CT Scanning of museum specimens: a case study of diversity from the inside out

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Evolutionary morphology and phylogenetics have long focused on:
Computed Tomography (CT) is being used increasingly for evolutionary morphology!

A charciform fish, *Hoplias*, collected ~1940s

but the extent and size of datasets present challenges to museum curators unlike any dissection ever did!
Today talk about a case study of anatomy using CT

Are gas bladders modified lungs?
What is a gas bladder?

Functions: buoyancy, respiration, hearing, sound production
Orthodoxy: gas bladder is a modified lung (but some controversy)

1. duct and lungs rotate dorsally
2. paired lung reduced to single

(relatively little modification)

(from Romer 1974 The Vertebrate Body after B. Dean 1895. Living and Fossil Fishes)
Is the bowfin pulmonary artery (PA) convergent or homologous?
3-D study of the arterial supply in rayfinned fishes & lungfish

Injected barium into dorsal aorta of euthanized fish
Imaged with micro-CT (spatial res 50-100 microns)
Analyzed with Microview and Osirix.
Using micro-CT to show what some AOs actually look like...

AO = air-filled organ, a collective term for lungs & gas bladders
Sturgeon (A. transmontanous)
lungs of bichir \textit{(Polypterus ornatipinnis)}

dorsal view

lateral view

gut

ventral view

lungs
African lungfish (*Protopterus dolloi*)

- Duct connects ventrally
- Lung largely dorsal
- Very long (98% coelom)
- Vesicular internally
Micro-CTs of injected fish

- Lungfish
- Gar
- Sturgeon
- Polypterus
Pulmonary arteries branch off the 4\textsuperscript{th} efferent branchial artery.
Comparative study of arterial vasculature

African lungfish

bichir

bowfin

paddlefish

sturgeon

gar

From Longo, Riccio, and McCune 2013
Sturgeon and paddlefish have small arteries which branch off the 4th branchial efferent arteries

Are these vestigial pulmonary arteries?

Longo, Riccio & McCune 2013
Bowfin PAs are homologous not convergent
PAs are synapomorphy of Osteichthyes

One project generated:

- ~12 jars
- and
- 100.43 GB of CT data (49,966 items)
- of associated data
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**Amia:** dorsal AO is long (~70% coelom), bilobed, and vesicular internally.

Endoscopy!
Swim bladder morphology is also diverse:

*Chitala chitala*
Soft tissue has been used some, but not extensively.