Imaging Techniques in the study of Fossil Spiders

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Characters in Modern Spiders

LEFT: anatomy of a female spider

BELOW: male spiders have no epigyne and their pedipalps are modified for sperm transfer

spinnerets
epigyne
sternum
chelicerae
pedipalp
**Characters in Modern Spiders**

The image shows structures such as:

- **Calamistrum**: A calamistrum is a row of curved bristles on the fourth leg in some spiders. These spiders also possess a **cribellum**, a plate with tiny spigots in front of the spinnerets.

- **Tarsal claws**: The tarsal claws of web-weaving spiders are depicted in the image, along with other structures such as paired claws, claw teeth, unpaired claw, accessory claws, and silk thread.
Characters in Modern Spiders

- A: plumose and feathery setae
- B: trichobothria base
- C–E: tarsal claws and accessory claws

LEFT: macrosetae, taste hairs and trichobothria (1–3)
Setal Ultrastructure

Examples:
- Uloboridae
- Deinopidae
- Megadictyna
- Filistatidae
- Hypochilidae
- Austrochilidae
- Uloboridae
- Deinopidae
- Thaida
- Nephilidae
- Araneidae
- Tetragnathidae
Paleoarachnological Research

- The fossil record
  - preservation in amber
  - rock matrix preservation
- Research techniques
  - use of modern techniques to extract the most information
- Interpretation
  - knowledge of arachnology
  - cladistic methods
Fossil Record

- Preservation in amber is generally good

- but features can be obscured, e.g. by other inclusions, or missing
Fossil Record

- Rock-matrix preservation can be very poor
- But the mere presence of a spider suggests exceptional circumstances of preservation
- Spiders are indicators of Fossil-Lagerstätten
- LEFT: spider in Miocene diatomite of New Zealand
Fossil Record

- Rock-matrix preservation can sometimes be extremely good
- LEFT: male palps on a Jurassic spider from Daohugou, China
- Modern palp
Fossil Record

- Rock-matrix preservation can sometimes be extremely good
- LEFT: male palps on a Jurassic spider from Daohugou, China

under alcohol
Fossil Record

- Female theridiosomatid from Cretaceous of Russia
- Epigyne shows internal ducts (BELOW)
Amber Spiders

- Light microscopy is commonly sufficient to get fine details from amber spiders
- Cretaceous amber spiders showing trichobothria
Amber Spiders

- Spatulate hairs typical of palpimanoids
- RIGHT: Cretaceous amber palpimanoid
- BELOW: modern *Palpimanus*
Z-stacks now get over the problem of narrow depths of field
Amber Spiders

Z-stacks now get over the problem of narrow depths of field.
Amber Spiders

Amber may be opaque, or morphology obscured, so x-ray CT scanning can help: Cretaceous amber *Orchestina*
Amber Spiders

- Amber may be opaque, or morphology obscured, so x-ray CT scanning can help

Modern *Orchestina* palp

Cretaceous amber *Orchestina* palp
Amber Spiders

- Internal structures can be seen too

French Cretaceous amber micropholocommatid
Amber Spiders

- Higher resolution can be obtained using synchrotron radiation

European Synchrotron Facility, Grenoble, France
Amber Spiders

- Higher resolution can be obtained using synchrotron radiation
Amber Spiders

- 3D print of CT-scanned amber spider, Cretaceous of Spain
Amber Spiders

- Resolution can be enhanced using phase contrast
- Koch & Berendt (1854) specimen from Baltic amber
Amber Spiders

Details of leg joints and tarsal claws place this specimen in Sparassidae: Eusparassinae
Details of cheliceral dentition and male palp structures place it in the modern genus *Eusparassus*.
Matrix Spiders

- At first impression, spiders in rock appear to preserve less detail than amber spiders.
- Alcohol can enhance definition.

Dry

Alcohol
Matrix Spiders

- Fine details such as tarsal claws seen using oil-immersion reflected-light microscopy
- This work done in 1980s; nowadays we can use z-stacks to expand depth of field
Matrix Spiders

High-resolution DSLR and digital image manipulation can extract very fine details from matrix-preserved spiders.
Matrix Spiders

Many images taken at high magnification can be merged into a single, high-resolution image with good depth of field.
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Matrix Spiders

- Whole specimen at high resolution
- Can zoom in and see detail
- Jurassic plectreurid from China
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Whole specimen at high resolution

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Jurassic plectreurid from China
Matrix Spiders

Helical end of embolus discovered by merging photos of part and counterpart

One of Nature magazine’s Images of the Year 2010
Matrix Spiders

A giant spider from the Jurassic of China

tibial trichobothria

Recent trichobothrial bases
Matrix Spiders

- Male fourth leg

- Tarsus
- Claws
- Macrosetae
- Calamistrum
Tarsal claws

- Paired claw
- Accessory claws
- Unpaired claw

Accessory claws
Setal ultrastructure

regular setae show outer layer of reticulate microspines (plumose)

plumose structure of macroseta

macroseta with curved tip
Juraraneus

Eskov (1984) described *Juraraneus rasnitsyni*, from the Middle Jurassic of Transbaikalia

First Jurassic spider described
Jurarineus

- Restudy of the only specimen showed it to be cribellate
- New SEM work shows plumose setae

[Images of spider and details]
Orbicularian Phylogeny

- SEM had never before been used in the study of fossil spiders.
- It has been shown to be very useful in revealing setal ultrastructure, and hence aid phylogenetic studies.

These Jurassic spiders lie near the base of the orbweaver clade, among the cribellate orbicularians.
The End

THANK YOU!

Paul Selden

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phoretic deutonymph of astigmatid mite on spider carapace, Baltic amber