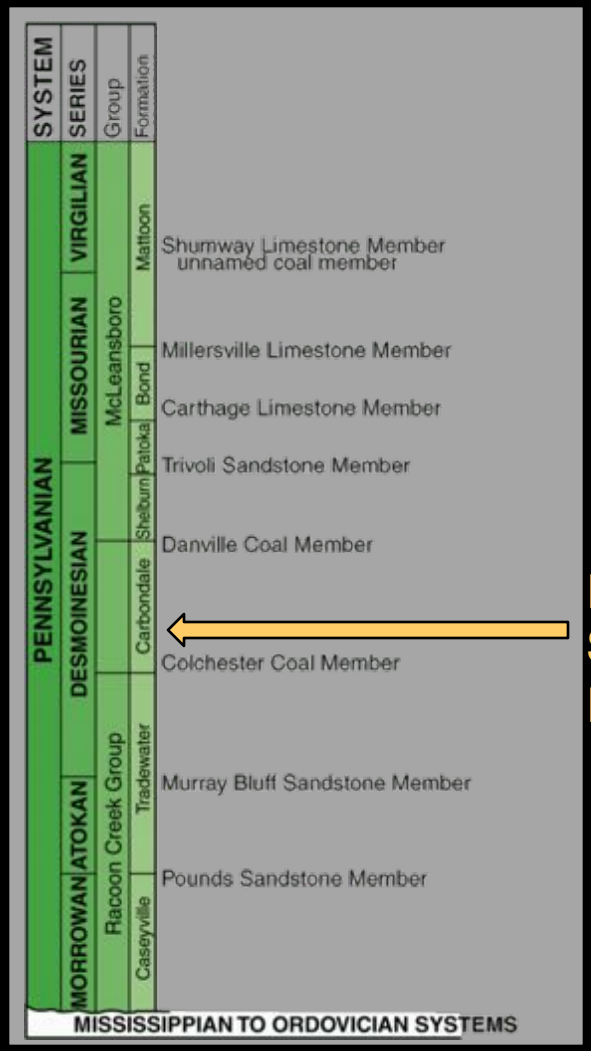
How Digitization Helped Tame The Tully Monster

By Paul Mayer
The Field Museum

Bedrock Geology Map of Illinois

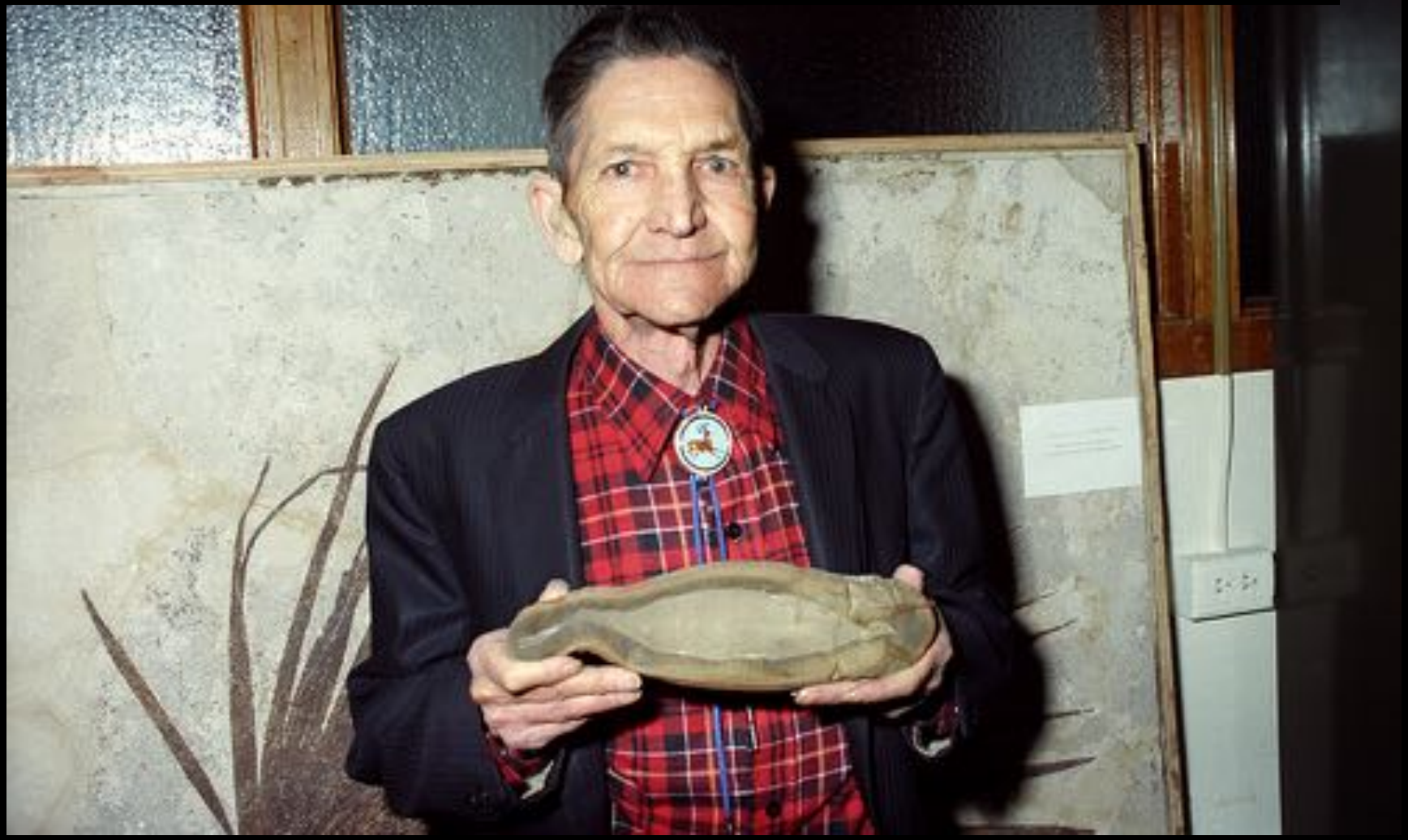


Francis Creek Shale Member

307 Million years ago

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

Francis Tully
Discovered the Tully Monster in 1955



Field Museum Member's Night, May 1987

Tullimonstrum gregarium

Described and named by Richardson in 1966 and placed in Problematica.

What is a Tully Monster ?

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

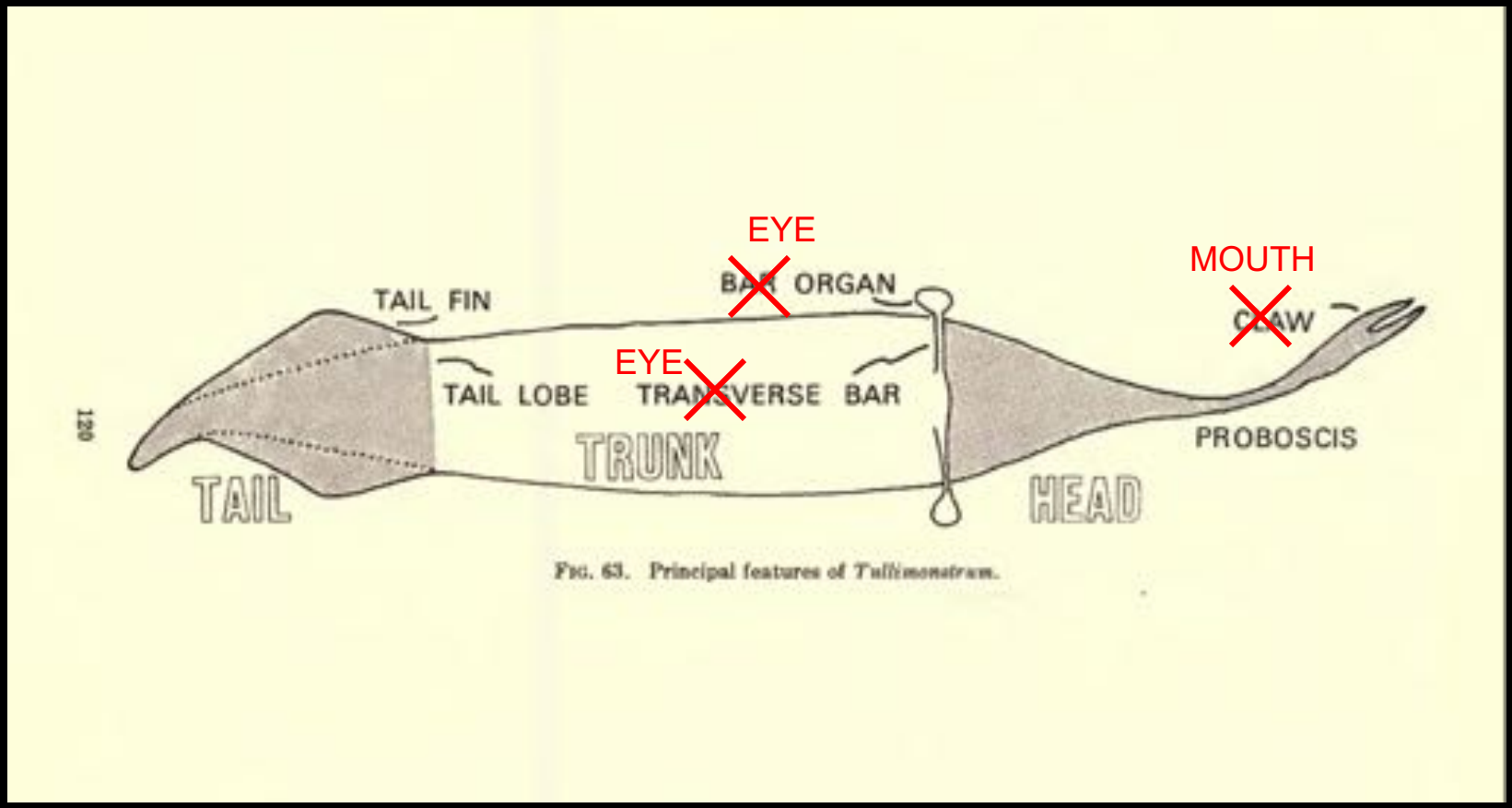


FIG. 63. Principal features of *Tullimonstrum*.

Louisella pedunculata
Priapulid worm
By Marianne Collins
artoffact

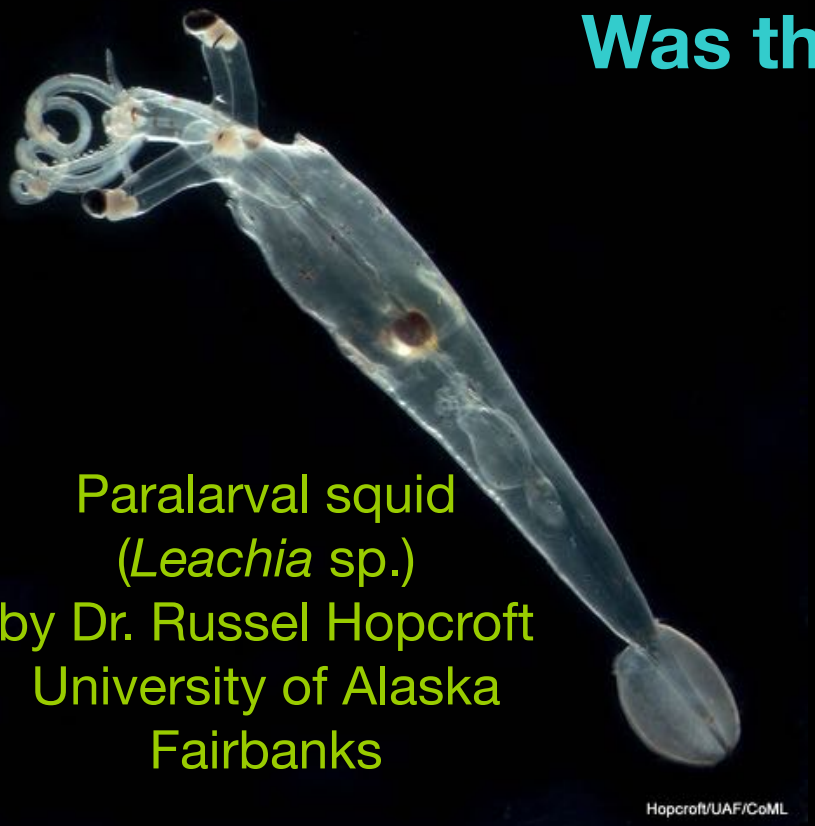
Was thought to be a …

Worm

Polychaete Worm

Was thought to be a …

Mollusk



Paralarval squid
(*Leachia* sp.)
by Dr. Russel Hopcroft
University of Alaska
Fairbanks

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

Nectocaris pteryx
by artist Nicholas Carter

Was thought to be a …

Chordate

Pikaia
by artist Karen Carr

Lancelet / Amphioxus

Conodont
by artist Karen Carr

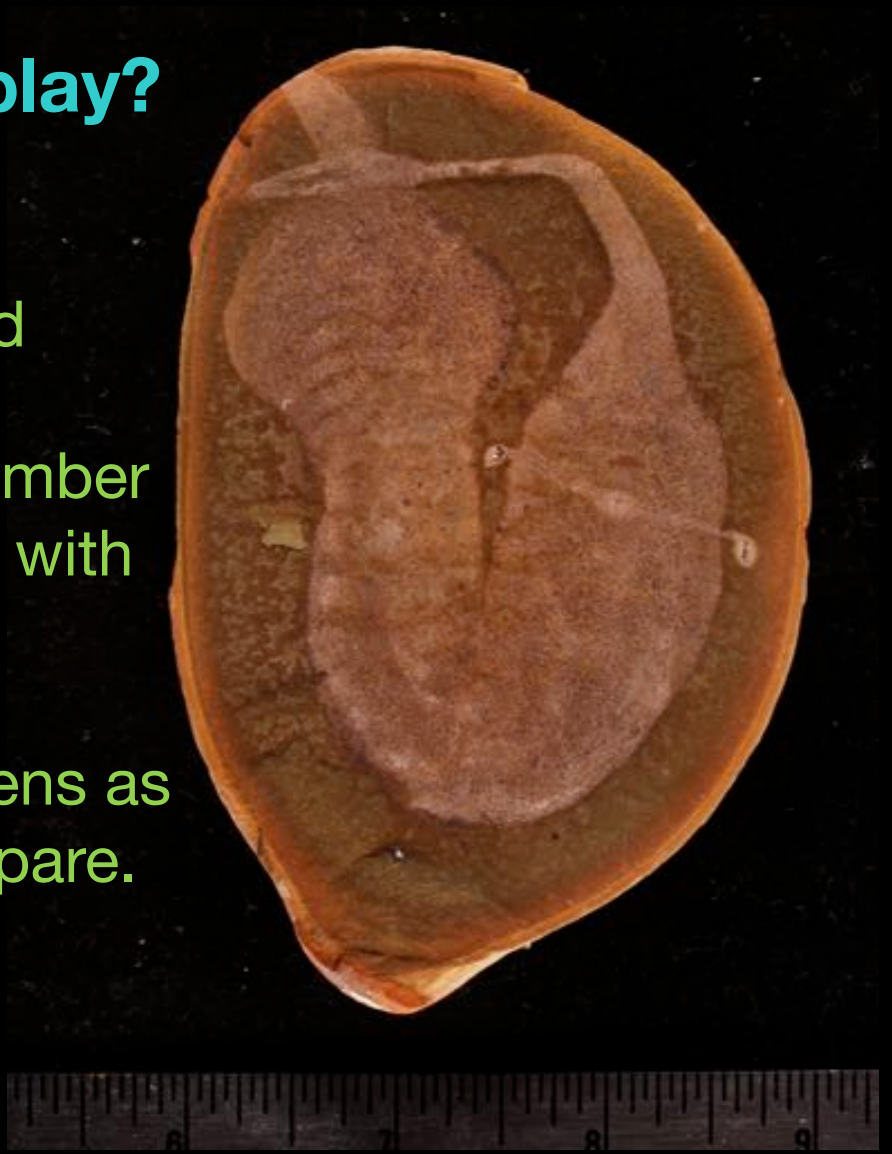
Tully Monster Digitization Project

What role did digitization play?

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

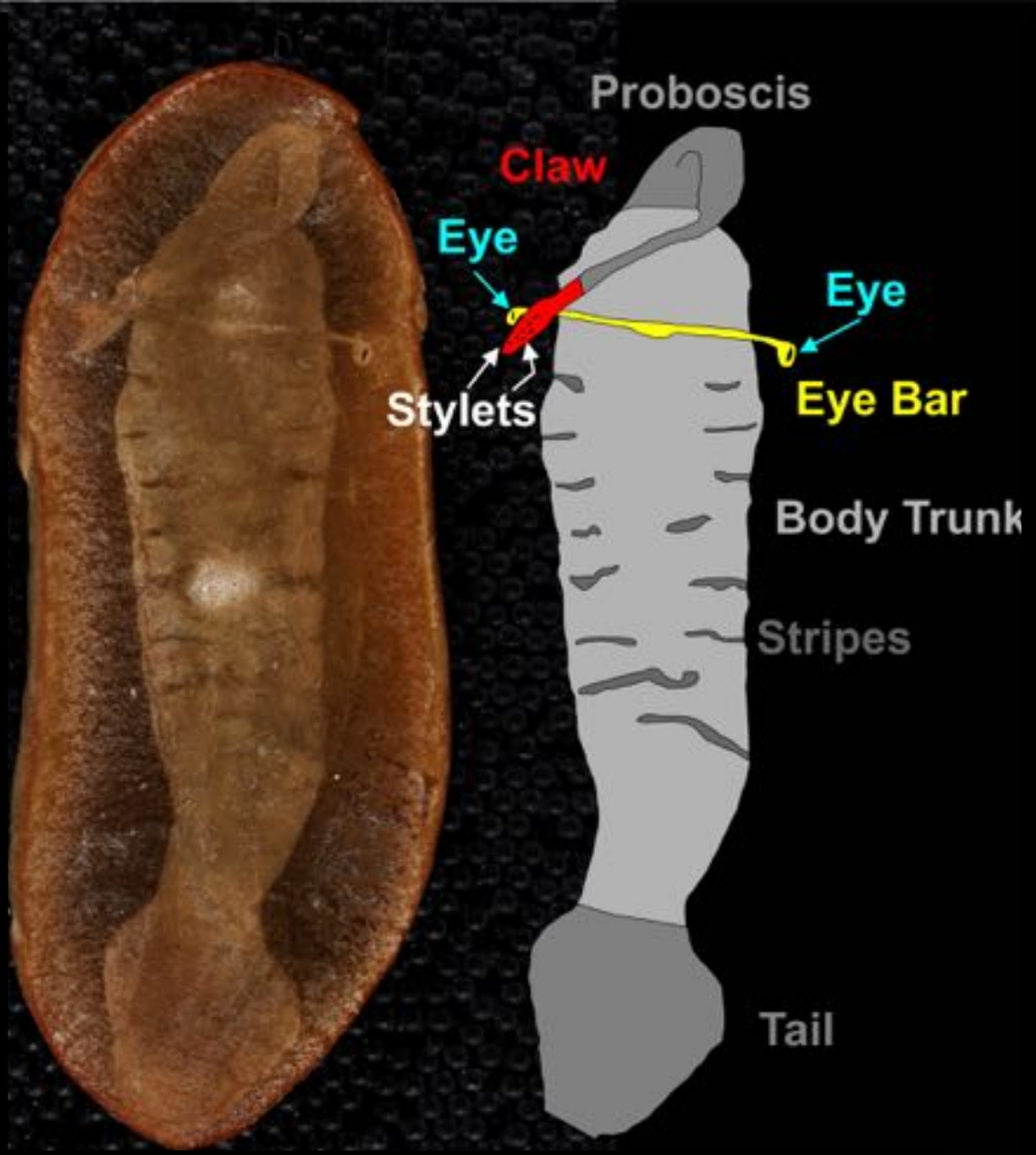
2) Images of as many of specimens as possible to measure and compare.



The Problem

Few complete Tully fossils

No way to search collection for specimens with these 8 morphologic traits



The Flaming Whip Method of Digitization

Overview of Tully Monster Digitization Project

Special thanks to Kate Webbink for producing this video

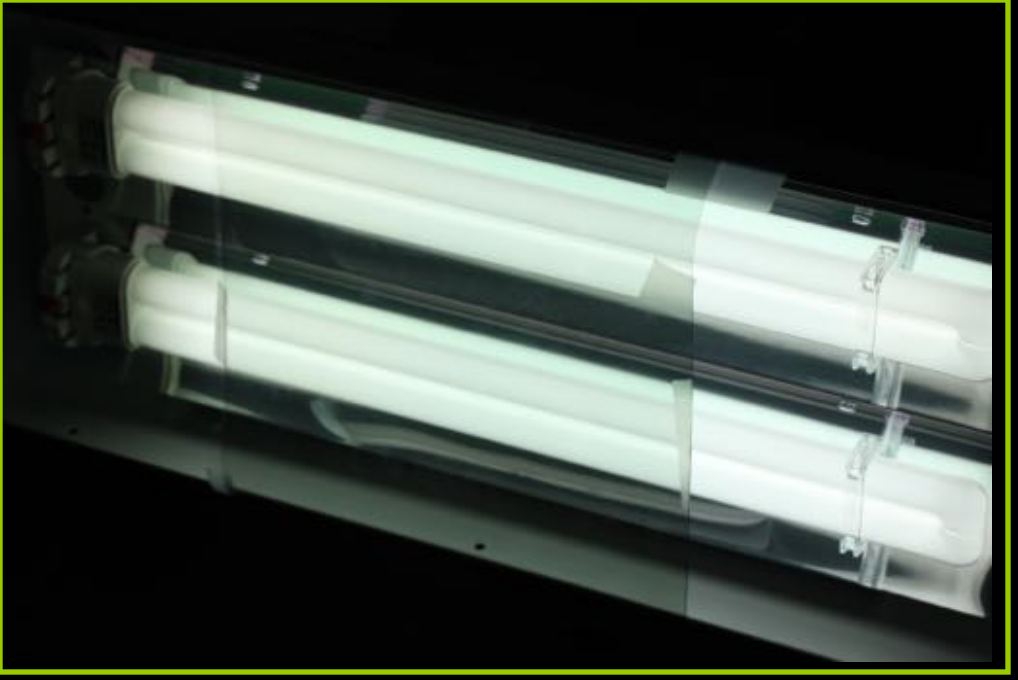
Nicole Karpus “Digitizing” Tully Monster Specimens

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

Workflow

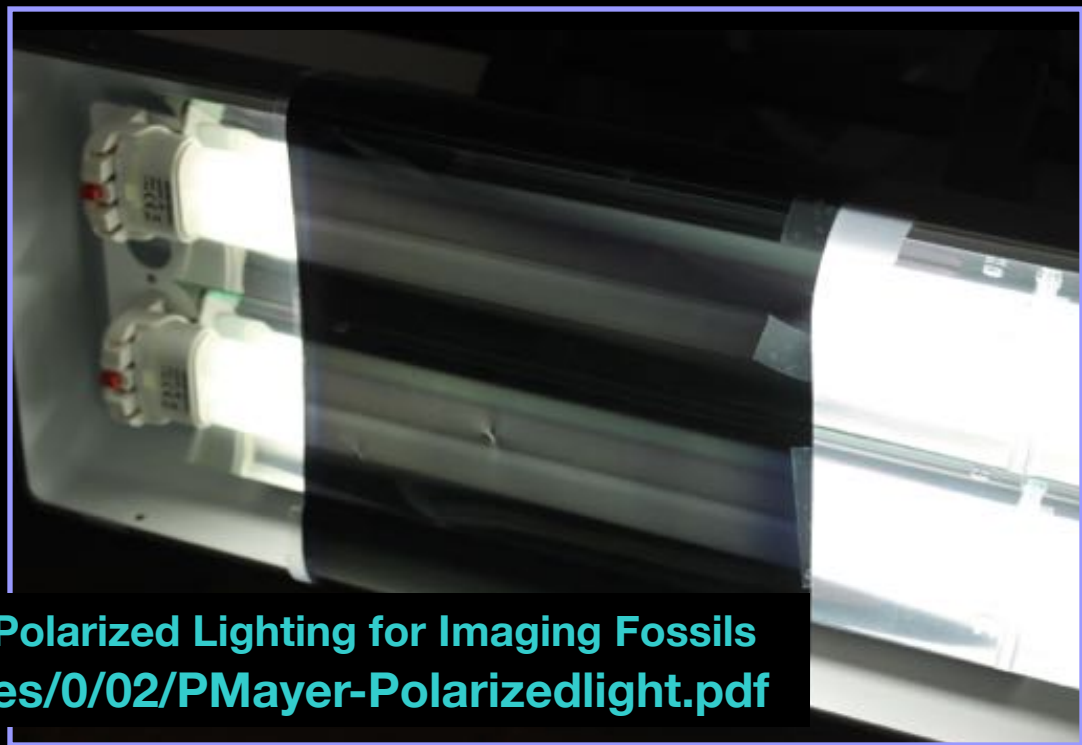
- Pull specimens from collection area
- Photograph each part and counterpart twice
  - Low-Angle lighting
  - Cross-Polarized lighting
- Name each image using the file naming protocol developed for this project
- Create batch upload spreadsheet from image name
- Upload to database
  - Images
  - Description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

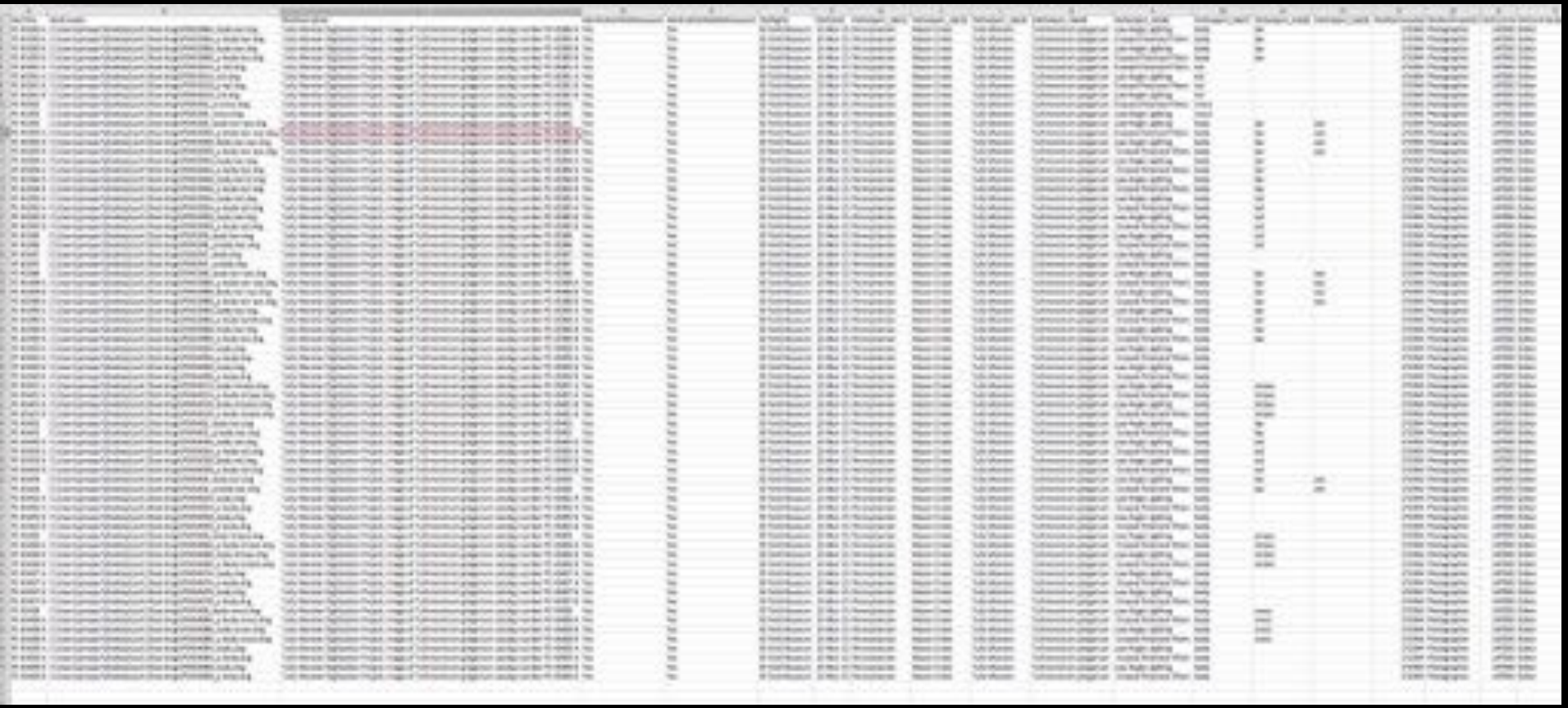
Mazon Creek, Pennsylvanian

File Naming Protocol

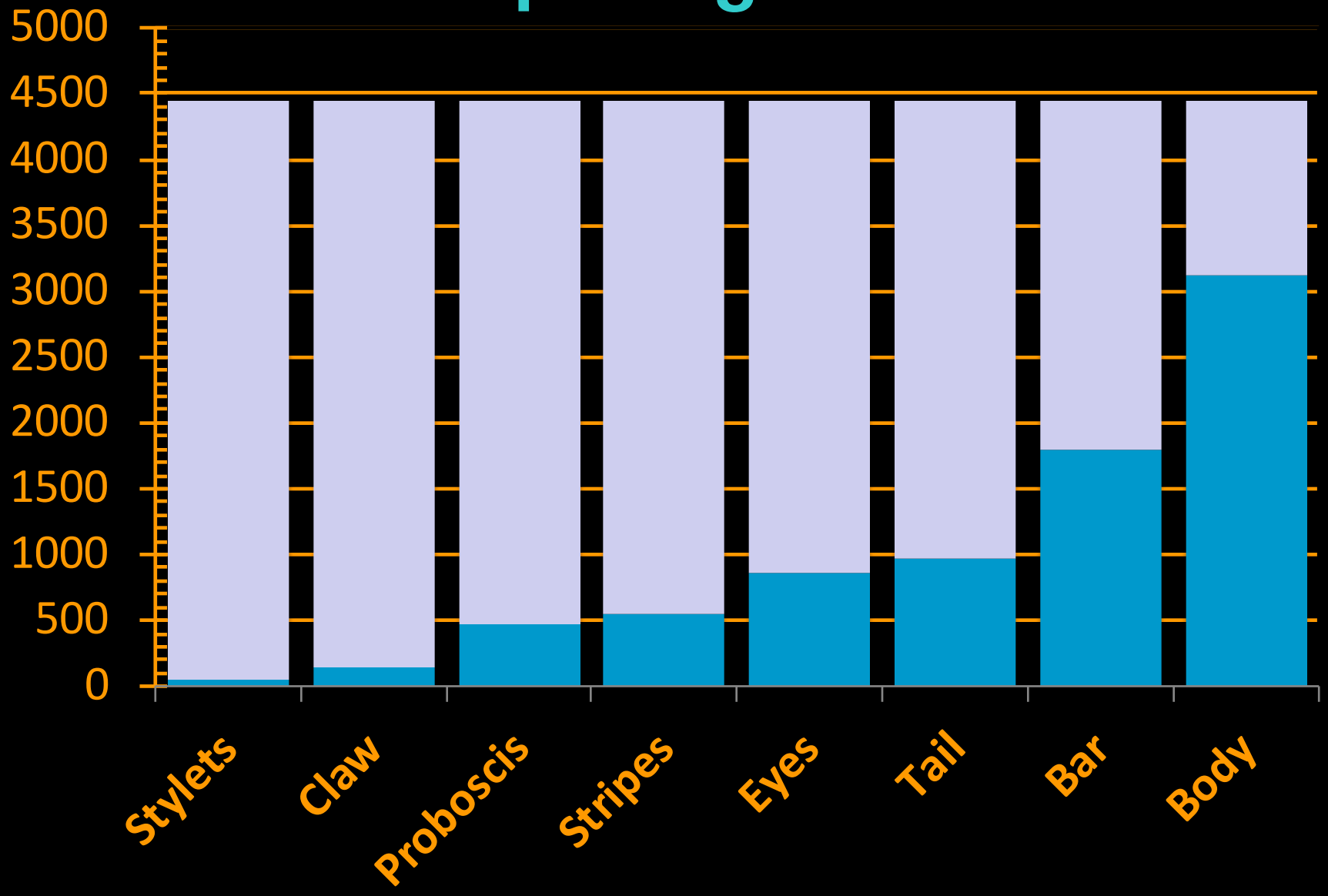
PE22093A_p-bar-snout-claw-teeth.dng

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

Batch Upload File for EMu

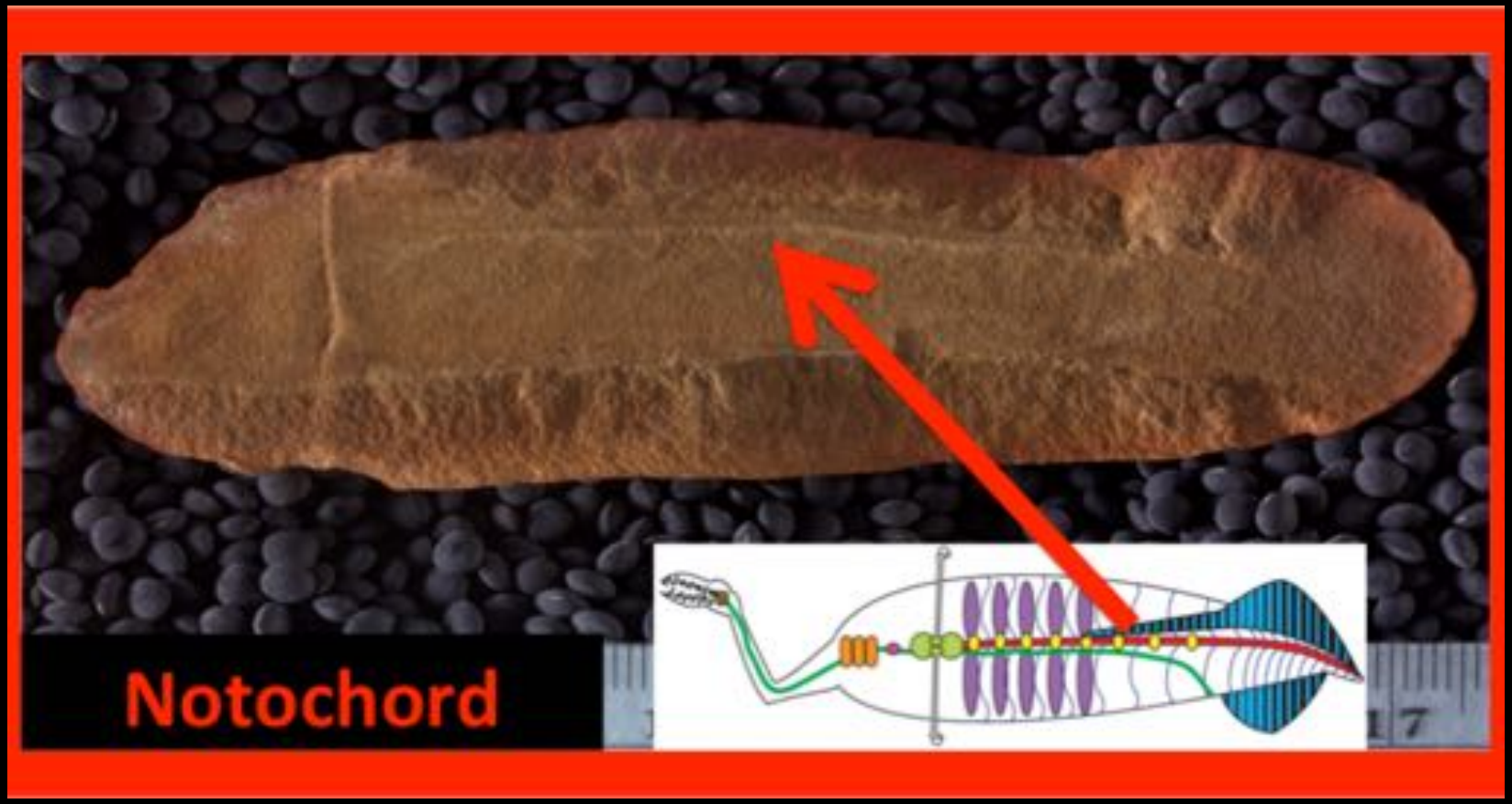


Images Tagged with Morphological Traits



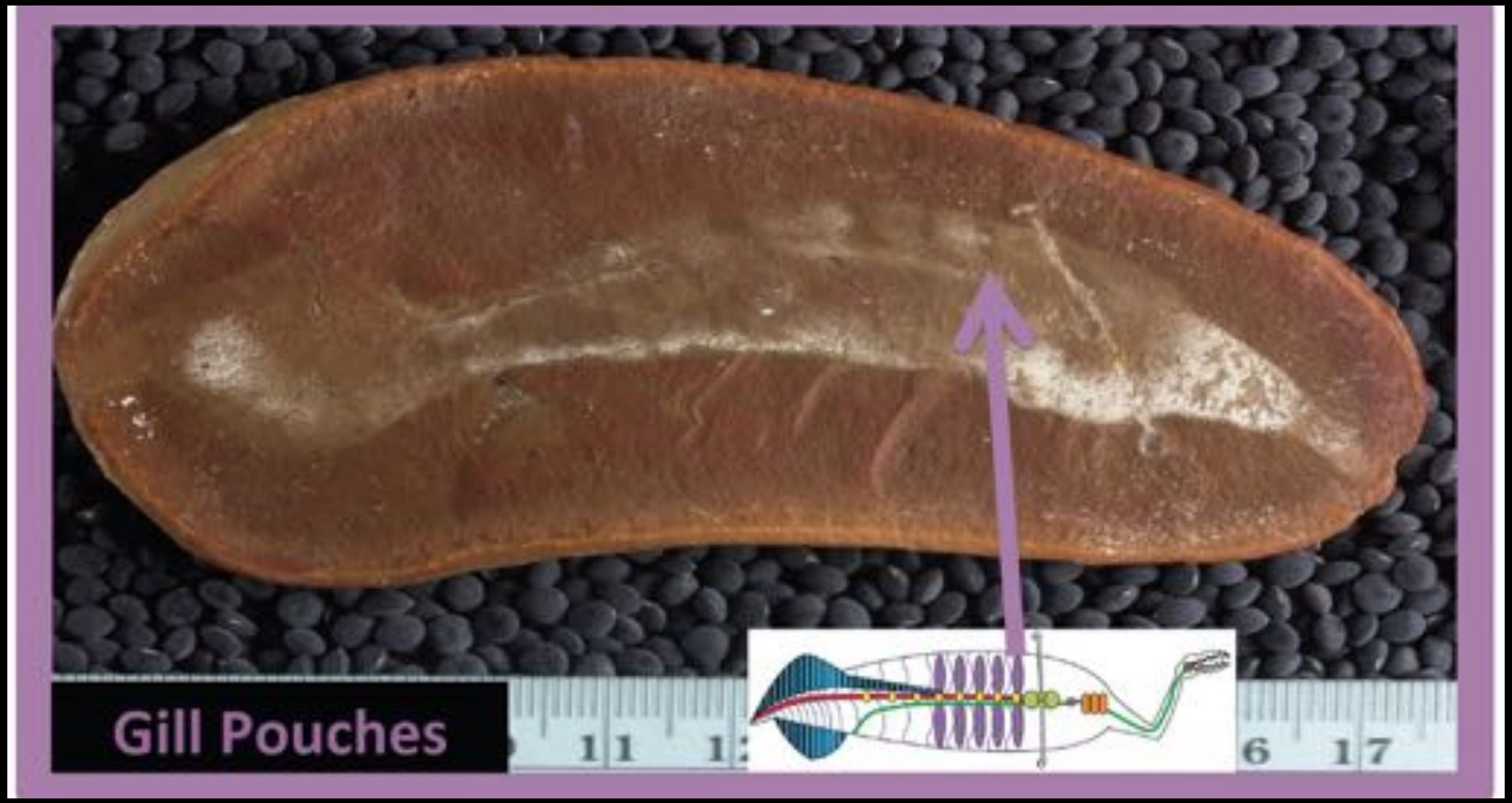
Notochord

Crossed polarized lighting



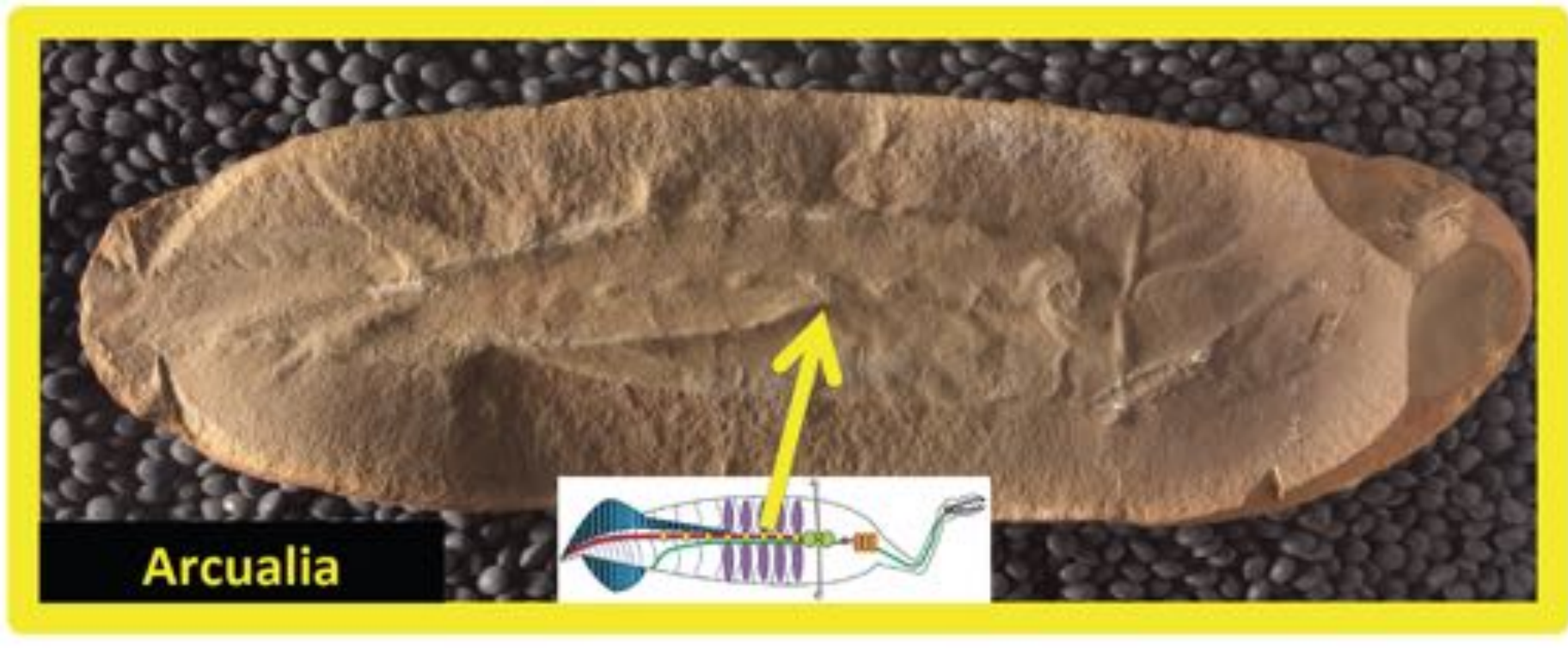
Gill Pouches

Crossed polarized lighting



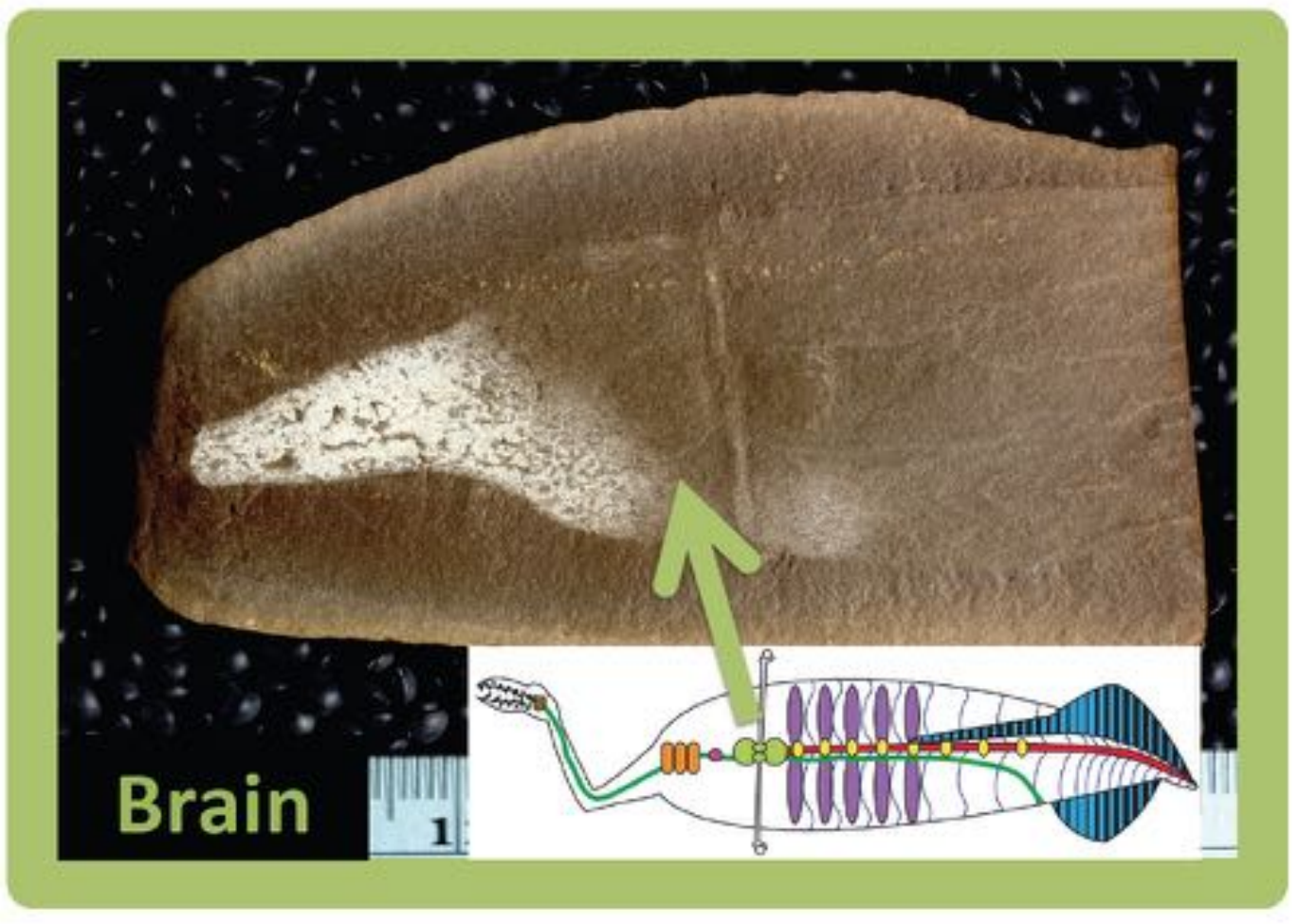
Arcualia

Low-Angle Lighting



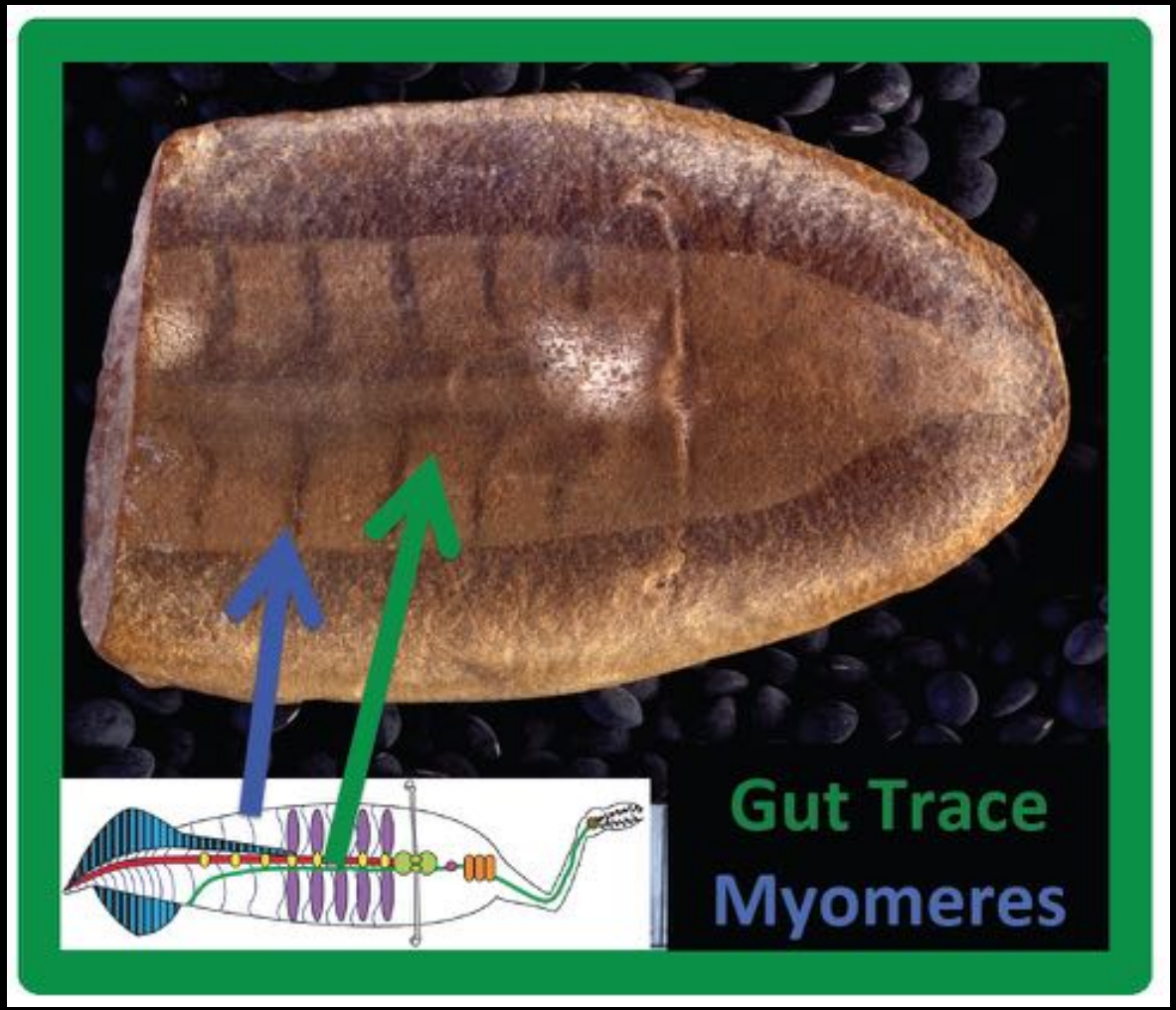
Brain

Low-Angle Lighting

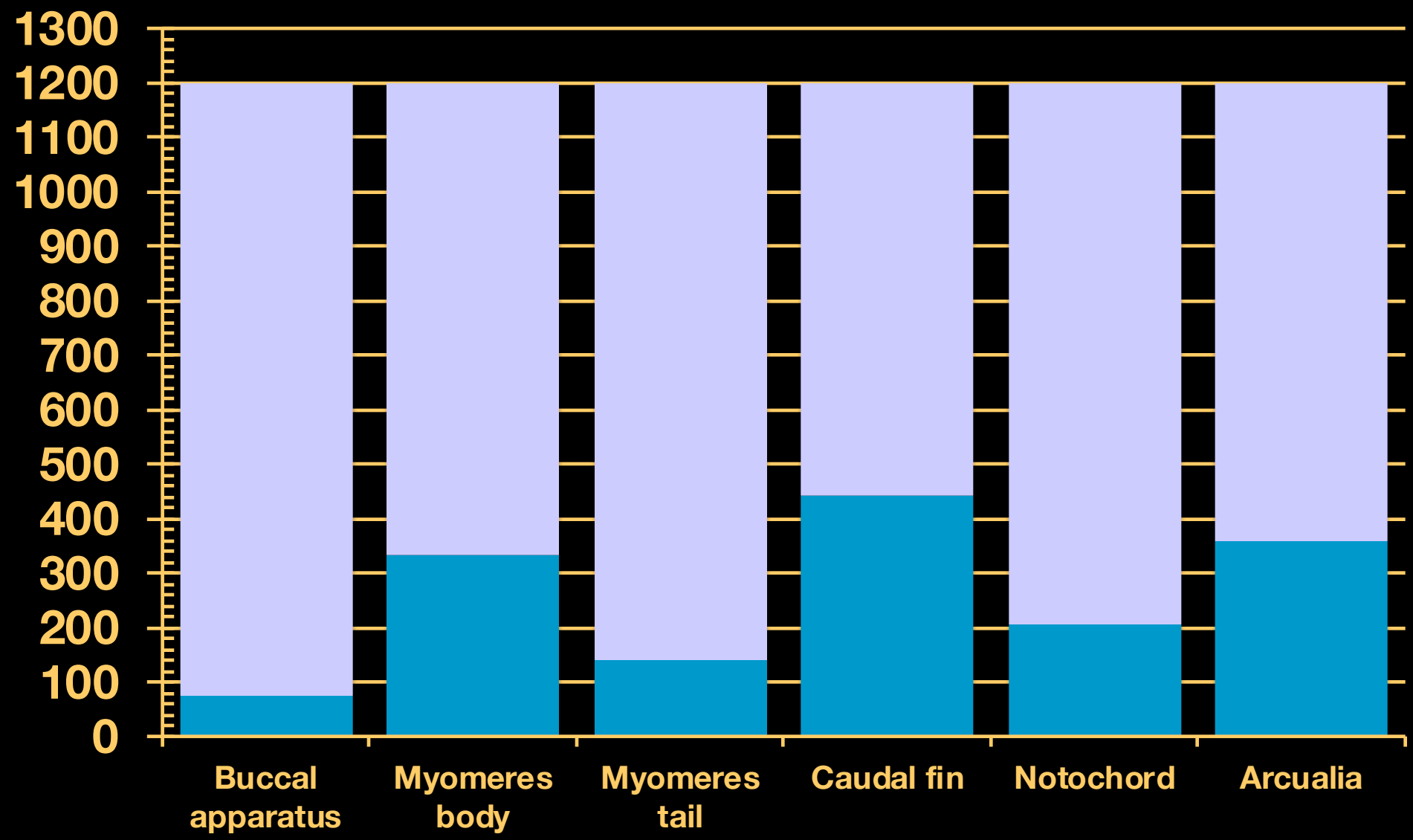


Gut Trace and Myomeres

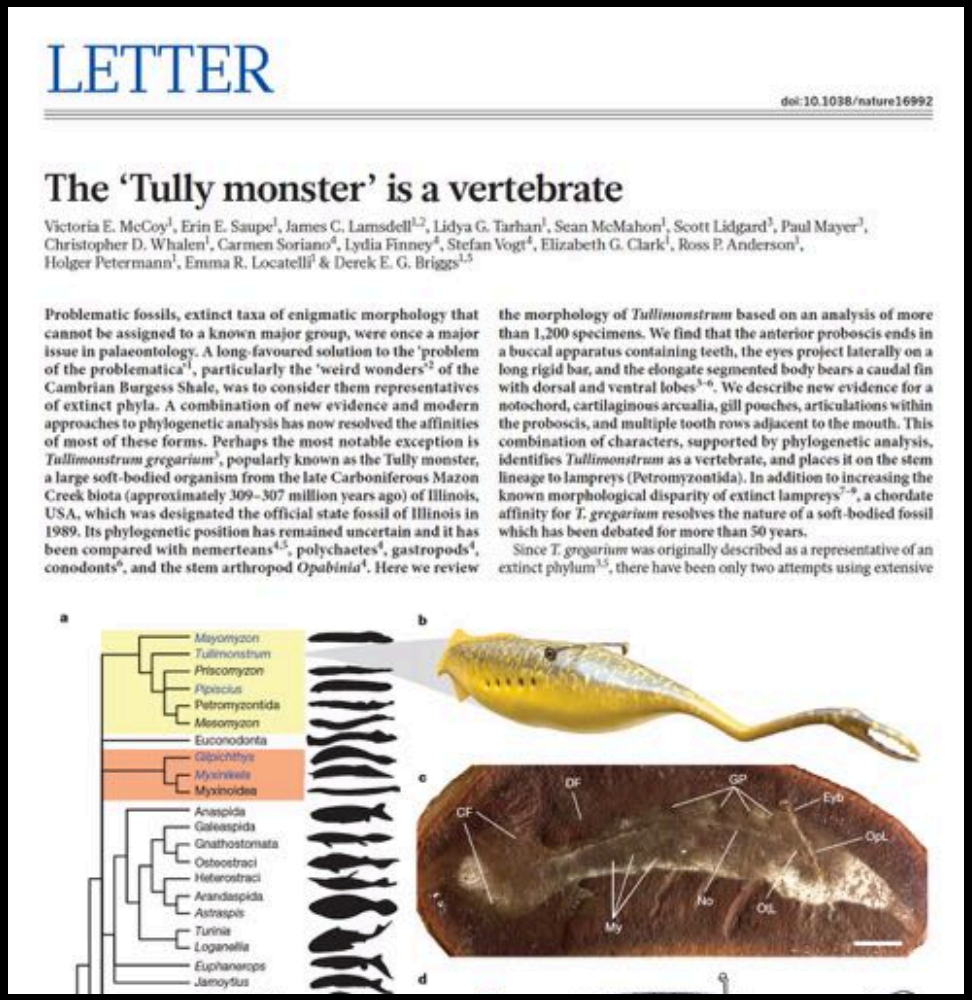
Crossed Polarized Lighting



Number of specimens tagged with new morphology traits by researchers



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], polychaetes[4], gastropods[4], conodonts[6], 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.

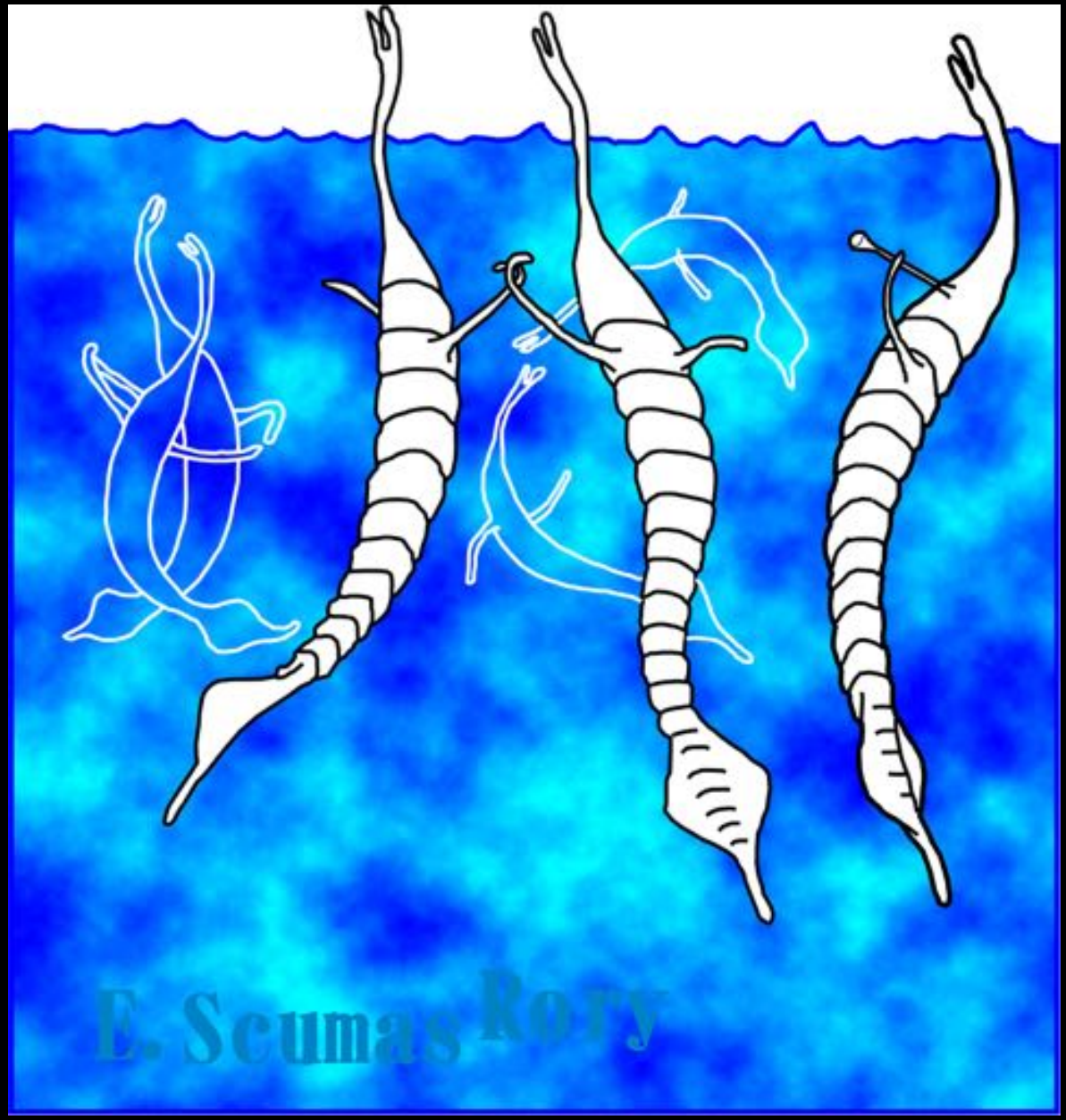
Since *T. gregarium* was originally described as a representative of an extinct phylum[3,5], there have been only two attempts using extensive

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

Agnathan or jawless fish

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



Mazon Creek Area, Northeastern Illinois