BEeS

The LifeWatch ERIC Biodiversity & Ecosystem eScience Conference

Heraklion, 30 June - 3 July 2025

LifeWatch ERIC

01 July 2025 | 16:25

BEeS
Heraklion
30 June - 3 July 2025

LifeWatch ERIC

hcmr ΕΛΚΕΘΕ

iMBBC ΙΘΑΒΒΥΚ

Session: Taxonomy: Identifying the units of diversity in life

1 July 2025 | 14:30-16:30

Reconstruction of the functional anatomy of *Phascolosoma stephensoni* Stephen, 1942 (Annelida: Sipuncula: Phascolosomatidae) through micro-CT: a potential tool for taxonomy

Presenter: Desirèe Dimichele

Authors: Desirèe Dimichele, Joachim Langeneck, Kleoniki Keklikoglou, Alessandra Martines, Emmanouela Vernadou, Eva Chatzinikolaou, Luigi Musco

BEeS Heraklion 30 June – 3 July 2025 LifeWatch ERIC

MAPWORMS

CoNISMa Consorzio Nazionale Interuniversitario per le Scienze del Mare

UNIVERSITÀ DEL SALENTO L'Ateneo tra i due mari

NBFC

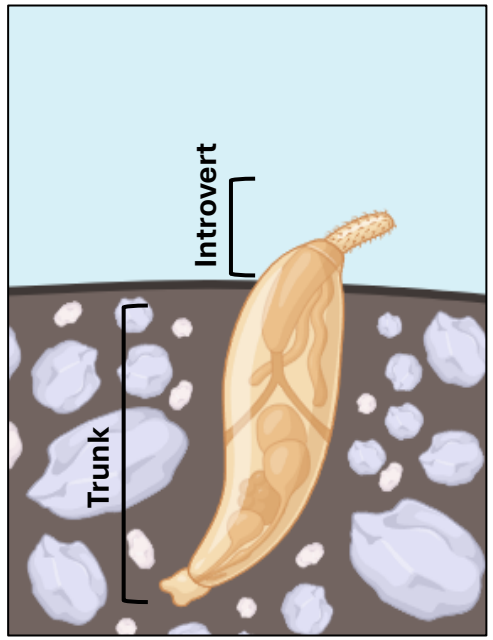
MAPWORMS Project: Mimicking Adaptation and Plasticity in WORMS

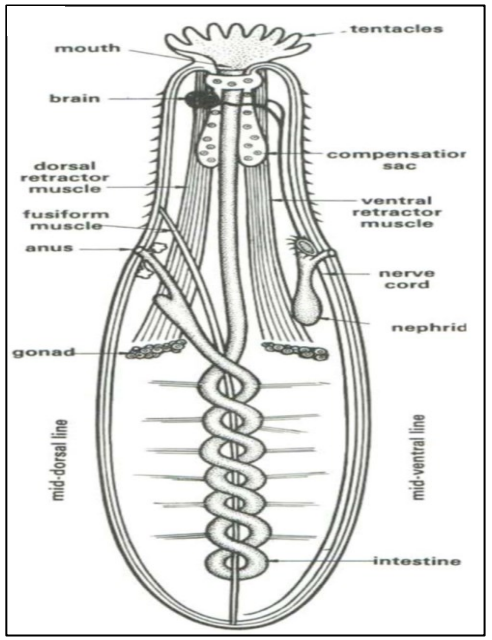
Integrated study of **marine annelids** focusing on some model worms showing interesting behavioural and anatomical features

Eversion/inversion of structures within the body

Bioinspired robots capable of **responding** to environmental stimuli **changing their shape** thanks to the composition of their smart materials

Sipuncula Rafinesque, 1814





For long been regarded as a phylum of their own (phylum Sipuncula Rafinesque, 1814)

Unsegmented worms
Simple body plan
Anterior region – **introvert** (protrusible)
Posterior region –**trunk**

Diagnostic traits for species identification
- Shape/length ratio between introvert and trunk
- Type/arrangement of hooks, spines and papillae
- Arrangement/number of tentacles in the oral disc
- Coloration and texture of the skin
- Number/size/insertion of retractor muscles

- Segmentation (in any phase of their life)
- Chaetae
- Circulatory system and respiratory pigments

Behavioural and anatomical features

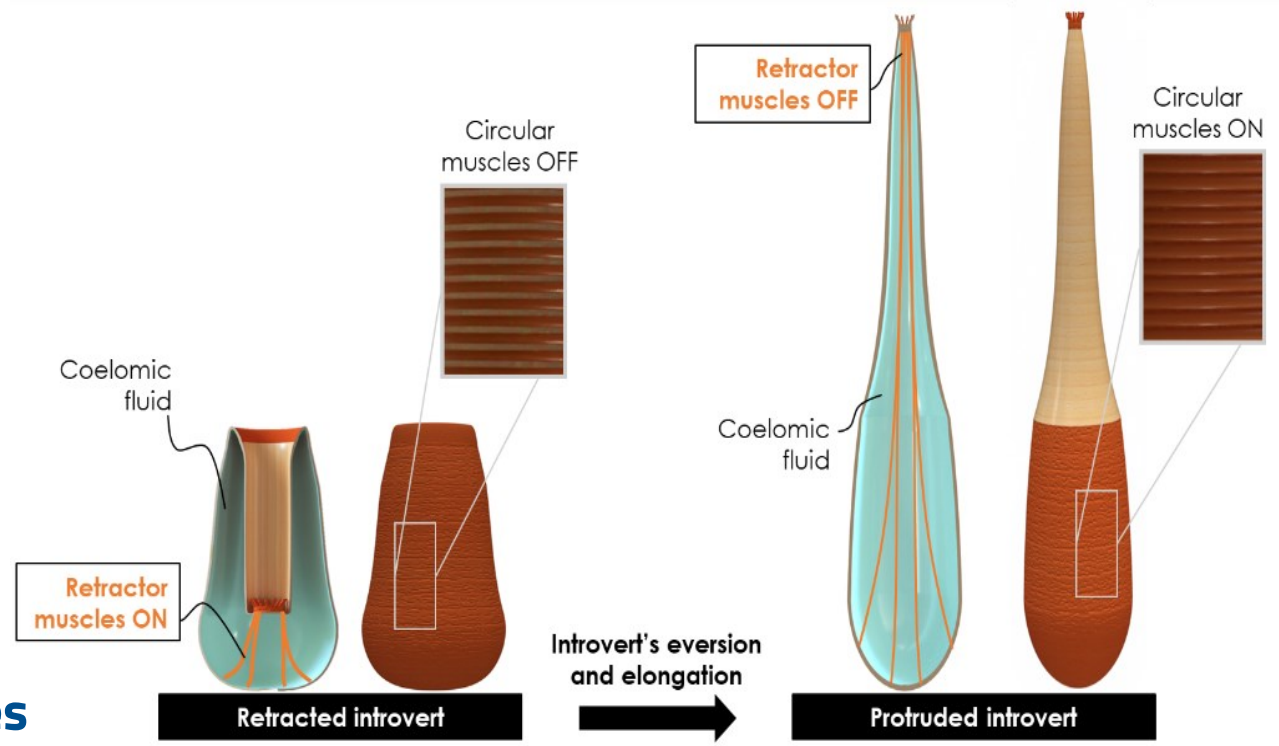
for bioinspiration purposes and taxonomic studies

Retractor muscles
→ Pull introvert inward (**retraction**)
Anchored to body wall and introvert tip
Circular muscles
→ Cause relaxation and **extension** of introvert
Act via hydrostatic pressure of coelomic fluid

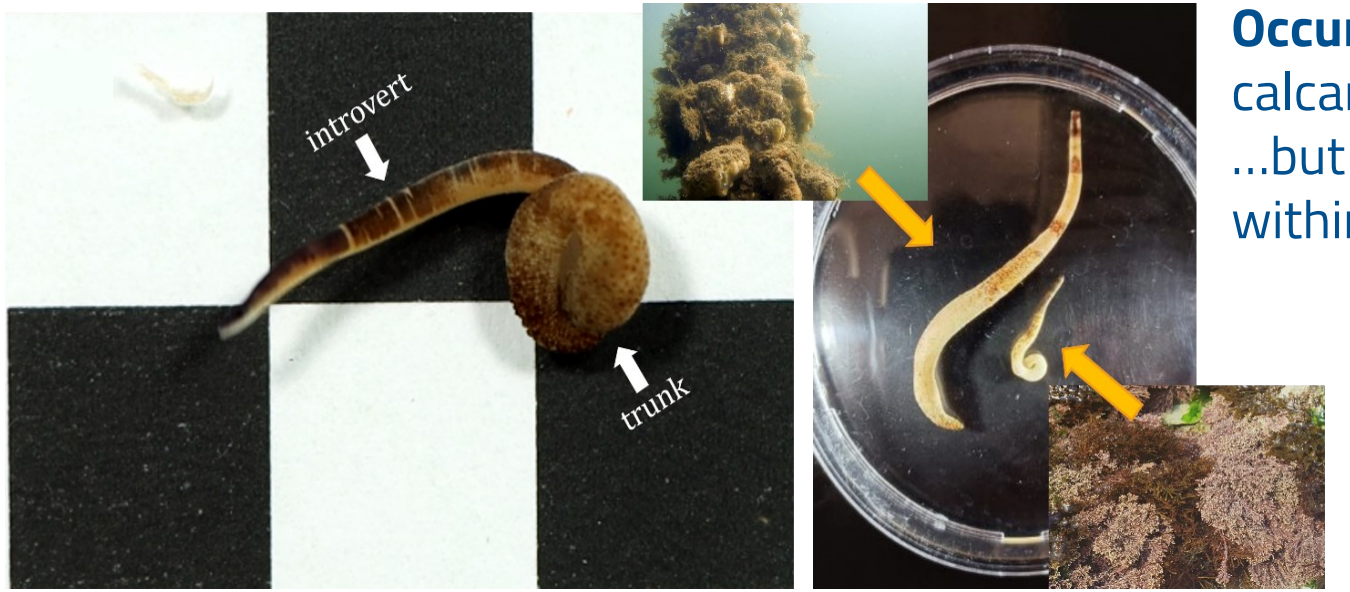
Internal anatomy for species **identification**

- **Higher resolution** than external features
- Crucial for identifying **cryptic** or **similar species**
- Reflects **evolutionary** and **ecological** differences

Biomechanics of the retraction/protrusion movement of the introvert in a sipunculan

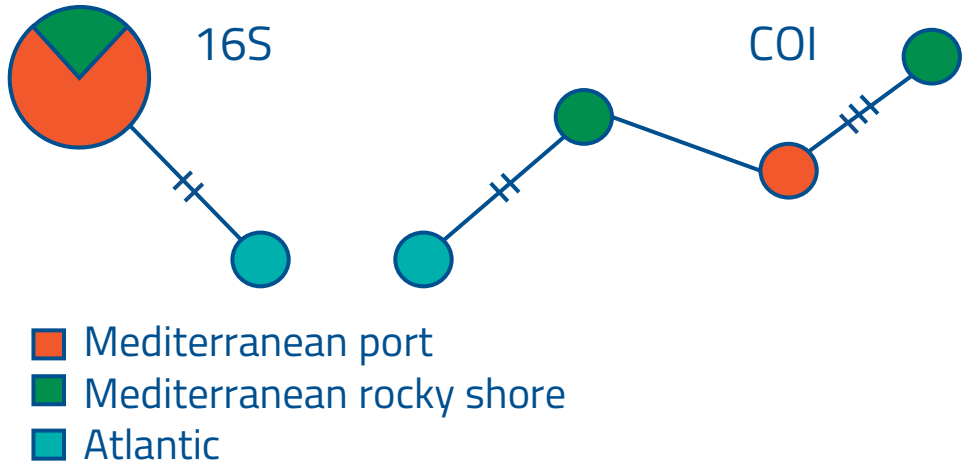


Phascolosoma stephensoni as model species



Occurrence in **shallow** environments under coralline calcareous algae (smaller individuals)
…but also coralligenous outcrops (30-40 m) and within sponges in **ports** (larger individuals)

Despite **differences** in both **morphology** and **ecological adaptations**, **same molecular lineage**:



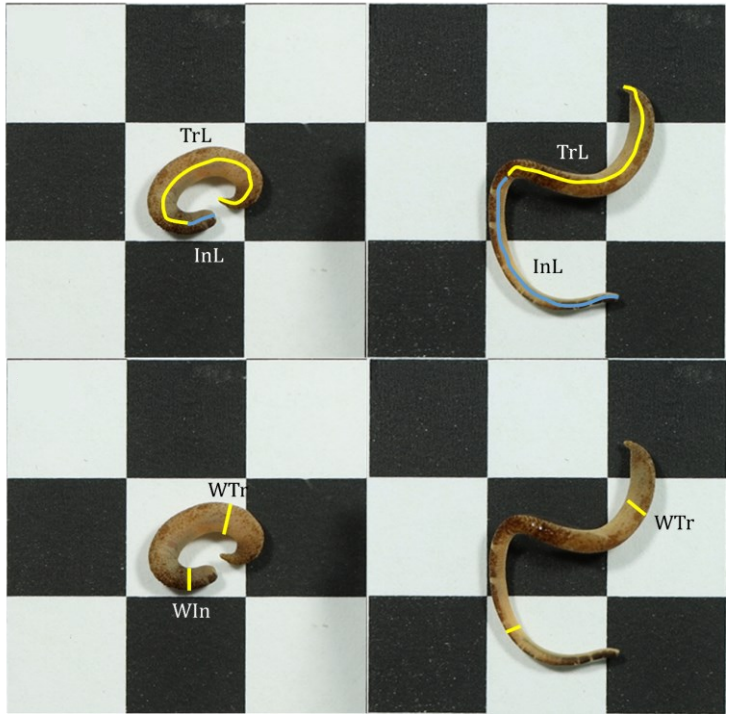
Structural divergence affects both **taxonomy** and biomechanical studies
Understanding diversity patterns in **different sets of data** aids both biodiversity studies and **bioinspired design**

Characterization of *Phascolosoma stephensoni*

External anatomy/shape-morphing/movement

Experimental **aquaria** to impose **planar movements** (4mm/ 7mm/10mm)

Image J analysis
Fully **contracted** state
Fully **extended** state



- **Basic biometric measurements**

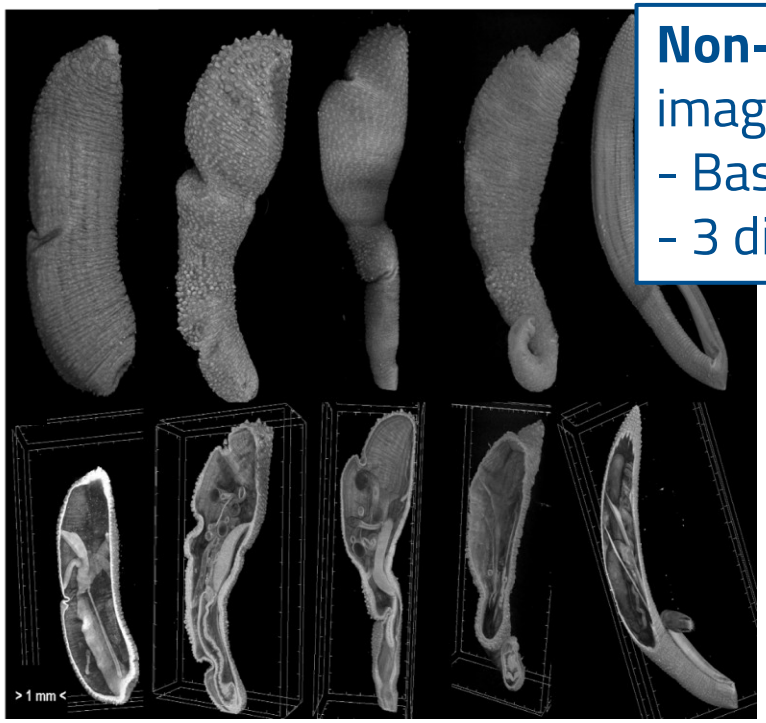
- **Speed** of the **protrusion** and **retraction** of the introvert

Experimental conclusions
- **Introvert** main part of the body contributing to **elongation**;
- **Trunk** deformation very **limited**

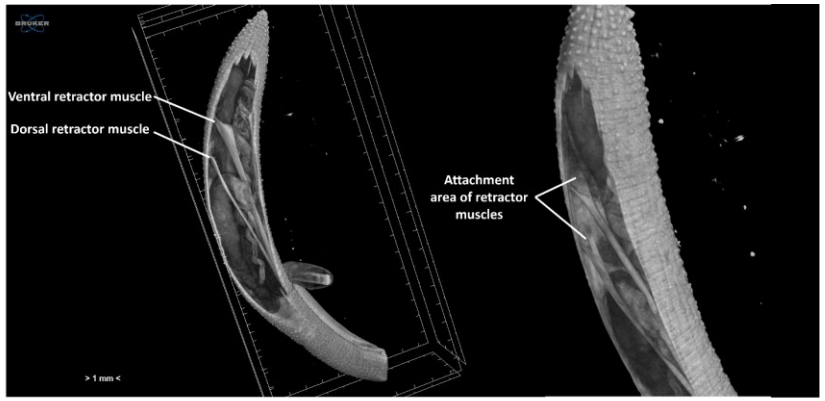
Micro-CT based functional anatomy of *P. stephensoni*

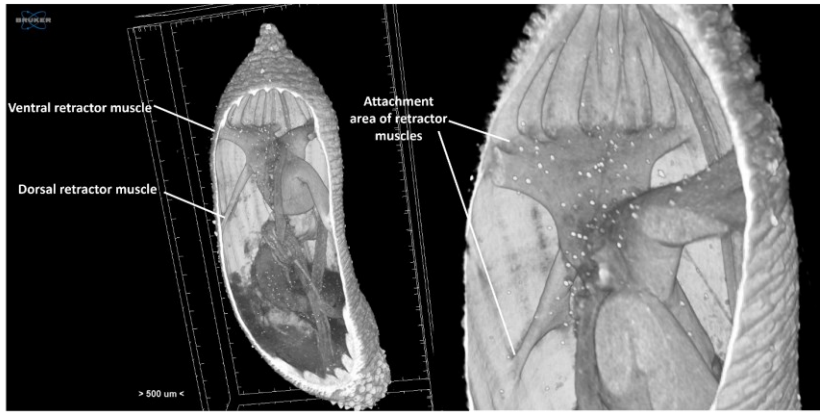
Characterization of the **internal anatomy** and **structural properties** of the target species

Provision of **data** necessary for **modelling** and **prototyping** the soft robot



Non-destructive imaging technique
- Based on X Rays
- 3 dimensions





Different body configurations scans

- Introvert fully retracted

- Introvert fully protruded

Micro-computed tomography scans through the Skyscan 1172 (Bruker, Kontich, Belgium)

Micro-CT based functional anatomy of *P. stephensoni*

Retraction

Retractor muscles (**2 dorsal**, **2 ventral**) contract

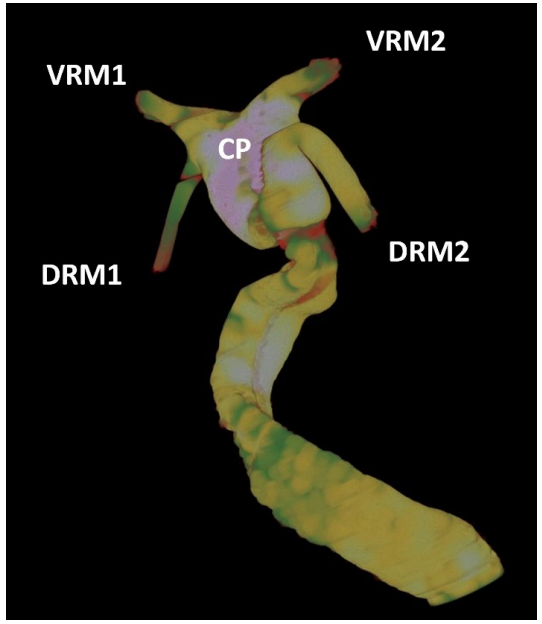
⟶ Become thicker and pull the introvert inward into the trunk

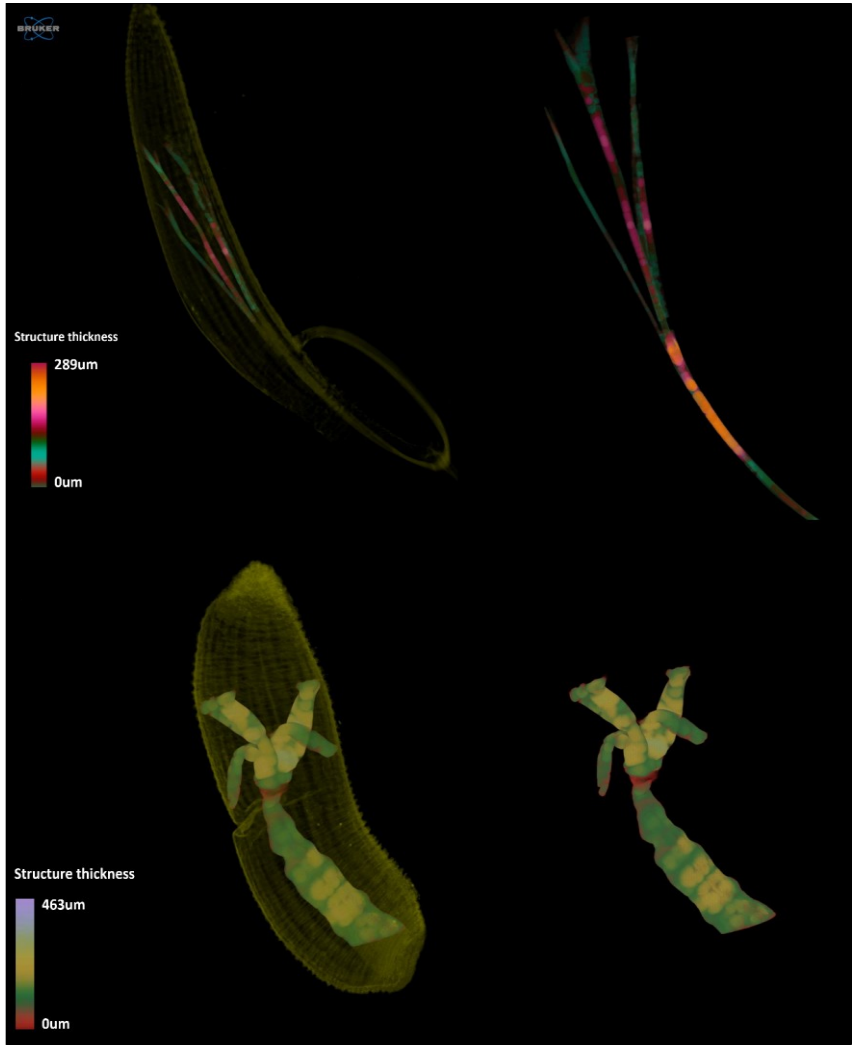
Protrusion

Circular muscles contract

⟶ Compress body wall

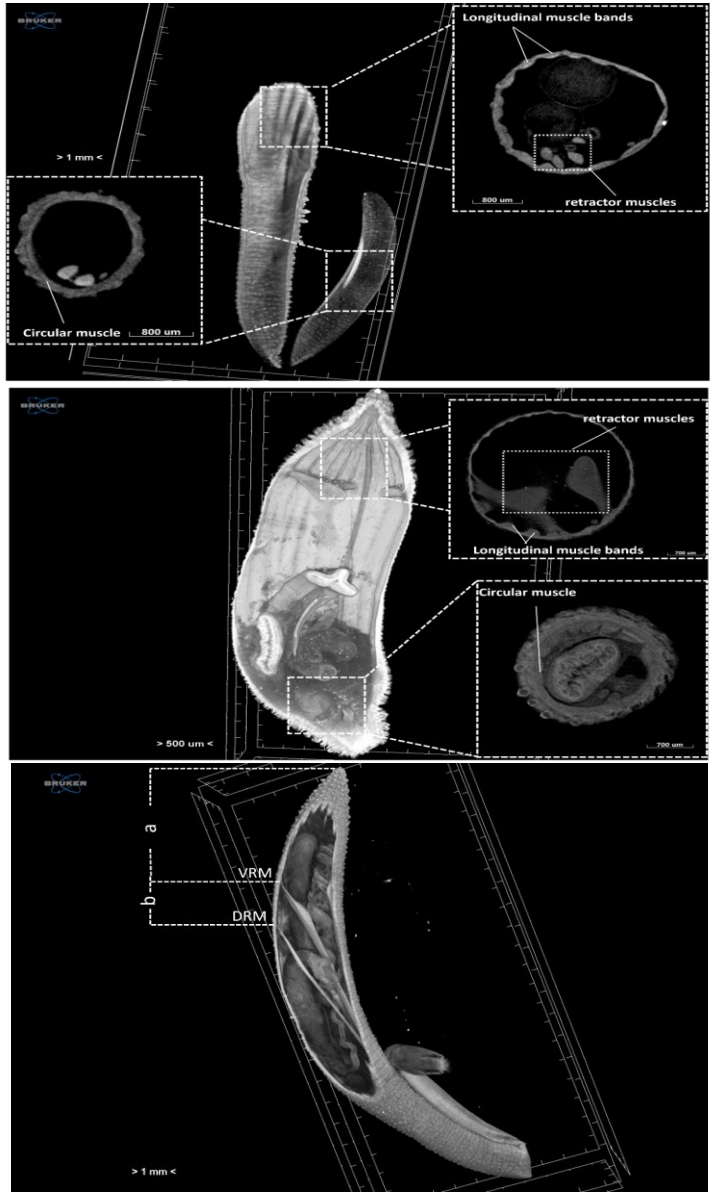
Negligible role of longitudinal muscles in introvert movement





Micro-CT based functional anatomy of *P. stephensoni*

- How the internal anatomical units involved in the two mecanisms of elongation and retraction interact between each other
- How their structural organization varies during the movements of the introvert
- Provision of quantitative data for a detailed modelling of **organism** and **single anatomical structures**



Micro-CT supporting taxonomy, phylogeny and functional studies

Additional line of evidence for integrated taxonomy studies

Description and functional characterization of internal anatomical structures
→ Both hard and soft tissues

Not invasive (no need for **dissection**)
→ **Preserved type material** for new species

What is relevant for **bioinspiration purpose** → Understanding of the **natural history** of the organisms

Thank you!

Questions?
desiree.dimichele@unipa.it

BEeS

The LifeWatch ERIC Biodiversity & Ecosystem eScience Conference

Heraklion, 30 June - 3 July 2025