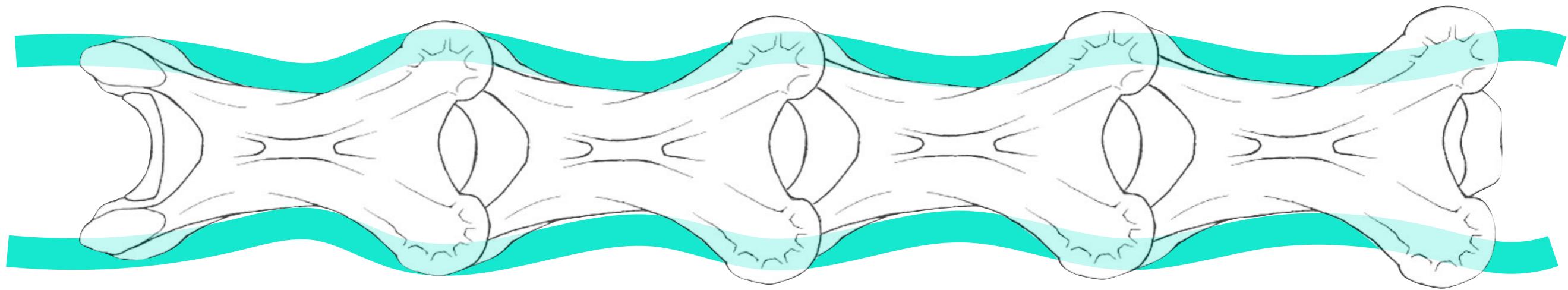
Presence and Absence of SMAs



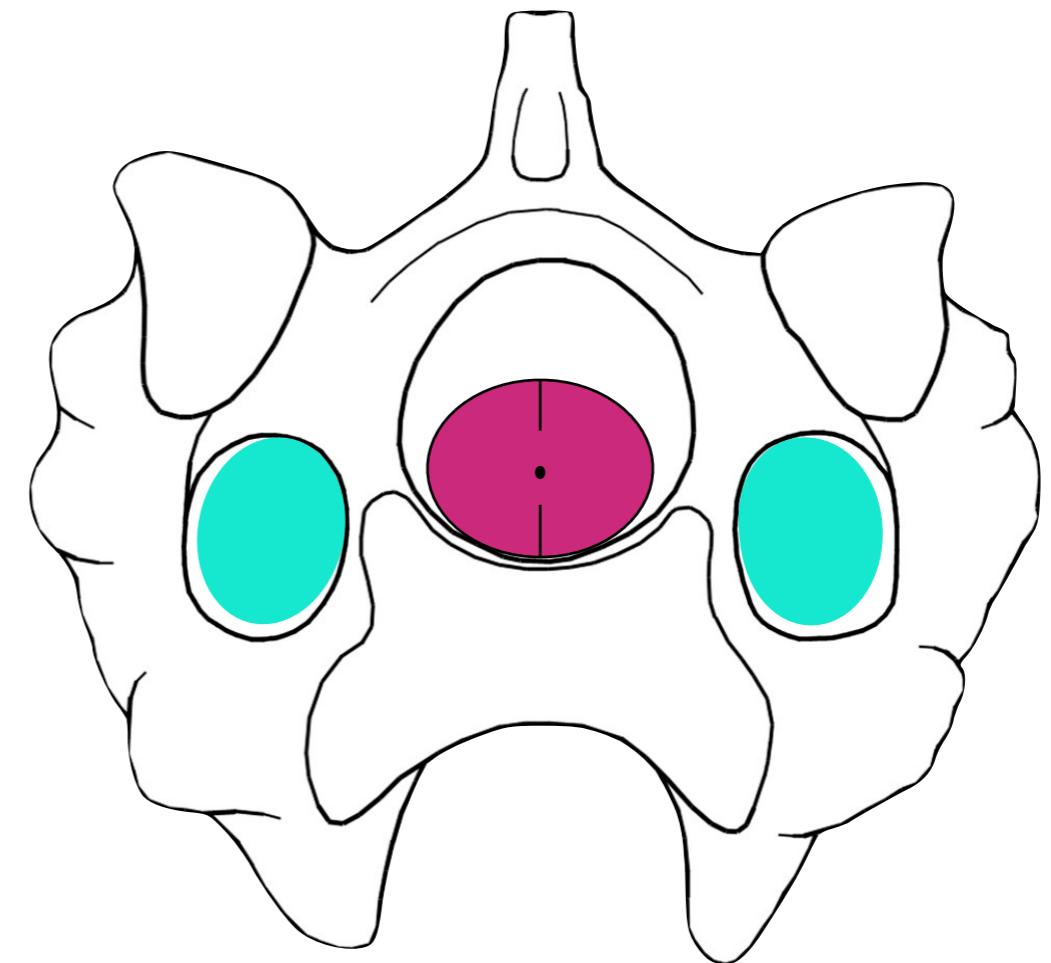
Morphology of Supramedullary Airways



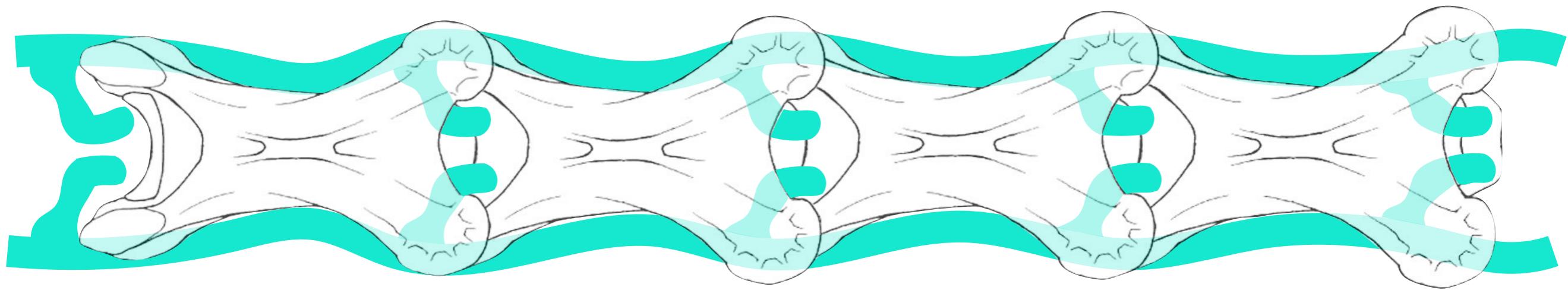
Morphology of Supramedullary Airways



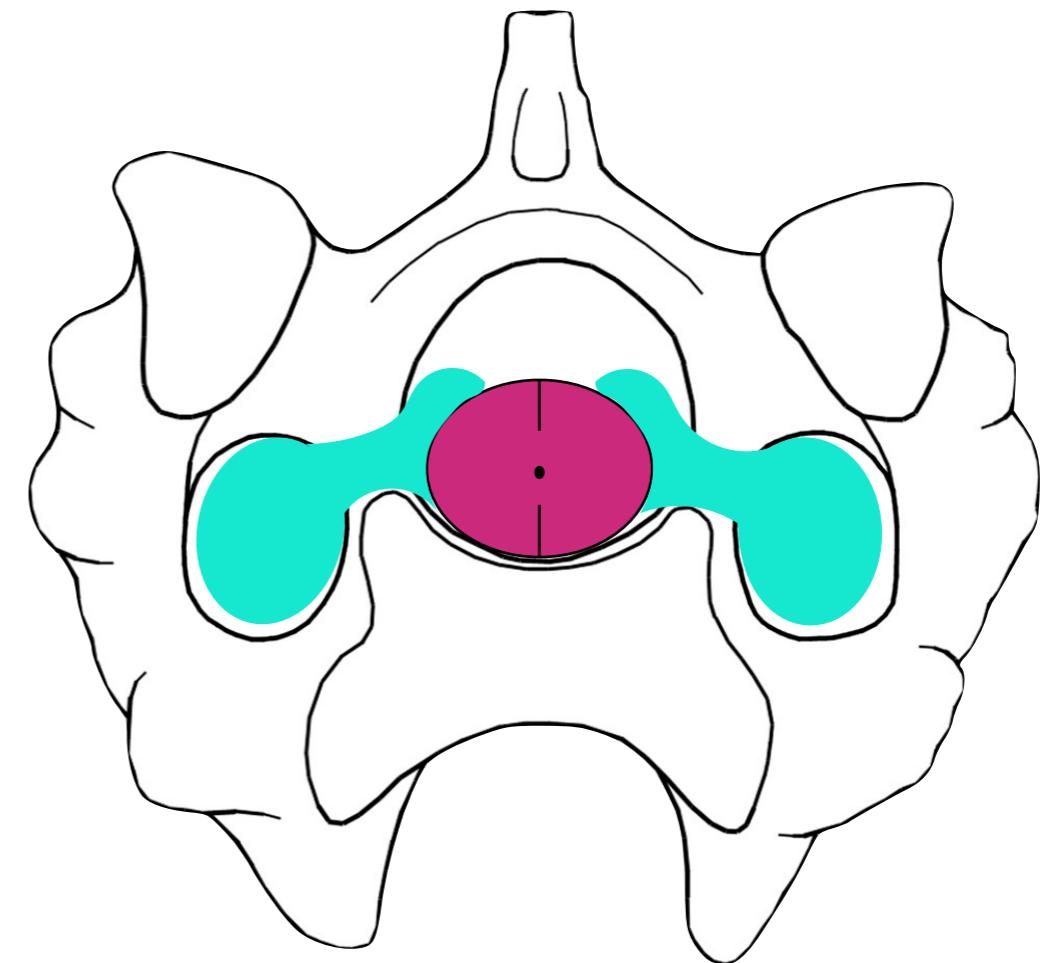
canalis intertransversarius only
(no SMAs)



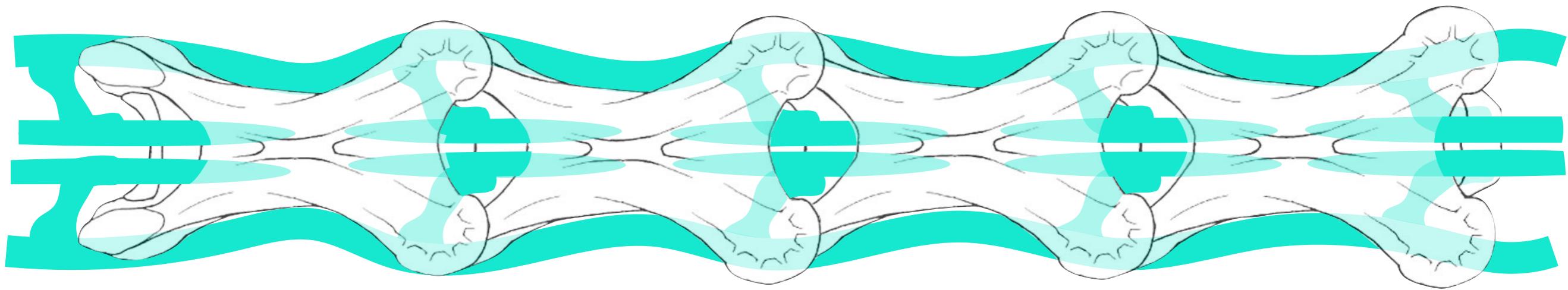
Morphology of Supramedullary Airways



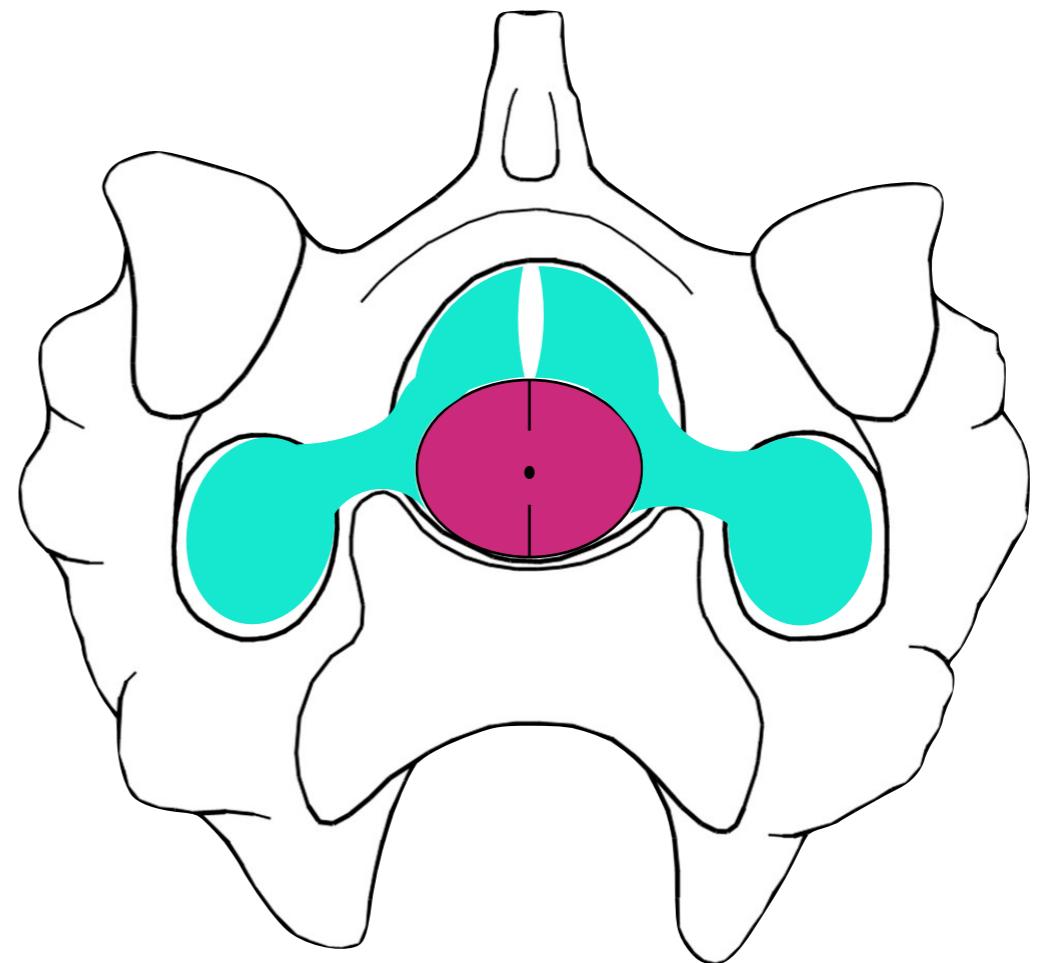
A. supramedullary airways
at intervertebral joints



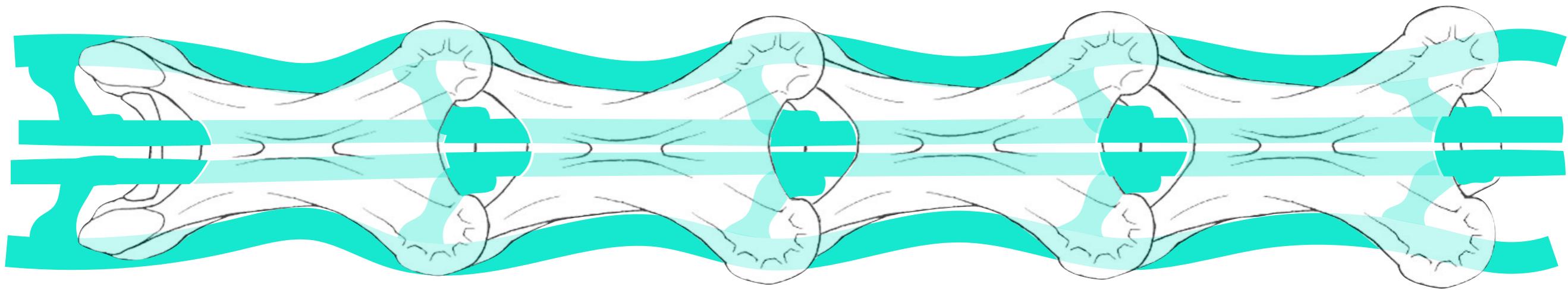
Morphology of Supramedullary Airways



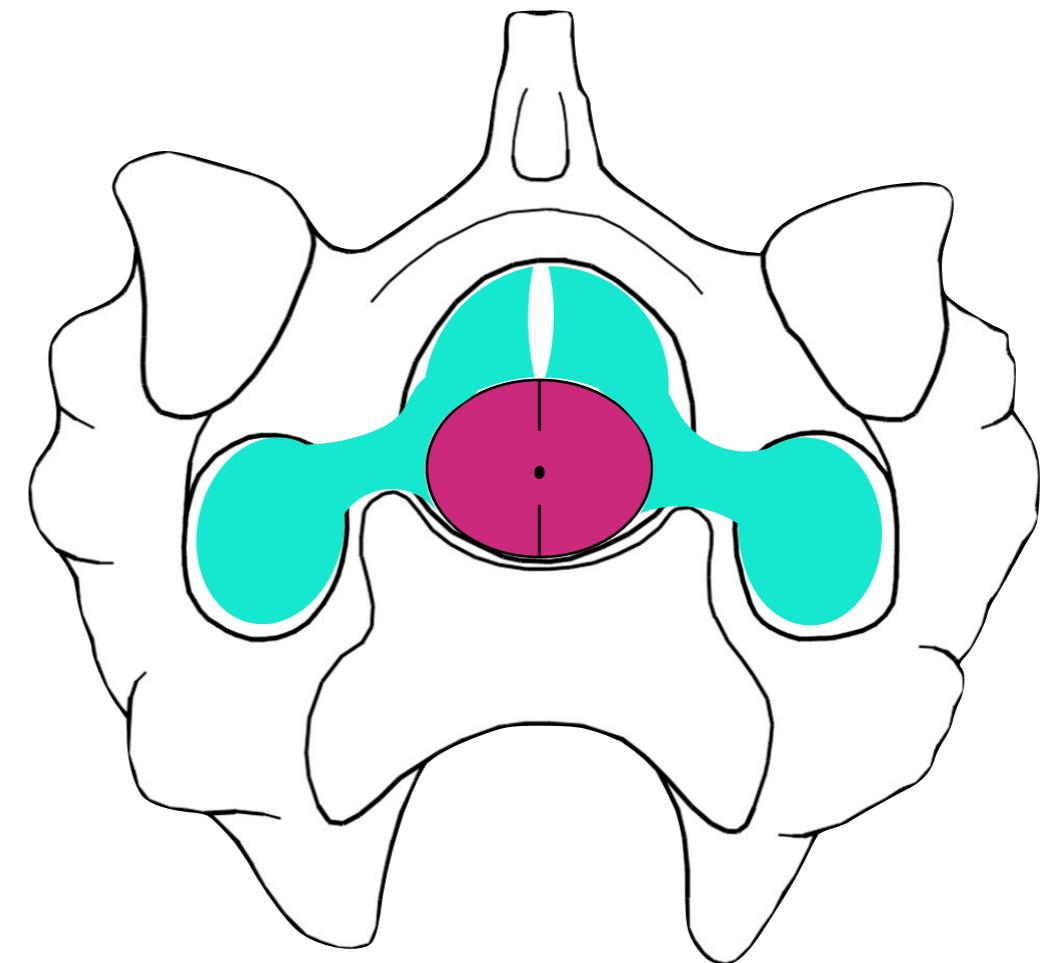
B. supramedullary airways
discontinuous through
vertebral canals



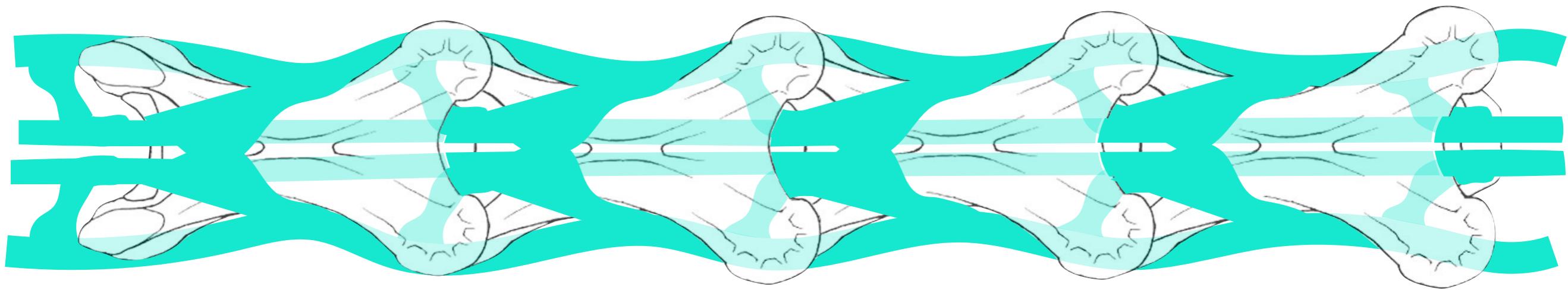
Morphology of Supramedullary Airways



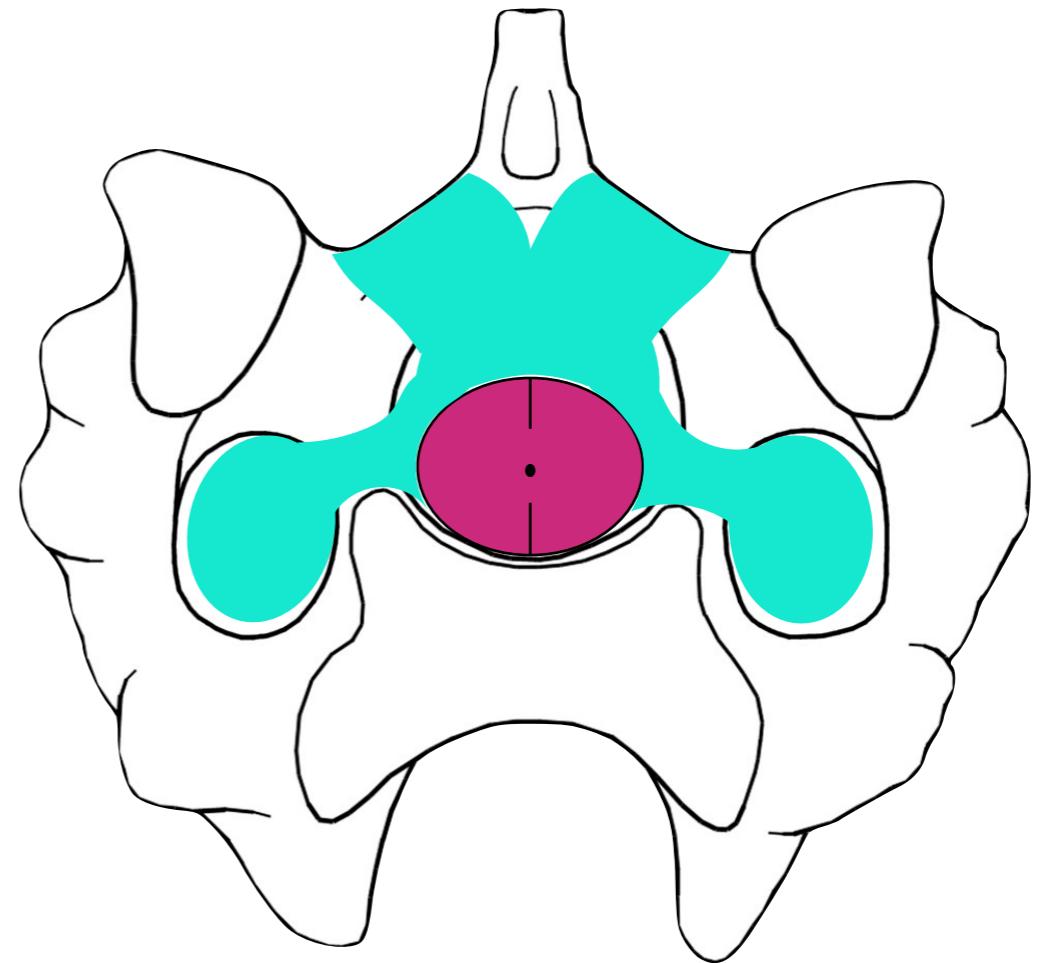
C. supramedullary airways
continuous through
vertebral canals



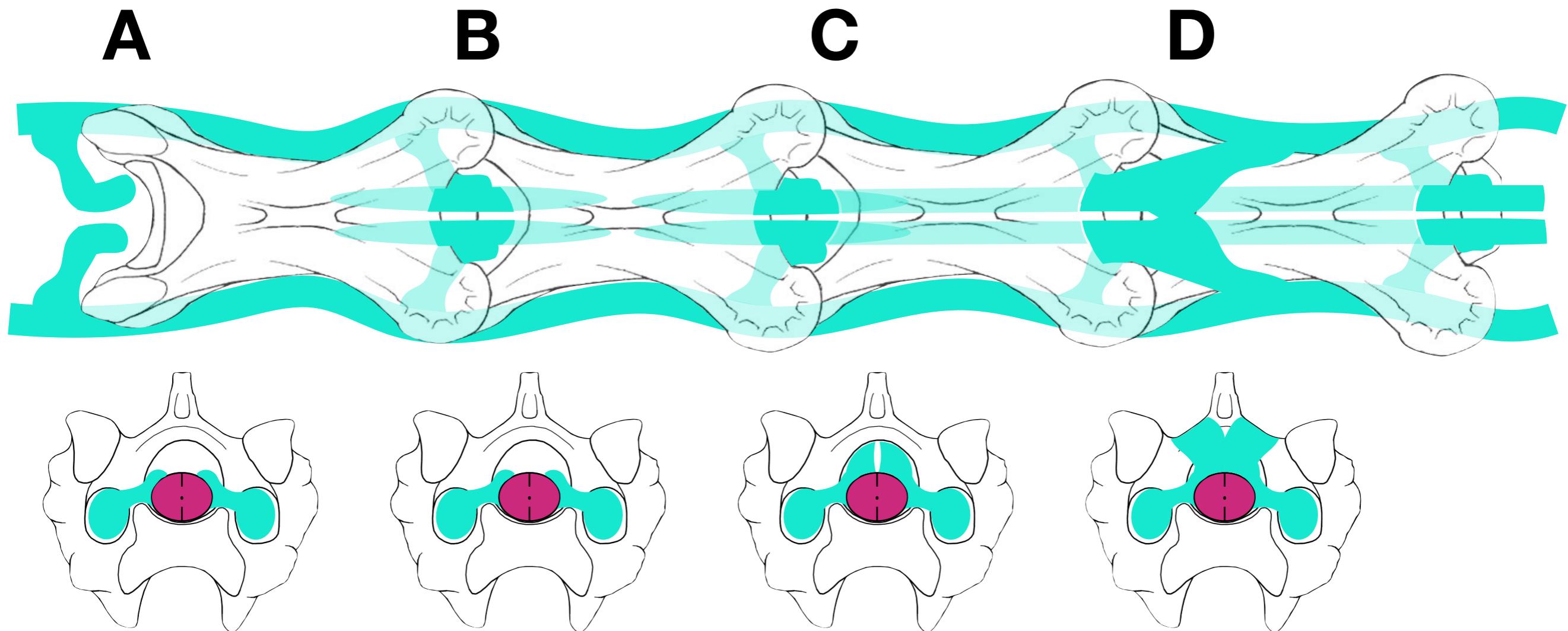
Morphology of Supramedullary Airways



D. supramedullary airways
merge with diverticula
supervertebralia



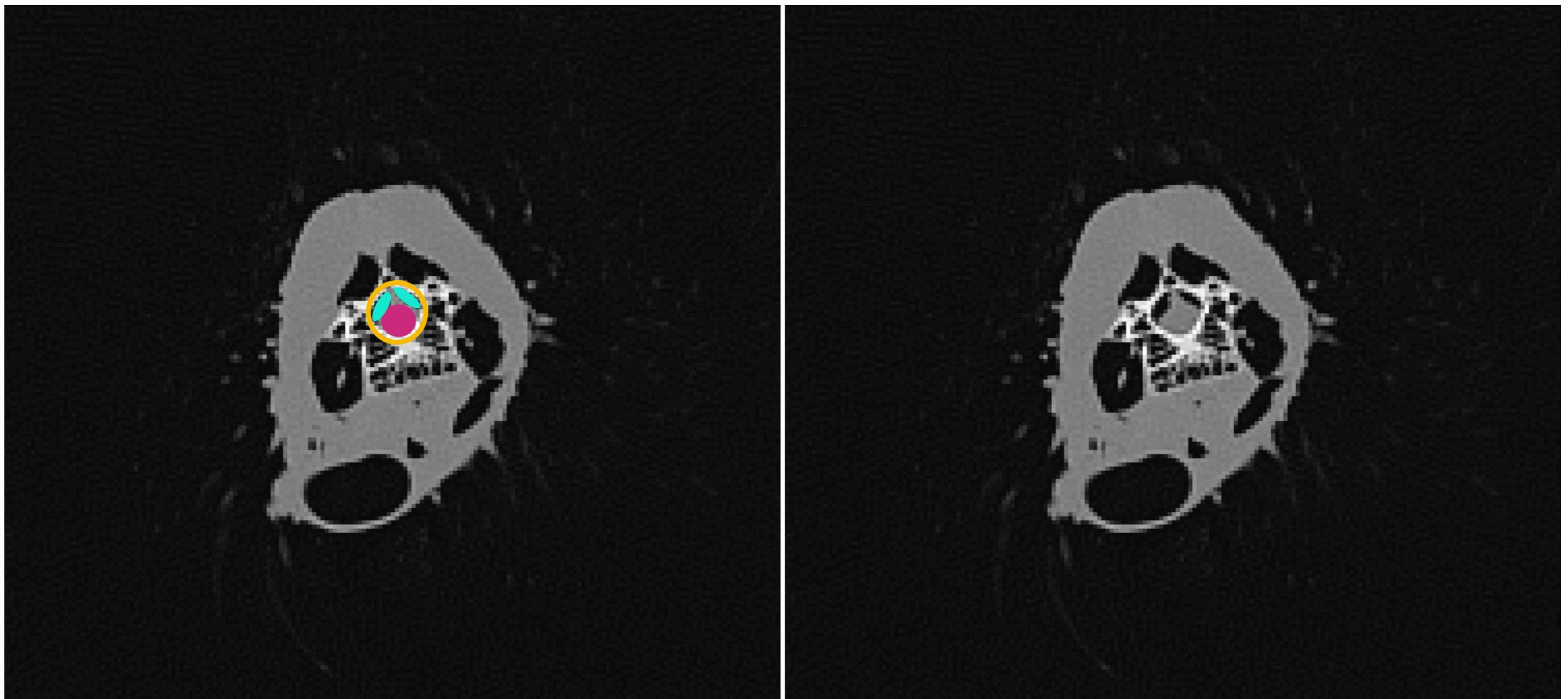
Morphology of Supramedullary Airways



variation across vertebral column is universal

Morphology of Supramedullary Airways

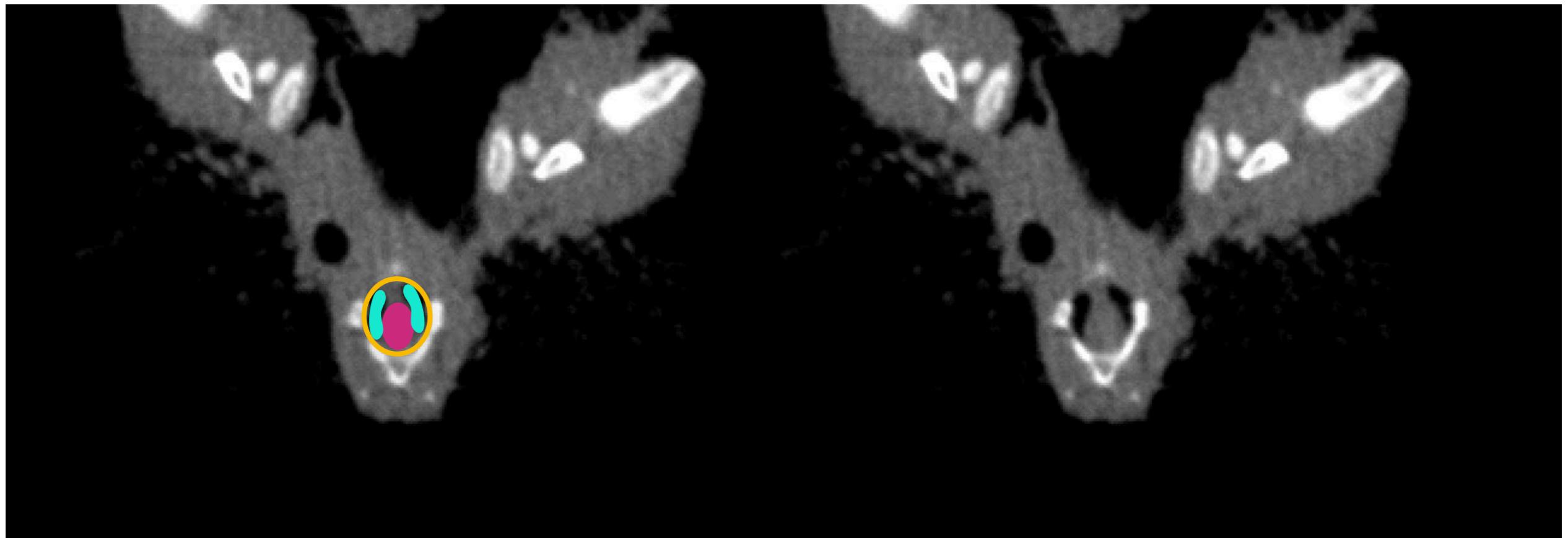
ostrich



2 dorsal tubes

Morphology of Supramedullary Airways

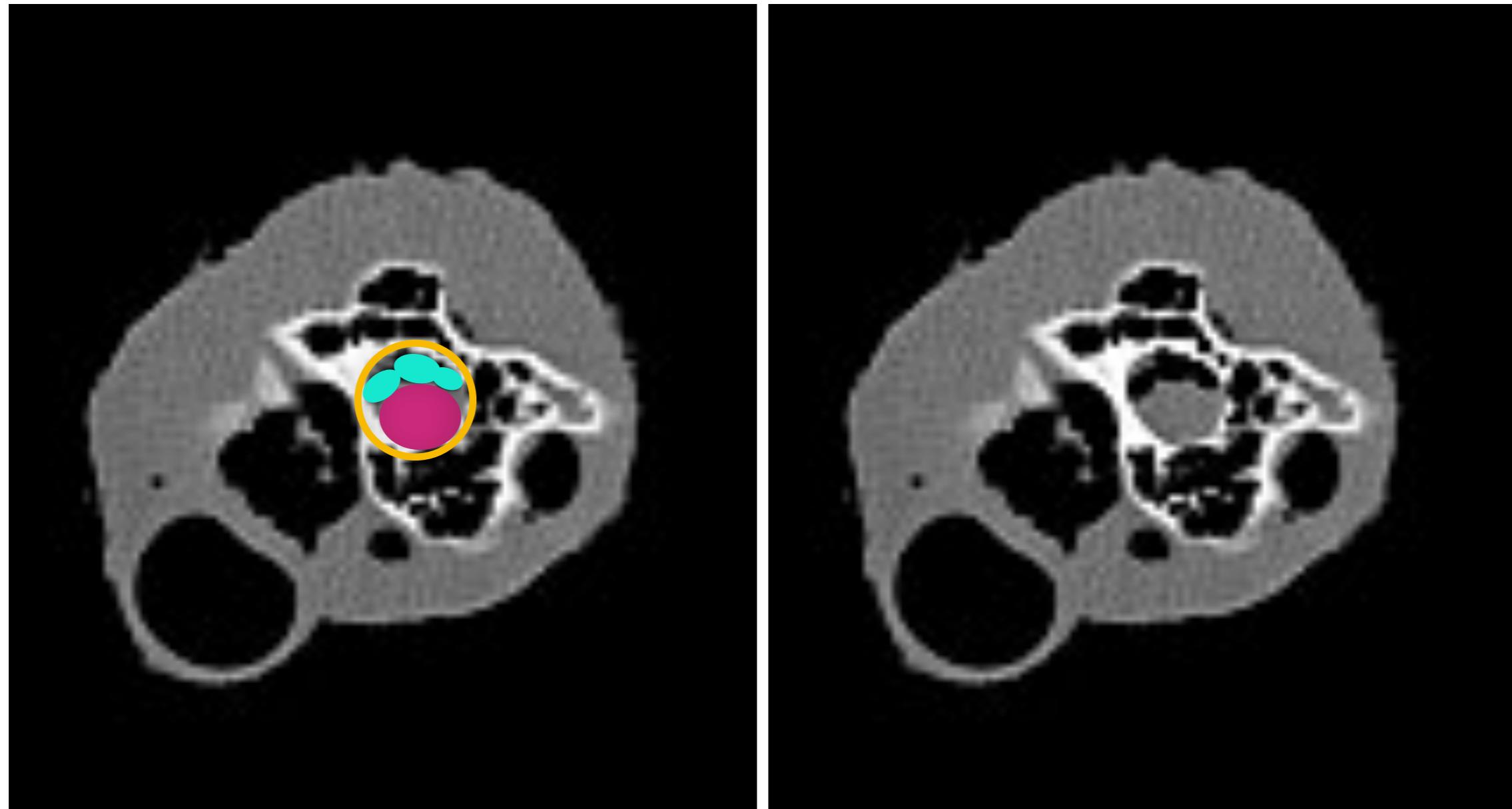
bushtit



2 lateral tubes

Morphology of Supramedullary Airways

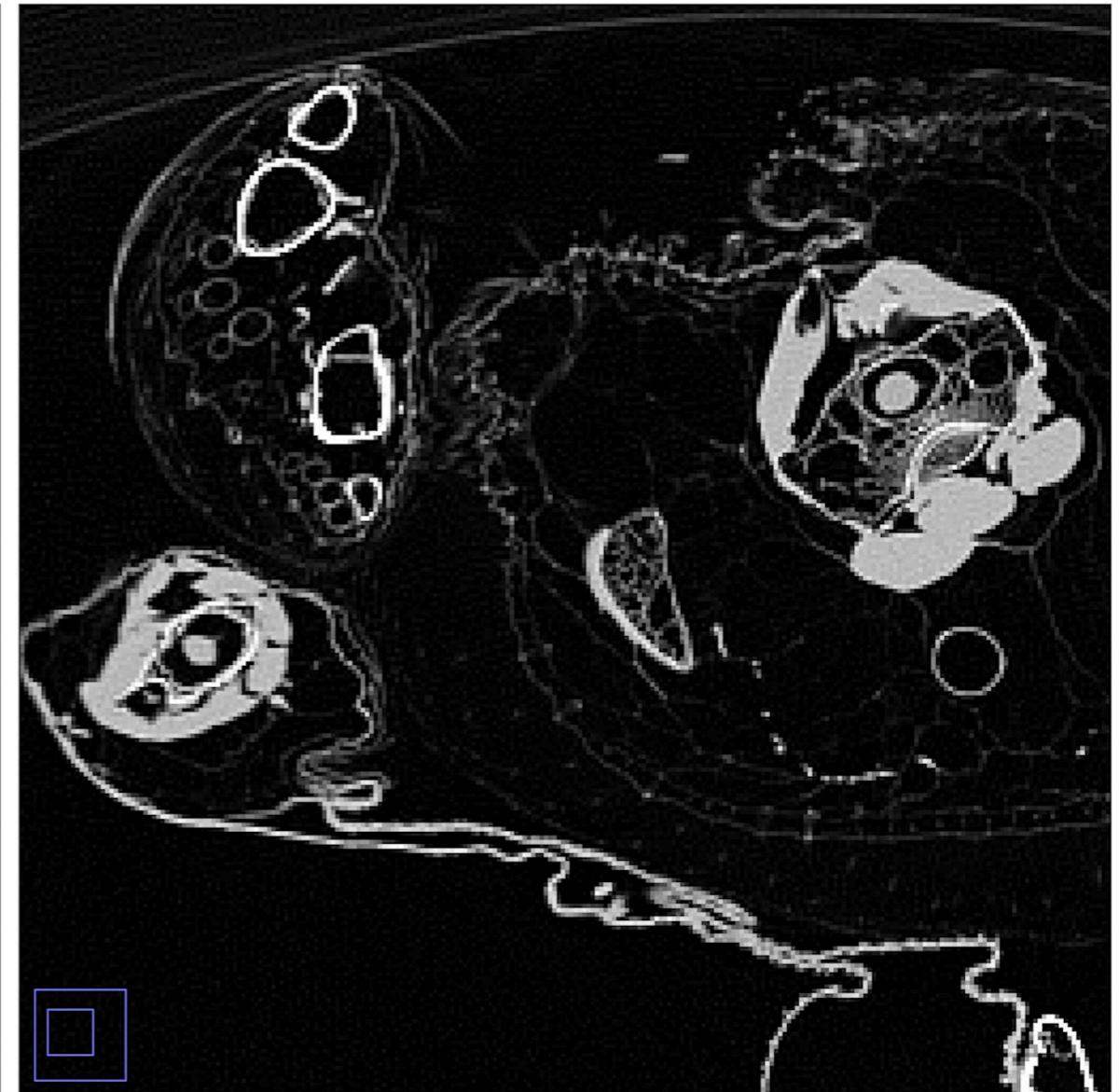
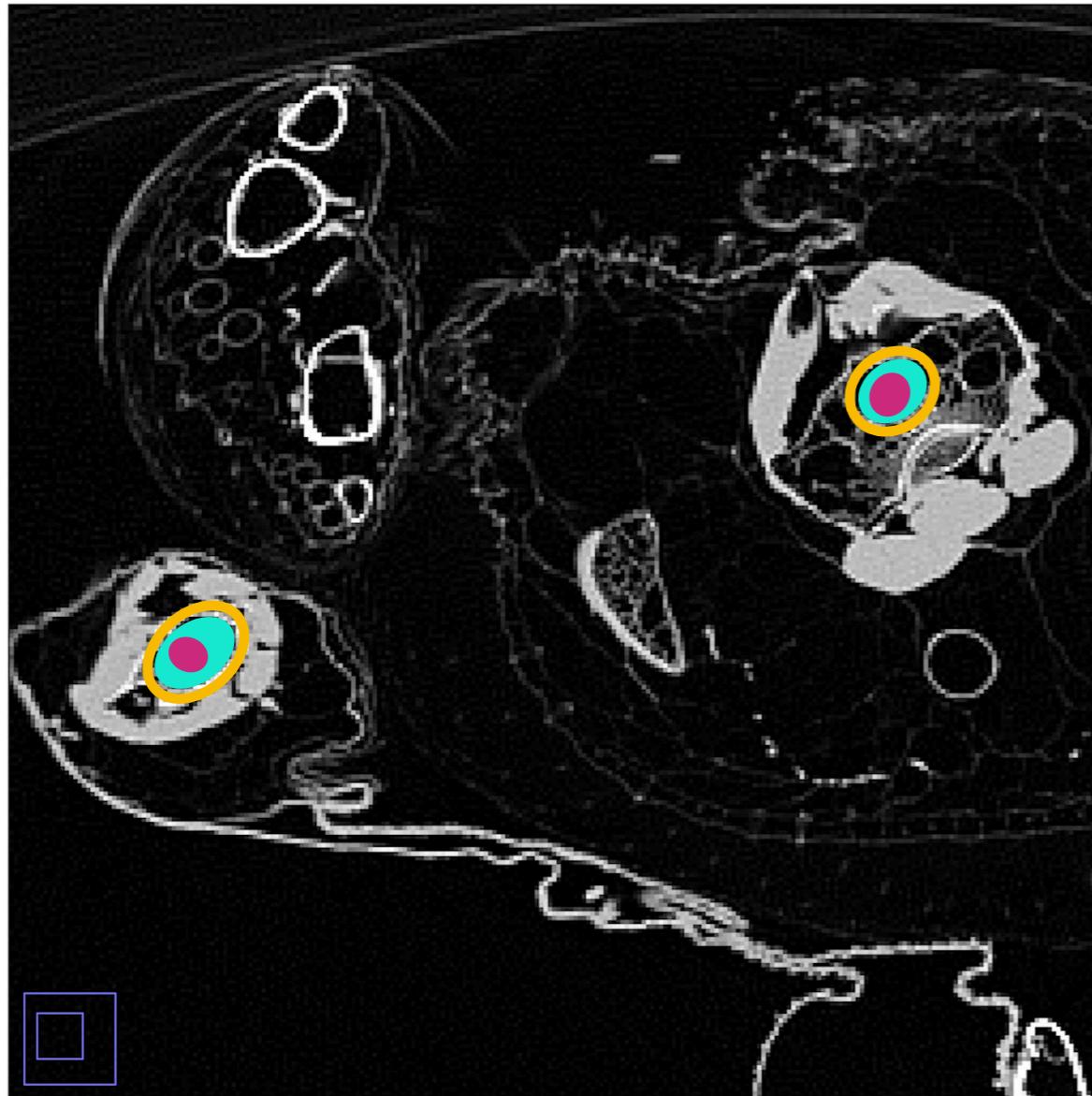
ostrich



3 dorsal tubes

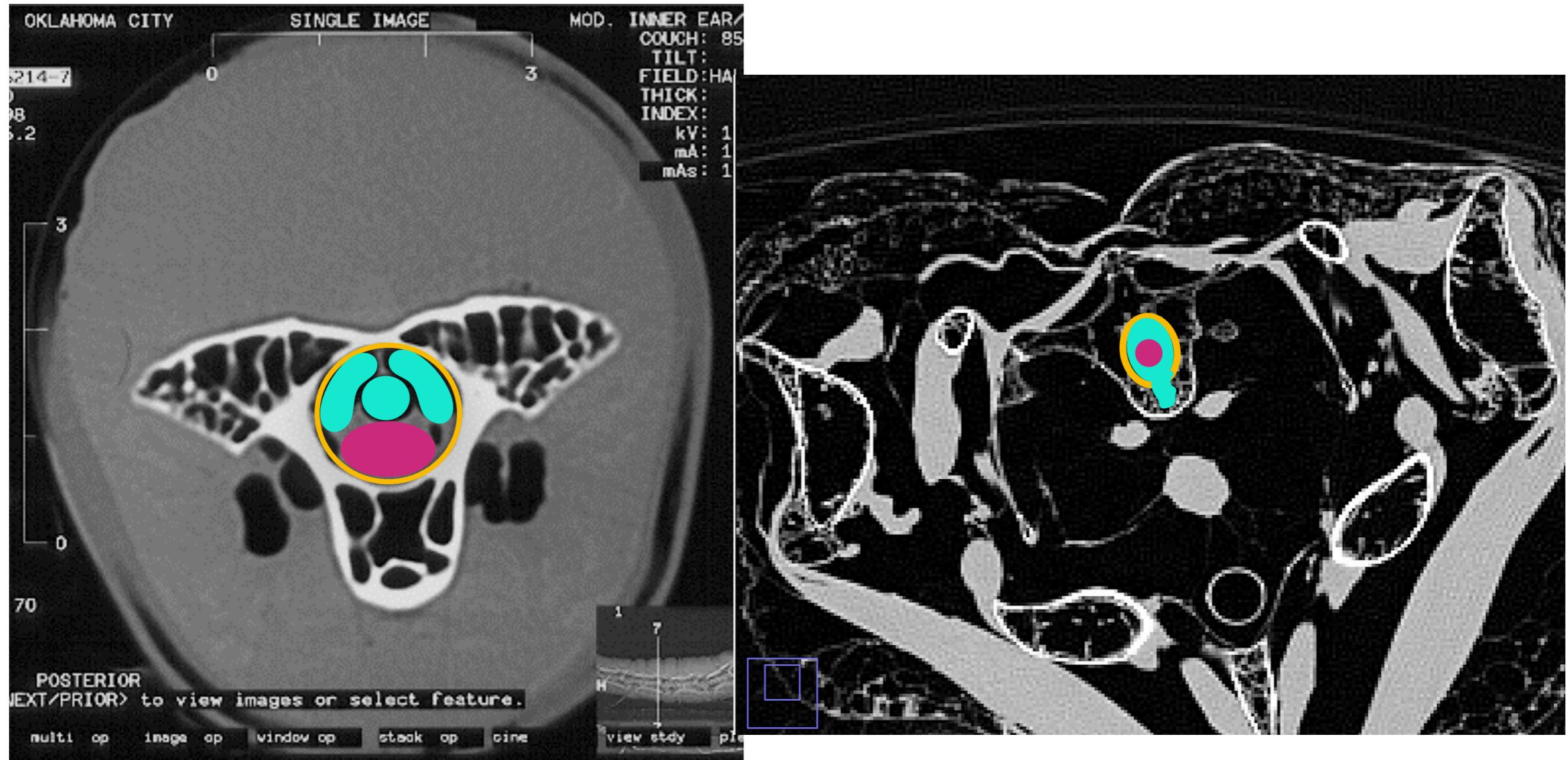
Morphology of Supramedullary Airways

pelican



spinal cord jacketed by SMAs

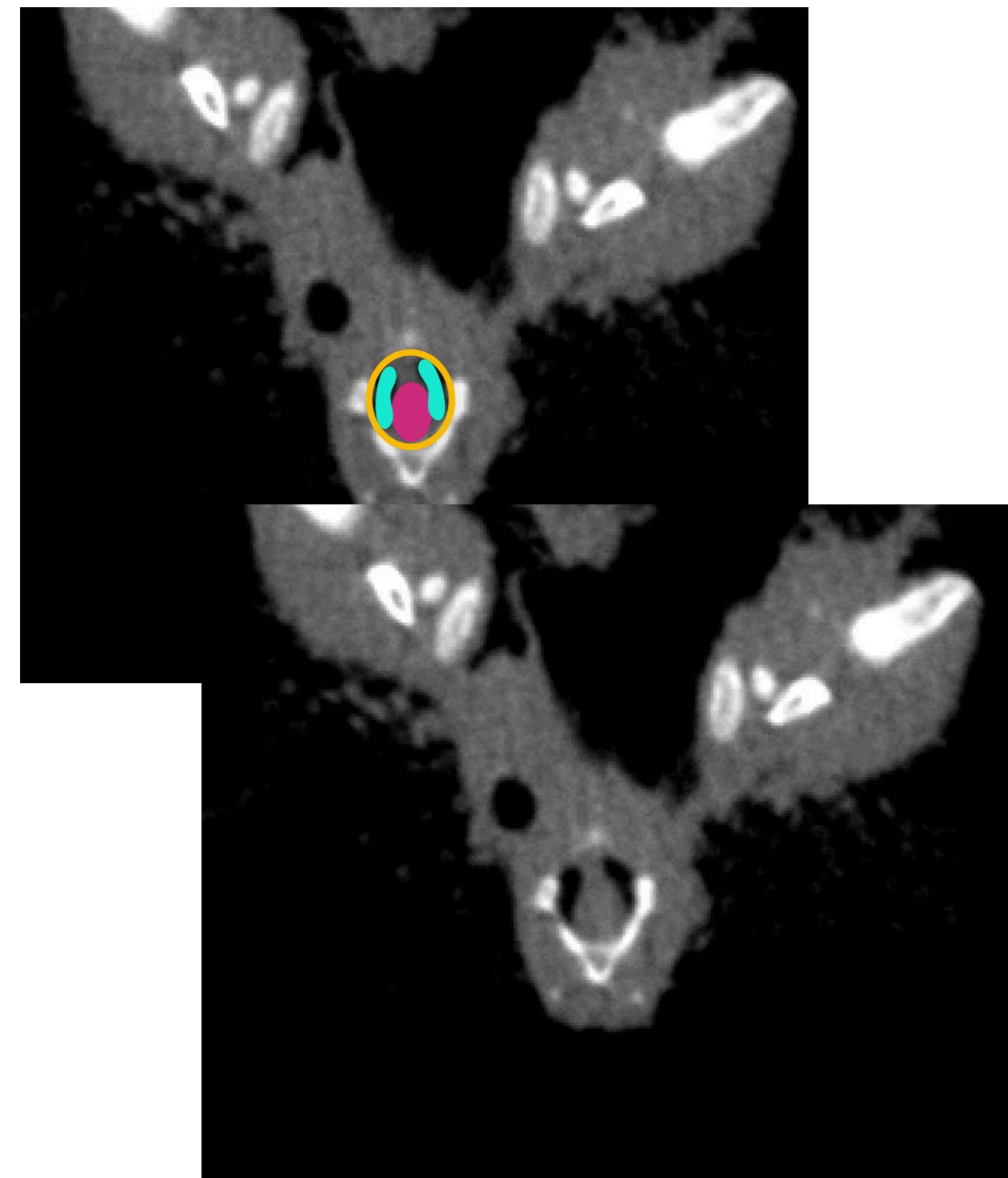
Variation with Body Size



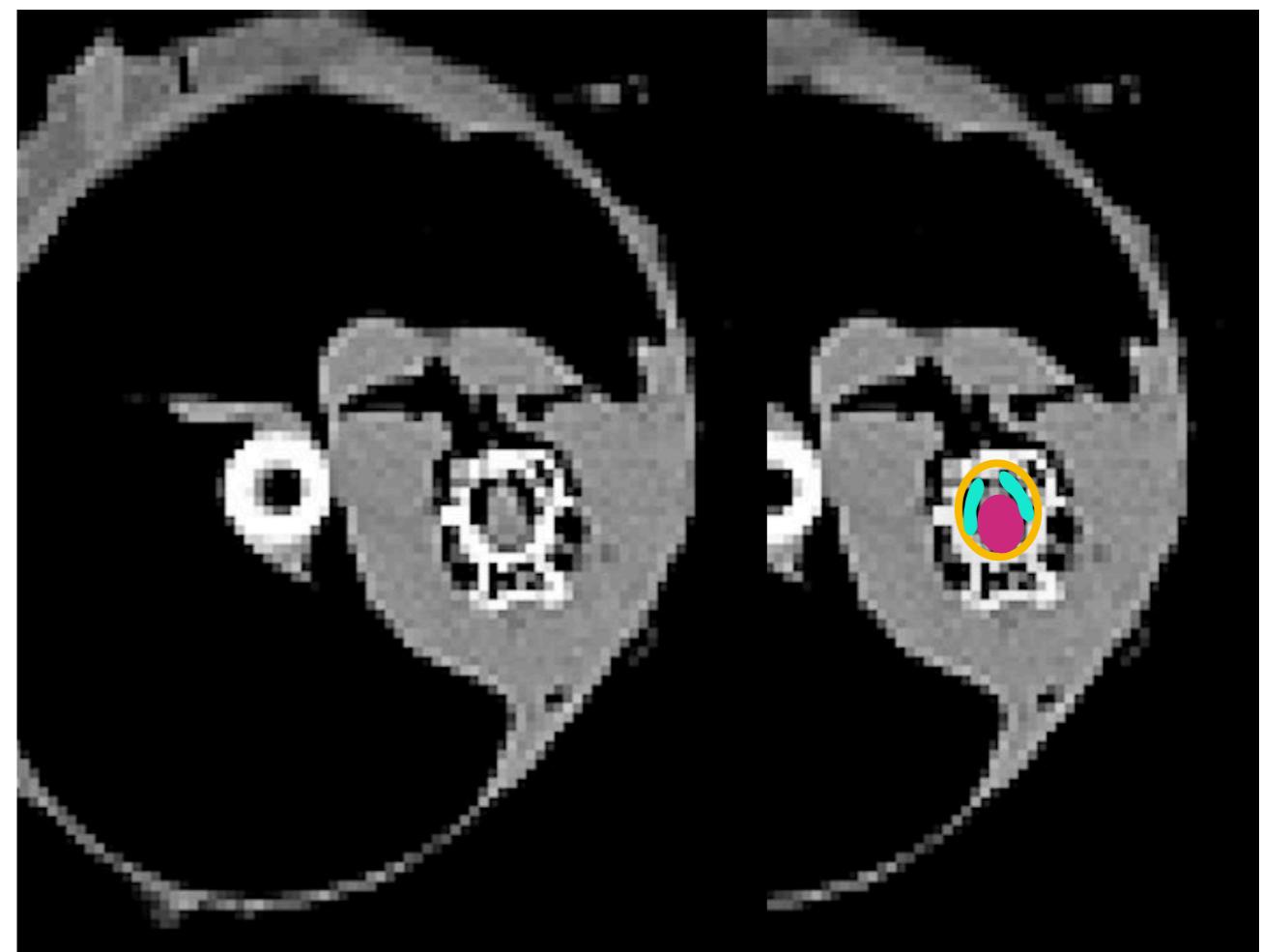
ostrich

pelican

Variation with Body Size?



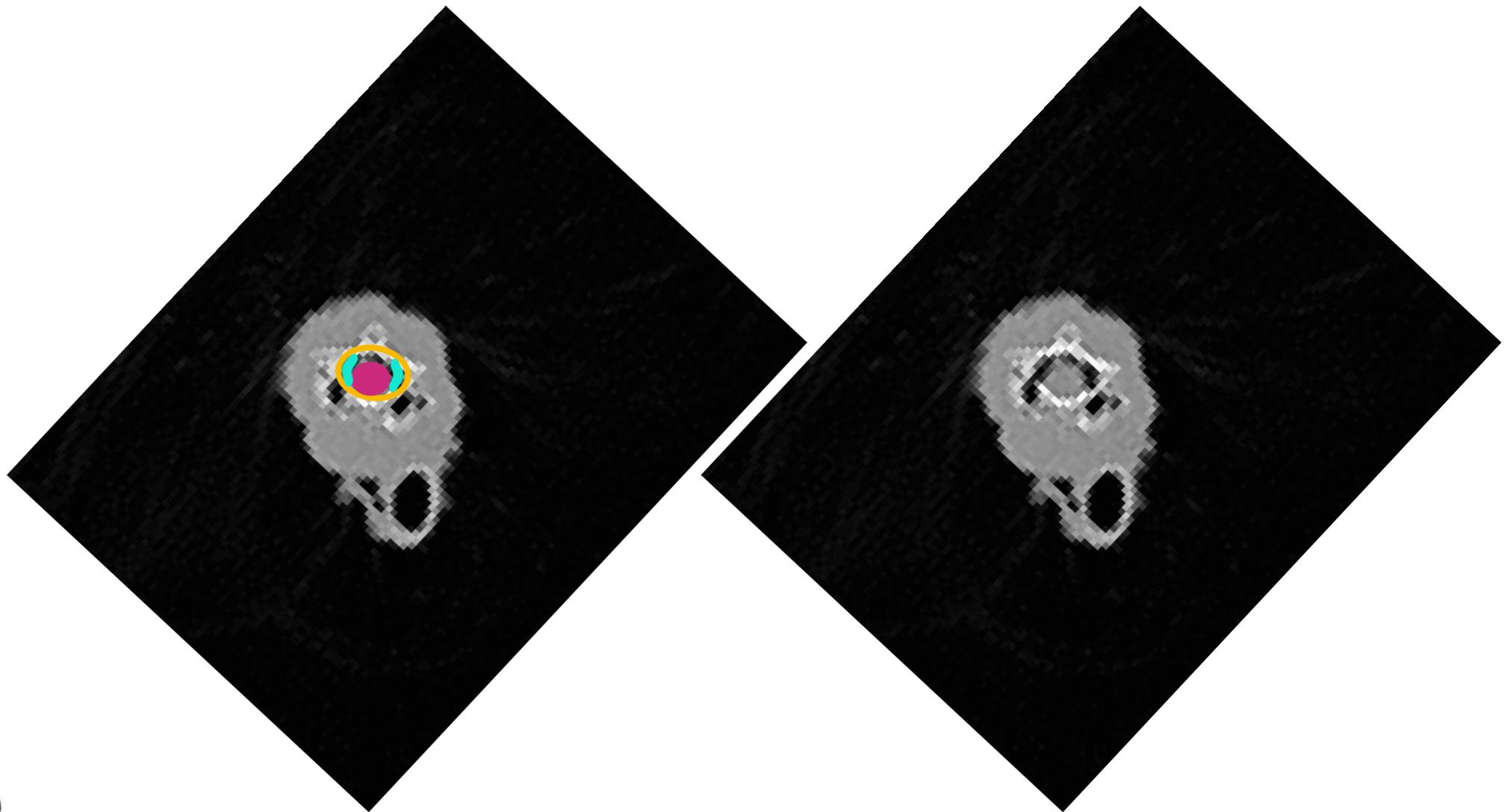
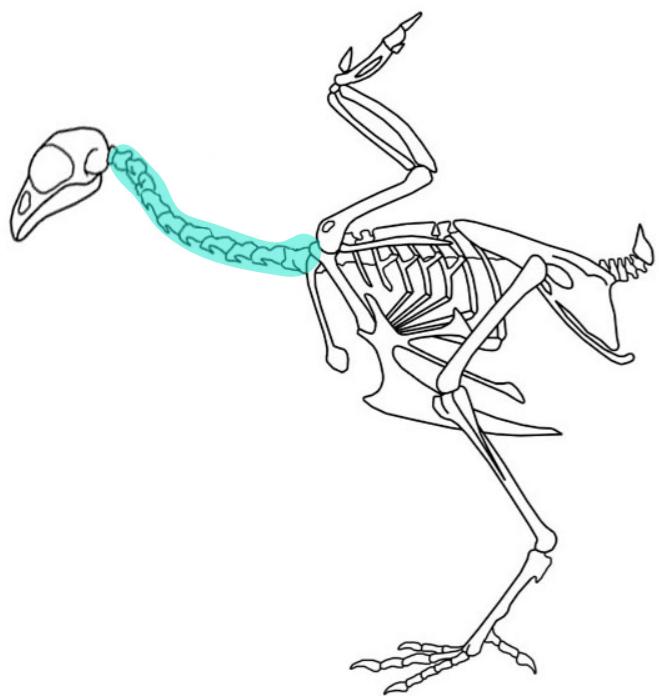
bushtit



turkey vulture

Variation Across Vertebral Regions

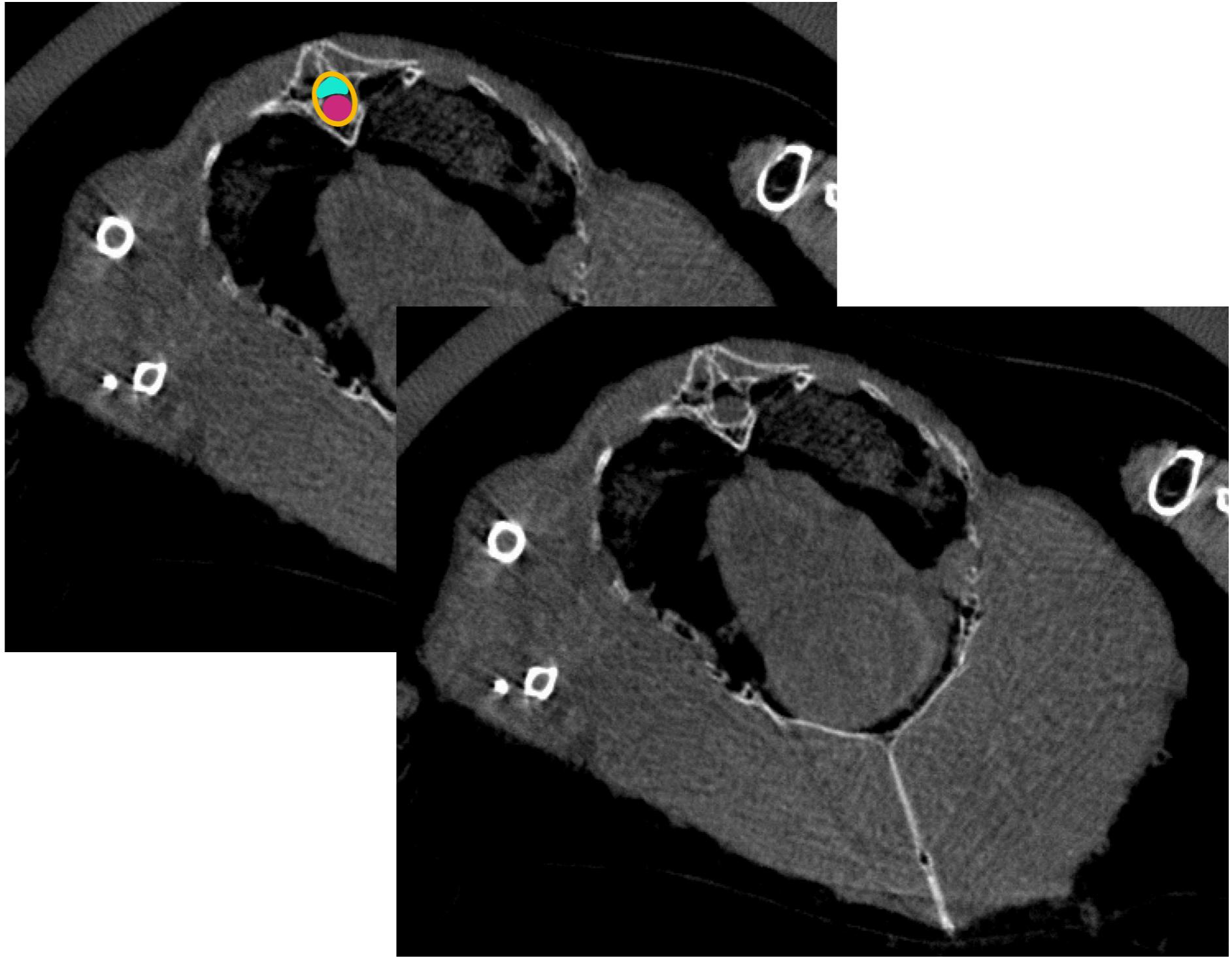
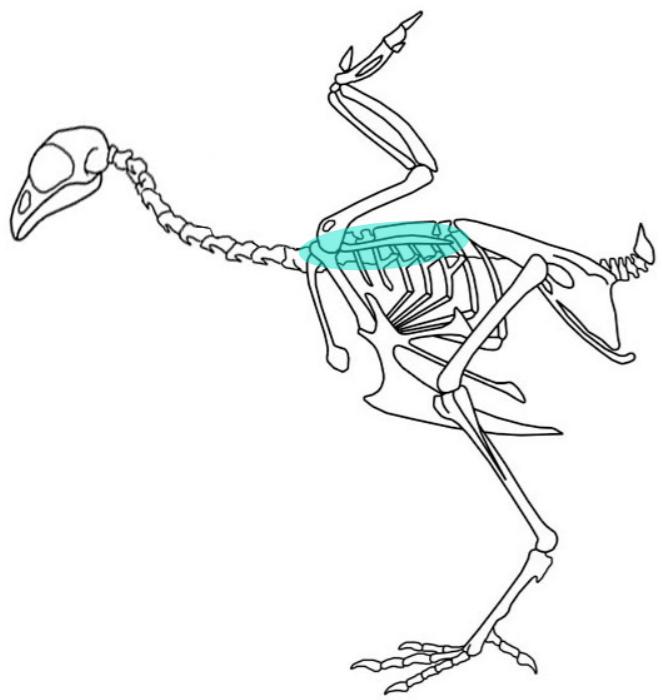
cervical vertebrae
present: 22 genera
absent: 0 genera



red-tailed hawk

Variation Across Vertebral Regions

dorsal vertebrae
present: 13 genera
absent: 9 genera

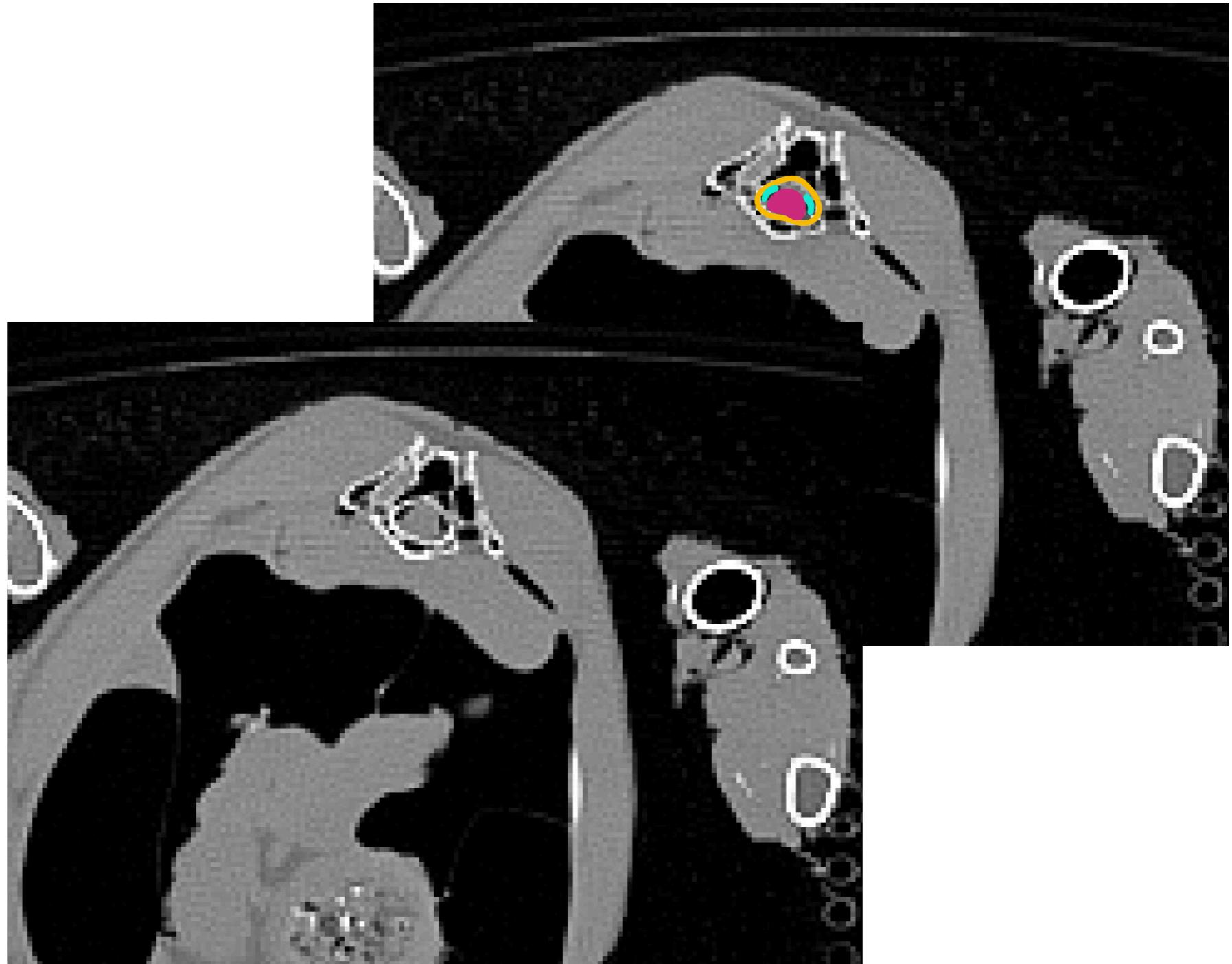
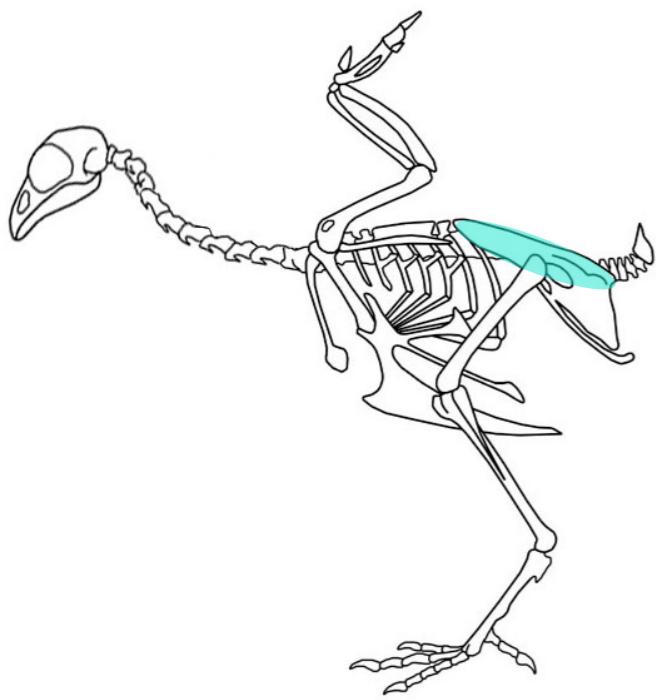


green-cheeked conure

Variation Across Vertebral Regions

synsacrum

*present: 5 genera
absent: 17 genera

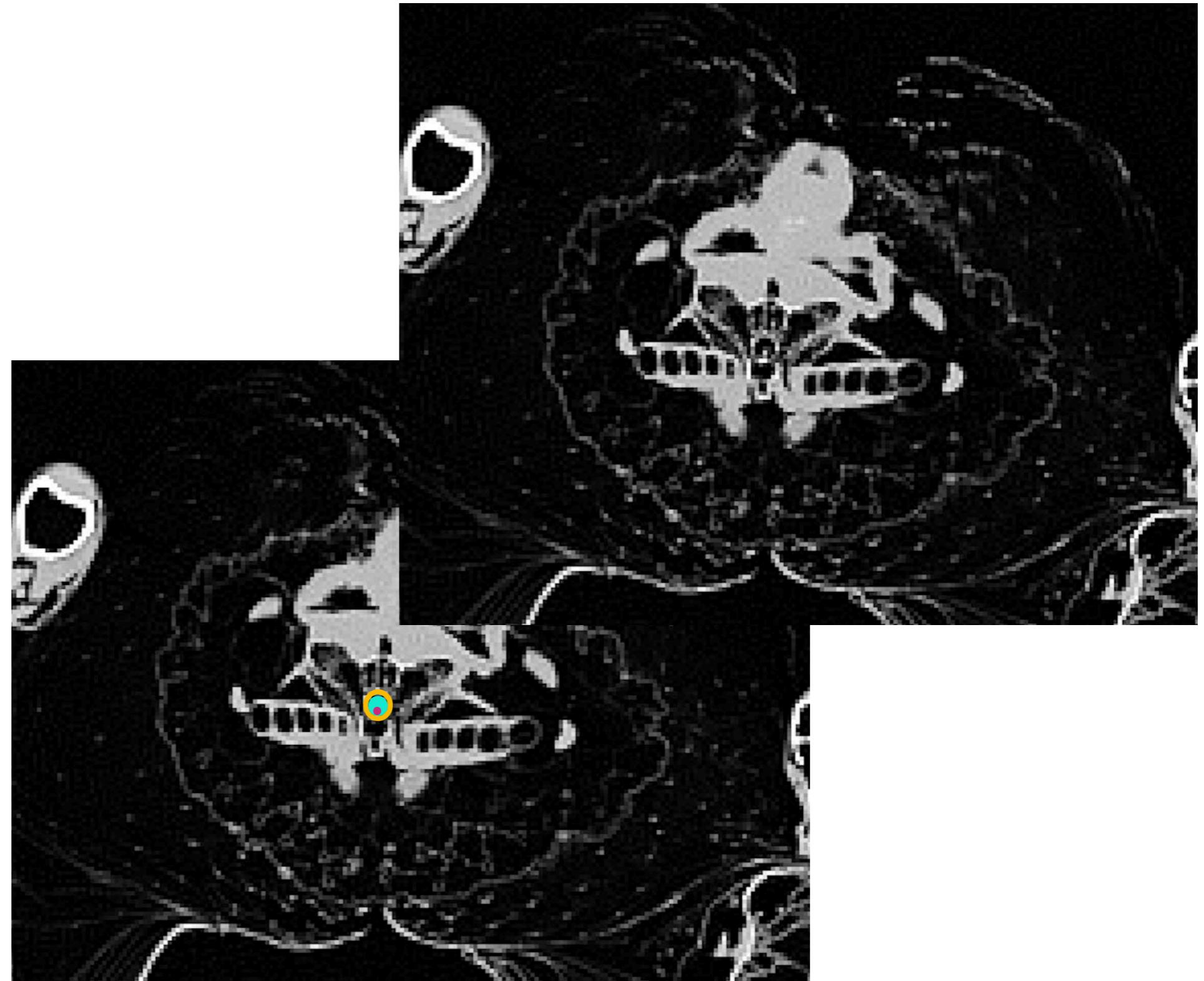
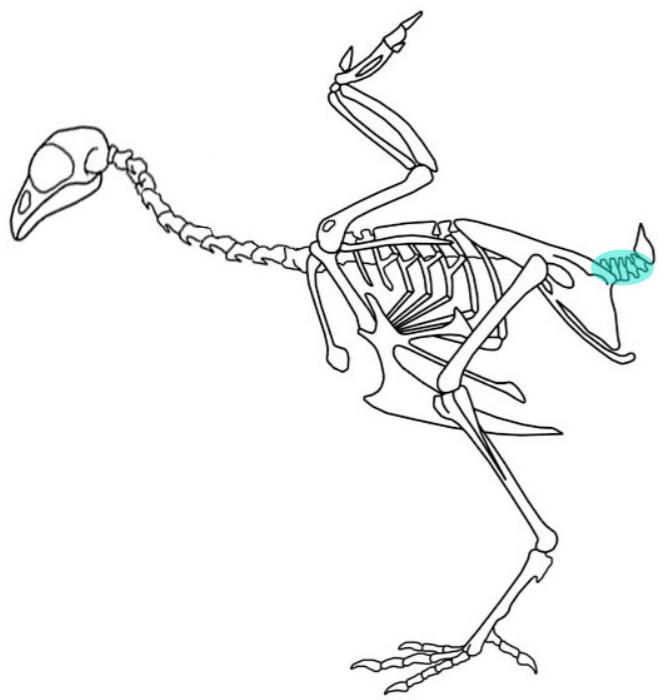


great-horned owl

*in posterior sacrals only

Variation Across Vertebral Regions

caudal vertebrae
present: 3 genera
absent: 19 genera

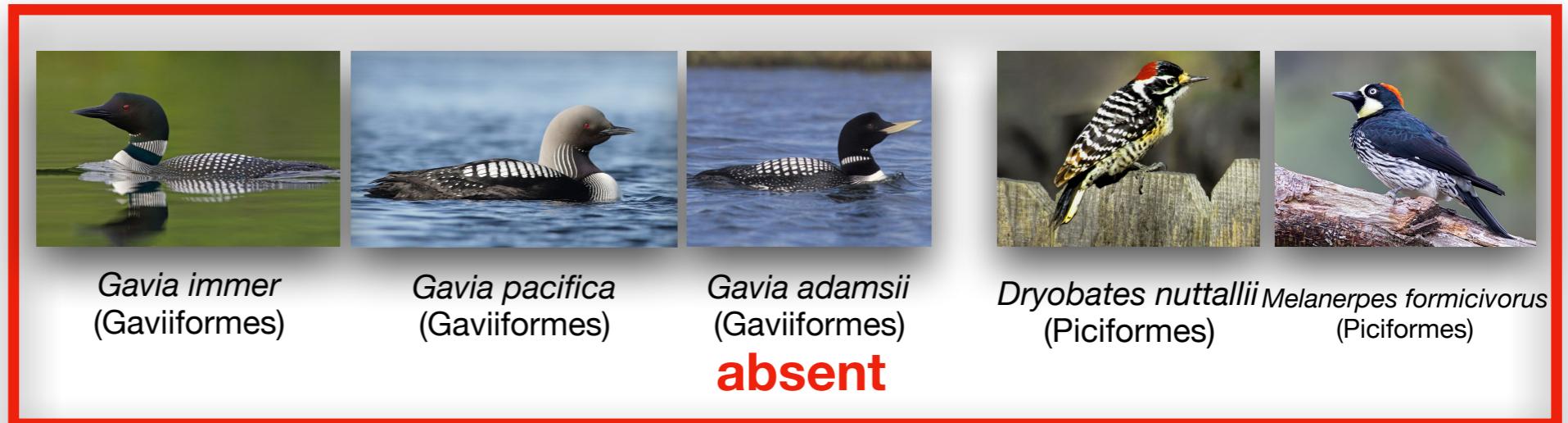


pelican

Conclusions: Variation in Supramedullary Airways

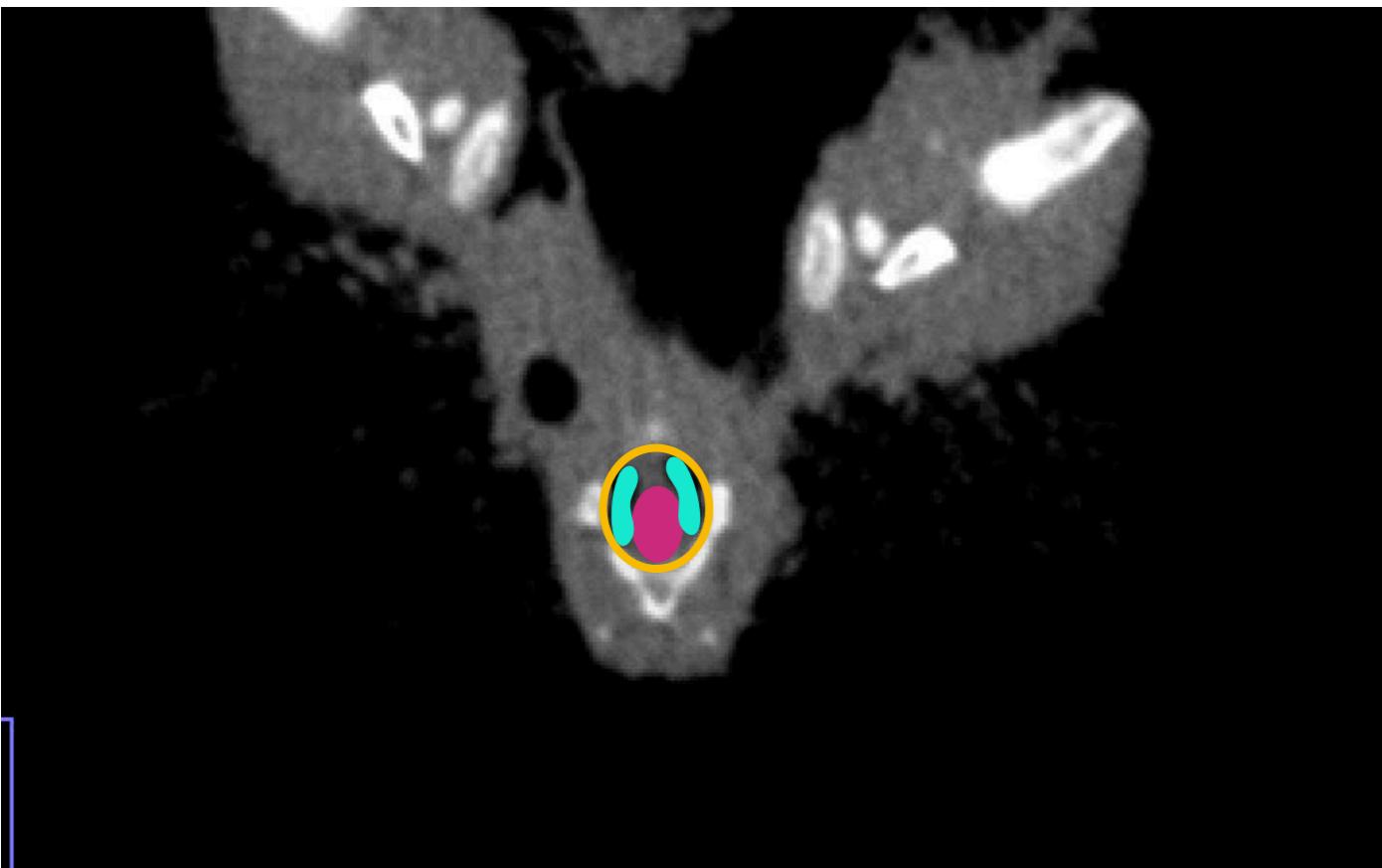
1. phylogenetic position
2. body size
3. vertebral region

*Strong
phylogenetic
signal*

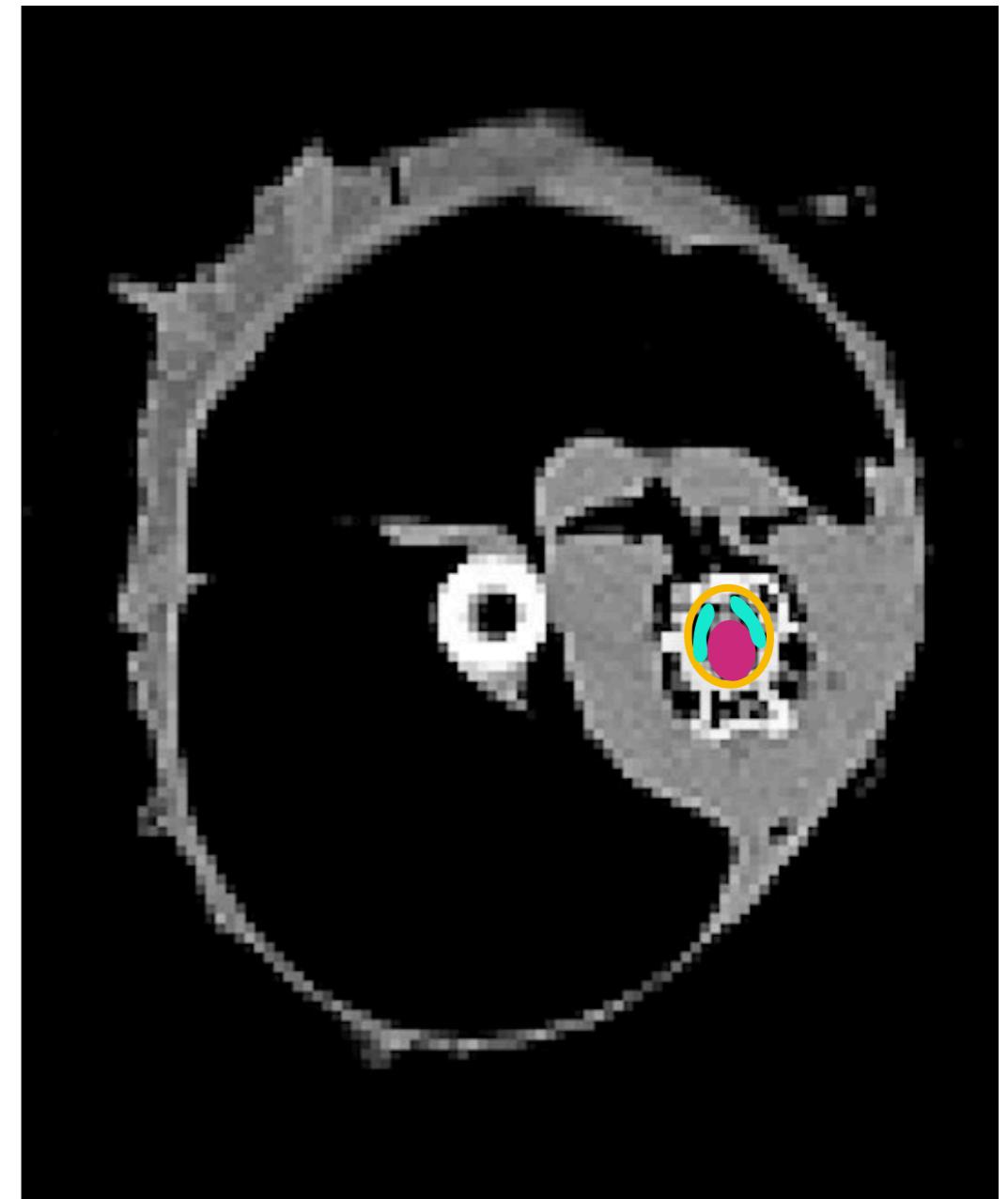


Conclusions: Variation in Supramedullary Airways

1. phylogenetic position
2. **body size?**
3. vertebral region



bushtit

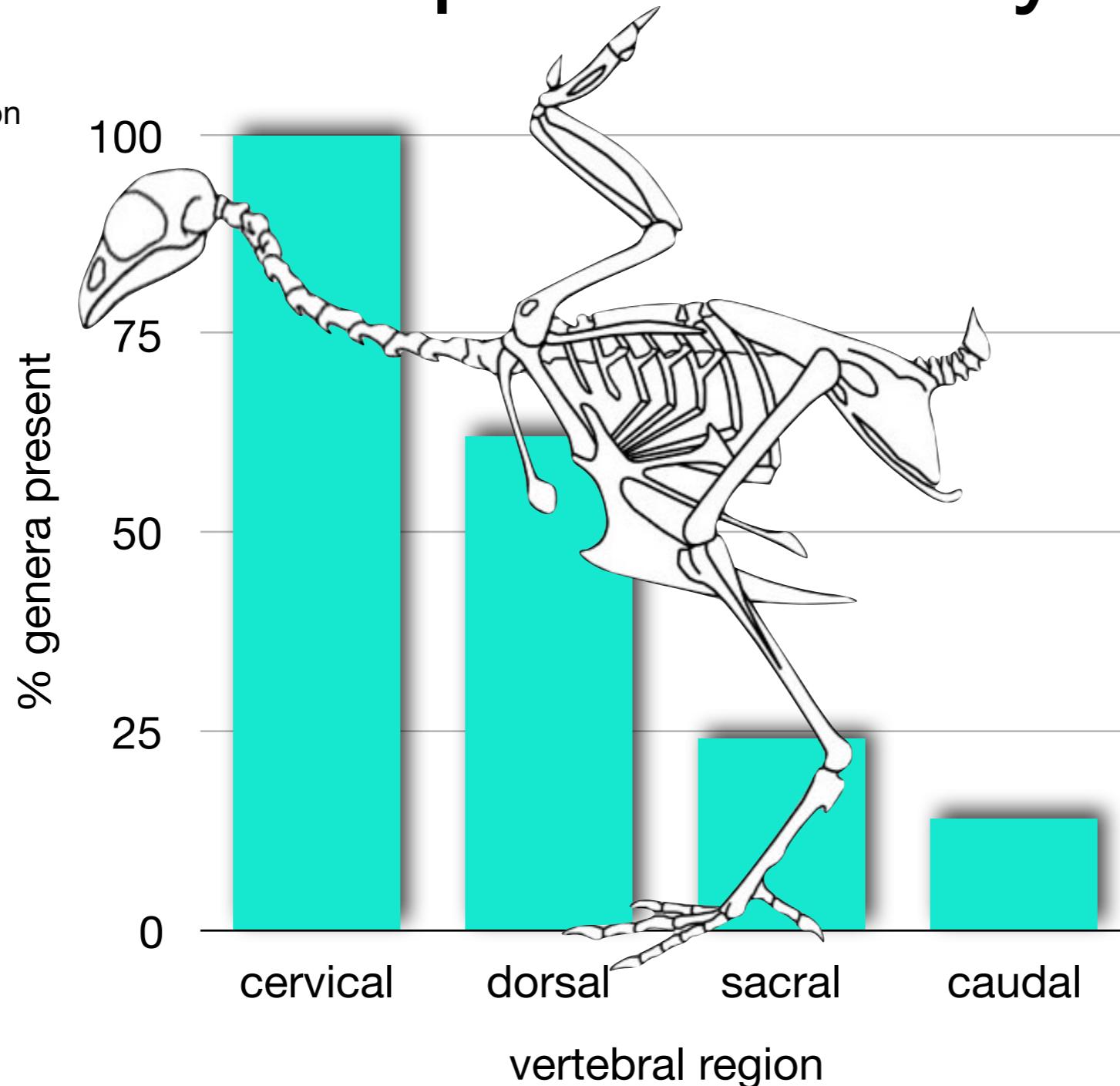


turkey vulture

Future studies: quantify volume of SMAs and spinal cord

Conclusions: Variation in Supramedullary Airways

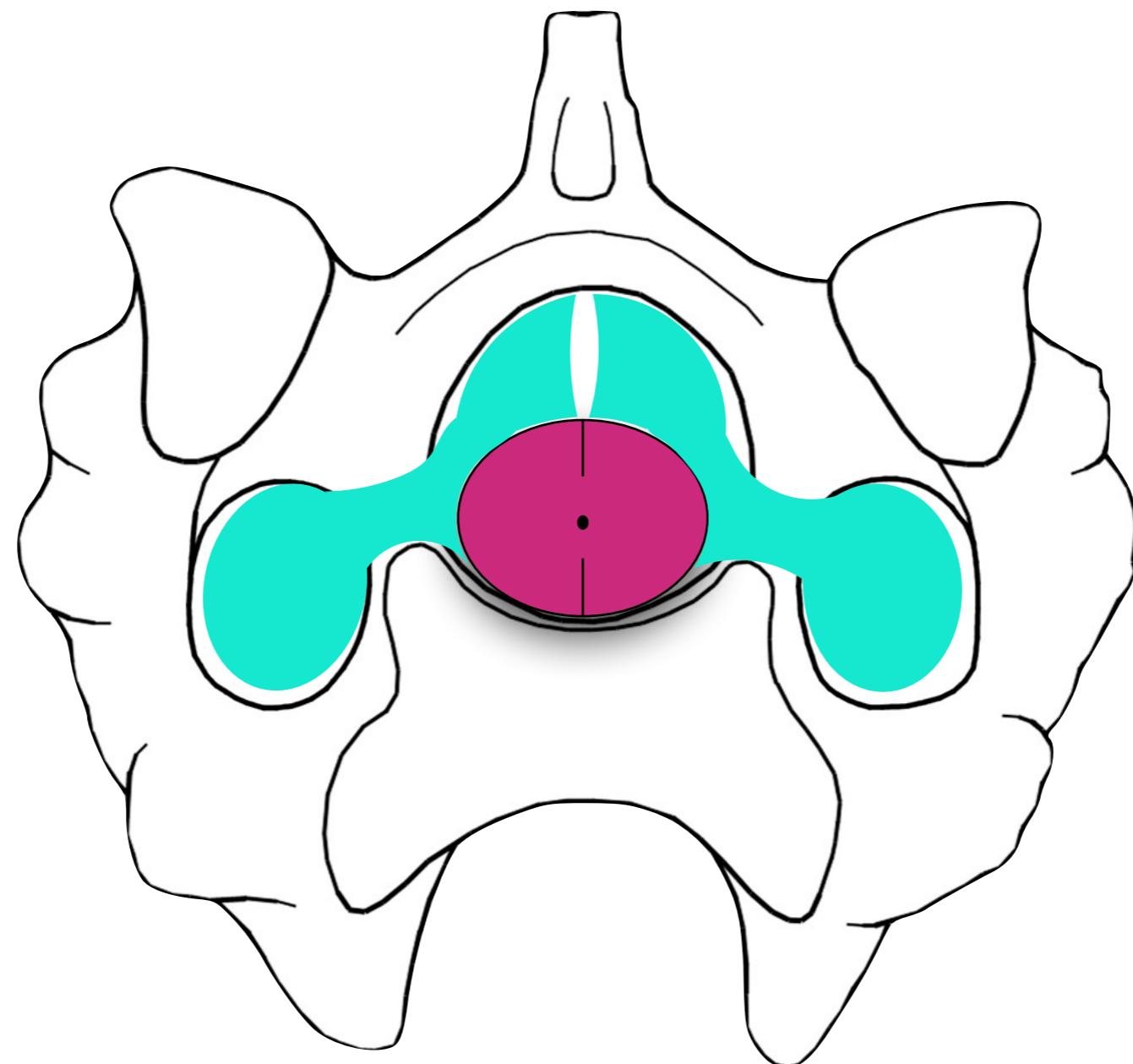
1. phylogenetic position
(body size)
- 2.
3. vertebral region



Function influences distribution of SMAs along vertebral column?
more movement → large SMAs
restricted movement → small (absent) SMAs

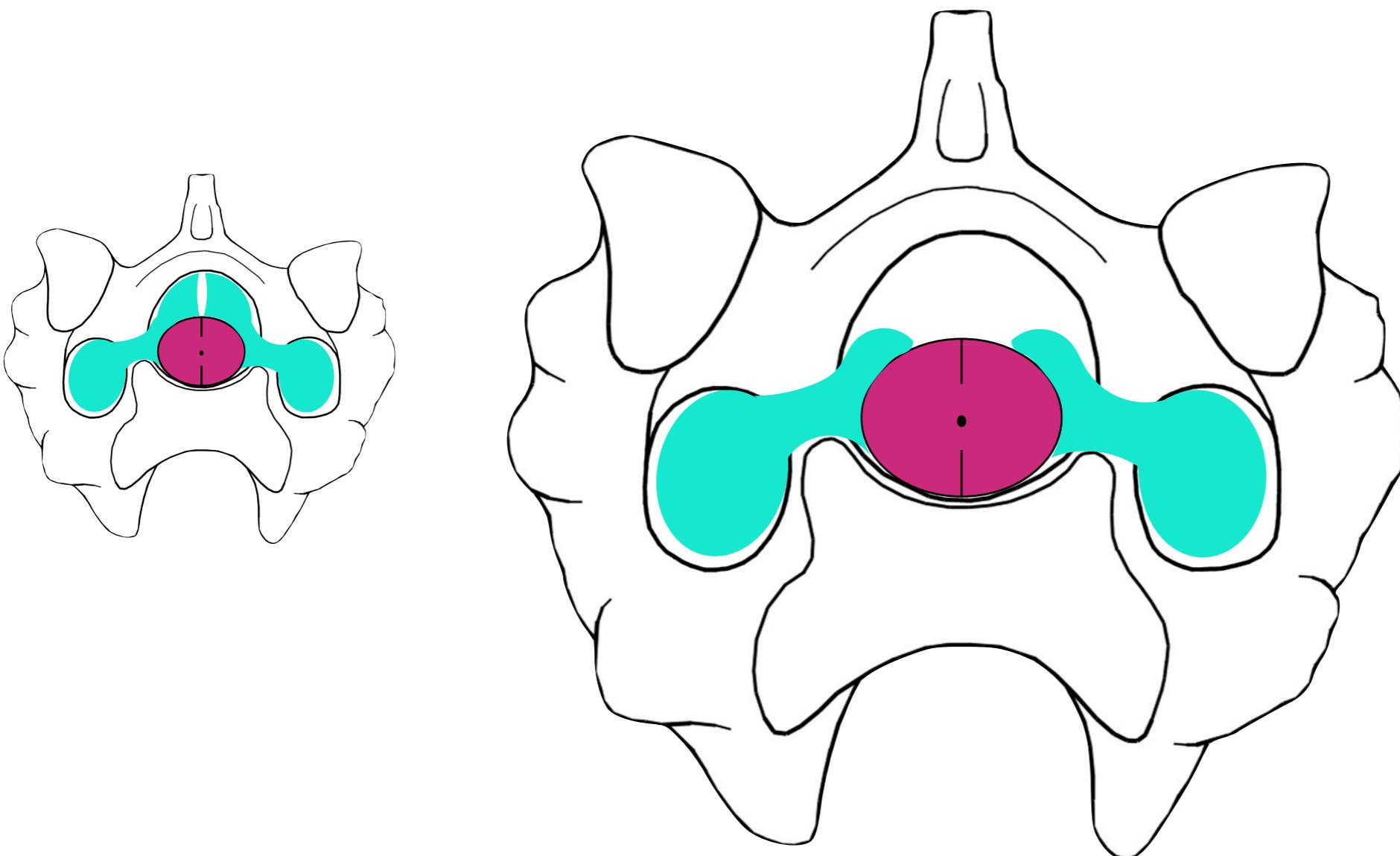
Conclusions: Defining “Supramedullary Airways”

- diverticula branching from lungs & air sacs
- inside vertebral canal
- dorsal to spinal cord



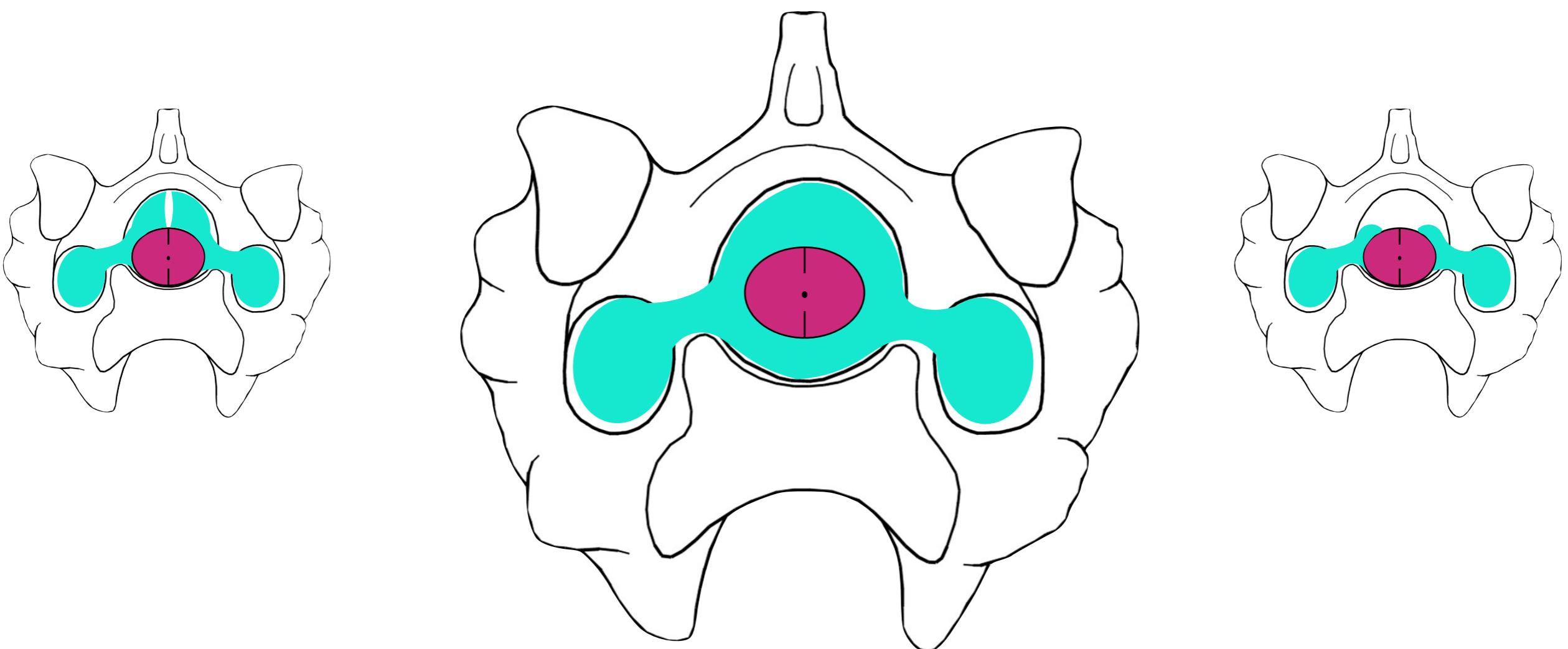
Conclusions: Defining “Supramedullary Airways”

- diverticula branching from lungs & air sacs
- inside vertebral canal or at *intervertebral joints*
- dorsal to spinal cord



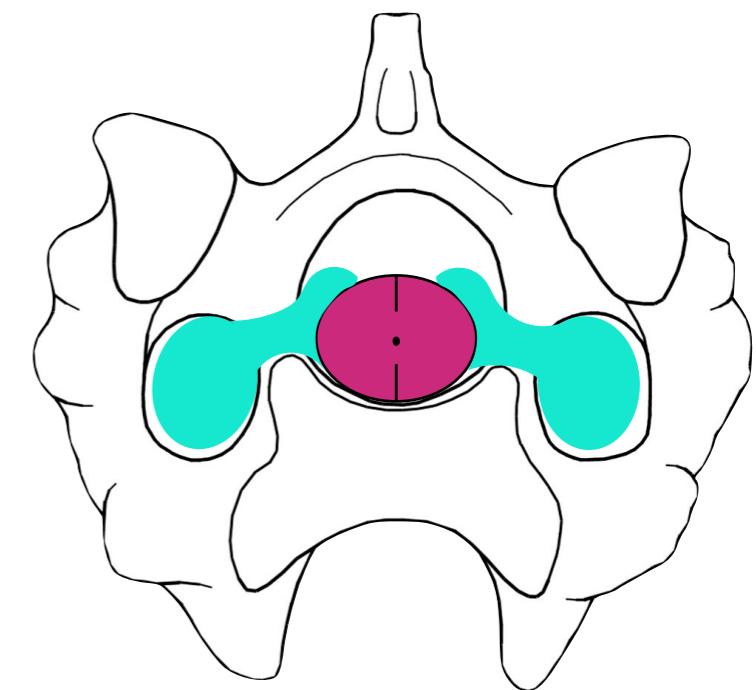
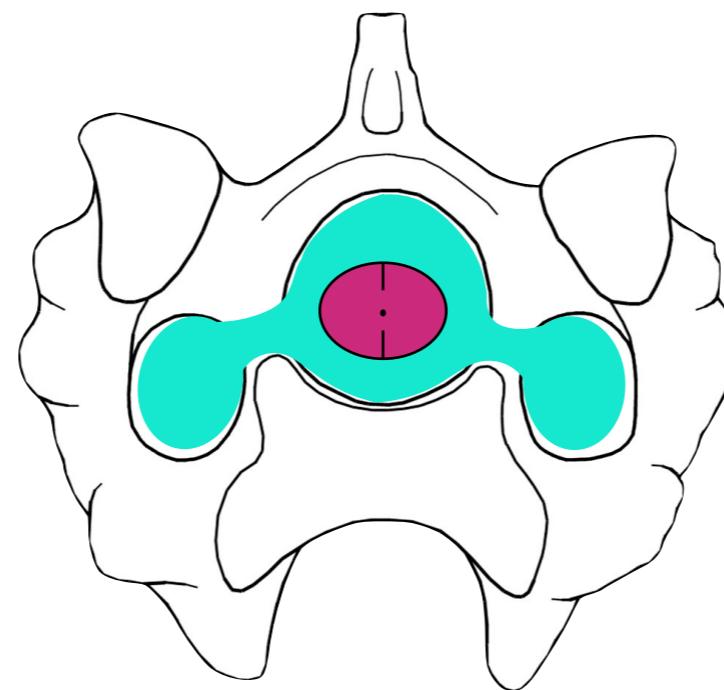
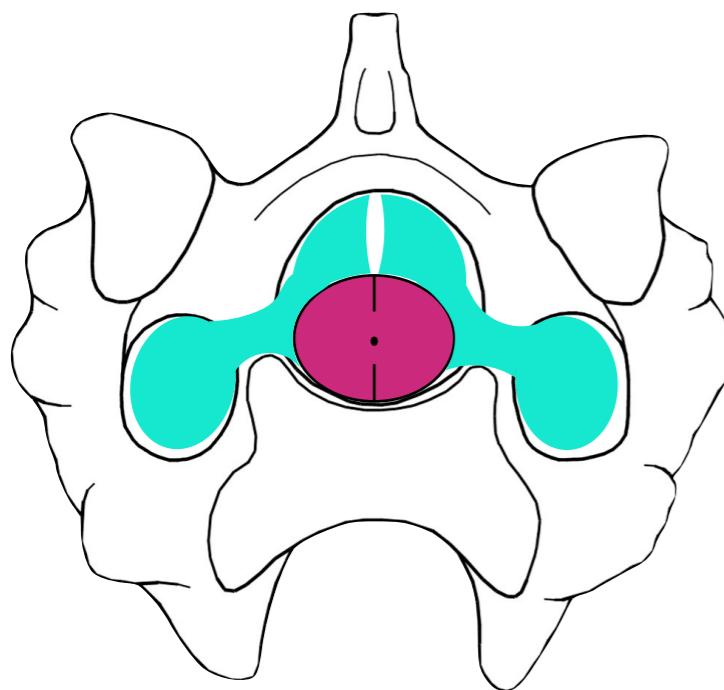
Conclusions: Defining “Supramedullary Airways”

- diverticula branching from lungs & air sacs
- inside vertebral canal or at *intervertebral joints*
- dorsal to spinal cord or otherwise in contact

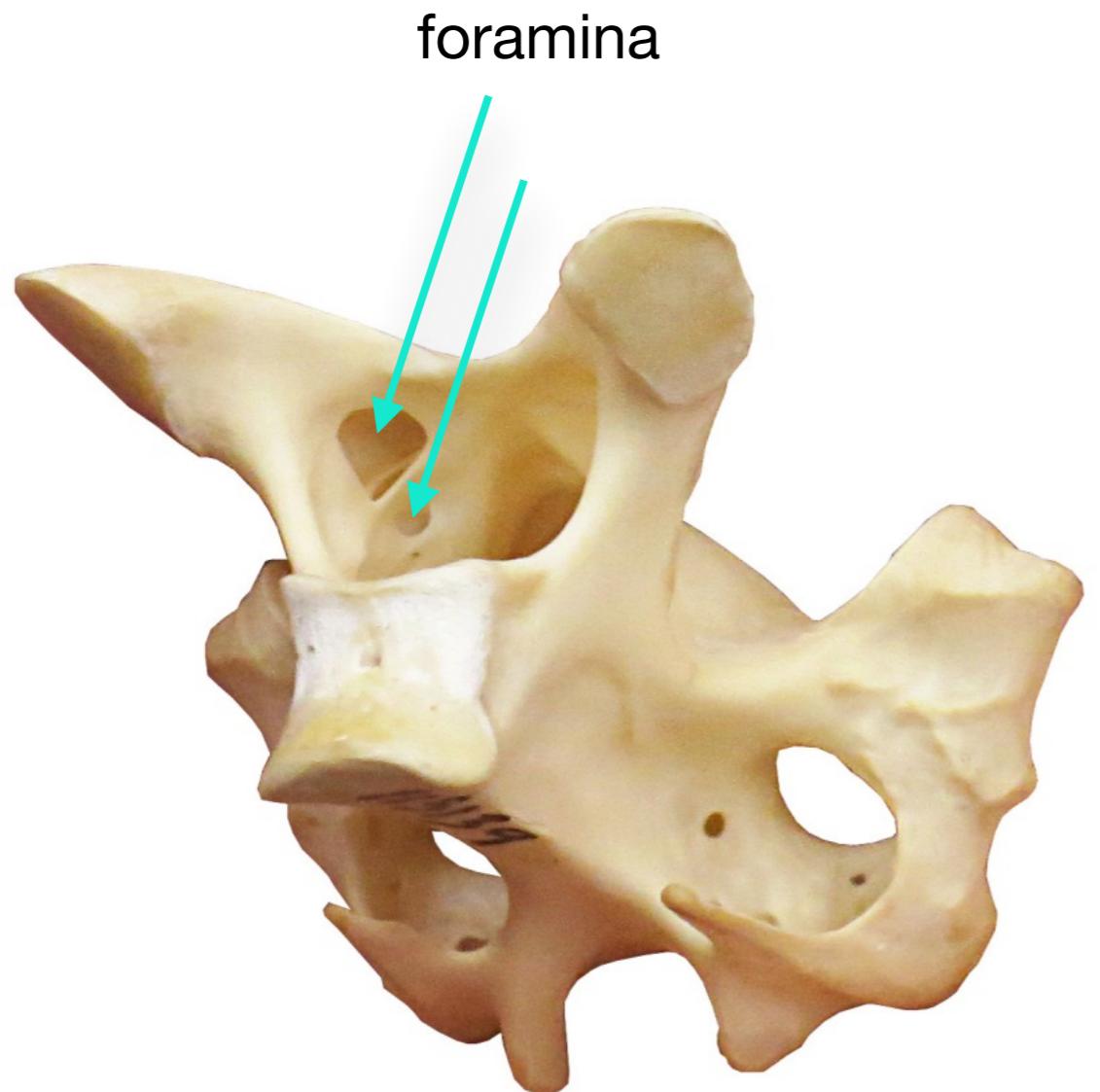


Conclusions: Paramedullary Diverticula

- diverticula branching from lungs & air sacs
- inside vertebral canal or at *intervertebral joints*
- dorsal to spinal cord or otherwise *in contact*

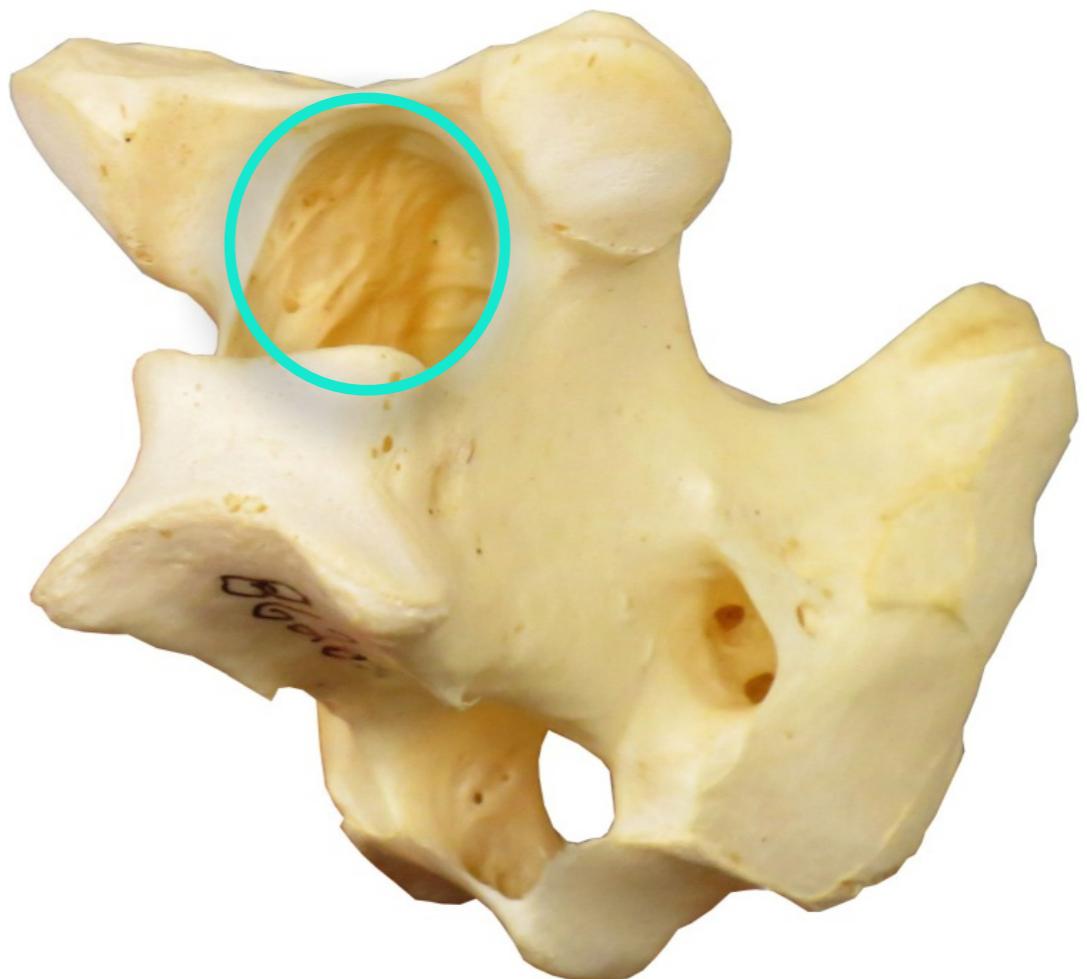


Osteological Correlates



Phoebastria nigripes
LACM 115139
Cervical 9
length 20mm

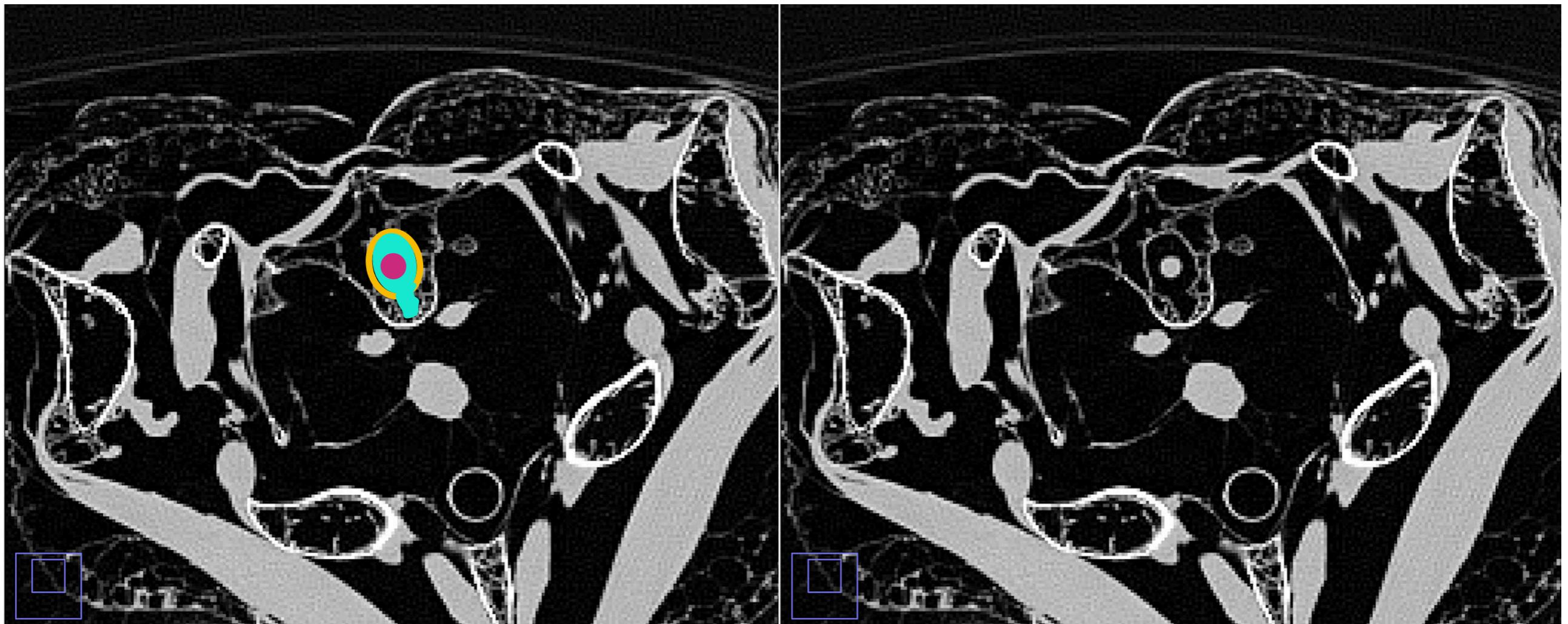
sculpting/fossae



Pelecanus
erythrorynchus
LACM 86262
Cervical 13
length 40mm

Osteological Correlates

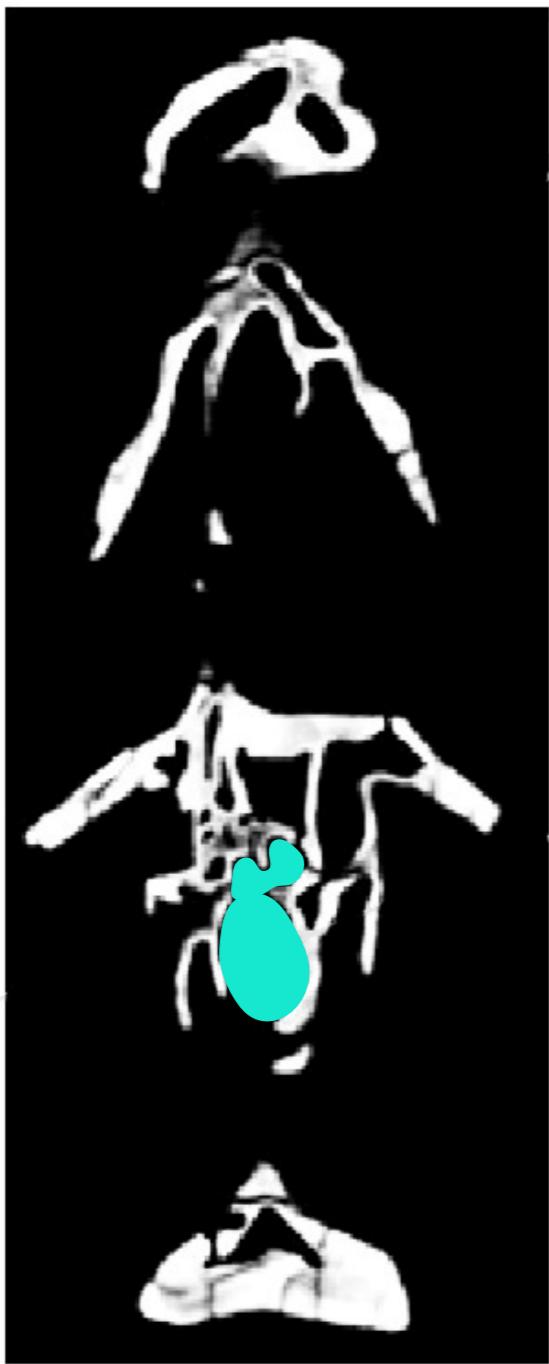
pelican



foramen in floor of vertebral canal

Osteological Correlates

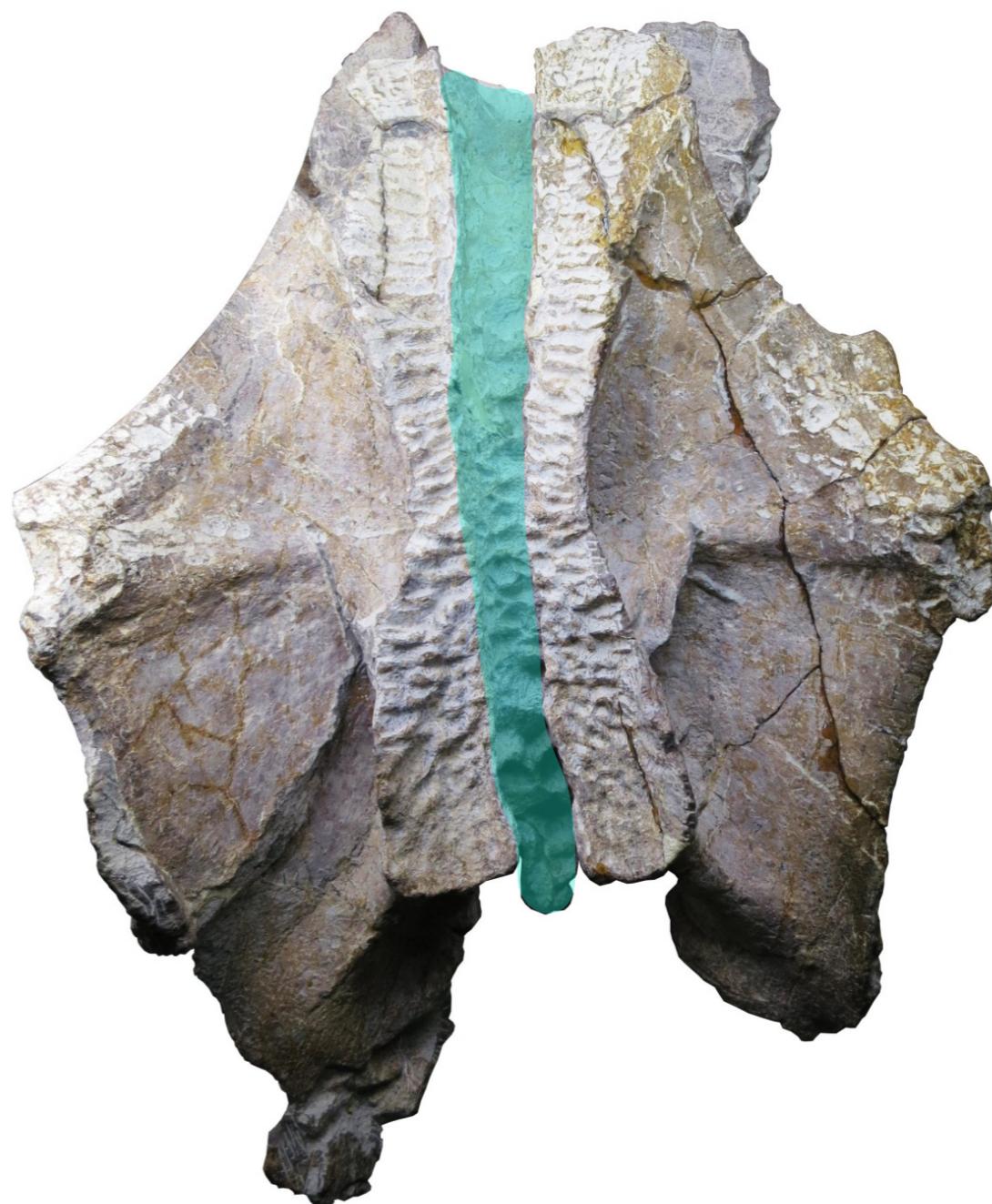
foramina



(Schwarz & Fritsch, 2006: Fig. 4)

Giraffatitan

sculpting/fossae



Alamosaurus

Conclusions: Paramedullary Airways in Other Archosaurs?



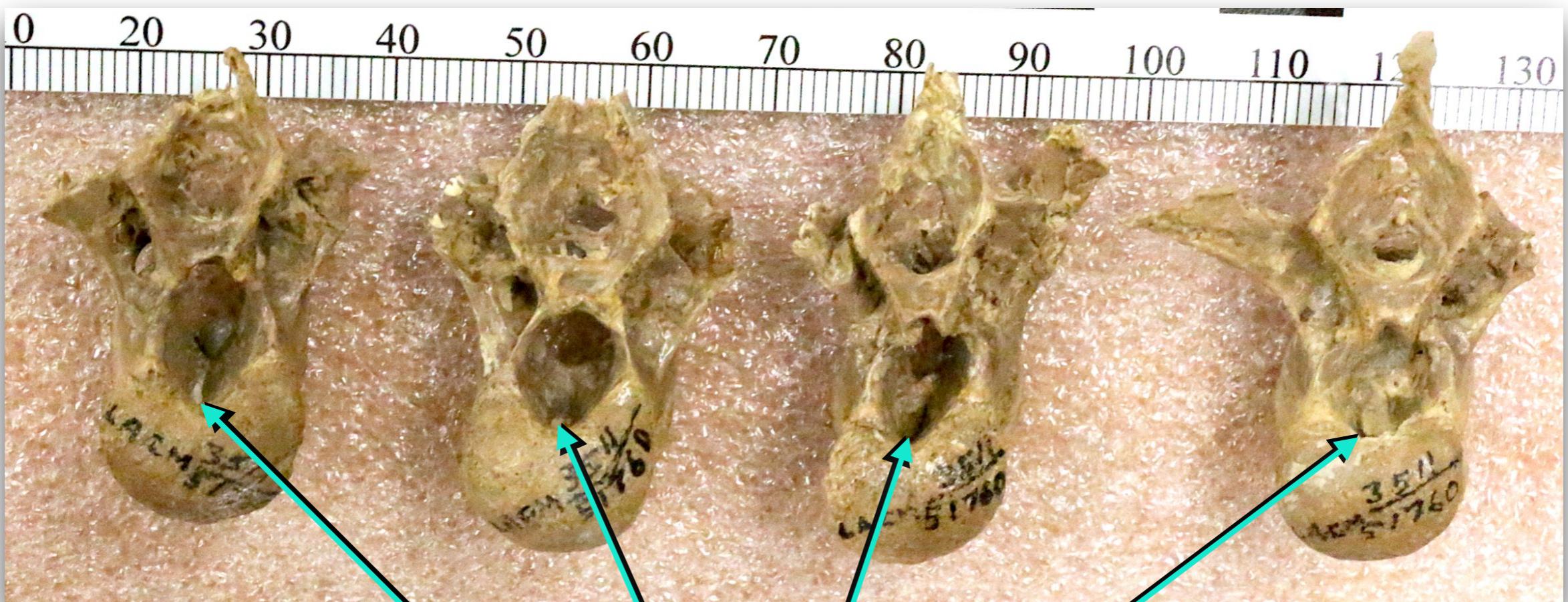
Illustration by Brian Engh
dontmesswithdinosaurs.com



Conclusions: Paramedullary Airways in Other Archosaurs?

Photo: Dave Hone

Pteranodon (LACM 51760)



foramina in floor of vertebral canal

Thank you!

Questions?



Illustration by Brian Engh
dontmesswithdinosaurs.com



svpow.com



@theladyanatomica