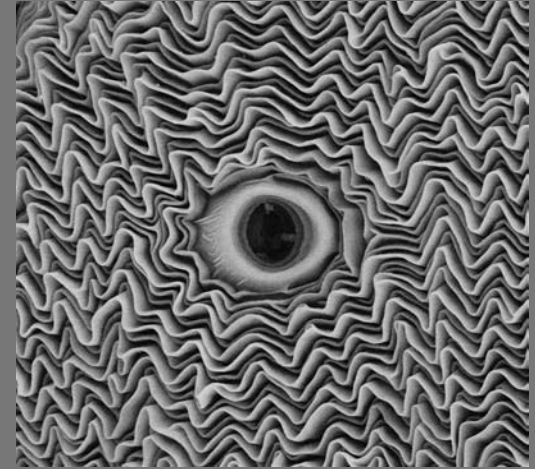


Ontologies, Image Databases, and Evolutionary Biology



Martín J. Ramírez

Museo Argentino de Ciencias Naturales – CONICET

Buenos Aires, Argentina

Evolutionary Biology & Ontologies Workshop

Evolution 2008, Minneapolis, 20 June 2008

Main topics

1. Use of an ontology to link images to a phylogenetic dataset:
The Spider AToL
2. Image annotation using the anatomical ontology
3. Notes on multi-species ontology design
4. Ontologies bridging communities of systematics and model organisms

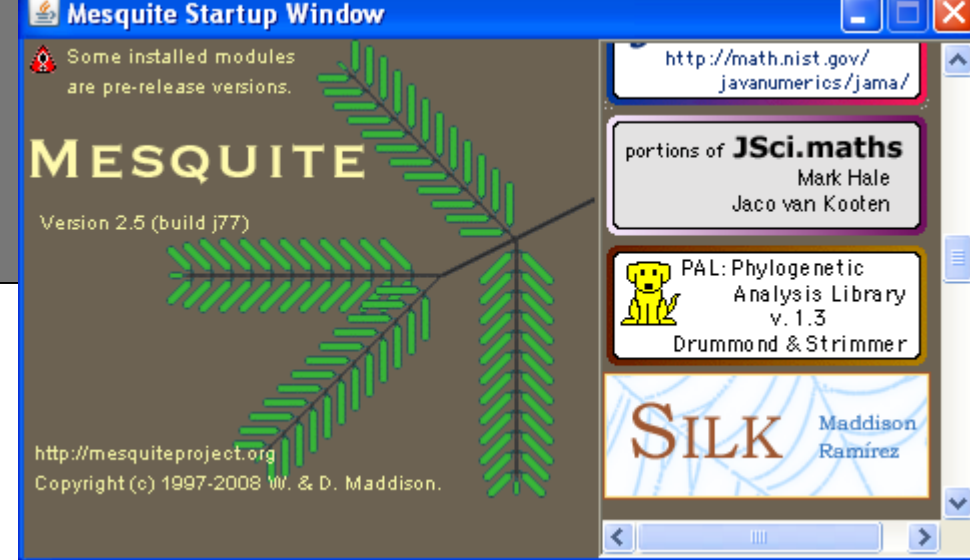
Who I am

Spider AToL curator of image collection. Atlas of anatomy & ontology.

Links to and from phylogenetic dataset.

Developed ontology (independently) to solve treatment of images

SILK



Syst. Biol. 56(2):283–294, 2007

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Linking of Digital Images to Phylogenetic Data Matrices Using a Morphological Ontology

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LORENZO PRENDINI,⁵ JEREMY MILLER,⁶ CHARLES E. GRISWOLD,⁶ GUSTAVO HORMIGA,⁷ PETRA SIERWALD,⁸
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Syst. Biol. 2007

SILK: Simple Image LinKing (Maddison & Ramírez 2006)

A Mesquite package for associating images with character matrices.

Beta test version available online at <http://mesquiteproject.org/SILK>

How to link images to dataset cells?

ATOL Spiders. Phylogenetic dataset with

500 terminals

1000 to **2000** characters

= **500,000** to **1,000,000** cells

1. It is impossible to link images one by one. Documentation should not be such a heavy burden
2. Ad-hoc links are difficult to maintain (characters and terminals revised, ...)
3. Further images can be produced after the scoring. Workflow for images and dataset may be independent
4. Images are very useful before scoring cells (how a structure looks in other terminals not yet scored?)

Mesquite (W. & D. Maddison) & SILK

AToLMatrixJZFused0706041.nex

File Edit Characters Taxa&Trees Matrix Select Cell_Info State_Info Collaboration Analysis Window Help

Project of "AToLMatrixJZFused0706041.nex" Taxa "JungxiaGenera" Character Matrix "JungxiaMatrix" StateNames (JungxiaMatrix) Characters "JungxiaMatrix" Character sets of JungxiaMatrix

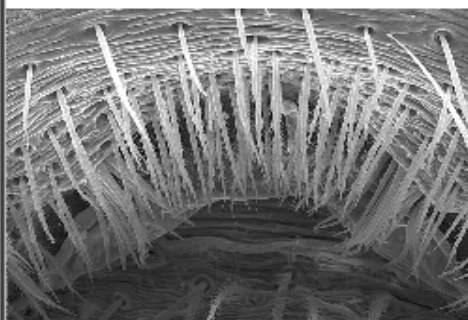
Graphics Text Parameters Modules Citations Search Features

Taxon \ Character	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505
247 Trachelas	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
248 Trachelas New World	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
249 Trachelopachys	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
250 Chumma	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
251 Ammoxenus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
252 Cithaeron	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
253 Galianoella	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
254 Meedo	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
255 Neato	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
256 Doliomalus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
257 Platyoides	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
258 Asadipus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
259 Centrothele	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
260 Lamponidae Transkei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
261 of Moreno	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
262 Lygromma	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
263 Molyoria	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
264 Neozimiris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
265 Texas of Prodidomidae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
266 Apodrossodes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
267 Camillina	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
268 Eilica	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
269 Gnaphosa	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
270 Micaria	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

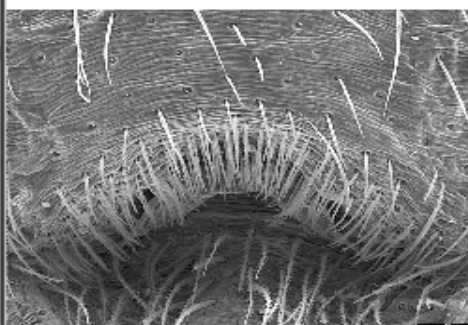
498. Epiand spigots grouping ID01370: (0) dispersed; (1) 2 bunch;

Character 498 in taxon Doliomalus

Epiand spigots grouping ID01370 in Doliomalus



male (retrieved from SV)



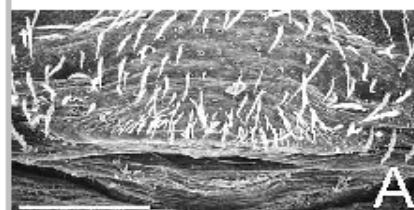
male (retrieved from SV)

States of Character 498

Character: Epiand spigots grouping ID01370

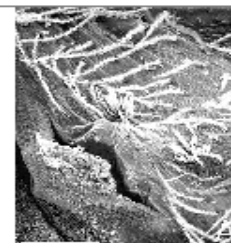
"Refers to the patten of epiandrous spigots, if present. qqAtlas char 67qq"

State 0 (dispersed)



Epiandrous spigots these are scattered along the margin of the epigastric furrow. Type taxon: Megadictyna_thilenii

State 1 (2 bunch)



Epiandrous spigots grouped into two separate bunches. Type taxon: Phyxelida_tanganensis

Character Annotations

Standard Views:

[t.256 c.498 s.7] Epiand spigots grouping ID01370: (0) dispersed; (1) 2 bunch; [in taxon "Doliomalus"]
Color of cell: Two images for this cell

Cell images

AToLMatrixJZFused0706041.nex

File Edit Characters Taxa&Trees Matrix Select Cell_Info State_Info Collaboration Analysis Windows Help

Project of "AToLMatrixJZFused0706041.nex" Taxa "JungxiaGenera" Character Matrix "JungxiaMatrix" StateNames (JungxiaMatrix) Characters "JungxiaMatrix" Character sets of JungxiaMatrix

Graphics Text Parameters Modules Citations Search Features

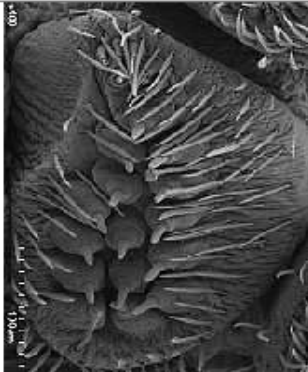
Taxon \ Character	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337
247 Trachelas	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
248 Trachelas New World	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
249 Trachelopachys	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
250 Chumma	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
251 Ammoxenus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
252 Cithaeron	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
253 Galianoella	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
254 Meedo	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
255 Neato	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
256 Doliomalus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
257 Platyoides	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
258 Asadipus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
259 Centrothele	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
260 Lamponidae Transkei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
261 of Moreno	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
262 Lygromma	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
263 Molyoria	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
264 Neozimiris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
265 Texas of Prodidomidae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
266 Apodrossodes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
267 Camillina	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
268 Eilica	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
269 Gnaphosa	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
270 Micaria	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

629. PMS paracribellar shafts insertion ID01662: (0) single; (1) grouped;


[t.249 c.629 s.7] PMS paracribellar shafts insertion ID01662: (0) single; (1) grouped; [in taxon "Trachelopachys"]
Color of cell: Two images for this cell

Character 629 in Trachelopachys

PMS paracribellar shafts insertion ID01662 in Trachelopachys



female (retrieved from SV)

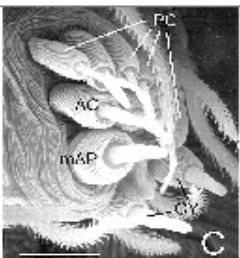


female (retrieved from SV)

States of Character 629

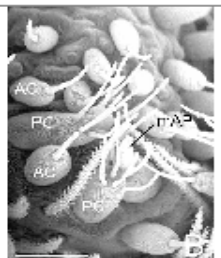
Character: PMS paracribellar shafts insertion ID01662
Refers to the number of shafts that arise from a base. qqAtlas char93qq

State 0 (single)



One shaft per base. Type taxon: Lathys_humilis

State 1 (grouped)



Few to several shaft arise from an enlarged base. Type taxon: Stiphidion_facetum

Character Annotations

Source: RamDio.264 (Jonathan Coddington)

Character state images & text

AToLMatrixJZFused0706041.nex

File Edit Characters Taxa&Trees Matrix Select Cell_Info State_Info Collaboration Analysis Window Help

Project of "AToLMatrixJZFused0706041.nex" Taxa "JungxiaGenera" Character Matrix "JungxiaMatrix" StateNames (JungxiaMatrix) Characters "JungxiaMatrix" Character sets of Jungxia

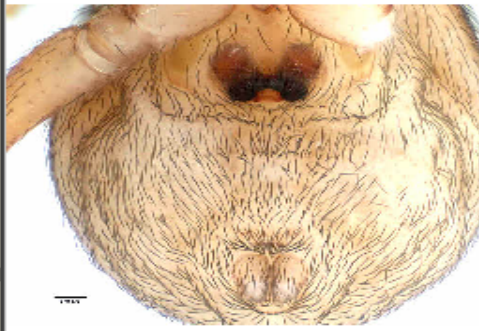
Graphics Text Parameters Modules Citations Search Features

Taxon \ Character	PL	PL	An	Su	An	Abdc	He	He	Fe	Ep	Ep	Sc	Ep	Co	Co	Ep
247 Trachelas	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
248 Trachelas New World	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
249 Trachelopachys	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
250 Chumma	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
251 Ammoxenus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
252 Cithaeron	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
253 Galianoella	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
254 Meedo	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
255 Neato	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
256 Doliomalus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
257 Platyoides	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
258 Asadipus	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
259 Centrothele	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
260 Lamponidae Transkei	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
261 of Moreno	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
262 Lygromma	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
263 Molyoria	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
264 Neozimiris	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
265 Texas of Prodidomidae	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
266 Apodrossodes	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
267 Camillina	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
268 Eilica	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
269 Gnaphosa	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
270 Micaria	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?

690. Epigynum ID02694: (0) abs; (1) pres;

Character 690 in taxon Chumma

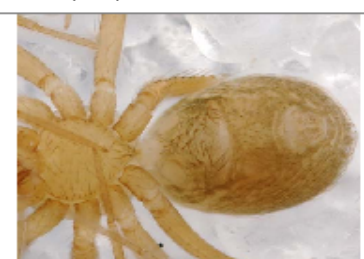
Epigynum ID02694 in Chumma



female (retrieved from SV)


Character: Epigynum ID02694
Any sclerotized modification of the cuticle around the female genital region. qqAtlas char 131qq

State 0 (abs)



Cuticle around genital region similar to surrounding. Type taxon: Archioleptoneta

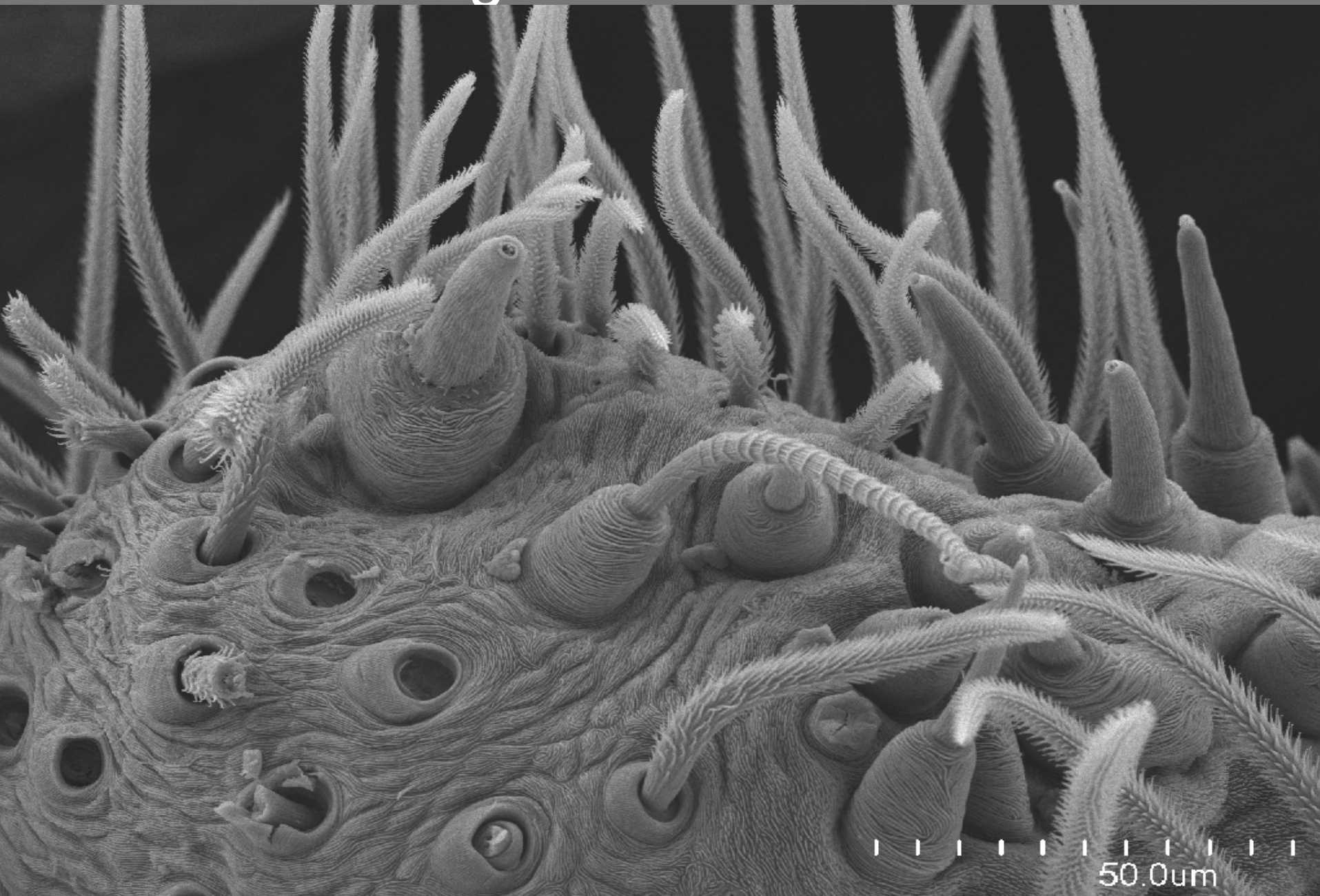
State 1 (pres)



"Cuticle around genital region sclerotized, contrasts to surrounding, may or may not have elaborate processes. Type taxon: "

Character Annotations
Source: n67.040 c55.115 m72.026

Double click: High resolution



Zoom in, move around, etc.

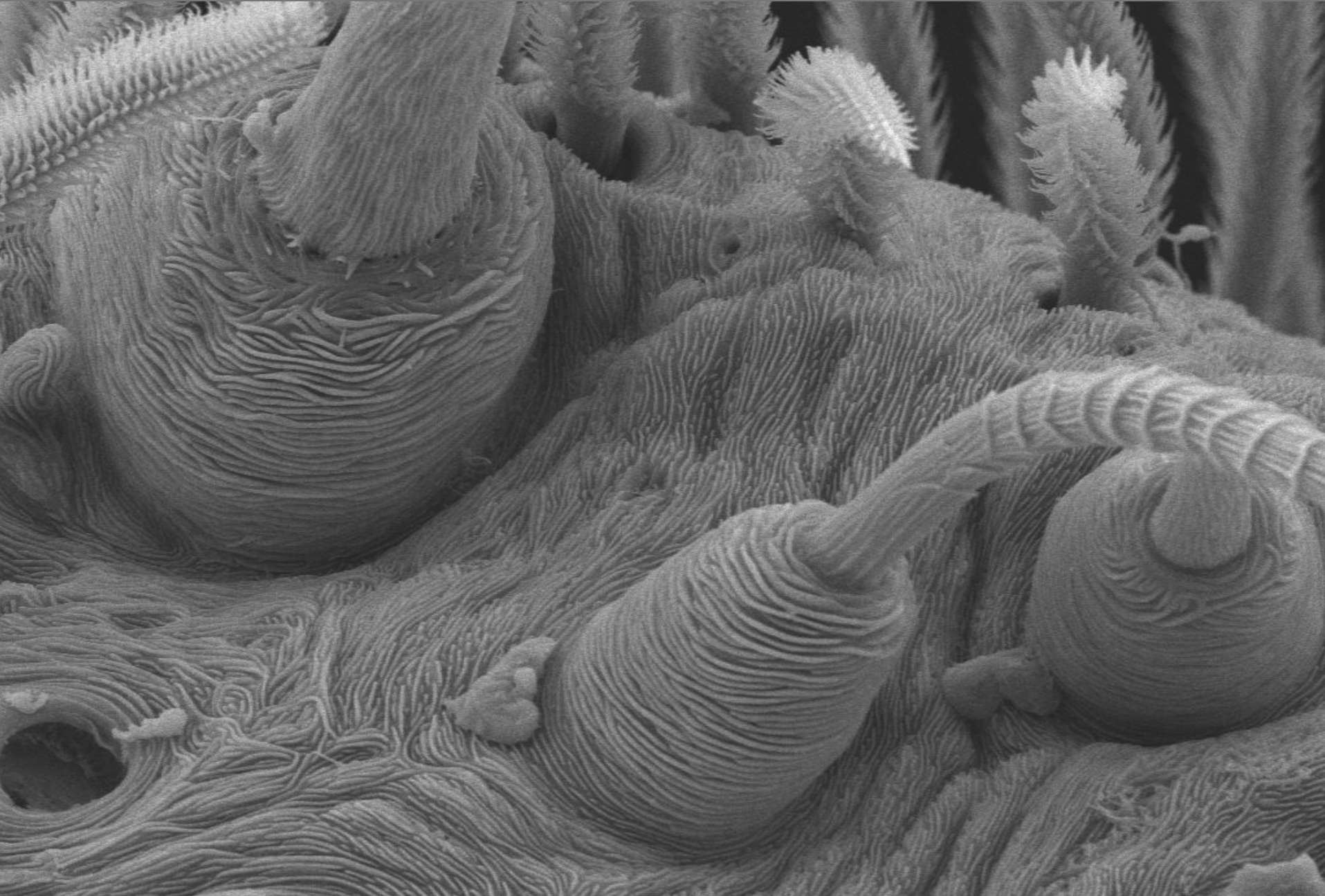


Image database: Metadata

The screenshot displays the IMatch software interface. On the left, a hierarchical tree shows folders organized by taxonomy, including Caponiidae, Cithaeronidae, Clubionidae, Corinnidae, Brachyphaea, Castianeira, Copa, C_flavoplumosa, C_indet_Analamazaotra, Corinna, Creugas, Falconina, Mandaneta, Medmassa, Meriola, Oedignatha, Paccius, Procopius, Pseudocorinna, Trachelas, Trachelas New World, Trachelopachys, Ctenidae, Cyatholipidae, Cybaeidae, Cycloctenidae, Deinopidae, Desidae, Dictynidae, Drymusidae, Eresidae, Filistatidae, Gallieniellidae, and Gnaphosidae. The center panel shows a grid of image thumbnails, with the third thumbnail (373aSpermatheca...) selected and highlighted with a red border. The right panel displays a detailed metadata table for the selected image.

IDImageInAccess	3,888
Magnification	130
AcceleratingVoltageV	10,000
EmissionCurrentNA	6,000
WorkingDistanceUm	24,700
SignalName	SE(M)
Vacuum	High
MicronMarkerNm	400000
SpecimenBias	1
SpotSize	0
Author	Martin J. Ramirez
LocationPlace	New York
LocationInstitution	AMNH
TaxFirstBin	Copa
TaxBin	Copa flavoplumosa
Genus	Copa

At the bottom of the interface, there are tabs for Properties, IPTC, EXIF, Categories, XMP, and User profiles (User 1, User 2, User 3). The status bar at the very bottom shows the file path: H:\Data\Ramirez_I\Projects\ATOL\ATOL_DataFolder\ATOLImages\HighRes\Corinnidae\Copa\C_flavoplumosa\ff\373aSpermathecae.jpg [WD

Image
Resolution
Microscope settings
Author ...

Preparation
Critical point dried
Coated ...

Voucher
Locality
Museum ID ...

Taxonomy
Species etc.
Identified by / date ...

Image metadata: Anatomical IDs

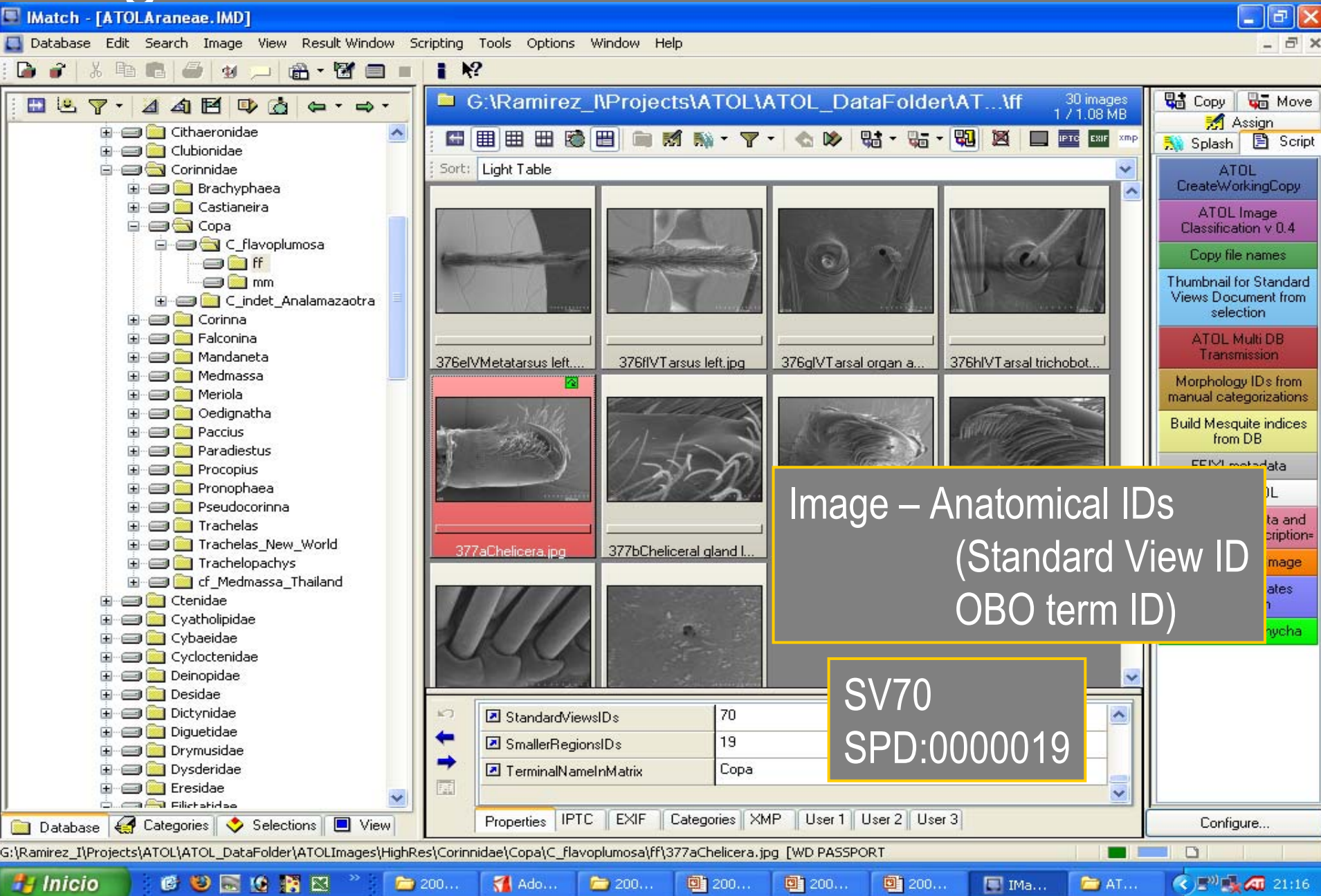


Image – Anatomical IDs
(Standard View ID
OBO term ID)

SV70
SPD:0000019

Images on the anatomical ontology

IMatch - [ATOLAraneae.IMD]

Database Edit Search Image View Result Window Scripting Tools Options Window Help

Morphology

- whole organism
- cephalothorax
 - SV
 - color
 - cuticle
 - labrum
 - labium
 - sternum
 - pleural area
 - carapace
 - appendages cephalothorax
 - leg articles multiple
 - color
 - chelicera
 - female palp
 - male palp
 - leg I
 - leg II
 - leg III
 - leg IV
 - setae appendages cephalothorax
 - hairs
 - scales
 - scopula
 - claw tuft
 - chemosensory setae
 - trichobothria
 - trichobothrial seta
 - trichobothrial socket
 - SV
 - Trichoboth socket SEM {353}
 - trichobothrial patterns
 - macrosetae

Trichoboth socket SEM {353}
trichobothrial socket: proper view (SEM)

393 images

Sort: Light Table

03050227.jpg 03051311.jpg 03051312.jpg 1003glLeft tarsal trich...

1020cltarsal trichobot... 1020plMetatarsus tric... 105bltarsal trichobothi... 12elVtarsus trichobothi...

13bpalpal tibia trichob... 13cpalpal tibia trichob... 14(4) Uroctea FF leg1 ... 152cBrachSim dT arsu...

Database Categories Selections View

Copy Move Assign Splash Script

ATOL CreateWorkingCopy

ATOL Image Classification v 0.4

Copy file names

Thumbnail for Standard Views Document from selection

ATOL Multi DB Transmission

Morphology IDs from manual categorizations

Build Mesquite indices from DB

FEIXLmetadata

scales ATOL

Check basic data and r=Copyright=Description=

Input Data for Image

ATOL char states typification

Thumbnail Dionycha

Configure...

G:\Ramirez_I\Projects\ATOL\ATOL_DataFolder\ATOLImages\HighRes\Amaurobiidae\Amaurobius\A_similis\ff\03050227.jpg [WD PASSPORT :]

Inicio 200... Ado... 200... 200... 200... 200... IMa... AT... 21:41

Characters annotated with Anatomical IDs

AToLMatrixJZFused0706041.nex

File Edit Characters Taxa&Trees List Columns Analysis Window Help

Project of "AToLMatrixJZFused0706041.nex" Taxa "JungxiaGenera" Character Matrix "JungxiaMatrix" StateNames (JungxiaMatrix) Characters "JungxiaMatrix" Character sets of JungxiaMatrix

Graphics Text Parameters Modules Citations Search Features

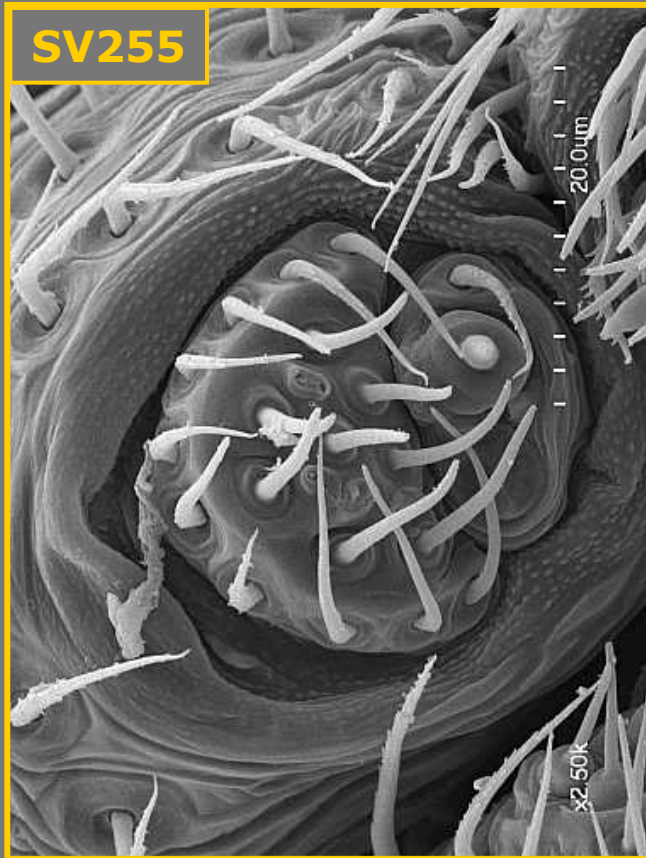
Character	Default	Inc	Group	Probability Model	ID	Standard View
242 Endite medial surface glands ID00572	240	✓	Endites	Mk1 (est.)	ID00572	SV77
243 Maxillary glands disposition ID03072	241	✓	Endites	Mk1 (est.)	ID03072	SV77
244 Palpal coxal hairs ID00736	242	✓	Endites	Mk1 (est.)	ID00736	SR242
245 Cuspules extending onto heel ID00560	243	✓	Endites	Mk1 (est.)	ID00560	SV78
246 Endite ventral surface ID00574	244	✓	Endites	Mk1 (est.)	ID00574	SV78
247 Palpal femur proximodorsal area ID00596	245	✓	Palp	Mk1 (est.)	ID00596	SV361
248 Palpal femoral prolateral surface ID00589	246	✓	Palp	Mk1 (est.)	ID00589	SV361, SV88
249 Short medially thickened female palpal tarsus ID00617	247	✓	Palp	Mk1 (est.)	ID00617	SV99
250 Female palpal tarsus chemosensory scopula on apical truncate	248	✓	Palp	Mk1 (est.)	ID00620	SV103, SV97
251 Palpal tarsus apical setae ID00622	249	✓	Palp	Mk1 (est.)	ID00622	SV103
252 Female palpal tarsus ventral lateral setae ID00623	250	✓	Palp	Mk1 (est.)	ID00623	SV103
253 Blunt seta at side of claw ID00647	251	✓	Palp	Mk1 (est.)	ID00647	SV103
254 Female palpal tarsus dorsal chemosensory scopula ID00619	252	✓	Palp	Mk1 (est.)	ID00619	SV103
255 Palpal tarsal tip ID00642	253	✓	Palp			
256 Palpal claw size ID00644	254	✓	Palp			
257 Shape of palpal claw apex truncate ID00645	255	✓	Palp			
258 Palpal claw form ID00646	256	✓	Palp			
259 Palp claw reduced to nubbin ID14101	257	✓	Palp			
260 Palpal claw tooth count ID14102	258	✓	Palp			
261 Palpal tarsus muscle M29 ID03110	259	✓	Palp			
262 Endite sexual dimorphism (placeholder) ID00545	260	✓	Palp	Mk1 (est.)	ID00545	SV78
263 Palpal coxa tibia apophysis surface(MM) ID00731	261	✓	Palp	Mk1 (est.)	ID00731	SV25, SV323
264 Palpal femur retrolateral surface (MM) ID01709	262	✓	Palp	Mk1 (est.)	ID01709	SV304, SV315
265 Retrolateral femoral apophysis of (MM) palp ID01710	263	✓	Palp	Mk1 (est.)	ID01710	SV304, SV315
266 Palpal femur ventral proximal surface (MM) ID01712	264	✓	Palp	Mk1 (est.)	ID01712	SV304, SV315
267 Palp femur ventral apical apophysis (MM) ID01713	265	✓	Palp	Mk1 (est.)	ID01713	SV304, SV315

Char ID – Anatomical IDs
(Standard View ID
OBO term ID)

Standard View

Inicio E... Z... A... M... U... A... A... C... M... A... 16:38

Standard Views



A combination of specific:

- **Ontology term**
- **Sex and life stage**
- **Orientation**
- **Device and preparation technique**

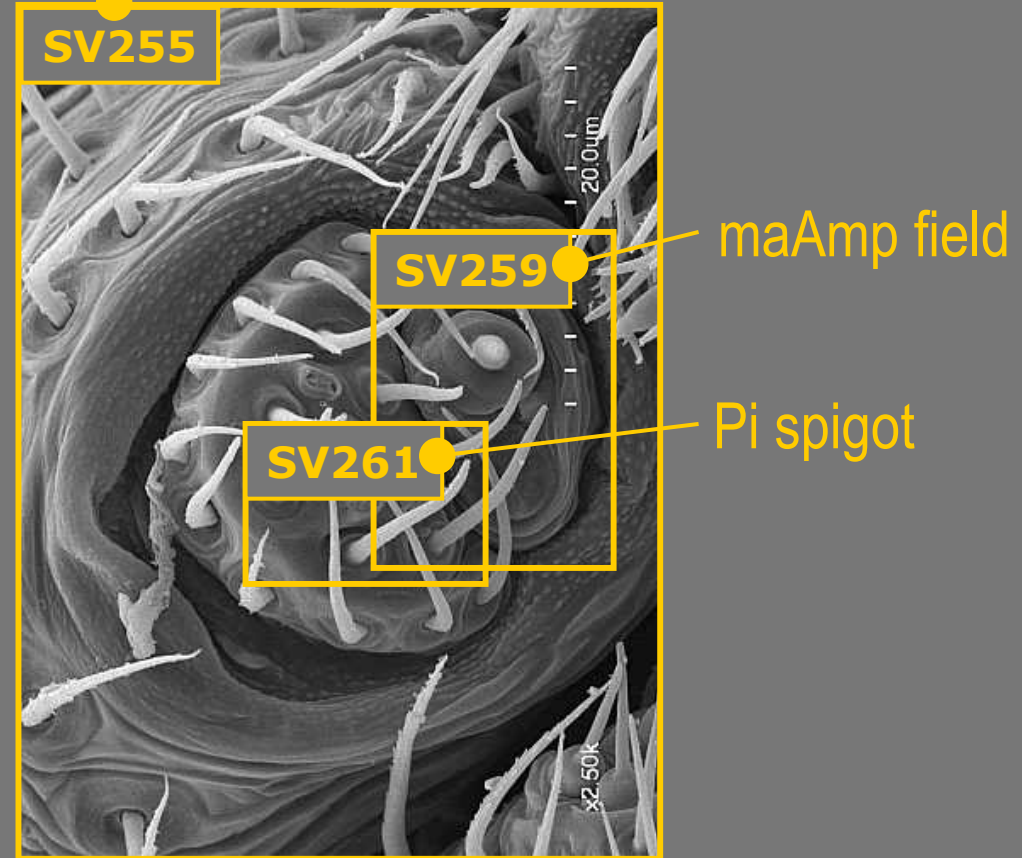
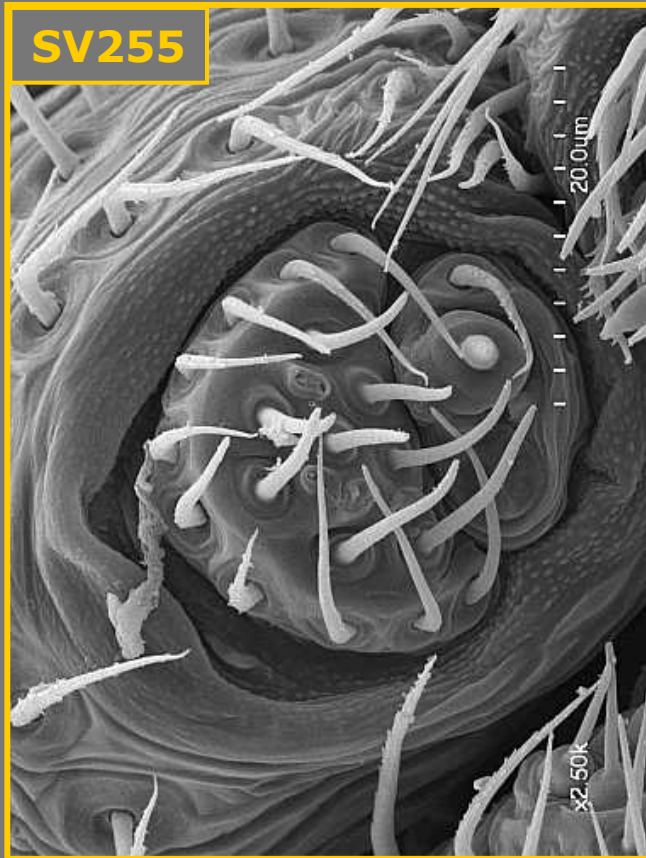
SV255: Male ALS spinning field SEM:

- **Anterior lateral spinneret (SPD:0000125)**
- **Adult male**
- **Ventral**
- **SEM**

Images are annotated as they are produced

Multiple SVs in one image

ALS spinning field



A **high resolution** image may serve multiple standard views (by zooming in)

Simple query to populate cells with images

Cell = Character X, Terminal Y

For Character X – Retrieve Anatomical IDs W (SVs, OBO IDs)

Cell images =

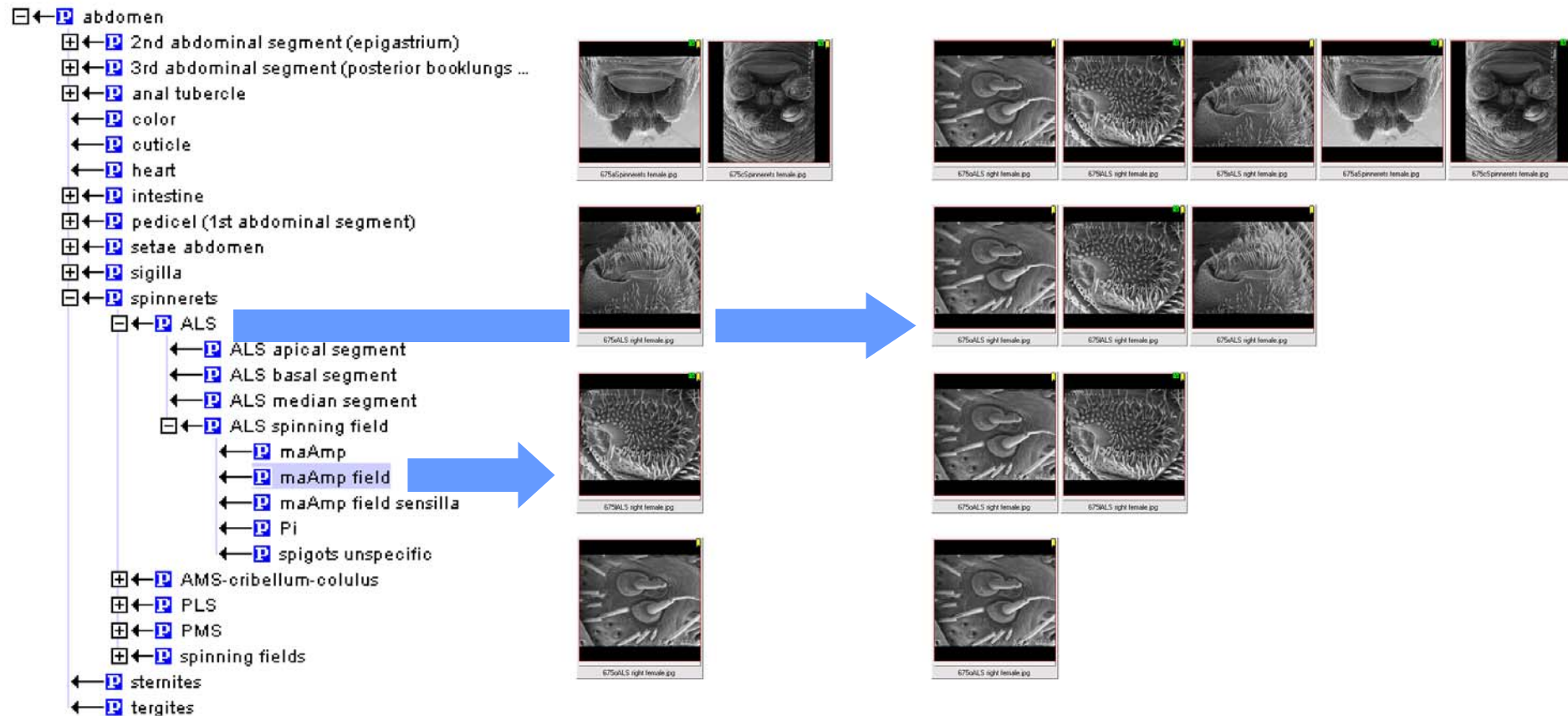
For Terminal Y – Retrieve images tagged with Anatomical IDs W

Next: Intelligent algorithms to fetch images

1. The basic:

Fetch parent terms for broader selection

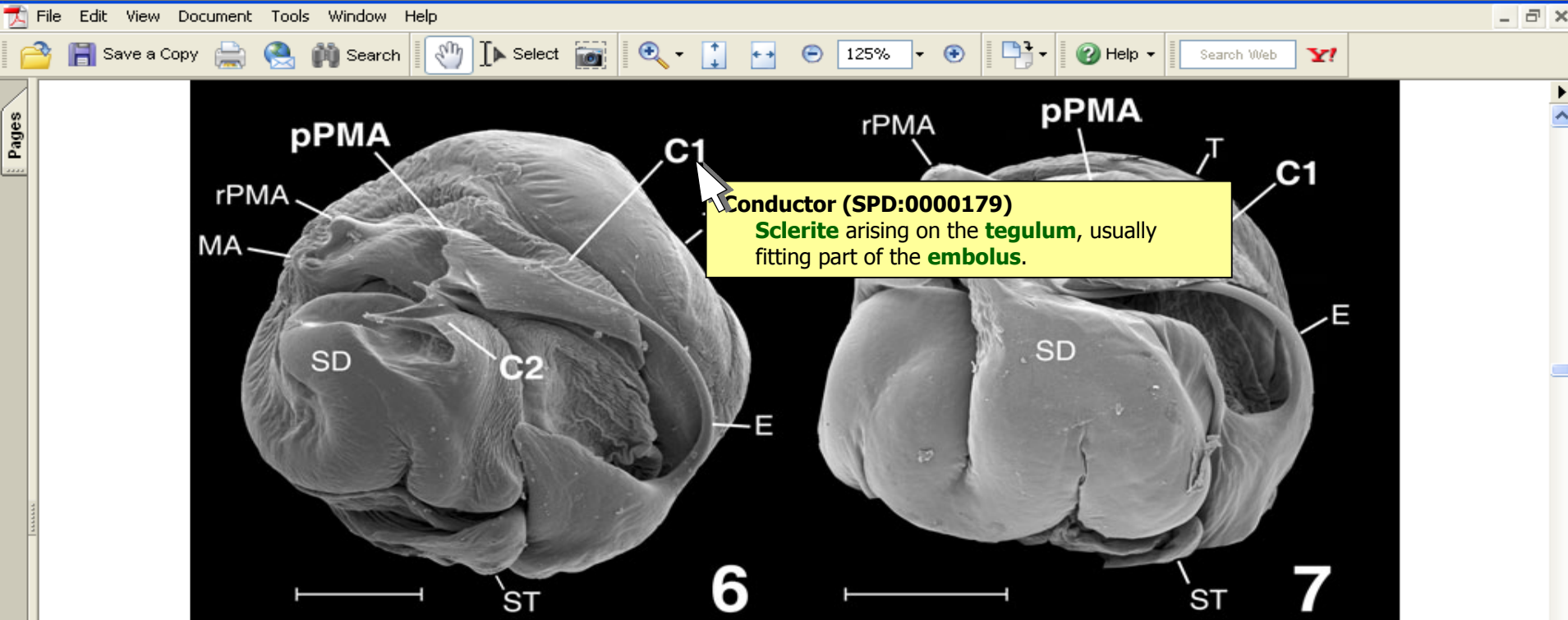
Fetch parent term if child does not retrieve images



2. Process feedback from users ...

Future: Links to OBO from PDF, HTML, ...

Morphster, working on labels. HymAToL on ontology-driven text recognition



Figs 4–7. Left copulatory bulbs of Amaurobioidini. 4. *Gamakia hirsuta* Ramírez. 5. *Coptoprepes flavopilosus* Simon. 6. *Ferrieria echinata* Simon. 7. *Ayseoides colecole* Ramírez. (C1 = primary conductor; C2 = secondary conductor; E = embolus; MA = median apophysis; pPMA = prolateral cusp of paramedian apophysis; rPMA = retrolateral cusp of the paramedian apophysis; SD = sperm duct on distal tegulum; ST = subtegulum; T = tegulum.) Scale bars = 0.1 mm.

some sclerites are missing in certain species. Between major groups, however, the correspondences are unclear. In Ramírez (2003) I made a thorough morphological examination of many representatives using an scanning electron microscope. expansions and dissec-

studies, especially the positional criterion, admitting that the election was to some extent arbitrary. Under an alternative schema of correspondences (Ramírez, 2003, p. 50), the C1 as identified in Gayennini could be homologous to the nPMA as identified in Amaurobioidini.

AToL Spider project, as of today

31,588 images, **62,121** anatomical annotations

910 characters (processed 4395 chars. from 67 datasets)

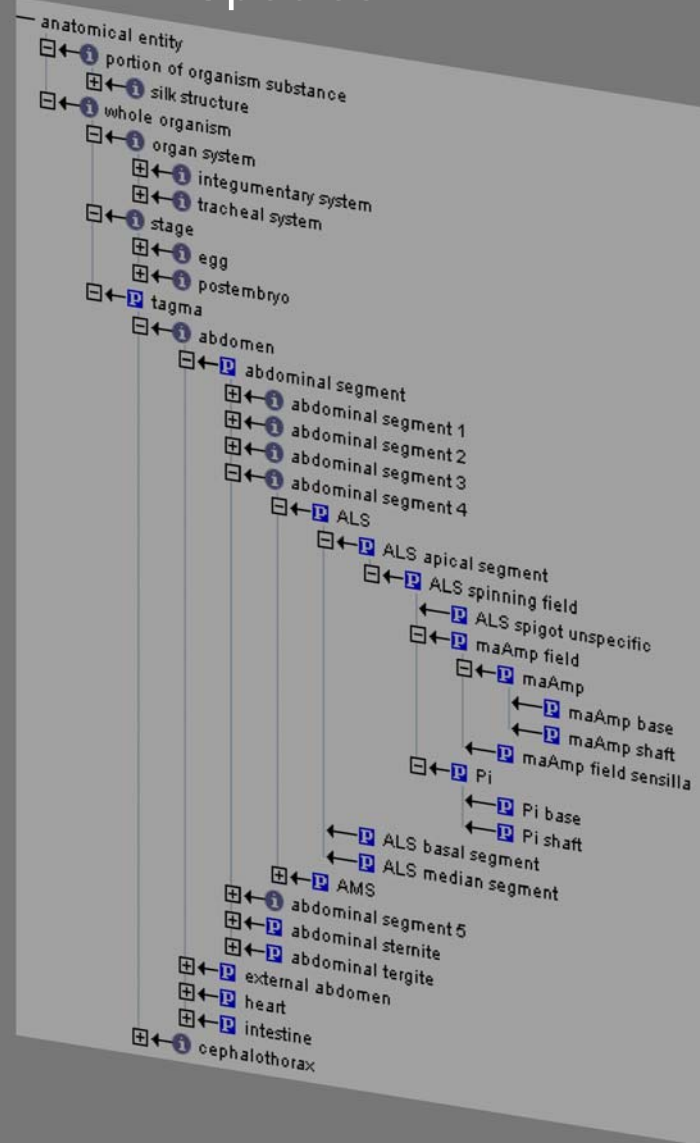
450 ontology terms (to accommodate characters).
Not only anatomy.

growing quickly...

Preparing migration to MorphBank

Documentation – Accumulation – Efficiency

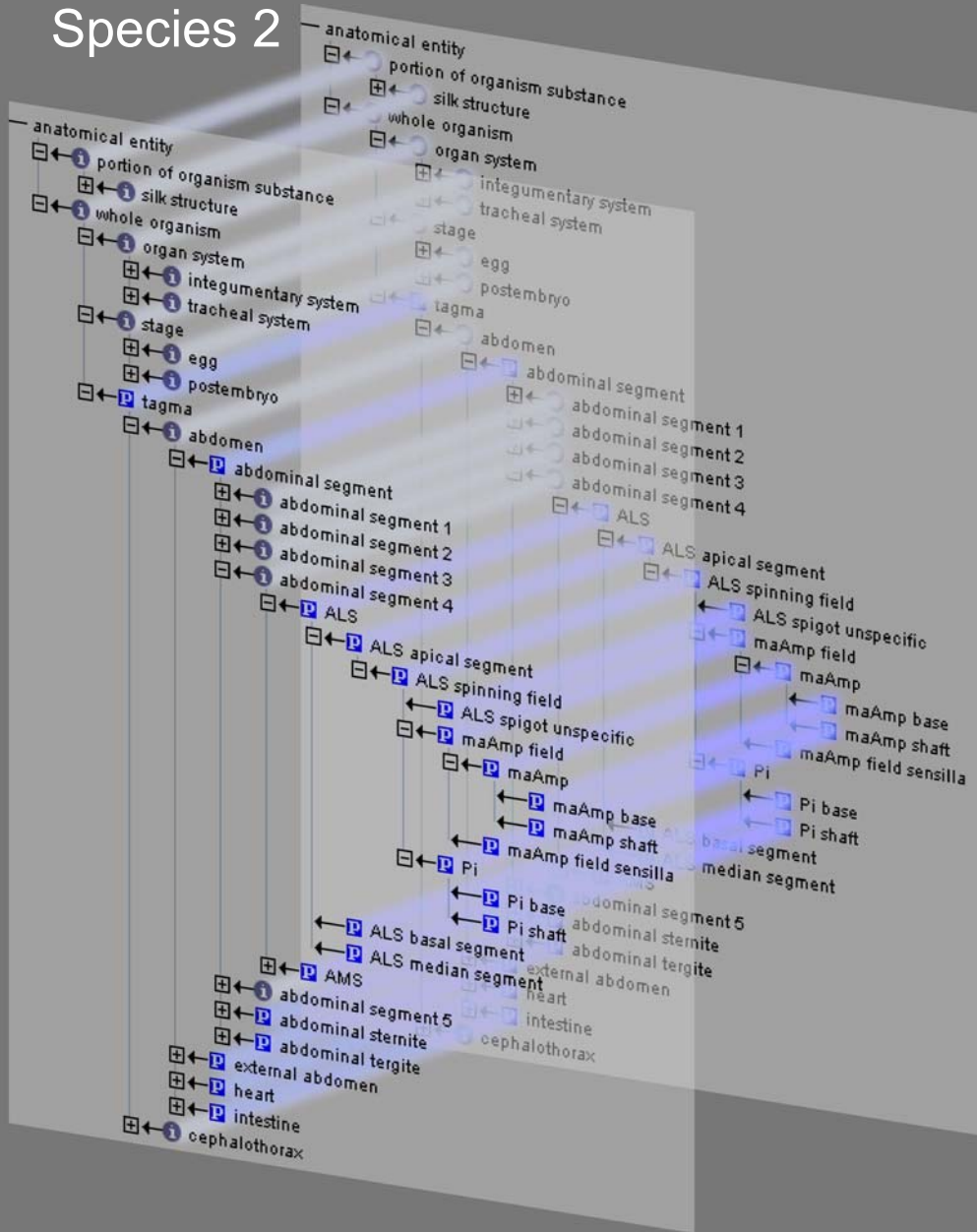
... Species n



Aligned ontologies

Species 2

Species 1



Aligned by homology relations

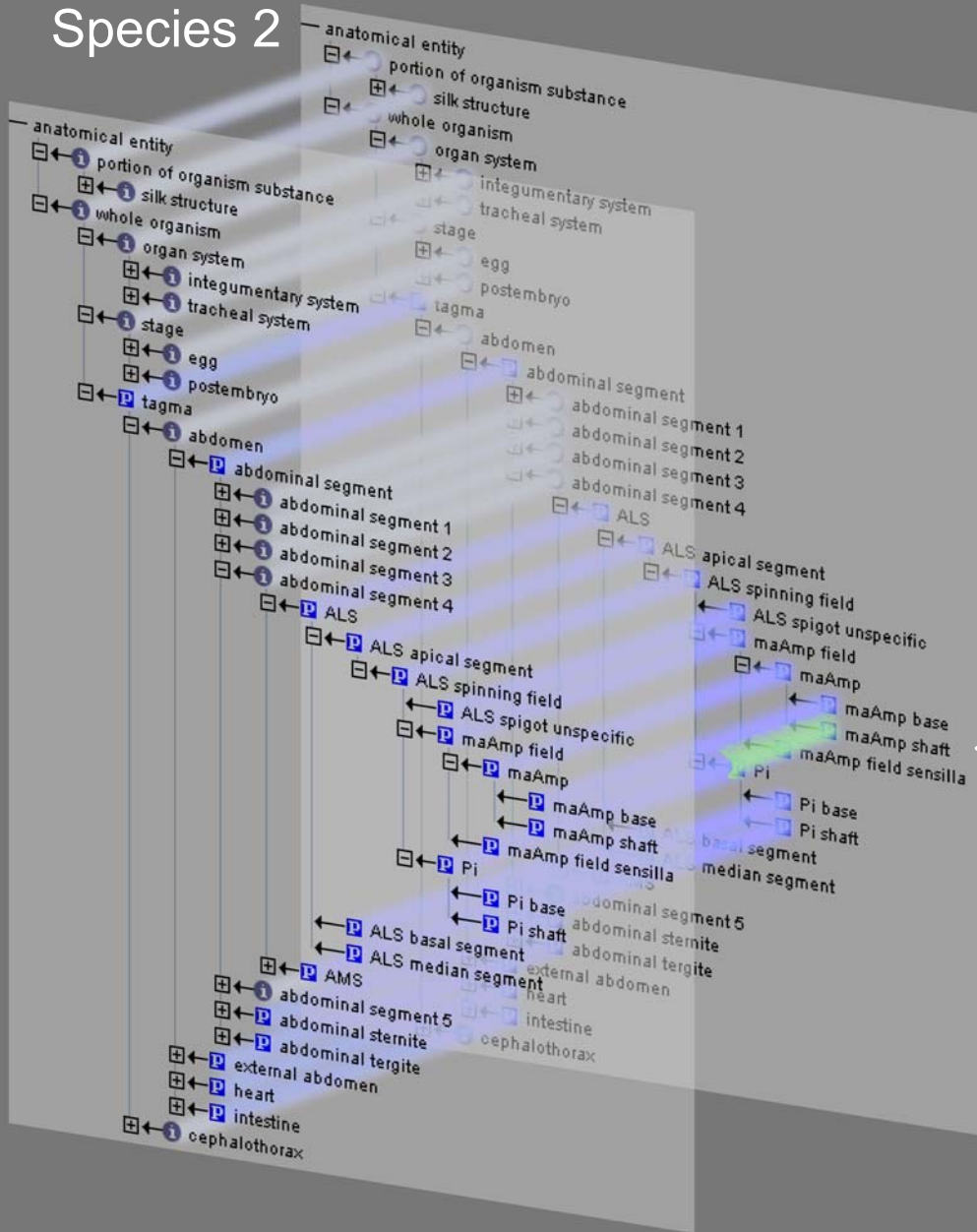
Contrasting with single-species ontologies, homology is mandatory

Otherwise, every term repeated for each species (or specimen!)

Transformation

Species 2

Species 1

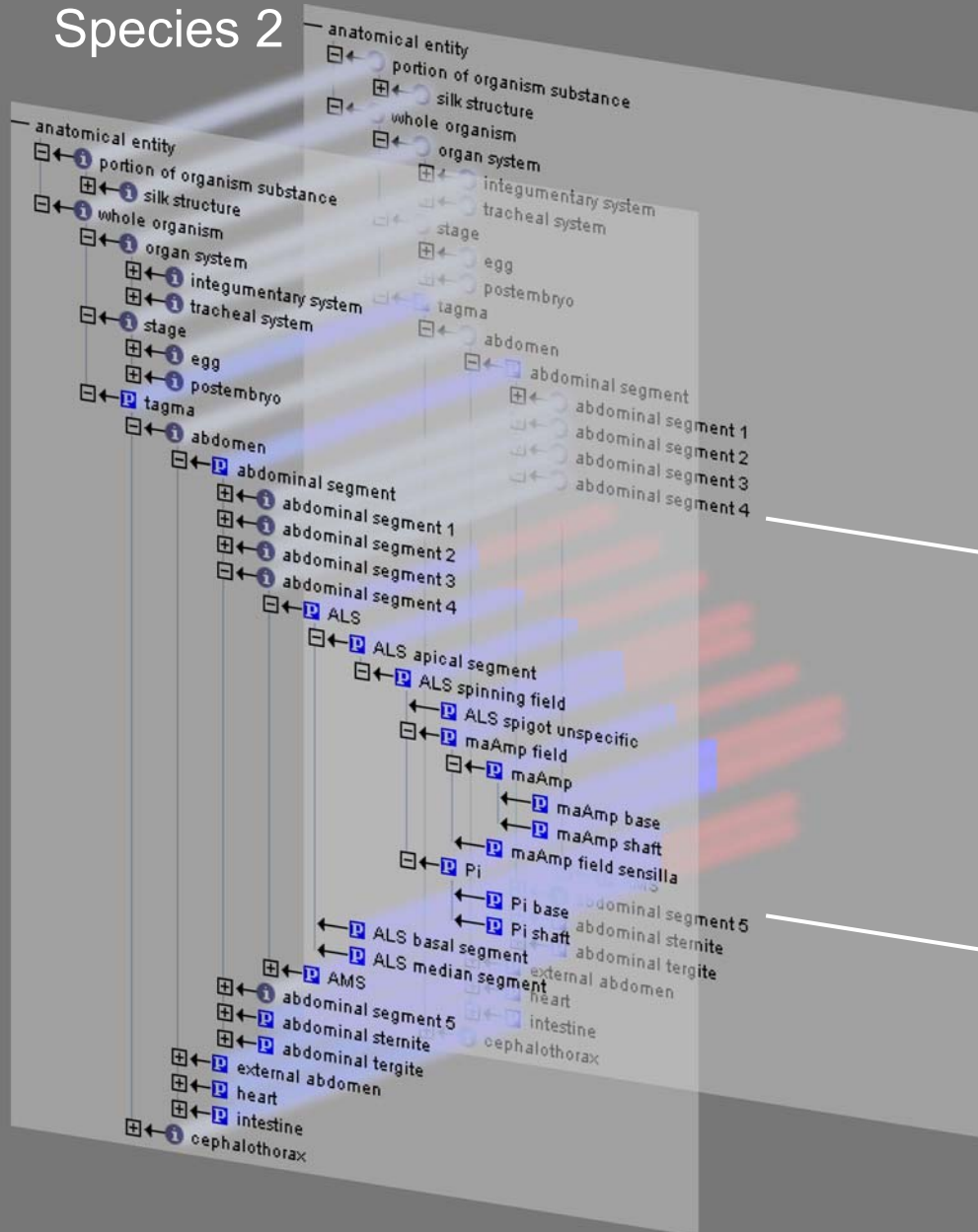


← ALS maAmp shaft transformed

Gains and losses

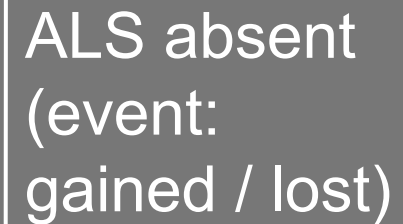
Species 2

Species 1



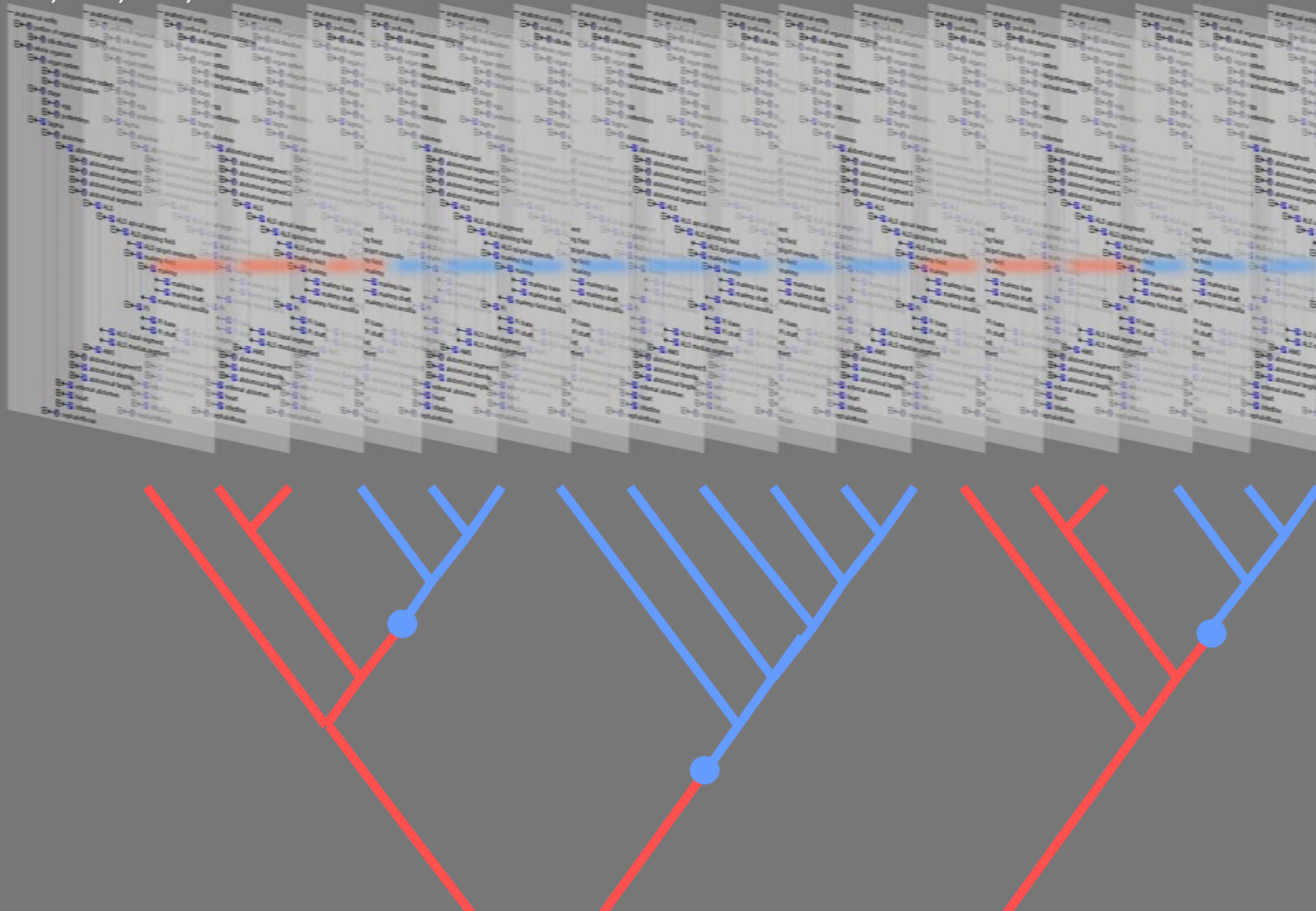
ALS absent

Species 1



Many options for the “same” term...

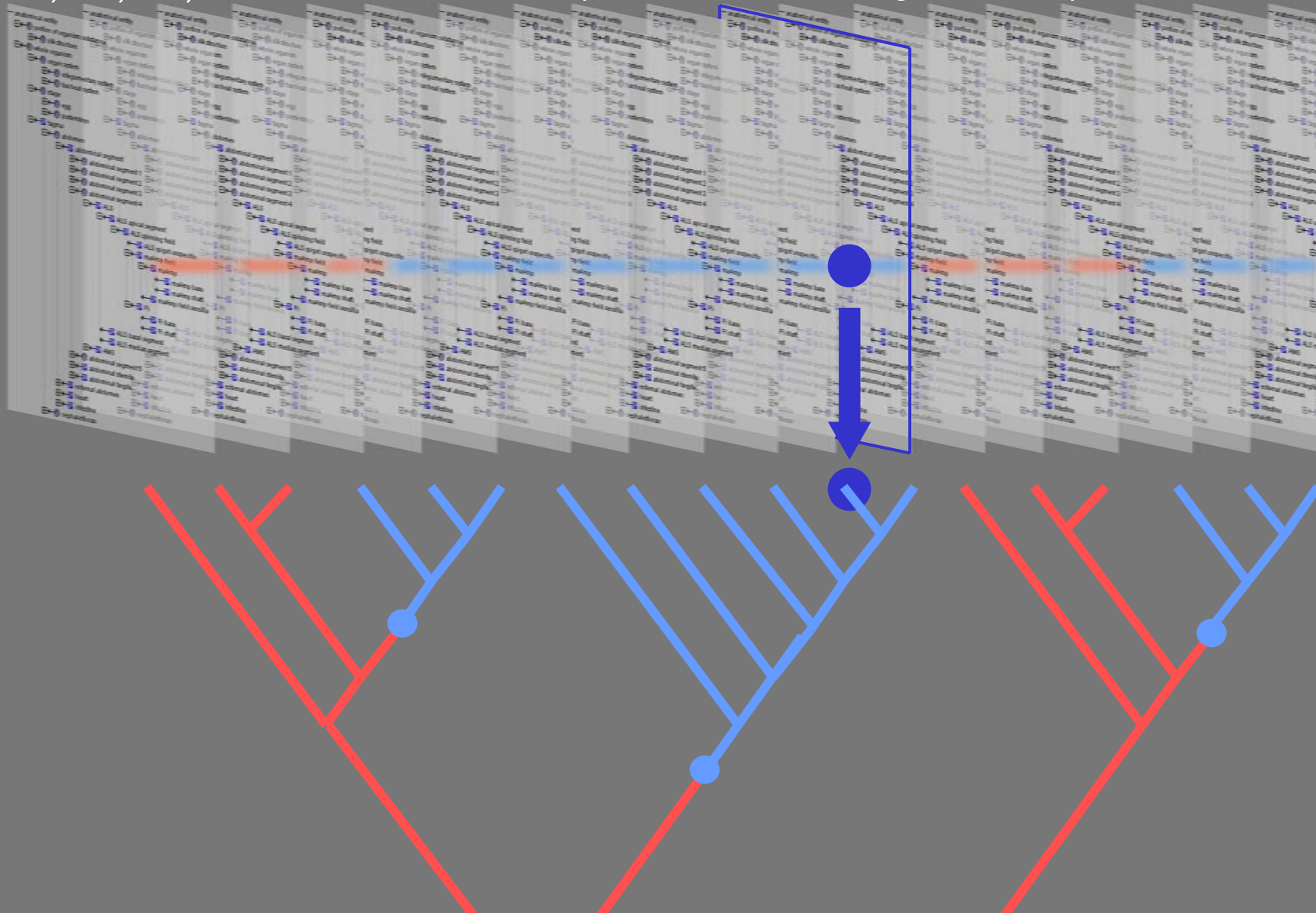
Species 1, 2, 3, ...



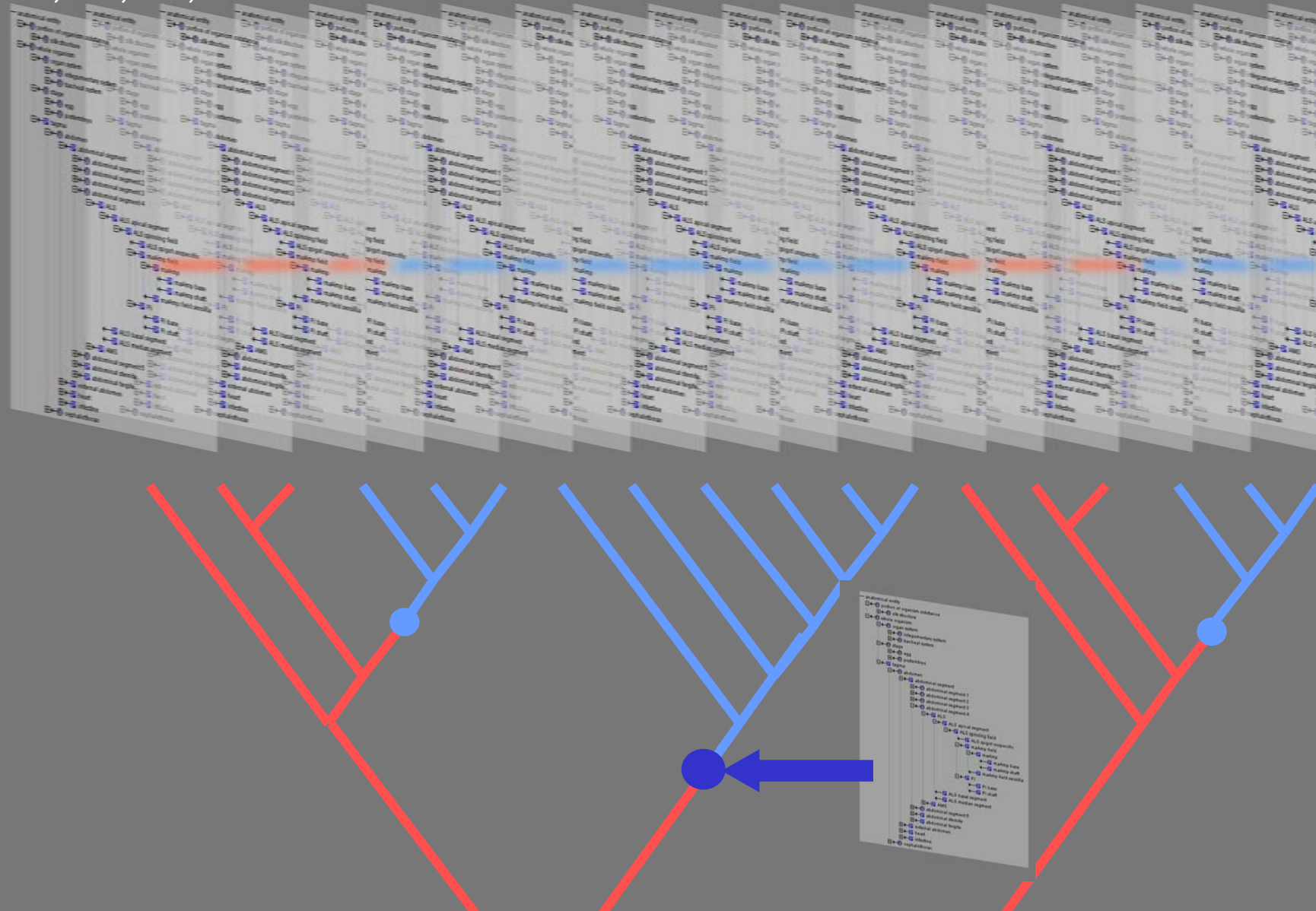
Typification

Species 1, 2, 3, ...

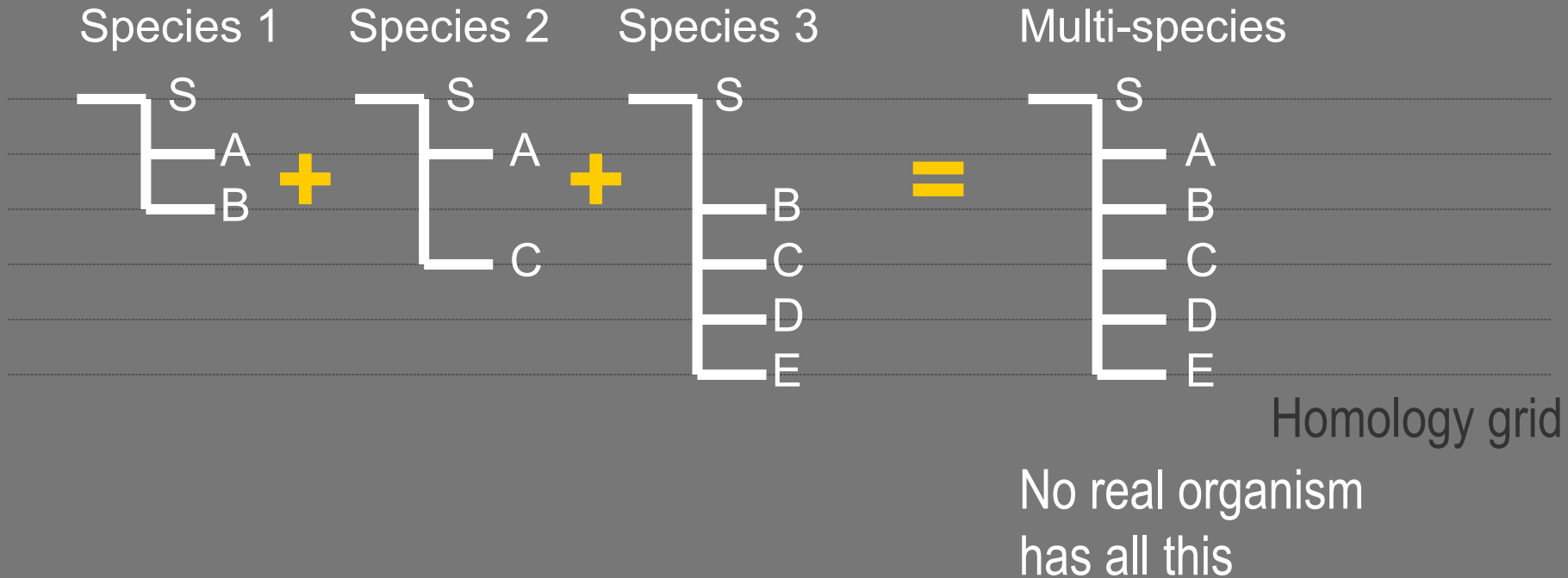
Fix meaning of terms by choosing
one species as reference
(Scharff & Coddington 1997)



Species 1, 2, 3, ...



Combinable components



Silk spigot types:

Pkf, Agg, Ac, Pi, maAmp, miAmp, Fg, Psg, MS, ...

Open question: What if they cannot be combined?

Pragmatism

Many conceptual issues left unsolved. For example, are we using several different meanings for “**is_a**”?

Leg IV **is_a** Leg

Leg IV **is_a (serial homolog of a)** Leg

Macroseta **is_a** Seta

Macroseta **is_a (modular homolog of a)** Seta

Tracheal system **is_a** Organ system

Tracheal system **is_a (granular level)** Organ system

part_of... according to external vs. internal anatomy?

part_of... according to body segment, or to (segmented) organ?

Ontologies: What we systematists can get?

- Document and share our data

 - Image a second species, not one species for the second time

 - Community feedback

- Curation of our data

- Permanent repository

- Accumulation of knowledge

- Expert contribution from research on model organisms

What we systematists can contribute?

A science of diversity



Diversity
Distinctiveness
Unique historical events

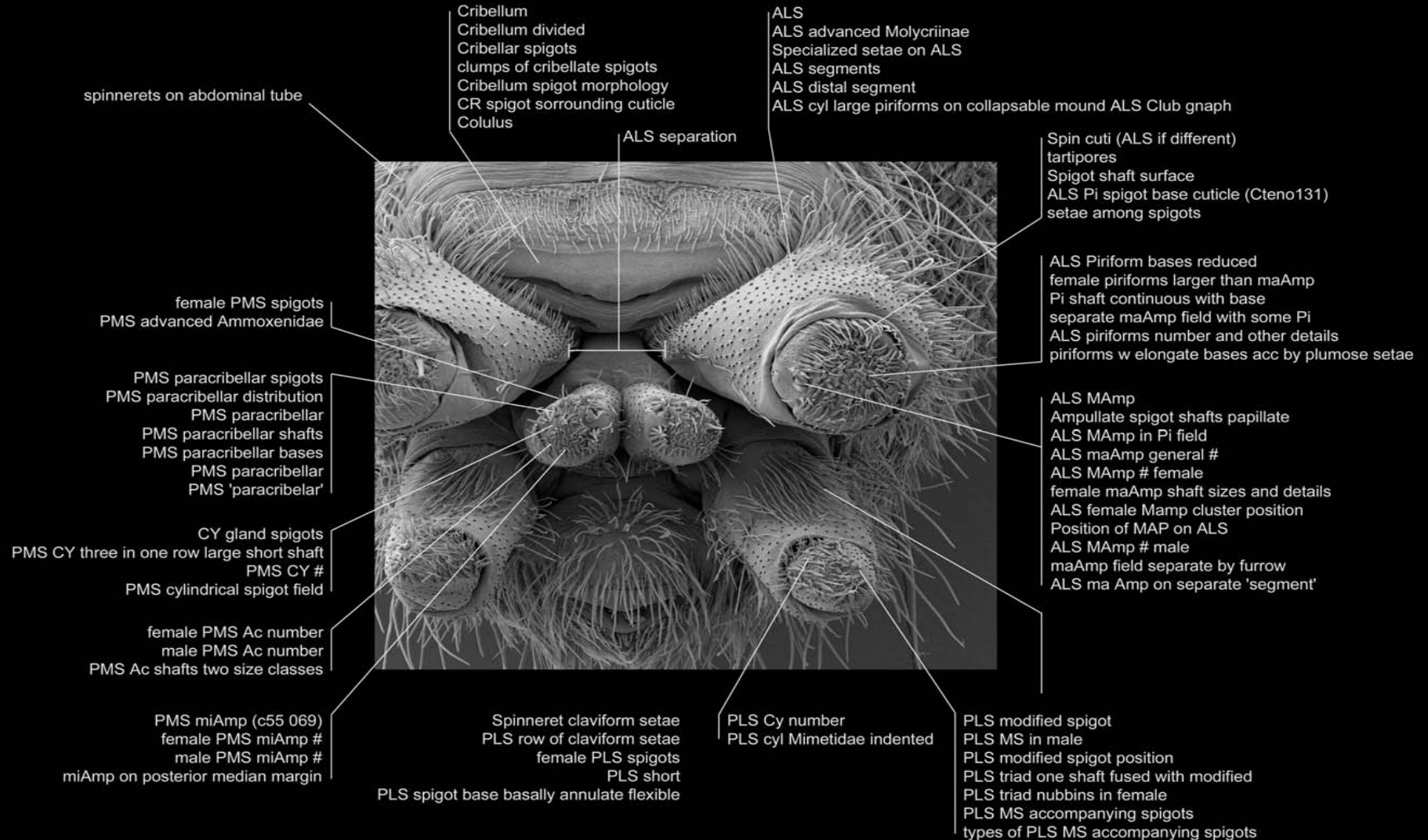
vs. generalization

A privileged access to diversity



Voucher localities for *Dionycha* study

The atomization of the organism in characters



Combing across diversity

If scorings in phylogenetic datasets
were processed as annotations,

Modest dataset

50 species, 100 characters
→ 5,000 annotations

Large datasets

150 species, 400 characters
→ 60,000 annotations

500 species, 2000 characters
→ 1,000,000 annotations

Plus: Homology annotations & combinatory

Future: Provide an environment for
the sytematics community to map
their data to ontologies

Summary

The ontology is a powerful schema to
Annotate images
Retrieve relevant images,
open to more elaborate algorithms
Organize workflow

Ontologies can bridge the communities of model organisms and
of diversity

A common problem: The mechanistic causes of the diversity of
morphology

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