Using nano-CT scanning to study novel ultrasound-producing structures across Lepidoptera

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Nano-computed Tomography (nano-CT)

- Higher-resolution version of micro-CT
Nano-computed Tomography (nano-CT)

• Higher-resolution version of micro-CT
• Higher-resolution version of regular CT
Nano-computed Tomography (nano-CT)

• Higher-resolution version of micro-CT
• Higher-resolution version of regular CT
• Non-invasive scanning of museum specimens, to create 3D model with pixel dimensions < 1 μm
Nano-computed Tomography (nano-CT)

- X-rays transmitted through a specimen
- Detector records x-rays that are not absorbed
- Software converts data to pixels
- More software creates a 2D cross section
- Rotate and repeat
• Assemble the 2D slices and convert into a 3D reconstruction

• Can selectively exclude certain body parts in order to view internal/obscured structures

Tiger moth – Melese

Iso-surface rendering
Tiger moth – Melese

Iso-surface rendering
METHODOLOGY

Virtual dissections through micro-CT scanning: a method for non-destructive genitalia ‘dissections’ of valuable Lepidoptera material

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Abstract. Since its first application to the field more than 10 years ago, micro-computed tomography (micro-CT) has been a state-of-the-art technology in the study of insect morphology and anatomy. Despite showing great potential for various types of non-destructive ‘dissections’, the method has, however, seen very limited use in...
METHODS

Virtual dissections through micro-CT scanning: a method for non-destructive genitalia ‘dissections’ of valuable Lepidoptera material

Peach fruit moth - Carposina sasakii
Identifying new sound-producing structures

- Field observations
- Electron microscopy
- Can nano-CT scanning also help locate these structures?
“The bat–moth arms race has existed for over 60 million years...” (Kawahara & Barber, 2015)
“The bat-moth arms race has existed for over 60 million years...”
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“The bat-moth arms race has existed for over 60 million years...”
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Evolution of defensive ultrasound production in moths
Evolution of defensive ultrasound production in moths

- Sphingidae – abdominal scales
Evolution of defensive ultrasound production in moths

- Sphingidae – abdominal scales

- Erebidae: Arctiinae – thoracic tymbals
Identifying new sound-producing structures

Pyralidae/Crambidae—dorsal thoracic scales

Barber et al. (in prep.)

Axel Hausmann, SNSB (2010)
Identifying new sound-producing structures

Pyralidae/Crambidae–dorsal thoracic scales

Barber et al. (in prep.)
Identifying new sound-producing structures

Erebidae: Calpinae – ventral abdominal scales
Identifying new sound-producing structures

- Field observations
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Identifying new sound-producing structures

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  MAYBE!!!
Marthula (Noctuoidea: Notodontidae)

Abdomen moves during ultrasound production, but no correlated structures observed with regular microscopy or SEM.
Notodontidae – Marthula

Iso-surface rendering
Notodontidae – Marthula

Volumetric rendering
Search for less dense cuticle – possible evidence of ultrasound production
Search for less dense cuticle – possible evidence of ultrasound production
Nano-CT offers new avenues for exploring insect biodiversity and morphological variation

Useful tool for developing new hypotheses
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