

How Digitization Helped Tame The Tully Monster



**By Paul Mayer
The Field Museum**

The Flaming Whip Method of Digitization



Tully Monster Digitization Project

The Problem

A team of researchers from Yale, FMNH and Argonne Labs needed

- 1) A quick way to find a small number of specimens in the collection with certain well-preserved traits
- 2) Images of as many of the specimens to measure and compare.

to solved a 60 year old taxonomic mystery



Francis Tully

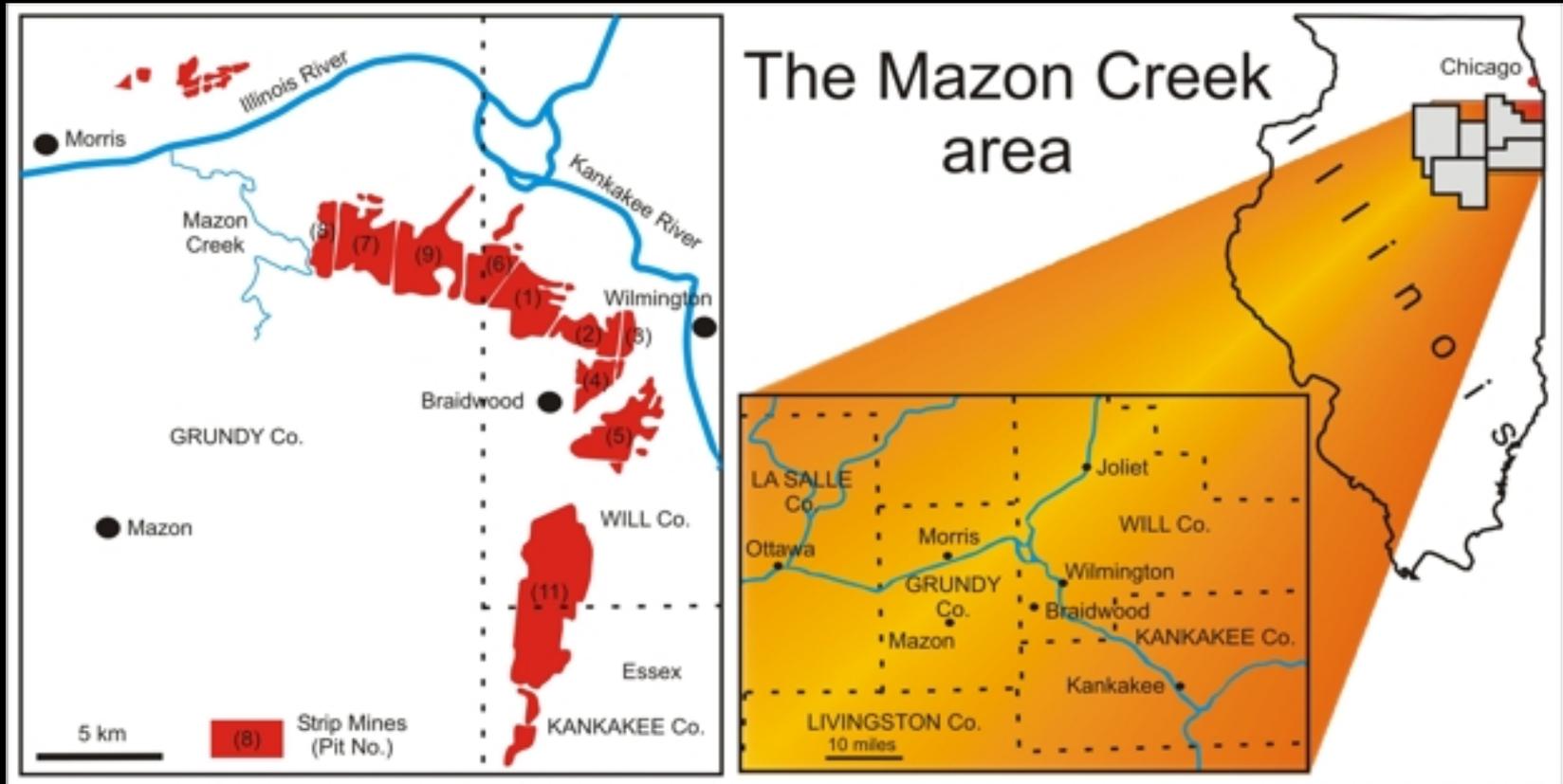
Discovered the Tully Monster in 1955



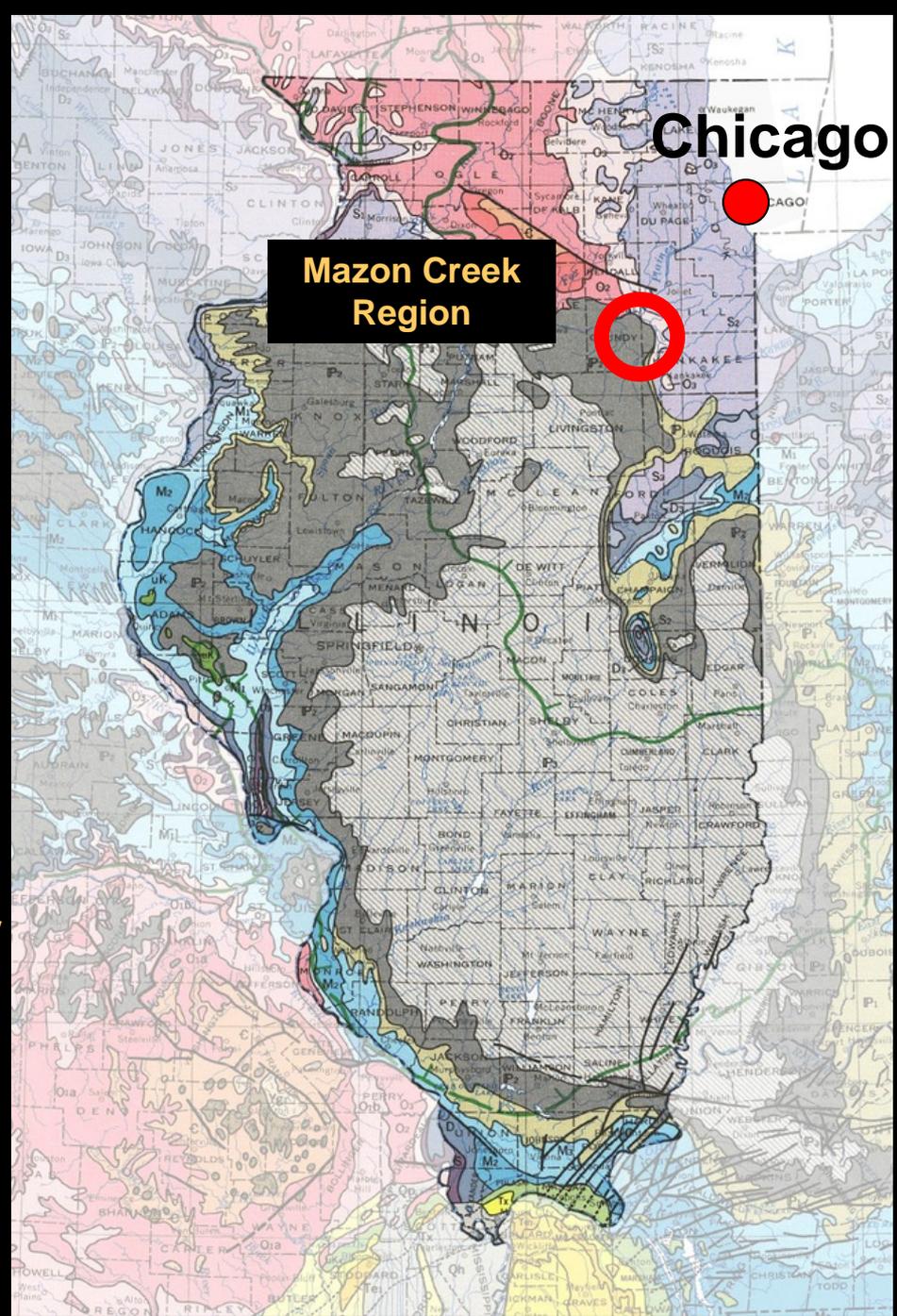
© The Field Museum, GN84794_21c, Photographer Ron Testa.
Field Museum Member's Night, May 1987



Mazon Creek Area, Northeastern Illinois



Bedrock Geology Map of Illinois



SYSTEM	SERIES	Group	Formation
PENNSYLVANIAN	VIRGILIAN	Mattoon	Shumway Limestone Member
			unnamed coal member
	MISSOURIAN	McLeansboro	Millersville Limestone Member
			Carthage Limestone Member
			Trivoli Sandstone Member
	DESMOINESIAN	Carbondale	Danville Coal Member
			Colchester Coal Member
	MORROWAN	Raccoon Creek Group	Murray Bluff Sandstone Member
			Pounds Sandstone Member
			Caseyville

MISSISSIPPIAN TO ORDOVICIAN SYSTEMS

Francis Creek Shale Member

307 Million years ago



Diorama of Mazon Creek - Braidwood Fauna 307 million years ago - Northeastern Illinois, USA



© The Field Museum, GEO85787_4c, Photographer John Weinstein.

What is a Tully Monster ?

- Placed in Problematika by E.S. Richardson in 1966
- Compared to Heteropod Gastropod by M. Foster in 1971
- Compared to Conodonts by B. Beall in 1991

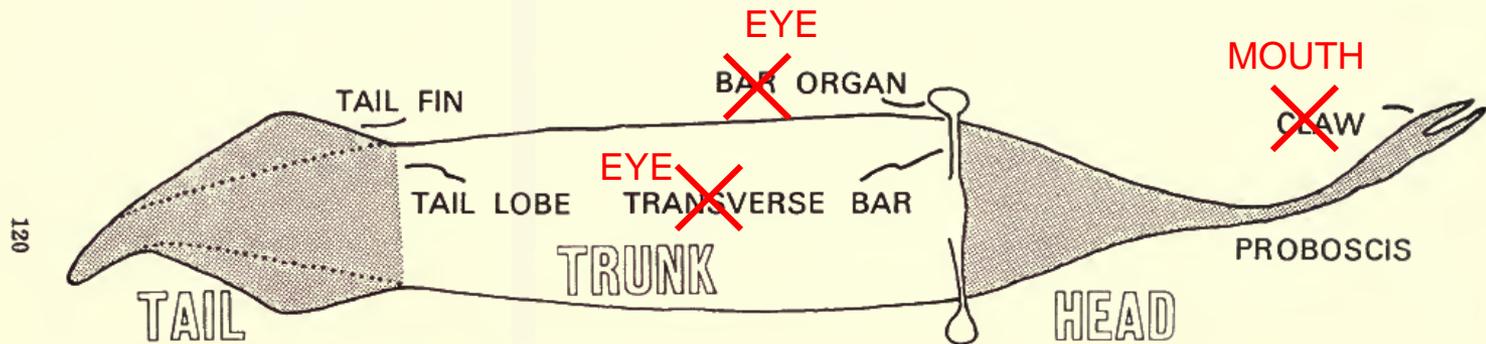


FIG. 63. Principal features of *Tullimonstrum*.



Louisella pedunculata
Priapulid worm
By Marianne Collins
artoffact

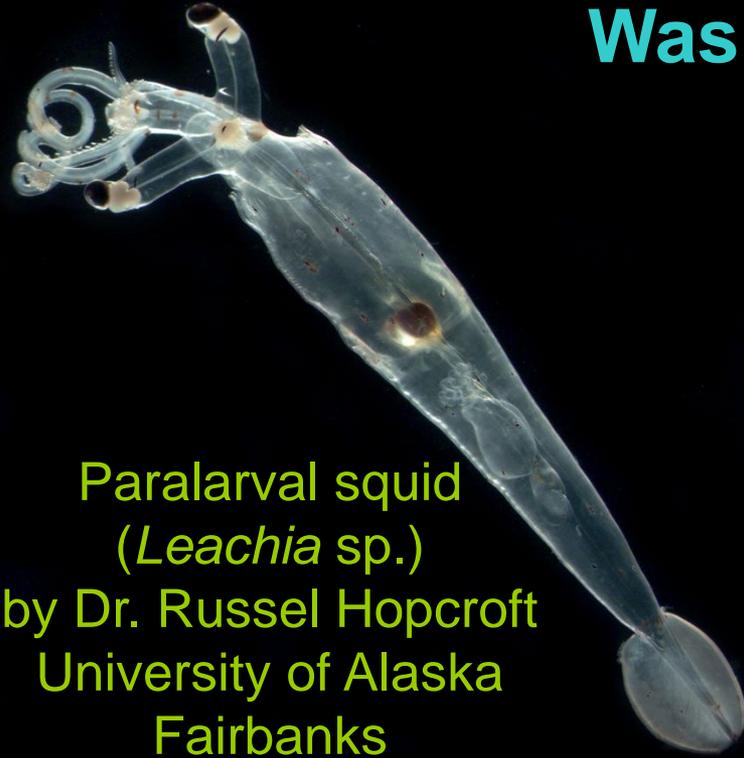
Was thought to be a ...
Worm

Polychaete Worm



Was thought to be a ...

Mollusk



Paralarval squid
(*Leachia* sp.)

by Dr. Russel Hopcroft
University of Alaska
Fairbanks

Hopcroft/UAF/CoML



Pterotrachea hippocampus
Photo by Dr. Russell Hopcroft
University of Alaska Fairbanks

Hopcroft/UAF/CoML



Nectocaris pteryx
by artist Nicholas Carter

Was thought to be a ...

Chordate



Pikaia
by artist Karen Carr

Lancelet / Amphioxus



Conodont
by artist Karen Carr

Research using 1200 specimens and digitized records resulted in April 28, 2016 Nature article identifying Tully Monster as an Vertebrate

LETTER

doi:10.1038/nature16992

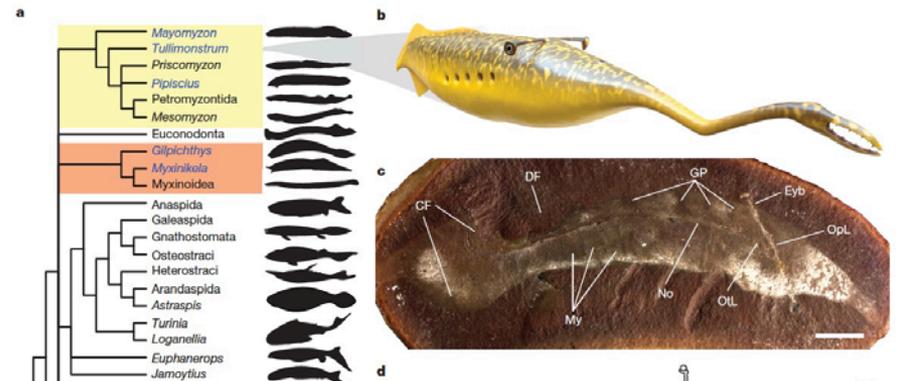
The 'Tully monster' is a vertebrate

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Problematic fossils, extinct taxa of enigmatic morphology that cannot be assigned to a known major group, were once a major issue in palaeontology. A long-favoured solution to the 'problem of the problematica'¹, particularly the 'weird wonders'² of the Cambrian Burgess Shale, was to consider them representatives of extinct phyla. A combination of new evidence and modern approaches to phylogenetic analysis has now resolved the affinities of most of these forms. Perhaps the most notable exception is *Tullimonstrum gregarium*³, popularly known as the Tully monster, a large soft-bodied organism from the late Carboniferous Mazon Creek biota (approximately 309–307 million years ago) of Illinois, USA, which was designated the official state fossil of Illinois in 1989. Its phylogenetic position has remained uncertain and it has been compared with nemerteans^{4,5}, polychaetes⁴, gastropods⁶, conodonts⁶, and the stem arthropod *Opabinia*⁴. Here we review

the morphology of *Tullimonstrum* based on an analysis of more than 1,200 specimens. We find that the anterior proboscis ends in a buccal apparatus containing teeth, the eyes project laterally on a long rigid bar, and the elongate segmented body bears a caudal fin with dorsal and ventral lobes^{3–6}. We describe new evidence for a notochord, cartilaginous arcualia, gill pouches, articulations within the proboscis, and multiple tooth rows adjacent to the mouth. This combination of characters, supported by phylogenetic analysis, identifies *Tullimonstrum* as a vertebrate, and places it on the stem lineage to lampreys (Petromyzontida). In addition to increasing the known morphological disparity of extinct lampreys^{7–9}, a chordate affinity for *T. gregarium* resolves the nature of a soft-bodied fossil which has been debated for more than 50 years.

Since *T. gregarium* was originally described as a representative of an extinct phylum^{3,5}, there have been only two attempts using extensive



**Digitization helps solves
60 year old mystery
the Tully Monster is an ...**



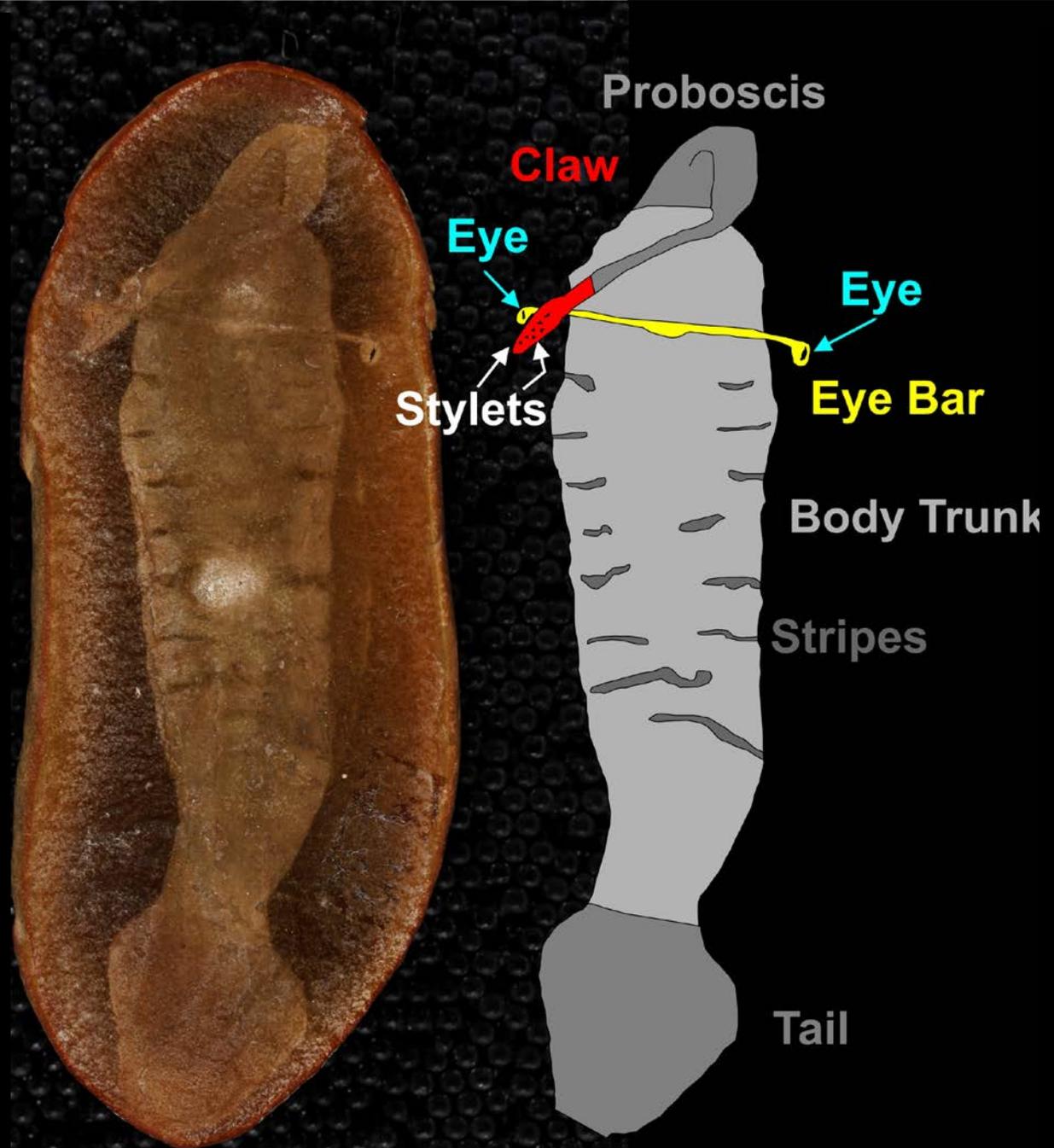
**Agnathan
or jawless fish**

© 3D Model by Sean McMahon, Yale University, 2016

What role did digitization play?

Needed a way to quickly search for specimens with particular morphological traits

Needed photographs that highlighted these traits and that could be used to measure and compare them





Overview of Tully Monster Digitization Project
Special thanks to Kate Webbink for producing this video

Nicole Karpus “Digitizing” Tully Monster Specimens



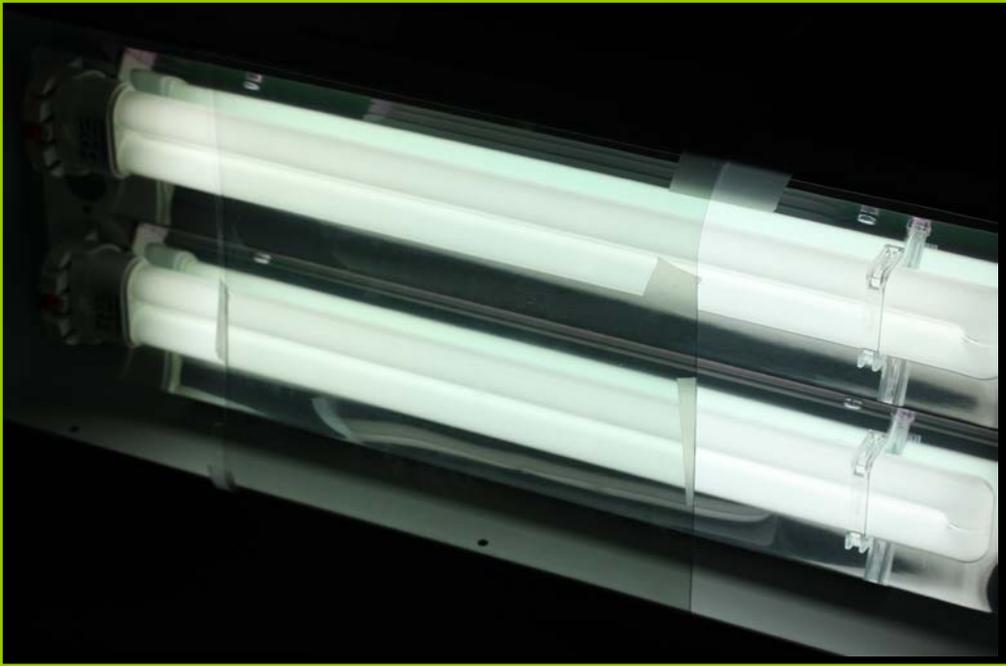
A total of 1300 Tully Monster specimens were digitized
in 3 weeks producing 4441 images

Workflow

- Pull specimens from collection area
- Photograph each part and counterpart twice
 - Low-Angle lighting
 - Cross-Polarized lighting
- Name each image using the file naming protocol developed for this project
- Create batch upload spreadsheet from image name
- Upload to database
 - Images
 - Description
 - Keywords and morphology

Low-Angle Lighting Setup

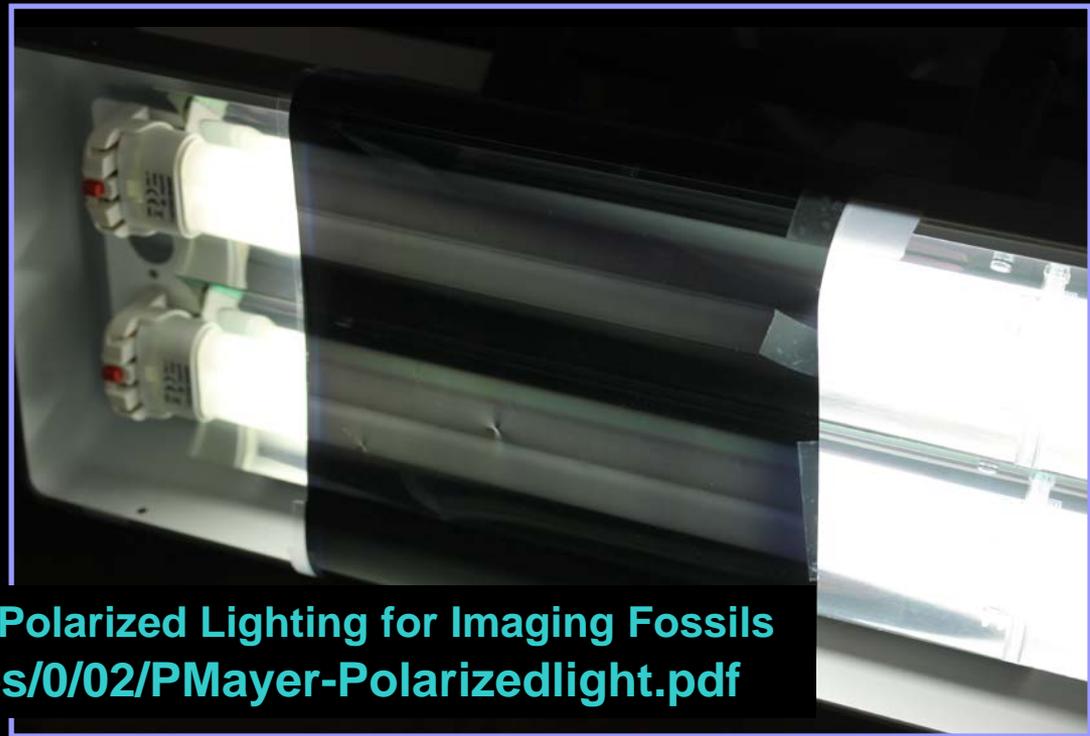




**Close up of lights
with uncrossed
polarizer filter**

**Close up of lights
with crossed
polarizer filter**

**iDigBio
Paleo Imaging Workshop
U of T – Austin April 2014**



**The Advantages in Using Textural and Polarized Lighting for Imaging Fossils
<https://www.idigbio.org/wiki/images/0/02/PMayer-Polarizedlight.pdf>**



PE 57188

Eubleptus maculosus

Mazon Creek, Pennsylvanian

PE22093A_p-bar-snout-claw-
teeth.dng



File Naming Protocol

PE22093A_p-bar-snout-claw-teeth.dng

PE22093

Multimedia Title, File Location, Description, and link to catalog entry

A & B

Part and Counterpart

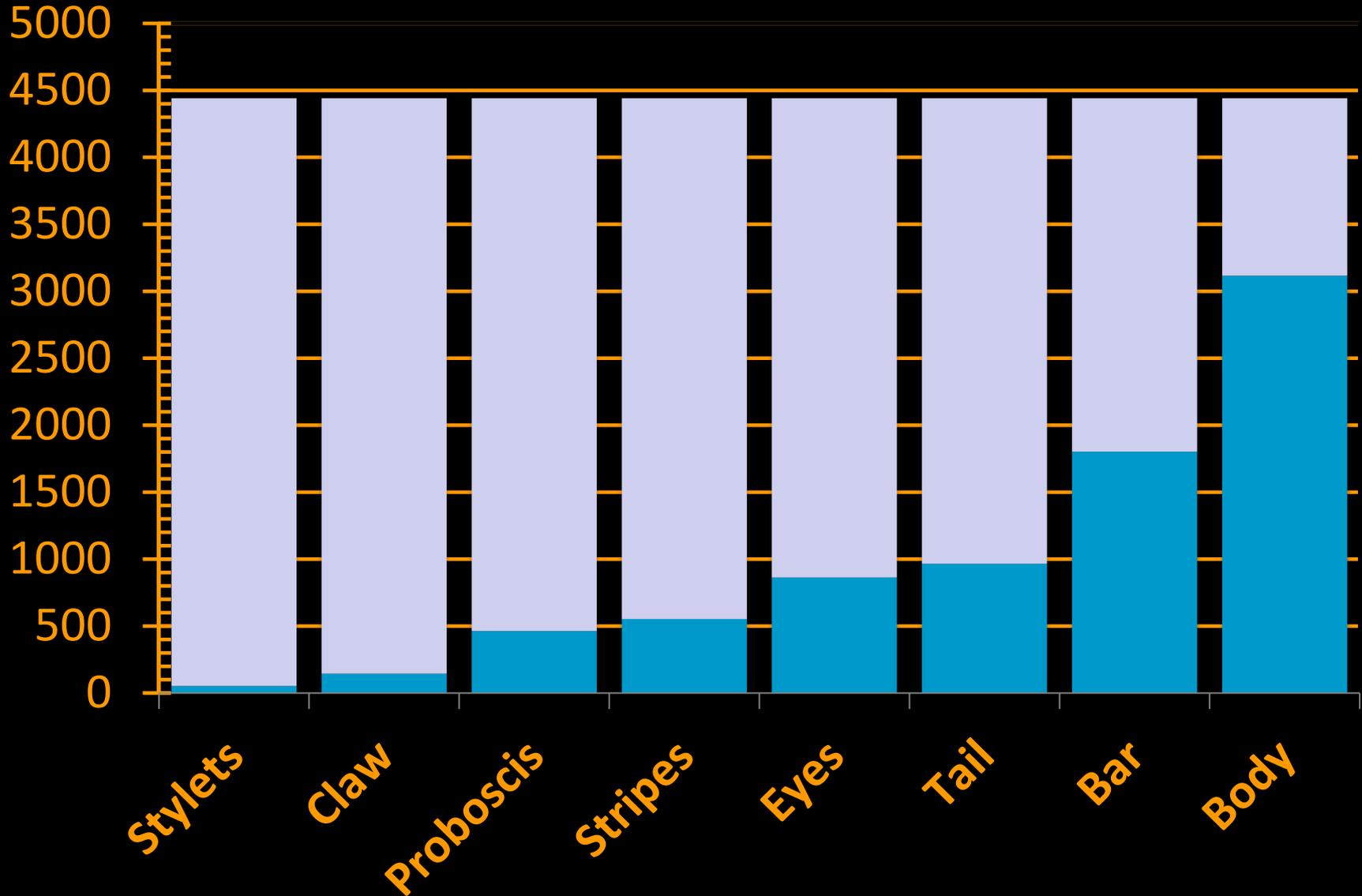
_p or _n

Crossed Polarized lighting or low-angle lighting goes in description and keywords

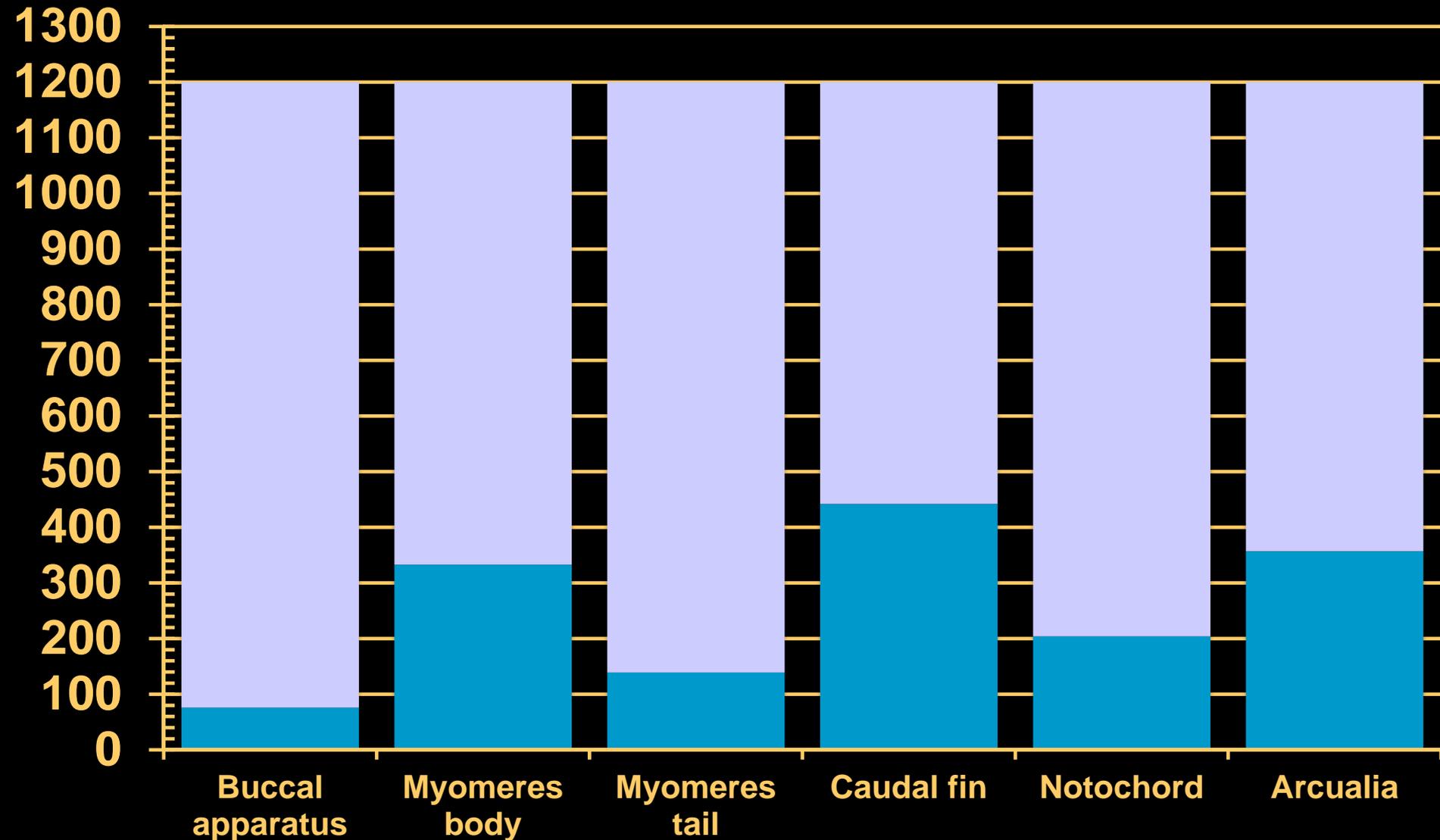
Bar, Eye, etc..

Keyword search in Multimedia, Morphology in catalog

Images Tagged with Morphological Traits



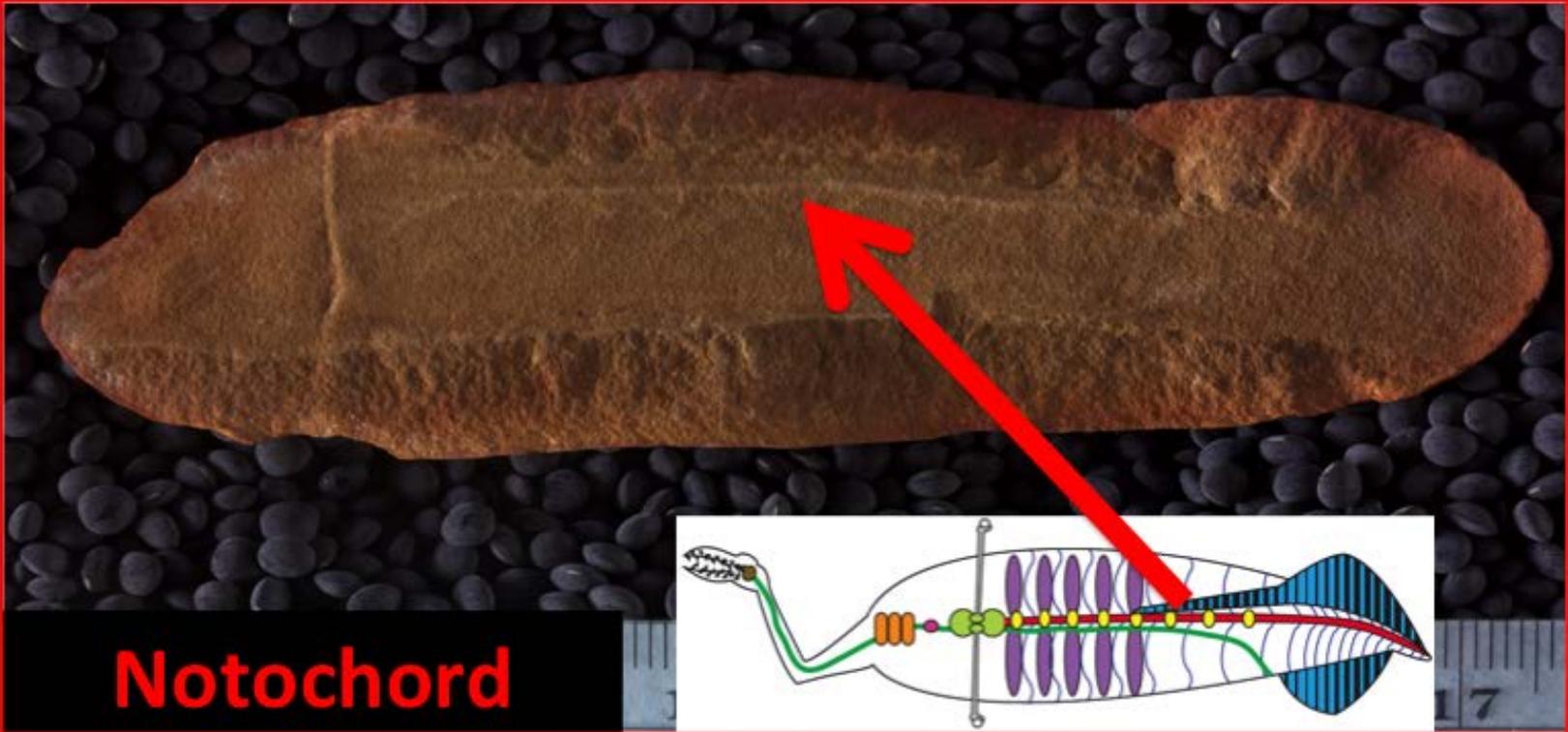
Number of specimens tagged with new morphology traits by researchers





Notochord

Crossed polarized lighting



Notochord

Gill Pouches

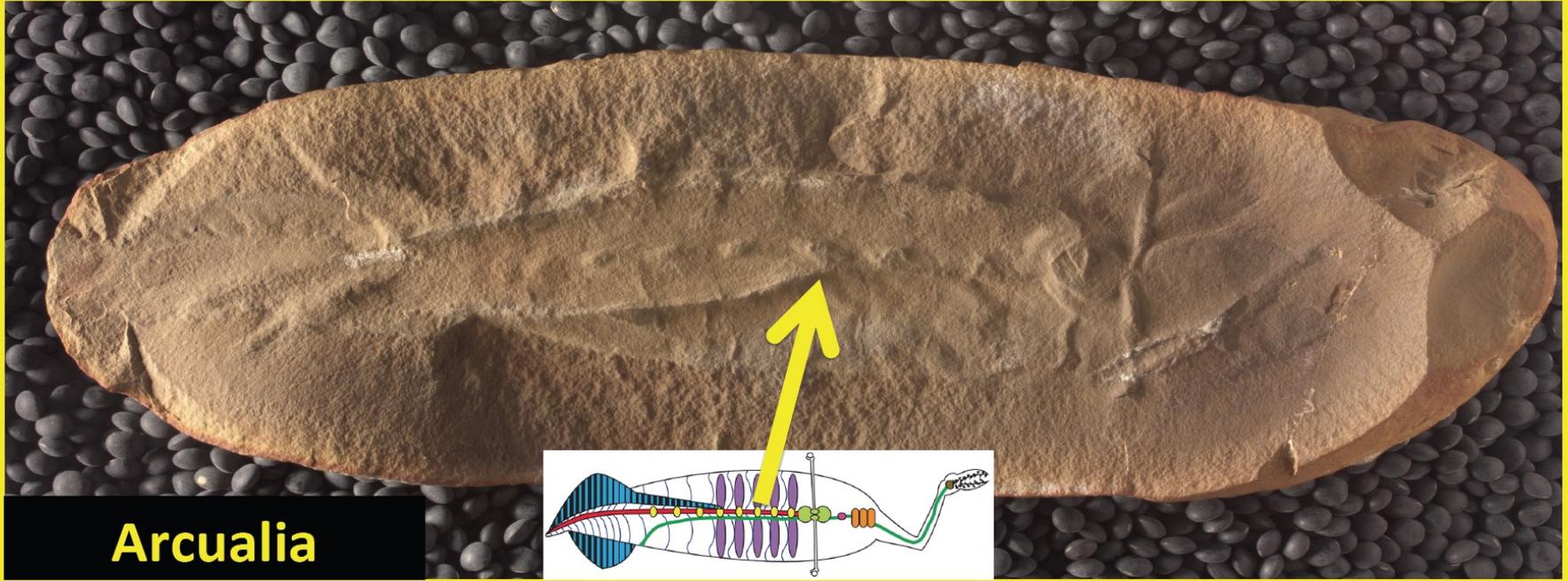
Crossed polarized lighting



Gill Pouches

Arcualia

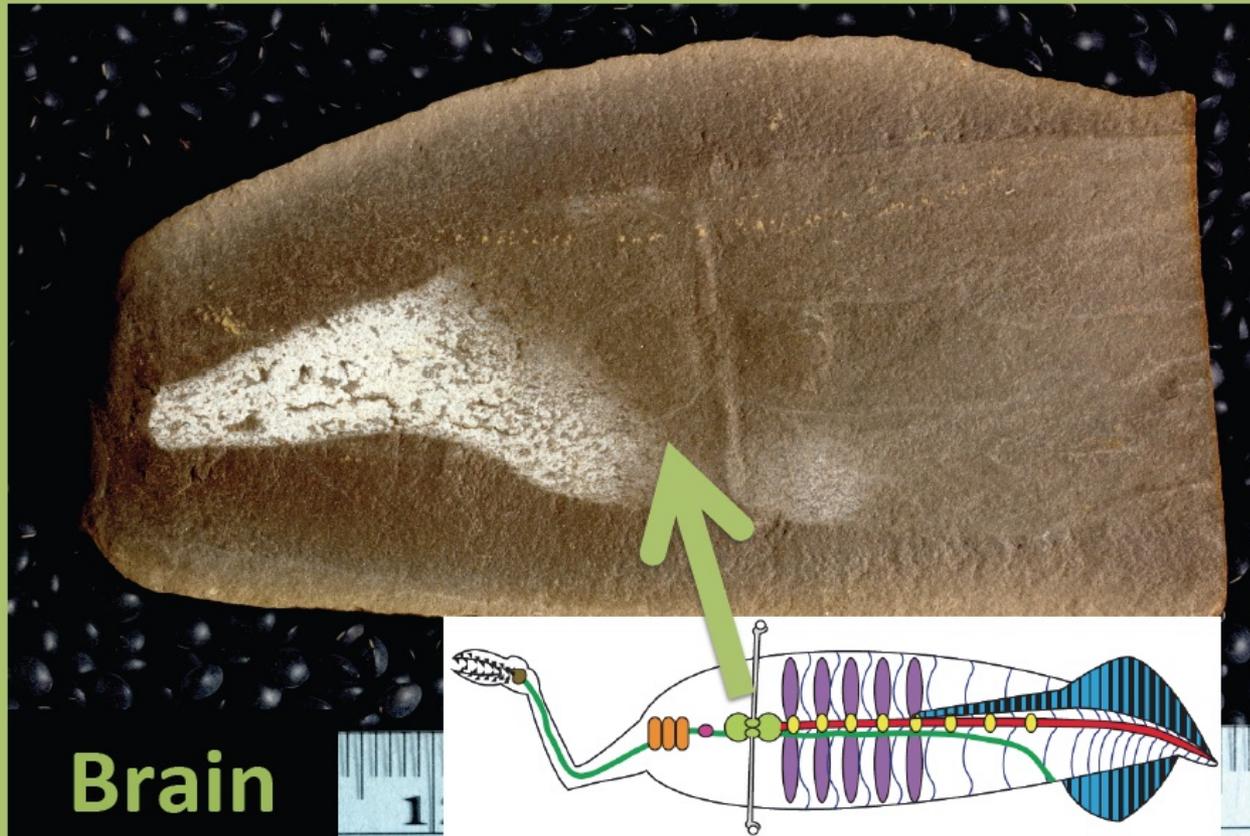
Low-Angle Lighting



Arcualia

Brain

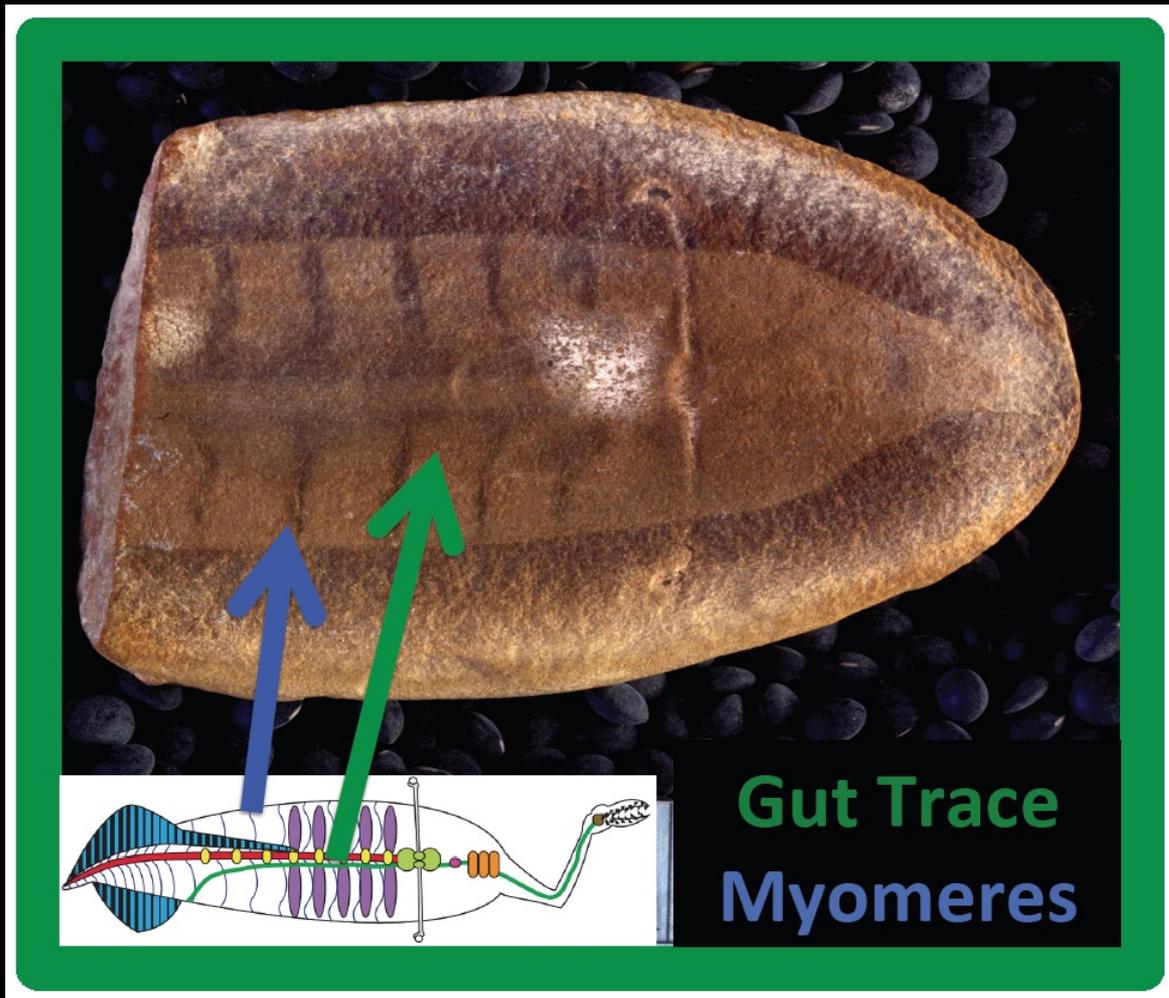
Low-Angle Lighting



Brain

Gut Trace and Myomeres

Crossed Polarized Lighting



Thank you to:

**Nicole Karpus
Kate Webbink
Victoria McCoy
Sharon Grant
Scott Lidgard
Carmen Soriano
Marc Lambruschi
Elaine Zeiger
Bill Stanley
Derek Briggs
Lidya Tarhan
Erin Saupe
Sean McMahon
The Yale Team**

